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**ERUPTION CYCLES AND MAGMATIC PROCESSES AT
A REAWAKENING VOLCANO,
MT. TARANAKI, NEW ZEALAND**

A thesis presented in partial fulfilment of the requirements for the
degree of

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Mt. Taranaki viewed from the north, March 2006.

Abstract

Realistic probabilistic hazard forecasts for re-awakening volcanoes rely on making an accurate estimation of their past eruption frequency and magnitude for a period long enough to view systematic changes or evolution. Adding an in-depth knowledge of the local underlying magmatic or tectonic driving processes allows development of even more robust eruption forecasting models. Holocene tephra records preserved within lacustrine sediments and soils on and surrounding the andesitic stratovolcano of Mt. Taranaki (Egmont Volcano), New Zealand, were used to 1) compile an eruption catalogue that minimises bias to carry out frequency analysis, and 2) identify magmatic processes responsible for variations in activity of this intermittently awakening volcano.

A new, highly detailed eruption history for Mt. Taranaki was compiled from sediment sequences containing Holocene tephra layers preserved beneath Lakes Umutekai and Rotokare, NE and SE of the volcano's summit, respectively, with age control provided by radiocarbon dating. To combine the two partly concurrent tephra records both geochemistry (on titanomagnetite) and statistical measures of event concurrence were applied. Similarly, correlation was made to proximal pyroclastic sequences in all sectors around the 2518 m-high edifice. This record was used to examine geochemical variations (through titanomagnetite and bulk chemistry) at Mt. Taranaki in unprecedented sampling detail.

To develop an unbiased sampling of eruption event frequency, a technique was developed to distinguish explosive, pumice-forming eruptions from dome-forming events recorded in medial ash as fine-grade ash layers. Recognising that exsolution lamellae in titanomagnetite result from oxidation processes within lava domes or plugs, their presence within ash deposits was used to distinguish falls elutriated from block-and-ash flows. These deposits are focused in particular catchments and are hence difficult to sample comprehensively. Excluding these events from temporal eruption records, the remaining, widespread pumice layers of sub-plinian eruptions at a single site of Lake Umutekai presented the lowest-bias sampling of the overall event frequency. The annual eruption frequency of Mt. Taranaki was found to be strongly cyclic with a 1500-2000 year periodicity.

Titanomagnetite, glass and whole-rock chemistry of eruptives from Mt. Taranaki's Holocene history all display distinctive compositional cycles that correspond precisely with the event frequency curve for this volcano. Furthermore, the largest known eruptions from the volcano involve the most strongly evolved magmas of their cycle and occur during the eruptive-frequency minimum, preceding the longest repose intervals known.

Petrological evidence reveals a two-stage system of magma differentiation and assembly operating at Mt. Taranaki. Each of the identified 1500-2000 year cycles represent isolated magma batches that evolved at depth at the base of the crust before periodically feeding a mid-upper crustal magma storage system.

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Chapter One:

Introduction

Chapter 1 provides the aims and outline of this thesis and motivation for this study. A brief description of regional and volcanic geology of Mt Taranaki is also presented.

1.1. Introduction

Global population growth has brought communities closer to volcanoes. It is estimated that around 10% of the world's population live at risk from volcanic hazards (Tilling and Lipman 1993). Increasing levels of development have also meant that the sophisticated infrastructure that now supports our communities is even more vulnerable to volcanic processes such as ash fall and lahars. Even a relatively minor eruption causing power failure in a city can now lead to severe disruption to communities and large losses for regional or sometimes national economies (Chester et al. 2001). There is an increasing drive in volcanological research to find ways to mitigate potential risk to modern communities. A basis for any mitigation planning, whether it is structural, land-use zonation, emergency preparedness or insurance, is reliable volcanic hazard forecasting. This requires a sound knowledge of volcanic processes, scales and types of activity, driving forces behind volcanism, and temporal models of eruption recurrence.

Volcanic systems are extremely varied, depending on the local tectonic regime that has led to their formation. Intermediate (andesitic) to silicic (rhyolite) volcanoes are the most common type in areas of human habitation (Tilling and Lipman 1993) and they are also the most productive magmatic systems on Earth (Price et al. 2005). These systems are typically identified as the most hazardous due to their unpredictable eruption behaviour and seemingly variable eruption frequency. In particular, those in long term states of quiescence may not be considered a real threat by the communities living on them, until they suddenly awaken. Historical examples of catastrophically reawakening volcanoes include the 1980 eruption of Mt. St Helens, which burst into spectacular life

after more than 120 years of quiescence (Lipman and Mullineaux 1981); Mt. Pinatubo, barely recognised as a volcano, but erupting violently after over 500 years of quiescence (Newhall and Punongbayan 1997); and the Chilean volcano Chaitén that reawakened explosively in May 2008, around 9000 years since its last eruption.

Collecting essential data for a robust volcanic hazard assessment includes compiling the most complete record of eruption activity possible from a volcanic centre, as well as characterising the types and magnitudes of activity possible and their relative frequencies. Since the time scales over which volcanoes operate are much greater than the majority of historic records in most parts of the world, volcanic histories are typically deduced from the geologic record (Crandell et al. 1984). Acquiring additional petrologic and geochemical datasets aids the identification of processes leading to eruption variability (Crandell et al. 1984; Tilling 1989). The combination of these datasets enables reconstruction of a volcano's past behaviour, which provides the basis for assessing potential hazards from future eruptions.

Mt. Taranaki in the western North Island of New Zealand (Fig. 1.1) is a typical example of an intermediate to silicic stratovolcano that has not been active throughout the local written history, i.e., since around AD 1840. For this reason it is commonly not treated as a serious volcanic risk by most community members, who compare it to the nearby Ruapehu volcano, which has erupted many times in the last few decades. Studies of the volcanic deposits in the Taranaki region (e.g., Neall 1972; Alloway et al. 1995) and ash-fall deposits found at more distal locations (i.e., Fig. 1.1; Auckland: Shane and Hoverd 2002, Waikato: Lowe 1988, and Hawkes Bay: Eden et al. 1993) paint quite a different picture and indicate that this volcano has been frequently active in prehistoric times.

The Taranaki region of the western North Island, New Zealand (Fig. 1.1) contains only 2.8% of the country's population (Statistics New Zealand 2004). Despite this, it is of critical national importance as it is the current locus of oil (gas and condensate) production. Around 32% of the regional Gross Domestic Product (GDP) is within the mining, electricity, construction, gas and water industries (Statistics New Zealand 2004). Associated with this are many dependent installations, including those for generation of synthetic fuels, resin, urea, natural gas processing and redistribution networks, and several electricity co-generation plants associated with these (Taranaki

Regional Council 2004). The region also provides 14% of the nation's dairy farming production and hosts the largest dairy factory in the Southern Hemisphere (Fonterra 2007). As well as exporting gas and oil out of Taranaki for industrial and domestic use, electricity is generated within the region at two gas-fired power stations and supplied to the national grid. High-level winds at Taranaki (above ~10 km) are directed NE to SE for 91% of the year (Neall and Alloway 1991), dispersing past high plumes several hundred kilometers eastward (Eden and Froggatt 1996). Being located on the south western coast, Mt. Taranaki has the potential to distribute ash across much of the North Island. Resulting disruption in communications, air transport, electricity generation and distribution, water supply and waste-water treatment throughout much of the most heavily populated regions of New Zealand is likely to be critical to the overall GDP (Johnston et al. 2000).

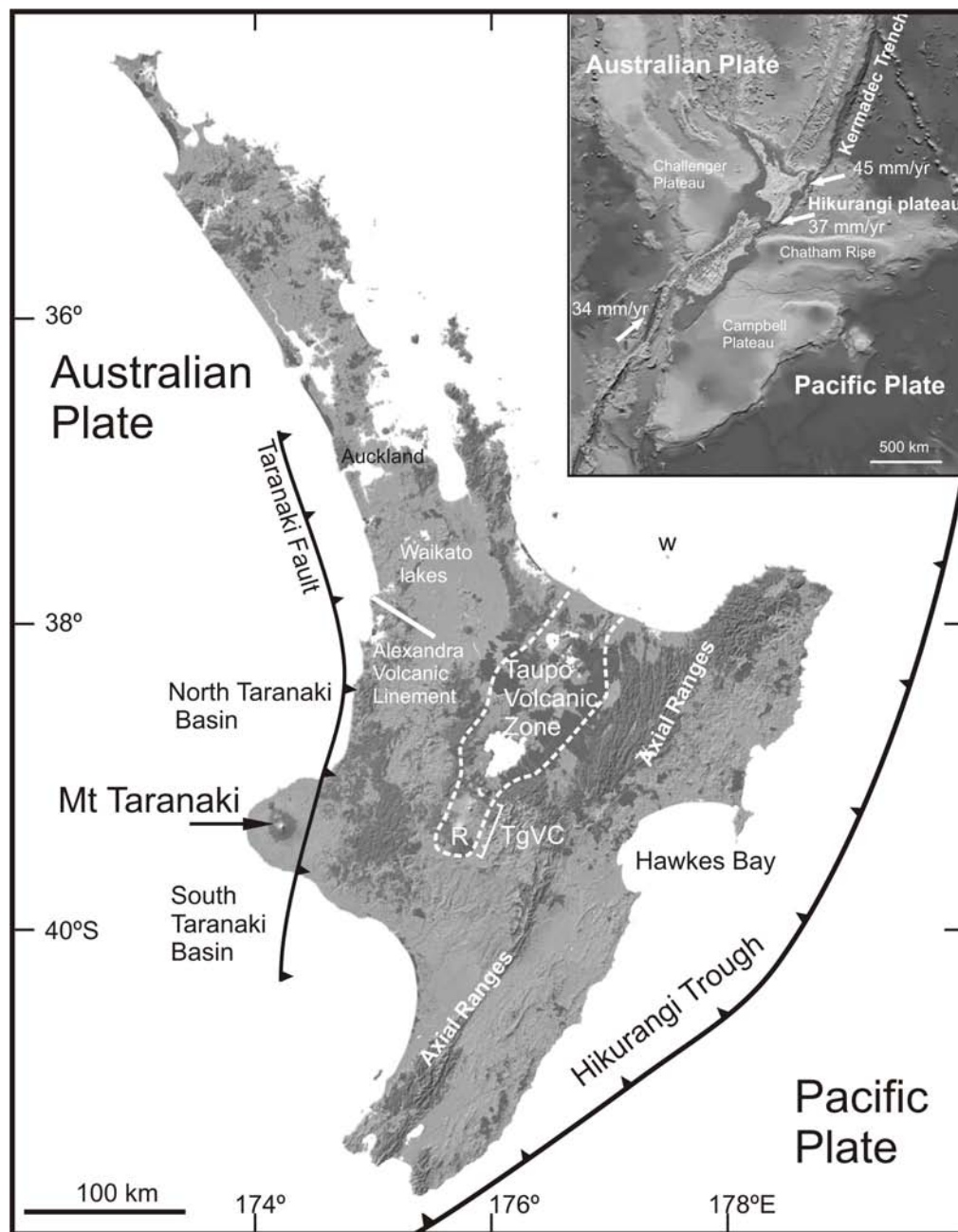


Figure 1.1: *The North Island of New Zealand showing the major volcanic provinces. Insert shows the plate tectonic setting of New Zealand. The area between the Hikurangi Trough and the axial ranges is the forearc. Volcanic provinces marked include the Tongariro Volcanic Centre (TgVC), Mt. Ruapehu (R), White Island (W) and the Alexandra Volcanic lineament defined by the white line.*

Mt. Taranaki rises to a summit of 2518 m from near sea level and its near symmetry is broken only by the parasitic cone of Fanthams Peak (1967 m) to the south (Fig. 1.2).

The volcano is situated at a latitude of approximately 39° S and experiences a moist, temperate climate. The vegetation type and slow soil development between 800-1100 m altitude on the edifice (McGlone and Neall 1994) preserves one of the best proximal pyroclastic records on the volcano. Higher on the flanks, greater erosion has caused loss of the stratigraphic record, whereas at lower altitudes and greater distances, ash falls from smaller volume eruptions are rapidly weathered and incorporated into growing soil profiles (Alloway et al. 1995). The most reliable medial and distal depositional environments are in lakes and swamps. Within organic lake sediments, ash fall deposits of <0.5 mm thickness can be easily identified and dated by radiocarbon methods. Using multiple dated horizons, precise sedimentation rate curves can be constructed to assign ages to all intervening ash fall deposits. Unfortunately, lakes are not always in optimal situations or distances from the volcano. Two small lakes, Umutekai and Rotokare, are in desirable locations, NNE and SE of Mt. Taranaki. Correlation of ash fall events between lake sites can be used to interpret proximal sequences and develop a near-complete eruption record. In addition, geochemistry and mineralogy from these sequences can be used to provide valuable information on the magmatic system responsible. These datasets not only allow a better insight into the volcanic system, but also enable realistic, probabilistic-based eruption forecasts to be made for timing and possible magnitudes of future eruptions.

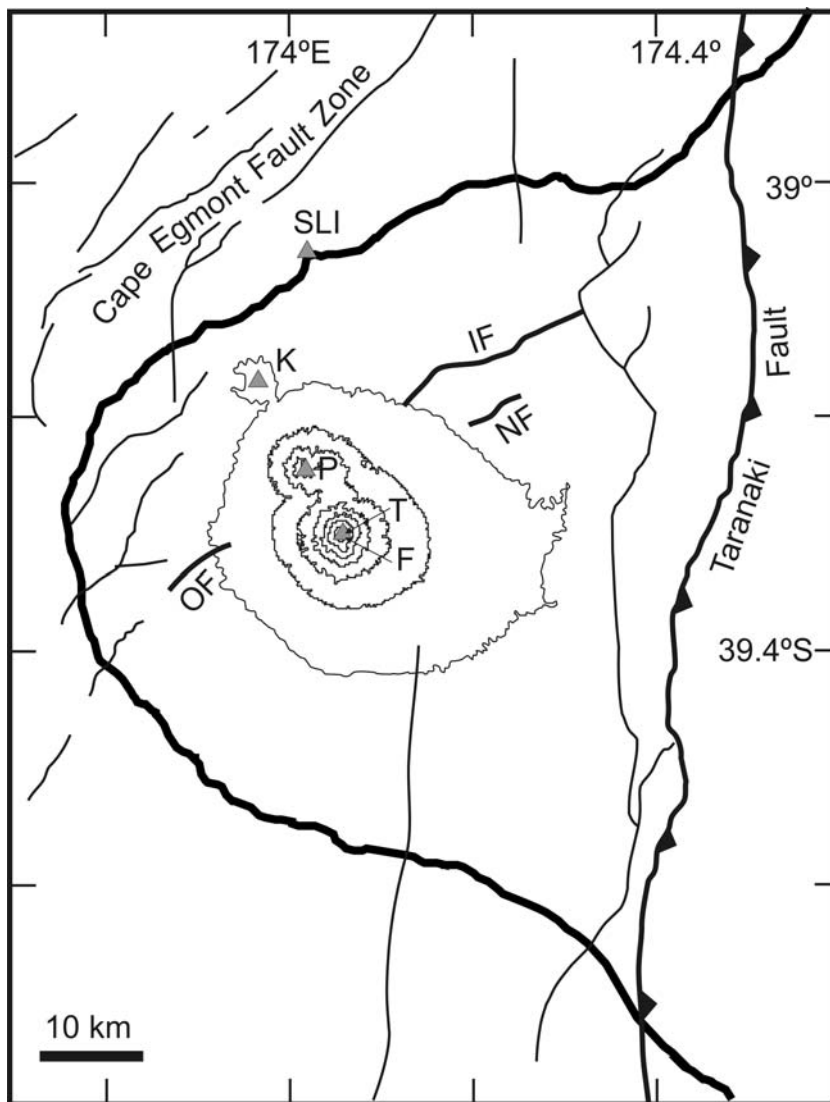


Figure 1.2: *Regional tectonic setting of western Taranaki. The Taranaki Volcanic Lineament comprises the Sugar Loaf Islands (SLI), Kaitake (K), Pouakai (P) and Mt. Taranaki (T) with Fanthams Peak (F). Contours begin at 300 m, rising at 300 m intervals for the volcanic edifices only. Modified after Sherburn and White (2005). There are three active oblique normal slip NE-SW-trending faults of the Taranaki region: the Oaonui Fault (OF), Inglewood Fault (IF), and Norfolk Fault (NF). The Oaonui fault shows a vertical displacement of 5 m over the last 6500 years (Hull and Dellow 1993).*

1.2 Problem statement and hypotheses

Traditional volcanic studies have concentrated on the most easily identifiable, largest volume eruption deposits in the case of andesitic volcanoes, typically sub-plinian tephra deposits and lava flows. These units, however, only account for a tiny portion of the complete eruption record. Analyses of eruption frequency are therefore typically underestimated, which in turn hinders development of accurate probabilistic forecasting. Similarly, magmatic models at andesite volcanoes are generally developed from petrological and geochemical observations from easily obtainable lava-flow or large volume pyroclastic deposit records. Lava-flows are inherently difficult to date on steep, high altitude volcano flanks and hence subtle and/or temporal changes in the magmatic system are difficult to analyse within any chronological context.

This leads to the following hypotheses:

- A) Combining the minor eruption record from stratovolcanoes with their large-event history will provide a more realistic database of volcanic eruption frequency that can be used to produce more precise hazard forecasts.
- B) The deposits of a precisely dated eruption record will provide a detailed source of both petrographical and geochemical data that can be used to constrain overall magmatic processes from melt generation to eruption.

1.3 Aims and Objectives

The aim of this study is to investigate the patterns of eruptive behaviour and the driving forces behind it, during the Holocene period (last ~10 000 years) at Mt. Taranaki. Stratigraphical, geochemical and petrological investigations will be related to previous geophysical data at the volcano to reconstruct the past eruption history. In order to construct a robust record of eruptions, reliable methods are needed for geochemical correlation of pyroclastic units emplaced in diverse sectors of the volcano and surrounding areas. To understand this record, and to develop a basis for future eruption type, frequency and magnitude forecasting, models of magma generation, differentiation

and ascent through to eruption are required. This leads to the two main objectives of this thesis:

- 1) To compile a near-complete Holocene tephra eruption record for Mt. Taranaki by integrating small- and large-scale eruptive event records.
- 2) To use the detailed eruption record to identify and model magmatic processes operating at Mt. Taranaki.

The datasets and information acquired during the fulfilment of these objectives were used in the continuing development of statistical recurrence eruption and hazard forecast models. Preliminary models were developed by Turner, Cronin, Bebbington and Platz (Turner et al. 2008; Appendix 1) based on an estimation of the Holocene eruption frequency. During this PhD research, these were further developed by obtaining successively better quality eruption records. Trends and patterns in eruptive behaviour were investigated. Adding to this, detailed geochemical and petrological investigations were made throughout the growing eruption catalogue to establish the magmatic processes that appear genetically related to the interpreted eruption magnitude/frequency records.

1.4 Regional geological setting

New Zealand is located on a convergent plate boundary between the Pacific and Australian Plates. The oceanic Pacific Plate is subducted beneath the continental crust of the Australian Plate of the North Island (Fig 1.1). In the South Island, a continental block on the Pacific Plate (comprised of the Chatham Rise and Campbell Plateau), is colliding with continental crust (Challenger Plateau) on the Australian plate. The relative plate motion in the South Island contains a margin-parallel component and much of the relative plate motion is accommodated in a mostly strike-slip fault system (van Dissen and Yeats 1991; de Mets et al. 1994) to the south of the continental collision, arc polarity is reversed and the Australian Plate is subducted eastwards along the Macquarie Ridge.

The Hikurangi Trough, east of the southern North Island (Fig. 1.1) marks the southernmost extremity of the Tonga-Kermadec trench. Along the trench, the relative plate motion decreases from north to south with plate convergence rates of up to 98 mm/yr in the Tonga trench and 42-50 mm/yr in the Hikurangi Trough (Minister and Jordan 1978; de Mets et al. 1994; Wallace et al. 2004). The Hikurangi Plateau, to the east of the lower North Island causes resistance to subduction (Fig. 1.1). This resistance in the south and subduction of oceanic crust in the north of the Hikurangi trough forces clockwise rotation between the trough and the axial ranges of the North Island (Wallace et al. 2004).

The clockwise rotation of the microplates contributes to the extension at the southernmost end of the active Tonga-Kermadec volcanic arc, the Taupo Volcanic Zone (TVZ). The continental crust within the TVZ area is extending at a rate of ~8-10 mm/yr and is also relatively thin at 12-15 km, with exceptionally high heat flow (~700 mW/m) (Stern 1987; Bibby et al. 1995; Villamor and Berryman 2001; Rowland and Sibson 2001; Henrys et al. 2003). This high heat flow has led to the TVZ being one of the most productive magmatic systems on Earth (Houghton et al. 1995; Wilson et al. 1995). The TVZ can be subdivided by the composition of eruptives from each centre (Fig. 1.1). Andesite dominates the volcanoes in the north (i.e., White Island) and to the south (i.e., Tongariro Volcanic Centre, TgVC), whereas the central part of the TVZ is dominated by rhyolites (Wilson et al. 1995). The TgVC consists of Mounts Ruapehu and Tongariro with the satellite cone of Mt. Ngauruhoe (Donoghue et al. 1995; Cronin and Neall 1997; Hobden et al. 2002).

The Taranaki Volcanic Lineament is located 130 km to the west of Mt. Ruapehu. The NNW-SSE lineament is defined by four andesite volcanoes with decreasing age southward: the Sugar Loaf Islands (1.75 Ma), Kaitake (0.75 Ma), Pouakai (0.5 Ma) and Mt. Taranaki (Neall 1979; Neall et al. 1986). Mt. Taranaki has been the main locus of volcanism for the last 120 000 years (Neall et al. 1986). The Taranaki Volcanic Lineament is geochemically and tectonically distinct to the TVZ setting, but is similar to the Alexandra Volcanic Lineament (Fig. 1.1) to the north (i.e., Briggs 1983; Briggs et al. 1989; Stagpoole 1999).

The subducting Pacific plate under the North Island plunges steeply into the mantle to lie approximately 100 km below Mt. Ruapehu at a distance of c. 280 km from the trench (Reyners et al. 2006). The depth of the subducted slab beneath the Taranaki region, located about 400 km from the trench, is approximately 250 km (Adams and Ware 1977; Boddington et al. 2004; Reyners et al. 2006). However, the Taranaki volcanoes are not directly overlying the slab, since it is only traceable to the south-eastern part of the Taranaki region, c. 35 km east of Mt. Taranaki (Stern et al. 2006).

The process causing the rise of magma to the surface in Taranaki is currently under debate. Traditional models invoke the hydrous fluxing of the mantle wedge by fluids driven off the subducting slab (c.f., Price et al. 1992). Recently Stern et al. (2006) proposed that, to the north of a line defined by Mt. Taranaki and Ruapehu and to the west of the TVZ, the area has lost the lower portion of the mantle lithosphere by convective instability and thus the hot asthenosphere has risen, melting metasomatised mantle.

The volcanoes of the Taranaki region intrude and overlay the sediments of the Taranaki Basin with volcanoclastic deposits. The basin sediments are on average 6 km thick and are composed of a Cretaceous to Cenozoic sequence of limestones, coal, silt-, and sandstones (King and Thrasher 1996). The eastern boundary of the basin is marked by the Taranaki Fault (Fig. 1.2), a crustal thrust fault that has accommodated a dip-slip displacement of 12-15 km in the last 80 Ma and vertically offsets the basement by about 6 km (King and Thrasher 1996; Nicol et al. 2004). The Cape Egmont Fault Zone (CEFZ) to the west divides the basin into the Eastern (Mobile Belt) and Western (Stable Platform) (King and Thrasher 1996). The CEFZ marks extension and has a dip-slip movement for the last 225 000 yrs of c. 0.8 mm/yr (Nodder 1993). Mortimer et al. (1997) interpreted the Taranaki basement rocks as being composed of calc alkaline subduction-related plutonic rocks which are part of a major terrain boundary unit, the Median Tectonic Zone.

1.5 Mt. Taranaki

1.5.1 Introduction and brief eruption history

The earliest evidence of volcanic activity from Mt. Taranaki is estimated to be 150 000 years old, based on laharic deposits lying directly beneath an uplifted marine-cut surface (Alloway et al. 1995). Since that time the volcano's history has been characterised by successive cone-building and collapse episodes, with at least 12 identified debris avalanche deposits (Zernack et al. 2006). The resulting fans of these deposits and inter-bedded laharic, pyroclastic, and alluvial volcanoclastics have built up much of the >25 km³ ring-plain (Neall et al. 1986; Alloway et al. 1995).

The current edifice of Mt. Taranaki has been mostly constructed since 10 000 yrs B.P. (Neall et al. 1986), with the upper lava field likely to be younger than 3000 years B.P. The eruptive history of the last 10 000 years has been characterised by sub-plinian eruptions interspersed with likely more-frequent effusive events (Alloway et al. 1995). The effusion of lava-domes and the destruction of these domes have lead to the deposition of extensive block-and-ash-flow deposits infilling paleo-valleys in most sectors of the edifice (Neall 1979; Neall et al. 1986).

At approximately 7000 years B.P. a sector collapse of the southern flank occurred, emplacing debris-avalanche, debris flows, and lahar deposits (Neall et al. 1986). A distinctive basaltic-andesite scoria-rich lapilli was erupted from the parasitic cone (Fanthams Peak) at c. 3100 yrs B.P. (Alloway et al. 1995). This is suggested to signify either an extensive period of eruptions or the formation of Fanthams Peak (Neall et al. 1986). The last c. 600 years of activity is defined as the Maero eruptive period and is characterised by dome-forming and collapse episodes and one sub-plinian eruption in AD 1655 (Burrell Lapilli). The last known eruption was considered to be in AD 1755; however recent stratigraphic and geochemical evidence confirms that two post AD 1755 dome collapse events occurred in c. AD 1800 and 1854 (Platz 2007).

1.5.2 Geophysical observations

Gravity data of Mt. Taranaki suggest that there is a near cylindrical intrusive body of approx. 5 km in diameter below the edifice (Locke et al. 1993; 1994; Locke and Cassidy 1997). If the intrusive body is modelled with a density contrast between the interpreted volcanic rocks (2.7 g/cm^3) and the surrounded country rock ($2.25\text{-}2.6 \text{ g/cm}^3$) of only 0.1 g/cm^3 , it would extend down to 15 km, i.e., into the basement (Locke and Cassidy 1997). An intrusive body extending to at least 10 km beneath Mt. Taranaki is also interpreted from 3-D models of P wave velocity, P- to S-wave velocity ratios, and P-wave quality factors by Sherburn et al. (2006).

A shallow crustal brittle-ductile transition zone (BDTZ) at 10 km depth beneath Mt. Taranaki was interpreted from seismic measurements using 75 broadband seismometers (Sherburn and White 2005). The BDTZ increases in depth to 25 km to the west and, at the Taranaki Fault to the east (Fig. 1.1), extends to near 35 km (Sherburn and White 2005). These depths are thought to represent the base of the crust which varies in thickness between the north to south ($\sim 25 \text{ km}$ to $>35 \text{ km}$) and east to west in the Taranaki region. The shallow BDTZ is thought to be caused by magmatic intrusions and is consistent with observed high heat flows (up to 73 mW/m^2 ; Allis et al. 1995). However, no magma storage was imaged within the upper 16 km, probably due to the 5 km spatial resolution of the models (Sherburn et al. 2006).

1.5.3 Petrology of Taranaki rocks

Hutton (1889) first described the igneous rocks in Taranaki as hornblende, augite and olivine andesites. Marshall (1907) also described the rocks as being hornblende-augite andesites and made the important petrological observation that many of the hornblendes were resorbed in these rocks. Although subsequent petrological observations were made (Clark 1912; Morgan and Gibson 1927), the first major study of the petrology of Taranaki andesite was performed by Gow (1968). He developed a classification scheme for Taranaki rocks based on the ferromagnesian mineral assemblages. The five rock-types recognised by this scheme were: 1) augite – andesites; 2) augite – hornblende andesite (augite $>$ hornblende); 3) augite – hornblende andesite (augite $\sim$ hornblende); 4) augite – hornblende andesite (augite $<$ hornblende); and 5) augite – olivine andesite (olivine ~ 7 modal percent). Of these, the most common is augite – hornblende andesite

2 (Neall et al. 1986). This rock classification scheme has been modified slightly by later studies to incorporate additional mineral phases such as plagioclase (Neall et al. 1986; Stewart et al. 1996). The mineral assemblage of Taranaki rocks consist of phenocrysts of plagioclase, clinopyroxene, hornblende and minor amounts of olivine, and groundmass comprised of orthopyroxene, clinopyroxene, titanomagnetite, and rare biotite (Gow 1968; Neall 1986; Stewart et al. 1996).

According to the classification scheme of Gill (1981), Taranaki rocks are classified as a high-K suite of basalt – basaltic andesite – low Si andesite, based on whole rock geochemistry (Neall et al. 1986; Price et al. 1992; Stewart et al. 1996; Price et al. 1999; Price et al. 2005). In addition, because of the increase in alkalis and silica within the rock suite with no iron enrichment, Taranaki rocks fit the calc-alkaline trend (c.f., Price et al. 1992). Trace element abundances of Taranaki rocks are also consistent with a typical ‘arc-signature’. The trace element abundances are characterised by relatively high proportions of large ion lithophile elements (LILE; e.g., Rb, Cs, Sr, Ba) and light rare earth elements (LREE), with deficiencies in high field strength elements (HFSE) (Price et al. 1992; 1999; 2005). Isotope studies show that Mt. Taranaki rocks display a tight range of $^{143}\text{Nd}/^{144}\text{Nd}$ and $^{86}\text{Sr}/^{86}\text{Sr}$ ratios (Price et al. 1992; 1999; 2005).

The enrichment of LILE and depletion of HFSE in Taranaki magmas is attributed to a low-degree of partial melting of a depleted mantle that contains a significant component of slab-derived fluids (Price et al. 1999). Magmas parental to eruptives of Mt. Taranaki were undersaturated, hydrous high-Mg basalts (Price et al. 1999). Crystal fractionation of these basalts, involving olivine, clinopyroxene and spinel, produced the high-Al basaltic magmas. Once the magma intersects the amphibole stability field and interacts with the upper-mantle and lower-crust material, basaltic-andesites are produced (Stewart et al. 1996). Further high-level crystal fractionation including amphibole crystallisation and fractionation can then drive the melt composition through andesite and dacite (Price et al. 1999). High level crustal storage of a dispersed, complex plumbing system and the combination of further high-level fractionation, crystal accumulation and magma mixing/mingling was thought to cause the observed geochemical and mineral textural variations within andesitic rocks through time (Price et al. 1999; 2005).

1.6 Outline of the thesis

This thesis consists primarily of published or submitted manuscripts; hence there is some degree of repetition between chapters, particularly introductory sections describing the geology of Mt. Taranaki and descriptions of the Holocene eruption record compiled throughout this study.

The paper: Turner MB, Cronin SJ, Bebbington, MS, Platz T (2008) *Developing probabilistic eruption forecasts for dormant volcanoes: a case study from Mt. Taranaki, New Zealand* Bull Volcanol 70: 507-515 (contained as Appendix 1), was a founding attempt at the onset of this study to produce a probabilistic eruption forecast from a detailed record of tephra fall within Lake Umutekai. Although major elements of this work were conducted at the outset of this thesis, it relies in great part on the contributions of the co-authors. It also formed the basis upon which this thesis was further developed.

Development of a stratigraphic framework of the eruption record at Mt. Taranaki is reiterated within Chapters 2 and 3 of this thesis. Statistical processes for geochemical finger-printing and correlation of tephras are described in Chapter 3, along with a further development of probabilistic eruption forecasting from the latest volcanic history records of the volcano. The discussion in Chapter 3 introduces the possible causes behind variations of eruption frequency throughout the Holocene. This subject is the main focus of Chapter 4. By applying a technique to distinguish two-end member eruption states using titanomagnetite textures, the periodic eruption frequency at Mt. Taranaki is identified. The geochemical evolution of individual magma batches is parallel to this, which suggests a causal link to the cyclic pattern in eruption frequency. Chapter 5 focuses on detailed petrology from a typical eruptive event, in order to provide inferences on the magmatic processes operating at Mt. Taranaki. A model of andesitic magma recharge of a residing magma is presented. In Chapter 6, the combined datasets and observations from geochemical, petrological and geophysical research are examined in relation to the temporal aspects of magma evolution and eruption history. The thesis is rounded off by the conclusions and suggestions for further work, presented in Chapter 7.

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Chapter Two:

Pyroclastic Eruption Records of Mt. Taranaki

Two depositional settings optimally preserve deposits from pyroclastic eruptions of Mt. Taranaki: 1) Soil and volcanoclastic profiles on the upper edifice flanks and, 2) Lakes and swamps surrounding the volcano. This chapter introduces the background of tephrochronology studies at Mt. Taranaki and describes the main stratigraphic sites used in the remainder of this research.

2.1 Introduction

The pioneering work of Thorarinsson (1944) showed that single widespread tephra layers can be used as marker horizons and, when well dated, as isochrones; introducing the principle of *tephrochronology*. Tephrochronology has been applied to many hazard studies, such as determining the recurrence of earthquakes (Kelsey et al. 1998) and tsunami (Nanayama et al. 2003), as well as providing time scales for understanding landscape development, events in human history (Hogg et al. 2003) and global and regional climate change (Bjorck et al. 1992; Alloway et al. 2007; McGlone and Neall 1994). In this study, tephra records were compiled to develop the most complete history of eruption events from Mt. Taranaki to date. This dataset was used to interpret patterns in the past frequency of eruptions as well as providing a basis for sampling and analysing the petrological and geochemical evolution of the volcanic system in unprecedented detail.

Mt. Taranaki has been in a state of quiescence since reliable written history began in this part of the North Island (since c. A.D. 1840). The only information of its past activity is contained within the geologic record. In this Chapter the development of the pyroclastic eruption record for Mt. Taranaki is chronicled, culminating in the description of key stratigraphic profiles.

2.2 Previous tephrochronology at Mt. Taranaki

In 1883 A.W. Burrell first recognised pumice fragments lodged in the forks of living matai (*prumnopitys taxifolia*) trees and, based on tree-ring counting, estimated the age of this tephra unit to be A.D. 1430 (Oliver 1931). The tephra was formally named the Burrell Lapilli (Oliver 1931; Druce 1966; Alloway et al. 1995) and its age refined to A.D. 1655 (Druce 1966). A distinctive grey ash that underlies the Burrell Lapilli in eastern Taranaki was termed the Newall Ash by Taylor (1954). Druce (1966) went on to describe, map and assign approximate ages to the most recent pyroclastic deposits found on the flanks of Mt. Taranaki, including block-and-ash flow deposits (describing them as coarse tephra and/or debris flow deposits) as well as ash-cloud surge and fall layers in peat and soil. A record of nine eruptions was reconstructed between A.D. 1400 to the present. This was refined by Neall (1979) who defined the Maero Formation to encapsulate the recent products of dome formation and collapse and constrained some of these events with radiocarbon dating of incorporated charcoal. Recently, Platz (2007) further revised this series of eruption events, defining the Maero Eruptive Episode and presenting additional radiocarbon ages.

In the areas surrounding Mt. Taranaki, Grange and Taylor (1933) recognised two widespread tephra ‘showers’ within the soil profiles of the region. The Stratford Ash (the upper unit) was identified extensively throughout eastern Taranaki, whereas the lower Egmont Ash was restricted to sites in north-eastern and south-eastern Taranaki (Grange and Taylor 1933). Within Holocene sections along the north Taranaki coastline, Wellman (1962) recognised eight distinctive tephra layers. He correlated the three upper tephra to the Burrell Lapilli, Newall and Stratford Ashes. Due to the composite nature of the ‘showers’ the terms Stratford and Egmont Ashes have since been considered redundant (Alloway et al. 1995).

For the overall tephra record from Mt. Taranaki, Neall (1972) provided the most comprehensive tephrostratigraphic record, identifying and describing tephra primarily within western Taranaki. Franks (1984) added to this by describing the tephra beds of eastern Taranaki. These stratigraphic records were combined, revised with additional soil-stratigraphy information and formalised by Alloway et al. (1995). Within the ring-

plain soil and peat profiles, 16 andesitic tephra formations were established, ranging in age from ~3000 yrs B.P. through to approximately 28 000 yrs B.P. Each formation consists of between two and ten individual tephra layers, with at least 76 of the tephra events described having volumes exceeding 10^7 m^3 since 28 000 yrs B.P. These events are representative of explosive eruptions at the higher end of the magnitude scale for Mt. Taranaki. Evidence of smaller eruptions that distributed finer-grained tephra to relatively more distal sites (>10 km from the vent) is not typically found within the rapid weathering environment of the andisol soils of the region (Alloway et al. 1995). The average periodicity of one eruption every c. 330 yrs was therefore a minimum estimate, when this PhD study started.

2.3 Edifice stratigraphic sections

Although Alloway et al. (1995) provide a comprehensive overview of the larger tephra layers from Mt. Taranaki, the study of Druce (1966) illustrates a far more complex record of explosive and effusive eruptions on the volcano flank sequences. These proximal records were a major focus of this thesis.

Due to optimal exposure conditions, access and distance from eruptive vents, much of the fieldwork component of this study focussed on identifying and describing the profiles revealed in stream banks and road/walking track cuttings on the mid-upper volcanic edifice. Twelve key stratigraphic locations were identified, providing the most complete record of pyroclastic eruptions. These were located at a semi-regular spacing of approximately 1000 m, circumnavigating the volcano at an altitude of 800-1100 m (Fig. 2.1).

2.3.1 Edifice stratigraphic descriptions

At each site, the section was sampled (bulk samples and individual clasts; see Appendix 3) and described including: deposit thickness, clast shapes and sizes, matrix, maximum clast-diameters, pumice, scoria, dense juvenile, lithic/accidental proportions, bedding,

grading, and sorting (see Appendix 3 for full descriptions). These characteristics were used to classify the volcanoclastic layers into the following categories (Fig. 2.1):

Pumice-rich ash-fall deposits: Well sorted (clast-supported), pumice fall deposits, also containing between 20-60 vol.% dense juvenile clasts or accidental foreign clasts.

Pumice-rich pyroclastic flow deposits: Pumice-rich deposits that are poorly sorted, with bomb/block and lapilli-sized clasts, typically supported by a medium ash of glass and crystal fragments. The deposit may contain a range of proportions of juvenile and foreign (lithic) clasts.

Surge deposits: Fine-coarse ash-dominated poorly sorted deposits. Common low-angle cross-bedding, dune structures, pinch and swell features and horizontal laminations. Dominant clast types either comprise pumice-glass fragments or dense juvenile clasts.

Block-and-ash-flow deposits: Massive or weakly horizontally bedded diamictons of dominantly monolithic, dense juvenile/dome lava material. May contain between 5-30 vol.% accidental clasts (including hydrothermally altered dome and summit-area rocks). Bed structure can be either clast- or matrix-supported.

Fine grey ash: Well sorted coarse to fine ash made up of typically dense juvenile andesite and ascribed to being fall units of co-ignimbrite ash from block-and-ash-flows.

The interbedded material between the pyroclastic deposits was subdivided from its appearance and texture into:

Paleosol: Dark brown-yellow (10YR 3/6) silty, firm-texture massive or coarse blocky structured.

Medial ash: Andisols, similar to those described by Alloway et al. (1995). Typically yellow to light brown (10YR 5/8) firm, massively structured. Identified as weakly developed soils of volcanic origin (Neall 1985)

2.3.2 Chronology

Pyroclastic-flow deposits may contain organic material such as twigs, branches, roots and leaves that have been charcoaled upon incorporation and deposition if the materials were hot enough. This charcoal, especially from short-lived species or fragments from leaves or twigs, can be used to provide a precise date for flow emplacement/eruption using the radiocarbon technique. In this study these were submitted to either the Radiocarbon Dating Laboratory, University of Waikato, for standard beta-counting ages; or the Rafter Radiocarbon Laboratory, National Isotope Centre, GNS Science, New Zealand, for Accelerator Mass Spectrometry (AMS) dating. Additional chronologic constraints to these stratigraphic records were provided by correlation of geochemically related tephra units, as detailed in Chapter 3.

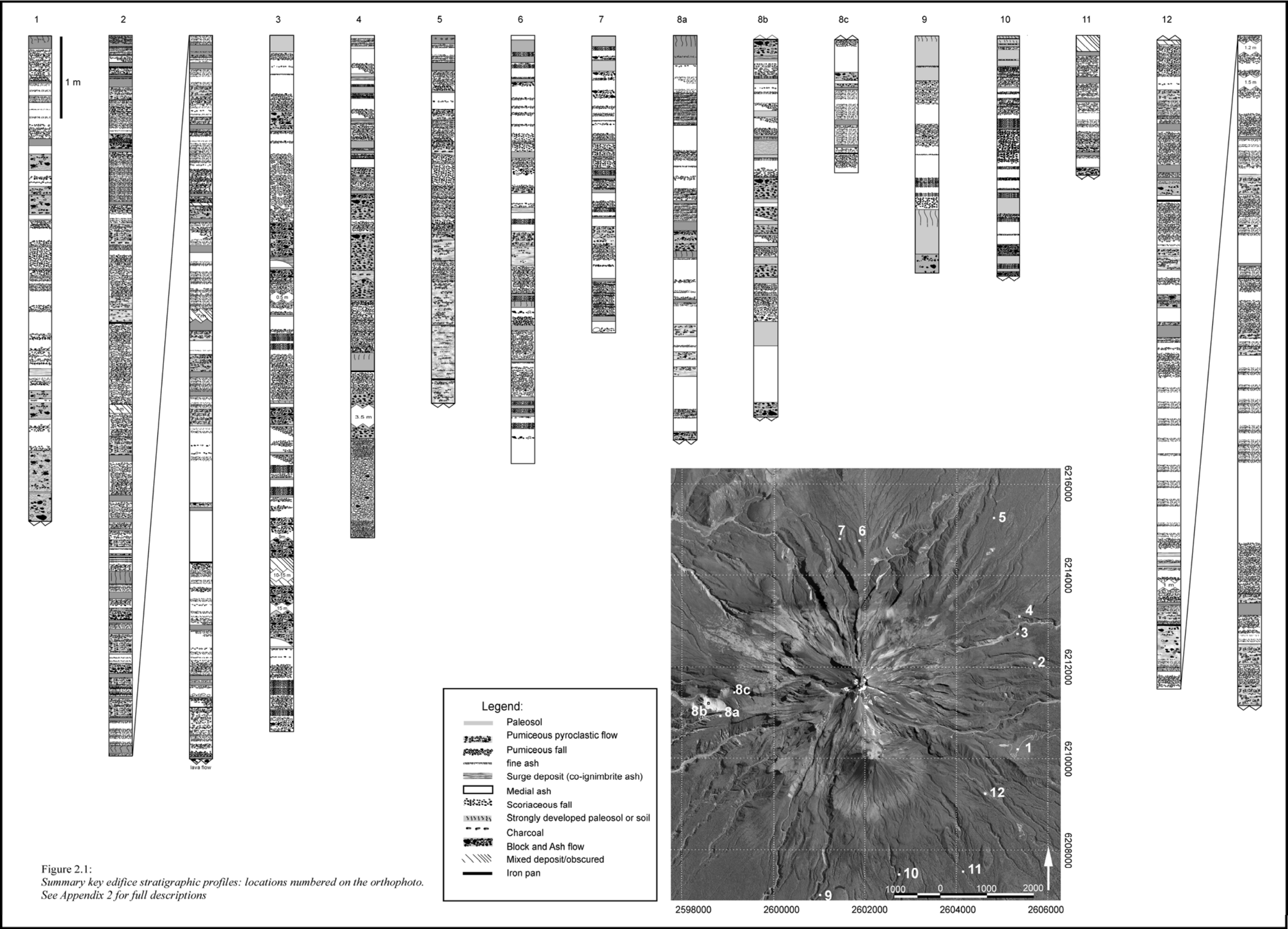
2.4 Lacustrine sediments

Distal tephra-fall deposits preserved in sediments within lakes downwind of volcanoes provide arguably the highest resolution and most continuous record of eruptions (Lowe 1988; Fontaine et al. 2007). The low-energy sedimentation environment allows tephra falls <1 mm thick to be preserved within essentially continuously accumulating organic-rich lacustrine materials (Fontaine et al. 2007). The organic-rich intervening deposits can be studied for fossil pollen as well as being readily radiocarbon dated (typically using the AMS technique that enables smaller sample sizes to be used). Focus on such tephra records has therefore been common in volcanic event frequency analysis in many parts of the world (e.g., Japan: Takemura et al. 2000; Europe: Chambers et al. 2004; Alaska: Fontaine et al. 2007; New Zealand: Lowe 1988; Shane 2005).

Lakes Umutekai and Rotokare are located within the Taranaki district (Fig. 2.2) and close to the main known dispersal axes of tephra fall from Mt. Taranaki (c.f., Alloway et al. 1995). They are also located close enough to record small-medium eruption events ($10^4 - 10^5 \text{ m}^3$), but not be overwhelmed by larger events. Lake Umutekai lies 25 km NNE of the summit of Mt. Taranaki (39°05.27'S, 174°08.22'E; Fig. 2.2), is c. 0.02 km² and up to 2 m-deep, lying within a swampy closed depression on a gently undulating old volcanoclastic surface. The surrounding landscape was densely forested throughout

all of the Holocene (McGlone and Neall 1994). This lake was previously cored by Neall and Newnham in the late 1980s, resulting in a ~11 m core from the edge of the lake with a date of $11\,550 \pm 250$ yrs BP (NZ7567) obtained from sediments near its base (Neall pers. comm. 2005). The readily observed, thickest tephra deposits (>5 mm) were correlated on the basis of stratigraphic position and appearance to the stratigraphy of Alloway et al. (1995). These tephrochronologic horizons aided in later pollen analyses of the organic sediments from this lake (Newnham and Alloway 2004). The sediments of this lake were re-sampled for this study by M. Turner and S. Cronin in April 2005.

Lake Rotokare lies 30 km SE of Taranaki's summit ($39^{\circ}27.10'S$, $174^{\circ}24.64'E$; Fig. 2.2). It is a Y-shaped lake formed by the damming of a paleo-river channel by a Holocene landslide. It is 0.25 km^2 in area with a maximum width of 200 m and a maximum water depth of 12 m at the apex of the Y-junction. Lake Rotokare and its headwaters are surrounded by steep ($10\text{-}20^{\circ}$) slopes of unstable, weakly consolidated Pleistocene and Pliocene marine blue-grey mudstones (Fleming 1976). In addition, because it is formed from a paleo-river channel, Lake Rotokare has a much larger catchment than Lake Umutekai. This lake was cored in 1980 by D. Lowe and C. Hendy. However, within a 1 m core, only two tephtras were identified. A radiocarbon date of 1920 ± 110 yrs B.P. (Wk 425) was obtained from the base of this core (Neall pers. comm. 2005). Sediments from this Lake were re-sampled for this study by M. Turner, J. Flenley and D. Feek in October 2005.



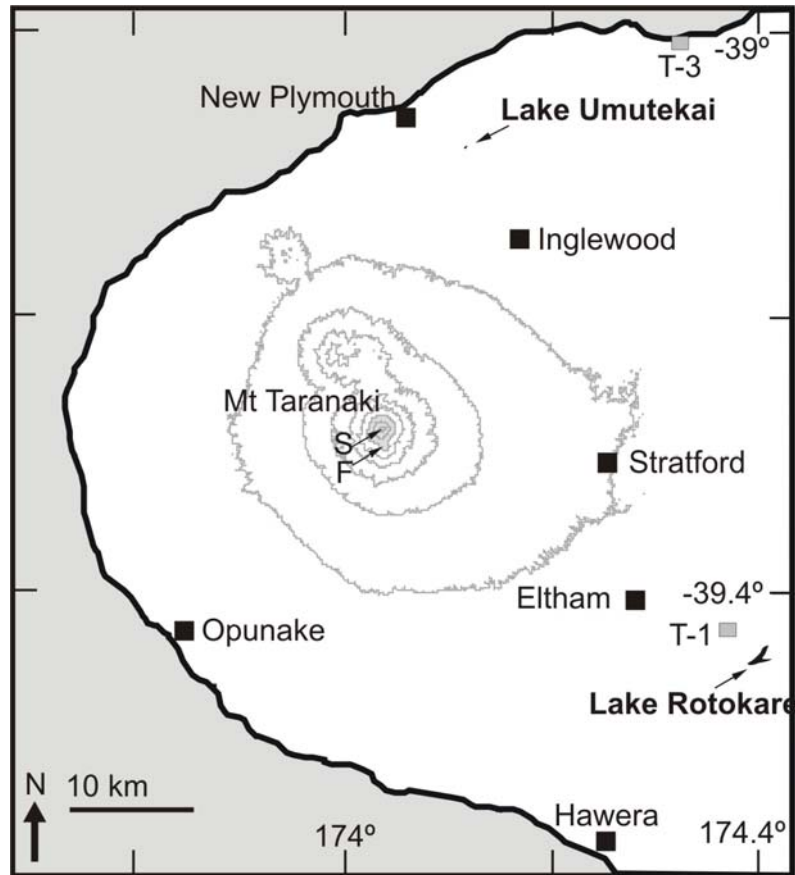


Figure 2.2: *Location map of the lakes used in this study. 300 m contours in thin grey lines. S = summit vent. F = Fanthams Peak vent. The grey squares T-1 and T-3 are the sample sites used by Alloway et al. (1994) to date the rhyolitic marker bed: the Stent Ash.*

2.4.1 Lake-sediment coring

Each lake was cored using a hand-operated Livingstone piston corer that is 1 m long, with a barrel of 35 mm diameter. The deepest part of the basin is likely to contain the most complete tephra record (c.f., Fontaine et al. 2007). Therefore, depth soundings were made to determine the bathymetry of each lake. Lake Rotokare bathymetry is much more varied and the deepest part of the basin occurs in approximately 12 m water depth at the apex of the Y-junction. Two cores were taken from this location. In contrast, Lake Umutekai has a water depth that is remarkably consistent at just over 1 m. Several cores were taken every few meters along a traverse of this lake. In addition, a 0.5 m, 35 mm diameter ‘D-section’ corer was used for field descriptions of the tephras preserved in Lake Umutekai (e.g., Fig. 2.3).

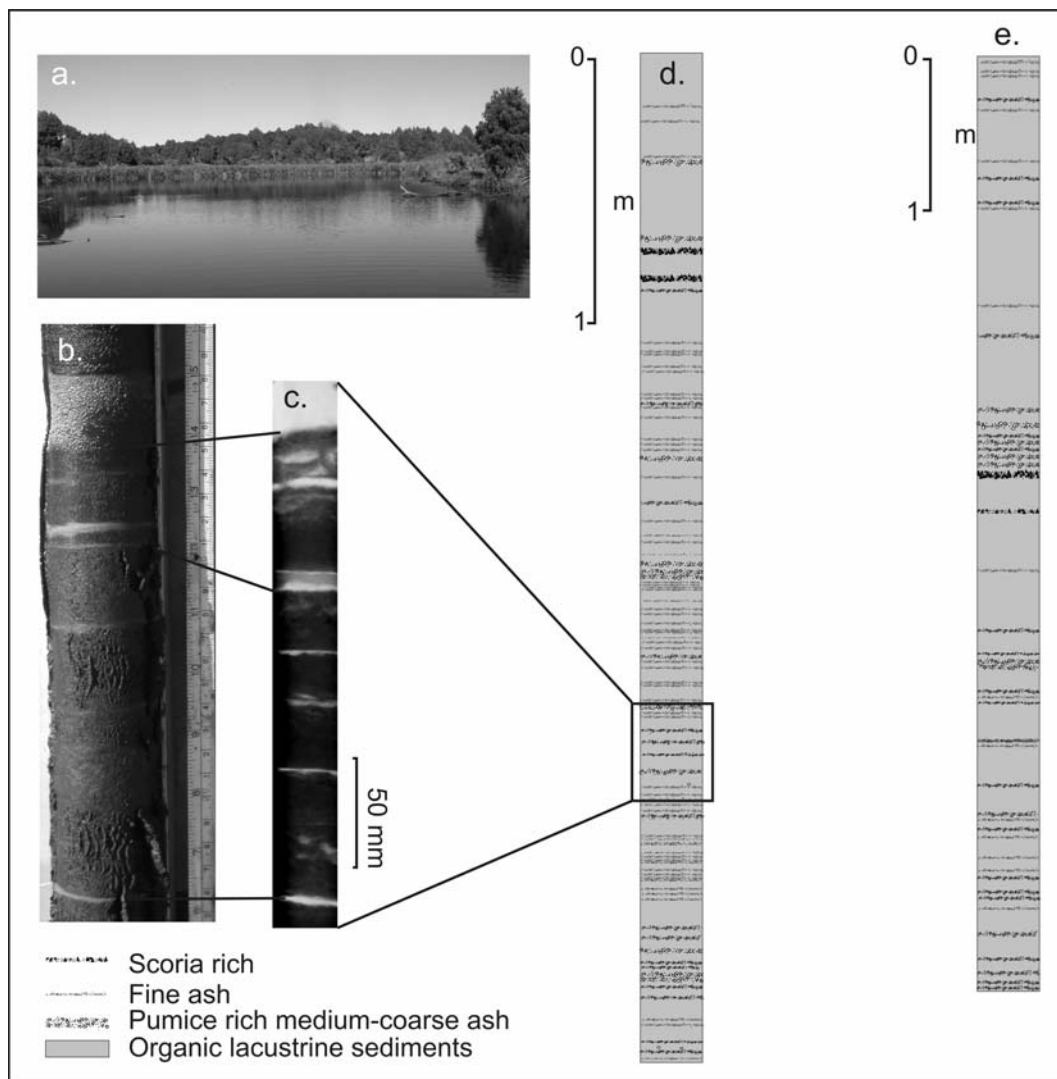


Figure 2.3: *Stratigraphy of Lakes Umutekai and Rotokare. (a) Photograph of Lake Umutekai, looking SW towards Mt. Taranaki; (b) part of the D-section core from Lake Umutekai; (c) X-Ray radiograph of approximately the same stratigraphic depth; (d) stratigraphic profile of Lake Umutekai; and (e) tephrostratigraphic profile of Lake Rotokare (excluding mud-layers).*

2.4.2 Recognition and sampling of tephra in lake sediments

The density differences between the tephra/mineral layers of the lake sediment cores and organic host sediment can be readily resolved by X-radiography (c.f., Lowe 1988). The cores from Lakes Rotokare and Umutekai were imaged with an X-Ray camera at the Institute of Veterinary Animal and Biomedical Sciences, Massey University. No

evidence of erosion (unconformities, disturbed beds) was found in the cores. All mineral layers identified within the Umutekai core were confirmed to be primary tephra by optical microscope; showing well sorted angular volcanic grains, including glass shards or glass-coated particles. However, not all were tephra in the Rotokare core. The mudstone hills surrounding Lake Rotokare have periodically contributed layers of mineral-rich mud to the lacustrine sediment profile. These mineral layers have a similar appearance to tephra deposits on X-Ray images and therefore each mineral layer was carefully examined to distinguish primary tephra layers. From several cores taken in each lake basin, the single core that contained the largest number of tephra layers was selected for further analysis (Fig. 2.3). Tephra down to 0.5 mm in thickness were readily recognised from the X-Ray radiographs and carefully sampled. The bulk sample was sieved (Appendix 2) and archived.

2.4.3 Chronology

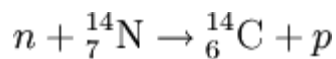
In both lakes, plant macrofossils (i.e., leaves, seeds) were not readily identified, so bulk samples of the peaty sediments were analyzed by Accelerator Mass Spectrometry (AMS) at the Rafter Radiocarbon Laboratory, National Isotope Centre, GNS Science, New Zealand. To obtain 2-3 grams of organic sediment for AMS radiocarbon dating, sediment slices 10-15 mm thick were taken. During core extraction, sediment smearing of the outer ~2 mm of the core may occur; therefore the outer layer of material was stripped and discarded before AMS sample submission.

Ten radiocarbon dates were acquired throughout the length of the Umutekai core and six from the Rotokare core (see Chapter 3; Appendix 1). These dates have normally distributed errors (Stuvier and Pearson 1992) and, along with the true sedimentation depth of each core (i.e., with instantaneous depositional events, such as tephra fall being subtracted), were used to construct the depositional/sedimentation rates for each lake by fitting a piecewise cubic Hermite interpolating polynomial (Fritsch and Carlson 1980; see also Appendix 1). One of the dates in the Lake Umutekai core (at about 1500 mm/4200 yrs B.P.) was clearly anomalous, because it implied a discontinuity in the polynomial fit. This date was therefore left out of polynomial fit and a much more physically reasonable curve was produced (see Chapter 3; Appendix 1). The core-depth

function was used to calculate estimated dates for all events represented in the core. Within the 3.5 m core obtained from Lake Umutekai, 104 tephras were identified between ~1550 and ~10 150 yrs B.P. By contrast, 42 tephras were identified between ~500 and ~6250 yrs BP of the 5 m core from Lake Rotokare (Fig. 2.3; see also Chapter 3).

Within the lacustrine sediment profiles of both lakes a silicic macroscopic tephra layer from Taupo Volcano Center was found: the Stent Ash (after Alloway et al. 1994). In both lakes it comprises a 10-20 mm thick fine ash, white to pink in colour (5YR 7/3). Alloway et al. (1994) give two radiocarbon dates (a third is listed as “contaminated”) for the Stent Ash from two separate locations near each of the lake sites of this study (Fig. 2.2; T-1 and T-3). These radiocarbon dates were averaged using the formula of Ward and Wilson (1978) to give an age of 3920 ± 59 yrs B.P. The Stent Ash therefore provides another date to constrain deposition rates at the two sites.

Radiocarbon (^{14}C) years are used within eruption frequency analyses presented in this thesis (i.e., Chapter 3; Appendix 1). Carbon-14 is produced in the Earth’s upper atmosphere by the impact of cosmic rays on nitrogen by the following reaction:



^{14}C is an unstable isotope of carbon and therefore decays back to nitrogen-14 with during a half-life 5568 ± 30 years (the Libby half-life; see Brook-Ramsey 2003). Plants take up atmospheric carbon dioxide by photosynthesis and are ingested by animals, so that every living thing is constantly exchanging carbon-14 with its environment as long as it lives. Once it dies, however, this exchange stops, and the amount of carbon-14 gradually decreases by radioactive beta decay. Therefore, assuming the proportions of carbon isotopes of the atmosphere has been constant throughout time, the age of organic material can be found. However, the level of atmospheric ^{14}C has not been constant because it is affected by variations in the cosmic ray intensity, which are in turn affected by variations in the Earth's magnetosphere. In addition, there are substantial reservoirs of carbon in organic matter, the ocean, ocean sediments, and sedimentary rocks. Changes in the Earth's climate can affect the carbon flows between these reservoirs and the atmosphere, leading to changes in the atmosphere's ^{14}C fraction. Raw radiocarbon

years, therefore, are not consistent with true calendar years and can not be used directly as a calendar age.

The raw radiocarbon dates, in B.P. years, are calibrated to give calendar ages. Standard calibration curves are available for each hemisphere, based on comparison of radiocarbon dates of samples that can be dated independently by other methods such as tree rings (dendrochronology) or deep ocean sediment cores (McCormic et al. 2004, Reimer et al. 2004, Stuiver and Pearson 1992). The differences between the radiocarbon years and calendar years is illustrated in Figure 2.4.

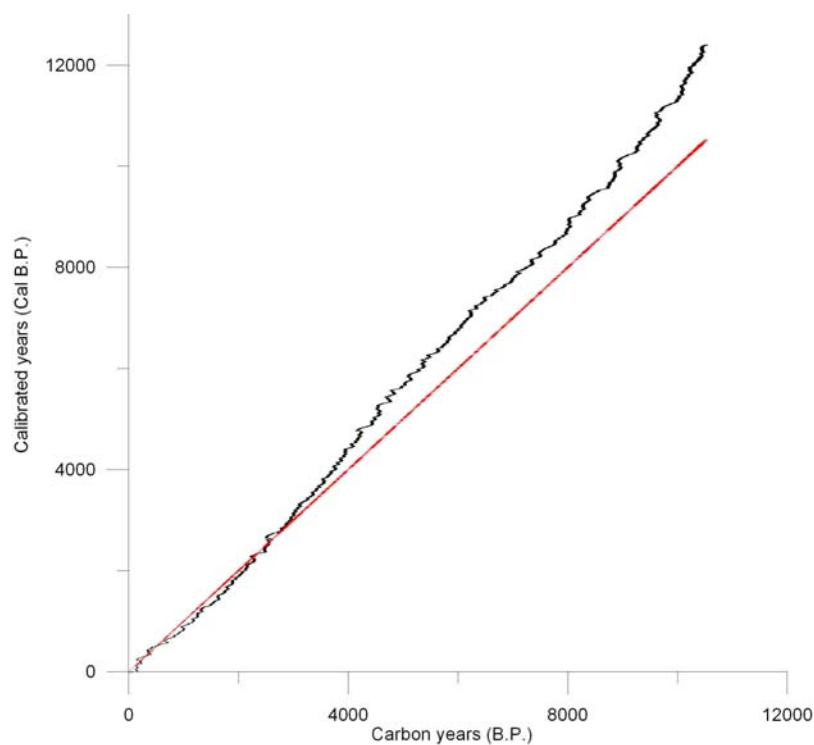


Figure 2.4 *The southern hemisphere, calibrated radiocarbon curve (McCormic et al. 2004). The width of each curve is equal to errors of one standard deviation.*

Normally distributed errors are associated with radiocarbon years and are the result of counting statistics of carbon-14 during analysis (Stuiver and Pearson, 1992). In contrast, the conversion of a radiocarbon age to that of a calendar year will produce a date that has significantly larger errors associated with it. These errors are due to the variation of the atmospheric carbon fraction with time resulting in irregular fluctuations

of the radiocarbon to calendar year curve (Fig. 2.4). In addition, the calibrated curve also contains a normal standard error associated with the radiocarbon dating of the known calendar year material (Fig 2.4). A single radiocarbon date with normally distributed errors may overlap the calibrated curve at a number of points; resulting in a date with much more complicated errors. This is clearly illustrated in Figure 2.5

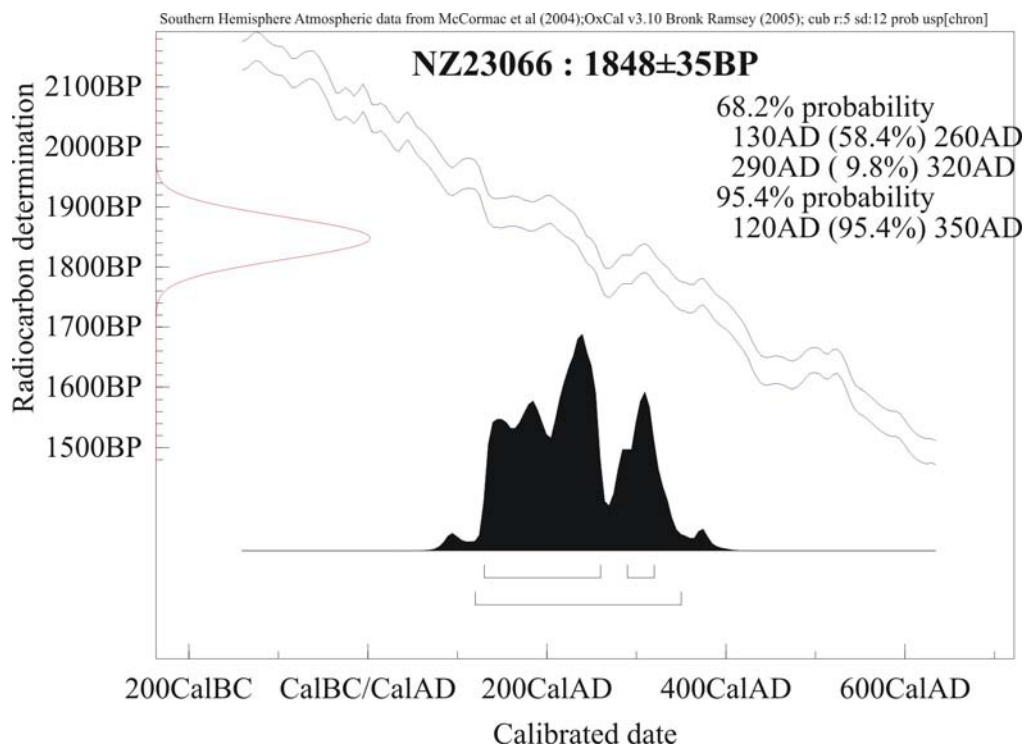


Figure 2.5 Calibration of radiocarbon date NZ23066 (years B.P.) to Calendar years (A.D.) years using OxCal v.3.10 (Brook-Ramsey 2005)

In Appendix 1 and Chapters 3, 4 and 6 of this thesis, a depth to age profile of the cores were used to assign radiocarbon ages to all of the individual tephtras. This data base is subsequently used in eruption recurrence analysis and forecast models (Appendix 1 and Chapter 3). The radiocarbon ages were initially used because they have relatively simple errors associated with them. Re-sampling can be made from within these error distributions, polynomials fitted, and interpolated dates obtained (Fritsch and Carlson 1980). Repeating the re-sampling procedure many times while maintaining the stratigraphic order will give interpolated dates with similar errors to those associated with radiocarbon dates (see Chapter 3 and Appendix 1). Performing the re-sampling procedure with calendar years would lead to a tendency in the Monte Carlo procedure to

group multiple tephra layers as single events. However, because tephra layers are separated by sediment, individual tephras must be separated in time. It was therefore decided that, in the first instance, radiocarbon years would be used for the recurrence analysis and subsequent eruption forecast models. However, since radiocarbon ages are not true years before present eruption predictions can not be accurately made. In Chapter 3 it is assumed that the forecasted probability using the radiocarbon event database is overstated by up to 14% because of the slightly longer timeframe (i.e. 6250 years B.P. calibrates to 7220-7050 Cal. years B.P.; Fig. 2.4).

In Chapters 4 and 6 the radiocarbon event database was smoothed into a probability of events per year function and variations in the eruption frequency from this curve (e.g. Fig. 4.7) form the discussion of these chapters. These observed variations in eruption frequency are real because they can be observed within the raw data of the core stratigraphy (see Chapter 3 and Appendix 1). In addition, because the variations in eruption frequency are observed over a relatively large time frame (c. 11 000 years B.P.), the difference between carbon years B.P. and calendar years B.P. is not so significant (i.e., Fig. 2.4).

2.4.5 Additional implications of the lake-records

The upper 300-500 mm of the lake sediments are not yet compacted; they are of low-density suspended material that is lost on extraction attempts. Hence the last c. 1500 yrs B.P. from the Umutekai record and c. 500 years B.P. of the Rotokare record are missing.

Ash layers preserved within the lacustrine environment may represent anywhere between a few hours to approximately a year of near continuous volcanic activity. The relatively slow sedimentation rate of the lacustrine environment means that time intervals of a few months between individual eruption plumes may not be separated by significant organic sediment. Each of the identified ash layers within these records are therefore used to define *events*. Simkin and Siebert (1994) define an *event* as a series of linked eruption-activity separated by intermittent quiescence of no more than three months.

Mud layers sourced from the surrounding Tertiary sediments are common throughout the cores extracted from Lake Rotokare. However, there are a number of time intervals where both the number and thickness of these layers increase dramatically: the base of the core to a depth of approximately 4 m (>6000-4500 yrs B.P.); between 3 and 2.6 m (~ 3400-3000 yrs B.P.) between 1.2 and 1.6 m (~1200-1500 yrs B.P.). This material is sourced from destabilisation of mudstone within the headwaters of the lake. Crozier et al. (1995) identify over 100 deep-seated landslides between 1200 - 1500 yrs B.P. within the district surrounding Lake Rotokare and suggested that these events were triggered by an earthquake centred near Waverly (~50 km SE of Lake Rotokare). Such landslides are expected to feed mud layers into the lake. Similar destabilisation events probably accompanied the latest movement of the Inglewood Fault (north of Lake Rotokare) between 3300 and 3500 yrs B.P. (Sherburn and White, 2006). This corresponds with a significant mud layer within the lake core. The lowermost mud layers may represent destabilisation of the headwaters at approximately 6500 yrs B.P. in association with the latest documented movement of the Oaonui Fault (Hull & Dellow 1993).

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Chapter Three:

Andesitic Tephrochronology and its Importance for Probabilistic Eruption Forecasting

This chapter demonstrates that titanomagnetite microphenocrysts, present within all eruptions from Mt. Taranaki, have compositions that are unique to each erupted magma or magma batch. This observation means that titanomagnetite compositions can be used to correlate tephra deposits between locations and therefore aid in compiling an eruption record that is more representative of the true eruption frequency of Mt. Taranaki.

3.1 Introduction

Chapter 2 introduced the locations of the most complete stratigraphic profiles of eruption events from Mt. Taranaki. These included 12 soil profiles of proximal sites at around 800 m altitude on the volcanic edifice, and two lacustrine sediment cores from the medial sites in the surrounding ring plain at Lake Rotokare and Lake Umutekai. Deriving a complete eruption history for reliable probabilistic eruption forecasting requires the integration of both these proximal and distal records. Typically the more distal lake records contain the most complete records. This is because the extremely low-energy sedimentation environment within lakes allows even very fine-grained and thin tephra falls to be preserved as identifiable layers within slowly, but constantly accumulating organic-rich sediment. Ashfall deposits within lacustrine records from lake basins or away from major stream inlets or outlets are mostly unaffected by erosion. At medial and distal sites, tephra deposits are also thin enough that they can be penetrated by standard peat-coring techniques, and allow long-term records to be contained within <10 m of core. The organic-rich lacustrine materials inter-bedded with the ash-fall deposits can also be readily radiocarbon dated. With multiple dated horizons, a very precise sedimentation rate curve with known errors can be constructed

to date all deposits of the lake. The method used to construct sedimentation-rate curves is presented within section 3.5 and also discussed in Appendix 1. From this curve, the dataset of tephra deposits are assigned ages that have similar means and errors associated with actual radiocarbon dates. The main focus of this chapter is to combine the tephra records from all studied sites and thus compile a complete Holocene eruption record at Mt. Taranaki.

The majority of this chapter is contained within the manuscript: *Merging Eruption Datasets: Building an Integrated Holocene Eruptive Record for Mt. Taranaki, New Zealand* by Michael B. Turner, Mark S. Bebbington, Shane J. Cronin, Robert B. Stewart, and Ian E.M. Smith, which has been recently accepted for publication in the journal *Bulletin of Volcanology*. This manuscript combines two techniques for correlating syn-eruptive tephra layers between the two lacustrine eruption records. Firstly, tentative matches are identified using the radiocarbon age and associated error of each event (section 3.6). Secondly, the compositions of titanomagnetite microphenocrysts are used as an independent check (sections 3.7-3.9). Eruption renewal models are fitted to the resulting combined dataset. The updated probabilistic eruption forecast provides an annual eruption probability that is almost double the previous predictions using a single site (i.e., Appendix 1). These analyses illustrate the importance of compiling an integrated eruption record for more reliable hazard assessments.

The contributions of each author to the study were as follows:

Michael .B. Turner: Principal investigator:

Carried out:	Field description and sampling
	Laboratory preparation
	Electron microprobe analyses
	Geochemical interpretation
	Manuscript preparation and writing

Shane J. Cronin

Chief Advisor:

Aided the study by: Assistance in field work
Discussion of data and interpretations
Editing and discussion of the manuscript

Mark S. Bebbington: Statistician:

Aided the study by: Construction of the sedimentation rate
curve (3.5)
Age correlation technique (3.6)
Assistance in Principal Component
analyses (3.9)
Development of the eruption Hazard
mode (3.10; see also Appendix 1)

Ian E.M. Smith, Robert B. Stewart: Advisors:

Aided the study by: Editing and discussion of the manuscript

Using the finding that titanomagnetite compositions can be used to reliably correlate co-erupted products from Mt. Taranaki, the last part of the chapter (3.14 - 3.15) demonstrates a correlation of the well-dated lacustrine deposits of Lakes Umutekai and Rotokare to all of the edifice records. Canonical discriminant function analysis (DFA) is used within this section to aid in correlations based on the compositional data.

3.2 Merging eruption datasets: building an integrated Holocene eruptive record for Mt. Taranaki, New Zealand

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3.2.1 Abstract

Acquiring detailed eruption frequency datasets for a volcano system is essential for realistic eruption forecasts. However, accurate datasets are inherently difficult to compile, even if one or more well-dated eruption records are available. A single site typically under-represents the eruption frequency, while combining two or more sites may result in an overrepresentation. Although glass compositions have proven to be successful in tephrochronological studies of dominantly rhyolitic tephras, microlitic growth and thin glass shards inhibit their application to andesitic tephras. A method consisting of a combination of two techniques for correlating syn-eruptive deposits is demonstrated on data from the typical andesitic stratovolcano of Mt. Taranaki, New Zealand. Firstly, tentative matches are identified using the radiocarbon age and associated error of each event. Secondly, the compositions of titanomagnetite microphenocrysts are used as an independent check, and shown to be a useful correlation tool where age data is available. Using two lake-core records containing tephra layers in an overlapping time-frame, the radiocarbon age-correlation procedure suggested 31 tephra matches. Geochemistry data were available for 15 of these pairs. In three of these cases, the titanomagnetite compositions did not match. Hence, these “paired” tephras were from compositionally distinct magmas and therefore likely represent separate events.

An additional three matches were reassigned within the temporal uncertainty limits of the dating procedure, based on better geochemical pairing. The final combined dataset suggests that there have been at least 138 separate ash fall-producing eruptions between 96 and 10 150 years B.P. from Taranaki. Using the combined dataset the mixture of Weibulls renewal model forecasts a probability of 0.52 for an eruption occurring in the next 50 years at this volcano. The present annual eruption probability is estimated at 1.6%. This likelihood is almost double that obtained when relying on a single stratigraphic record.

3.3 Introduction

The largest obstacle for accurate natural hazard evaluation is that datasets of past events are often of poor quality, underestimating or overestimating the true frequency of hazard events. Despite this, probabilistic hazard forecasts have often been the goal of volcanic hazard evaluations (see, for example, Burt et al. 1994; Connor and Hill 1995; Bebbington and Lai 1996a; Cronin et al. 2001, De la Cruz-Reyna and Carrasco-Nunez 2002; Marzocchi et al. 2004; Eliasson et al. 2006; Turner et al. 2008a). A vast array of tephra-producing eruption styles is possible from andesitic volcanoes; from locally distributed pyroclastic flows to widespread plinian or sub-plinian eruptions. This large variation in eruption styles means that compiling an accurate eruption record is particularly problematic. Tephra dispersal is highly variable, dependent on the dominant wind strength and direction(s) during the eruption of the volcanic plume (e.g., Carey and Sparks 1986). Not all tephra-producing eruptions may, therefore, leave a deposit at a single location. Thus using the frequency of these events will result in under-representation of the true number of eruptions from a volcano. In contrast, because a single eruption will disperse tephra over a wide area, combining one or more records can result in a doubling-up of events, which can result in an over-representation of the number of eruptions. Obtaining a detailed record that spans a long-enough period to incorporate short-term variations of the volcano's activity is also difficult.

Here it is demonstrated that if two or more well-dated tephra records are obtained, they can be combined, once probable duplicates of common events are subtracted. The

resulting composite record is a more accurate representation of the true eruption frequency and recurrence. It is also illustrated that titanomagnetite is a useful phase to fingerprint andesitic eruptions from medium to distal locations. Re-application of the renewal process hazard model of Turner et al. (2008a; Appendix 1) demonstrates the benefits of obtaining a composite dataset in the marked improvement of probabilistic eruption forecasts.

3.3.1 Mt. Taranaki: the eruption records

Mt. Taranaki (Egmont volcano) is a basaltic to andesitic-dacitic strato-volcano that rises in near perfect conical form to 2518 m above sea level (Fig. 3.1). It is the westernmost expression of current volcanic activity within New Zealand, lying some 180 km behind the active volcanic arc (Cole 1990). Although currently in a state of quiescence, recent studies (Alloway et al. 1995; Turner et al. 2008a; Appendix 1) have shown it to have been very active, with VEI 4+ pumice eruptions occurring interspersed with relatively smaller scale explosive and lava extrusion episodes. The frequency-volume curve estimated from the Umutekai lake core by Bebbington et al. (2008) shows a logarithmic relation with slope approximately 1. Approximately 15% of the estimated volumes are greater than 0.1km^3 , with the largest at 0.94 km^3 . Turner et al. (2008a) noted that there appears to be no significant relationship between eruption size and the following (or preceding) repose period. This type of activity, and also the geochemistry/petrology of the resulting deposits, is very similar to those of several recently highly active volcanoes, including Merapi (Indonesia), Unzen (Japan), Colima (Mexico) and Augustine (Alaska) and hence Mt. Taranaki must be seen as having a similar hazard potential as these volcanoes. The date of the most recent eruption from Mt. Taranaki is controversial. Druce (1966) used dendrochronology to date a distinct, locally distributed ash within the soil profile of the edifice to AD 1755. Paleovegetation studies and pollen evidence (Lees and Neall 1993) indicated that the last tephra producing event was around AD 1860, at or near the time of European settlement in the area. Recent stratigraphic and geochemical evidence confirms that two post AD 1755 events occurred at c. AD 1800 and 1854 (Platz et al. 2006).

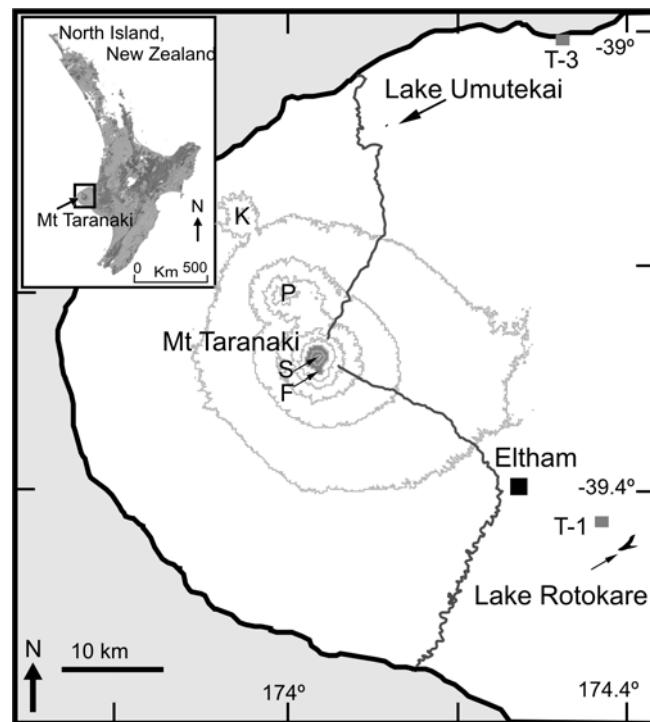


Figure 3.1: *Map of the Taranaki region showing the locations of the sample sites; Lake Umutekai and Lake Rotokare in relation to Mt. Taranaki's edifice. 300 m contours shown in grey with the >1500 m highlighted. (S) Summit vent, (F) Fanthams Peak vent, (P) Pouakai Volcano (extinct), (K) Kaitake Volcano (extinct). The grey squares T-1 and T-3 are the sample sites used by Alloway et al. (1994) to date the rhyolitic marker bed: the Stent Ash. The black square gives the location of Eltham Township and main river channels which direct flows towards the lakes are shown in dark grey (see text). Insert: North Island, New Zealand.*

In order to compile as complete as practicable eruption dataset for Mt. Taranaki, three separate eruption records were acquired. Two of these were obtained from sediment cores from lakes that are located sufficiently near to the volcano to record minor eruptive events, but at a great enough distance to be mostly unaffected by debris and pyroclastic flow deposits. Lake Umutekai, lying 25 km NNE of the summit of Mt. Taranaki (Fig. 3.1), is a lake approximately 0.02 km² and up to 2 m-deep formed within a swampy depression on a planar volcanoclastic surface. The surrounding landscape was densely forested throughout the Holocene (McGlone and Neall 1994). Lake Rotokare lies 30 km southeast of Taranaki's summit (Fig. 3.1). It is a Y-shaped lake, formed by a landslide damming event. It is 0.25 km² in area with a maximum width of 200 m and a

maximum water depth of 12 m at the apex of the Y-junction. Lake Rotokare and its head waters are surrounded by steep unstable hills of weakly consolidated Pleistocene and Pliocene marine blue-grey mudstones (cf., Fleming 1976).

Several cores were collected in 1 m sections from each lake using a 35 mm diameter hand-operated piston corer. The cores were imaged with an X-Ray camera to identify mineral layers within the organic host sediments, particularly sub-mm units. No evidence of erosion (non-deposition or sediment disturbance) was found in the cores. All of the mineral layers identified within the Umutekai core were confirmed to be primary tephras by optical microscopy (well sorted angular grains, including glass shards or glass-coated particles). However, the mudstone hills surrounding Lake Rotokare have periodically contributed layers of mineral-rich, mudstone material. Therefore each mineral layer identified within the X-ray images was carefully examined under microscope and primary tephras layers were identified and sampled for further analysis.

Table 3.1: *Radiocarbon dates from lake sites used in this study*

Date Code or age source	Age (Yrs B.P.) ^a	Material	Sample Depth (mm)	Source
<u>Umutekai core</u>				
S39° 05.27'				
E174 °08.22'				
NZ23065	1559 ± 40	Peat	148-163	Turner et al. (2008a)
NZ23066	1848 ± 35	Peat	356-379	Turner et al. (2008a)
NZ23067	2098 ± 35	Peat	570-585	Turner et al. (2008a)
NZ23117	2369 ± 30	Peat	678-695	Turner et al. (2008a)
NZ23068	3142 ± 35	Peat	1029-1045	Turner et al. (2008a)
NZ23069	3507 ± 35	Peat	1189-1205	Turner et al. (2008a)
NZ23085	4345 ± 40	Peaty silt loam	1699-1715	Turner et al. (2008a)
NZ23089	7068 ± 55	Peaty silt loam	2399-2415	Turner et al. (2008a)
NZ23118	9219 ± 45	Peaty silt loam	3027-3045	Turner et al. (2008a)

Table 3.1: *cont.***Rotokare core**

S39° 27.10'

E174 °24.64'

NZ5511	547 ± 35	Peat	260-273	This Study
NZ5512	2120 ± 35	Peat	2077-2090	This Study
NZ5513	3065 ± 30	Peat	2630-2645	This Study
NZ5463	3749 ± 30	Peat	3400-3415	This Study
NZ5464	4662 ± 30	Peaty silt loam	4093-5005	This Study
NZ5465	6074 ± 40	Peaty silt loam	4776-4790	This Study

Slices (1 cm) of the organic sediments were sampled for radiocarbon age determination using the AMS method at the Rafter Radiocarbon Laboratory, New Zealand. Nine samples (a tenth was contaminated, and discarded) were dated from the Umutekai core (Turner et al. 2008a) and six from Rotokare (Table 3.1). In addition to these dated horizons, the rhyolitic ‘Stent Ash’ sourced from the Taupo Volcanic Centre ~250 km NE of Mt. Taranaki produces a common horizon within each record (cf., Alloway et al. 1994). These dates (Table 3.1) have normally distributed errors (Stuvier and Pearson 1992) and along with the true sedimentation depth of each core (i.e., with instantaneous depositional events, such as tephra fall being subtracted), have been used to construct depositional/sedimentation rates for each lake (Fig. 3.2). The sedimentation rate of Lake Umutekai is considerably slower than that of Lake Rotokare, with the 3.5 m core obtained from Lake Umutekai containing 104 tephtras between ~1550 and ~10,150 years B.P.; compared to 42 tephtras between 500 and ~6250 years B.P. of Lake Rotokare’s 5 m core.

Ash layers preserved within the lacustrine environment may represent anywhere between a few hours to approximately a year of near continuous volcanic activity. The relatively slow sedimentation rates within the lakes means that time intervals of a few months between individual eruption plumes will not be separated by organic sediment. Therefore each of the identified ash layers within these records are termed *events*

because the Simkin and Siebert (1994) *event* definition is of a series of linked eruptions separated by intermittent quiescence of no more than three months.

Table 3.2: *Radiocarbon dates of ‘near source events’ used in this study*

Date Code or age source	Age (yrs B.P.) ^a	Location	Material	Material	Source
		Lat (°S)	Long (°E)		
Estimated historical age ^b	96	N.A.	N.A.	N.A.	Turner et al. (2008a)
Estimated historical age ^b	150	N.A.	N.A.	N.A.	Turner et al. (2008a)
NZ5593	<250	39° 16.30’	174° 00.00’	Charcoal	Turner et al. (2008a)
Dendrochronology age ^c	195	N.A.	N.A.	Tree rings	Druce (1966)
NZ721	249 ± 55	39° 20.30’	174° 13.70’	Wood	Grant-Taylor and Rafter (1971)
Wk 2376	300 ± 60	39° 15.41’	173° 56.10’	Charcoal	This study
Wk11590	305 ± 39	39° 16.26’	174° 00.80’	Charcoal	Turner et al. (2008a)
NZ63	300 ± 60	39° 18.46’	174° 07.50’	Charcoal (anthropogenic)	Fergusson and Rafter (1957)
NZ64	400 ± 60	39° 18.46’	174° 07.50’	Charcoal	Fergusson and Rafter (1957)
<i>R-Combine of NZ63 and NZ64^d</i>	356 ± 42	N.A.	N.A.	N.A.	N.A.
Wk11593	382 ± 39	39° 15.91’	173° 58.73’	Charcoal	Turner et al. (2008a)
Wk11585	387 ± 43	39° 16.65’	174° 00.32’	Charcoal	Turner et al. (2008a)
NZA941	404 ± 44	39° 15.10’	173° 56.10’	Charcoal	Neall (1979)
NZ720	439 ± 55	39° 16.5’	174° 00.1’	Leaves	Grant-Taylor and Rafter (1971)
NZ1141	447 ± 40	39° 15.10’	173° 56.10’	Charcoal	Turner et al. (2008a)
Wk11589	453 ± 43	39° 16.26’	174° 00.80’	Charcoal	Turner et al. (2008a)
<i>R-Combine of NZ720, NZ1141 and Wk11589^d</i>	447 ± 26	N.A.	N.A.	N.A.	N.A.
Wk11584	468 ± 42	39° 16.65’	174° 00.32’	Charcoal	Turner et al. (2008a)
Wk11591	475 ± 42	39° 16.26’	174° 00.80’	Charcoal	Turner et al. (2008a)
<i>R-Combine of Wk11584 and Wk11591^d</i>	472 ± 30	N.A.	N.A.	N.A.	N.A.

NZ567	537 ± 55	39° 18.10'	173° 59.00'	Charcoal	Grant-Taylor and Rafter (1971)
NZ1256	620 ± 74	39° 16.31'	174° 00.01'	Charcoal	Neall (1979)
Wk11594	605 ± 42	39° 15.91'	173° 58.73'	Charcoal	Turner et al. (2008a)
<i>R-Combine of NZ1256 and Wk11594^d</i>	609 ± 37	N.A.	N.A.	N.A.	N.A.
Wk11592	649 ± 49	39° 16.26'	174° 00.80'	Charcoal	Turner et al. (2008a)
Wk11586	878 ± 39	39° 16.66'	174° 00.32'	Charcoal	Turner et al. (2008a)
Wk2378	970 ± 40	39° 05.10'	173° 56.90'	Wood	Neall (1999)
NZ5596	1000 ± 60	39° 16.30'	174° 00.00'	Charcoal	Turner et al. (2008a)
<i>R-Combine of Wk2378 and NZ5596^d</i>	979 ± 33	N.A.	N.A.	N.A.	N.A.
Wk-16391	1130 ± 34	39° 17.11'	174° 06.00'	Charcoal	Turner et al. (2008a)
NZ6508	1390 ± 150	39°19.01'	174° 08.60'	Peat	McGlone et al (1988)
<u>'Stent ash'</u>					
Combined average of: Wk1259, Wk1032 ^d	3920± 59	N/A	N/A	N/A	Alloway et al. (1994)

^a Radiocarbon age in years before present (B.P.) using Libby half-life

^b Eruption age estimated from historical evidence (T. Platz, unpublished data)

^c Dendrochronology estimate from damage to living trees by Druce (1966)

^d Average radiocarbon dates, combined using OxCal v.3.9, Brook-Ramsay (2003).

The soft, saturated and unconsolidated lake sediment within the upper 300-500 mm of the lake was difficult to sample because it could not be easily extracted using the piston-core method. Hence the last c. 1500 years B.P. from the Umutekai record and c. 500 years B.P. of the Rotokare record are missing (Fig. 3.2). Turner et al. (2008a; Appendix 1) completed the Umutekai record by compiling a dataset of 23 dated eruptions deposited on the edifice (Table 3.2). These eruptions occurred between the most recent known event at 96 years B.P. to one that occurred approximately 1400 years B.P. This dataset has also been included in the eruption hazard model section of this study.

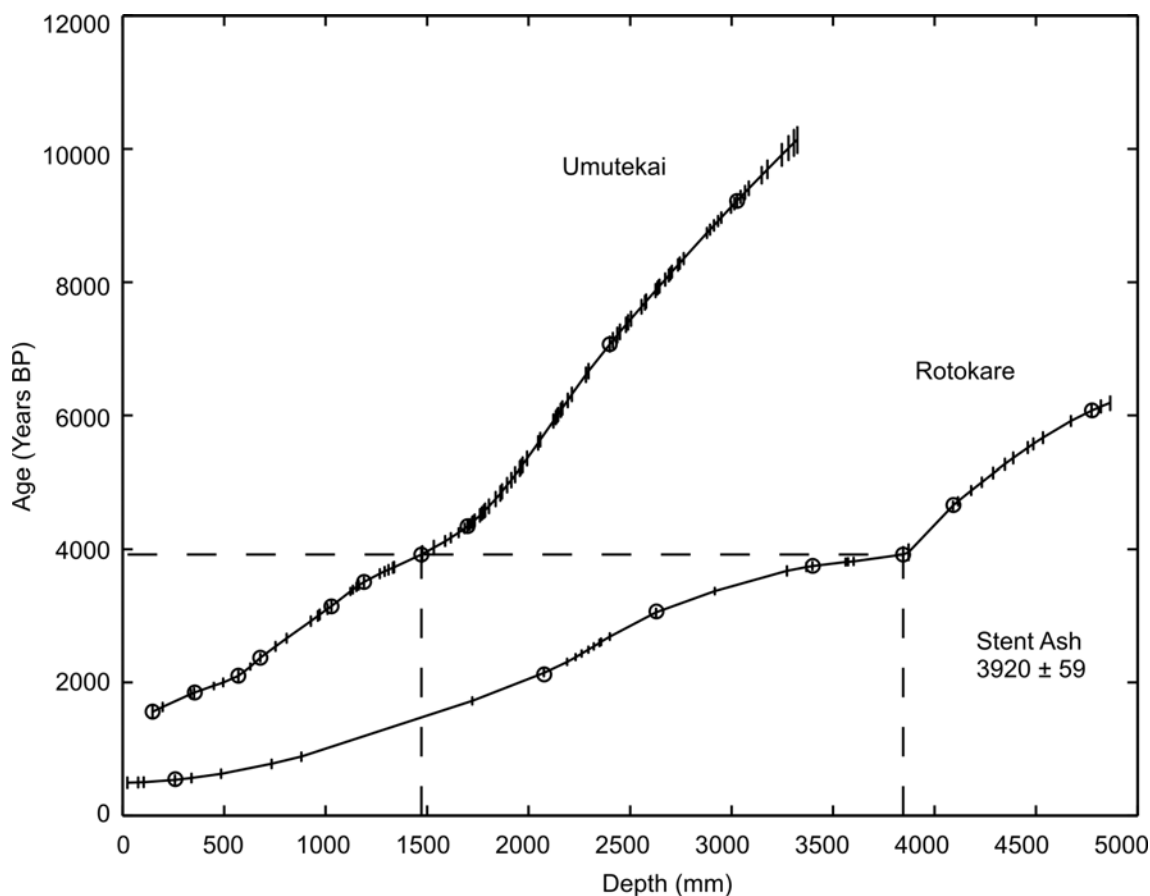


Figure 3.2: *Depth-age curves. Dated events indicated by circles, imputed events by their estimated age 2 standard deviations.*

3.3.2 The age/depth curves of Lake Umutekai and Lake Rotokare

Radiocarbon (^{14}C) ages expressed in years B.P. are used here because this enables application of normally distributed errors to the dates (i.e., characterised by only a standard deviation) rather than the complex error distributions associated with the calibration of radiocarbon to calendar years (see Bronk-Ramsey 2003). Nine depth slices from Umutekai and six from Rotokare were dated and used to interpolate ash-layer (event) ages within each core via a piecewise cubic Hermite interpolating polynomial fit (cf., Turner et al. 2008a; Appendix 1). Since the core dates have estimated errors, re-sampling can be made from within the error distributions, polynomials fitted and interpolated dates obtained. Repeating the re-sampling procedure many times while maintaining the stratigraphic order of tephras within the core produces similar means and errors for the interpolated core depths to those associated

with actual radiocarbon dates. In addition, Alloway et al. (1994) give two radiocarbon dates (a third is listed as “contaminated”) for the Stent Ash from two separate locations near each of the lake sites of this study (Fig. 3.1; T-1 and T-3). These radiocarbon dates were averaged using the formula of Ward and Wilson (1978), and were used in both cores to constrain the matching procedure at a known fixed point.

Variations in the sedimentation rate at each site appear to follow a similar pattern, probably occurring in response to regional climate changes during the studied interval. For example, the sedimentation rate between 9000 and 5000 years B.P. at Lake Umutekai relates to a time when the region experienced a milder, more equable climate than at present (McGlone and Neall 1994).

3.4 Combining datasets using the event ages

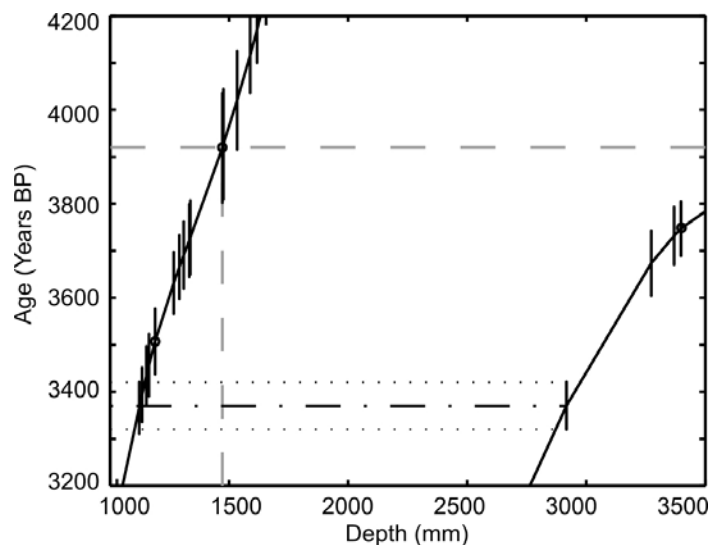


Figure 3.3: *A magnified section of the depth-age curves from Umutekai (left) and Rotokare (right).*

In total there are 169 events from all three records. However, one eruption event may deposit tephra in more than one of the sites. Since each event in both records has an assigned age with associated normally distributed errors, an event age may overlap that of one or more events within the other record(s). For example, within the magnified section of the sedimentation-rate curves from each lake (Fig. 3.3), the estimated age of

Due to having normally distributed errors in age determinations, the age *distance* (d) between two tephtras in different sites with mean ages m_1 and m_2 , and standard deviations s_1 and s_2 can be calculated by:

$$d_{1,2} = \frac{|m_1 - m_2|}{\sqrt{s_1^2/2 + s_2^2/2}} \sim N(0,1)$$

Table 3.3: *Temporal distances between Umutekai (U) and Rotokare (R) tephros. Tephros in bold have geochemistry results available, and the Stent Ash (R27-U27) is highlighted. A distance that is the minimum in both row and column is in bold italics. Underlining indicates matches inconsistent with the geochemistry, and italics preferred alternatives. Parentheses indicate other potential alternative matches. See text for further details.*

[illegible]

Table 3.3: *cont...*

	R29	R30	R31	R32	R33	R34	R35	R36	R37	R38	R39	R40	R41	R42
U41	2.2													
U42	1.7													
U43	0.3	1.8												
U44	2.2	0.8	2.8											
U45		2.6	1.0											
U46			0.3											
U47			1.8	1.0										
U48				0.7	2.1									
U49				2.3	0.5									
U50					1.5	1.3								
U51					2.0	0.9	2.8							
U52					2.7	0.2	2.1							
U53					3.0	1.8	0.2							
U54								1.5	0.3	1.7				
U55								2.5	1.3	0.7				
U56											0.0			
U57											1.2	2.3		
U58											1.9	1.7	2.8	
U59											2.3	<i>1.2</i>	2.4	
U60												0.1	<i>1.2</i>	2.1
U61												0.2	1.1	<i>2.0</i>
U62												0.9	0.5	1.4
U63													1.9	<u>0.7</u>
U64														2.4

This identifies possible *candidates*, i.e., those pairs at a distance less than three that could be from the same eruption. Table 3.3 reports all distances less than three between the Umutekai and Rotokare tephras. From these possible candidates, the mutually closest pairs can be indentified, as the minimum in both the row and column. Subtracting these pairs, the remaining pairs (outlined in Table 3.3) can be checked again to identify possible matches where one or both of the tephra(s) had an alternative match. This respects the stratigraphic order within each record. The resulting matched tephras are tentatively identified as representing a single event. Similar results for the near-source events are given in Table 3.4.

Table 3.4: *Temporal distances between near-source (N) and lake (U + R) derived tephras. A distance that is the minimum in both row and column is in bold. See text for further details.*

	N10	N11	N12	N13	N14	N15	N16	N17	N20	N21	N22	N23
R1	2.3	1.4	0.3	1.2								
R2	2.6	1.7	0.5	1.1								
R3	2.8	1.8	0.7	1.0								
R4			1.9	0.1	2.2							
R5				0.7	1.4	2.9						
R6				2.6	0.6	1.2						
R8							0.2	2.7				
R9									0.5			
U3										2.9		
U4										2.4		
U5										0.1	1.7	
U6										1.4	0.2	
U7											2.4	
U8												0.7

3.5 Geochemical fingerprinting

Tephrochronology employs a number of techniques to characterise individual tephras so that they can be used as isochrons in a wide-range of stratigraphic sequences and landscapes. Physical characteristics of the tephra (e.g., mineral components, distinct bedding features, pumice-to-lithic ratios, etc.) and stratigraphic position within the depositional sequence are used to identify widespread tephra deposits within proximal locations (e.g., Westgate and Gorton 1981; Froggatt 1983). Geochemical fingerprinting becomes more important at medial-distal sites (e.g., Cronin et al. 1996a; Shane 2005; Grönvold et al. 1995). Typically, major element components of glass shards determined by electron microprobe (EMP) are used to distinguish erupted magma from different events and sources. This technique has proven to be ideal for identification of widespread silicic tephras from typically caldera-forming eruptions where, due to the relatively viscous magma and low mineral cargo, thick glass shards are quenched with very little compositional variation (e.g., Froggatt 1983; Smith et al. 2005; Stokes et al. 1992). However, attempts at fingerprinting and correlating andesitic tephras have proven to be difficult. Many studies have identified large geochemical heterogeneity.

For example, Shane (2005) identified variations in silica greater than 10 wt% in a single unit of andesite tephra from Mt. Taranaki. Syn- and post-eruption crystallisation of nanolitic (200-1000 nm) Fe-oxides and microlitic ($<10\ \mu\text{m}$) plagioclase can lead to fine-scale heterogeneity of the interconnecting glass, through element diffusion (Best 2003). This fine-scale crystallisation is difficult to identify under back-scatter electron imaging and also difficult to avoid with the large analysis area ($\sim 20\ \mu\text{m}$) required for glasses (Platz et al. 2007). In addition, lower magma viscosity in andesites gives rise to very thin glass shard walls in pyroclasts (Hunt and Hill 1993). Identifying a glass shard that is thick enough for analysis ($>20\ \mu\text{m}$, cf., Froggatt 1983) and uncontaminated by microlite growth is therefore particularly difficult.

Alternative approaches to andesitic tephra discrimination have been attempted. These include using the major element compositions of phenocryst phases by EMP analysis (Smith and Leeman 1982; Cronin et al. 1996a; Smith et al. 2005), trace-element geochemistry of bulk rocks by X-ray fluorescence spectrometry (XRF) (Donoghue et al. 2007) and laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) (Perkins et al. 1994). Kohn (1970) identified widespread, rhyolitic tephra on the basis of titanomagnetite compositions. Cronin et al. (1996b) also showed that by using discriminant function analysis, titanomagnetites can be used to distinguish between andesite tephra from Mt. Taranaki and the Tongariro Volcanic Centre ($\sim 200\ \text{km}$ to the east) and importantly, suggested that individual Mt. Taranaki tephra may have unique titanomagnetite compositions.

3.5.1 Titanomagnetite geochemistry

Titanomagnetite is an ideal mineral phase for tephra discrimination, because it is ubiquitous in most andesitic tephra and being smaller than other andesitic phenocrysts (typically $63 - 125\ \mu\text{m}$) it can be easily carried to distal locations. Titanomagnetite is also resistant to post-depositional weathering and in some cases can be the only indication of a primary tephra deposit within a highly weathered soil profile (Kohn 1970). It is also easily extracted from very small sample volumes ($<45\ \text{mm}^3$) by a low-powered magnet and can be well polished for efficient EMP analysis (Fig. 3.4 a,b,c).

Large element diffusion coefficients of titanomagnetite mean that elemental components (or ratios) can reflect changes within the surrounding magma compositions and conditions (Tomiya and Takahashi 2005). For example, assuming a Ti diffusion coefficient of $1.3\text{--}10.3 \times 10^{-17} \text{ m}^2/\text{s}$, a typical 80–100 μm diameter grain at andesitic temperatures (900 $^{\circ}\text{C}$) would be homogenized with respect to Ti within 1.5–12 years (Freer and Hauptman, 1978). Increasing temperature at constant $f\text{O}_2$ or decreasing $f\text{O}_2$ at constant temperature results in an increase in titanomagnetite Ti contents (Devine et al. 2003). In contrast, the concentrations of other major elements (i.e., Al and Mg) are more closely related to the composition of the surrounding melt from which they have crystallised. For example, Al_2O_3 contents could be dependent on a change in melt composition resulting from abundant plagioclase crystallisation (Tomiya and Takahashi 2005). Unlike andesitic glass, titanomagnetites are unaffected by the majority of syn- and post-explosive eruption processes, because element diffusivity is slower than the time for the eruptive material to quench.

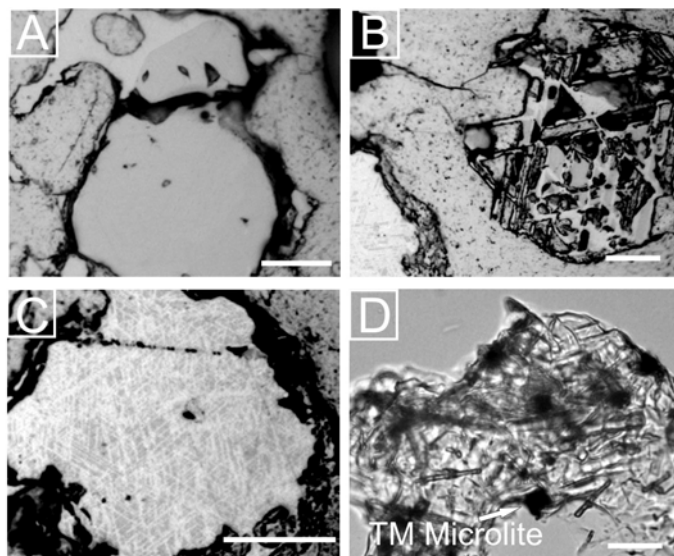


Figure 3.4: *Photomicrograph of titanomagnetite grains from distal fall deposits at Lake Umutekai, Mt. Taranaki. A: Homogeneous grain in reflective light. B and C: Exsolved grains in reflective light. D: Titanomagnetite microlite in transparent light. TM = titanomagnetite. The white scale bar is 25 μm in length.*

Although titanomagnetites have many advantages over glass in tephrochronology studies of andesitic tephra, there are four main areas of limitations that need to be considered:

- 1) Under the relatively slow cooling and oxidising conditions of dome-forming eruptions, titanomagnetites may exsolve into a trellis of ilmenite and magnetite (Buddington and Lindsley 1964). EMP analyses of such grains could therefore result in heterogeneous compositions. Fortunately these exsolved grains are readily identified under backscatter electron images and reflective light by their highly contrasting, distinctive exsolved lamina (Turner et al. 2008b) and thus can be avoided during EMP analyses (Fig. 3.4 b,c).
- 2) During explosive eruptions, groundmass Fe-oxides may form during syn- and post-eruption microlitic crystallisation. The compositions of these grains will be highly variable, relating to the heterogeneity of the surrounding glass (as discussed above). These grains are much smaller than the target microphenocrysts and hence can also be easily excluded (Fig. 3.4 d).
- 3) Pre-eruption magma mixing, or thermal/compositional zonation within a single magma batch can result in heterogeneity within the titanomagnetite population (Tomiya and Takahashi 2005). Resulting EMP analyses will reveal either a bimodal population or, depending on the nature and time frame of magma mixing, a larger spread of compositions. These ‘mixed’ magmas are distinctive and although sometimes apparently complex, they can still be used for correlation, especially within a known stratigraphic context.
- 4) A final and important constraint to using titanomagnetite compositions is that some fine-grained distal deposits may lack appreciable numbers of titanomagnetite grains. Although titanomagnetites are typically relatively small (in comparison to other phenocrysts) and they are often carried to distal locations (e.g., Cronin et al. 1996b, Shane 2005), if the eruption event produces a relatively small plume, gravitational settling and atmospheric winnowing of the relatively high-density titanomagnetite grains confines them to relatively proximal areas, compared to that of pure glass.

3.6 Titanomagnetite geochemical correlations

Preliminary correlation studies using titanomagnetites compositions of Mt. Taranaki events involved two-oxide or two-element plots. Kohn (1970) and Cronin et al. (1996b) showed that these compositions could be used to discriminate unique magmas. Analyses of titanomagnetite grains from representative eruptions throughout the Holocene record are given in Table 3.5.

Table 3.5: *Representative titanomagnetite analyses. Sample numbers refers to the dataset used in this study (i.e. U05 = Umutekai lake samples). FeO^T = total Fe.*

Sample no.	Age ^a	+/-	SiO ₂ ^b	TiO ₂	Al ₂ O ₃	FeO ^T	MnO	MgO	Cl	Cr ₂ O ₃	Total
U05-4	1843	34.04	0.00	8.31	4.10	79.68	0.69	4.02	0.03	0.12	96.95
U05-4	1843	34.04	0.00	8.21	4.06	80.28	0.60	4.32	0.06	0.09	97.62
U05-6	2097	35.35	0.11	7.04	3.99	79.52	0.72	3.13	0.03	0.02	94.56
U05-6	2097	35.35	0.22	7.02	3.35	80.53	0.63	2.67	0.08	0.11	94.61
U05-19	3456	33.22	0.09	7.53	1.98	82.96	1.22	1.73	0.08	0.13	95.72
U05-19	3456	33.22	0.08	7.54	1.80	83.47	1.26	1.74	0.05	0.00	95.94
U05-44	4960	54.78	0.09	8.33	2.83	79.20	0.98	2.77	0.00	0.00	94.20
U05-44	4960	54.78	0.11	8.01	2.81	80.81	0.98	2.52	0.00	0.06	95.30
U05-56	6074	50.00	0.07	9.79	2.75	81.27	0.85	2.99	0.08	0.00	97.80
U05-56	6074	50.00	0.19	9.86	2.70	81.23	0.72	2.72	0.07	0.12	97.61
U05-72	7711	51.05	0.13	8.77	2.85	79.32	0.79	2.84	0.00	0.04	94.74
U05-72	7711	51.05	0.05	8.67	2.81	80.03	0.95	2.83	0.02	0.10	95.46
U05-85	8969	39.57	0.23	9.92	3.02	77.61	0.74	3.14	0.00	0.04	94.70
U05-85	8969	39.57	0.14	9.72	3.30	76.88	0.76	3.15	0.03	0.06	94.04
U05-95	10093	97.18	0.20	7.59	2.94	81.66	0.95	2.85	0.10	0.01	96.30
U05-95	10093	97.18	0.16	7.52	3.05	81.33	0.52	2.26	0.00	0.05	94.89

^a Radiocarbon age in years before present (B.P.) using Libby half-life

^b Silica data are included to show that the analysed point is free of silicate inclusions.

Here, stepwise discriminant function analyses (STEPPDISK, SAS Institute Inc., 2004) were used to establish a subset of variables that enabled the greatest separation between tephras. The stepwise discriminant function analysis is a technique that reduces the dimensionality of data, such as compositional data. This means that instead of working

with large numbers of oxide values per analysis to discriminate groups of samples, one or two variables are able to be identified by a step by step process (Stokes and Lowe 1988). The model used in stepwise discriminant analysis is related to the principal component analysis (PC) which involves the factorization of a matrix (spread of data) into structural (conical) form. It can be thought of revealing the internal structure of the data in a way that best explains the variance of that data (SAS Institute Inc., 2004). Applying the stepwise procedure to titanomagnetite compositional data of Mt Taranaki events, the most discriminating oxide variables were, in order: TiO_2 , Al_2O_3 , FeO and MgO. FeO was excluded from further analysis due to the inconsistencies of $\text{FeO}_{(\text{total})}$ for titanomagnetite analyses, because the EMP was typically calibrated for silicate analyses (R. Sims pers. comm. 2007). TiO_2 , Al_2O_3 and MgO were chosen for principal component analysis and gave the following principal components:

$$\text{PC1} = -0.195 \text{ TiO}_2 + 0.711 \text{ Al}_2\text{O}_3 + 0.675 \text{ MgO}$$

$$\text{PC2} = -0.949 \text{ TiO}_2 + 0.036 \text{ Al}_2\text{O}_3 - 0.312 \text{ MgO}$$

The results of the principal component analyses of each tephra can be converted via the means and standard deviations of their principal components, into ellipses centred at the means, with axes length equal to four times the standard deviation (Fig. 3.5). Standard deviations were used over standard errors, because the titanomagnetite composition reflects a mixture of a number of magmas. Hence the measures of interest are the location and spread of compositions, rather than the composition of the 'average magma'. Of the 24 Umutekai-Rotokare pairings in Table 3.3, titanomagnetite compositions are available for 15. Figure 3.5 illustrates the geochemical correlations of the already assigned age-matched tephtras. Nine have definite overlaps, three age matches are geochemically different; U7-R10, U8-R11 and U63-R42, and U23 had a single data point resulting from a very small sample size. The remaining two had partial overlaps and thus give inconclusive evidence of possible miss-matching.

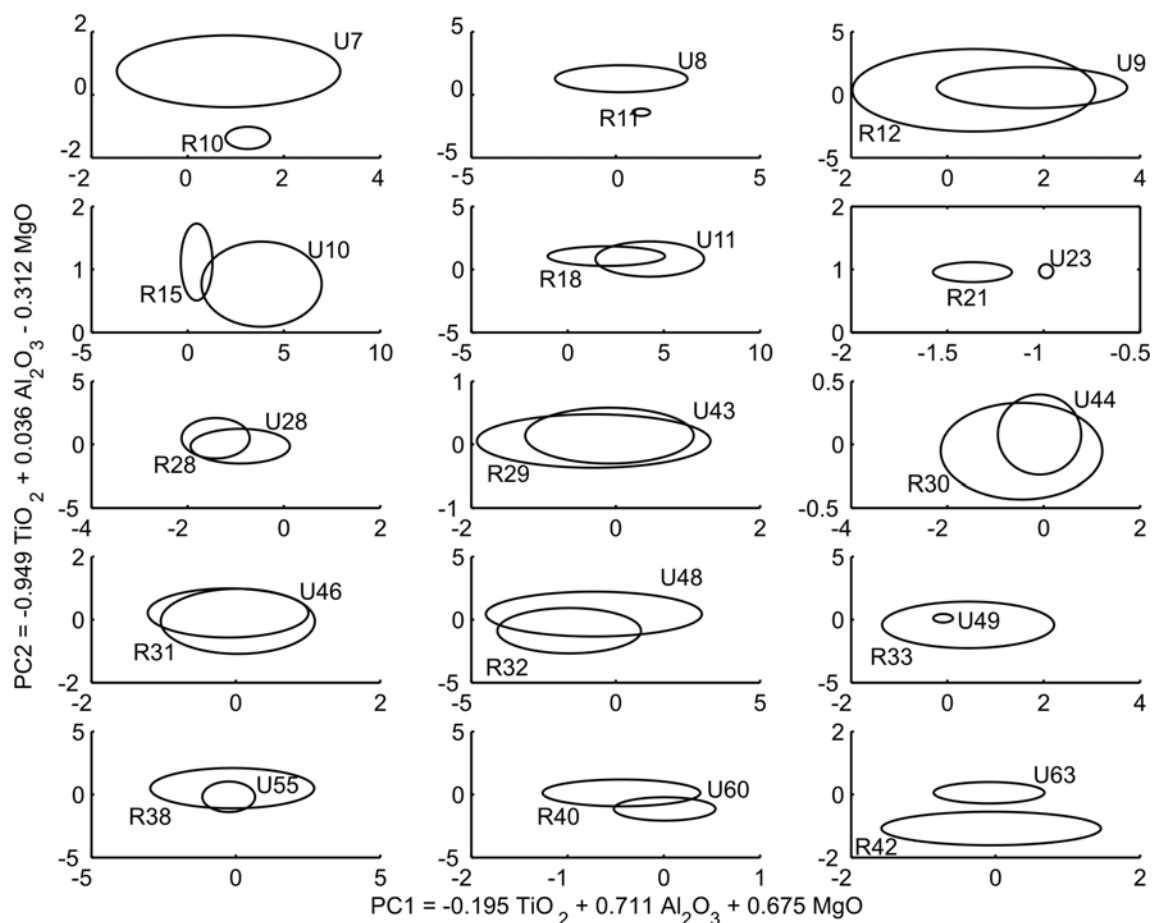


Figure 3.5: *Geochemistry of the matches initially identified in Table 3.2. Data from Umutekai is labelled by the tephra number positioned above and to the right, Rotokare below and to the left. Titanomagnetites from the tephras preserved within the lake sediments were extracted and EMP analyses were carried out with a JEOL JXA-840 equipped with an energy dispersive spectrometer at the University of Auckland. Analytical conditions included an accelerating voltage of 15kV, a beam current of 600 pA and 100 seconds live time. A focused beam of 2 μm was used for each analysis.*

The titanomagnetite compositional PC distributions from other possible age correlation *candidates* (see Table 3.3) can be displayed on the same axes to determine if any other closely aged tephras may be from the same event. In Figure 3.6, plots of U7-U8 and R9-R11 indicate that R9 is from a similar magma to both U7 and U9, while U7-U8 and R10-R11 are distinctly different. However, the estimated ages of 1723 ± 54 years B.P. (R9) and 2097 ± 71 years B.P. (U7) make this very unlikely. Instead, it appears that these tephras are all derived from distinct magma compositions and thus could be from

different events, with some events distributing ash to the northeast while others distributed ash to the southeast.

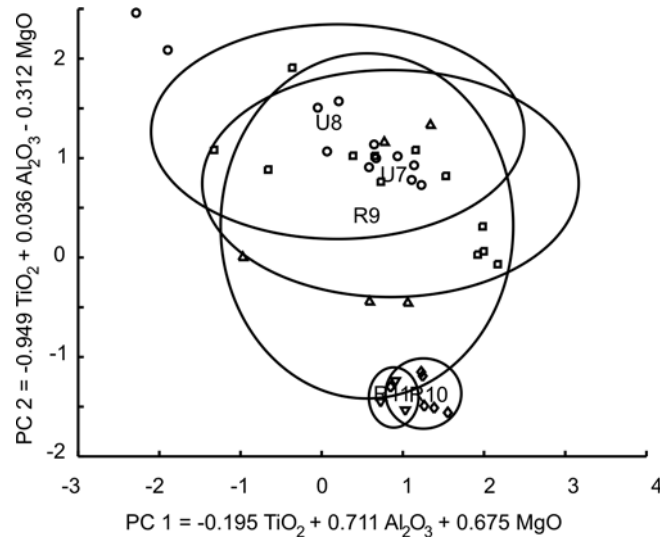


Figure 3.6: *Geochemistry of the U7-R10 and U8-R11 matches. Data points are squares (U7), circles (U8), upward pointing triangles (R9), diamonds (R10) and downward pointing triangles (R11). Ellipses are labelled at their centre.*

The tephras U63-R42 are also geochemically mismatched (Fig. 3.5), suggesting that they represent the eruption of different magmas having tephra distributed in different directions from the volcano. To identify any other possible correlations of events occurring before or after this time, the geochemical components of Umutekai tephras U60 to U65 were plotted against Rotokare tephras R40, 41, and 42 (Fig. 3.7). R40 has an actual radiocarbon date (Table 3.1: NZA 25465) of 6074 ± 40.8 years B.P. and within these age errors, R40 is possibly correlated with the six Umutekai tephras U57 to U62 (*candidates*), with the closet age-matched tephra being U60. However, R40 only partially matches U60 geochemically (Fig. 3.8) and instead better geochemically correlates with that of U63 and U64. Meanwhile U60 and U61 correlate well with R41 and R42. This suggests that it is more likely that the following matches are correct based on age and geochemistry: R42-U61, R41-U60, and R40-U59 (*italicised* in Table 3.3). Similar geochemical analysis (Fig. 3.8) shows that the magma chemistry for R21-R26 is consistent with that of U24-U25. These potential alternative matches are indicated by parentheses in Table 3.3.

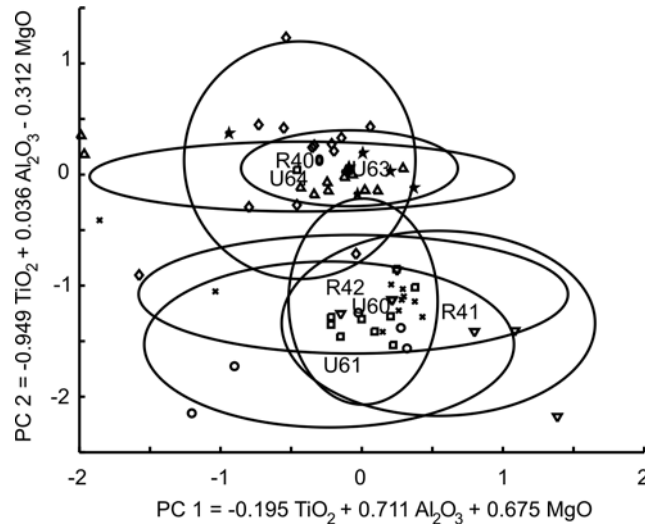


Figure 3.7: *Geochemistry of the U63-R42 match. Data points are squares (U60), circles (U61), stars (U63), upward pointing triangles (U64), diamonds (R40), downward pointing triangles (R41) and crosses (R42). Ellipses are labelled at their centre.*

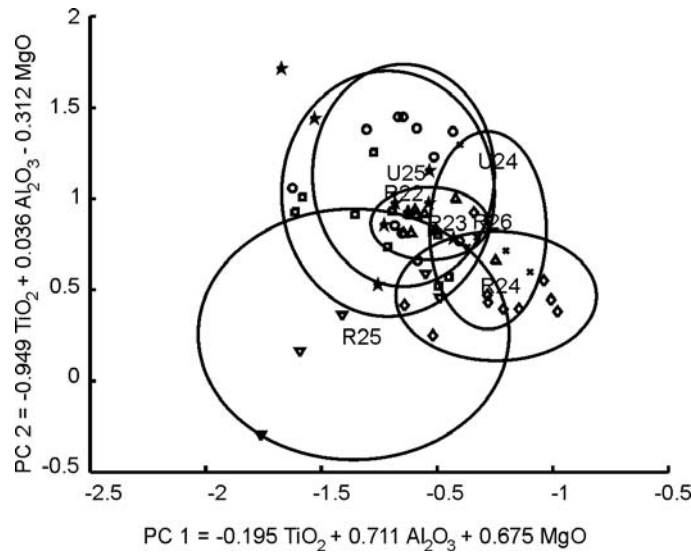


Figure 3.8: *Geochemistry of the U24-25 matches. Data points are squares (U24), circles (U25), stars (R22), upward-pointing triangles (R23), diamonds (R24), downward-pointing triangles (R25) and crosses (R26). Ellipses are labelled at their centre; the U24 ellipse includes the entire diagram.*

3.7 Eruption Hazard Model

The final results of combining all three datasets, matching U59-U61 to R40-R42, and considering U7-U8 and R10-R11 as distinct events, are given in Table 3.6. The first and last interval counts are based on only near-source and Umutekai data respectively, the

others are based on data from at least two sources. There are a total of 138 distinct events, with a lower bound of 135 using the largest possible number of matches.

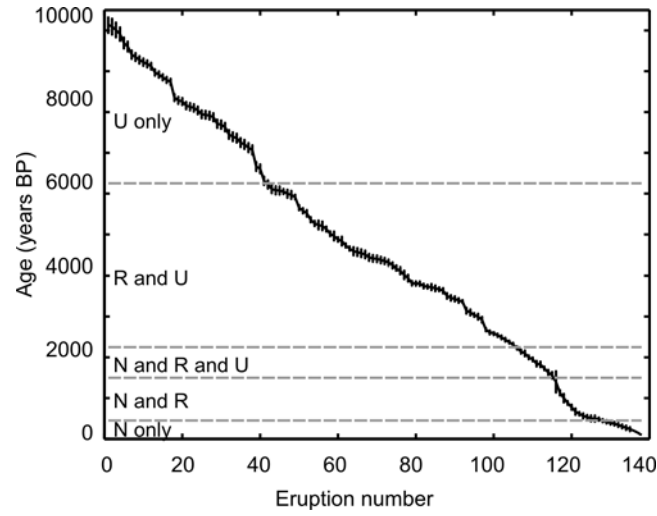


Figure 3.9: *Dates of eruptions. Error bar is $\pm$ twice the estimated standard deviation. The dashed lines indicate the potential data sources for the given age range.*

Figure 3.9 shows the combined eruption record (omitting the Stent Ash). Where tephra appear in only one source, the mean age and its standard deviation are taken directly. Where a tephra appears in two sources, with mean ages m_1 and m_2 , and standard deviations s_1 and s_2 , the mean age is estimated by the error-weighted mean $\bar{m} = (m_1/s_1^2 + m_2/s_2^2) \bar{s}^2$, where the variance is $\bar{s}^2 = (1/s_1^2 + 1/s_2^2)^{-1}$ (Ward and Wilson, 1978). An exception was made for the U60-R41 and U61-R42 matches, where only the better constrained Umutekai values were used, in order to maintain the stratigraphic ordering in the Umutekai core. The older part (i.e., 6250 – 10 150 years B.P.) of the record is derived from the single site of Umutekai and therefore, as expected, there appears to be a change in the event frequency across the 6250 years B.P. boundary. Hence the eruption hazard model was fitted to only the post-6250 years B.P. data, a total of 97 events.

Turner et al. (2008a; Appendix 1) calculated the volcanic eruption hazard using only the data from the Umutekai core for the period 10150 – 2250 years B.P. and near-source events from 2250 years B.P. - present. Repeating the analysis using the new combined

data set allows evaluation of the updated hazard estimate, and a comparison of the multi-site dataset of this study with an earlier analysis based on a predominantly single-site data set.

Table 3.6: *Eruption coverage of each site (number of events). Numbers in parentheses indicate an alternative matching scenario of U22-U26 to R21-R25.*

Coverage	Years B.P.				
	96 – 450	450 – 1500	1500 – 2250	2250 – 6250	6250 – 10150
Near Source Only	11	4			
Near Source + Umutekai			3		
Near Source + Rotokare		4	1		
Umutekai Only			5	33 (30)	41
Umutekai + Rotokare				21 (24)	
Rotokare Only		4	1	10 (7)	

Bebbington and Lai (1996a; 1996b) developed the use of a Weibull renewal process to model inter-event times for volcanic activity. This has the ability to model both over-dispersed (i.e., clustered) or under-dispersed (i.e., semi-periodic) inter-event times although, as the data used are not actual eruption dates, but events separated by sediment deposition, there is very little likelihood of ‘clustering’, i.e., of an over-dispersed distribution fitting the data (cf., Cronin et al. 2001). Turner et al. (2008a; Appendix 1) found that the inter-event data appeared to be bi-modal, and so fitted it by a mixture of Weibull distributions (cf. Jiang and Murthy 1995, 1998).

$$f_{\text{mW}}(\tau) = p\alpha_1\beta_1^{\alpha_1}\tau^{\alpha_1-1}\exp\left(-(\beta_1\tau)^{\alpha_1}\right) + (1-p)\alpha_2\beta_2^{\alpha_2}\tau^{\alpha_2-1}\exp\left(-(\beta_2\tau)^{\alpha_2}\right)$$

where $0 < p < 1$ is the mixing proportion, and there are modes at $\tau = (1 - 1/\alpha_1)^{1/\alpha_1} / \beta_1$ and $\tau = (1 - 1/\alpha_2)^{1/\alpha_2} / \beta_2$. Noting that the Weibull distribution, $f_{\text{W}}(\tau) = \alpha\beta^{\alpha}\tau^{\alpha-1}\exp\left(-(\beta\tau)^{\alpha}\right)$ with a periodic ($\alpha > 1$) mode at $\tau = (1 - 1/\alpha)^{1/\alpha} / \beta$, and the exponential distribution (or Poisson process) $f_{\text{E}}(\tau) = \beta\exp(-\beta\tau)$ are nested

models within the mixture of Weibulls, they will be fitted to check on the significance of the additional parameters. The parameters are fitted by maximizing the likelihood, $L = (1 - F(\tau_0))^M \prod_{i=1}^{nM} f(\tau_i)$, where $\tau_1, \dots, \tau_{nM}$ are the sampled inter-event times, and τ_0 is the elapsed time since the last eruption. In this $M = 1000$ Monte Carlo runs were carried out in order to allow for the uncertainties in the dates, and there were $n = 96$ inter-event time distributions. Thus $nM = 96,000$ sampled inter-event times were used to derive the range of fitted densities shown in Figure 10.

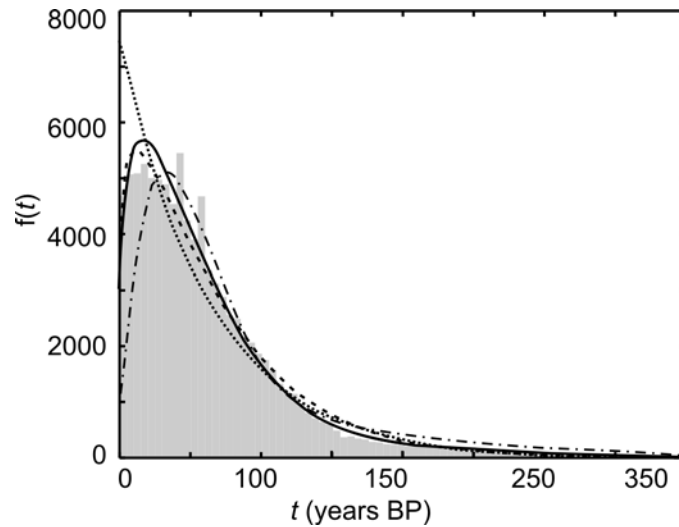


Figure 3.10: *Histogram of 96,000 sampled inter-event times based on 1000 Monte Carlo runs. Curves show the fitted densities for this data set: Dotted line = exponential distribution, dashed line = Weibull, solid line = mixture of Weibulls, dot-dashed line = mixture of Weibulls from Turner et al. (2008a; Appendix 1).*

As in Turner et al. (2008a; Appendix 1), the best fit is achieved by the mixture of Weibulls model. The fitted parameters, along with those of the earlier study, are given in Table 3.7. The significant changes from the previous study indicate that the fitted distribution of inter-event intervals now has a strong primary mode at 16 years, with a diffuse second mode of 232 years. The corresponding modes identified by Turner et al. (2008a; Appendix 1) were at 32 and 137 years respectively. The second mode is now more sharply defined than that of the earlier study (as indicated by the increase in α_2). In addition, this second mode now represents only 4%, rather than the 25% weight of the earlier study which is a result of many of the longer intervals being filled in with new observations. However, there appear to be a number of longer intervals (5 intervals

of 2-300 years) that have not been filled in this way. It is interesting that these longer intervals are grouped within a number of defined periods of approximately 1500-2000 years apart throughout the combined record.

A renewal model can be used to estimate the likelihood of an eruptive event at a given time in the future. For the purposes of eruption forecasting the assumption is made that the duration of a year B.P. (carbon date) can be equated to duration of a calendar year. The rational for, and the effects of, making the assumptions are as follows. The normally distributed errors in the years B.P. dates make for faster computation, allowing for much larger Monte Carlo samples. A conversion to calendar years would also require discretizing the age, and invalidate the current formula for the 'distance' $d_{1,2}$. Further, because of the non-monotonicity of the years B.P. to calendar years conversion, additional dated material has the undesirable effect of making calculations in calendar years even slower if stratigraphic ordering is to be respected. These factors can result in a decided tendency in the Monte Carlo procedure to place eruptions very close together in time, as a sequence of several eruptions can be sandwiched closely together between dated layers. However, as eruptions are identified as layers of tephra separated by sediment, such a sequence of eruptions would not be identifiable as distinct events, leading to a contradiction. The results would also appear to be non-homogeneous, incompatible with a renewal process. For these reasons, all calculations are performed in years B.P. The consequence of using years B.P. for forecasting is that the hazard is overstated by approximately 14% (18% over the whole of the Holocene). However, as noted below, the combined record still likely underestimates the number of eruptions and thus the hazard from this volcano, and therefore a forecast in years B.P. counters the known bias.

Table 3.7: *Fitted mixture of Weibull distributions.*

Parameter	This study	Turner et al (2008a)
α_1	1.2469	1.6442
β_1	0.0166	0.0176
α_2	3.4601	1.9293
β_2	0.0039	0.0050
p	0.9620	0.7526

Supposing that the most recent event occurred T years ago, the probability of no event in the next t years is

$$\Pr(\tau > T + t \mid \tau > T) = \frac{\int_{T+t}^{\infty} f(\tau) d\tau}{\int_T^{\infty} f(\tau) d\tau}.$$

The annual eruption probability, given no eruption in the interim, can be calculated by differencing this, as shown in Figure 3.11.

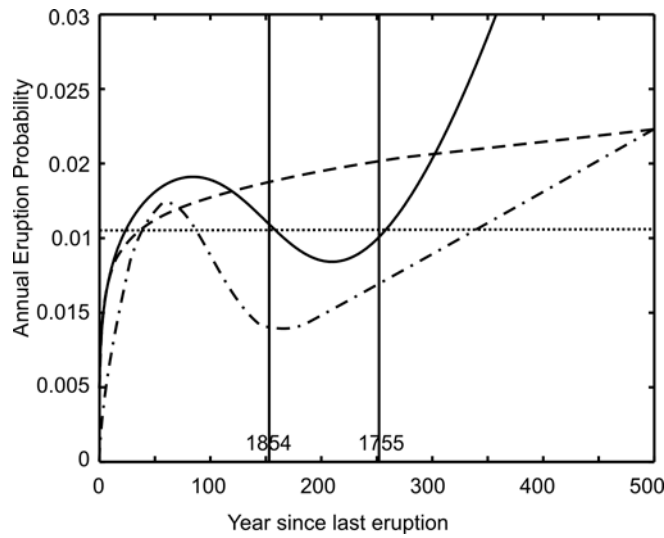


Figure 3.11: *Annual eruption probabilities. Dotted line = exponential distribution, dashed = Weibull, solid = mixture of Weibulls, dot-dashed = mixture of Weibulls (Turner et al, 2008a; Appendix 1). Vertical line indicate present (AD 2008) hazard depending on the date of the last eruption.*

The mixture-of-Weibulls model (Fig. 3.11) shows an early peak in the annual eruption probability at 84 years after the previous eruption, followed by a trough at 210 years, and then a steady increase in probabilities thereafter representing the tail of the distribution. Compared to the estimate based on the single Umutekai record (Turner et al. 2008a), the probability of an eruption within the next 50 years has increased 0.37 to 0.52, assuming that the most recent eruption was in AD 1854 (or 154 years ago). On the other hand, if it were assumed that the most recent event was in 1755, it would then have been 253 years since the last eruption. The mixture-of-Weibulls model then provides an increase to a probability of 0.59 of an eruption within 50 years, where Turner et al. (2008a) estimated 0.48. This is a consequence of coming out of the trough rather than going into it (cf., Fig. 3.11).

3.8 Implications for probabilistic eruption forecasts

The average eruption rate has increased from 0.012 per year in the earlier analysis to 0.016 (Turner et al. 2008a) as a consequence of the additional events from the Rotokare core. The more subtle, although very important, change in the mixture-of-Weibulls model is the result of the additional events filling in some of the gaps of the original single site Umutekai record, 'sharpening' the secondary mode, which now represents only 4% of the recurrence distribution. As a result, the 50 year probability has increased from 0.37 to 0.52 (or almost doubling the present annual eruption probability (AEP) from 0.9% to 1.6%). In general, filling in the record with additional events increases the AEP, and also appears to smooth out the peak and trough in probability following the last eruption (cf., Fig. 3.11). If the remaining long intervals corresponding to the second mode were to be filled in, then the parameter (p) would tend to 1, and the best-fit model would then be the simple unimodal Weibull distribution shown as the dashed line in Figure 3.11. However, within the 6250 B.P. – 10 150 years B.P. Umutekai record there are 2 distinct periods where there are apparently no events: 6500-7000 years B.P. and 8200-8700 years B.P. Moreover, these periods of decreased activity, and the long inter-event times in the combined record post 6250 years B.P. occur fairly regularly on 1500-2000 year cycles (Fig. 3.9). This regularity may correspond to long term cycling in magma system replenishment relating to either (1) the recurrence of regional tectonic events affecting the magma system (e.g., triggering magma batch rise), or (2) where large magma batches reach minimum buoyancy to rise and erupt (cf., Turner et al. 2008b).

The combination of all three datasets provides a more robust eruption record for this volcano (i.e., Figs. 3.10 and 3.11). However, the combined dataset is still incomplete and therefore likely under-represents the true eruption recurrence from Mt. Taranaki. There are 31 matches based on the age-correlated technique (Tables 3.3 and 3.4), of which 15 were able to be compared by titanomagnetite compositions. The titanomagnetite compositions of the tephras near the base of the Rotokare record indicate that the correlation of these tephras (R40, 41, and 42) to those within the Umutekai core (U60-U65) by their radiocarbon ages is slightly incorrect. Each correlation was out by a consistent factor (i.e., a distance of 1.2-2; Table 3.3), possibly

suggesting a systematic bias in this part of the record in the depth-age profile of one or both of the cores. In addition, some of the age-matched tephras had distinctively different geochemistry to one another, suggesting that they were derived from compositionally different magmas. This indicates that some of the 16 matches that could not be checked by the titanomagnetite geochemically may also represent distinct events, and therefore there are additional eruptions which need to be accounted for in the eruption hazard model. However, it is also possible that a single *event* from Mt. Taranaki involved the eruption of more than one distinct magma batch (for example a basaltic andesite and dacitic magma) within the defined time period of an event (cf., Simkin and Siebert 1994).

The eruption of more than one magma batch during a relatively short period may be a common process at andesitic volcanoes. This is especially true at Mt. Taranaki where, since ~3000 years B.P. there have been eruptions of different compositionally distinct magma batches from the summit vent and the more basaltic satellite cone of Fanthams Peak (Neall et al. 1986). For example, U10 is a basaltic andesite tephra likely to have been sourced from Fanthams Peak. It partially overlaps with the similarly dated R15 on the geochemical PC diagram. Under binocular microscope, two distinct grain types can be identified within the tephra deposit of R15; finer grained (<500 μm) scoria clasts, likely to be a correlative to U10; and relatively larger (>500 μm) lighter-coloured pumice clasts not observed within the U10 tephra. This suggests that Tephra R15 likely records two closely spaced events from Mt. Taranaki, which given the sedimentation rate for Lake Rotokare, must have been within a year or two of each other because any longer period would result in >1mm of lacustrine sediment being deposited. Therefore, at approximately 2540 years B.P., ash from an eruption of Fanthams Peak was distributed to the NE and deposited in Lake Umutekai whereas shortly after (or before) an eruption producing andesitic pumiceous material distributed ash towards Lake Rotokare to the SE of the volcano.

More significantly, this combined record is almost certainly still missing some events altogether. For example, of 64 events in the period 2250 – 6250 years B.P., 33 (52%) appear only in the Umutekai record, 10 (16%) in only the Rotokare record, and the remainder in both. This indicates that the 138 events in the record could well be further

augmented by additional sites. If 84% from the 2250 – 6250 years B.P. record is taken as the upper bound for the Umutekai “detection probability”, it can be expected that there should be at least 8 missing events within the Umutekai record 6250 – 10 150 years B.P.

During the studied period there are also a number of variations in the eruption frequency curve (cf., changes in the slope of Fig 3.8). Between 96 and ~500 years B.P. the frequency of identified eruptions increases dramatically, in contrast to the relatively lower eruption frequency just prior to it (500-2200 years B.P.). The <500 year record of events is mainly from many smaller, well dated, dominantly block-and-ash-flow-related events (cf., Turner et al. 2008a). Later events (>500 years B.P.) are either unidentified (i.e., buried by the younger events) or un-datable within the older edifice record. In addition to this, block-and-ash-flow related events have comparatively small co-eruptive ash plumes and are therefore likely to be underrepresented within the medial-distal lake records. In support of this, Turner et al. (2008b) identified periods when block-and-ash-flow events identified within Lake Umutekai are more frequent. These increased periods of activity correlate directly to a period when block-and-ash-flows were being directed down the NE oriented channels towards Umutekai (Turner et al. 2008b). The young record between 500 and 1500 years B.P. is from the edifice dataset and Rotokare datasets only. The relatively rapid sedimentation rate of Lake Rotokare provides a less-ideal environment compared to the very slow sedimentation of Lake Umutekai, to preserve small (sub-mm) tephra within a single identifiable layer. In addition, the topographic high near the township of Eltham (Fig. 3.1) means that any pyroclastic flows would have been diverted away 8 km to the west of the lake. Therefore, block-and ash-flows associated thin and fine ash deposits are unlikely to have been recorded as discrete layers within Rotokare sediments. In comparison, Lake Umutekai is situated just over a kilometre away from a dominant channel (Fig. 3.1). The highly variable nature of block-and-ash-flow events recorded within our dataset also gives evidence that although this is the most robust record yet from Mt. Taranaki, it appears that it substantially under estimates the frequency and reoccurrence of block-and ash-flow events. Similarly, dominantly effusive or lava-flow producing eruptions may also have occurred during this period (cf., Neall et al. 1986) with no tephra produced at all.

Further work to improve the homogeneity in the data is very desirable in order to aid in regime identification in the behaviour of the volcano (Bebbington 2007). In the interim, future eruption reoccurrence modelling, where a complete record is unavailable (due to the lack of well-dated records) could use the identified explosive event record (i.e., excluding the highly variable block-and-ash-flow record) and then scaling up the intervening block-and-ash-flow record from parts of the record that are well dated.

3.9 Conclusions

Combining eruption records derived from multiple sites on the basis of the age of individual tephras requires independent confirmation to avoid under-estimating the size of the final record by miss-matching distinct, but near-contemporaneous, events. Andesitic tephra correlations for use in tephrochronology and resulting eruption and hazard forecasts have remained difficult to accomplish. However, as demonstrated here, realistic andesitic tephra correlations can be made using the composition of titanomagnetite microphenocrysts. The compositions of these grains are unique to each magma erupted from the andesitic volcano and thus they can be used in a similar way to glass compositional fingerprinting in tephrochronology studies. Using the case study from Mt. Taranaki, New Zealand, the titanomagnetite compositions were used to check the correlation of tephras from two, well dated lacustrine sites. The titanomagnetite composition identified a number of possible miss-matched tephras from age-correlation methods, adding further evidence that although the combined eruption record produces the most complete record for Mt. Taranaki eruptions to date, with 138 separate events occurring between 96 and 10 150 years B.P., it is still likely that it under-represents the true eruption frequency from the volcano.

To estimate an accurate probabilistic eruption forecast for Mt. Taranaki a mixture of Weibulls renewal model was used. The distribution reveals a peak inter-event renewal interval of approximately 16 years and a second more diffuse renewal period of 232 years. The longer repose periods may represent the incompleteness of the eruption record, or possibly cyclic periods where the volcano is erupting less frequently. Using the combined eruption record and the mixture-of-Weibulls model, an estimate of 0.52 is

made for the probability of an eruption occurring within the next 50 years. This estimate is 1.5 times that of the previous one derived from a single site record (i.e., 0.37; Turner et al. 2008a).

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3.11 An integrated temporal record of edifice deposits

3.11.1 Introduction

In Chapter two, twelve key stratigraphic profiles were identified, from the mid-flanks of Mt. Taranaki at an ideal altitude for preservation of proximal tephra fall as visually distinct horizons within soil profiles and at approximately equal spacings around the volcano. Many of these profiles, however, show evidence of erosion between some units, making an accurate estimated of unit ages at times impossible to determine. In addition, deposits containing fragments of charcoal or reliable organic material for radiocarbon dating are rare.

As described above, two lake records have been identified that contain very high-precision Holocene eruption records. Although these lakes are located at the two margins of the main tephra dispersal axis defined by Alloway et al. (1995), the edifice stratigraphic profiles as well as the conclusions reached above in sections 3.11-3.12 suggest that some events are missing from these records. Therefore, future integrated eruption records should combine all known sites of tephra deposits from around the volcano.

The first part of this chapter demonstrated that the compositions of titanomagnetite phenocrysts can be used to correlate syn-eruptive deposits between locations. The main purpose of the second section of this chapter is to show that correlation is possible between Lakes Umutekai and Rotokare, and the edifice records. Canonical discriminant function analysis was applied, a related technique to the principal component analysis used in the first part of this chapter.

3.11.2 Discriminant function analysis

Canonical discriminant function analysis (DFA) is a technique that reduces the dimensionality of data, such as compositional data, that typically have a large number of independent variables. Canonical DFA enables the derivation of a small number of linear combinations of variables that best discriminate pre-defined groups of analyses. The theory of DFA is outlined in many texts on multivariate analysis (for example, (Srivastava and Carter 1983; Johnson and Wichern 1992). The D^2 or Mahalanobis distance statistic is produced within the results and indicates the “spacing” between data groups in multi-dimensions (Srivastava and Carter 1983). The D^2 statistic is therefore useful to measure the separation of groups of samples and has been proven valuable to tephrostratigraphy studies (for example in New Zealand: Stokes and Lowe 1988; Stokes et al. 1992; Cronin et al. 1996a; 1997).

In addition, the DFA technique can also be used as a method to select variables that have the greatest discriminating power. The method is known as the stepwise DFA and is further described by Strivastava and Carter (1983). In section 3.9, stepwise DFA was used to establish a subset of variables that enabled the greatest separation between tephtras. The most discriminating oxide variables (excluding FeO_t) were, in order: TiO_2 , Al_2O_3 and MgO . These variables are used below in the subsequent canonical DFA to give the resulting D^2 statistics. In this study the SAS system program STEPDISC was used for the stepwise DFA and CANDISC was used for canonical DFA (SAS Institute Inc. 2004).

3.11.3 Titanomagnetite tephrochronology

At each of the edifice locations, samples from selected pumice-bearing and datable block-and-ash-flow deposits were taken for further geochemical analysis. Due to the reasons outlined in the first part of this chapter, titanomagnetite compositions were chosen for canonical DFA analysis.

3.11.4 DFA on the titanomagnetite dataset

Table 3.8 *An example of D^2 statistics from canonical DFA: Rk samples from Lake Rotokare are compared to selected M05 samples of edifice location 2 (see Figure 2.1 and Appendix 4).*

	M05-61	M05-67	M05-69	M05-70	M05-74	M05-75	M05-78
Rk-25	0.419	3.502	15.019	11.512	16.588	10.886	14.183
Rk-26	0.085	2.476	13.173	9.615	14.876	9.024	12.301
Rk-27	0.687	1.286	8.673	5.250	9.015	4.561	7.411
Rk-29	1.348	1.222	6.687	3.731	6.813	3.411	5.649
Rk-30	2.413	0.228	6.278	5.994	9.930	5.768	6.382
Rk-31	5.830	0.925	1.896	3.042	5.210	3.438	2.421
Rk-32	13.354	8.822	7.013	8.807	11.065	10.987	8.809
Rk-33	13.332	5.573	0.585	2.182	1.559	2.660	0.653
Rk-34	5.600	2.557	4.565	3.143	3.485	2.234	3.178
Rk-35	8.532	2.698	0.929	2.151	3.332	2.871	1.420
Rk-36	7.679	2.493	1.051	0.469	1.387	0.513	0.428
Rk-37	7.098	2.421	1.590	0.520	1.391	0.344	0.680
Rk-39	10.798	3.472	1.493	2.542	4.110	2.602	1.487
Rk-40	9.047	2.661	0.317	1.121	2.126	1.532	0.388
Rk-41	15.212	7.533	1.165	1.580	0.547	2.039	0.659
Rk-43	5.991	1.321	1.714	1.364	2.658	1.133	1.150
Rk-44	6.287	1.087	1.559	2.584	4.236	2.766	1.811
Rk-46	10.449	3.147	0.218	1.682	2.489	2.041	0.431
Rk-47	6.933	1.806	3.882	4.673	5.670	3.794	3.374
Rk-48	6.741	1.629	1.402	1.909	2.909	1.956	1.266
Rk-49	20.936	14.149	6.209	4.823	1.807	4.870	4.483
Rk-50	16.008	9.714	4.068	2.151	0.264	1.693	2.068

The titanomagnetite dataset from the well dated lacustrine deposits (see 3.2 – 3.12 and Chapter 2 for further details) are used as the reference dataset for canonical DFA analyses of those titanomagnetites from the edifice deposits. The D^2 values of the canonical DFA are listed in Appendix 4 and an example is given in Table 3.6. The D^2 statistic of these datasets is highly dependent on the spread of compositional data from each tephra within the reference dataset. With larger compositional spreads, there is a higher likelihood that unknown tephras will fit into several groups and the resulting D^2 will be relatively small. To overcome this problem, and identify likely matched tephras from one or more deposits, all D^2 statistics from each deposit were grouped and a 95 percentile found. Any compositions that had a D^2 statistic within this percentile were classified as having similar titanomagnetite compositions (Appendix 4). Using these datasets and also forcing stratigraphic order within the each of the profiles, correlation of the lacustrine records to the sampled edifice tephras was achieved (Appendix 4). Individual eruptions can be distinguished on the basis of this technique. Temporal groupings of possible correlatives are also observed, and are discussed further in Chapter 4 (4.7-4.15). Each of these temporal groupings of similar titanomagnetite compositions appears to represent the eruption of a chemically distinct magma “batch”. Within the lake records, eight magma batches were identified. Figure 3.11 groups the correlations made by canonical DFA into these defined magma batches. This shows the 12 main stratigraphic profiles defined in Chapter 2 and is hinged upon the first identifiable scoria-bearing basaltic-andesite eruption, termed the Manganui-A (Alloway et al. 1995), which on correlation to the Rotokare core occurred c. 3100 yrs B.P.

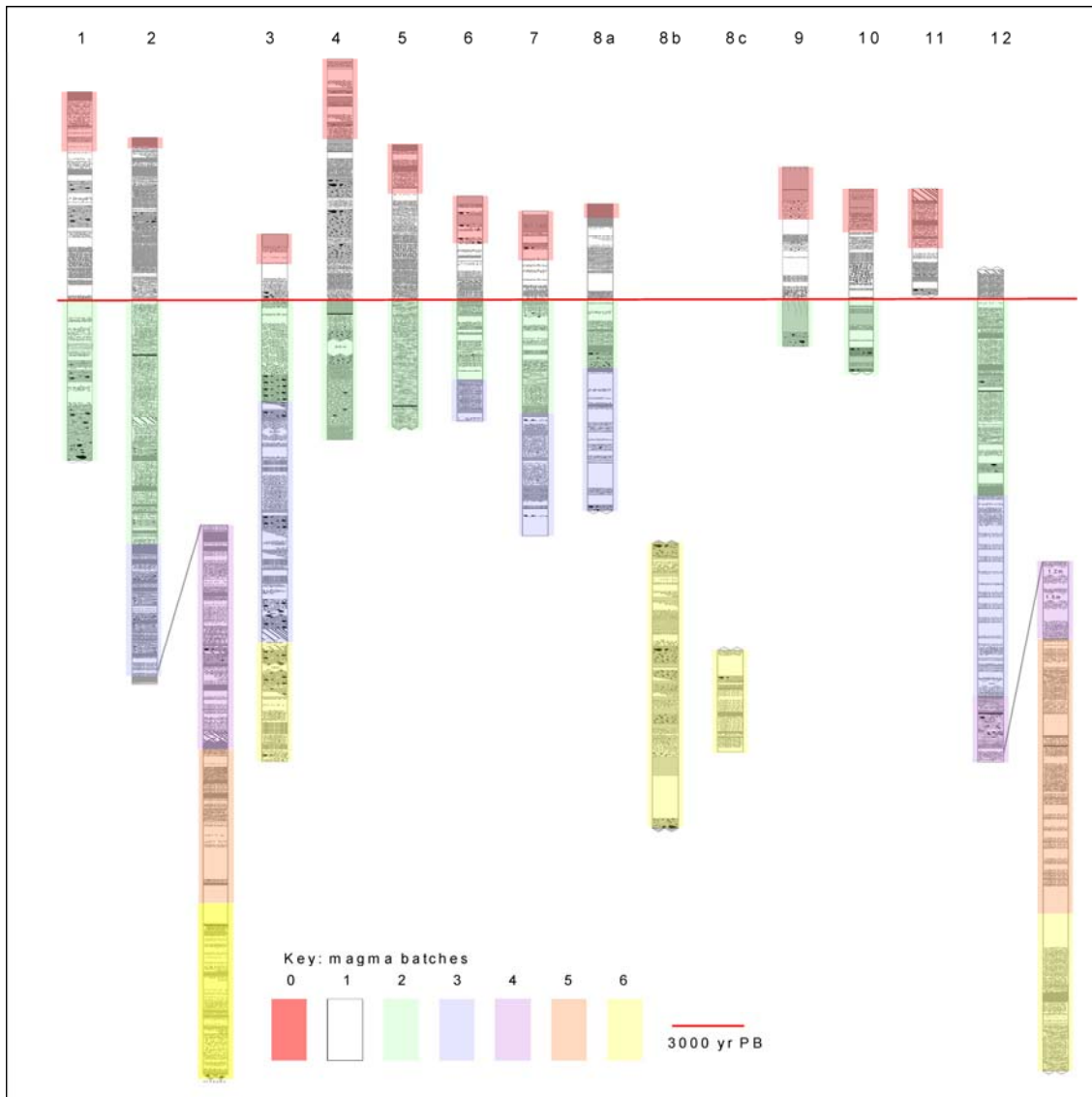


Figure 3.12: *Correlation diagram of edifice stratigraphic sites identified in Chapter 2. Each site is correlated to the better-dated eruption records of Lakes Umutekai and Rotokare by canonical DFA on titanomagnetite compositions. The correlations are simplified and grouped into the temporally defined eruption of the magma batches as identified in Chapter 4.*

3.12 Conclusions

The compositions of titanomagnetite microphenocrysts are unique to most individual magmas and magma batches erupted from Mt. Taranaki. Hence the correlation of eruptions from this volcano can be made on the basis of these compositions, using multi-parameter statistical techniques such as Principal Component Analysis (3.2-3.13) or Canonical Discriminant Function Analysis. The compositions of the titanomagnetite phenocrysts are not always unique to a single eruption, but always relate to a compositionally and temporally defined magma batch. Therefore the methods identified here need to be used in conjunction with detailed field descriptions, physical characteristics of the deposit, and/or geochemistry of other mineral phases in order to correlate all units.

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Chapter Four:

Eruption Classification and Identification of Cyclic Volcanic Processes at Mt. Taranaki.

This chapter consists of two parts. Firstly, a technique to distinguish two-end member eruption states using titanomagnetite textures is examined. The technique was applied to the deposits from Lake Umutekai and resulted in the identification of a periodic eruption rate from the volcano. The second part of the chapter examines the possible magmatic-system processes that are likely responsible for causing eruption periodicity.

4.1 Introduction

In the previous chapter, methods of andesitic tephrostratigraphy were developed to enable the combination of two or more records from differing sectors of the volcano and thus generate more accurate estimates of eruption frequency. Developing a full eruption record from andesitic volcanoes may, however, be an impossible task, since they produce a wide array of eruption products with highly varying deposition areas that often never overlap (e.g., lava-flows vs. tephra falls). To overcome this obstacle, it is more statistically valid to identify one particular eruption style, develop the best possible record for it, and then use this sub-sample of the eruption frequency as a proxy for the overall eruption frequency.

The first part of this chapter consists of the manuscript ‘*Using titanomagnetite textures to elucidate volcanic eruption histories*’ by: Michael B. Turner, Shane J. Cronin, Robert B. Stewart, Mark S. Bebbington and Ian E.M. Smith, published within *Geology*, (January 2008; vol. 36: 31-34). This manuscript outlines a method of using titanomagnetite textures to identify tephra-producing eruption styles in the context of two simplified end-members states: 1) fast magma-ascent eruptions, typically producing sub-plinian events and 2) slow-ascent eruptions, typically resulting in effusion of lava-

domes, deposition of associated block-and-ash-flows and co-pyroclastic flow ash falls. By using this method, it is shown that the frequency of sub-plinian eruptions at Mt. Taranaki is highly periodic, with a cyclic variation in eruption frequency that is of around 1500 years in amplitude.

The contributions of each author to the study were as follows:

Michael .B. Turner: Principal investigator:

Carried out: Field description and sampling
Laboratory preparation
Optical microscopy
Technique development
Electron microprobe analyses
Manuscript preparation and writing

Shane J. Cronin: Chief advisor:

Aided the study by: Assistance in the field
Discussion of methodology and results
Editing and discussion of the manuscript

Ian E.M. Smith, Robert B. Stewart: Advisors:

Aided the study by: Discussion of methodology and results
Editing and discussion of the manuscript

Mark S. Bebbington: Statistical advisor:

Aided the study by: Produced Fig. 4.5; the smoothed annual eruption rate curve from Taranaki.
Editing and discussion of the manuscript

The second part of this chapter aims to identify the underlying causes of this periodic eruption frequency at Mt. Taranaki. By using titanomagnetite compositions as a proxy for the geochemistry of the magma just prior to eruption, it is demonstrated that the eruption frequency is parallel and in phase with an overall cyclic pattern of magma

evolution. This implies a genetic link between the two and has significant implications for developing possible time-variable hazard forecasting models from similar reawakening volcanoes.

The manuscript: ‘*Cyclic magma evolution and associated eruption frequency at andesitic volcanoes and its implications to eruption forecasting: a case study from Mt. Taranaki, New Zealand*’ by: Michael B. Turner, Shane J. Cronin, Robert B. Stewart, Mark S. Bebbington and Ian E.M. Smith will be submitted to *Earth and Planetary Science Letters*. The contributions of each author to the study were as follows:

Michael B. Turner: Principal investigator:

Carried out:	Field description and sampling
	Laboratory preparation
	EMP and XRF analyses
	Manuscript preparation and writing

Shane J. Cronin: Chief advisor:

Aided the study by:	Assistance in the field
	Discussion of data, results and models
	Editing and discussion of the manuscript

Ian E.M. Smith, Robert B. Stewart: Advisors:

Aided the study by:	Discussion of data, results and models
	Editing and discussion of the manuscript

Mark S. Bebbington: Statistical Advisor:

Aided the study by:	Produced Fig. 4.7; the smoothed, annual eruption rate from Mt. Taranaki.
	Discussion of data, results and models
	Editing and discussion of the manuscript

4.2 Using titanomagnetite textures to elucidate volcanic eruption histories

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4.2.1 Abstract

Mineral assemblages in volcanic rocks record both pre-eruptive conditions and changes experienced by magma as it rises. Titanomagnetite in andesitic magmas is especially sensitive to changes in temperature and oxygen fugacity immediately prior to and during eruptions. Two end-member eruption states can be distinguished by examining titanomagnetite textures in erupted rocks. Slow-ascent eruptions – characterised by near-stagnant magma bodies and slow effusion of lava domes – show solid-state exsolution of titano-hematite/ilmenite lamellae within titanomagnetite hosts. By contrast, fast-ascent eruptions – characterised by rapid chilling of magma in sub-plinian events - contain titanomagnetites without such exsolution features. This mineralogical distinction is particularly useful in examining very fine-grained distal tephra layers where other characteristic properties of the two eruptions types are not present. Such tephra records in lake deposits typically provide the most precise long-term eruption records from andesitic volcanoes. Using an example from Mt. Taranaki, New Zealand, we show that by classifying eruption styles within such sequences, the underlying magmatic system processes at a volcano can be elucidated and separated from other environmental factors such as vent/crater configuration.

Keywords: titanomagnetite, exsolution, andesite volcanism, Mt. Taranaki

4.3 Introduction

Typically, the most complete long-period eruption records from volcanoes with well-constrained chronology are derived from tephra fall sequences at medial to distal sites (Chesner et al. 1991; Larsen et al. 1998). Lakes and swamps provide excellent preservation environments for pyroclastic fall deposits, as well as the opportunity for detailed dating. However, the typically fine-grained nature of many of the fall units at tens to hundreds of kilometres from source precludes standard volcanological discrimination of the eruption style.

In this paper we outline a technique for identifying eruption styles in the context of two simple end-member states:

- 1) Fast-ascent eruptions, characterised by open-system behaviour where volatile-rich magma rises to the surface and is explosively erupted (Luhr 2002). Typically, subplinian eruptions are produced.
- 2) Slow-ascent eruptions, typically involving near-stagnant magma bodies rising slowly at shallow levels. Eruptions involve lava effusion usually producing domes (Luhr 2002), with associated block-and-ash flows. Not all such eruptions will produce extensive tephra-fall deposits (e.g., during lava flow formation). However, elutriated ash from dome-collapse block-and-ash flows, phreatic explosions, and short-lived vulcanian blasts is commonly deposited at distal locations (Watanabe et al. 1999).

Although these states are end-members of a continuum in eruption types from andesite volcanoes, they provide a useful tool for interpreting magmatic processes and consequent hazard implications at andesitic volcanoes over periods of high-frequency eruptions.

4.4 Titanomagnetite in fast- and slow-ascent eruptions

Distal falls almost always contain mineral grains and micro-phenocrysts within glass or rock fragments. The compositions and types of the crystalline phases are sensitive to pre- and syn-ascent conditions. Each mineral phase records the responses to variations in magma rise rate and so mineralogy can be used to identify fast- or slow-ascent regimes. For example, the restricted pressure/temperature/oxygen fugacity stability field of hornblende and its consequent break-down outside this field is commonly used to constrain magma rise rates (Rutherford and Devine 2003). Here we focus on titanomagnetite because it is ubiquitous in andesite tephra and the exsolution features formed during the eruption of slow-ascent magmas are readily observable using simple techniques.

High temperature oxidation of Fe^{2+} to Fe^{3+} in titanomagnetites occurs as temperature falls and/or during increases of oxygen fugacity (Buddington and Lindsley 1964). Oxidation of Fe in titanomagnetite produces vacancies in octahedral sites of the {111} crystal planes, allowing for increased diffusion of Ti to these regions (Aragon et al. 1984). The oxidation process leads to the formation of Ilmenite-Hematite lamellae (<1–10 μm) along the original {111} planes of the titanomagnetite host (e.g., Figure 4.1A and 4.1B). Variations in oxygen fugacity and cooling rate control the scale and degree of the oxidation-induced exsolution, with several stages recognized (e.g., Haggerty 1991) ranging from rare lamellae, through to advanced oxidation characterised by the presence of pseudobrookite. The resulting composite grains are preserved when rapidly cooled from above 600 °C (Burton 1991).

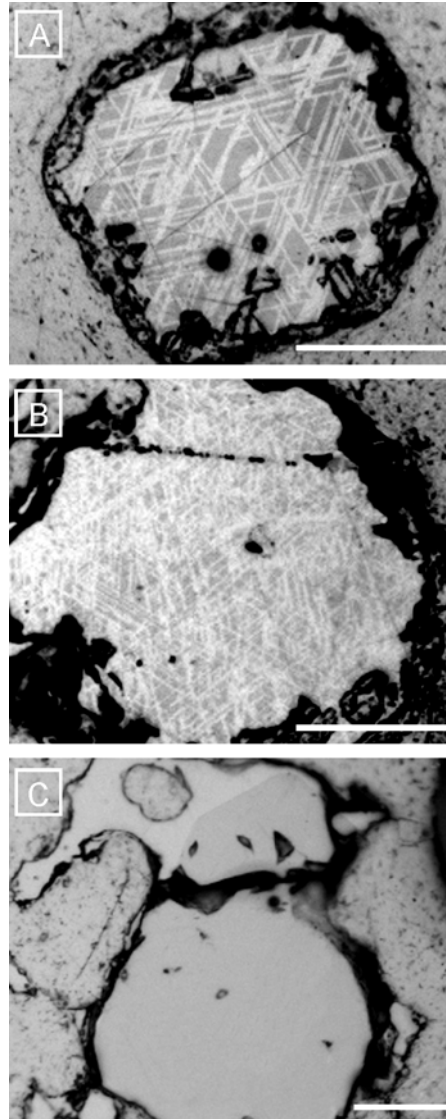


Figure 4.1: *Photomicrographs in reflected light of sectioned and polished titanomagnetite grains from distal fall deposits at Lake Umutekai, Taranaki. (A and B) Exsolved grains from a slow-ascent eruption; (C) Homogenous grain from a fast-ascent eruptive. The white scale-bar is 25 μm in length.*

In cases of fast-ascent eruptions little observable titanomagnetite exsolution occurs because the magma ascends and quenches before oxidation can take place. By contrast, in slow-ascent eruptions, magma stagnation in shallow conduits or domes is highly favourable for oxidation. Subsequent rapid cooling of the rocks during dome collapse preserves the exsolution features. Degrees of exsolution are also variable across a dome, reflecting the outer oxygen-rich and cooler surface and the relatively oxygen-poor and hotter core (Saito et al. 2004). Hence, a single eruption unit from a slow-ascent system

will contain a spectrum of titanomagnetite grains with variable degrees of exsolution, contrasting with a homogenous population of grains from a fast-ascent eruption.

4.5 Application to volcanic eruption history

We have applied the concepts of fast- and slow-ascent magmas and observations of titanomagnetite to refining the eruption record of Mt. Taranaki, western North Island, New Zealand. This andesitic stratovolcano is typical of subduction related systems throughout the world and is petrographically and chemically (Stewart et al. 1996) similar to several recently active volcanoes, including Merapi (Indonesia), Unzen (Japan), Colima (Mexico) and Augustine (Alaska).

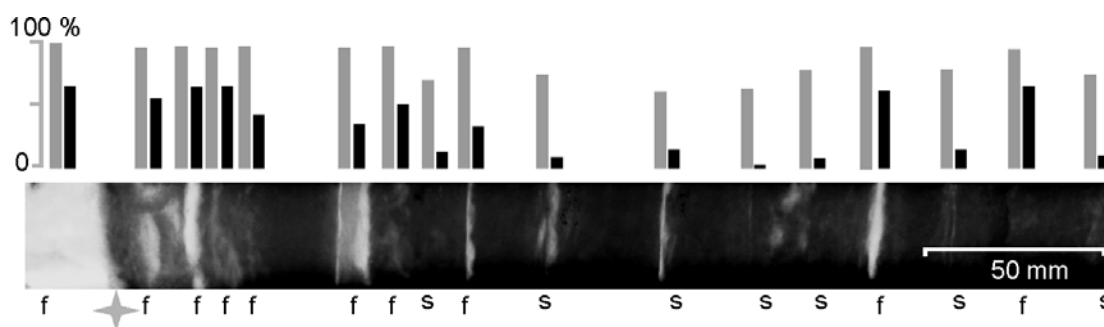


Figure 4.2: *X-ray photograph of the 1910–2210 mm section of the Lake Umutekai core (measured depth). Tephra (white layers) have contrasting density. Each unit is classified as being either slow(s)- or fast(f)-ascent eruption deposits by its proportions of glass (black bar) and non-exsolved titanomagnetite grains (grey bar). The grey star indicates the location of radiocarbon date NZ23085: 4354 ± 40 yrs B.P..*

A high-precision temporal eruption record for Taranaki was constructed from lacustrine and peat swamp cores downwind of the volcano. A key site, Lake Umutekai, lies 25 km NNE of Mt. Taranaki (NZ Map Grid; 2608436E, 6234799N). Several cores were collected in 1 m sections using a hand-operated piston corer of 35 mm diameter. The cores were imaged with an X-Ray camera to identify cm to sub-mm mineral layers within the organic host sediments (i.e., Fig. 4.2). In a 4 m core, representing a time span of 10 000–1500 yr B.P., 103 individual tephra layers were recognized. No evidence of erosion (unconformities, disturbed beds) was found. Each identified tephra layer within

the core was assigned an age (with estimated errors) from a spline-fit, core-depth function calculation (Turner et al. 2008a; Appendix 1), interpolated from 9 radiocarbon dates collected through the core (Fig. 4.3). This site lies near the major E-NE tephra fall dispersion axis and contains the most detailed record known from the volcano. It is also close enough to Mt. Taranaki to allow the independent characterisation of most layers by visually identifying tephra components (e.g., pumiceous clasts from fast-ascent eruptions). Where these visual identifications were possible they were used to compare the traditional grain lithology method and the titanomagnetite classification of eruption type.

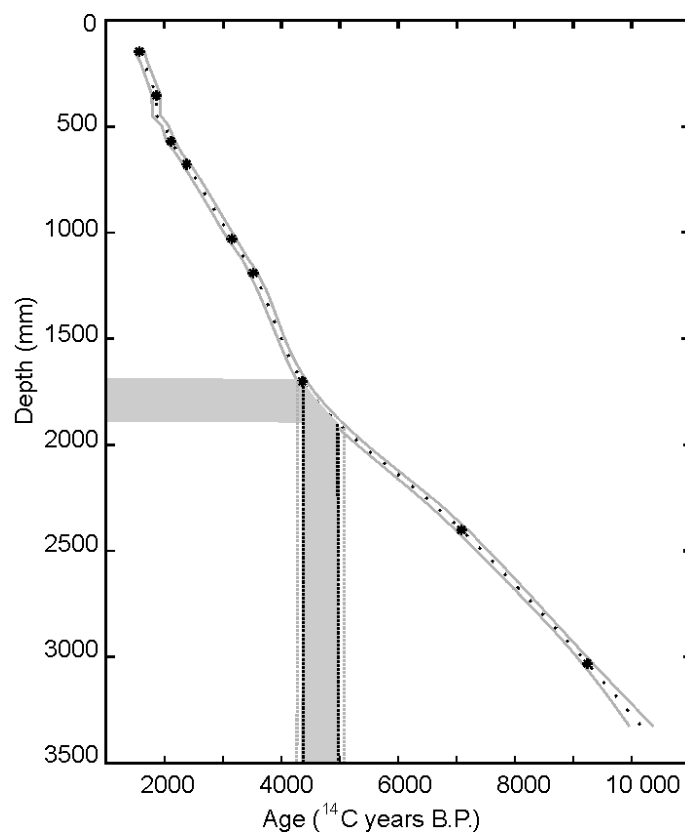


Figure 4.3: *Plot of the radiocarbon age versus sediment depth (mm – less tephra) model for the Lake Umutekai core. Radiocarbon dated layers are indicated by stars and dotted lines. The highlighted area corresponds to Figure 4.2.*

4.5.1 Grain lithology

Layers representing slow and fast-ascent eruptions are differentiated by grain lithology counts ($n = 300$) in the 3–4 ϕ (63–125 μm) fraction. Fast-ascent eruption products contain highly angular grains with distinctive sharp edges and shapes characteristic of disrupted vesicle-walls. Vesicular glass shards are the dominant component (20–60 vol.%) and often contain microlites. Whole or fragmented phenocrysts are present and most grains have vesicular glass selvages. Grains of slow-ascent eruptions, in contrast, are predominately sub-rounded with smooth to irregular edges. These are mostly (30–50 vol.%) hylocrystalline andesitic lithic fragments, with fewer crystal fragments and rare glass shards. The rare glass present contains abundant microlites of plagioclase, pyroxene $\pm$ titanomagnetite.

4.5.2 Titanomagnetites

Titanomagnetite microphenocrysts were isolated from the 3–4 ϕ (63–125 μm) fraction of each layer using a magnet. The crystals were mounted in epoxy resin, thin-sectioned and polished. For each layer 100–300 grains were counted under reflected-light microscopy. In deposits from slow-ascent eruptions, typically >25% and up to 50% of the grains show exsolution features. Exsolved grains show a Ti-poor titanomagnetite host with a trellis of relatively Ti-rich lamellae that may reach up to 30 wt.% TiO_2 (Fig. 4.4). Exsolved grains range from simple single lamellae sets (Fig. 4.1A) through to intersecting sets of densely spaced lamellae (Fig. 4.1B). The wide range in exsolution features and the presence of non-exsolved grains in the closed-system deposits are consistent with domes as described above. Titanomagnetite in deposits representing fast-ascent eruptions are predominantly homogeneous with only one to two grains per 100 showing exsolution. The grains are either euhedral with occasional selvages of clinopyroxene (Fig. 4.1C), or have resorbed edges and may contain selvages of glass.

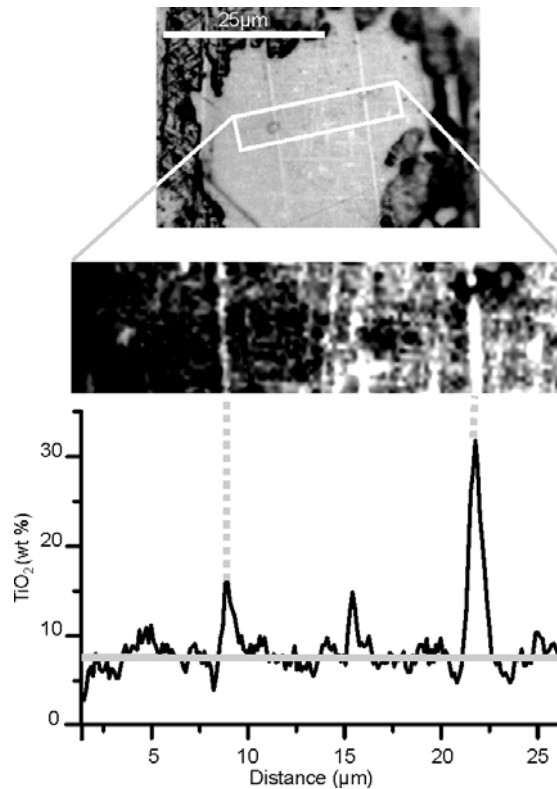


Figure 4.4: *Electron microprobe line-scan across an exsolved titanomagnetite grain (Jeol JXA840 electron microprobe of the Auckland University using a Princeton GammaTech Prism 2000 Si (Li) EDS X-ray detector and an accelerating voltage of 12.5 kV at 600 pA. A 2 μm focused beam and 10 second live-time count was used, with one analysis every 1 μm along the line). The grey horizontal line indicates the TiO_2 content of an unexsolved grain from the same deposit.*

4.5.3 Identification of eruption styles

Over half of the tephra layers of the Umutekai core contained large ($>500 \mu\text{m}$ in diameter) recognizable pumice clasts and hence were identified as being the deposit of a fast-ascent eruption. These ‘larger’ deposits were used to assess the reliability of the grain lithology and titanomagnetite classification techniques (e.g., Fig. 4.2). The titanomagnetite method correctly identified each of these tephras as being from a fast-ascent system. In contrast, eight of these tephras were identified by their fine-grain lithology as being of slow-ascent. These differences in identification were likely the result of difficulties in recognising fine-grained dark mafic glass shards, weathered grains, or shards mantled in clay. The titanomagnetite technique was therefore more

reliable and hence used to classify the remaining 47 very fine-grained tephras layers in the core.

The eruption deposits at Umutekai were treated as being from two extreme end-member eruption types. Some eruptions lasted several months, involving phases of both slow- and fast-ascent eruptions and mingling of several magma types (Platz et al. 2007a). Similarly individual contrasting events may have been separated by up to 10 years, but still preserved as a single layer in the sediment. In these cases lower percentages of exsolved grains would occur, and the layer is classified as a slow-ascent eruptive. In the case of fast-ascent eruption, incorporation of country rock fragments during vent widening may give rise to a few (two-three per hundred) titanomagnetite grains showing exsolution in an otherwise homogenous population.

4.5.4 Elucidation of magma-system processes in eruption histories

Using the depositional rate curve (Fig. 4.3), an annual eruptive rate can be estimated by using an exponential-cubic kernel smoother (Silverman 1986). The overall probability function for all eruptions shows irregular variations in eruption rate (Fig. 4.5). After classification of the event types from titanomagnetite textures, an underlying highly regular variation in eruption rate of fast-ascent eruptions is revealed with a periodicity of around 1500 yrs. The record of slow-ascent eruption is, by contrast, less systematic (Fig. 4.5).

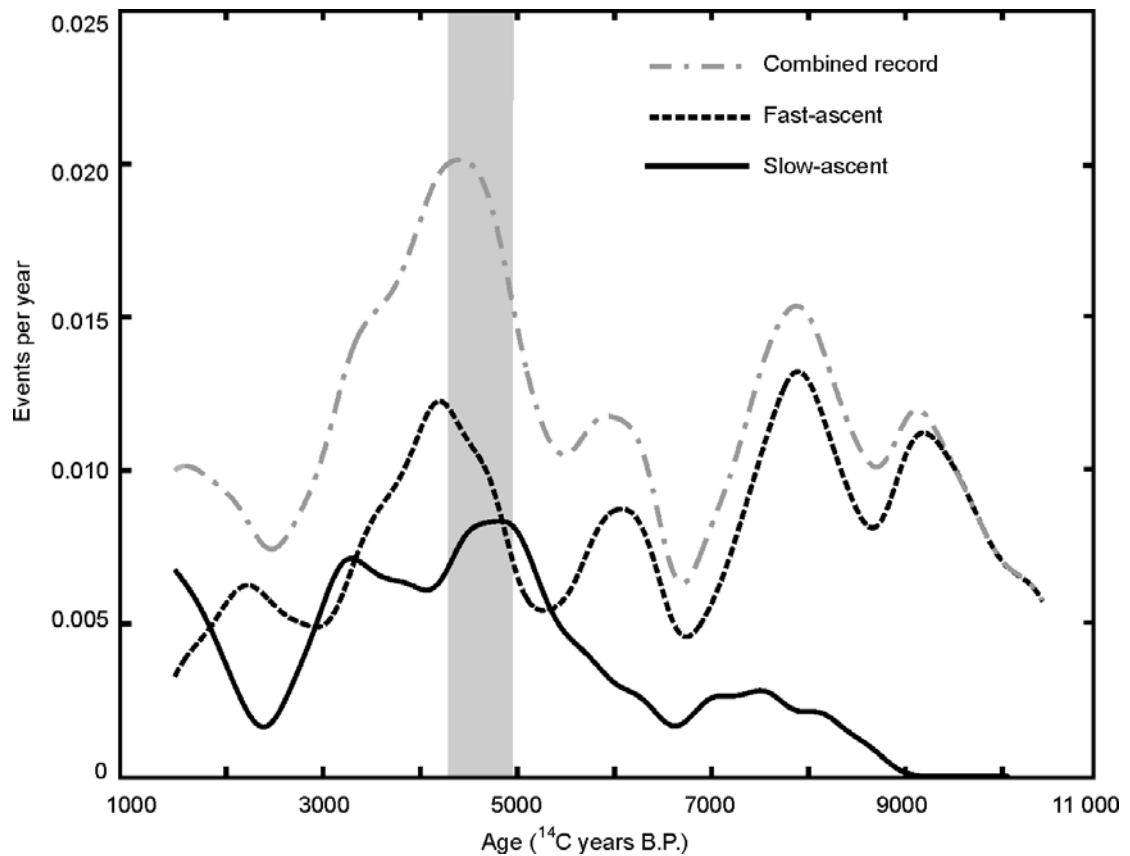


Figure 4.5: *Kernel smoother estimates for the overall annual eruption rate from Mt. Taranaki, split into the component rates for fast-ascent and slow-ascent eruptions. The bandwidth of the smoother was optimized at 485 yr using the Kullback-Leiber score (Marron 1985), and edge effects were dealt with by inverse weighting of the kernel density (Diggle 1985). The highlighted area corresponds to Figure 4.2.*

To build an accurate eruption history of a volcano in order to predict future hazards, it is important to recognize the range in eruption styles possible. Slow- and fast-ascent eruptions produce distinct hazard types that impact differently on surrounding areas. For example, block-and-ash flows with associated surges are channelised into particular sectors of an edifice, whereas sub-plinian activity impacts depend on prevailing wind. In building time-variable hazard forecasts, being able to distinguish periods during which either fast- or slow-ascent system behaviour dominated is as important as quantifying the frequency of individual events.

Lake Umutekai is ideal for recording the majority of fast-ascent sub-plinian eruptions and use of a single site also simplifies the statistical approach. Although the site may

have a bias toward certain types or scales of events, the bias is likely to be consistent over the period analysed. Assuming an equal probability of tephra from these eruptions reaching the lake, the Holocene record of fast-ascent eruptions from this site (Fig. 4.5) is probably well representative for the volcano. The most striking feature of this curve is its c. 1500 yr periodicity (Fig. 4.5). Significantly, each peak of fast-ascent eruption activity also corresponds to the largest-volume sub-plinian eruptions known from this centre¹ (c.f., Alloway et al. 1995). This may reflect: (1) the periodicity of magma-system replenishment; (2) the recurrence of regional tectonic events affecting the magma system (e.g., triggering magma batch rise); or (3) the period for large magma batches to reach high enough over-pressures or minimum buoyancy to rise and erupt. The identification of such cyclicity in the eruption history of a volcano is significant for magmatic system modelling. Notably, the ranges of variation in the rate of fast-ascent eruptions at Mt. Taranaki appear to have been constant during the Holocene. This suggests that the volcano has been in a “steady state” over this time.

The slow-ascent eruption record at Umutekai is not so systematic. However, the peaks in this record (Fig. 4.5) do relate closely to four specific periods of block-and-ash flow deposition in the eastern and north-eastern tributaries closest to the lake site (1500–2000 yr B.P.; 3100 yr B.P.; c. 3600 yr B.P.; and >7000 yr B.P.; Neall 1979). Deposits from pyroclastic flows on southern or western flanks, in contrast, are unlikely to be present in the Umutekai site. The trough in frequency of slow-ascent eruptions between 3000 and 5000 yr B.P. corresponds to a peak in fast-ascent eruptions. This may be a coincidence, however, it is intriguing to consider the possibility that slow-ascent eruptions precede and follow periods of intense fast-ascent eruptions.

Being able to analyse eruption records in this detail from active volcanoes such as Mt. Taranaki, will aid probabilistic forecasting of future activity. Intervals between eruption periods are often treated as independent variables, and modelled by renewal processes (Bebbington and Lai 1996). By recognizing other processes in the volcanic system that control eruptive behaviour and frequency, further refinements in renewal-process based eruption forecasting can be made by the application of Markov models and hidden

¹ Note, further research has shown this may not be true, see the second part of this chapter.

Markov models, such as those used to examine apparent clustering of events (e.g., Cronin et al. 2001).

4.6 Conclusions

We show that by examining titanomagnetite exsolution textures in distal fine-grained fall deposits from andesite volcanoes, individual eruptions can be reliably classified into two end-member states:

- 1) Fast-ascent eruptions (fresh, homogenous titanomagnetite) that imply sub-plinian style hazards: pyroclastic flows, widespread falls.
- 2) Slow-ascent eruptions (exsolved titanomagnetite) that imply dome-growth related hazards: block and ash flows, blasts.

By separating individual records of fast- and slow-ascent eruptions, hidden systematic variations in annual eruption frequency can be revealed. In our example from Mt. Taranaki the fast-ascent eruptions show a highly periodic variability in eruption frequency. This leads us to hypothesise a regular periodicity in the processes controlling magma-system replenishment. The contrasting record of slow-ascent eruptions is highly dependent on environmental factors, such as crater morphology, that affect the distribution of block-and-ash flows.

4.7 Acknowledgements

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4.8 Cyclic magma evolution and associated eruption frequency at andesitic volcanoes and its implications to eruption forecasting: a case study from Mt. Taranaki, New Zealand

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4.8.1 Abstract

Realistic probabilistic eruption predictions and hazard forecasts rely on an in-depth knowledge of volcanic processes and resulting eruption scenarios at times of both quiescence and eruption. Here we demonstrate that the longer-term eruption frequency at intermediate and silicic arc volcanoes is coupled to overall cyclic evolution of magma differentiation. The Holocene frequency of pumice-producing, explosive eruptions from Mt. Taranaki, New Zealand, is highly cyclic, showing a 1500-2000 year periodicity. The MgO component of titanomagnetite microphenocrysts in eruptive products also shows distinctive 1500-2000 year cycles that are mirrored in whole-rock geochemical patterns, and are in phase with the changes in eruption frequency. This observation implies a possible genetic coupling between the geochemical and eruption frequency cycles. The largest known Holocene eruptions from this centre occur regularly in the trough of the eruption frequency curve, coinciding with the end of a compositional cycle. These largest events are uniformly the most evolved (silicic) andesites of the centre. Confirming a relationship of magma compositional cycles to the eruption frequency at volcanoes such as Mt. Taranaki is important for constraining the timescales

and nature of magmatic processes, as well as being a key foundation for time-varying hazard assessments for andesitic volcanoes.

4.9 Introduction

Historic eruption activity from some of the world's best documented intermediate and siliceous volcanoes show semi-regular periods of volcanic activity separated by intervals of quiescence (e.g., Vesuvius: Scandone et al. 1993; Merapi: Andreastuti et al. 2000; Fuji: Miyaji 1988). Recent developments in micro-analytical geochemistry and volcano surveillance technology have led to advancements in both understanding magmatic processes (e.g., Rutherford and Devine 2003; Devine et al. 2003) and forecasting realistic behaviour scenarios for volcanoes that are within an active episode (e.g., McGuire and Kilburn 1997). However, difficulties remain in the integration of these findings into holistic and long-term models of eruption recurrence at re-awakening volcanoes. One of these is the acquisition of comprehensive eruption records that are long enough to smooth out any short-term anomalies in eruption history. Another is developing an equally comprehensive and time-constrained view into the magmatic system of the volcano.

In this paper we use geochemical data from an extremely precise Holocene eruption record of the andesitic Mt. Taranaki (New Zealand) to demonstrate a genetic link between regular cycles of magmatic evolution and variations in the eruptive frequency of the volcano. In addition, the magmatic cycles also appear to control the semi-regular timing of the largest (plinian) events in the eruption record.

4.10 The Holocene eruption rate of Mt. Taranaki

4.10.1 Mt. Taranaki

Mt. Taranaki western North Island, New Zealand (Fig. 4.6) is typical of arc-related systems throughout the world, with Holocene eruptions comprising mostly basaltic-andesite to dacite magmas (Stewart et al. 1996). Summit-sourced eruptions are

generally andesitic to dacitic, while those from the parasitic Fanthams Peak are typically basaltic andesite. Although Mt. Taranaki has been in a state of quiescence for at least 150 years, edifice and ring-plain deposits indicate a complex history of frequent explosive volcanism, dome construction and lava-extrusion (Neall et al. 1986), similar to a number of recently active volcanoes, such as: Unzen (Japan), Merapi (Indonesia), and Augustine (Alaska). Like many dormant volcanoes, prehistoric eruption records and geochemical studies have largely concentrated on easily identifiable and accessible deposits (Neall et al. 1986; Alloway et al. 1995). Although these provide the basic framework for geochemical models of magma genesis (Price et al. 1999) and eruption frequency for larger eruptions (Alloway et al. 1995), this preliminary work does not contribute to our understanding of the shorter term (months to centuries) eruption record or the magmatic processes responsible for this more-typical activity. To rectify this, a high-precision temporal eruption record for Mount Taranaki was constructed from lacustrine and peat swamps surrounding the volcano (Chapter 3) and used to define the sampling regime for the geochemical aspects of this study. Lake Umutekai, lying 25 km NNE from the summit of Mt. Taranaki (Fig. 4.6) provided a key location for this study. In a four metre core from this lake, 103 individual tephra layers were recognised between c. 1500 to 10 500 yrs B.P. Lake Rotokare, 34.5 km (Fig. 4.6) to the SE of the summit provides a second, detailed record of ashfall. In a c. five metre core from this lake, 42 tephras were dated between 500-6250 yrs. B.P. Each tephra layer from these cores was assigned a unique age (with associated normally distributed error) from a spline-fit, core-depth function calculation, interpolated from 9 radiocarbon dates for Umutekai and 6 for Rotokare (Chapter 3).

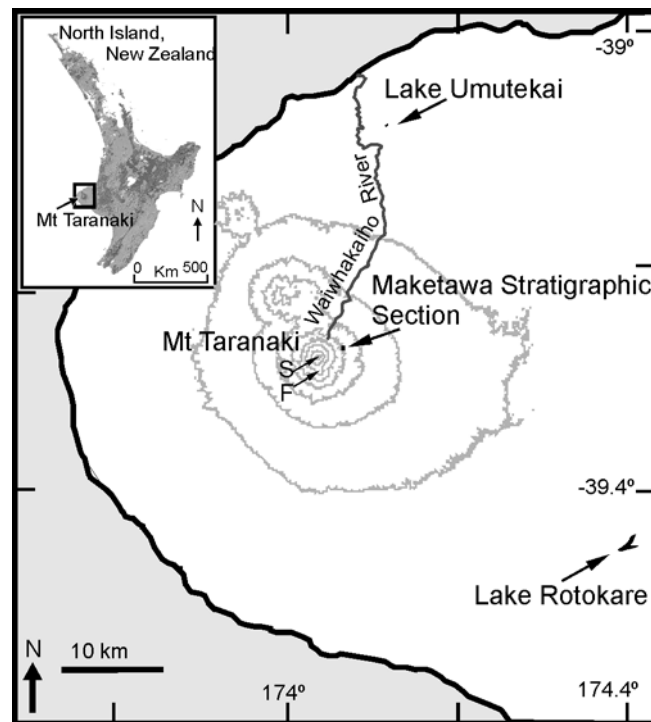


Figure 4.6: *Location map of tephra deposition sites around Mount Taranaki used in this study. 300 m contours are in grey. S = Summit vent. F = Fanthams Peak vent.*

4.10.2 Eruption frequency analysis

For eruption frequency analyses, combining multiple records from various locations that cover various time ranges (Chapter 3) may involve variable levels of bias. A single-site record may be more suitable, because if wind patterns have a constant degree of variability, the sampling probability of the single site will remain the same. Hence, eruption frequency analysis was performed on the Lake Umutekai record. This lake lies near the major NE tephra fall dispersion axis and during the Holocene insignificant changes to the overall high level winds occurred (c.f., Alloway et al. 2005). This means that there was a near-constant probability that during a widespread eruption, ash would have been deposited at this site. To reduce a second form of bias created by the restricted distribution of ash fall from dome collapses, only eruptions producing high central columns were considered. Such eruptions are most likely to be from fast-ascending magma, producing sub-plinian style eruptions and thus are represented in the geological record as pumice-rich fall layers. Pumice-bearing deposits within this record

were identified by a combination of glass and titanomagnetite observations (c.f., Turner et al. 2008b; this Chapter).

The upper part of the lake record was unobtainable due to the uppermost sediment column being unconsolidated. To complete the eruption record, in Chapter 3 a database of well dated events from near-source deposits was compiled. However, most of this ‘recent’ record relied on the dating of block-and-ash flow deposits produced during dome building eruptions. To overcome these problems and therefore complete the record of sub-plinian eruptions, an edifice site was used (Maketawa Stream; Fig. 4.6). At this site block-and-ash-flow and fall deposits are preserved, with intervening paleosols and medial ash. The Maketawa Stream site is ideally situated, directly between the summit and Lake Umutekai (Fig. 4.6) and it contains two marker horizons; a well recognised pumice-bearing pyroclastic deposit of the AD 1655 Burrell eruption (Druce 1966) and a charcoal bearing block-and-ash-flow (NZ-16391; 1130 ± 34 yrs B.P.).

Renewal processes were applied to the Lake Umutekai (Turner et al. 2008b; Appendix 1) and combined lake-edifice records to obtain a probability function of events per year for each year during the Holocene period. The resulting record of sub-plinian eruptions frequency at Mt. Taranaki during the Holocene shows a periodic variation in eruption rates (Fig. 4.7). A characteristic period of 1500-2000 years occurs. These cycles include periods of intense eruption activity separated by decadal periods (or less) of repose and periods where eruption activity is characterised by 100+ year repose periods (Fig. 4.7).

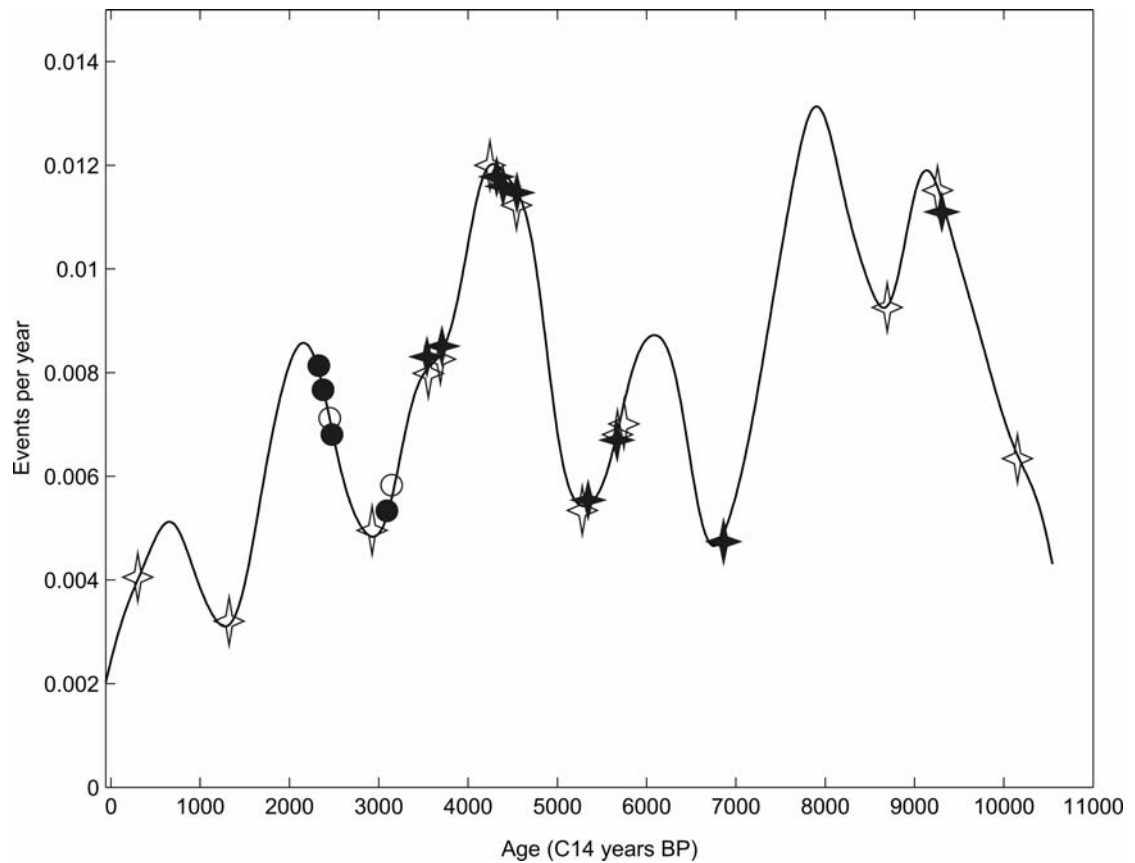


Figure 4.7: *Kernel smoother estimates for a sample of the annual eruption rate from Mt. Taranaki, concentrating on fast ascent, sub-plinian eruptions from the combined datasets of Lake Umutekai and Maketawa eruption records. Modified after Turner et al. (2008b; Appendix 1). Open stars (summit-sourced) and circles (Fanthams Peak sourced) represent the best-estimated positions of the larger tephra ($>0.6 \text{ km}^3$ bulk rock) identified by Alloway et al. (1995). Filled stars and circles represent positions of largest tephra as identified from dated lake records and geochemically correlated to major units on the edifice.*

4.10.3 Large eruption dataset

Evidence of the most voluminous eruptions ($>0.6 \text{ km}^3$ bulk rock²) of Mt Taranaki are found preserved as thick pumice layers within the soil of the surrounding ring plain, mostly to the east of the volcano (Alloway et al. 1995). Many of these were identified and assigned approximate ages by their relative stratigraphic position in relation to radiocarbon dated horizons. Their ages are therefore often approximate, with associated errors spanning ≥ 200 years (Table 4.1; Fig. 4.7; open stars). Mt. Taranaki sourced

² Using the method of Legros (2000) on datasets from Alloway et al. (1995).

tephras are also identified within sediments of lakes of the Waikato district, 200 km NE of the volcano. Due to the distance from source, these units are also likely to be derived from large events. These were precisely dated by Lowe (1988) (Table 4.1). In addition, we have independently identified the largest Holocene eruptions on the basis of the thickest (>1 cm) and coarsest (mean >250 μm) fall deposits contained within the records of Lakes Umutekai and Rotokare. These units were also correlated by their unique geochemical compositions to large (~ 1 m thick) pumice deposits within soil sequences on the edifice. This process enabled a much more precise estimate of ages, with smaller and well-defined error ranges typically less than ± 50 years) (Table 4.2; Fig. 4.7, black [summit-sourced] and grey [Fanthams Peak sourced] filled stars). These large-volume explosive eruptions occur on a semi-regular interval of ~ 400 - 600 years. Importantly, the majority of them occur during periods of relative quiescence in eruption activity and typically immediately prior to a substantial period of repose, as evidenced by the longest periods of paleosol development in regional stratigraphic profiles.

Table 4.1: *Largest known explosive pyroclastic eruptions ($>0.6 \text{ km}^3$) from Mt. Taranaki. The named tephra and associated dates are described by Neall (1972). In addition, Mt. Taranaki tephra identified within lakes of the Waikato district (Lowe 1988) are listed.*

Tephra name	Age (yrs B.P.)	Data code	Source	Tephra symbol (Lowe 1988)	Age (yrs B.P.) ^d
Burrell Lapilli	300 ± 60	NZ63	Fergusson and Rafter (1957)		
Kaupokonui Tephra	1390 ± 150	NZ6508A	Lees and Neall (1993)	Eg-1 ^c	2500
Maketawa Tephra	2890 ± 100	NZ3423A	Alloway et al. (1995)		
Manganui Tephra	c.3100 ^b		Alloway et al. (1995)		
Inglewood Tephra (a) ^a	3610 ± 80	NZ3353A	Neall (1979)	Eg-2	3700
Inglewood Tephra (b) ^a	3690 ± 80	Wk-1031A	Alloway et al. (1995)	Eg-3	3750
Korito Tephra	>4150 ± 100	Wk-1033A	Alloway et al. (1995)	Eg-4	4100
Tariki.e	4590 ± 100	Wk-1034A	Alloway et al. (1995)	Eg-5	4400
Wakipuku Tephra	5260 ± 90	Wk-1035A	Alloway et al. (1995)	Eg-6	5250
				Eg-7	5850
				Eg-8	5900
Kaponga.f	8947 ± 130	NZ7986A	Hull (1994)	Eg-9	9300
				Eg-10	9600
Konini.b	10 150 ± 100	NZ3153A	McGlone and Neall (1994)	Eg-11	10100

^aDivided into two tephra on the bases of radiocarbon ages and the description of a 'medial interbed <0.14m thick' separating the two (see Alloway et al. 1995).

^bFanthams Peak eruptive. Estimated age based on sediment thickness between radiocarbon dates (NZ3423A) of 2890 ± 60 and (NZ3139A) of 3320 ± 60 yrs BP (McGlone et al. 1988).

^cLikely to be part of the 'Manganui tephra' based on the radiocarbon age compared to Manganui tephra found in the Umutekai record.

^dMost dates interpolated between two radiocarbon dates acquired directly above and below the sampled tephra. Some are interpolated from the sedimentation rate (see Lowe 1988).

Table 4.2: *Largest tephra identified within the lacustrine record (>1 cm and mean grain size >250 μm) that are also correlated to major on-edifice units. See Turner (Chapter 3) for details of interpolated ages.*

Lake Umutekai tephra no.	Interpolated age (yrs B.P.)	Lake Rotokare tephra no.	Interpolated age (yrs B.P.)
		10 ^a	2142 $\pm$ 25
8 ^a	2237 $\pm$ 24		
9 ^a	2368 $\pm$ 30		
		18 ^a	2687 $\pm$ 26
		19 ^a	3051 $\pm$ 29
		21	3674 $\pm$ 35
25	3722 $\pm$ 39	23	3747 $\pm$ 29
33	4311 $\pm$ 36		
34	4346 $\pm$ 38		
		29	4656 $\pm$ 30
		35	5362 $\pm$ 41
		40	6070 $\pm$ 40
67	7069 $\pm$ 56		
95	9221 $\pm$ 45		

^aDeposit characteristics and titanomagnetite compositions indicate a Fanthams Peak source.

4.11 The magmatic evolution of the volcano during the Holocene period

Typically whole rock geochemistry, particularly trace element components are used to decipher and model the magma parental sources and subsequent differentiation through ascent (e.g., Price et al. 2005). The tephra deposits collected from the lacustrine and swamp cores of this study are typically less than 55 mm³, too small to produce consistent whole-sample compositional data, due to variations in the relative abundances of atmospherically sorted phenocrysts. Alternatively, glass composition is also used to provide an indication of the magma composition and inferences on ascent and storage processes (c.f., Shane 2005; Gamble et al. 1999; Andreastuti et al. 2000). At andesite volcanoes, however, glass composition studies often reveal large spreads in

data (Shane 2005; Platz et al. 2007b). This spread is caused by variable degrees of crystallisation and diffusion processes operating during their ascent and eruption (Blundy et al. 2006), meaning glass will not give an accurate proxy of the true magma composition. A procedure developed by Platz et al. (2007b) can be used to estimate the proportions of the main contaminant phase(s) of andesite glass analyses and thus allow back-calculation of glass compositions to more closely estimate those of the melt prior to eruption. However, variations of particle type are also common to andesitic tephra, resulting from the incorporation of material from the conduit walls or lava plug/domes, generating additional composition variation (Platz et al. 2007b). Very late stage crystallisation of microlites also leads to strong variations in the surrounding melt on the micro-scale (Best, 2003). In addition, it was found throughout this present study that glass shards from Mt. Taranaki are typically very thin, typically $<10\text{ }\mu\text{m}$, and hence too small for the defocused electron beam used for reliable glass analyses.

Ideally, the composition of crystalline phases in equilibrium with a surrounding melt should be used to determine the magmatic evolution of that magma. However, there are many processes that control the composition of the crystallising mineral. For example, variations in pressure, temperature and oxygen fugacity may control the resulting composition (e.g., Hammarstrom and Zen (1986) suggests that abundance of Al_2O_3 within an amphibole crystal is mostly controlled by pressure). In addition, most crystalline phases exhibit solid solutions between distinct end-member compositions and differences in the activation energy at the surface of crystal may favour the partitioning of one element over another (Ghiorso and Sack 1995). Titanomagnetite, however, is mostly unaffected by these processes because it always exhibits a homogeneous core equilibrated with the magma (Tomiya and Takahashi 2005).

4.11.1 Titanomagnetite compositions

Titanomagnetite microphenocrysts ($\sim 60\text{--}100\text{ }\mu\text{m}$) are abundant in andesitic eruptions and, unlike the typically large phenocrysts of other mineral phases ($>150\text{ }\mu\text{m}$), these microphenocrysts are often incorporated in glass shards that are deposited great distances from the volcano (c.f., Shane 2005). Large elemental diffusion rates in titanomagnetite mean that its composition reflects the composition of the surrounding

melt and physical conditions just prior (days to years) to eruption (Devine et al. 2003; Tomiya and Takahashi 2005). In addition to this, the relatively rapidly ascending and quenched magma of sub-plinian, pumice producing eruptions means that the titanomagnetite compositions are unaffected by ‘late-stage’ crystallisation and chemical differentiation (Burton 1991). Titanomagnetite MgO, and Al₂O₃ compositions reflect the relative proportions of these elements within the surrounding melt (Streck et al. 2002). In general, MgO and Al₂O₃ within the melt decrease during continued crystallisation (Hill and Roeder 1974). For example, if extensive plagioclase and/or amphibole are crystallised, then the amount of Al₂O₃ available for subsequent titanomagnetite crystallisation would be relatively low (e.g., Tomiya and Takahashi 2005). In contrast, the abundance of TiO₂ within titanomagnetite is strongly dependent upon oxygen fugacity and temperature of the surrounding melt (Buddington and Lindsely 1964; Devine et al. 2003).

The titanomagnetite composition for all sub-plinian events from the composite Mt. Taranaki record were determined by electron microprobe analyses using a JEOL JXA-840 equipped with an energy dispersive spectrometer at the University of Auckland. Analytical conditions include an accelerating voltage of 15kV, a beam current of 600 pA and 100 seconds live time.

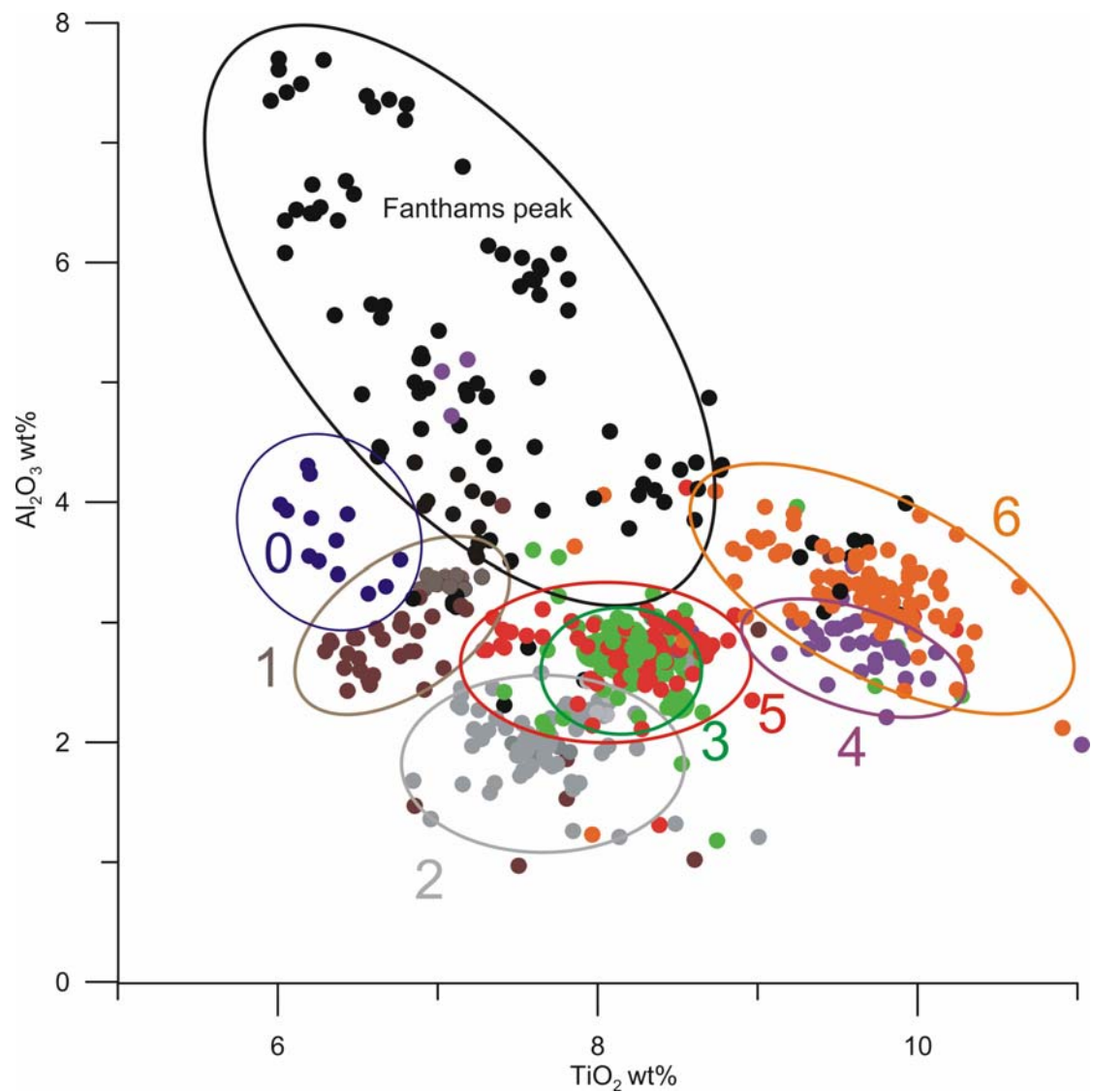


Figure 4.8: *Plot of electron-microprobe derived Al_2O_3 vs. TiO_2 wt.% in titanomagnetite grains for the entire Holocene record of sub-plinian tephra eruptions from Mt. Taranaki. Each numbered and coloured set of points indicates individual batches of related compositions erupted from the summit vent, which are also temporally constrained (hence the apparent overlaps of some groups). The black dots indicate titanomagnetite derived from more primitive Fanthams Peak eruptions that overlap temporally with summit batches 0 and 1.*

4.12 Identification of distinct magma batches and geochemical cycles

4.12.1 Titanomagnetite-defined magma batches

The precise age model for the Holocene tephra record of Mt. Taranaki provides the best opportunity to identify changes within magma compositions and thus allow interpretation of the magmatic processes and their timescales. To ensure that between various locations, consistent individual eruption products were used, the STEPDISK procedure (SAS Institute Inc., 2004) was employed to classify correlatives based on their TiO_2 , Al_2O and MgO contents within titanomagnetite (Chapter 3). Since Al_2O_3 and MgO abundances within the titanomagnetites are closely related to the composition of the magma, whereas TiO_2 is related to oxygen fugacity, bi-variant plots of either Al_2O or MgO vs. TiO_2 can be used to identify clusters of eruptives whose magmatic conditions were similar. On the basis of the age of the eruption, along with its titanomagnetite geochemistry, the Holocene dataset of Mt. Taranaki eruptions was divided into seven compositionally and temporally distinct clusters of data (Fig. 4.8, ellipsoids labelled 0-6). This implies there were individual parental magmas for each cluster, each with a unique magmatic evolutionary history (Table 4.3). Here we define these compositionally and temporally classified clusters as magma “batches”. Along with the seven batches, an additional highly spread group of high- Al_2O_3 titanomagnetites occurs (black dots on Fig. 4.8) that overlaps in age with magma batches 0 to 2. Tephras of this group are basaltic-andesite in whole-rock composition and scoriaceous in appearance, which through correlation to near-source sequences, show they were sourced from the basaltic-andesite satellite cone of Fanthams Peak, rather than the summit vent (see Fig. 4.6). The Fanthams Peak eruptions are therefore grouped separately. Each of seven summit magma batches generated a series of eruptions that was ~1000-2000 years long.

Table 4.3: *Titanomagnetite analyses from each of the identified magma batches. Sample numbers refer to dataset used in this study. M=Maketawa. U=Umutekai. FeO and Fe₂O₃ recalculated (36 oxygens per 24 cations).*

Batch no. (Age ranges yrs B.P.)	0 (0- 1800)	1 (1800 - 3000)	2 (c.3000 - 4600)	3 (4600- 6000)	4 (6000 – 7700)	5 (7700- c.8600)	6 (c8600 – 10 100)	7 >10100	Fanthams Peak
Sample no.	M04-52	U05-6	U05-19	U05-44	U05-56	U05-72	U05-85	U05-95	U05-8
<i>Wt%</i>									
SiO ₂	0.15	0.15	0.01	0.29	0.2	0.09	0.27	0.15	0.10
TiO ₂	6.01	6.94	7.46	8.26	9.69	8.51	9.73	7.76	7.32
Al ₂ O ₃	3.93	3.99	1.94	2.62	2.69	2.98	3.29	3.12	4.40
FeO	32.71	33.29	34.38	35.01	36.00	33.86	35.39	33.91	32.36
Fe ₂ O ₃	53.66	51.48	53.16	52.25	49.95	50.65	47.26	52.85	52.82
MnO	0.41	0.47	1.13	0.97	0.89	0.88	0.65	0.58	0.56
MgO	2.82	2.73	1.8	2.73	2.92	2.85	3.13	2.92	3.28
Total	99.69	99.05	99.88	102.13	102.34	99.83	99.72	101.29	100.75

4.12.2 Magma batches defined by whole-rock geochemistry

Although the tephras within the lacustrine deposits of this study are not suitable for whole-rock geochemical analyses (see above), in Chapter 3 the correlation of tephras to proximal deposits on the volcanic edifice, using titanomagnetite chemistry, was made. The proximal equivalents have clasts large enough for more representative whole-rock geochemical analysis. Fresh dense juvenile and pumice clasts were individually selected for analysis (Table 4.4).

The whole-rock major and trace element data of these dated tephras also clearly group the eruptive record into compositional and temporal 1500-2000 year batches, identical to those from the titanomagnetite chemistry (Fig. 4.9). This is also consistent with the conclusions of Downey et al. (1994) who identified probable ages of four lava-flow groups on Mt. Taranaki and suggested that each was emplaced during eruption cycles lasting 1000-2000 years. Although these lava-flow groups are not precisely dated,

contrasting geochemical variations between these different stratigraphic groups (Price et al. 1999) is consistent with the trace element data presented here (Fig. 4.9).

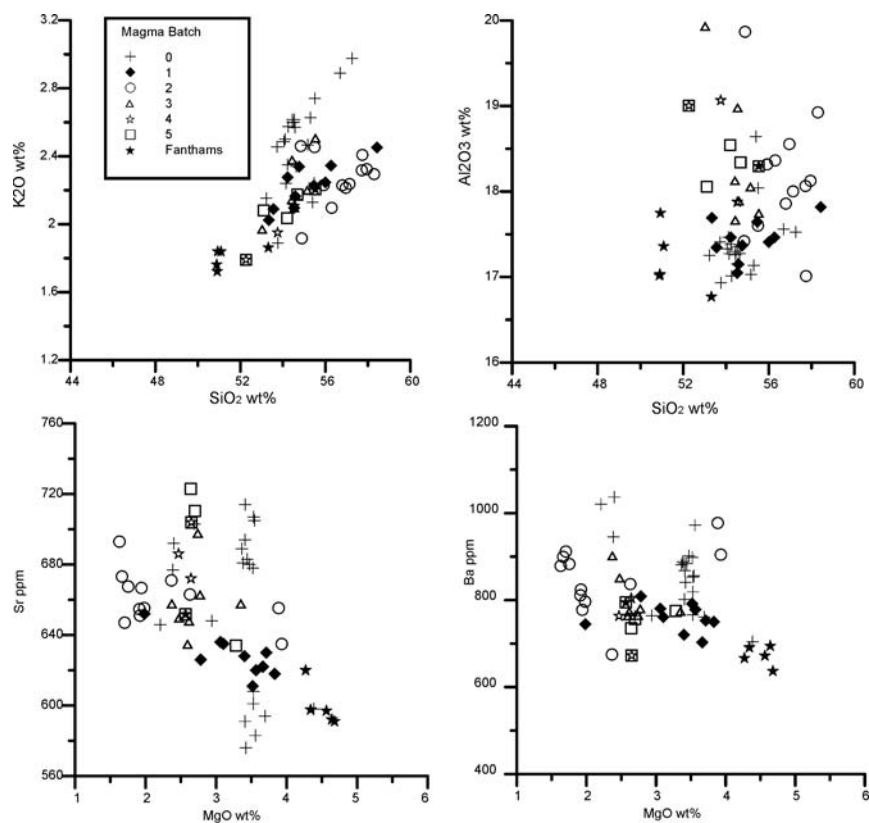


Figure 4.9: *SiO₂ and MgO variation diagrams for Taranaki eruptives. These data also cluster into defined “batches” labelled identically to those defined on the basis of titanomagnetite chemistry.*

Table 4.4 *Representative whole rock geochemical samples. Major and trace element concentrations were measured by X-ray fluorescence (Siemens SRS303AS spectrometer) using standard techniques on glass fusion discs prepared with SPECTRACHEM 12-22 (lithium tetraborate/lithium metaborate) flux following the method of Norrish and Hutton (1969). Major elements have one-sigma relative errors <1%, whereas trace elements have one-sigma relative errors of <1% for Sr and Zr, 1-3% for V, Cr, Cu, Zn, Ga and Y, 3-5% for Sc and Ni and 5-10% for Rb and Nb. In addition Cs, Ba, Pb, Th, U, Hf, Ta, and Rare Earth Elements (REE) were analysed by LA-ICP-MS at the Research School of Earth Sciences, Australian National University, using an Excimer LPX120 laser and Agilent 7500 series mass spectrometer. For this work the same fused glass discs as for XRF were used. Detection limits are <1 ppb and analytical errors <1% relative.*

Sample no.	M04-52	M04-57	E02-84	E02-173	M04-80	M04-90	M04-166L	M04-176L
Age (yrs B.P.)	300	500-800	1900	1800	3600	3600	4600	4800
Batch no.	0.00	0.00	1.00	1.00	2.00	2.00	3.00	3.00
Wt%								
SiO ₂	55.30	55.51	53.34	53.56	56.96	57.95	55.14	54.42
TiO ₂	0.77	0.81	0.84	0.86	0.60	0.60	0.82	0.83
Al ₂ O ₃	17.14	18.04	17.69	17.35	18.55	18.13	18.04	18.11
Fe ₂ O ₃	7.21	6.91	8.21	8.18	5.74	5.73	7.49	7.59
MnO	0.15	0.15	0.17	0.17	0.17	0.17	0.16	0.16
MgO	3.56	2.40	3.40	3.71	1.67	1.70	2.77	2.62
CaO	7.85	6.68	8.18	8.55	6.69	6.67	8.04	7.71
Na ₂ O	3.62	3.91	3.59	3.61	3.99	4.10	3.80	3.67
K ₂ O	2.63	2.74	2.02	2.09	2.21	2.32	2.19	2.14
P ₂ O ₅	0.27	0.33	0.28	0.27	0.29	0.29	0.29	0.29
H ₂ O	0.17	0.45	0.44	0.21	0.78	0.51	0.37	0.49
LOI	0.71	1.64	1.26	0.78	1.63	1.16	0.13	0.55
Total	99.37	99.58	99.41	99.35	99.28	99.32	99.24	98.58
ppm								
Sc	20.00	15.00	15.00	22.00	5.70	5.30	10.00	11.50
V	202.00	185.00	210.00	219.00	105.90	108.60	203.50	204.90
Cr	41.00	4.00	23.00	37.00	16.40	8.40	23.00	12.50
Ni	10.00	0.00	4.00	4.00	3.20	0.00	6.70	6.60
Cu	92.00	84.00	66.00	83.00	23.10	59.40	18.70	82.30
Zn	81.00	83.00	87.00	88.00	76.80	99.20	80.20	96.40
Ga	23.00	24.00	19.00	19.00	21.20	19.00	21.20	21.40
Rb	67.00	70.00	51.00	52.00	56.00	55.80	59.60	58.60
Sr	583.00	692.00	628.00	630.00	673.20	647.00	662.00	647.20
Y	22.00	24.00	23.00	23.00	24.00	24.50	24.30	24.80

Zr	134.00	153.00	127.00	118.00	143.40	139.90	134.20	135.10
Nb	5.16	6.18	4.65	4.46	5.11	5.05	4.62	4.55
Cs	3.92	3.74	2.75	2.75	3.56	3.77	2.96	3.51
Ba	972.32	1037.04	720.25	753.13	899.44	911.76	777.15	770.43
La	20.51	22.79	15.21	17.57	21.75	21.53	16.56	20.04
Ce	38.72	43.98	31.17	32.12	42.69	42.04	33.71	35.89
Pr	4.84	5.46	4.00	4.18	5.25	5.33	4.36	4.70
Nd	20.28	23.30	18.13	18.61	22.29	22.70	19.62	20.72
Sm	4.62	5.16	4.12	4.33	4.91	4.87	4.49	4.54
Eu	1.27	1.34	1.22	1.27	1.25	1.35	1.35	1.40
Gd	4.12	4.79	4.12	4.39	4.45	4.53	4.30	4.58
Tb	0.69	0.73	0.67	0.71	0.71	0.72	0.69	0.76
Dy	3.95	4.11	3.75	3.78	4.04	4.14	3.93	4.32
Ho	0.78	0.81	0.78	0.81	0.83	0.86	0.87	0.89
Er	2.23	2.28	2.19	2.31	2.54	2.49	2.40	2.48
Tm	0.30	0.31	0.28	0.31	0.33	0.32	0.28	0.32
Yb	2.16	2.26	2.01	2.11	2.42	2.36	2.17	2.33
Lu	0.33	0.36	0.30	0.32	0.36	0.37	0.38	0.37
Hf	4.22	4.60	3.44	3.24	3.97	4.04	3.86	3.90
Ta	0.73	0.79	0.38	0.40	0.40	0.45	0.39	0.38
Pb	13.46	13.87	10.87	10.17	14.87	14.63	10.68	11.23
Th	8.57	9.06	6.27	5.87	8.74	8.32	6.45	6.24
U	2.04	1.97	1.33	1.30	2.00	1.92	1.47	1.43

Table 4.4 (continued)

Sample no.	M05-74	M05-75	M05-78	M05-78L	M04-100	M04-102	E03-61	EB-4b
Age	7068	7700	7939	7939	8917	9347	1700	1700
Batch no.	4.00	4.00	5.00	5.00	6.00	6.00	Fanthams	Fanathams
Wt%								
SiO ₂	54.54	55.55	53.75	54.53	54.20	54.68	50.93	51.08
TiO ₂	0.89	0.83	0.75	0.75	0.88	0.89	1.06	1.01
Al ₂ O ₃	18.96	19.22	19.07	17.88	18.54	18.34	17.75	17.36
Fe ₂ O ₃	7.79	7.19	7.42	7.47	7.75	7.60	9.90	9.63
MnO	0.17	0.17	0.17	0.17	0.17	0.16	0.18	0.17
MgO	2.60	2.48	2.47	2.64	2.64	2.70	4.27	4.56
CaO	7.87	7.65	7.59	7.69	8.28	8.16	9.74	9.44
Na ₂ O	3.65	3.74	3.59	3.69	3.94	3.89	3.43	3.37
K ₂ O	2.09	2.10	1.95	2.11	2.04	2.17	1.84	1.84
P ₂ O ₅	0.33	0.31	0.32	0.29	0.31	0.30	0.28	0.27
H ₂ O	0.25	0.00	0.56	0.82	0.31	0.27	0.06	0.05

LOI	0.30	0.28	1.91	1.64	0.66	0.58	-0.04	0.52
Total	99.44	99.52	99.54	99.67	99.73	99.74	99.39	99.32
<i>ppm</i>								
Sc	12.00	14.00	9.00	10.00	10.00	12.20	22.00	25.00
V	190.00	164.00	161.00	174.00	197.40	203.40	297.00	277.00
Cr	0.00	22.00	3.00	6.00	11.60	10.10	20.00	41.00
Ni	0.00	7.00	2.00	2.00	3.10	4.10	8.00	12.00
Cu	50.00	40.00	55.00	23.00	75.00	73.00	113.00	100.00
Zn	94.00	96.00	86.00	92.00	82.40	74.00	89.00	84.00
Ga	25.00	25.00	25.00	24.00	22.20	21.90	19.00	19.00
Rb	52.00	53.00	48.00	52.00	50.50	51.70	44.00	43.00
Sr	634.00	671.00	686.00	672.00	722.90	710.40	620.00	597.00
Y	26.00	27.00	23.00	22.00	25.00	24.70	23.00	21.00
Zr	140.00	148.00	127.00	119.00	132.30	127.40	106.00	105.00
Nb	5.17	5.64	5.27	4.88	4.94	4.49	3.87	3.90
Cs	3.02	3.22	3.00	2.68	2.92	2.97	2.25	2.23
Ba	760.74	778.43	763.47	804.29	735.08	756.41	666.37	671.87
La	18.37	18.76	19.51	15.61	19.60	17.64	13.46	15.42
Ce	36.45	38.35	34.29	30.88	37.95	35.50	28.83	27.45
Pr	5.06	5.22	4.36	3.98	4.95	4.68	3.79	3.67
Nd	22.18	22.77	19.36	17.68	21.90	21.04	17.42	16.96
Sm	4.95	5.15	4.37	4.11	5.13	4.90	4.48	4.08
Eu	1.46	1.45	1.31	1.30	1.43	1.41	1.30	1.27
Gd	5.25	4.92	4.14	3.86	4.93	4.88	4.11	4.14
Tb	0.83	0.82	0.68	0.65	0.79	0.75	0.70	0.66
Dy	4.50	4.56	3.88	3.62	4.16	4.14	3.81	3.69
Ho	0.97	0.98	0.78	0.76	0.87	0.86	0.78	0.74
Er	2.68	2.76	2.28	2.17	2.44	2.37	2.21	2.14
Tm	0.34	0.36	0.31	0.28	0.32	0.31	0.29	0.29
Yb	2.51	2.45	2.18	1.98	2.26	2.26	1.95	1.96
Lu	0.38	0.37	0.34	0.31	0.34	0.35	0.28	0.28
Hf	4.35	4.37	3.72	3.53	3.77	3.60	2.93	2.83
Ta	0.55	0.39	0.50	0.37	0.37	0.36	0.27	0.33
Pb	12.47	13.35	13.63	11.64	11.54	11.67	4.66	4.97
Th	7.01	7.34	6.77	6.12	6.06	5.79	4.45	4.53
U	1.48	1.54	1.59	1.46	1.35	1.35	1.06	1.08

4.13 Geochemical magma cycles

The MgO content of titanomagnetite microphenocrysts can be used to approximate the overall composition of the magma from which they were crystallised. Hence they provide an opportunity to identify changes and/or trends within the evolution of Mt. Taranaki's magmatic system throughout the Holocene (Fig. 4.10). A regular fluctuation between primitive and relatively evolved end members is apparent, with a periodicity of between 1000 to 2000 years. The compositional trend from Fanthams Peak also displays a gradual decrease in MgO content from its initial eruption 3000 years ago, through to its last observed eruption approximately 1500 years B.P. Therefore, the magma batches feeding Fanthams Peak eruptions are also following a similar compositional evolution trend as that observed for the summit magmas (Fig. 4.10). With the exception of the partly overlapping geochemical trends between batches 2 to 3, each peak in eruption frequency corresponds with rise of an individual magma batch. This shows a strong relationship between the mid-point of a magma batch's existence and the highest eruption frequency. During the period in which batches 2 and 3 erupted, the geochemistry of individual tephra indicates that eruptions were at times tapping both magma batches more or less concurrently.

The remarkably similar periodicity of the eruption rate curve and the compositional curve therefore provide a strong indication that eruption rate is linked to the geochemical cycles of the volcano. This leads to the possibility that over longer periods, the latter record could be used to develop a process-based eruption hazard model.

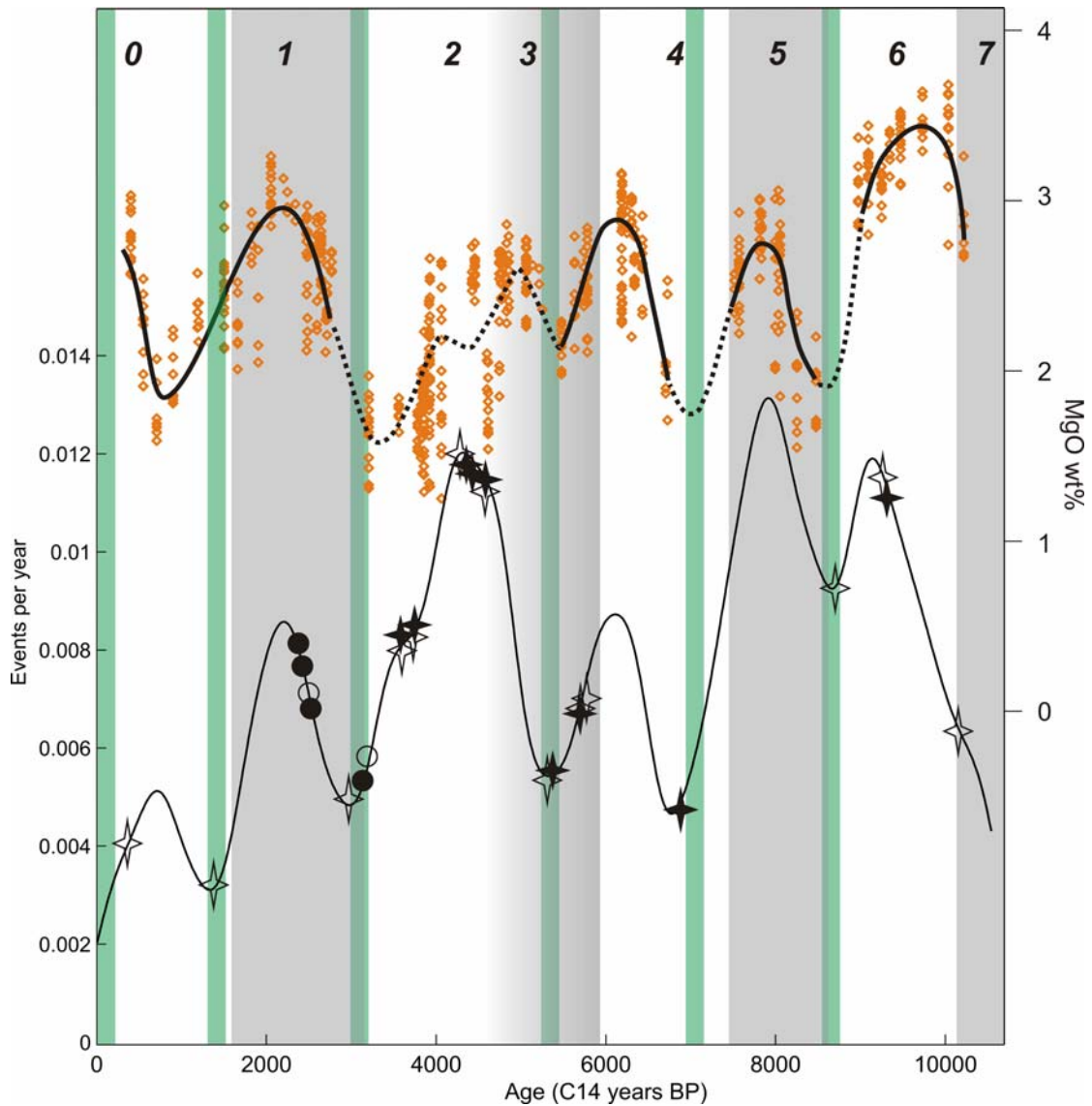


Figure 4.10: Lower curve shows the rate of sub-plinian (pumice) eruptions (left Y-axis), including star (summit-sourced) and circle (Fanthams Peak sourced) symbols showing the timing of the largest-known eruptions ($>0.6 \text{ km}^3$ in bulk volume). Upper orange symbols represent the ranges of MgO concentrations in titanomagnetite crystals within erupted products. These are used to define the upper curve showing variations in the geochemistry (confident=solid line, tentative=dotted line). Individual magma batches, indicated from geochemistry are vertically shaded alternately white and grey. Periods of intense soil development (indicating quiescence) from on-volcano sites are indicated by vertical green shaded zones.

4.14 Implications for probabilistic eruption forecasting

Turner et al. (2008a) showed that there was no relationship between the repose period preceding an eruption from Mt. Taranaki and its size. However, this previous study neglected large eruptions that were not directed towards Lake Umutekai. Using a more complete dataset of the largest tephras identified by both Alloway et al. (1995) and in this study (Tables 4.1 and 4.2), suggests that the largest eruptions precede the longest periods of repose.

The last recorded eruption from Mt. Taranaki was at least 150 years ago (Platz 2007) and this was relatively minor (i.e., dome growth activity). At present an organic-rich soil is developing on edifice stratigraphic profiles. This demonstrates that we are clearly within a period of repose. The Burrell eruption (300 ± 60 yrs B.P.; Fergusson and Rafter 1957) was the latest large eruption from Mt. Taranaki and the largest over the past 1500 years. Like the other large eruptions, it was erupted prior to an extended period of repose. The highly evolved compositions of the magma involved in this eruption compared to the previous in the series indicates that the volcano may be about to erupt a new magma batch (Fig. 4.10).

Although we can simplify the geochemical trend for the volcano into c. 1500 year magma batches with repeating evolutionary cycles, the magmatic system is likely to be far more complex, with the magma of individual eruptions also being affected by late-stage magma mixing, assimilation, and crystal fractionation processes (Price et al. 2005; Annen et al. 2006). Evidence of this at Mt. Taranaki can be observed within the complex geochemical trends during eruptions of magma batches 2 and 3 (4000-5000 yrs B.P.). In addition, the geochemistry of the Korito Tephra (4150 ± 100 yrs B.P.; Alloway et al. 1995) is much more evolved than the titanomagnetite geochemical trend suggests (Fig. 4.7). The Korito Tephra may therefore also be an “end of cycle” eruption.

4.15 Conclusion

A very complete and precisely dated Holocene record of eruption activity from Mt. Taranaki, New Zealand, has provided an unprecedented opportunity to examine the magmatic driving forces behind variations in eruption frequency at andesitic volcanoes. Highly cyclic eruption frequency was identified at this volcano, with a periodicity of 1500-2000 years. This is matched by geochemical indicators of regular repeating cycles of magma supply, as reflected in titanomagnetite mineral. Each of the ~1500 year periods corresponds to the eruption of a single, geochemically distinct magma 'batch'. Onset of each magma batch is represented by an initial eruption of relatively mafic magma followed by progressively more siliceous eruption products. Each batch culminates in the largest known explosive pyroclastic eruptions from this centre ($>0.6 \text{ km}^3$ magma), typically before an extended period of repose. Currently, Mt. Taranaki appears to be within a period of repose, following the latest large explosive eruption occurring at AD 1655. Based on extrapolation of Holocene trends, the next eruptions of Mt. Taranaki should coincide with the onset of a new magma batch. Developing such geochemically controlled models of eruption magnitude/frequency are vital for development of a new generation of time-variable probabilistic hazard forecasts for re-awakening andesitic volcanoes.

4.16 Acknowledgements

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Chapter Five:

Identification of Magmatic Replenishment

This chapter focuses on the magma rise, differentiation and mixing processes operating at andesitic volcanoes prior to eruptions, as exemplified by a typical eruption episode at Mt. Taranaki.

5.1 Introduction

In the previous two chapters, geochemically and temporally defined magma “batches” were identified from the Mt. Taranaki eruption record. Each “batch” was recognised by eruptive products that follow a distinct pattern of geochemical evolution. Initial eruptives comprise mostly primitive magmas, followed by successively more evolved magmas.

The following manuscript ‘*Eruption episodes and magma recharge events in andesitic systems: Mt. Taranaki, New Zealand*’ published in the “Journal of Volcanological and Geothermal Research” (2008; 177(4): 1063-1076) aims to elucidate the main magma differentiation, evolution and ascent processes active at Mt. Taranaki. To achieve this, a detailed petrological analysis was performed on phenocrysts within products of an eruptive event that represented the first signs of the most recent magma batch (see Appendix 5 for analyses). Compositional profiles and textures from plagioclase, amphibole and clinopyroxene crystals illustrated the complex processes of magma mixing and crystallisation prior to eruption. Bi-modal titanomagnetite compositions and morphologies indicate that mixing occurred within a very short period before the eruption, possibly acting as a trigger. The petrological characteristics described and discussed within this chapter can be used to identify and constrain magma mixing events just prior to other eruptive events from this and similar volcanoes, a method applied in the following Chapter 6.

This manuscript is currently under review in the “Journal of Volcanology and Geothermal Research”. The contribution of each author to the work was:

Michael.B. Turner: Principal investigator:

Carried out: Field description and sampling
Laboratory preparation
Optical microscopy
EMP, XRF analyses
Manuscript preparation and writing

Shane J. Cronin: Chief advisor:

Aided the study by: Assistance in the field and sampling
Discussion of methodology and results
Editing and discussion of the manuscript

Ian E. Smith, Robert B. Stewart, Vince E. Neall: Advisors:

Aided the study by: Discussion of methodology and results
Editing and discussion of the manuscript

5.2 Eruption episodes and magma recharge events in andesitic systems: Mt. Taranaki, New Zealand

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5.2.1 Abstract

Eruption episodes, where a series of eruption events are generically related, can include a wide spectrum of volcanic activity over decadal periods. This paper concentrates on the opening phases of an eruption episode that occurred approximately 1800 years B.P. from Mt. Taranaki, New Zealand. These events spanned the eruptions of differing bulk compositions and styles from two distinct vent locations; an andesitic sub-plinian eruption from the summit vent and a scoria-cone building eruption involving basaltic magma from a satellite vent. Compositional profiles and zoning textures of plagioclase, amphibole and clinopyroxene phenocrysts from the opening andesitic event show evidence for magma mixing and subsequent crystallisation immediately prior to the initiation of the eruption episode. Titanomagnetite grain morphology and Ti variation suggest that the magma mixing event occurred within a few days to weeks before the eruption, acting as a trigger. We present a magmatic model that is constrained by the petrological observations and eruptions during the episode. In this model, magma differentiation at depth causes its rise and recharging of a mid-crustal magma storage area at 5-7 km depth. Although the recharging magma differed slightly in oxygen fugacity and temperature, it was compositionally and physically similar enough to the residing andesitic magma to allow efficient mixing. The petrological characteristics described here can be readily observed and enable identification of mixing events in other recent eruption episodes.

Keywords: magma recharge, mineral studies, compositional zoning, eruption episodes, titanomagnetite, plagioclase, clinopyroxene, amphibole, Mt. Taranaki, andesite

5.3 Introduction

Studies that provide a holistic model of the magmatic system that feeds volcanic eruptions are becoming more important for defining and assessing volcanic hazards. Magmatic models of volcanic systems, especially within arc settings, are commonly based on lava flow sequences because lava samples are less likely to be affected by post depositional alteration (e.g., Price et al. 1999). Much less suitable from a petrologic perspective, but often chronologically better constrained, are pyroclastic deposits, especially in intermediate to distal sequences.

Studies of the pyroclastic record at many volcanoes are focussed on the deposits of larger (>sub-plinian) eruptions (Crandell and Mullineaux 1975; Alloway et al. 1995; Donoghue and Neall 1996). This is often because these are most easily identifiable, coarser and thus least-altered and more readily sampled, in comparison to the more numerous minor units that require detailed fine-scale studies. Thus, petrological data of volcanic processes (magmatic and eruptive) at any given centre are commonly limited to only one end of the possible eruption magnitude/frequency spectrum. Integration of petrological studies of all eruptives throughout the eruption history of a volcano is essential for a complete understanding of volcanic systems and also for accurate forecasting of an eruption's progression.

5.3.1 Mt. Taranaki

The near-symmetrical stratocone of Mt. Taranaki/Egmont (2518 m) dominates the landscape of the western North Island of New Zealand (Fig. 5.1). It is located in a 'back-arc' position, approximately 400 km west of the Hikurangi Trough, in-turn, located at the southern-most end of the Tonga-Kermadec subduction system. Eruptives from Mt. Taranaki are relatively potassium-rich compared to the andesitic volcanoes of the Taupo Volcanic Zone 140 km to the east (Neall et al. 1986; Price et al. 1992;

Stewart et al. 1996; Price et al. 1999), hence the magmas are classified as high-K andesites in the Gill (1981) system. Taranaki has been active for at least 125 000 years. A highly detailed eruption chronology for the Holocene has been established through studies of tephra-fall deposits in downwind soil environments, with correlations to more complete near-vent sequences (Druce 1966; Neall 1979; Alloway et al. 1995).

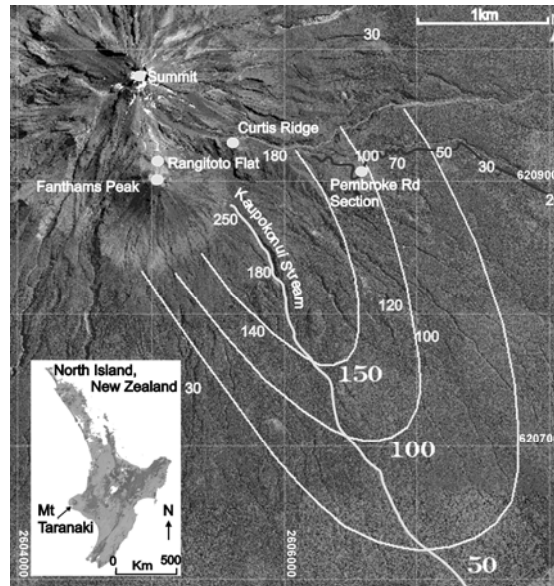


Figure 5.1: *Orthophotograph showing Mt. Taranaki and the distribution of the Curtis Ridge unit-1 eruptive. 50, 100 and 150 mm isopachs are shown. Spot thicknesses in mm. Localities mentioned in the text are labelled.*

In this study, we have extracted a record from a sequence of ‘minor’ eruption products ($0.15 - 0.01 \text{ km}^3$; total volume) of Mt. Taranaki to establish a model for the patterns of small-scale activity at a typical andesitic stratovolcano. Here we concentrate on a sequence of pyroclastic deposits erupted ~1800 yrs B.P., informally termed the Curtis Ridge eruption episode. Our aim is to develop a model of the magmatic processes and possible eruption-drivers for this and similar volcanoes.

5.4 The Curtis Ridge eruption episode

One of the more complete sequences of Holocene tephra fall deposits on Mt. Taranaki occurs on its eastern flanks, c. 3.5 km from the summit (Fig. 5.1: Pembroke Road, $39^{\circ}18'35''\text{S}$, $174^{\circ}06'04''\text{E}$). This is a type locality for a number of sub-plinian fall units

from Mt. Taranaki (Neall et al. 1986; Alloway et al. 1995). Within this outcrop is also a group of visually unremarkable deposits, less than 10 cm in total thickness, which had not previously been mapped, named or correlated to other localities. The units are here described as the Curtis Ridge eruption episode (CR) named after the type locality (the Curtis Ridge; Fig. 5.1) where the stratigraphy of all units within this eruption episode is represented. The CR units are underlain by a charcoal-bearing pyroclastic flow deposit dated at 1950 ± 90 yrs B.P. (NZ3886C; Neall and Alloway 1986). This deposit is overlain by weathered, fine medial ash and a small, unrelated pumiceous fall deposit in which a paleosol is weakly developed. Based on estimates of soil development within the Mt. Taranaki environment (c.f., Lees and Neall 1993), we interpret the age of the eruption episode to be c. 1800 yrs B.P. Detailed field mapping extending out from the Pembroke Road locality was used to determine the aerial extent of CR deposits, thus establishing a full stratigraphy for this episode and providing the basis for petrologic sampling.

5.4.1 Stratigraphy of the Curtis Ridge events

The fall deposit of CR unit-1 (Fig. 5.2) comprises approximately 60 % dense grey andesite lapilli, together with 40 % greyish-brown pumice lapilli (approx. $1.5\text{--}1.9\text{ g cm}^{-3}$). The dense grey clasts show characteristic radially fractured and/or bread-crusting features, which suggest that they were a juvenile component of this eruption. They are also of very similar bulk composition to associated pumice clasts (Table 5.1). We therefore interpret these clasts as being juvenile and derived from degassed magma within the upper conduit, or from a lava dome situated over the vent. These dense clasts were disrupted and incorporated into the eruption column during eruption of more gas-rich (pumice-producing) magma of the lower conduit, similar to the model of Platz et al. (2007) for the most recent pumice-producing eruption from this volcano. The proportion of pumice gradually increases upward to 70% through the unit. The pumice has greater density (approx. $1.2\text{--}1.5\text{ g cm}^{-3}$) than typical lapilli from the larger subplinian tephras at Mt. Taranaki (approx. $0.8\text{--}1.1\text{ g cm}^{-3}$). The dull brown, vesiculated, glass-dominated groundmass contains microlites of plagioclase, clinopyroxene, titanomagnetite $\pm$ amphibole (Fig. 5.3a). The phenocryst assemblage (approx. 45 vol.%) comprises plagioclase, clinopyroxene, amphibole and titanomagnetite. This is similar to

the dense grey andesite clasts within the deposit, with the exception that the dense clasts have larger and more numerous microlite phases (Fig. 5.3b). In exposures along the banks of the Kaupokonui Stream (e.g., Fig. 5.1: 39°20'13'', S 174°05'34'' E) the basal portion of this unit is a wavy-planar bedded, poorly sorted ash deposit of a pyroclastic surge (Fig. 5.2).

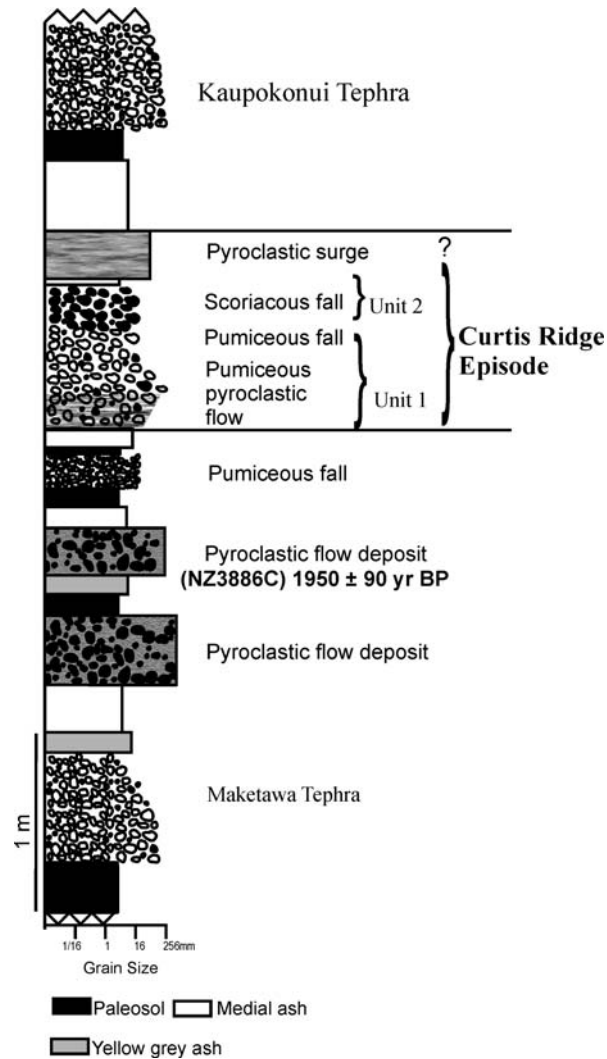


Figure 5.2: *Partial composite stratigraphic record of Holocene eruptions, eastern Mt. Taranaki. Modified from Neall and Alloway (1986).*

CR unit-2 (Fig. 5.2) is a fall deposit that directly overlies unit-1 in many locations on the eastern flanks of Mt. Taranaki. The diffuse boundary and absence of medial ash, colluvium or soil development between the two units suggest that the CR unit-2 eruption occurred very shortly (days to <1 year) after the CR unit-1 eruption. It comprises a black, basaltic-andesite, scoria lapilli layer with ~10% hypocrySTALLINE,

non-juvenile, monolithic grey basaltic-andesite. Basaltic-andesite eruptions are rare in the Holocene record at Taranaki and were primarily erupted from the satellite cone of Fanthams Peak (Neall et al. 1986). In thin-section, the groundmass (55 vol %) varies in its degree of crystallinity and comprises dull-grey glass with microlites of plagioclase, clinopyroxene, titanomagnetite $\pm$ olivine and orthopyroxene (Fig 5.3c). The crystal assemblage consists of approximately 20 vol.% plagioclase (0.12-1.2 mm), ~10 vol.% clinopyroxene (0.2-1.7 mm), ~8 vol.% amphibole (~1.5 mm), a few vol.% olivine (~1.6 mm) as phenocrysts and a few vol.% titanomagnetite microphenocrysts (~0.3 mm). The hypocrystalline, non-juvenile component of the eruptives is not discussed further.

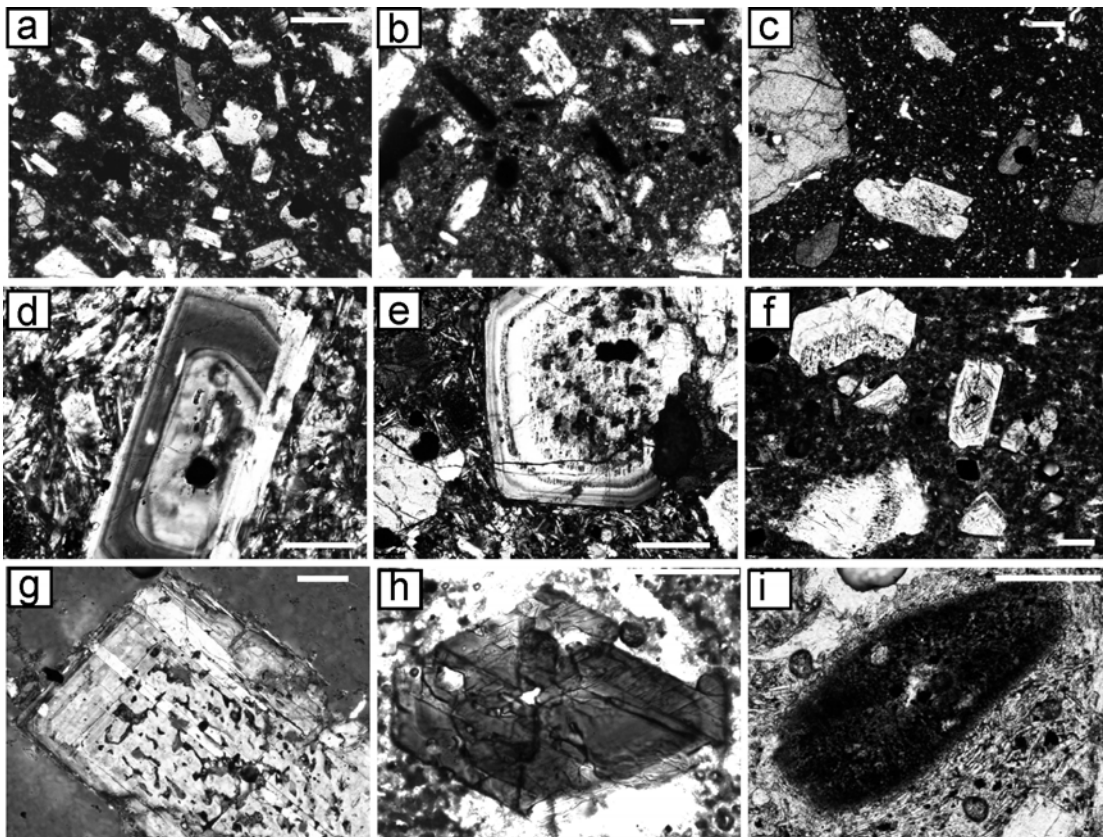


Figure 5.3: *Optical micrographs of selected phenocrysts under cross-polarised light from CR units. The white scale bar is 0.5mm in a, b and c, and 100 μ m in d, e, f, g, h and i. (a) Overview of CR unit-1 pumice clast (b) Overview of CR unit-1 dense-juvenile clast (c). Overview of CR unit-2 scoria clast. (d) Plagioclase with patchy textured core in CR unit-1 pumice. (e) Plagioclase with patchy textured core and rim in CR unit-1 pumice. (f) Plagioclase texture variability in CR unit-1 pumice. (g) Plagioclase phenocryst with patchy/sieve textured core in CR unit-2 basaltic scoria (h) Amphibole of CR unit-1 pumice. (i) Replaced amphibole in CR unit-1 dense-juvenile clast.*

The distribution (Fig. 5.1) and whole-rock chemistry for these units indicate that unit-1 was most likely erupted from a summit vent, while unit-2 was sourced from a flank vent. Hence these two chemically and physically different magmas were erupted almost contemporaneously from different vents during the Curtis Ridge eruption episode. Overlying these deposits at many locations along the Kaupokonui Stream and Pembroke Road sections (Fig. 5.1) is a poorly sorted, dune to planar-bedded deposit (Fig. 5.2). This unit is characteristic of an ash-cloud surge unit associated with block-and ash-flows (c.f., Watanabe et al. 1999). The lack of intervening fine-medial ash between the CR tephra and overlying block-and ash-flow deposits (Fig. 5.2) suggests that very little time separates the events. Hence these block-and-ash-flow events were probably associated with the CR eruption episode. In this paper we concentrate on the petrological characteristics of the opening phases (i.e., units-1 and -2) of this small-scale (but typical) eruption episode from Mt. Taranaki, New Zealand.

5.5 Whole-rock geochemistry

Clean fragments of pumice, scoria and dense juvenile specimens from the two opening units of the CR eruptive episode were crushed between tungsten carbide plates and a 100 g sub-sample was ground in a tungsten carbide ring grinder to pass through a 200 mesh sieve. Major and trace element concentrations were measured by X-ray fluorescence (Siemens SRS303AS spectrometer) using standard techniques on glass fusion discs prepared with SPECTRACHEM 12-22 (lithium tetraborate/lithium metaborate) flux following a method of Norrish and Hutton (1969). Trace elements were analysed using pressed powder pellets according to methods based on Norrish and Chappell (1977). Major elements have one-sigma relative errors of <1%, whereas trace elements have errors of <1% for Sr and Zr, 1-3% for V, Cr, Cu, Zn, Ga and Y, 3-5% for Sc and Ni and 5-10% for Rb and Nb. Representative analyses of CR units and summit lava flows are given in Table 5.1.

Table 5.1: *Selection of whole-rock major and trace element data for Taranaki eruptives.*

Sample:	EB-4b	E03-61b	EB-24c	E03-19	EB-4p	E03-50	E03-57	EB-26
Rock type	BA	BA	A	A	P	A	A	A
Stratigraphic group:	CR-unit-2	Scoria cone	CR-unit-1	CR-unit-1	CR-unit-1	<1.5 ka BP lava flow	<1.5 ka BP lava flow	<1ka BP lava flow
Major elements (wt%)								
<i>SiO₂</i>	51.33	51.13	54.59	54.77	53.60	54.72	54.29	55.59
<i>TiO₂</i>	0.99	1.05	0.82	0.82	0.86	0.90	0.92	0.87
<i>Al₂O₃</i>	17.78	17.98	17.30	17.10	17.44	17.76	17.77	17.32
<i>FeO_{total}</i>	9.47	9.85	8.13	8.05	8.16	8.15	8.39	7.51
<i>MnO</i>	0.17	0.18	0.17	0.17	0.17	0.16	0.16	0.16
<i>MgO</i>	4.45	4.39	3.80	3.85	3.86	3.38	3.45	3.27
<i>CaO</i>	9.69	9.87	8.38	8.53	8.77	8.04	8.19	7.60
<i>Na₂O</i>	3.42	3.42	3.31	3.66	3.15	3.27	3.26	3.79
<i>K₂O</i>	1.87	1.86	2.17	2.20	2.08	2.34	2.31	2.70
<i>P₂O₅</i>	0.28	0.28	0.25	0.25	0.27	0.27	0.27	0.30
<i>LOI</i>	0.23	-0.05	0.05	0.25	0.55	0.05	0.14	0.26
<i>Total</i>	99.89	99.9	99	99.9	99.46	99.07	99.26	99.63
Trace Elements (ppm)								
<i>Ba</i>	726	740	783	756	785	836	836	798
<i>Rb</i>	40	43	51	47	48	55	55	59
<i>Sr</i>	608	628	598	604	604	599	603	625
<i>Pb</i>	5	9	24	13	14	20	18	15
<i>La</i>	13	10	11	11	11		16	13
<i>Ce</i>	23	15	69	45	52	65	61	32
<i>Y</i>	21	19	21	19	21	21	23	21
<i>Zr</i>	92	104	101	104	103	111	106	127
<i>Nb</i>	6	7	5	7	6	6	5	7
<i>Sc</i>	25	21	22	21	24	20	18	17
<i>V</i>	289	227	220	227	226	230	246	207
<i>Cr</i>	53	46	58	46	52	8	7	7
<i>Ni</i>	18	19	15	19	15	6	8	12
<i>Cu</i>	104	29	30	29	92	97	106	74
<i>Zn</i>	77	85	101	85	82	81	80	72
<i>Ga</i>	20	19	19	19	20	20	19	20

Major element concentration: wt% at 110 °C. Stratigraphic groups: Lava flows from eastern side of the current crater estimated to be <1500 yrs B.P. (Price et al. 1999); CR = Curtis Ridge units; Clast type: BA: Basaltic andesite; A: Dense rock andesite; P: Andesitic pumice.

Volcanic rocks erupted during the Holocene at Mt. Taranaki are high-K basaltic andesites and andesites from the main summit cone and basalts from the parasitic cone of Fanthams Peak (Fig. 5.1). Over its ~130 000 yrs of eruption history, Mt. Taranaki eruptives have progressively become more potassic and siliceous (Zernack et al. 2006). The youngest rocks generally contain the highest potassium and mean silica contents (Price et al. 1992; Stewart et al. 1996). However, within any given eruption period, variations across the whole spectrum of compositions may occur, as is shown by the analyses of this study. Major, trace element and isotopic compositions of the broad Taranaki rock suite are described in more detail by Price et al. (1992), Stewart et al. (1996) and Price et al. (1999).

Major element/oxide variation of selected eruptives from the Holocene are shown using silica-variation diagrams (Fig. 5.4). The clasts from the CR unit-1 event have almost homogenous major element chemistry (Fig. 5.4), with only minor variations in SiO_2 (53.6-54.8 wt%), CaO (8.3-8.8 wt%), $\text{FeO}_{\text{total}}$ (8-8.6 wt%) and Al_2O_3 (17.1-17.5 wt%). The dense grey clasts are at the highest end of the silica range. The scoria clasts from CR unit-2 are also nearly homogenous in major element composition (Fig. 5.4), with much lower silica contents of 51-51.5 wt%. Trace element abundances are also uniform across the sample suite with minor variations for Sr (46-58 ppm) and Sr (598-628 ppm). $\text{FeO}_{\text{total}}$, MgO , and CaO abundances decrease systematically and linearly with increasing SiO_2 , whereas Na_2O and K_2O abundances increase (Fig. 5.4). Al_2O_3 is much less variable.

Trace element abundances are characterised by relatively high proportions of large ion lithophile elements (LILE; e.g., Rb, Cs, Sr, Ba) and light rare earth elements (LREE), with deficiencies in high field strength elements (HFSE; Ta, Nb, Zr; Price et al. 1992; 1999; 2005). These, as well as other trace element characteristics, such as depletion of Nb relative to La, and enrichment of Pb and Sr relative to Ce, are typical arc-signatures (see Table 5.1).

The major and trace element concentrations of the CR unit-1 rocks are similar to those of most other deposits, erupted between 1500-3000 yrs B.P. (Fig. 5.4). This observation is consistent with that of Downey et al. (1994) who, based on the lava flow sequence of

Mt. Taranaki, first suggested that groups of geochemically similar magma erupted during cycles with durations of 1000 – 2000 years (Price et al. 1999).

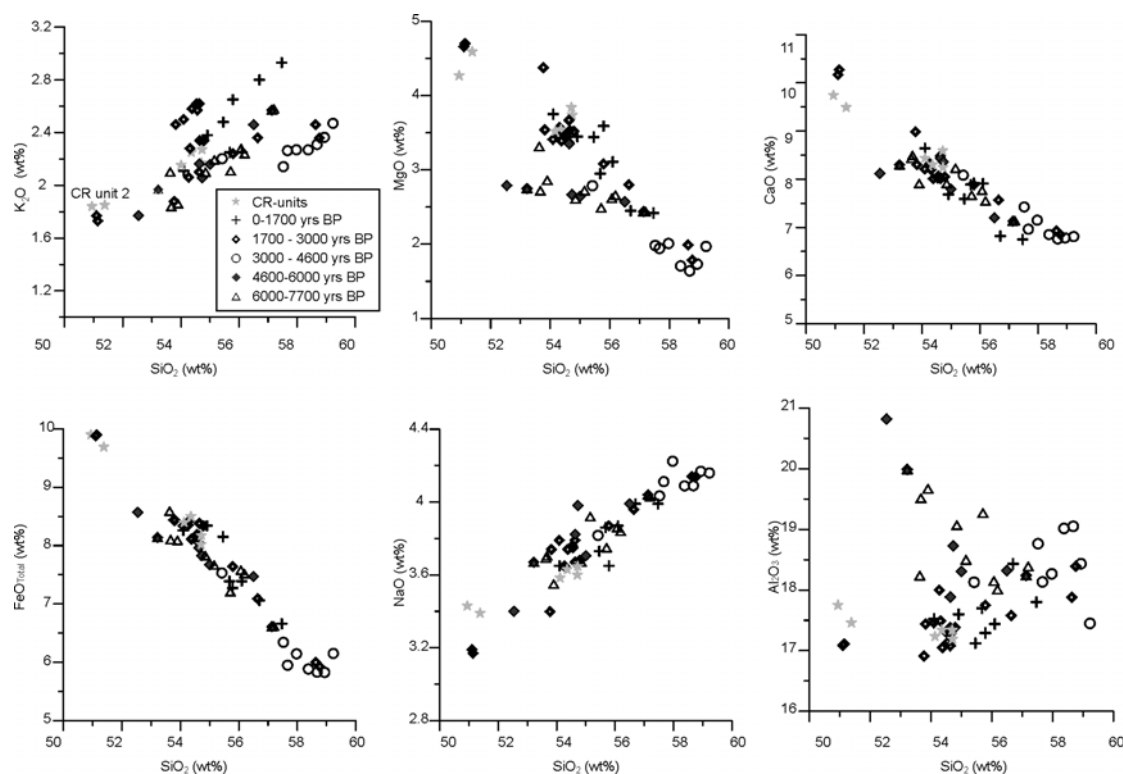


Figure 5.4: Major oxide variations as a function of SiO_2 abundances for Taranaki eruptives. Samples are grouped by age.

5.6 Petrology

The mineral assemblages of thin-sectioned juvenile clasts from Curtis Ridge unit-1 and 2 were characterised under the optical microscope and using the backscatter mode of a scanning electron microscope (SEM). For mineral chemistry an additional 10 juvenile pumice and scoria clasts were crushed and sieved. Individual phenocrysts of hornblende and plagioclase were hand-picked from the 500 μm – 1 mm fraction. These crystals were embedded in epoxy resin and polished. Because of the difficulty in extracting non-fractured crystals from the dense juvenile clasts of unit-1, phenocrysts of these samples were studied in thin section. The composition of each mineral phenocryst was determined by energy dispersive (EDS) electron microprobe (Jeol JXA-840) at the University of Auckland. The analytical data were collected using a Princeton GammaTech Prism 2000 Si (Li) EDS X-ray detector, a 2 μm focused beam,

accelerating voltage of 12.5 kV, beam current of 600 pA and 100 second live count time. This microprobe recently took part (along with 64 other participating laboratories) in the ‘G-Probe-2 international proficiency test for microbeam laboratories’. The results of which were within the acceptable deviation from the NKT-1G basaltic glass standard (i.e., Potts et al. 2005). Representative analyses for each mineral are given in Tables 5.2, 5.3, 5.4 and 5.5. EMP compositional line-scans, with an analysis every 5 μm and 20 s live-count times, were carried out on phenocrysts from CR unit-1. The line-scan data were checked against spot analyses (Fig. 5.5a).

5.6.1 Plagioclase

The plagioclase phenocrysts in samples from the CR units show complex compositional and textural variations. Two categories of zoning were recognised:

- 1) Small scale, cyclic oscillatory zoning (1-10 μm) with compositional changes of <10 Anorthite (An) mol%, and mostly ~8 An mol%.
- 2) Larger-scale, sieve textured, partial resorption/dissolution zones (10-100 μm) with compositional changes of >20 An mol%. These sieve-textured zones contain abundant large, elliptical inclusions (>20 μm) of andesitic (~58 % silica) melt and rare clinopyroxene and magnetite. The number and thickness of the An-rich, sieve-textured zones also varies between individual crystals.

Table 5.2: *Representative patchy/sieve textured plagioclase phenocryst analyses.*

	CR unit-1 pumice						CR unit-2 scoria		
	Core ¹	Core ²	Rim	Core ¹	Core ²	Rim	Core ¹	Core ²	Rim
SiO ₂	56.47	52.86	55.90	54.61	48.55	55.98	58.20	47.57	44.49
Al ₂ O ₃	26.96	29.49	27.01	27.91	31.25	27.17	24.62	31.98	34.01
FeO ^T	0.44	0.44	0.15	0.30	0.49	0.40	0.66	0.67	0.27
CaO	9.44	12.64	9.83	10.84	15.20	9.98	7.27	16.49	18.34
Na ₂ O	5.79	4.14	5.76	11.97	2.72	5.56	6.29	1.83	0.72
K ₂ O	0.63	0.24	0.56	0.40	0.19	0.51	1.55	0.35	0.20
Total	99.69	99.82	99.27	99.15	98.47	99.63	98.67	98.90	98.13
Si ⁴⁺	2.553	2.402	2.533	2.486	2.258	2.532	2.653	2.211	2.092
Al ³⁺	1.433	1.579	1.442	1.498	1.713	1.449	1.322	1.752	1.885
Fe ²⁺	0.017	0.017	0.006	0.011	0.019	0.015	0.025	0.026	0.015
Mn ²⁺	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.00	0.00
Mg ²⁺	0.001	0.000	0.004	0.008	0.005	0.000	0.000	0.001	0.00
Ca ²⁺	0.457	0.615	0.477	0.529	0.758	0.484	0.355	0.821	0.924
Na ⁺	0.508	0.365	0.506	0.439	0.245	0.488	0.556	0.165	0.066
K ⁺	0.037	0.014	0.033	0.023	0.011	0.029	0.090	0.021	0.012
Total	5.006	4.992	5.000	4.994	5.009	4.999	5.001	4.997	4.994
An	0.46	0.62	0.47	0.53	0.75	0.48	0.35	0.82	0.92
Ab	0.51	0.37	0.50	0.44	0.24	0.49	0.56	0.16	0.07
Or	0.04	0.01	0.03	0.02	0.01	0.03	0.09	0.02	0.01

¹ Relatively sodic 'blebs' of plagioclase² Relatively calcic plagioclase^T Total Iron

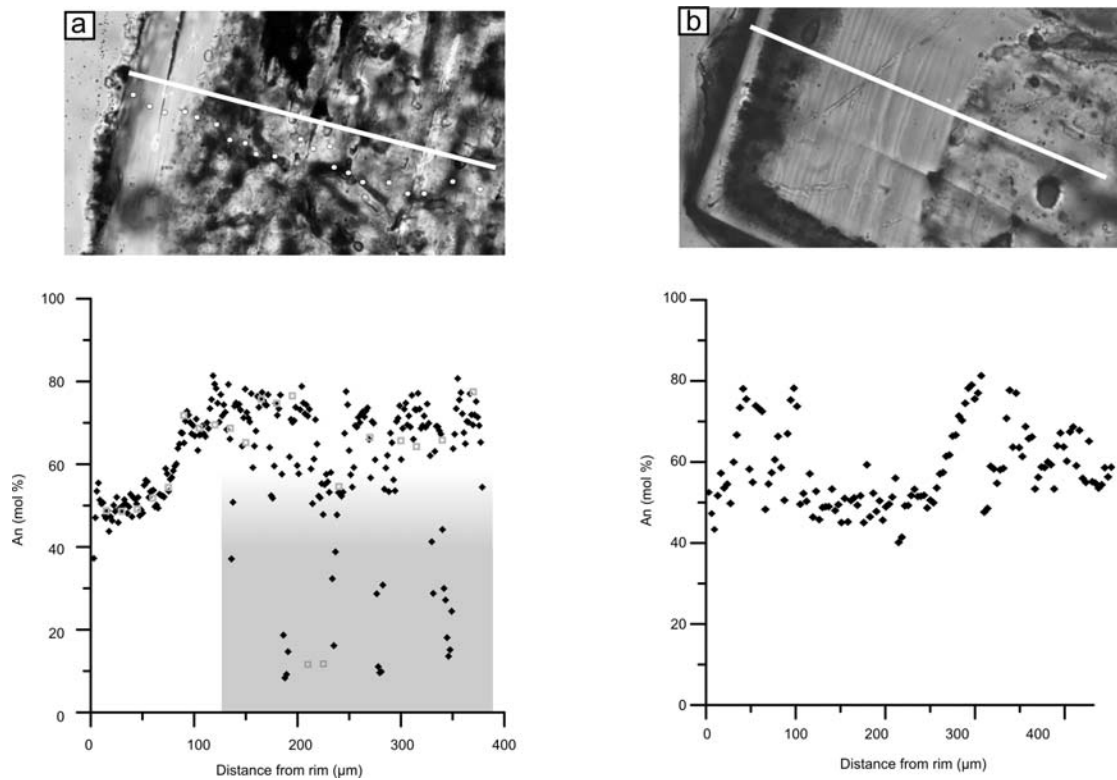


Figure 5.5: *Compositional transects of selected plagioclase phenocrysts from the CR unit-1 pumice. Rim to core compositional profiles of two phenocrysts (a) and (b) were determined by EMP analyses. Black-diamonds represent 20 sec live-time EMP analyses every 2.5 μm along the white line. Grey squares represent 100 sec live-time EMP spot analyses of the locations shown as white spots. For (a) the compositions within the shaded area represent glass contamination.*

The unit-1 eruptives (dense juvenile and pumice) contain many larger plagioclase phenocrysts (>1 mm) that exhibit both types of textural zoning. These include patchy-textured cores, which may include irregular blebs of melt and rare clinopyroxene and magnetite microlites (Fig. 5.3d, e and f). Patchy-textured cores are either comprised of moderately (An_{70-60}) or highly calcic plagioclase (An_{80-70}) surrounded by channels or blebs of either melt, or relatively sodic plagioclase (An_{65-55}) (Table 5.2; Fig. 5.5). The cores are surrounded by a mantle, approximately 80 μm thick, of fine-scale (1-5 μm) oscillatory zoning (An_{55-45}). A zone of partial resorption (sieve textured), approximately 40 μm from the rim, divides the oscillatory mantle in two (Fig. 5.3e). This sieve-textured zone is relatively more calcic ($An_{\sim 80-70}$) than the oscillatory zoning. Microphenocrysts and microlites of unit-1 eruptives have similar compositions to those of the outer oscillatory zones of plagioclase phenocrysts (An_{54-48}).

The cores of plagioclase phenocrysts of unit-2 dark-grey scoria are similar in appearance and composition to the cores of those in unit-1 (Fig. 5.3g). Plagioclase phenocrysts rims and microphenocrysts display fine oscillatory zoning. The rims are approximately 15 μm thick and are mostly free of glass and dissolution and/or partial resorption zones. The rims are relatively calcic (An_{90-85}) (Table 5.2).

5.6.2 Amphibole

A third of amphibole phenocrysts within unit-1 pumice clasts have cores that contain large melt, plagioclase and magnetite inclusions (Fig. 5.3h), with $\text{Mg\#}^3$ of approximately 0.64. These cores have diffuse, 50–100 μm zones that record Al_2O_3 changes of >1 wt.%, corresponding with inverse changes in SiO_2 contents (Table 5.3; Fig. 5.6). These cores are surrounded by ~ 50 μm oscillatory zoned rims that are optically lighter than the cores. These rims have grown on irregular rounded, dissolution surfaces and are free of inclusions (Fig. 5.3h). Al_2O_3 decreases from 12 wt% to approximately 10 wt%. $\text{Mg\#}$ increases by approximately 5 wt% across this boundary (Fig. 5.6). The remaining amphibole phenocrysts and microphenocrysts (0.2–0.6 mm) have patchy, inclusion-rich cores. These cores are surrounded by either rims of oscillatory zoning, or display evidence of dissolution with rounded and embayed surfaces. Amphibole phenocrysts are mostly pseudomorphed, with some textural variability depending on the crystal size. Smaller crystals (0.2–0.6 mm) have been completely replaced by microlites of titanomagnetite, clinopyroxene and plagioclase (Fig. 5.3i). Larger phenocrysts (0.8–2.5 mm) have thick (~ 300 μm) resorption-textured rims of fine-grained titanomagnetite, pyroxene $\pm$ plagioclase surrounding optically zoned oxy-hornblende cores.

³ $\text{Mg\#} = \text{Mg}/(\text{Mg} + \text{Fe})$ normalized cations per formula unit; minimum Fe^{3+} estimated after Schumacher (1997)

Table 5.3: *Representative compositions and structural formulae of amphibole phenocrysts.*

	CR unit-1 pumice					CR unit-2 scoria			
	Rim	Mid	Core	Rim	Core	Rim	Core	Rim	Core
SiO_2	42.84	41.04	42.08	42.03	42.97	41.67	40.63	42.04	40.20
TiO_2	2.98	2.93	3.27	2.97	3.40	2.69	1.91	2.64	2.04
Al_2O_3	10.25	13.00	10.97	10.72	10.82	13.36	15.00	13.68	14.38
FeO^T	11.98	13.05	12.86	11.67	13.04	11.87	10.60	11.49	10.70
MnO	0.43	0.31	0.14	0.61	0.36	0.24	0.46	0.31	0.10
MgO	15.04	12.51	12.99	13.87	12.25	14.06	14.40	13.38	13.39
CaO	11.52	11.63	10.83	10.82	11.13	11.65	12.00	11.77	12.27
Na_2O	2.29	1.76	1.91	2.56	2.56	2.92	2.47	3.35	1.54
K_2O	0.99	0.96	1.17	1.10	1.19	1.02	0.92	0.97	1.24
<i>Total</i>	98.32	97.19	96.22	96.32	97.72	99.48	98.38	99.63	95.86
Si^{4+}	6.28	6.10	6.32	6.30	6.69	6.06	5.867	6.09	5.95
Ti^{4+}	0.33	0.33	0.37	0.34	0.38	0.29	0.21	0.28	0.23
Al^{IV}	1.72	1.90	1.68	1.70	1.63	1.94	2.13	1.91	2.06
Al^{VI}	0.05	0.38	0.26	0.19	0.26	0.35	0.42	0.43	0.45
Fe^{3+}	0.18	0.17	0	0	0	0.01	0.43	0.03	0.45
Fe^{2+}	1.29	1.46	1.61	1.46	1.62	1.38	0.85	1.36	0.87
Mn^{2+}	0.05	0.04	0.02	0.08	0.05	0.03	0.06	0.04	0.01
Mg^{2+}	3.29	2.77	2.91	3.00	2.71	3.05	3.10	2.89	2.95
Ca^{2+}	1.81	1.85	1.74	1.74	1.77	1.82	1.86	1.83	1.94
Na^{M4}	0	0	0.06	0.06	0.18	0.01	0	0.12	0
Na^A	0.64	0.51	0.49	0.68	0.56	0.81	0.69	0.82	0.44
K^+	0.18	0.18	0.22	0.21	0.23	0.19	0.17	0.18	0.23
<i>Total</i>	15.82	15.69	15.68	15.86	15.76	15.94	15.79	15.98	15.58
$\text{Mg\#}$	0.69	0.63	0.64	0.68	0.62	0.68	0.71	0.67	0.69

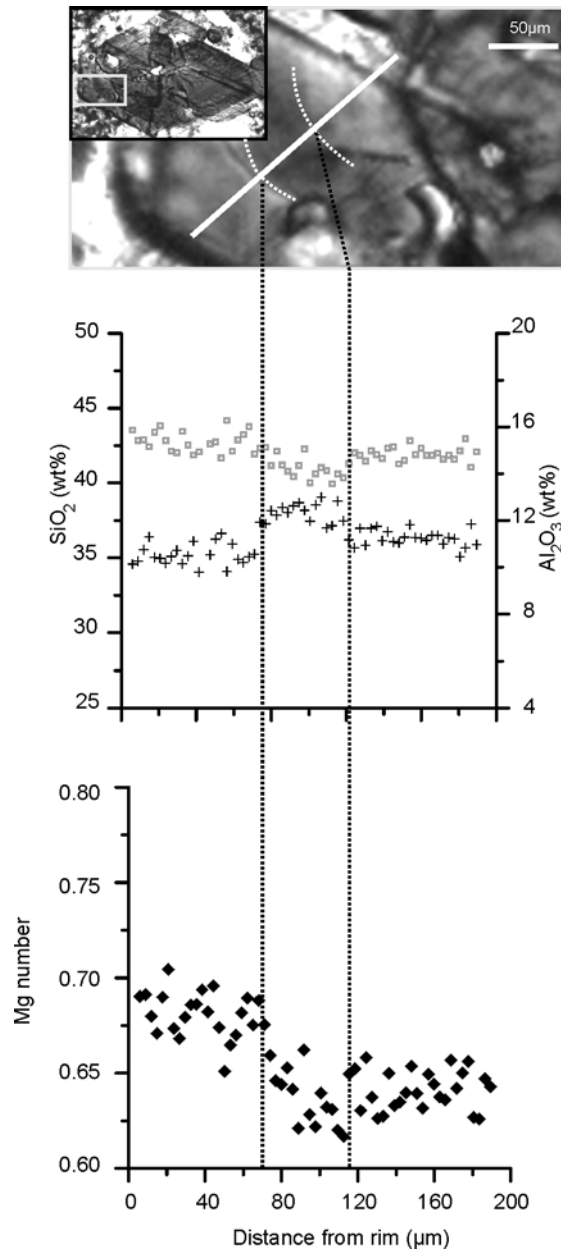


Figure 5.6: *Compositional transect of an amphibole phenocryst from CR unit-1 pumice. EMP analyses with 20 second live-count times were collected every 4 μm along the white line. Grey squares indicate SiO_2 contents; black crosses are Al_2O_3 and $\text{Mg}\#$ are black diamonds. The grey dashed line on the photomicrograph highlights gradual diffuse zoning. The rim is apparent by a thick black zone in the photomicrograph.*

Amphibole phenocrysts do not display any textural zoning but commonly contain inclusions of titanomagnetite and plagioclase. The cores of amphibole phenocrysts from the scoria clasts of unit-2 have Al_2O_3 and SiO_2 of approximately 14.5 wt% and 40.5 wt%, respectively, and $\text{Mg}\#$ of 0.70 (Table 5.3). There is a gradual decrease of Al_2O_3 associated with an increase of SiO_2 from core to rim of 1-1.5 wt%.

5.6.3 Clinopyroxene

Clinopyroxene phenocrysts of unit-1 eruptives commonly form glomerocrysts with titanomagnetite and rare plagioclase crystals. The cores of these phenocrysts have Mg# of approximately 0.75 - 0.77 and are either homogenous or show diffuse zones with changes in Al_2O_3 of ~ 1 wt% (Fig. 5.7). These cores are surrounded by 50–200 μm thick oscillatory zoned rims, which are associated with increases of Mg# to 0.80 accompanied by a >1 wt% decrease in Al_2O_3 (Table 5.4).

Clinopyroxene phenocrysts of unit-2 are often found in association with titanomagnetite $\pm$ plagioclase phenocrysts as glomerocrysts (~ 4 mm). These phenocrysts have patchy textured cores with similar Mg# (i.e., 0.79; Table 5.4) to those of the CR unit-1 eruptives. Broad compositional zones with large changes of Al_2O_3 from 2.7 to >6 wt% (Table 5.4) are also present.

Table 5.4: *Representative clinopyroxene phenocryst analyses.*

	CR unit-1 pumice					CR unit-2 scoria			
	Core	Mid	Rim	Core	Rim	Core	Rim	Core	Rim
SiO_2	50.43	52.01	53.09	50.41	53.18	50.90	46.82	50.68	46.67
TiO_2	0.41	0.61	0.71	0.62	1.09	0.48	1.18	0.66	1.00
Al_2O_3	3.09	2.28	1.55	3.15	1.36	2.96	7.18	2.67	6.62
FeO^T	7.33	7.42	6.83	7.83	6.71	7.09	8.18	7.85	8.16
MnO	0.7	0.51	0.31	0.00	0.31	0.22	0.10	0.25	0.21
MgO	13.98	14.29	15.39	13.05	15.27	14.71	12.44	15.40	12.40
CaO	22.51	21.56	21.49	21.97	21.26	22.85	23.43	22.02	23.01
Na_2O	0.94	0.5	0.32	0.60	1.23	0.00	0.42	0.28	0.46
K_2O	0.24	0.23	0.17	0.25	0.00	0.15	0.08	0.00	0.00
<i>Total</i>	99.64	99.40	99.86	97.88	100.43	99.36	99.84	99.80	98.48
Si^{4+}	1.891	1.936	1.951	1.914	1.952	1.893	1.763	1.880	1.777
Ti^{4+}	0.012	0.017	0.020	0.018	0.030	0.013	0.034	0.019	0.029
Al^{3+}	0.136	0.100	0.067	0.141	0.059	0.130	0.319	0.117	0.297
Fe^{2+}	0.23	0.231	0.210	0.249	0.206	0.221	0.258	0.244	0.260
Mn^{2+}	0.022	0.016	0.010	0.00	0.010	0.007	0.003	0.008	0.007
Mg^{2+}	0.782	0.793	0.843	0.738	0.836	0.816	0.698	0.852	0.705
Ca^{2+}	0.904	0.860	0.846	0.894	0.836	0.911	0.946	0.876	0.940
Na^+	0.069	0.036	0.023	0.044	0.088	0.000	0.031	0.020	0.034
K^+	0.011	0.011	0.08	0.012	0.000	0.007	0.004	0.000	0.000
<i>Total</i>	4.057	4.000	3.978	4.010	4.017	3.988	4.083	4.016	4.049
<i>En</i>	0.38	0.39	0.42	0.37	0.41	0.41	0.34	0.42	0.35
<i>Mg#</i>	0.77	0.78	0.80	0.75	0.80	0.79	0.73	0.78	0.73

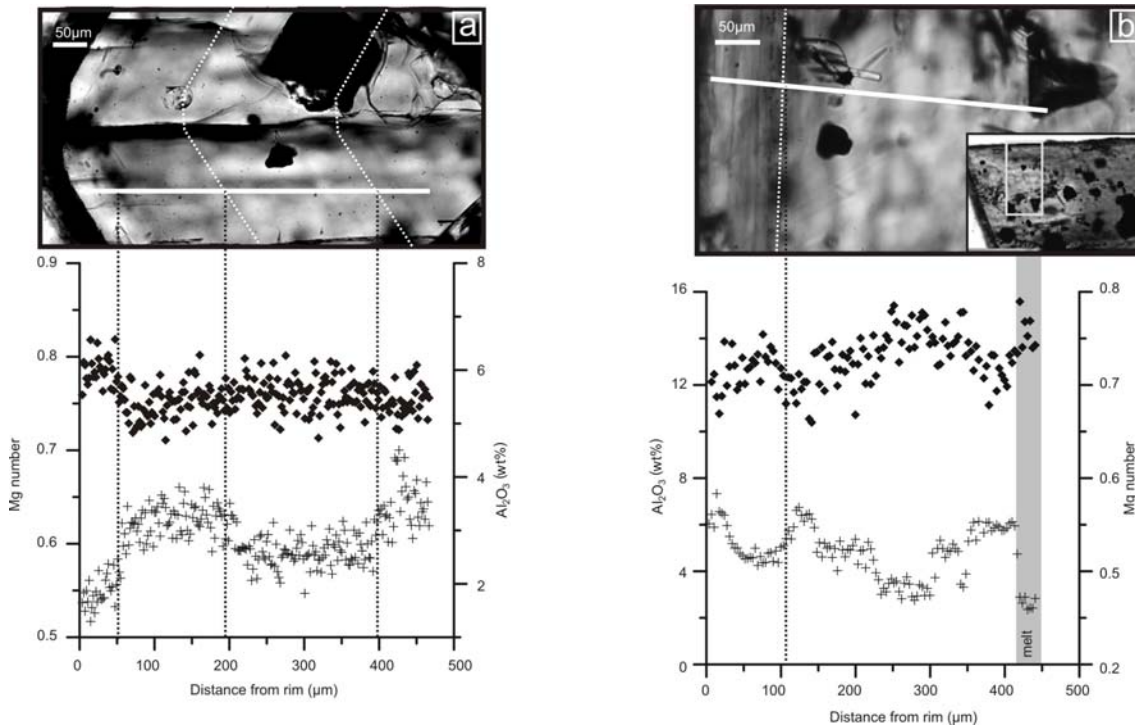


Figure 5.7: *Compositional transects through selected clinopyroxene phenocrysts. (a) 20 sec live-count time EMP analyses every 2 μm from CR unit-1 pumice and (b) CR unit-2 scoria with analyses every 4 μm. Mg# are represented as black diamonds and Al₂O₃ contents as black crosses. Note scales are different between each graph. Grey bar in (b) refers to accidental analyses of glass/melt inclusion.*

5.6.4 Titanomagnetite

Titanomagnetite, the most common Fe-Ti oxide, is microphenocrystic (<1.0 mm) and commonly forms glomerocrysts with clinopyroxene ± plagioclase. The titanomagnetites of CR unit-1 pumices can be divided into two distinct populations based on TiO₂ content and morphology: 1) Resorbed, high-TiO₂ grains with TiO₂ contents from 6.4 to 7.2 wt.% (1.44-1.55 Ti pfu), which are also rich in apatite inclusions (Fig. 5.8), and 2) Euhedral, low-TiO₂ grains, with 5.9 to 6.2 wt% (1.25-1.40 pfu) TiO₂ (Table 5.5; Fig. 5.8). Both types are common within the microphenocryst assemblage. However, resorbed/sub-euhedral grains are common within the cores of clinopyroxene and amphibole, whereas euhedral grains are typically incorporated within the clinopyroxene rims and glomerocrysts with clinopyroxene and plagioclase. Titanomagnetites from the basaltic-andesite scoria of CR unit-2 have a distinctly higher Al₂O₃ content of between

6.5–7.7 wt% (2.2–2.6 pfu), while the TiO_2 content is more uniform at 6–6.4 wt% (1.25–1.35 pfu).

Table 5.5: *Representative titanomagnetite analyses.*

	CR unit-1 pumice						CR unit-2 scoria		
	Euhedral			Resorbed			Euhedral		
SiO_2	0.07	0.01	0.04	0.08	0.05	0.05	0.08	0.06	0.19
TiO_2	6.22	6.17	6.21	6.98	7.01	7.01	6.12	6.25	6.35
Al_2O_3	2.40	2.27	2.73	3.16	3.08	2.81	7.59	6.70	6.65
FeO^T	83.19	82.67	82.13	80.45	80.15	81.16	76.90	77.35	77.78
MnO	0.81	0.90	0.9	0.72	0.72	0.77	0.29	0.52	0.45
MgO	1.55	1.61	1.61	2.80	2.71	2.20	3.97	4.07	3.51
CaO	0.07	0.16	0.16	0.00	0.02	0.00	0.04	0.10	0.02
Cr_2O_3	0.07	0.15	0.22	0.01	0.10	0.07	-	-	-
<i>Total</i>	94.38	93.94	94.29	94.20	93.84	94.07	94.99	95.05	94.95
Si^{4+}	0.021	0.003	0.012	0.024	0.015	0.015	0.023	0.017	0.054
Ti^{4+}	1.399	1.386	1.391	1.552	1.567	1.572	1.304	1.331	1.365
Al^{3+}	0.846	0.799	0.958	1.101	1.079	0.987	2.533	2.236	2.240
Cr^{3+}	0.017	0.035	0.052	0.023	0.024	0.017	-	-	-
Fe^{3+}	12.298	12.514	12.184	11.725	11.735	11.822	10.953	10.953	10.778
Fe^{2+}	8.501	8.139	8.269	8.160	8.179	8.415	7.550	7.366	7.809
Mn^{2+}	0.205	0.228	0.237	0.180	0.181	0.195	0.070	0.125	0.109
Mg^{2+}	0.691	0.717	0.870	1.234	1.200	0.978	1.676	1.718	1.495
Ca^{2+}	0.022	0.051	0.019	0.00	0.006	0.000	0.012	0.30	0.006

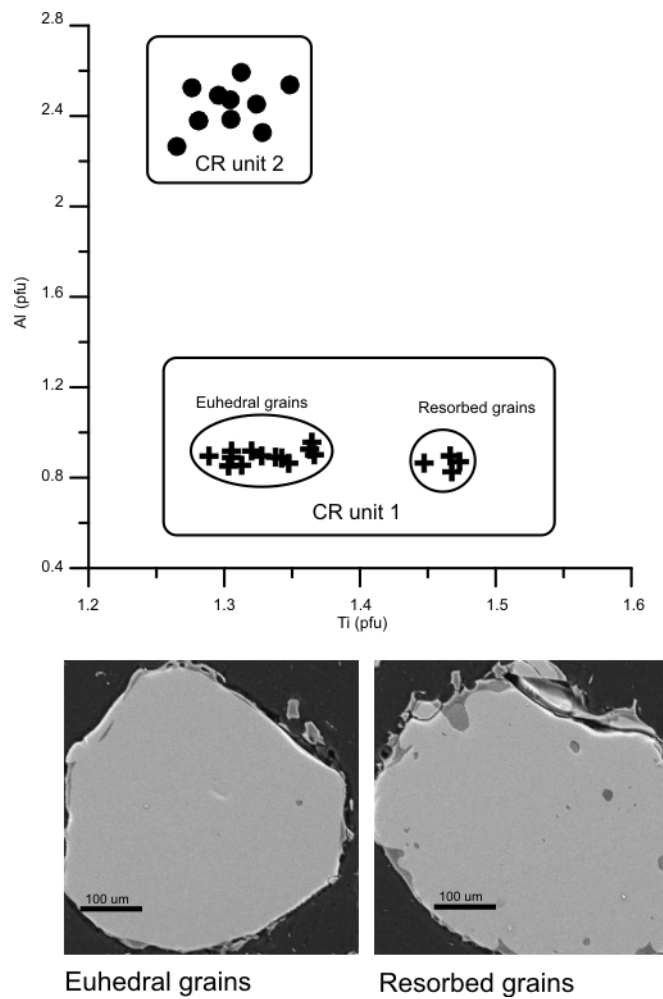


Figure 5.8: *Al and Ti contents of titanomagnetite microphenocrysts from CR units. Filled circles: analyses from CR unit-2 scoria. Crosses: analyses from CR unit-1 pumice. Compositions and Scanning Electron Microscope (SEM) backscatter micrographs of euhedral and resorbed grains are highlighted (discussed in text). Al and Ti pfu: normalised Al and Ti contents of titanomagnetites per unit formula (atoms per 24 cations, 36 oxygen formula unit). Inclusions of resorbed grain are apatite.*

5.7 Discussion

In recent years, models of volcanic magma systems have been refined by the use of fine-scale petrological observations of mineral and rock textures, and intra-grain chemical variations (Devine et al. 2003; Landi et al. 2004; Saito et al. 2005; Tepley et al. 2000; Zellmer et al. 2003). Such studies use petrological observations to infer the

conditions (temperature, pressure and melt compositions) that prevailed in magmas before and during their ascent to eruption. Here we use the petrological variations observed within the minerals and rocks from the studied CR units in conjunction with field evidence to interpret the magmatic conditions that lead to the initiation of an eruption episode. We have therefore concentrated on the primary pumice clasts of the CR unit-1 deposits for much of this discussion. Figure 5.9 summarises the discussion of phenocryst chemical and textural variations.

5.7.1 Plagioclase zoning

The compositional and textural complexity of plagioclase is well documented in many andesite systems (Landi et al. 2004; Stewart and Fowler 2001; Tepley et al. 2000; Zellmer et al. 2003). The very slow diffusion rate of major elements (e.g., Ca-Al exchange is 10^{-20} cm/s; Morse 1984) within the plagioclase lattice means that compositional zoning preserves the magma conditions that prevailed during the growth of the crystal. Furthermore, the wide occurrence of plagioclase in volcanic rocks and its potential to crystallise over the entire magmatic history of an eruptive episode, has resulted in it becoming an important tool in determining conditions of magmatic storage, ascent and eruptive processes (Singer et al. 1995; Tepley et al. 2000; Stewart and Fowler 2001; Couch et al. 2003; Landi et al. 2004). The compositional and textural zoning of plagioclase phenocrysts observed within Taranaki eruptives are similar to those described elsewhere (e.g., Stewart and Fowler 2001; Landi et al. 2004) and include oscillatory zoning with both major and minor resorption surfaces, as well as patchy or partial resorption/dissolution zones and cores. These features appear in all eruptives from the CR episode.

Small scale, high frequency, cyclic oscillatory zoning (zones 1-10 μm with compositional oscillations of <3-5 mol% An), occurred throughout the growth of the examined plagioclase phenocrysts (e.g., Fig 5.3e) and are thought to reflect near equilibrium diffusion-controlled growth (Pearce and Kolisnik 1990; Pearce 1993). Kinetic effects occur at the crystal-melt boundary layer, where the liquid composition immediately surrounding the crystal is different from that of the bulk melt (Stewart and Fowler 2001). These effects are difficult to constrain and have been theoretically,

numerically and experimentally modelled in terms of plagioclase equilibria and growth kinetics (Housh and Luhr 1991; L'Heureux and Fowler 1994). The high frequency oscillations and repeated minor resorption surfaces can also be attributed to thermal and compositional changes in the order of ≤ 5 mol% An and/or 5-25 °C (Ginibre et al. 2002).

In a supersaturated liquid, a local boundary layer is formed at the crystal-melt interface, that is then periodically destroyed by a shear pulse that brings new melt to this interface. A combination of this mechanism, together with the small thermal change associated with the replenishment of new melt to the crystal surface, may also explain the oscillatory zoning and minor resorption surfaces (Ginibre et al. 2002). Recently, Blundy et al. (2006) suggested that oscillatory zoning in plagioclase phenocrysts could be related to the opposing effects of decompression and heating on the equilibrium liquidus of plagioclase. Decompression of a hydrous magma decreases An in the crystallising plagioclase, while the latent heat released by crystallisation increases An. Therefore, the characteristic normal oscillatory zoning is the result of a complex interplay between the two effects (Blundy et al. 2006). Small melt inclusions may be trapped between the overgrowth and resorption surface resulting in skeletal textures and fine sieve textures (Stewart and Fowler 2001).

Larger scale, partial resorption zones (zones 10-100 μm and compositional changes of 10-20 mol% An) are commonly referred to as having a sieve texture, due to the presence of abundant melt inclusions (Landi et al. 2004; Stewart and Fowler 2001; Tepley et al. 2000; Zellmer et al. 2003). These zones are usually associated with well-developed dissolution surfaces. Compared to the small-scale oscillatory zoning formed in close-to-equilibrium conditions, abrupt compositional and textural changes in plagioclase phenocrysts are likely to be due to dramatic changes to the surrounding melt resulting from changes in temperature, pressure, volatile content or melt composition (Pearce and Kolisnik 1990; Singer et al. 1995). Dissolution zones are thought to be produced by relatively Na-rich plagioclase being subjected to a higher-temperature melt, where Ca-rich plagioclase should be in equilibrium (Tsuchiyama 1985). Coarse, relatively calcic sieve-textured zones, with large elliptical melt inclusions (>20 μm), have been experimentally shown to require the surrounding melt to either have become hotter, or to have increased in $p\text{H}_2\text{O}$ (e.g., increase of volatile content) compared to the

original conditions under which the oscillatory zones crystallised (Tepley et al. 2000; Stewart and Fowler 2001; Zellmer et al. 2003). A large increase in volatile content would result in a lowering of the plagioclase solidus temperature, favouring Ca-rich plagioclase (Tepley et al. 2000). Subsequent release of the volatiles during eruption would result in the crystallisation of a lower An-plagioclase. Reheating the plagioclase above its equilibrium solidus temperature, but below its liquidus, will generate rapid re-crystallisation, producing a sieve-texture zone of very fine-grained, relatively An-rich plagioclase and trapped glass. Although these compositional and textural characteristics and compositional changes of plagioclases can be produced by closed-system processes (Tepley et al. 2000), with independent evidence within other phenocryst phases or isotopic variations, they are commonly ascribed to the intrusion and/or ponding of a hotter magma at the base of a resident magma (Stewart and Fowler 2001; Couch et al. 2003; Zellmer et al. 2003; Landi et al. 2004).

The majority of plagioclase phenocrysts in the studied rocks (including the scoria CR unit-2 clasts) have patchy-textured cores (Fig 5.3d, e, f and Fig. 5.5). Hence we suggest that these cores represent plagioclase that has grown at depth and was partially resorbed during ascent. Humphreys et al. (2006) described similar textures within plagioclase phenocrysts from Shiveluch volcano (Kamchatka). They suggest that patchy cores are the result of partial resorption from ascent of an H₂O-rich but undersaturated magma. The resulting crystals contain a patchy An-rich area, along with relatively Ab-rich plagioclase and trapped melt inclusions (Price et al. 2005; Humphreys et al. 2006). This is very similar to the cores of the studied Taranaki plagioclase phenocrysts.

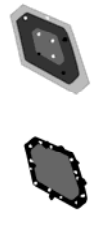
Mineral	Observation	Interpretation
Plagioclase 	Oscillatory zoning Cyclic zones (1-10 μm) with compositional changes of <10 An mol%. Minor resorption surfaces Sieve textured zones 10-100 μm zones with abundant inclusions of melt, Mt or pyroxene. Partial resorption surfaces with compositional changes of >20 An mol% Patchy textured cores Calcic plagioclase (An₈₀₋₆₀) surrounded by blebs of melt and/or relatively sodic plagioclase (An₆₅₋₅₅)	Kinetic effects: Periodic destruction of the crystal-melt boundary layer which brings new melt to the crystal-melt interface. Formed under 'close-to-equilibrium' conditions Reheating: Reheating plagioclase results in rapid crystallisation of relatively An rich plagioclase producing a sieve-textured zone of trapped glass. Partial resorption: Phenocryst cores formed at depth under high $p\text{H}_2\text{O}$ conditions. Resorption occurs during decompression under H_2O-undersaturated conditions.
Amphibole 	Patchy textured, diffuse zoned cores Near uniform in compositions with diffuse Al and Si oscillations ~ 50 μm apart. Al decreases from core to rim by 1-1.5 wt% Rims >50 μm rim Mg no. 5 % higher than core values. Al >2 wt% lower. Grown on an irregular, partially resorbed surface. Replaced rims ~100-200μm rims have been replaced by Mt, pyroxene and/or plagioclase	Changes in temperature: Diffuse zones result by changes in temperature or X_{An} within an H_2O-undersaturated melt. Increased oxygen fugacity: Higher Mg-no. indicates crystallisation under higher $f\text{O}_2$ conditions. Decrease in Al results from cooler conditions or during X_{An} within an H_2O-undersaturated melt. Resorption occurs during magma mixing. Decompression: phenocryst is subjected to lower pressures outside its stability field for at least a week.
Pyroxene 	Patchy textured, diffuse zoned cores Abundant melt inclusions and rounded/resorbed Mt inclusions. Diffuse zones of Al. Oscillatory zoned rims Cyclic zones (1-5μm). Higher Mg number (5-10 % relative to core) and lower Al than core values. Large Mt and plagioclase inclusions.	Changes in temperature: Diffuse zones result by fluctuations of temperature. Reheating: Reheating and/or crystallisation under higher $f\text{O}_2$ results in the formation of higher Mg# pyroxene. Lower Al results from X_{An} within an H_2O-undersaturated melt. Increased Mt crystallisation under higher $f\text{O}_2$ conditions. Oscillatory zoning formed by the periodic destruction of the crystal melt boundary.
Titano-magnetite 	Resorbed grains Abundant inclusions of apatite and glass. Relatively high Ti content. Euhedral grains Lower Ti content.	Derived from a hotter melt: Relatively low $f\text{O}_2$ results in higher Ti content in titanomagnetites. Resorption occurs from ascent-related decompression. Derived from the residing andesite (cooler) melt: unaffected by the heating and/or mixing event.

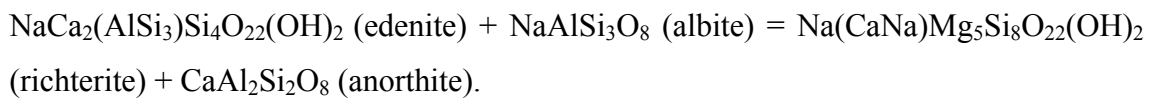
Figure 5.9: Summary of phenocryst textures, their chemical characteristics and interpreted origins.

5.7.2 Amphibole

Amphibole phenocrysts of the dense juvenile lapilli from unit-1 have thick rims (~100-200 μm), or have been completely replaced by magnetite, pyroxene and plagioclase. Such rims occur when the amphibole phenocrysts are subjected to pressures outside their stability field (Rutherford and Devine 1988; Rutherford and Hill 1993; Browne and Gardner 2006). The sizes of the replacement minerals and thickness of the rims are

directly related to the depth and the amount of time a magma is held at this depth before being erupted (Browne and Gardner 2006). Comparing the observations from Taranaki to those of Redoubt dacite (Browne and Gardner 2006) and Mount St. Helens dacite (Rutherford and Hill 1993), we infer that amphibole phenocrysts of the CR unit-1 dense juvenile component stalled at higher levels with pressures outside that of amphibole stability (<100 Mpa for Taranaki amphibole; T. Platz, pers. comm. 2007) for a period greater than seven days before being quenched. This implies that the grey dense juvenile component represents the upper, degassed portion of the magma system, similar to the conclusions from recent studies by Platz et al. (2007). By contrast, amphibole in the CR unit-1 pumice clasts have no decompression rims and therefore must have rapidly risen from depths where it was stable (3-7 km c.f., Platz et al. 2007).

Compositional profiles of amphibole phenocrysts can be used to infer pressure, oxygen fugacity, $p\text{H}_2\text{O}$ and temperature conditions of the magma system during phenocryst growth (Foden and Green 1992; Holland and Blundy 1994). Al_2O_3 variations of the patchy textured, diffusely zoned cores of Taranaki amphiboles (Fig. 5.6) can be explained by fluctuations in temperature, because the compositional exchange vector $\text{Si}^{\text{IV}} + (\)^{\text{A}} = \text{Al}^{\text{IV}} + (\text{Na,K})^{\text{A}}$ is strongly controlled by this factor. Increasing temperature results in higher Al_2O_3 in amphibole (Blundy & Holland 1990). Holland and Blundy (1994) provide an alternative explanation where the composition of amphibole reflects the Al_2O_3 content of the magma, which, in-turn, is related to the crystallisation of plagioclase by the following compositional exchange reaction:



Decreases in Al_2O_3 content of amphibole could, therefore, relate to an increase in the growth of a relatively An-rich plagioclase.

A rounded interface separates the cores and the brighter coloured rims of most CR unit-1 amphiboles (Fig. 5.6). This is also associated with a decrease in Al_2O_3 content and increase in $\text{Mg}\#$. The effect of temperature on the $\text{Mg}\#$ of amphibole is likely to be small (Humphreys et al. 2006), whereas increases in $f\text{O}_2$ produce strong increases in

Mg# (Scaillet and Evans 1999). Therefore, the rims are inferred to have crystallised under conditions of relatively high fO_2 , compared to the conditions during which the amphibole cores were crystallised. The amphibole rims contain lower Al_2O_3 than the cores. This is most likely the result of amphibole crystallisation under conditions which are both lower in temperature and Al_2O_3 , with the decrease of Al_2O_3 relating to substantial An-rich plagioclase crystallisation.

5.7.3 Clinopyroxene compositional profiles

In general, Taranaki clinopyroxene phenocrysts have diffusively zoned cores. The zones are between 50 and 200 μm wide and record subtle changes in compositions, particularly that of Al_2O_3 and Mg# (Fig. 5.7). Changes of Mg# within clinopyroxene reflect temperature and fO_2 fluctuations during crystallisation, with increases of Mg# resulting from increases in temperature and fO_2 (Nakagawa et al. 2002). Al_2O_3 is assumed to be proportional to the Al_2O_3 content of the melt (Cortés et al. 2005) and Al_2O_3 availability is related to plagioclase crystallisation within the surrounding melt (c.f., Humphreys et al. 2006). Therefore, decreases in clinopyroxene Al_2O_3 content relates to an increase in the crystallisation of An-rich plagioclase. This may result from an increase in magmatic temperature (Tepley et al. 2000; Stewart and Fowler 2001; Zellmer et al. 2003), or during the decompression ascent of an H_2O -undersaturated magma (Humphreys et al. 2006).

The diffusively zoned clinopyroxene cores are surrounded by distinct 50-200 μm oscillatory zoned rims. Partial resorption surfaces with abundant melt inclusions separate the core from the rims. The rims have higher Mg#, suggesting that they crystallised from a slightly hotter magma than their cores (e.g., Fig. 5.7). Al_2O_3 also decreased within the clinopyroxene rims, which is expected from An-rich plagioclase crystallisation that has depleted the melt in Al_2O_3 also resulting from an increase in temperature (c.f., Tepley et al. 2000).

5.7.4 Titanomagnetite

Two distinct populations of CR unit-1 titanomagnetites are defined by their TiO_2 content and morphology (Fig. 5.8): 1) Resorbed titanomagnetites have relatively high TiO_2 content and are rich in apatite inclusions; while population 2) has slightly lower TiO_2 titanomagnetites, are euhedral and relatively free of inclusions. Resorbed titanomagnetites are a common accessory phase within the cores of clinopyroxene phenocrysts, whereas euhedral types are present in clinopyroxene rims. Both phases are also common microphenocrysts.

Oxygen fugacity and temperature changes influence the composition of titanomagnetites in hydrous andesitic systems (Frost and Lindsley 1991). Increasing temperature at constant $f\text{O}_2$, or decreasing $f\text{O}_2$ at constant temperature, results in an increase in titanomagnetite TiO_2 contents (Devine et al. 2003). The different TiO_2 contents of the titanomagnetite microphenocrysts therefore relate to either changes in oxygen fugacity, or temperature, or both. Mg# compositional profiles of clinopyroxene phenocrysts indicate that the cores of these phenocrysts were formed under relatively lower temperatures and lower $f\text{O}_2$ than their rims. The relatively high TiO_2 content of the resorbed titanomagnetites that co-crystallised with these cores must, therefore, reflect relatively low $f\text{O}_2$ of the melt, rather than crystallising under relatively higher temperatures. This interpretation is supported by amphibole data, where relatively lower Mg# of the phenocryst cores indicate that relatively low $f\text{O}_2$ existed during their crystallisation.

In contrast, the euhedral, co-crystallising titanomagnetites are low in TiO_2 (Fig 5.8). We argue that this is a result of rapidly increasing $f\text{O}_2$ that more strongly influenced titanomagnetite compositions than the increasing temperature. Increasing Mg# in the amphibole rims also implies an increasing $f\text{O}_2$ environment during phenocryst rim formation.

5.8 Magma recharging and the generation of an eruption episode

Models of volcanic magmatic systems have conventionally focussed on relatively shallow-level magma chambers that fractionate during slow cooling (Shaw 1985). This simplistic model can explain some of the observations at rhyolite volcanoes (Smith et al. 2004), or for short magmatic residence times (Zellmer et al. 2003), and short-term eruptive variability (Hobden et al. 1999; Platz et al. 2007). Mingling and mixing textures common in andesites, however, indicate more complex magma systems (Price et al. 2005). Yet since andesitic stratovolcanoes erupt similar crystal-rich compositions over thousands of years, it suggests that their magma system is periodically recharged with new material from depth (Eichelberger et al. 2006). This may be basaltic magma derived from partial melting of the mantle wedge, in the case of high Mg-basalts, or modified basalt or andesite derived from a combination of crystallisation of the primary basalt (Grove et al. 2002) and melting crustal rocks within the lower crust or upper mantle (Price et al. 2005).

The petrological evidence from the opening phase of the Curtis Ridge eruption episode (CR unit-1) provides strong evidence for the mixing of two magmas, shortly before eruption, that differed only slightly in both temperature and fO_2 . Many plagioclase phenocrysts have a partial resorption zone within a few μm of the edge of the phenocryst. Amphibole and clinopyroxene phenocrysts have dissolution zones surrounded by compositionally different rims. Plagioclase, clinopyroxene and amphibole resorption are the result of a relative increase in magmatic temperature and fO_2 . Two compositionally different titanomagnetite microphenocrysts also suggest an interaction of two magmas.

The original model of magma mixing involves a residing andesite magma being reheated by injection and/or ponding of a basaltic magma (Eichelberger 1978; Murphy et al. 2000). However, this does not adequately account for the patchy and/or diffusely zoned cores of the plagioclase, amphibole and clinopyroxene phenocrysts, or the occurrence of two compositionally and morphologically distinct sets of titanomagnetite microphenocrysts. In addition, the eruption of basaltic material immediately after, or simultaneously with an andesitic eruption is globally rare (Eichelberger et al. 2006).

This is because once magma fractures the country rock to rise to the surface, subsequent magma flow will be preferably channelised through the fracture rather than elsewhere (Eichelberger et al. 2006). Therefore if the CR unit-1 andesite magma was injected by the basalt of the CR unit-2, it would seem likely that this basaltic magma should have erupted from the same vent as the andesite. Injection of the CR unit-2 magma into the andesitic magma should also have led to the entrainment of basaltic-andesite blebs to form enclaves (Eichelberger et al. 2006; Nakagawa et al. 2002). These were not observed. We therefore propose the following magmatic process, which is based on similar mechanisms to those described by Price et al. (2005) and Humphreys et al. (2006), involving the recharge of a residing andesitic magma by a magma of similar composition.

5.8.1 Recharge of andesite magma

High level crustal magma storage and the presence of dispersed and complex plumbing systems were thought to cause the observed geochemical and phenocryst textural variations within andesitic rocks (Price et al. 2005). However, many of these features can be accounted for by sub-volcanic magma systems that grow incrementally via the coalescence of many smaller magma bodies (Humphreys et al. 2006). The model adopted here is consistent with Price et al. (2005) who proposed that andesite magmas are generated in the lower crust. These migrate upwards as crystal- and lithic-rich magmas, containing melt phases of up to rhyolitic and dacitic composition. If a recharging magma has similar properties to a residing magma body, then evidence of mixing will be difficult to determine due to the limited disequilibrium between crystals and melt (D'Lemos 1996), cryptic magma mixing results (Humphreys et al., 2006). The efficiency of mixing under such circumstances depends on the volume ratio of intruding-to-resident magma, as well as relative differences in temperature, dissolved volatile content and composition between the two magmas (Sparks and Marshall 1986). We propose that the upper andesite magma system (5-7 km depth) of Taranaki was recharged by a similar, but slightly hotter and more volatile-rich magma. The geochemical and physical differences must have been small enough to allow efficient cryptic mixing. The textural characteristics of the patchy plagioclase cores indicate resorption resulting from H₂O-undersaturated decompression (c.f., Humphreys et al.

2006). The patchy cores of the amphibole and clinopyroxene phenocrysts are also explained by a similar decompression resorption scenario (c.f., Candela 1986). The apatite inclusions and resorption of the high-Ti titanomagnetite suggest that they were crystallised from a different magma to that of the lower-Ti, euhedral grains. We therefore suggest that these four phases were originally crystallised at depth (Fig. 5.10a). Upon ascent each phase was resorbed (Fig. 5.10b) due to decompression-driven superheating, relative to the liquidus (Annen et al. 2006), then by volatile dissolution and subsequent decompression crystallisation.

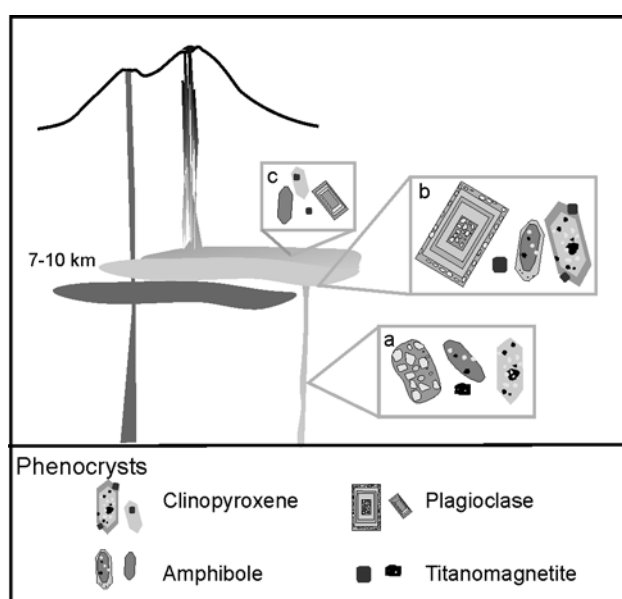


Figure 5.10: *Schematic diagram of andesite magma recharge. The recharging magma contains phenocrysts of amphibole, plagioclase, clinopyroxene and titanomagnetite that are resorbed due to decompression upon ascent (a). Rims of phenocrysts are crystallised under the magmatic environment of the upper storage area (b). Areas of the residing magma which are not affected by the recharging event are shown in (c).*

The phenocryst assemblage of the residing andesitic magma consisted of plagioclase, clinopyroxene and amphibole phenocrysts, which were either from a prior magma recharge event (containing phenocryst cores that display patchy/resorption textures of decompression), or they crystallised under near-constant magmatic conditions within the residing andesitic magma (i.e., oscillatory zoned plagioclase phenocrysts). The residing magma also had a higher fO_2 compared to the recharging body. Euhedral titanomagnetite grains are crystallised as: microphenocrysts, inclusions within the rims

of clinopyroxene, or within glomerocrysts with plagioclase and clinopyroxene within the upper residing magma system. Recharge of an andesitic magma that is relatively hotter and has elevated $p\text{H}_2\text{O}$ will result in the formation of a sieve-textured zone near the rims of the plagioclase phenocrysts (Stewart and Fowler 2001; Tepley et al. 2000; Zellmer et al. 2003). The high-Mg# and low-Al contents of amphibole and clinopyroxene rims of the intruding phenocrysts are in response to a recharge-induced increase in both temperature and $f\text{O}_2$. Figure 5.10 illustrates the possible spatial relationships between the phenocryst assemblages for this recharge model.

Within the whole rock geochemical sample suite, there are dominantly linear trends of major element variation (Fig. 5.4). These are consistent with a broad control by crystal fractionation processes (Bowen 1928; Gill 1981; Gamble et al. 1990). However, Price et al. (1999) suggest that because of the complexity of crystal fractionation, later crystal resorption and assimilation processes (AFC processes; DePaolo 1981), modelling of the geochemical variations in the Taranaki eruptives is extremely problematic. This is because much of the phenocryst assemblage is apparently unrelated to the surrounding melt, making whole rock analyses not the result of simple liquid lines of descent (see example in Price et al. 1999). The results presented here imply that, although phenocryst rims are in equilibrium with the surrounding erupted melt, much of the grains crystallised under different conditions at lower-crustal levels. Under the proposed model, much of the magma differentiation occurs at lower levels within the crust, from which melts and crystal cargo subsequently rise and recharge the upper system. Differences in AFC processes within the deeper part of the system and subsequent rise are responsible for much of this variation. Later, shallow crustal processes would also overprint whole-rock geochemical and petrographical variations. These processes may include further fractional crystallisation (Stewart et al. 1996) and magma mingling.

5.8.2 Timescales of recharge and/or heating before eruption: Eruption triggering?

The high diffusion coefficients of Ti in titanomagnetite mean that their compositions reflect the magma conditions just prior to eruption (Tomiya and Takahashi 2005). At Taranaki andesite magma temperatures of 800 - 900°C (Stewart et al. 1996), Ti diffusion coefficient of titanomagnetite is between 1.3 and $10.3 \times 10^{-17} \text{ m}^2/\text{s}$ (Freer and Hauptman 1978). Homogenisation of Ti within a spherical solid with a radius equivalent to Taranaki titanomagnetite phenocrysts (c. 100 μm) would take between 1.5 and 12 years (Crank 1975 p. 92). This can be used to constrain the timescales of recharge within the bimodal population of titanomagnetites. The high-Ti titanomagnetite grains are resorbed and contain apatite inclusions, whereas low-Ti titanomagnetite grains are euhedral and inclusion free. The occurrence of these two titanomagnetite types within both cores and rims of clinopyroxene and amphibole phenocrysts also provides strong evidence that the compositional differences result from differences in $f\text{O}_2$ during their crystallisation. Therefore, we interpret that sub-euhedral titanomagnetites were crystallised at depth and subsequently ascended and cryptically mixed with the phenocryst assemblage of the CR unit-1 pumice (Fig. 5.10b). Rapid Ti diffusion means that changes of the surrounding magmatic temperature or $f\text{O}_2$ would result in strong rim-to-core Ti diffusion gradients (Devine et al. 2003). The lack of these strongly suggests that the two magmas were mixed together only briefly (i.e., hours/weeks) before eruption/quenching.

Magma recharge events are widely acknowledged as potential eruption triggers (Sparks 1977; Eichelberger and Izbekov 2000; Murphy et al. 2000). The addition of new material increases pressurisation of a magma system. Reheating residual magma causes volatile exsolution and, along with addition of volatiles from the recharging magma, further increases pressurisation and hence potential for fracturing of country rock and eruption (Murphy et al. 2000).

5.9 Conclusions

We have used detailed field observations and fine-scale petrological studies of the c. 1800 yrs B.P. Curtis Ridge (CR) eruption episode as the basis for a model of the upper magma system of Taranaki. This episode was initiated with an andesitic sub-plinian eruption from the summit vent, followed by a basaltic-andesite eruption from the volcano's flank. The remainder of the episode continued with a period of dome building with associated block-and-ash-flow production.

The phenocryst assemblage of the deposits from the opening phase of the CR eruption episode provides clear petrological evidence of magma mixing just prior to its onset. This includes calcic, sieve-textured zones near the rims of plagioclase phenocrysts and rims of high Mg# in clinopyroxene and amphibole phenocrysts. These all suggest that rim crystallisation occurred under a hotter, high fO_2 magmatic environment than during core formation. In addition, a bi-modal titanomagnetite population implies two different magmatic components.

We propose that two compositionally and physically similar andesitic magmas were cryptically mixed within the upper magmatic system of Mt. Taranaki prior to the CR episode. Andesitic magma was differentiated at depth and subsequently rose to recharge the upper 7-10 km magmatic system. Decompression-induced resorption of the recharging magma formed patchy-textured plagioclase phenocryst cores and rounding of the amphibole and clinopyroxene phenocrysts. Subsequent crystallisation within the upper magma storage area under higher oxygen fugacity and temperature generated rims of differing composition. Plagioclase phenocrysts within the residing magma also indicate temperature changes relating to the mixing event.

Two discrete groups of titanomagnetite microphenocrysts co-exist within the erupted CR unit-1 dense juvenile component: 1) a resorbed, high-Ti group which contains abundant apatite inclusions, and 2) euhedral, low-Ti group. A lack of Ti diffusion in these co-existing minerals implies recharging and/or reheating occurred within days to weeks before the eruption and hence the recharge event likely triggered the eruption.

Similar evidence of magma recharge is also seen in the phenocrysts of other major eruptions from this volcano, suggesting this process of magma recharge is common and responsible for the initiation of many of the eruption episodes from Mt. Taranaki and other volcanoes of a similar nature.

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Chapter Six:

Understanding Magma Batch Production at Andesitic Volcanoes: A case study from Mt. Taranaki, New Zealand

In this Chapter, combined results from geochemical, petrological and geophysical research are examined and interpreted in the context of the temporal patterns in the eruption record at Mt. Taranaki. Models of magma generation are proposed to explain the periodic and cyclic geochemical processes observed at the volcano.

6.1 Introduction

Traditionally volcanological research was divided into two fields: 1) physical volcanology, which aims to understand eruption, emplacement and depositional processes through observations of volcanic events and inferences from deposits (e.g., Wilson 1985; Sparks and Wilson 1976), and; 2) igneous petrology, which aims to understand magmatic processes through studies of petrographic textures, rock and mineral chemistry. Only following the 1980 eruption of Mt. St Helens were these two approaches integrated (Lipman and Mullineaux 1981; Cashman and Taggart 1983; Carey and Sigurdsson 1985). With the development of high-precision, micro-geochemical techniques and isotope analyses (Turner et al. 2001; Zellmer et al. 2003; Condomines et al. 2003), together with detailed modelling (Zellmer et al. 1999; Costa et al. 2003; Morgan et al. 2004), geochemical studies are now able to provide precise constraints for the location and timescales of magma differentiation. However, despite increasingly finer detailed observations, a holistic understanding of some of the more basic problems of volcanic systems has remained elusive (c.f., Marsh 2007).

Previous chapters of this thesis detail a temporally well-constrained record of past events from Mt. Taranaki. The identification of a cyclic structure in the event frequency (i.e., 1500-2000 yrs periodicity) provides invaluable information for hazard forecasting

and emergency management at this and probably similar centres. In Chapter 4, it was shown that cyclicity in the eruption frequency at Mt. Taranaki is linked to the underlying magmatic processes. In addition, petrological and geochemical observations of the ~1800 yrs B.P. Curtis Ridge eruptive episode (Chapter 5) revealed that a two-stage magmatic system operates beneath Mt. Taranaki, where magma is firstly differentiated at depth and subsequently rises to assemble at mid-crustal levels before eruption. The important petrological observations of the Mt. Taranaki system are briefly reiterated here. In combination with geophysical data, these observations help constrain the locations of magma sources, along with sites of subsequent evolution and assembly. The remainder of this chapter introduces and discusses a model of magma differentiation within the lower crust below Mt. Taranaki that builds on that proposed by Stewart et al. (1996) and is consistent with the concepts developed by Annen et al. (2006). This model is compared with the temporal geochemical evolution data of Mt. Taranaki to help explain the apparent periodicity of magma evolution.

6.2 Evidence of two-stage magmatic storage, crystallisation and fractionation and Magma batch development.

Taranaki basaltic-andesite to dacitic rocks contain abundant plagioclase (c. 15-30%), amphibole (hornblende; c. 5-20%) and clinopyroxene phenocrysts (c. 3-15%), along with accessory titanomagnetite (c. 5%) and apatite. Minor proportions of biotite phenocrysts (<1%) are also found within rare Holocene units (Stewart et al. 1996). The composition and zoning of these phenocrysts can be used to constrain important aspects of magma storage (e.g., pressure and temperature), ascent and eruption processes (c.f., Blundy and Cashman 2001; Davidson et al. 2005; Humphreys et al. 2006). In Chapter 5, compositional profiling and zoning textures of the dominant Mt. Taranaki phenocrysts indicated that there is at least a two-stage system of magma generation and assembly.

6.2.1 Phenocryst evidence of two-stage magma differentiation

Plagioclase phenocrysts (~1-2 mm) in Mt. Taranaki rocks commonly display complex textural and compositional variations. Many phenocrysts contain distinctive patchy

textured An-rich cores that are characterised by irregular, partially resorbed plagioclase overgrown with relatively Ab-rich material. These core textures were (in Chapter 5) attributed to the partial resorption of the plagioclase during decompression of high H₂O-rich, but still undersaturated magma (c.f., Holtz and Johannes 1994; Clemens et al. 1997; Humphreys et al. 2006). Oscillatory zoned rims of lower An-content surrounding these cores indicate a subsequent second stage of crystallisation at lower pressures.

Clinopyroxene and amphibole phenocrysts in Taranaki tephras have cores that are diffusively zoned, surrounded by distinct, oscillatory and relatively Mg-rich rims. Exsolution surfaces separate the cores from the rims, implying a two-stage evolution. A bimodal population of Taranaki titanomagnetite microphenocrysts also represents crystallisation under two distinctively different magmatic environments

6.2.2 Mechanisms for magma generation at andesite volcanoes

In Chapters 3 and 4, geochemical evidence from titanomagnetite and whole-rock datasets of Mt. Taranaki eruptives was used to identify geochemically and temporally distinct magma batches. Each magma batch has a history of around 1500-2000 years of eruptions and geochemical evolution, from relatively mafic to increasingly silicic compositions. The depth of this magmatic evolution and the processes by which it occurs has not yet been fully explained, particularly with respect to the cyclicity in the production of magma batches.

Traditional models of andesitic magma differentiation involve crystal-fractionation and assimilation (AFC) of mantle derived basaltic or basaltic-andesite magma in shallow crustal chambers (Sisson and Grove 1993; Grove et al. 1997). For example, fractional crystallisation of H₂O-saturated basalts and basaltic-andesites at andesitic temperatures (950-1050 °C) by crystallizing plagioclase (An₆₀₋₉₀) + clinopyroxene + amphibole + oxides ± orthopyroxene ± olivine can generate an andesitic magma (Sisson and Grove 1993; Grove et al. 1997). However, differentiation of basaltic magma within the upper crust would result in abundant, dense, complementary mafic cumulates and these do not occur within the shallow crust (Glazner, 1994). To overcome the problems of the missing mafic cumulates; recent research has focused on similar fractionation processes. Instead of taking place within upper crustal zones, these processes occur at or close to

the Moho (Annen and Sparks 2002; Mortazavi and Sparks 2004; Prouteau and Scaillet 2003). Primitive basaltic magmas that have a wide range of compositions are produced by partial melting of harzburgite in the mantle wedge, fluxed by either a combination of H₂O-rich fluids liberated from the subducting slab (Tatsumi 1982; Grove et al. 2002; Carmichael 2002), or decompression melting resulting from mantle flow (McKenzie 1985). The characteristically high-Mg magmas are subsequently intruded into the upper mantle/lower crust. Numerous intrusions of this material accumulate within the lower crust and raise the geotherm, resulting in the development of an environment suitable for new magma generation. This zone is here termed the “lower crustal hot-zone” (c.f., Annen et al. 2006). Silicic and intermediate magmas are generated by 1) incomplete crystallisation of basaltic material (Annen and Sparks 2002; Prouteau and Scaillet 2003); 2) the dehydration partial melting of earlier, partly crystallised basalt intrusions and/or meta-basalts (amphibolite) by the intrusion of new hot mantle-derived magma (Smith and Leeman, 1987; Annen and Sparks 2002; Price et al. 2005); and 3) crustal assimilation (DePaolo et al. 1981; 1992). The gradients of temperature, pressure and water contents within the lower crust control the rate of melt production, which ultimately controls the composition of the melt that segregates and rises to upper crustal areas. These magmas are intruded to the limit of “neutral buoyancy” based on their density in relation to host rock (Jackson et al. 2003). As the ponded magma thickens, density-stratified layers begin to form (i.e., when differences in density exceed c. 100 kg/m⁻³; Dufek and Bergantz 2005), driven by differences between areas of local cooling vs. areas affected by a semi-continuous influx of new material from the mantle. The boundary between each layer may not be well defined, and mixing between layers of different degrees of evolution may occur. Hence the entire zone could be conceptualised as a stratified crystal mush (similar to that described in Couch et al. 2003).

6.2.3 Temporal evolution of the lower crustal hot zone: Generation of high K-andesite at Mt. Taranaki

Price et al. (1999) highlighted an enrichment of K₂O during the evolution of Mt. Taranaki from relative stratigraphic positions of an edifice lava-flow dataset and lava blocks from older debris flow deposits surrounding the volcano. Their observations are confirmed by the whole-rock data of this study (Chapters 4 and 5), and the long-term

trend in potassium enrichment identified by Zernack et al. (2006). Two different models can be used to explain this phenomenon: 1) progressively lower degrees of partial melting of the mantle source, and 2) the progressive underplating and intrusion of magma into the lower crust, resulting in the breakdown of previously emplaced amphibole-bearing assemblages. The second model is also consistent with the hypothesis of a lower crustal hot zone as described above.

During ascent of a hydrous, Mg-rich, mantle-source melt, amphibole will be precipitated as soon as it encounters the amphibole stability boundary (i.e., 1.5-2 GPa; Allen and Boettcher 1983). Prolific amphibole crystallisation in melts that have crossed this phase boundary (Barclay and Carmichael 2004) in the cooler crust, may contribute to magma stalling, due to increasing magma viscosity. Davidson et al. (2007) used trends of REE ratios to identify the fractionation of amphibole in arc magmas. The ratio Dy/Yb decreases during amphibole fractionation. Of the dominant gabbroic assemblages at Taranaki, clinopyroxene is the only phase that significantly alters the concentration of these elements in the melt, with the effects of clinopyroxene fractionation being similar to that for amphibole. However, the partition coefficients of REEs in clinopyroxene are substantially lower than in amphibole (Davidson et al. 2007). Mt. Taranaki andesite has Dy/Yb ratios which decrease with continued magmatic differentiation (Fig. 6.1), consistent with observations from arc systems in Davidson et al. (2007) used to infer amphibole fractionation.

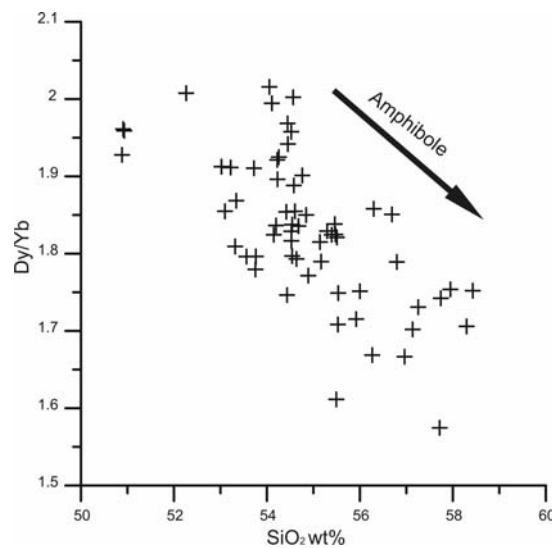


Figure 6.1: *Plots of Dy/Yb vs. SiO₂ wt% for Mt. Taranaki Holocene tephras showing trends relating to amphibole fractionation (c.f., Davidson et al. 2007). Raw data can be found in Appendix 6.*

The progressive intrusion of magmas into the lower crust over long periods could raise the geothermal gradient so that amphibole becomes unstable and subsequently reacts with incoming basaltic melts (Foden and Green 1992; Stewart et al. 1996). Small-volume partial melts can be produced depending on the intrusion rate (heat-flux) of mantle-derived basalts, the prevailing geotherm, and the extent to which the melting region is fluxed by H₂O liberated from the crystallising basalt (Annen et al. 2006). Partial melting of amphibole-rich lower crustal material can directly produce the elevated potassium contents observed in Taranaki-like volcanoes (Dufek and Bergantz 2005). Continued intrusions of mantle-derived basalt magmas could generate a gradual rise in the geothermal gradient, allowing later mantle-derived basalts to assimilate increasingly more amphibolite, gradually enriching potassium in the erupted andesites (Price et al. 1992; 1999; Stewart et al. 1996).

6.2.4 Magma recharge models

As described earlier, the Mt. Taranaki eruptives have a typically complex phenocryst assemblage that indicates equally complex magmatic evolution processes, including magma mixing (Heiken and Eichelberger 1980), entrainment of old crystals from

previously consolidated magmas (Davidson et al. 2005), crystal growth through degassing (Blundy and Cashman 2001) and some degree of amalgamation of magma bodies derived from many precious episodes of ascent.

In Chapter 5, it was shown that the zoning profiles of plagioclase, clinopyroxene and amphibole rims suggest that Taranaki magmas have undergone a number of ‘recharges’ with influxes of new magmas that were only slightly hotter and richer in H₂O than the resident bodies. Compositional data from titanomagnetite microphenocrysts from many Holocene eruptions in this study, compiled for correlation purposes in Chapter 3, indicate that bi-modal populations are common in many Holocene units (Fig. 6.3), and are clearly represented in their TiO₂-contents. Bimodality in this case indicates magmas that have erupted soon after recharge, without time for the resident titanomagnetites to re-equilibrate (see Chapter 5). Here titanomagnetites are used to indicate recharge events in the temporal record (although other recharged magmas may be missing from this record, if the recharge event occurred some decades before eruption). The recognised recharge events occur periodically, separated by irregular intervals of 400-500 years. They are evidently no more intense during high-frequency periods of eruption, nor are they concentrated in the early phases of a geochemical cycle. This implies that such recharge events occur independently of the magma batches recognised earlier and therefore reflect some other magma segregation process occurring at depth.

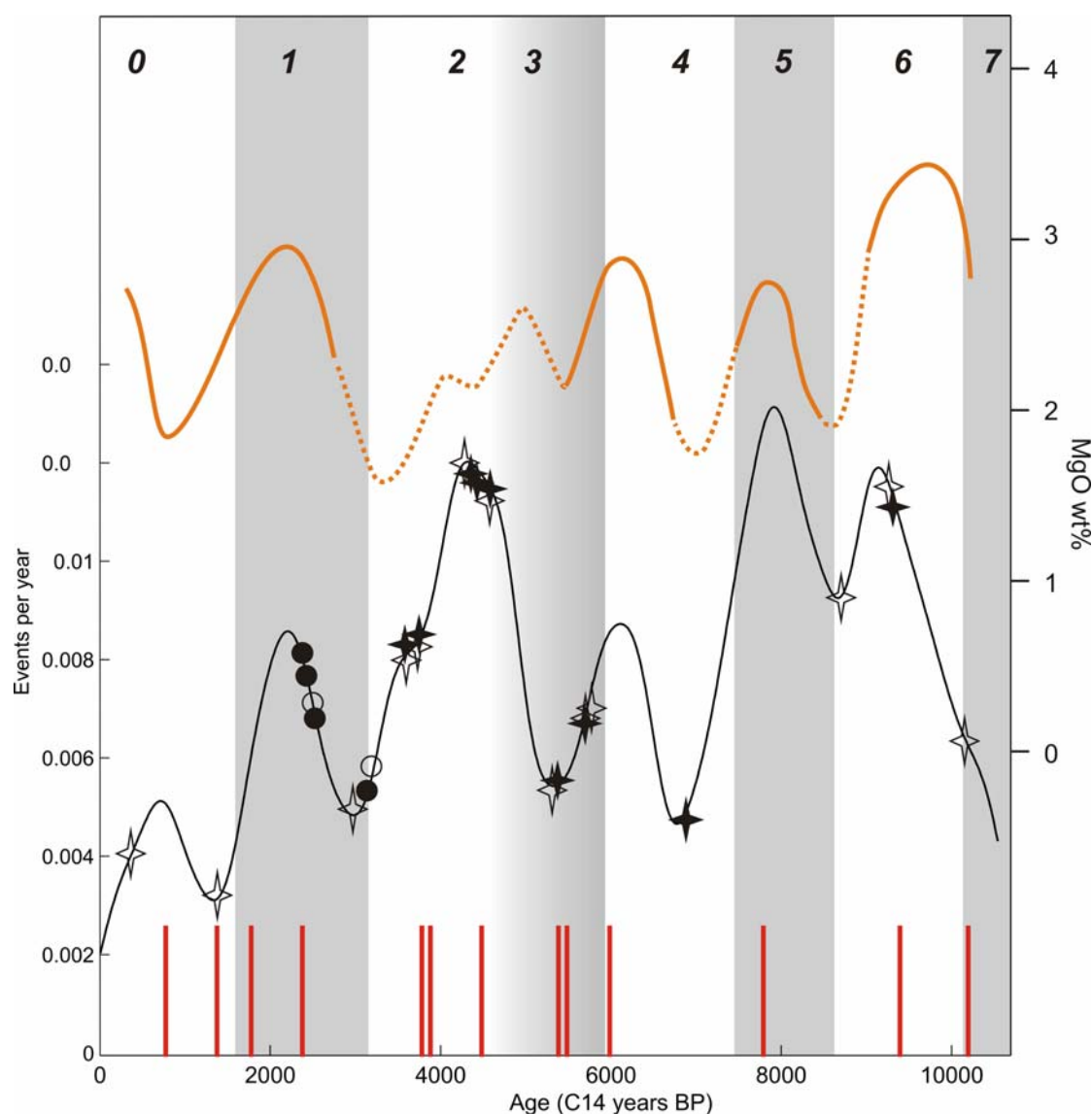


Figure 6.2: *Eruption rate curve (black line), with large eruptions from Mt. Taranaki summit (stars) and Fanthams Peak (circles) [see Chapter 4]. The orange/broken line above is the geochemical trend indicated by MgO content of titanomagnetite. The shaded, numbered stripes indicate time-frames of geochemically constrained magma batches [see Chapter 4]. Red vertical lines represent eruptions where late-stage magma recharge is indicated by bi-modal titanomagnetite compositions.*

The Holocene geochemical trends observed at Mt. Taranaki (Fig. 6.2) can result from either:

- 1) multiple recharges to an upper-level magma system throughout the geochemical cycle. In this case magma differentiation occurs at depth and recharge events bring up sequentially more evolved magma until a new magma batch is tapped, or

- 2) due to a complex interplay of different magma at various levels within the upper crustal system (i.e., Price et al. 2005), recharged magma may mingle and mix with other bodies of magma resulting in ‘recharge’ signatures within many eruptions shortly following the intrusion of new magma from depth.

6.2.5 Magma segregation

The segregation of a buoyant, partial melt and its crystal cargo from a single layer within the deep crustal hot zone can result from a number of mechanisms. Compaction-induced magma segregation may occur if continued intrusion and emplacement of mantle-derived basalts into the zone occurs, increasing local pressures (e.g., McKenzie 1985). In this case, melt segregation produces porosity waves which move buoyantly upwards (Jackson et al. 2003). Mantle-derived basalts have densities of over $2600 \pm 100 \text{ kg/m}^{-3}$, depending primarily on their water contents (McKenzie 1985). During subsequent AFC processes, magma densities can also be significantly altered; producing buoyancy instability and porosity waves (Jackson et al. 2003). Once the melt is segregated, magma will continue to move upwards and accumulate at depths just above the solidus (Jackson et al. 2003; Annen et al. 2006), or where it encounters crustal rocks that are considerably less dense and thus impermeable.

At Taranaki, the regional basement crustal rocks belong to the Median Tectonic Zone; a series of plutonic/volcanic and ultramafic rocks of Cretaceous age (Mortimer et al. 1997). These rocks are abutted by greywacke, which is geophysically constrained as occurring at 7-12 km depth (Sherburn et al. 2006). Greywacke, the lowest density of basement rocks, at 2700 kg/m^{-3} is denser than andesitic melts of 2555 kg/m^{-3} ; (Platz 2007), $2680 \pm 150 \text{ kg/m}^{-3}$ (Hunt and Woodward 1971), and $2640 \pm 100 \text{ kg/m}^{-3}$ (Locke and Cassidy 1997). Magma should therefore easily pass through these basement rocks. Pleistocene to Eocene sandstones and mudstones are the dominant rock strata above 6 km depth (Sherburn et al. 2006), with densities increasing with depth/age from 2200 kg/m^{-3} to 2600 kg/m^{-3} (Hatherton and Leopard 1964). Andesitic melts segregated from the lower crust will rise to a maximum depth of c. 7 km before stalling in these lower-density materials. Basaltic-andesites of the Fanthams Peak suite probably stalled at slightly lower levels (6-10 km) because their densities are similar to that of greywacke

(Platz 2007). The geophysically identified brittle-ductile transition at approximately 10-7 km also independently constrains the upper limit of magma assembly beneath Mt. Taranaki (Sherburn and White 2006).

6.2.6 Structural consequences of magma assembly

Increased pressurisation and the onset of magma ascent and eruption may be driven by continued degassing and crystallisation of a magma body within the upper magma system. Pressurisation resulting from the input of new magma and/or crystallisation of existing magma, generates low-magnitude earthquake swarms as the surrounding country rock adjusts (Gerst and Savage 2004). An example of this are the earthquake swarms that occurred during the 1995-1996 eruptions of Mt. Ruapehu, up to 20 km SE of the volcano (Hayes et al. 2004). Earthquake swarms on the Cape-Egmont Fault Zone, 15-20 km west of Mt. Taranaki, are inferred to be the result of changing pressures in the magmatic system (Sherburn and White 2006).

The N-S orientation of the Holocene vents of Mt. Taranaki provide an indication of the orientation of the conduit dike system (Sherburn and White 2006). Magma intrusion into this system would result in a local stress field that would be east-west compressive, consistent with that currently observed in earthquake swarms of the Cape-Egmont Fault Zone (Sherburn and White 2006). In Taranaki there are two recently active fault structures, the Inglewood and Oaonui Faults (see Chapter 1). Like many of the faults within the Taranaki district, these have a northeast-southwest orientation, relating to their initial formation during a continental rifting event that separated New Zealand from Australia at around 80 Ma (King and Thrasher 1996). Therefore their orientation no longer reflects the current stress field (Sherburn and White 2006). Oblique-normal movements are characteristic of the intermittent movements on these faults (Sherburn and White 2006), which is in contrast to the current, local east-west compressive stress of western Taranaki. The last major movement on the Oaonui Fault occurred at approximately 6500 yrs B.P. (Hull and Dellow 1993) and for the Inglewood Fault 3300-3500 yrs B.P. (Sherburn and White 2006). These movements are coincident with two of the largest eruptions from Mt. Taranaki during the Holocene:

- 1) Tephra 63 of the Umutekai core (bulk-rock erupted volume⁴ of 0.65 km³ at 6219 ± 49 yrs B.P.). This tephra is likely to be a correlative of one of the Kaponga Tephra members described by Alloway et al. (1995) and the E-8 ash deposit of Lowe (1988); and
- 2) Tephra 23 of the Rotokare core and Tephra 25 of the Umutekai core correlates with the 3750 yrs B.P. Inglewood eruption (Alloway et al. 1995). This is the largest Holocene eruption from Mt. Taranaki, with a bulk-rock volume of 1.17 km³.

Sherburn and White (2006) consider that pressurisation of the 6-10 km magmatic system causes fracturing of the surrounding rock. During eruption, release of the local east-west compressive stress induced normal faulting.

6.3 Speculation on eruption frequency and magmatic processes

The geochemical record of Mt. Taranaki shows broad 1500-2000 year long cycles from mafic through to evolved magmas that represent individual magma batches (Chapter 4). Some magma batches, such as 5 and 6, are well defined (Fig. 6.2), however others, such as 2 and 3, are not so distinct. The eruption frequency curve is also more irregular during the eruption of magma batches 2 and 3 (Fig. 6.2). This appears to be the result of an overlap in timing of production of these two batches, and also their semi-contemporaneous rise and eruption.

From c. 3000 yrs B.P., eruption of a relatively mafic magma batch began from the satellite vent of Fanthams Peak. This followed the last major movement of the Inglewood Fault. Eruption of basaltic-andesite from Mt. Taranaki is not restricted to the last 3000 years of activity and has been identified in rare individual, older lava flows on the edifice (Price et al. 1999) and within the clasts of debris-flows from proto-Taranaki cones (Price et al. 1999; Zernack et al. 2006). However, the basalts and basaltic-andesites of the older record have a much greater mantle component and are lower in

⁴ Estimated volume using the single isopleths method of Legros (2000)

K₂O relative to SiO₂ (Price et al. 1999). In addition, samples from the older record (for example Sample T90/42A; Table 2 in Price et al. 1999) have relatively high MgO (6.75 wt%), Ni (119 ppm) and Cr (113 ppm) abundances, suggestive of lower degree melts of the mantle source and subsequently lesser-degrees of fractionation during ascent and eruption (Price et al. 1999).

The trace element geochemistry from the summit and Fanthams Peak magmas between 3000 to 1500 yrs B.P. are virtually identical, which suggests that the two magmas were derived from a similar or single source. This observation is consistent with the concept of the developing lower crustal hot zone. The zone is continually heated as long as mantle-derived basalt continues to be injected. As the whole system is heated, the generation of more-mafic melts may begin. The Fanthams Peak magmas may hence represent melts from a hotter area within the same layer, which is concurrently producing siliceous magmas erupting at the summit. By contrast, the basaltic andesites of the early Taranaki record represent more primitive melts that have passed through the lower crust with little interaction during the early stages of hot-zone development.

6.4 Conclusions

The primary cause of geochemical variations in Mt. Taranaki magmas is either variation in the degree of amphibole fractionation, and/or the breakdown of pre-existing amphibolite/gabbro assemblages within a 'lower-crustal hot zone'. This model of amphibole fractionation and assimilation at the base of the crust is consistent with Mt. Taranaki's phenocryst and xenolithic assemblage having formed at lower crustal depths. The model is also consistent with the geophysical evidence of Sherburn and White (2005) in which a rise of the brittle-ductile transition from the lower crust (~25 km) to approximately 10 km depth beneath Mt. Taranaki is identified. This suggests that a zone containing partial melts extends between these two depths. This is also consistent with the lower-crustal hot zone model proposed by Annen et al. (2006).

The 1500-2000 year periodicity of magma batches erupted at Mt. Taranaki agrees with the Annen et al. (2006) model, where individual melt-crystal magma batches are formed at depth and subsequently rise to upper crustal magma storage areas. The record of

Holocene eruptions that show direct evidence of recharge (represented by bi-modal titanomagnetite chemistry) suggests that rises occur at regular intervals of <100-400 years. These recharge events, however, do not appear to be the controlling factor in eruption frequency of this volcano. Instead the 1500-2000 year geochemical cycle of each magma batch generated at the base of the crust appears to control the overall eruption rate of Mt. Taranaki.

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Chapter Seven:

Conclusions and Avenues for Future Research

7.1 Conclusions

The overall aim of volcanological research in New Zealand is to understand how specific volcanoes operate, so that accurate hazard and risk assessments can be developed for communities that live around them. The aim of this study was to investigate the patterns of eruptive behaviour and the driving forces behind them at Mt. Taranaki, to form the basis for accurate probabilistic eruption and hazard forecast models.

Underpinning this aim was the need to establish a chronostratigraphic framework for Holocene eruptives of Mt. Taranaki (Objective 1; Chapter 1). During the first two years of this research, many soil profiles were described and sampled at proximal locations around all sectors of the volcanic edifice (Chapter 2). In addition, two lake sites were identified in down-wind medial sites of eastern Taranaki: Lake Umutekai to the NE and Lake Rotokare to the SE of the summit of Mt. Taranaki. Within organic sediments cored from these lakes, individual ash layers <0.5 mm in thickness were easily identified and dated by radiocarbon methods. Using multiple dated horizons, a precise sedimentation-rate curve was constructed. From this curve, ages, with associated well-defined errors, were assigned to all intervening ash fall deposits. The most complete single record found, obtained from Lake Umutekai, provided the database for the first models of probabilistic eruption recurrence at Mt. Taranaki (Appendix 1). This single location naturally misses ash falls directed elsewhere and thus underestimates the true eruption frequency from the volcano.

In order to gain a better understanding of the volcano's true eruption frequency, a method using the composition of titanomagnetite phenocrysts was developed to correlate syn-eruption deposits between multiple sites (Chapter 3). The two detailed lake records could be combined using this method, along with application of statistical

measures of age “closeness” between near-concurrent tephra layers between the two sites. The combined record indicated an eruption frequency that was less variable than estimates obtained from the single site. Fitting a revised recurrence model showed a probability of an eruption onset within the next 50 years at 52%. This was 1.5 times that of the preliminary study on a single site record (27%; Appendix 1).

During electron microprobe analysis of titanomagnetite grains, it became apparent that many (but not all) fine ash-layers within the Umutekai Lake record contained titanomagnetite with distinctive exsolution lamellae. These result from oxidation processes as magma stagnates in near-surface conduits or domes. Subsequent rapid cooling of the rocks during dome-collapse preserves these exsolution features in their deposits and within elutriated ash clouds. By contrast, during eruptions where the magma rises quickly from depth, the titanomagnetite phenocrysts are quenched before the oxidation process can take place. Based on this, the Umutekai record was split into deposits of two end-member states, representing ‘fast-ascent’ and ‘slow ascent’ eruptions (Chapter 4). This revealed hidden systematic variations in eruption frequency. The annual eruption rates of fast-ascent eruptions showed a regular 1500 year periodicity. By examining a single site, there is an equal probability of tephra from these eruptions reaching Lake Umutekai during the Holocene. Hence this periodicity is likely to be strongly representative of the true eruption frequency of Mt. Taranaki. By contrast, the slow-ascent eruption record closely approximated the main known periods of block-and-ash-flow deposition reconstructed from proximal sites.

During the titanomagnetite study, a trend in their compositions also became apparent. Specific time intervals of c. 1500 years showed broadly similar compositions in titanomagnetite that were reflected in whole-rock geochemistry (Chapter 4). Defining geochemically and temporally constrained ‘magma batches’, the tephra deposits within the edifice soil profiles described in Chapter 2 were given approximate ages (Chapter 3).

In Chapter 4 the Mg content of titanomagnetite was used as a proxy to show evolution from relatively mafic to siliceous compositions during the life-span of each magma batch. Initiation of each magma batch and onset of a new geochemical cycle of the volcano closely matched the identified ~1500 year periodic pattern in eruption

frequency. Therefore, it was hypothesised that the overall eruption frequency of Mt. Taranaki is controlled by the geochemical evolution of individual magma batches. In addition, the largest eruptions identified at this volcano occur at semi-regular intervals – coinciding with minima in the eruption frequency cycle and typically preceding the longest repose intervals known over Holocene time (Chapter 4).

In fulfilment of Objective 2 (Chapter 1), fine-scale petrological studies from a typical eruptive sequence at Mt. Taranaki were used to provide inferences on the magmatic processes operating (Chapter 5). Zoning profiles in the phenocrysts of plagioclase, clinopyroxene and amphibole suggest that a two-stage magma differentiation and assembly process occurs at Mt. Taranaki. Bi-modal populations of titanomagnetite crystals, defined by their TiO_2 contents, indicate that new andesitic magma, differentiated at depth, recharged an upper magma storage area shortly before the studied eruption. This process appears common to generation of several of the other larger eruptions at Mt. Taranaki.

In Chapter 6, the Annen et al. (2006) concept of a ‘lower-crustal hot zone’ was shown to be consistent with the temporal and geochemical observations from Mt. Taranaki. The 1500-year periodicity of magma batches erupted at Mt. Taranaki may result from individual magmas forming at depth, from which sub-magmas are periodically extracted to rise to upper crustal storage areas. Bi-modal titanomagnetite populations were also identified to be a proxy for magma rise from the lower-system shortly before eruptions. The Holocene record of eruptions recording these bi-modal populations suggests that rise and recharge events also occur at regular intervals, however, on much shorter timescales of 100-400 years. Due to limitations of this method to observe rise events, these intervals are probably absolute minima.

The construction of a composite eruption record of Mt. Taranaki and the subsequent identification of cyclic eruption frequency being linked to magmatic processes contributes significantly to understanding the eruption behaviour of this volcano. These datasets, in combination with recognition of the volcano’s current state, can now be analysed realistically within probabilistic forecasting models to define the timing and possible magnitude and style of the next eruptions from this volcano. The methods

developed in this study and the conclusions reached may also be very widely applicable to other similar re-awakening andesitic volcanoes around the world.

7.2 Avenues for future research

The outcomes of this study provide important observations of timescales associated with the magmatic processes at a re-awakening andesitic volcano such as Mt. Taranaki, along with their probable impacts on eruption frequency. However, it is recognised that this work is only a step along the way to understanding the overall magmatic processes of andesitic volcanism, and hence providing accurate assessments of this future risk. Upon completion of this work, there remain many aspects that would benefit from further, focused study. The following avenues of research would contribute to a more comprehensive knowledge of the volcanic processes at volcanoes such as Mt. Taranaki and strongly improve the quality of future eruption predictions.

- 1) Predictions developed of the likely occurrence of future eruption activity at Mt. Taranaki (for example Chapter 3), do not currently include the likely time-varying impacts of underlying magma processes. Incorporation of some of the processes identified in Chapters 4 and 6, possibly through a Markov-model approach (e.g., Cronin et al. 2001) could build a more robust volcano process-based model. Similarly, future probabilistic based predictions need to incorporate more details that forecast the likely eruption style and size. These may be difficult to constrain in detail, but Chapter 4 identifies that the very largest Holocene eruptions at Mt. Taranaki occur at semi-regular intervals, probably related to the underlying cyclic magma processes. The frequency of effusive eruptions leading to lava flow and dome growth/destruction also needs to be better constrained in order to develop a complete eruption record. At present, a major obstacle to this is the ability to accurately identify and date these units/events. A possibility to overcome this obstacle would be to constrain the average frequency of these events in the most accurately identified and dated period known from Mt. Taranaki over the last 800 yrs B.P. (Platz 2007). This window of activity could be ‘scaled-up’ to constrain estimates of the “missing” parts of volcanic records over the rest of the Holocene.

- 2) The incorporation of additional data obtained from other sites will continue to improve the compiled eruption record. In particular, more distal sites (such as lakes and swamp sites) will provide valuable data for modelling the attenuation and dispersal characteristics of widespread tephra producing eruptions. In addition, gaining accurate records of tephra producing eruptions prior to the Holocene period will provide an opportunity to observe possible longer-term trends in magma processes and eruption frequency.
- 3) A detailed study of the basaltic activity at Mt. Taranaki needs to be undertaken. Specifically, how do eruptions from Fanthams Peak fit into the eruption frequency of the volcano? When was the initiation of eruptions from this parasitic cone? Within the lake and edifice profiles of this study, the earliest known events occurred at 3050 ± 28 years B.P. (i.e., tephra 19, sample Rk 22 of the Rotokare core) suggesting that this was the initiation of the vent. Previous examples of such mafic compositions were also identified – do these imply similar parastic vents?
- 4) The timescales of andesite magma processes such as magma differentiation, rise, mixing and storage may be better constrained by isotopic clocks (i.e., U-series) and element and isotope diffusion re-equilibration studies in a variety of minerals (c.f., Turner and Costa 2007). Recent studies at geochemically similar volcanoes to Mt. Taranaki indicate comparable timescales of magma differentiation to that identified within this thesis. For example, Ra-Th disequilibria data from plagioclase separates of Api volcano (Indonesia) provided estimates of magma differentiation to occur approximately 1700 years before eruption (Turner et al. 2003). Zellmer et al. (1999; 2003) used intra-crystalline trace element diffusion studies on several andesitic volcanoes. For Kameni Island dacites (Santorini, Greece), plagioclase phenocrysts suggested that the residence time of these magmas within the upper crust were between 100-450 yrs before eruption. A single rock sample from Soufriere Hills (Montserrat), had plagioclase residence ages between 10 and 1000 years (Zellmer et al. 1999). Similar studies undertaken at Mt. Taranaki may help to refine the timescales and geochemical models defined in this thesis. Conversely, if isotopic or diffusion studies are undertaken at Mt. Taranaki in the context of the detailed eruption record, a better understanding of

what the isotope or element diffusion timescales are really showing may result (i.e., magma residence times in the upper crust or timescales between recharge events and eruption).

- 5) Tectonic aspects, such as the surrounding stress regime of volcanoes such as Mt. Taranaki, need further consideration in understanding volcanic processes. For example, periodic changes from compressional to extensional stress of the region could enable dyke initiation and propagation. These processes may occur over regular intervals, leading to the possible ~400 years intervals between magma recharges events identified in this study.

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List of Appendices:

Appendices (on CD)

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Turner MB, Cronin SJ, Bebbington MS, Platz T (2008) *Developing a probabilistic eruption forecast for dormant volcanoes; a case study from Mt. Taranaki, New Zealand*. Bull Volcanol 70: 507-515. (DOI: 10.1007/s00445-007-0151-4).

Appendix 2

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Developing probabilistic eruption forecasts for dormant volcanoes: a case study from Mt Taranaki, New Zealand

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Abstract The majority of continental arc volcanoes go through decades or centuries of inactivity, thus, communities become inured to their threat. Here we demonstrate a method to quantify hazard from sporadically active volcanoes and to develop probabilistic eruption forecasts. We compiled an eruption-event record for the last c. 9,500 years at Mt Taranaki, New Zealand through detailed radiocarbon dating of recent deposits and a sediment core from a nearby lake. This is the highest-precision record ever collected from the volcano, but it still probably underestimates the frequency of eruptions, which will only be better approximated by adding data from more sediment core sites in different tephra-dispersal directions. A mixture of Weibull distributions provided the best fit to the inter-event period data for the 123 events. Depending on which date is accepted for the last event, the mixture-of-Weibulls model probability is at least 0.37–0.48 for a new eruption from Mt Taranaki in the next 50 years. A polymodal distribution of inter-event periods indicates that a range of nested processes control eruption recurrence at this type of arc volcano. These could possibly be related by further statistical analysis to intrinsic factors such as step-wise processes of magma rise, assembly and storage.

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Introduction

Volcanoes, like many other geological entities, are very hard to compare with other hazard agents, such as floods, storms, etc., on an equal time frame. Balancing investment into insurance or other risk-preparedness activities across a spectrum of hazards is hence difficult, yet this is the task that public authorities, insurers, businesses and communities are asked to carry out when considering their ongoing activities and future prosperity. For frequently occurring hazard events, such as floods, robust statistical models can be established, with high-frequency smaller events being used to model “scaled-up” more rare occurrences. The public are familiar with concepts such as a “100-year flood” or a “one in 50-year event”, but how realistic is this approach with respect to volcanic eruptions? Probabilistic forecasts have often been the goal of volcanic hazard evaluations (Carta et al. 1981; Connor and Hill 1995; Bebbington and Lai 1996a, b; Ho and Smith 1998; Cronin et al. 2001), but a lack of detailed eruption datasets spanning a long-enough period have hindered development of realistic eruption forecast models. We demonstrate here an approach that, for some types of volcanoes, allows the development of quantitative forward-looking models of eruption recurrence. In this process we also elucidate some of the intrinsic properties of eruption frequency in a common type of continental arc volcano.

Mt Taranaki

The strikingly conical Mt Taranaki/Egmont (2,518 m) dominates the landscape of the western North Island of New Zealand (Fig. 1). It is a basaltic andesite stratovolcano typical of continental-arc systems throughout the world, with geochemistry, petrology and volcanology (Neall et al. 1986; Price et al. 1999) similar to those of several recently highly active volcanoes, including Merapi (Indonesia), Unzen (Japan), Colima (Mexico) and Augustine (Alaska). Unlike these other examples, however, Taranaki has been ominously quiet for at least the last 150 years. Hence, like the bulk of the globe's dormant volcanoes, it is commonly considered to be, if not extinct, at least of very low threat by its surrounding communities.

Taranaki has been active for at least 125 thousand years, and for the late Pleistocene a highly detailed eruption chronology has been established through studies of tephra-fall deposits in downwind soil environments, with correlations to more complete near-vent sequences (Druce 1966; Neall 1979; Alloway et al. 1995). This level of detail is enough to establish that there has been a rough periodicity of 300–500 years between the largest-scale eruption events. However, it is only enough to make broad inferences on the

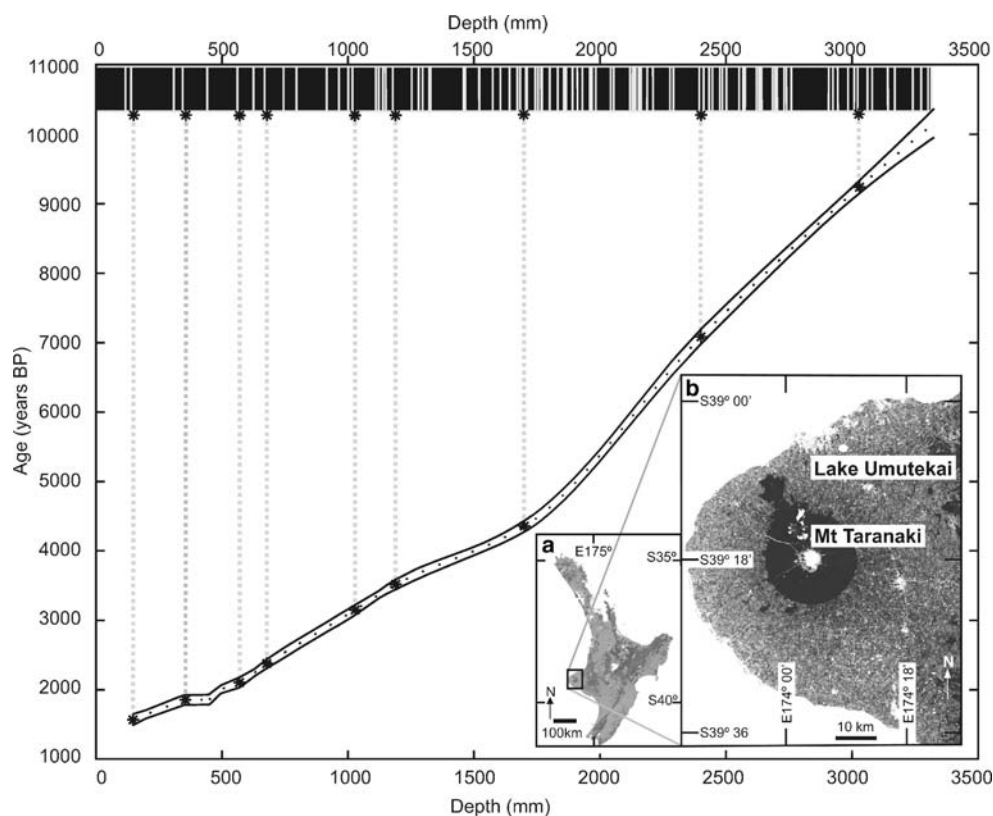
recurrence of the apparently more-frequent smaller events in between.

The aims of this study have been twofold: firstly to derive a new-generation record of volcanic activity at Taranaki and, secondly, to develop a statistical approach to evaluate these types of volcanic records and derive probabilistic forecasts to maximise appropriate risk management responses.

Constructing an eruption record at Taranaki

In order to establish a more detailed quantitative record of past activity from this centre, lakes in the downwind areas of the volcano were targeted for drilling studies. Lake Umutekai, lying 25 km N of the summit of Mt Taranaki (Fig. 1 inset b) revealed the most detailed record yet found in any one location. The c. 0.02 km² lake, within a swampy depression on a volcanoclastic surface reaches c. 2 m maximum water depth at coring sites in its centre. This location is sufficiently near the volcano to record minor eruptive events and those producing low-intensity falls (such as dome-forming eruptions and block-and-ash flows, particularly on the northern flanks), but is also close to the major

Fig. 1 Plot of the radiocarbon age versus depth model (mm) for tephra layers in the sediment core from Lake Umutekai (inset location maps of: **a** North Island of New Zealand and **b** Taranaki). The core stratigraphy is displayed at the top of the plot with white-layers representing tephra deposits. The locations of radiocarbon dated layers are indicated by stars



downwind dispersal axis for larger falls, which have also deposited tephra across the largest urban and industrialised areas of New Zealand (c.f., Eden and Froggatt 1996; Shane 2005). The depositional site in a small, shallow lake is an ideal trap for fall deposits, being within an area of low rolling and stable landscape that was densely forested throughout all of the Holocene (McGlone and Neall 1994). Several cores were collected in 1 m sections using a hand-operated piston corer of 35 mm diameter. The cores were imaged with an X-ray camera to identify mineral layers, including sub-mm units, within the organic host sediments. No evidence of erosion (unconformities, disturbed beds) was found in the core. Each of the layers was sampled and examined under an optical microscope to confirm it is a tephra (well sorted angular grains, including glass shards or glass-coated particles). The layers range between <0.5 mm up to 5.5 cm thick, with c. 50% of units >1 mm.

One-centimeter slices of the organic sediments were sampled for radiocarbon age determination using the AMS method. These dates (Table 1) have normally distributed errors (Stuiver and Pearson 1992) and were used to develop the age model for the depositional rate in the core. The overall organic sedimentation rate at Umutekai (excluding tephra) is similar to that found in other low-elevation wetland areas of Taranaki (McGlone and Neall 1994).

The upper part of the sequence in Lake Umutekai was not recovered in the core barrels due to its uncompacted and saturated state; hence the detailed record of events in this core is limited to events between 9,100 and 1,500 years BP. To complete the record, intensive dating of young and correspondingly well-preserved eruptives from near-source sequences were used to complete the stratigraphy of events (Table 1). For the volcano-flank sites organic material (mostly charcoal) within or below pyroclastic units was radiocarbon dated. Due to the inherent uncertainties of this process some stratigraphically distinct units have overlapping age estimates within standard 14C error ranges. In addition, recent studies of the youngest deposits on the volcano and the present summit dome indicate two further events following the previously accepted “last” event estimated at AD1755 using dendrochronology (Druce 1966). Paleovegetation studies and pollen evidence (Lees and Neall 1993) indicated that the last tephra event in this area was around AD1860, at or near the time of European settlement in the area. More recent stratigraphic and geochemical evidence confirms that two post AD1755 events occurred and places them at c. AD1800 and 1854 (Platz et al. 2006). The latest date corresponds to diary entries of a local settler, recording a week-long period of earthquakes and rumbling noises from the volcano (during poor weather/visibility). The latest eruptive activity is inferred to be a rapid extrusion of a small lava dome at the volcano’s summit (Platz et al. 2006).

The post 1,500 years BP stratigraphy includes some events that have not been radiocarbon dated and it may also over-represent block-and-ash flow events, which may not have left deposits in the lake (Cronin et al. 2003). Nevertheless, it was assumed that this is the best obtainable record of the units that would have been represented in the upper, unobtainable, part of the Umutekai sequence.

Extracting an event age model

For this analysis, radiocarbon ages and radiocarbon years were used, because the normally distributed errors associated with the dates are far easier to work with than complex error distributions associated with the calibration of radiocarbon years to calendar dates (see, Bronk-Ramsay 2003).

The data of this Taranaki record falls into two sets:

- (1) A small number of ‘young’ events individually dated, plus
- (2) A number of depths corresponding to the thickness of sedimentary deposits between ‘old’ events from the core.

Ten samples were dated from the core, and were used to interpolate the remaining core event ages. These were combined with the young dates to form the most “complete” record available of eruption episodes since c. 10,000 years BP. Due to the limitations inherent in working from deposits rather than observations, the record necessarily will lump together separate eruptions occurring as part of a single episode, because there may be no observable evidence to separate them. In addition, the core record is based on a single site, which may not have received or preserved products from all eruptions of this volcano. On balance, the dataset probably underestimates the true event frequency, so the rates calculated are a minimum.

To estimate dates for the interpolated events in the core, the dates were considered as a function of depth, and a piecewise cubic Hermite interpolating polynomial (Fritsch and Carlson 1980) was fit. The polynomial fitting automatically corrects for the compaction. The tephra layers were subtracted before fitting the polynomial. An alternative is a cubic smoothing spline, but the results are very similar. Since the core dates have estimated errors, we can re-sample from within the error distribution of these dates, fit the polynomial, and obtain interpolated dates. Repeating this re-sampling many times while preserving their order with a random sample for the core dates each time, produces means and errors for the interpolated dates. One of the dates, at about 1,500 mm/4,200 BP was clearly anomalous, as it forced a discontinuity on the polynomial fit. Dispensing with this date produced a much more physically reasonable model (Fig. 1). The core-depth function can be used to calculate estimated dates for all events represented in the core and these inferred dates can be combined with

Table 1 Radiocarbon dates and other age determinations used in this study

Date code or age source	Age (year BP) ^a	Location		Material	Event no.	Source
		Lat (°N)	Long (°E)			
Young events ^b						
Estimated historical age ^c	90	N.A.	N.A.	N.A.	-19	This study
Estimated historical age ^c	150	N.A.	N.A.	N.A.	-18	This study
NNZ5593	<250	39°16.30'	174°00.00'	Charcoal	-18	This study
Dendrochronology age ^d	195	N.A.	N.A.	Tree rings	-17	Druce (1966)
NNZ721	249±55	39°20.30'	174°13.70'	Wood	-16	Grant-Taylor and Rafter (1971)
Wk2376	300±60	39°15.41'	173°56.10'	Charcoal	-15	This study
Wk11590	305±39	39°16.26'	174°00.80'	Charcoal	-14	This study
NNZ63	300±60	39°18.46'	174°07.50'	Charcoal	-13	Fergusson and Rafter (1957)
NZ64	400±60	39°18.46'	174°07.50'	Charcoal	-13	Fergusson and Rafter (1957)
R-Combine of NZ63 and NZ64 ^e	356±42	N.A.	N.A.	N.A.	-13	N.A.
Wk11593	382±39	39°15.91'	173°58.73'	Charcoal	-12	This study
Wk11585	387±43	39°16.65'	174°00.32'	Charcoal	-11	This study
NZA941	404±44	39°15.10'	173°56.10'	Charcoal	-10	Neall (1979)
NZ720	439±55	39°16.5'	174°00.1'	Leaves	-9	Grant-Taylor and Rafter (1971)
NZ1141	447±40	39°15.10'	173°56.10'	Charcoal	-9	This study
Wk11589	453±43	39°16.26'	174°00.80'	Charcoal	-9	This study
R-Combine of NZ720, NZ1141 and Wk11589 ^e	447±26	N.A.	N.A.	N.A.	-9	N.A.
Wk11584	468±42	39°16.65'	174°00.32'	Charcoal	-8	This study
Wk11591	475±42	39°16.26'	174°00.80'	Charcoal	-8	This study
R-Combine of Wk11584 and Wk11591 ^e	472±30	N.A.	N.A.	N.A.	-8	N.A.
NZ567	537±55	39°18.10'	173°59.00'	Charcoal	-7	Grant-Taylor and Rafter (1971)
NZ1256	620±74	39°16.31'	174°00.01'	Charcoal	-6	Neall (1979)
Wk11594	605±42	39°15.91'	173°58.73'	Charcoal	-6	This study
R-Combine of NZ1256 and Wk11594 ^e	609±37	N.A.	N.A.	N.A.	-6	N.A.
Wk11592	649±49	39°16.26'	174°00.80'	Charcoal	-5	This study
Wk11586	878±39	39°16.66'	174°00.32'	Charcoal	-4	This study
Wk2378	970±4039°05.10'	173°56.90'	Wood	-3	Neall (1999)	
NNZ596	1,000±60	39°16.30'	174°00.00'	Charcoal	-3	This study
R-Combine of Wk2378 and NZ5596 ^e	979±33	N.A.	N.A.	N.A.	-3	N.A.
Wk-16391	1,130±34	39°17.11'	174°06.00	Charcoal	-2	This study
NNZ6508	1,390±150	39°19.01'	174°08.60'	Peat	-1	McGlone et al. (1988)
Umutekai core ^f						
NZ23065	1,559±40	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23066	1,848±35	39°05.27'	174°08.22'	Peat	N.A.	This study

NZ23067	2,098±35	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23117	2,369±30	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23068	3,142±35	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23069	3,507±35	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23070	4,088±35	39°05.27'	174°08.22'	Peat	N.A.	This study
NZ23085	4,345±40	39°05.27'	174°08.22'	Peaty silt loam	N.A.	This study
NZ23089	7,068±55	39°05.27'	174°08.22'	Peaty silt loam	N.A.	This study
NZ23118	9,219±45	39°05.27'	174°08.22'	Peaty silt loam	N.A.	This study

^a Radiocarbon age in years before present (BP) using Libby half-life

^b Young events: <1,500 years BP dated event deposits from near source sequences

^c Eruption age estimated from historical evidence (T. Platz, unpublished data)

^d Dendrochronology estimate from damage to living trees by Druce (1966)

^e Averaged radiocarbon dates, combined using OxCal v.3.9, Bronk-Ramsay (2003)

^f Umutekai core: radiocarbon dates from Lake Umutekai

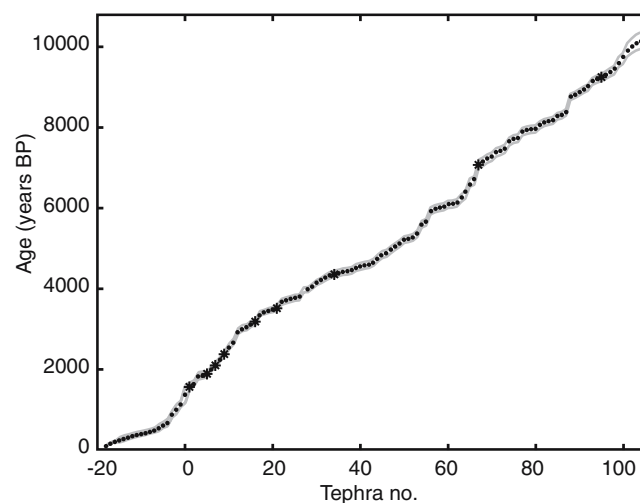


Fig. 2 Estimated dates and errors for all eruption events since 9,500 years B.P. Eruption events are numbered on the *x*-axis; the young dates are numbered from −18 (youngest) to 0, the core dates from 1 to 104. The stars indicate the core dates, the dots mark the interpolated event dates, and the solid lines the error limits

dates from young tephras to produce a comprehensive age sequence (Fig. 2).

Model selection

We note that the data is necessarily non-homogeneous, being obtained by differing methods for the core dates and young dates. Both data sets are needed; the longer core record to provide the basis of the model, and the ‘on-mountain’ data to extend this, and most importantly, to give us a starting point for the current forecast. Creating a probabilistic model requires identifying any structure in the data.

Firstly the core dates were checked for departure from stationarity using Pearson’s chi-square statistic. Looking at the number of observed events in 500-year intervals, we obtain a chi-square statistic of 17.87 on 16 degrees of freedom, with a *P* value >0.1, indicating that there is no significant evidence of trend or cyclicity in the data. Any variation in recurrence rate observed in this data appears to relate to physical factors, such as the crater being open to the N during the period 4,000–5,000 BP and hence preferentially guiding block-and-ash flows and associated ash clouds over this time. These factors are unrelated to the magma supply rate. Secondly, the inter-eruption times were examined for autocorrelation. Note that as the distribution of the inter-eruption times are clearly non-normal, these were transformed by taking logarithms, otherwise one might see a spurious autocorrelation produced by the fact that short intervals predominate. We found that there are no significant autocorrelations or partial autocorrelations, and hence time-series models such as autoregressive models are not applicable.

Relationships between the inter-eruption time and the size of either the previous eruption or the subsequent eruption were also investigated. The former is called the ‘time-predictable’ model (Bacon 1982), and the latter the ‘size-predictable’ model (De la Cruz-Reyna 1991). Rhoades et al. (2002) showed that, at a fixed observation point, the expected tephra thickness is approximately linearly related to the volume of the eruption. Hence, we conducted a regression analysis of interval against tephra thickness, taking logarithms of each quantity (cf. Sandri et al. 2005). There was no discernable relation between the size of the preceding event and the following interval (Fig. 3), which is confirmed by the P value of 0.77. The interval and the size of the subsequent eruption similarly have no relation, with a P value of 0.25.

We concluded that there was no evidence of any structure to the inter-event process beyond that in the distribution of interval times. In other words, a renewal process. The mean and standard deviation of the core intervals are 83.3 years and 76.6 years respectively ($n=103$), against 70.5 years and 75.1 years ($n=18$) for the young dates. The minimum interval was 10 years, whereas the maximum was c. 420 years. The difference between the two data sets indicates that the core record is possibly incomplete, but an approximate t -test of the difference between the two samples of interevent times produces a t -statistic of 0.67, which is not statistically significant. Hence there is no obstacle to treating the data as a whole using a renewal model.

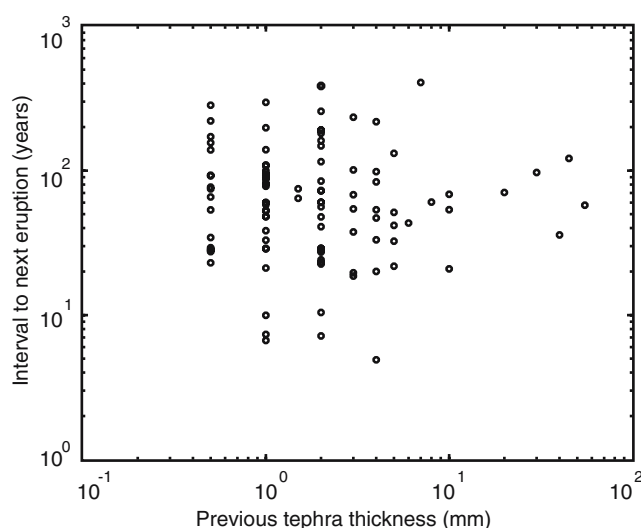


Fig. 3 Relation between event size (estimated by ash thickness in mm on the x-axis) and interval (years, y-axis). The time to the next event is uncorrelated with the size of the event

Developing a renewal-process hazard model

Bebbington and Lai (1996a, b) developed the use of a Weibull renewal process to model inter-event times for volcanic activity. Due to its ability to model both over-dispersed (i.e., clustered) or under-dispersed (i.e., semi-periodic) inter-event times, it proved to be superior to the lognormal distribution commonly used in seismology (c.f., Nishenko and Buland 1987). However, in the present situation, the data set does not comprise actual eruption dates. Instead we can only distinguish events separated by sediment deposition, and hence there is very little likelihood of “clustering”, i.e., of an over-dispersed distribution fitting the data. This was also inferred by Cronin et al. (2001) but here, because the events are represented in a single core, we have depth as a proxy, instead of the very imprecise dates based on geomorphological characterisation used in the former analysis.

So, both the Weibull distribution,

$$f_W(\tau) = \alpha\beta^\alpha \tau^{\alpha-1} \exp(-(\beta\tau)^\alpha)$$

with a periodic ($\alpha > 1$) mode at $\tau = (1 - 1/\alpha)^{1/\alpha} / \beta$, and the lognormal distribution

$$f_{\ln}(\tau) = \left(\sqrt{2\pi\sigma\tau}\right)^{-1} \exp\left(-0.5(\ln \tau - \mu)^2 / \sigma^2\right)$$

with a mode at $\exp(\mu - \sigma^2)$ are reasonable alternatives. The exponential distribution (or Poisson process) is also useful as a benchmark. In addition, as shall be shown, the inter-event data appears to be bi-modal or even poly-modal, and so it will also be fitted to a mixture of Weibull distributions

$$f_{mW}(\tau) = p\alpha_1\beta_1^{\alpha_1}\tau^{\alpha_1-1}\exp(-(\beta_1\tau)^{\alpha_1}) \\ + (1-p)\alpha_2\beta_2^{\alpha_2}\tau^{\alpha_2-1}\exp(-(\beta_2\tau)^{\alpha_2}),$$

where $0 < p < 1$ is the mixing proportion, and there are modes at $\tau = (1 - 1/\alpha_1)^{1/\alpha_1} / \beta_1$ and $\tau = (1 - 1/\alpha_2)^{1/\alpha_2} / \beta_2$. The parameters are fitted by maximizing the likelihood

$$L = \prod_{i=1}^n f(\tau_i),$$

Table 2 Fitted parameters for the renewal models tested

Distribution	Parameters	logL/no. of samples
Exponential	$\lambda=0.0122$	-660.1
Lognormal	$\mu=4.0113$, $\sigma=0.9572$	-657.1
Weibull	$\alpha=1.1661$, $\beta=0.0115$	-657.7
Mixture of Weibulls	$\alpha_1=1.6442$, $\beta_1=0.0176$ $\alpha_2=1.9293$, $\beta_2=0.0050$, $p=0.7526$	-652.2

where $\tau_1, \dots, \tau_n$ are the sampled inter-event times. In this case 1,000 Monte Carlo runs, i.e., 122,000 sampled inter-event times were carried out to derive a range of fitted densities (Fig. 4). This allows for the uncertainties in the dating processes.

The estimated parameters and average log likelihoods (Table 2) show that the lognormal and Weibull models, with an additional parameter, improve slightly on the exponential distribution, but this is not significant when the additional parameter is taken into account via, for example, the Akaike Information Criterion:

$$AIC = -2 \log L + 2k,$$

where k is the number of parameters. A lower AIC indicates a better fit, penalising the additional parameters. A difference of 1.5–2 is usually considered significant. Using the same criteria, the mixture of Weibulls, even with four additional parameters, still generates an AIC difference of 8.0, and is thus clearly superior. The mixture model contains a strong mode at 32 years and a more diffuse mode at around 137 years. The Weibull and lognormal distributions have single modes at 16 years and 22 years, respectively.

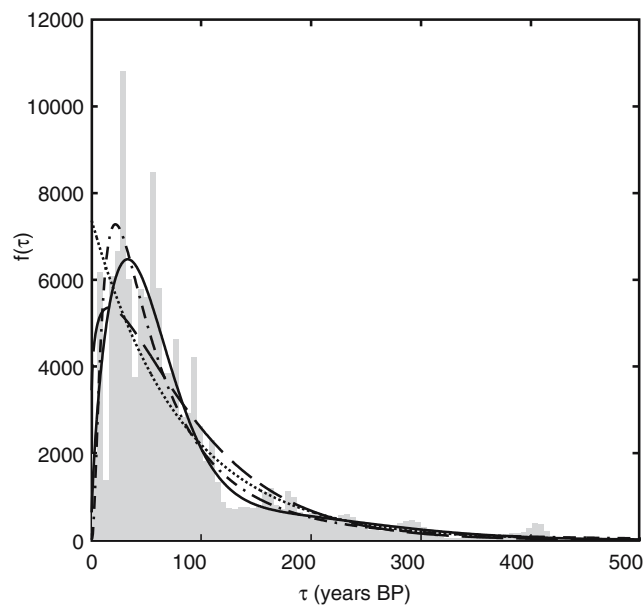


Fig. 4 Histogram of 122,000 sampled inter-event times based on 1,000 Monte Carlo runs. Curves show the fitted densities for this data set: Dotted line Exponential distribution, dot-dash lognormal, dashed Weibull, solid mixture of Weibulls

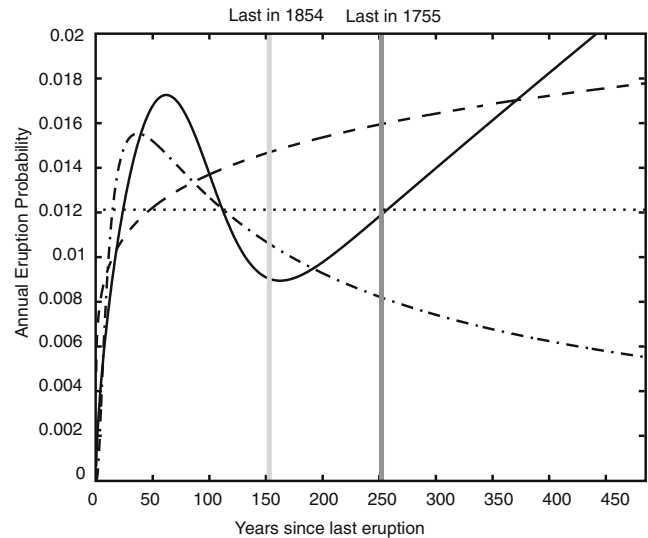


Fig. 5 Annual eruption probabilities using a range of distributions. Dotted line exponential distribution, dot-dash lognormal, dashed Weibull, solid mixture of Weibulls. Vertical lines indicate present (2007) hazard depending on the date of the last eruption

Probabilistic forecasting

The model(s) developed above can be used to estimate the likelihood of an eruptive episode at a given time in the future. Supposing that the most recent event occurred T years ago then, assuming that the duration of a year BP (carbon date) can be equated to duration of a calendar year, the probability of no event in the next t years is

$$\Pr(\tau > T + t | \tau > T) = \frac{\int_{T+t}^{\infty} f(\tau) d\tau}{\int_T^{\infty} f(\tau) d\tau}.$$

The annual eruption probability, given no eruption in the interim, can be calculated by differencing this (Fig. 5). We see that the best fitting mixture-of-Weibulls model produces an early peak in the annual eruption probability at about 60 years after the previous eruption, followed by a trough at about 165 years, and steadily increasing probabilities thereafter as the tail of the distribution is entered. Assuming that the most recent eruption was in AD1854, or 153 years ago, we find a probability of 0.37 of an eruption within the next 50 years. The lognormal distribution provides a similar probability of 0.41. The worst case is presented by the Weibull distribution with a probability of 0.53 of an event within the next 50 years.

If we ignore the evidence of the last two events (1800 and 1854), there is little change in the curves in Fig. 4 and Fig. 5, and the parameter estimates in Table 2. However, it would then have been 252 years since the last eruption, which Fig. 4 shows to be uncommon in the observed history. Although the exponential model retains a 50-year probability of 0.46, the Weibull model 50-year probability

increases to 0.56, while the lognormal probability decreases to 0.33 (cf. Fig. 5). The biggest change, however, is in our preferred mixture-of-Weibulls model, where we see an increase to a probability of 0.48 of an eruption within 50 years. This is a consequence of the trough being long past in this case (Fig. 5).

Discussion and conclusions

Robust probabilistic hazard models from volcanoes are achievable, even from volcanoes lacking a well-known record of recent historic activity. Taranaki represents one of the most common volcano types on Earth. Like many of these centres worldwide, there has not been enough detailed information collected from its past eruption record to establish reliable quantitative estimates of its hazard potential. This lack of data has also hindered the understanding of the driving processes behind recurrence of volcanism in such arc systems. Here we demonstrate that if high-quality chronostratigraphic sites can be found, a modification of Weibull renewal models can be used to describe the event-recurrence data structure. It was shown to be necessary to employ a mixture model because the inter-event distribution exhibits both a strong peak and a long tail with subsidiary peaks. The former dictates a strong degree of periodicity, but the latter implies the existence of atypically long intervals from time to time.

The variability of event frequency over the past 10,000 years represented in the core (Fig. 2) shows that there have been periods either when (1) there was less-frequent activity, or (2) activity occurred in weather conditions unfavourable for transport of ash to the lake, or alternatively (3) the summit crater was open to different directions, focussing pyroclastic flows and consequent elutriated ash clouds in directions unfavourable for transport of ash to the site cored. In support of the third alternative, between 4,000 and 5,000 years BP, stratigraphic records show that the crater was open to the N–NE and that there were a number of large pyroclastic events affecting this sector (Alloway et al. 1995), hence favouring transport of elutriated ash from pyroclastic flows to Lake Umutekai. In these cases, pyroclastic flows could commonly have reached within 15 km of Umutekai, with momentum of overlying ash clouds being directed toward the site. In the core sequence, there is an increase in ash layers representing events in the organic sediments deposited during the corresponding period.

This initial stage of analysis was hampered because our sampling methods are biased toward indicating a periodicity of eruption recurrence at this centre. However, several modes are present in the inter-event period distribution. This leads us to hypothesise that there are a nested set of controls

on eruption recurrence at these types of volcanoes. It may be possible to correlate some of these to eruption magnitude variations as well as underlying cycles in geochemistry, petrology and eruption type. A greater challenge is to understand whether apparent eruption periodicity is real and perhaps controlled by the time required for assembly of magmas at high levels in the crust. This may correspond to the petrological and geochemical evidence at this centre for assembly of magmas from multiple slow-flowing dyke systems before eruption triggering (Stewart et al. 1996; Price et al. 2005).

From a perspective of understanding volcanic hazard recurrence at Taranaki, this study has demonstrated the first step toward putting volcanic hazard into the same context as other common hazards that a community may need to address. Being able to demonstrate that there is a 37–48% chance of an eruption in the next 50 years by the best-fitting estimate provides the first chance to develop quantitative risk assessments. This goes a long way toward de-mystifying volcanism and helping to effectively plan for it in a modern technological society.

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Appendix 2: Lake core records

Appendix 2.1: Lake Umutekai – Sample analysis

Sampled Tephra Number (U05-xx)	Tephra at depth (mm)	Visual identification of pumice	Shards (1=lithic 2=shard)	Mag (1=Slow- ascent 2= Fast- ascent)	Identified eruption style	Magma batch	Graphic mean Grain size (groups)	Tephra thickness (groups)	Tephra thickness (mm)
1	148	1 or 2	1	1	1		2	2	2
2	197	1 or 2	1	1	1		2	1	1
3	337	1 or 2	1	1	1		2	1	1
4	352	2	1		2	f	2	4	4
5	450	2	2	2	2	1	4	1	1
	496	1	1	1	1				1
6	570	2	2	2	2	1	2	2	2
7	629	2	2	2	2	1	5	3	10
8	678	2	1	2	2	f	5	4	55
9	753	2	1		2	f	3	3	5
10	808	2	1	2	2	f	3	1	1
12	927	1 or 2	1		1		3	1	0.5
	961.5	1	1		1				
13	971.5	1 or 2	2	1	1		3	1	1
14	1009.5	2	2	2	2	2	3	1	0.5
15	1029	2	1	2	2		2	1	1.5
16	1122.5	1 or 2	1	1	1		2	1	1
17	1134.5	1 or 2	1		1		3	2	2
18	1152.5	1 or 2	1	1	1		3	2	3
19	1163.5	2	2	2	2	2	2	2	2
20	1189.5	2	2	2	2		3	2	3
21	1267.5	1 or 2	2		2		2	1	0.5
22	1291	2	2		2		3	1	0.5
23	1309.5	1 or 2	1		1		2	2	2
24	1332.5	2	2	2	2	2	5	4	30
25	1337.5	1 or 2	1	1	1		2	2	2
26	1471.5	2	2		2	stent ash	1	3	10
27	1476.5	2	2	2	2	2 to 3	2	1	1
28	1533.5	2	2	2	2		2	2	2
29	1588.5	1 or 2	1	1	1		2	1	1
30	1617.5	1 or 2	1	1	1	3	2	1	1
31	1655.5	1 or 2	1	1	1		1	2	2
32	1684.5	2	2	2	2		5	3	10
33	1699.5	2	2		2		4	4	40
	1709.5								1
34	1721.5	1 or 2	2	2	2		3	3	4
35	1725.5	2	2	2	2		2	1	1
	1734.5	2	2	2	2				1
36	1760.5	2	2	2	2	3	2	3	7

37	1770.5		1 or 2	2	2	2			2	2	3
Sampled Tephra Number (U05-xx)	Tephra at depth (mm)		Visual identification of pumice	Shards (1=lithic 2=shard)	Mag (1=Slow- ascent 2= Fast- ascent)	Identified eruption style	Magma batch		Graphic mean Grain size (groups)		
										Tephra thickness (groups)	Tephra thickness (mm)
38	1780		1 or 2	1	1	1			1	1	1
39	1786.5		2	2	2	2			2	1	1
40	1804.5		1 or 2	1	1	1			2	2	2
41	1837.5		1 or 2	1	1	1			2	2	2
42	1860.5		1 or 2	1	1	1			2	1	1
43	1869.5		1 or 2	1	1	1			2	1	1
44	1894.5		2	2	2	2	3		3	3	4
45	1914.5		1 or 2	1	1	1			3	1	1
46	1933.5		2	2	2	2			3	1	0.5
	1957		1	1	1	1					0.5
47	1962.5		1 or 2	1	2	2			2	1	1
48	1970.5		1 or 2	1	1	1			3	2	3
49	1992.5		1 or 2	2	2	2			2	1	0.5
50	2047		1 or 2	1	1	1			2	1	1
51	2058		2	2	2	2	3		3	2	2
52	2122		1 or 2	2	2	2			1	1	1
53	2134		1 or 2	1		1			1	2	1.5
54	2140.5		1 or 2	1	1	1			1	1	0.5
55	2145		2	1	2	2			2	1	0.5
56	2158.5		2	2		2	4		4	3	5
57	2160		2	2	2	2	4		3	1	1
58	2166.5		2	1		2			5	1	1
60	2192.5		2	2	2	2	4		4	2	2
59	2213.5		2	2	2	2	5		2	2	3
61	2282.5		2	2	2	2	5		3	2	2
62	2295.5		1 or 2	1	1	1			4	1	1
63	2399.5		2	2	2	2	4		5	4	20
64	2415.5		2	2	2	2			3	1	0.5
65	2437		1 or 2	1		1			5	1	1
66	2450		2	2	2	2			4	2	2
67	2480		1 or 2	2		2			1	2	2
68	2490		1 or 2	1	1	1			3	3	4
69	2505		2	2	2	2	5		5	3	8
70	2556		1 or 2	2	2	2			2	2	2
71	2573		2	2	2	2	5		4	3	5
72	2579		2	2	2	2	5		1	1	1
73	2625		1 or 2	1		1			2	2	2
74	2636		2	2	2	2	5		5	2	2
75	2642		2	1	2	2	5		2	2	2
76	2645		1 or 2	2		2	6		1	1	1
	2673		1 or 2	2	2	2					0.5
77	2690.5		1 or 2	2	2	2			1	1	0.5
78	2699		1 or 2	2	2	2	6		3	2	3
79	2707		1 or 2	2	2	2			1	1	0.5
82	2736.5		2	2	2	2			4	3	4
80	2744.5		2	1	2	2			2	2	2

Sampled Tephra Number (U05-xx)	Tephra at depth (mm)	Visual identification of pumice	Shards (1=lithic 2=shard)	Mag (1=Slow- ascent 2= Fast- ascent)	Identified eruption style	Magma batch	Graphic mean Grain size (groups)	Tephra thickness (groups)	Tephra thickness (mm)
81	2764.5	1 or 2	1	1	1		2	2	2
	2879.5	1 or 2	2	2	2				0.5
	2894								0.5
83	2913.5	1 or 2	2	2	2	6	3	3	6
84	2933.5	1 or 2	2	2	2		2	3	4
85	2949.5	2	2	2	2	6	4	3	5
86	2997.5	2	2	2	2	6	5	1	0.5
87	3014	2	2		2		4	2	2
88	3027	2	2	2	2	6	5	4	45
	3045	2	2	2	2				0.5
89	3066.5	2	2	2	2	6	5	3	5
90	3085.5	2	2	2	2		4	1	1
91	3148.5	2	2	2	2	6	5	3	4
92	3176.5	2	1	2	2		3	2	2
93	3247.5	2	2	2	2	6	3	3	4
94	3280.5	2	1	2	2		4	2	3
95	3307.5	1 or 2	2	2	2	7	2	2	2
	3323.5	2	2	2	2				2
							Range of graphic mean	Thickness Range	
							5=250- 1000µm	4=>10mm	
							4=187.5- 250µm	3=3.1-10mm	
							3=125- 187.5µm	2=1.6-3mm	
							2=63- 125µm	1=<1.5mm	
							1=<63µm		

Appendix 2.2: Lake Umutekai – Grainsize analysis

Sample	Weight Sample + Beaker	Weight Beaker	Sample	> 1mm	500 um to 1 mm	250 um to 500 um	125 um to 250 um	63 um to 125 um	<63 um	not sieved (too small)	Sample Weight
U05-0	1.479	1.29	0.189	0	0	0	0.096	0.058	0.032		0.186
U05-1	1.402	1.294	0.108	0	0	0.02	0.3	0.19	0.005		0.515
U05-2	1.29	1.262	0.028	0	0	0.009	0.014	0.21	0.017		0.25
U05-3	1.352	1.302	0.05	0	0.013	0.015	0.021	0.032	0.021		0.102
U05-4	1.665	1.293	0.372	0	0.008	0.066	0.092	0.17	0.041		0.377
U05-5	1.721	1.299	0.422	0.007	0.067	0.187	0.072	0.06	0.036		0.429
U05-6	1.364	1.267	0.097	0	0	0.01	0.029	0.059	0		0.098
U05-7	2.769	0.61	2.159	1.015	0.459	0.239	0.155	0.188	0.087		2.143
U05-8	12.995	0.607	12.388	1.486	7.003	3.411	0.383	0.086	0.017		12.386
U05-9	3.824	0.616	3.208	0.29	0.153	0.846	1.313	0.485	0.093		3.18
U05-10	1.358	1.284	0.074	0.016	0.017	0.016	0.013	0.007	0		0.069
U05-11	6.442	0.615	5.827	2.471	3.432	1.42	0.125	0.021	0.002		7.471
U05-12	1.357	1.289	0.068	0	0.009	0.007	0.02	0.021	0.002		0.059
U05-13	1.397	1.298	0.099	0.01	0.014	0.017	0.014	0.038	0.017		0.11
U05-14	1.391	1.288	0.103	0	0.03	0.027	0.037	0.036	0.021		0.151
U05-15	1.408	1.302	0.106	0	0	0	0.07	0.027	0.008		0.105
U05-16	1.359	1.302	0.057	0	0	0.014	0.027	0.031	0.017		0.089
U05-17	1.516	1.295	0.221	0	0.041	0.059	0.062	0.056	0.023		0.241
U05-18	1.664	1.284	0.38	0	0	0.101	0.092	0.122	0.063		0.378
U05-19	1.045	0.608	0.437	0	0	0.022	0.207	0.142	0.063		0.434
U05-20	1.724	1.298	0.426	0	0.093	0.056	0.077	0.15	0.058		0.434
U05-21	1.307	1.286	0.021	0		0	0.008	0.009	0.004		0.021
U05-22	1.309	1.288	0.021	0	0	0.009	0.005	0.009	0		0.023
U05-23	1.307	1.281	0.026							0.025	0.025
U05-24	11.12	0.62	10.5	7.211	2.343	0.586	0.17	0.147	0.031		10.488
U05-25	1.491	1.29	0.201	0	0	0.025	0.06	0.086	0.023		0.194
U05-26	2.783	0.623	2.16	0	0		0.023	0.726	1.405		2.154
U05-27	1.536	1.293	0.243	0	0.004	0.015	0.061	0.121	0.054		0.255
U05-28	1.545	0.617	0.928	0.019	0.07	0.129	0.134	0.415	0.192		0.959
U05-29	1.308	1.283	0.025	0	0	0.003	0.007	0.009	0		0.019
U05-30	1.331	1.287	0.044	0	0	0.006	0.008	0.027	0		0.041
U05-31	1.567	1.273	0.294	0.004	0.007	0.02	0.07	0.118	0.067		0.286
U05-32	1.255	0.625	0.63	0.242	0.212	0.078	0.043	0.035	0.007		0.617
U05-33	18.848	0.609	18.239	0.008	0.906	10.081	7.043	0.181	0.021		18.24
U05-34	3.135	0.623	2.512	0.007	0.088	0.574	0.865	0.539	0.401		2.474
U05-35	1.941	1.3	0.641	0	0	0.089	0.16	0.245	0.14		0.634
U05-36	2.28	1.302	0.978	0	0	0.047	0.347	0.378	0.144		0.916
U05-37	1.795	1.299	0.496	0	0	0	0.195	0.22	0.073		0.488
U05-38	1.445	1.283	0.162	0	0	0	0.046	0.049	0.56		0.655
U05-39	1.747	1.27	0.477	0	0	0.006	0.25	1.49	0.046		1.792
U05-40	1.996	1.295	0.701	0.009	0.01	0.015	0.203	0.316	0.137		0.69
U05-41	2.017	1.293	0.724	0.006	0.015	0.067	0.18	0.307	0.139		0.714
U05-42	1.409	1.283	0.126	0	0	0.016	0.037	0.067	0.034		0.154
U05-43	1.606	1.285	0.321	0	0	0.032	0.112	0.131	0.052		0.327
U05-44	2.312	0.626	1.686	0.007	0.128	0.266	0.569	0.491	0.225		1.686
U05-45	1.568	1.285	0.283	0	0	0.068	0.077	0.1	0.034		0.279
U05-46	1.414	1.3	0.114	0	0.017	0.02	0.044	0.036	0.017		0.134
U05-47	1.556	1.291	0.265	0.019	0.032	0.066	0.062	0.067	0.057		0.303
U05-48	1.593	1.304	0.289	0	0.038	0.088	0.064	0.074	0.026		0.29

Sample	Weight Sample + Beaker	Weight Beaker	Sample	> 1mm	500 um to 1 mm	250 um to 500 um	125 um to 250 um	63 um to 125 um	<63 um	not sieved (too small)	Sample Weight
U05-50	0.932	0.624	0.308	0.031	0.037	0.023	0.03	0.111	0.058		0.29
U05-51			0.316	0	0	0	0.281	0.025	0.01		0.316
U05-52	1.732	1.286	0.446	0	0.007	0.022	0.072	0.225	0.11		0.436
U05-53	1.918	1.258	0.66	0.012	0.028	0.052	0.078	0.341	0.188		0.699
U05-54	1.65	1.29	0.36	0.047	0.023	0.024	0.042	0.169	0.059		0.364
U05-55	1.43	1.278	0.152	0	0.01	0.019	0.042	0.057	0.03		0.158
U05-56	3.082	0.614	2.468	0	0.256	1.306	0.743	0.132	0.026		2.463
U05-57	1.323	1.282	0.041	0	0.014	0.015	0.015	0.017	0.012		0.073
U05-58	1.893	1.294	0.599	0	0.526	0.035	0.009	0.021	0.006		0.597
U05-59	1.797	1.297	0.5	0	0.016	0.033	0.658	0.219	0.163		1.089
U05-60	1.467	1.265	0.202	0	0	0.142	0.018	0.032	0.007		0.199
U05-61	2.091	1.298	0.793	0.003	0.018	0.186	0.19	0.315	0.069		0.781
U05-62	1.513	1.269	0.244	0	0.076	0.061	0.046	0.049	0.016		0.248
U05-63	13.088	0.614	12.474	6.489	3.196	2.017	0.332	0.273	0.188		12.495
U05-64	1.64	1.284	0.356	0.05	0.024	0.026	0.104	0.123	0.055		0.382
U05-65	1.634	1.282	0.352	0.107	0.027	0.035	0.051	0.066	0.028		0.314
U05-66	1.891	1.282	0.609	0.003	0.001	0.044	0.114	0.279	0.169		0.61
U05-68	2.805	1.285	1.52	0.075	0.292	0.199	0.247	0.445	0.257		1.515
U05-69	8.72	0.617	8.103	1.875	2.289	2.267	1.088	0.367	0.198		8.084
U05-70	1.453	1.283	0.17	0	0	0.038	0.074	0.063	0.028		0.203
U05-71				0.014	0.071	0.424	0.334	0.113	0.046		1.002
U05-72	1.772	1.271	0.501	0.04	0.043	0.22	0.062	0.159	0.16		0.684
U05-73	1.484	1.292	0.192	0.018	0.019	0.011	0.017	0.075	0.043		0.183
U05-74				0.399	0.177	0.021	0.122	0.152	0.039		0.91
U05-75	1.753	1.289	0.464	0.036	0.028	0.066	0.15	0.125	0.052		0.457
U05-76	1.346	1.286	0.06	0	0	0.032	0.003	0.008	0.002		0.045
U05-77	1.51	1.282	0.228	0	0	0.059	0.052	0.071	0.046		0.228
U05-79	1.678	0.617	1.061	0.044	0.038	0.104	0.264	0.394	0.219		1.063
U05-80	1.812	0.616	1.196	0	0	0.056	0.398	0.49	0.25		1.194
U05-82	1.077	0.61	0.467	0	0.197	0.059	0.083	0.122	0.031		0.492
U05-83	1.285	0.616	0.669	0	0	0.325	0.1	0.2	0.034		0.659
U05-84	1.729	1.301	0.428	0.001	0.015	0.03	0.068	0.193	0.098		0.405
U05-85	1.887	1.284	0.603	0.091	0.126	0.029	0.09	0.221	0.051		0.608
U05-87	1.991	1.309	0.682	0.105	0.29	0.094	0.62	0.097	0.026		1.232
U05-89	1.516	0.616	0.9	0.134	0.343	0.205	0.086	0.063	0.024		0.855
U05-90	1.262	0.619	0.643	0.016	0.154	0.264	0.094	0.121	0.017		0.666
U05-92	1.267	0.625	0.642	0.138	0.155	0.055	0.86	0.152	0.047		1.407
U05-93	1.52	0.615	0.905	0.039	0.097	0.284	0.19	0.199	0.064		0.873
U05-94	1.406	0.617	0.789	0.141	0.067	0.067	0.258	0.21	0.038		0.781

Appendix 2.3: Lake Rotokare – Sample analysis

Sampled Tephra Number (Rk-xx)	Tephra at depth (mm)		Proxy: graphic mean Grain size	Proxy: tephra thickness	Tephra thickness (mm)		Notes	
1	24		3	1	1		dispersed	
2	77		2	2	2			
3	104		2	3	4			
4	258		1	1	1.5			
5	339		2	2	3			
7	485		2	3	5			
8	734		3	3	7			
9	881		2	3	5			
12	1723		3	4	12			
13	2075		5	4	20			
14	2190		5	3	4			
15	2232		3	1	1.5			
16	2262		3	3	5			
17	2294		5	2	3			
18	2321		5	3	6			
19	2349		1	1	1.5			
20	2358		2	3	7			
21	2400		5	4	30			
22	2628		5	4	14			
24	2917		2	2	3			
25	3273		5	4	15			
26	3369		4	1	1			
27	3398		5	4	33			
29	3562		5	3	5.5			
30	3574		1	3	5			
31	3602		3	2	2.5			
33	3845		1	4	28			Rhyolite - Stent Ash
34	3872		2	3	5			in mud layer 72
36	4091		5	4	34			
37	4116		4	3	4			
38	4181		3	3	4			
39	4233		2	2	3			
41	4289		3	3	4			
42	4347		1	2	2			
43	4388		4	4	16			
44	4460		2	4	11			
45	4487		3	3	6			
46	4534		5	3	9			
47	4672		5	4	13			
48	4774		5	4	18			
49	4820		3	4	20			
50	4865		3	3	5			
			Range of graphic mean	Thickness Range				
			5=250-1000µm	4=>10mm				
			4=187.5-250µm	3=3.1-10mm				
			3=125-187.5µm	2=1.6-3mm				
			2=63-125µm	1=<1.5mm				
			1=<63µm					

Appendix 2.3 Lake Rotokare – Grainsize analysis

Sample	>1mm	500um<1mm	250<500um	125<250um	63<125um	<63um	sample weight
RK-1	0.000	0.000	0.008	0.016	0.015	0.003	0.042
RK-10	0.000	0.000	0.010	0.023	0.026	0.012	0.071
RK-11	0.000	0.000	0.012	0.013	0.016	0.001	0.042
RK-14	0.023	0.393	0.804	0.075	0.059	0.022	1.376
RK-15	0.000	0.020	0.012	0.027	0.045	0.019	0.123
RK-16	0.099	0.479	0.788	0.490	0.688	0.39	2.934
RK-17	0.120	0.772	0.416	0.054	0.148	0.059	1.569
RK-18	0.073	1.120	2.164	0.226	0.089	0.064	3.736
RK-19	0.000	0.000	0.013	0.020	0.033	0.028	0.094
RK-2	0.000	0.000	0.007	0.018	0.022	0.009	0.056
RK-20	0.169	0.533	0.298	0.256	1.043	0.626	2.925
RK-23	1.870	3.120	0.769	0.441	0.159	0.039	6.398
RK-24	0.000	0.000	0.012	0.018	0.020	0.003	0.053
RK-25	3.155	1.557	1.129	0.392	0.288	0.219	6.740
RK-26	0.062	0.130	0.099	0.065	0.109	0.049	0.514
RK-27	9.520	4.658	1.557	0.399	0.479	0.246	16.859
RK-28	0.000	0.000	0.000	0.060	0.061	0.009	0.130
RK-29	0.191	1.681	1.590	0.926	0.424	0.313	5.125
RK-3	0.000	0.006	0.006	0.008	0.017	0.001	0.038
RK-30	0.000	0.005	0.010	0.039	0.100	0.052	0.206
RK-34	0.000	0.000	0.032	0.140	0.124	0.055	0.351
RK-39	0.000	0.004	0.023	0.026	0.046	0.026	0.125
RK-4	0.000	0.000	0.003	0.009	0.019	0.017	0.048
RK-42	0.000	0.000	0.002	0.042	0.062	0.044	0.150
RK-44	0.000	0.000	0.178	0.728	0.987	0.799	2.692
RK-45	0.049	0.373	0.085	0.107	0.404	0.302	1.320
RK-46	0.388	0.005	0.020	0.030	0.049	0.032	0.524
RK-47	0.162	0.089	0.129	0.125	0.113	0.098	0.716
RK-49	0.000	0.152	0.503	0.297	0.265	0.102	1.319
RK-5	0.000	0.000	0.013	0.018	0.005	0.001	0.037
RK-7	0.000	0.000	0.007	0.012	0.017	0	0.036
RK-8	0.000	0.153	1.397	1.793	0.297	0.201	3.841
RK-9	0.052	0.128	0.375	0.643	0.552	0.52	2.270

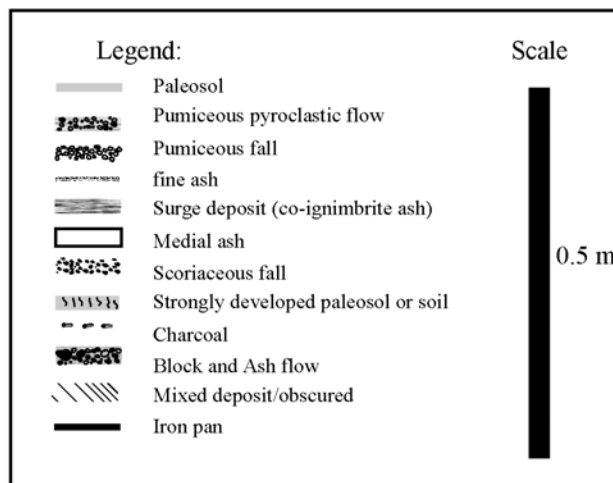
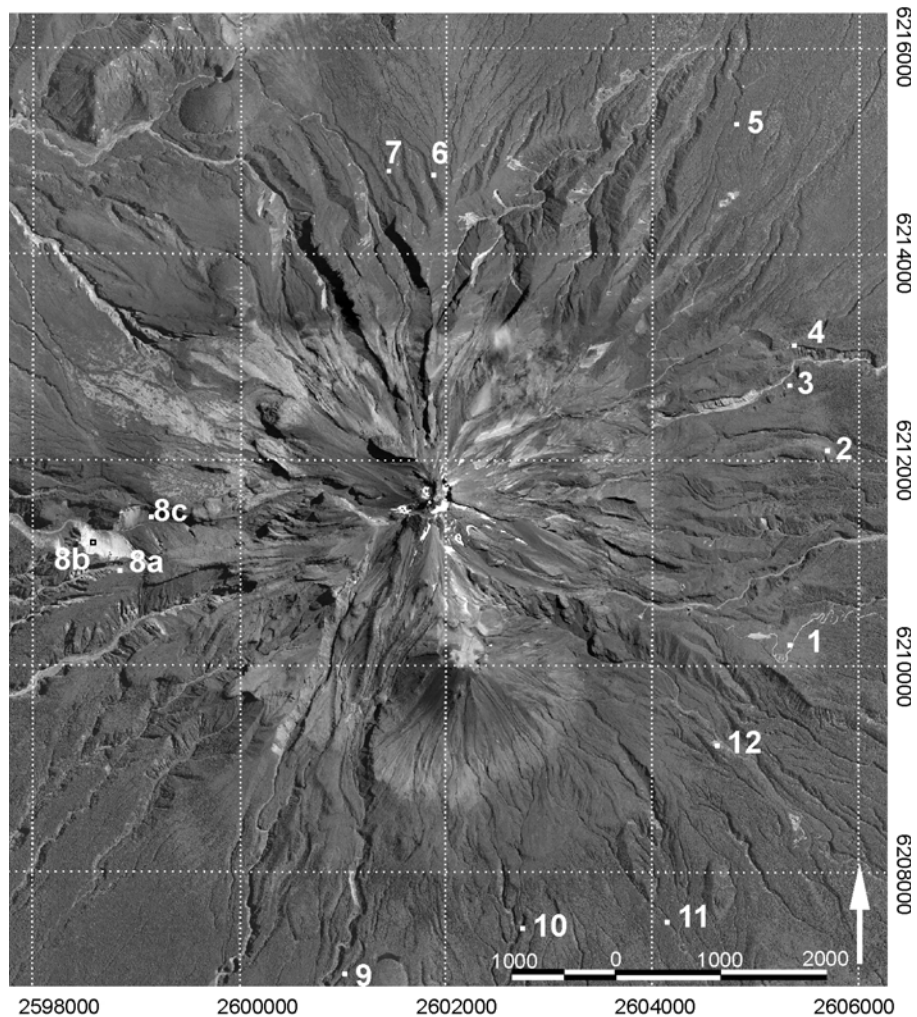
Appendix 2.4: Interpolated Tephra ages

Tephra no.	U05-xx	Umutekai	Rk-xx	Rotokare
1		1 1558.4 41.375		491.89 40.059
2		2 1631.4 30.969		497.2 37.854
3		3 1824.8 34.167		500.99 36.878
4		4 1843.7 34.037		536.12 33.052
5		5 1949.6 27.564		563.46 32.036
6	*	1998.3 28.583	7	627.17 31.358
7		6 2097.4 35.354	8	775.14 31.663
8		7 2236.8 23.954	9	883.35 31.826
9		8 2368.3 29.993	12	1722.8 26.907
10		9 2540.3 34.302	13	2141.5 25.07
11		10 2662.4 33.569	14	2307.4 24.108
12		12 2920.8 35.684	15	2378.6 23.739
13	*	2995.7 36.997	16	2431.8 23.628
14		13 3017.4 37.211	17	2490.1 23.708
15		14 3100.7 36.808	18	2540 23.952
16		15 3143.8 35.646	19	2592.2 24.372
17		16 3365.7 27.534	20	2609 24.541
18		17 3393.5 29.049	21	2687 25.492
19		18 3433.5 31.751	22	3050.5 28.462
20		19 3456.8 33.222	24	3370.3 25.243
21		20 3507 34.731	25	3673.7 34.532
22		21 3631.7 33.03	26	3732 30.745
23		22 3665.1 33.996	27	3747.3 29.085
24		23 3690.6 35.663	29	3806.1 27.293
25		24 3721.7 38.752	30	3809.2 27.671
26		25 3728.4 39.543	31	3816.6 28.797
27		26 3919 58.46	33	3919.7 56.417
28		27 3927 58.523	34	3953 59.114
29		28 4020.3 52.375	36	4655.6 30.199
30		29 4116.2 40.268	37	4718.2 30.891
31		30 4170.6 35.184	38	4878.8 33.316
32		31 4247.4 33.551	39	5004.6 35.567
33		32 4311.1 36.241	41	5137 37.904
34		33 4345.9 38.358	42	5270.2 39.886
35		4370.1 39.849	43	5361.6 40.862
36		34 4400.4 41.634	44	5515.9 41.49
37		35 4410.7 42.221	45	5571.5 41.336
38	*	4434.6 43.512	46	5665.2 40.574
39		36 4507.3 46.935	47	5914.4 36.688
40		37 4536.8 48.101	48	6070.3 39.773
41		38 4565.5 49.123	49	6131.8 45.901
42		39 4585.5 49.772	50	6186.2 55.319
43		40 4642.7 51.353	*	*
44		41 4753.3 53.435	*	*
45		42 4834.6 54.295	*	*
46		43 4867.2 54.509	*	*
47		44 4960.3 54.783	*	*
48		45 5037.2 54.7	*	*
49		46 5111.9 54.415	*	*
50	*	5206.5 53.847	*	*
51		47 5228.9 53.688	*	*

Tephra no.	U05-xx	Umutekai	Rk-xx	Rotokare
53		49 5353.3 52.706		*
54		50 5585.7 50.876		*
55		51 5633.5 50.568		*
56		52 5914 49.67		*
57		53 5966.9 49.708		*
58		54 5995.5 49.757		*
59		55 6015.3 49.803		*
60		56 6074.8 49.998		*
61		57 6081.4 50.025		*
62		58 6110 50.152		*
63		60 6223.9 50.832		*
64		59 6315.4 51.548		*
65		61 6609.3 54.345		*
66		62 6663.2 54.843		*
67		63 7068.7 56.375		*
68		64 7126.9 56.103		*
69		65 7204.7 55.672		*
70		66 7251.7 55.376		*
71		67 7359.6 54.59		*
72		68 7395.4 54.296		*
73		69 7449 53.828		*
74		70 7630.3 51.993		*
75		71 7690.3 51.302		*
76		72 7711.5 51.05		*
77		73 7872.8 48.986		*
78		74 7911.2 48.462		*
79		75 7932.1 48.172		*
80		76 7942.5 48.027		*
81	*	8039.6 46.642		*
82		77 8100.1 45.761		*
83		78 8129.3 45.332		*
84		79 8156.9 44.929		*
85		82 8257.9 43.459		*
86		80 8285.2 43.07		*
87		81 8353.3 42.126		*
88	*	8739.4 38.601		*
89	*	8787.5 38.547		*
90		83 8851.8 38.673		*
91		84 8917.6 39.06		*
92		85 8969.9 39.571		*
93		86 9126 42.263		*
94		87 9179.3 43.599		*
95		88 9221.1 44.801		*
96	*	9278.8 46.677		*
97		89 9347.4 49.232		*
98		90 9407.8 51.765		*
99		91 9606.1 61.871		*
100		92 9693.3 67.134		*
101		93 9911.8 82.371		*
102		94 10012 90.306		*
103		95 10093 97.175		*
104	*	10141 101.4		*

Appendix 3: Edifice Stratigraphy

Appendix 3.1: Section location map



Appendix 3.2:

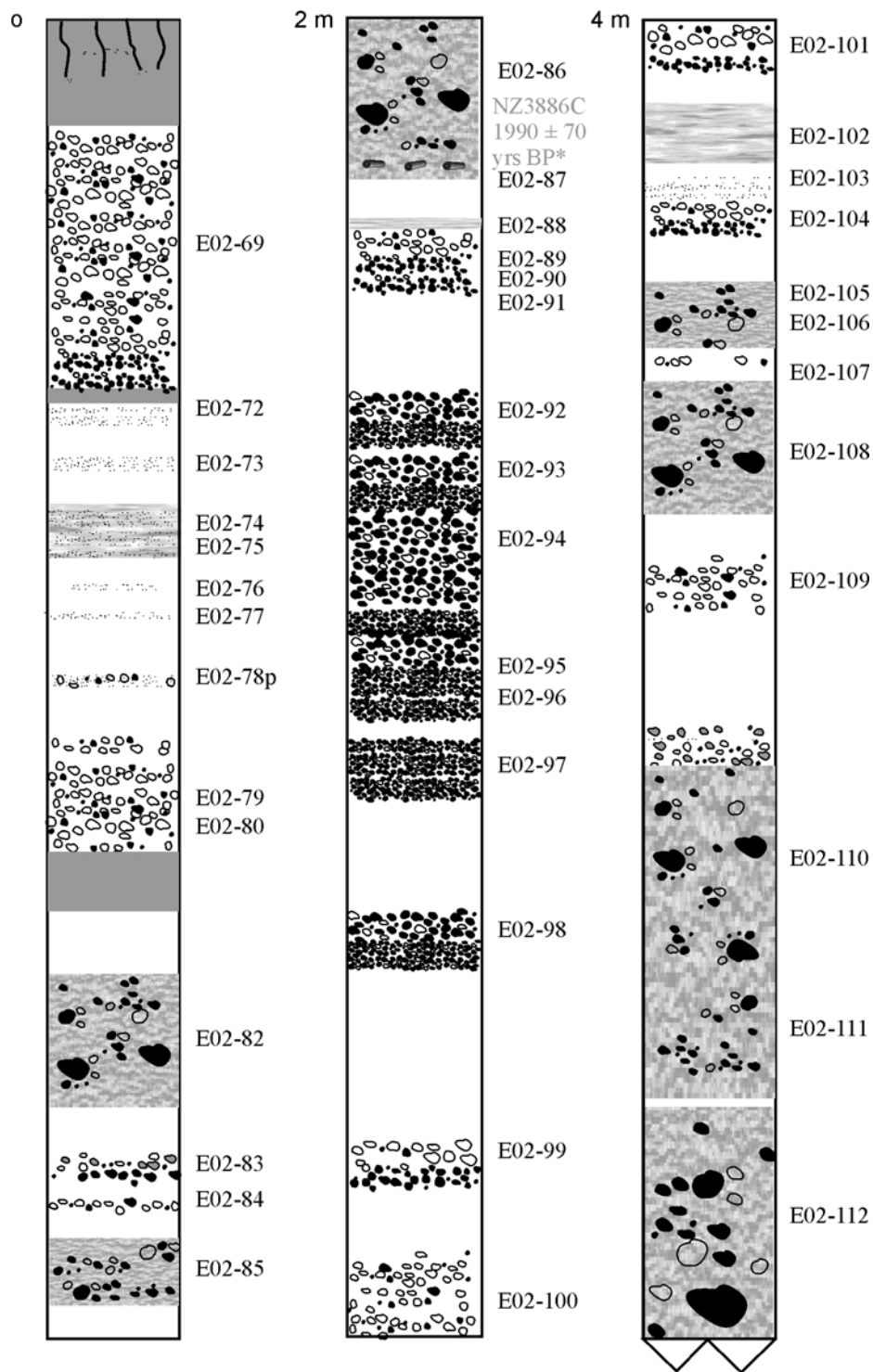
Section 1 Pembroke Road

N621 0180

E260 5200

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
180			Dark brown silt loam (<i>current soil</i>)
390	E02-69		Pale brown and pale yellow brown reverse graded fine-med to med-coarse pumice lapilli. Rare grey lithic lapilli.
30			Brown silt loam (<i>paleosol</i>)
10-45	E02-72		Pale grey fine-med ash, pocketing and lensing, with wavy cross-bedding and planar bedding on a mm scale
30			Greyish brown silt loam (<i>m-ash</i>)
20-40	E02-73		Pocketing pale grey shower-bedded fine-med ash
40			Brown silt loam (<i>m-ash</i>)
30-40	E02-74		Pocketing grey med ash
5-40	E02-75		Pocketing pale brown very fine ash
70			Greyish brown gritty silt loam with iron staining in 1 cm
10	E02-76		Pocketing pale brownish grey fine ash
100			Greyish brown greasy silt loam (<i>m-ash</i>)
10	E02-77		Pocketing pale brown fine ash
70			Greyish brown greasy silt loam (<i>m-ash</i>)
10	E02-78		Single layer of pale grey and pale brown pumice and lithic fine lapilli
30-40			Greyish brown greasy silt loam (<i>m-ash</i>)
110-200	E02-79		Pale brown and yellow brown med pumice lapilli, rare grey lithic lapilli (5%)
	E02-80		
130			Dark brown silt loam (<i>paleosol</i>)
200	E02-82		Bedded (laminated, cm-scale) monolithic diamicton; dark grey andesite clasts.
70			Dark brown silt loam (<i>paleosol</i>)
60	E02-83	1800	Pumice and grey andesite clasts. Approximately 15% black scoria.
30			Yellow-brown silt loam (<i>m-ash</i>)
40	E02-84		Yellow-brown pumiceous fine lapilli.
40			Yellow-brown silt loam (<i>m-ash</i>)
100	E02-85		Massively bedded, grey andesite diamicton
50			Brown silt loam (<i>m-ash</i>)
250	E02-86		Normally graded, grey andesite diamicton. Med ash matrix.
	E02-87		Pink med ash at the base. Contains charcoal.
60			Brownish yellow silt loam (<i>m-ash</i>)
10	E02-88		Grey fine-med ash (surge)
100	E02-89		Reversely graded pumiceous fine-med lapilli.
	E02-90		
	E02-91		
150			Brown silt loam (<i>m-ash</i>)
530	E02-92	3000	Shower bedded (cm-scale) black scoria lapilli. 5 distinct sub-units (sampled)
	E02-93		
	E02-94		

	E02-95		
	E02-96		
60			Brown silt loam (<i>m-ash</i>)
90	E02-97		Shower bedded (cm-scale) black scoria fine lapilli
150			Yellow-brown silt loam (<i>m-ash</i>)
150	E02-98		Reversely graded black scoria fine-medium lapilli
200			Yellow-brown silt loam (<i>m-ash</i>)
50	E02-99		Reversely graded pumiceous fine lapilli
90			Yellow-brown silt loam (<i>m-ash</i>)
200	E02-100	3700	Yellow-brown pumiceous lapilli, Two sub-units 90-100 mm
	E02-101		thick each. Basal unit reversely graded. Top unit normally
			graded.
40			Sandy yellow silt loam (<i>m-ash?</i>)
100	E02-102		Well sorted, med ash-fine lapilli. Polyolithic
40	E02-103		Light grey andesite and yellow pumice, med ash, laminated
			(mm-scale) some cross bedding (surge)
80	E02-104	3800	Reversely graded pumiceous fine-medium lapilli
80			Brown greasy silt loam (<i>m-ash</i>)
100	E02-105		Poorly sorted diamicton. Grey andesite clasts in med ash matrix
	E02-106		
100	E02-107		Single line of pumice and grey andesite lithics within yellow-
			brown silt loam (<i>m-ash</i>)
200	E02-108		Poorly sorted diamicton. Grey andesite clasts in med ash matrix
80			Brown-greyish silt loam (<i>m-ash</i>)
100	E02-109		Pumiceous fine-medium lapilli
160			Brown silt loam (<i>m-ash</i>)
	E02-110		Diffusely bedded (50 cm each sub-unit) grey andesite
	E02-111		diamicton. Clasts d max 20 cm in med ash matrix.
	E02-112		



* Date from: Neall and Alloway, 1986

Appendix 3.3:

Section 2: Waipuku Section

E260 5496
N621 2007

The top 30-50 cm is not well preserved.

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
110			Pumice med lapilli preserved within the current root system of the top soil. Pumice d-max 3.5cm Lithics d-max: 1.7cm
20			Dark brown silt loam (<i>paleosol</i>)
10-20			Yellow medium ash, lensing and pocketing
10			Greasy brown silt loam (<i>paleosol</i>)
80			Light grey base up to dark grey top, fine to med ash.
10			Brown silt loam (<i>paleosol</i>)
50-80			Lensing pumiceous lapilli. Pumice d-max 4cm, modal 2.5cm. lithic d-max: 1.5cm
40-60			Dark brown, greasy silt loam (<i>paleosol, not well preserved</i>)
80			Shower bedded (mm-scale) dark black med ash and coarse ash, rare pumice and lithic clasts 0.5-1cm 0.5cm layers of fine-med yellow ash
160			Dark brown silt loam. <i>Well developed paleosol</i> 2cm -p-sol 1cm pinkish med ash with pumice clasts (0.5cm) 2cm p-sol 1cm single line of pumices 10cm p-sol
160			Reversely graded base, normally graded top. Pumice and lithic p-flow. Matrix is a fine pumiceous yellow ash (turned to a silt loam). Top 6cm contains d-max: 2cm pumices. Lower 6cm mainly matrix ash only. Middle section contains the mostly lithics.
5			Iron pan
60	M05-51		Shower bedded (cm-scale), dark grey to black andesite, coarse ash-fine lapilli. Rare pumices 4cm (clasts d-max 3cm)
10			Dark grey to purplish pink fine-med ash
5-10	M05-52		Dark grey (almost black) med-coarse ash
270	M05-53		Scoriaceous dark grey lapilli, normally graded from clasts 3.5cm to 0.5cm. Predominately dark grey clasts with distinctive large hornblende phenocrysts. 2-5% red clasts (hydro-alt?) 5% grey
10			Yellow-brown, sandy loam (<i>m-ash</i>)

10			Grey (slightly purple) pocketing coarse ash
25			Sandy, brown loam (<i>m-ash</i>)
35cm			80% dense grey lithics (d max: 1-2cm) and yellow pumices (d max: 2.5cm) within a pinkish/grey ash coarse ash matrix.
20			Grey coarse ash with rare andesite clasts, (d max: 0.5cm - grey dense andesite)
5			Pink fine-med ash
35	M05-54		Grey to purple-pink med-coarse ash containing pumices and lithics (d max: 2cm)
50-80	M05-55 M05-56 Charcoal		Graded, monolithic diamicton; grey sugary andesite clasts (almost pumice-like), semi-rounded containing large plagioclase phenocrysts. Middle clast ~2cm. Charcoal bearing.
40			Dark brown greasy silt loam (<i>well developed paleosol</i>) <i>Wavy, erosion contact</i>
160	M05-57		Normally graded, black to lightly brown (d max: 2cm) scoria rich. Similar to above unit (sample M05-53) except the clasts do not contain large hornblende phenocrysts. Also there are more red and grey (Fantham peak type lava?) lithics (i.e. lava clasts with large plagioclase and clinopyroxene phenocrysts. Phenocryst 20mm in length)
20:			Coarse grey ash
160	M05-58		Shower bedded (cm-mm scale) coarse ash to fine lapilli (d max: 1cm clasts) clasts appear to be denser than overlying scoriaceous sub-unit.
80			Normally graded med-coarse lapilli. Similar clasts to those of sample M05-57.
200			Shower bedded fine lapilli similar to clasts of sample M05-58
20			Fine ash – yellowish base
40			Dark brown, greasy silt loam (<i>well developed paleosol</i>)
120	M05-59		Reversely graded fine-med lapilli. Dark grey to black (d: 2cm) scoriaceous clasts. Clasts contain large hornblende phenocrysts. 2% red lithics, rare dense grey lithics
50			Brown-grey, coarse ash (Possibly poorly developed paleosol)
70			Coarse-fine lapilli, brown-black clasts.
5			iron pan
250	M05-60 M05-60b Charcoal		Lensing fine-med ash matrix p-flow. Mixture of pumices and grey andesite clasts. Normally graded and charcoal bearing
100			Pumiceous grey, med ash (basal ash)
80			Yellow-brown sandy loam (<i>medial ash-paleosol</i>)
550	M05-61	3100	Reversely graded pumice fall deposit. 5% monolithic lithics: angular, radially fractured grey andesite Pumice d-max: 9cm. Lithic modal: 3cm Pumice d-max: 20cm. modal: 14cm. Lithics d-max: 6cm modal: 4cm
140	M05-62		Lensing pumiceous coarse ash matrix p-flow. 80% monolithic angular grey andesite, d max: 10cm modal 1-2cm
5			Iron pan
120	M05-63		Grey coarse-fine ash. Not well sorted, contains rare pumices and lithic d max ~3cm near the middle of the

20			unit
~1000			Iron pan
			Pumiceous fall deposit. Largely shower bedded, < 5% light grey andesite lithics, angular and radially fractured. 19cm pumices modal: 3.5cm, max: 5cm. Lithics modal: 1cm max 1.8cm
			50cm reversely graded with no/very rare lithics. Pumice d max: 20cm (top) lithics d max: 4cm (top). Pumice d max: 3cm (base) lithics d max 1cm (base)
			+30cm reversely graded pumice med lapilli
1000			<i>Outcrop covered by vegetation.</i>
300			Pumice lapilli (lower most fall deposit to large pumice unit described above?). Basal 5cm: Coarse pumiceous ash.
20			Yellow-brown, sandy loam (<i>m-ash?</i>) possibly continuous; part of the same eruption
30			Pinkish-grey medium ash
220	M05-65		Pumiceous, coarse ash matrix p-flow. Coarser at the base and at the top of the unit, grey andesite at the base (modal: 2.5cm) and pumice at the top (modal: 2cm)
80			Sandy, yellow medium ash
150	M05-65b charcoal		Coarse, grey slightly purple ash, charcoal bearing.
80			Brown, greasy silt loam (<i>paleosol</i>)
380	M05-66		Pumiceous fall unit. Non-graded, slightly more lithics at the base (5%). Pumice d-max: 4.5cm-8cm. Lithics d-max: 2.5cm. Sits on 1.5cm of medium grey ash
80			Brown, greasy silt loam (<i>Paleosol</i>)
190	M05-67	3800	Reversely graded, not well sorted p-flow/fall? Contains 20% sugary/steely grey ~8cm. Pumices are notable hornblende phenocrystic rich. Matrix is coarse ash/fine pumiceous lapilli. Large lithic (~20cm) lying on its axis within the unit.
50			Dark brown, greasy silt loam (<i>paleosol</i>)
80			Pumiceous fall. Pumices d-max: 3cm. Lithics d-max: 1.6cm. 5-8% lithics mainly at the base of the unit. Lithics are monolithologic; dense grey andesite.
30			Brown, greasy silt loam (<i>Paleosol</i>)
80			Pumiceous unit; pumices lying on long axis. Pumice d-max: 2cm. Lithics monolithologic, dense grey-dark grey andesite. Lithic d-max: 0.5-1cm.
10			Grey creamy fine-medium ash
25			Wavy coarse dark grey ash with an orange lower contact (iron staining)
50			Lensing fine lapilli. Not well sorted with pumices up to 2cm. lithics seemingly monolithologic
25			Sandy brown loam (<i>m-ash</i>)
10			Lensing grey, medium ash
40			Sandy brown loam (<i>m-ash</i>)
20			Pumice p-flow unit. Monolithologic lithics at the base (<0.5cm) dense grey andesite. Pumices up to 1.5cm near the top
25			Dark brown, greasy silt loam (<i>Paleosol</i>)
20			Grey medium ash

20			Sandy brown loam (<i>m-ash, not well developed paleosol</i>)
40			Grey, purplish med-coarse ash
10			Sandy yellowish grey loam (<i>m-ash</i>)
10			Grey medium ash
10			Greasy brown silt loam (<i>paleosol</i>)
15			Grey medium ash
20			Sandy yellow-brown loam (<i>m-ash</i>)
80			Pumice fall unit, massive. Pumice d-max: 4cm. polyolithologic lithics d max1-2cm - mixture of light grey and darker grey andesite.
150			Brown, silt loam (<i>well developed paleosol</i>) with a; Pocketing grey med-fine ash at 5cm and one at 10cm
20			Purplish grey medium ash
20			Brown, sandy loam (<i>m-ash</i>)
80	M05-68		Coarse, dark grey ash to fine lapilli. BAF co-ig ash? Sits on 2cm of fine pinkish ash
60			Dark brown sandy loam (<i>paleosol</i>)
80			Pumiceous fall unit. 10% monolithologic, dense crystalline grey lithics, d-max: 1.5cm. Pumices d-max: 3.5cm
30			Sandy brown silt loam (Pos. not a paleosol?)
20			Purplish grey medium ash (pocketing)
40			Sandy brown loam (<i>m-ash/paleosol?</i>)
120	M05-69	4600	Reversely graded pumice and lithic p-flow. Basal 8cm; 60% lithics and 40% pumice fine lapilli. Matrix throughout is a coarse pumiceous ash. Lithics are monolithologic, dark grey andesite, dense and not very phenocrystic rich. Top 4cm contain ~70% pumices (floated) with distinctive banded pumices; modal 4-5cm in diameter.
40			Dark brown, sandy loam (<i>paleosol</i>)
80			Medium-coarse grey/purplish ash. Not well sorted
60			Dark brown silt loam (<i>paleosol</i>)
270			Cm bedded flow unit, containing anti-dunes. Matrix is a coarse grey and pumiceous ash. Mixture of clasts, but only a few pumices. Clasts lying on long axes; 1cm wide and up to 5cm long.
20			Brown, sandy loam (<i>m-ash</i>)
20			Grey, medium ash
20			Brown, sandy loam (<i>m-ash</i>)
20			Grey, medium ash
20			Brown, sandy loam (<i>m-ash</i>)
150	M05-70	5100	40-60% monolithologic lithics at the base, slightly grey, dense andesite. D-max: 2cm. pumices abundant at the top, d-max: 3.8cm
50			Sandy to greasy dark brown loam (<i>paleosol</i>)
100			Pumiceous and coarse grey ash matrix p-flow. Polyolithic clasts of sugary grey andesite to hydrothermal. ~40% hydrothermally altered clasts/iron stained. 1-2cm d-max.
120	M05-71		Grey bedded coarse-fine ash (mm-scale). Slightly pinkish in colour. Lenses of fine lapilli, monolithologic; plagioclase rich, dark grey to black, angular andesite.
30			Greasy, brown silt loam (<i>paleosol</i>)
80			Yellow-brown sandy loam (<i>m-ash?</i>)
30			Dispersed polyolithic clasts within medial yellow ash, d- max: 1cm
50			Yellow-brown sandy loam (<i>m-ash or part of the deposit?</i>)

150			Lensing gravely, polyolithic deposit. Clasts lying on their axis, reversely graded from <0.5cm to clasts 4-5cm. clasts of sugary grey, red and dark grey, dense andesite, although ~75% are the more 'typical' plag-rich, darker grey andesite.
30			Dark brown, sandy loam (<i>paleosol</i>)
20			Grey med-coarse, poorly sorted ash
35			Sandy brown silt loam (<i>m-ash</i>)
10			Dark brown silt loam (<i>paleosol</i>)
120	M05-72		Bedded (mm-cm scale), fine-coarse as, purplish grey at the base to pink and yellow coarser beds at the top.
30			Sandy brown loam (<i>m-ash</i>)
50			Coarse, light grey ash
90			Well developed greasy brown paleosol. (<i>paleosol</i>)
10-40			Pocketing/lensing grey medium-coarse ash
80			Shower bedded (cm-scale) medium-ash-fine lapilli. Mainly grey andesite, fine layers are slightly pink.
140			Well developed greasy brown paleosol with (<i>paleosol</i>) with: Single line of lithics at 5cm depth. Pocketing yellow fine ash at 10cm depth
20			Almost single line of monolithic grey andesite clasts (0.5-1cm diameter clasts)
10			Continuation of well developed paleosol (<i>paleosol</i>)
5			Pocketing, grey medium ash.
40			Sandy yellow-brown loam (<i>m-ash</i>)
5-10			Lensing pinkish-grey medium ash.
10			Sandy brown loam (<i>m-ash</i>)
10			Lensing purplish grey medium ash
10			Brown sandy silt loam
5-10			Coarse grey ash with <0.5cm pumices
80			Brown, greasy silt loam (<i>paleosol</i>)
90			Bedded (mm-scale) fine-medium ash. Layers of pink (fine ash) and grey (med ash)
50			Sandy brown silt loam (<i>m-ash</i>)
20			Pinkish coarse ash with fine 0.5cm sized lapilli top
50	M05-73 charcoal?		Sandy grey/brown med-coarse ash with possible charcoal
120			Gravely, possibly flow unit, comprised of 70% angular dark grey andesite. Also contains pumices and sugary grey andesite (d-max: 2cm) medium grey ash matrix. Shows cm bedding
20			Line of 'bright' yellow/white pumices, d-max: 0.8cm
110	M05-74	7100	Normally graded (possibly fall) pumiceous unit. Pumices are yellow to white with a d-max; 6 cm, modals 2.5-3cm. Contains ~40% monolithic dark grey, plagioclase phenocrystic rich andesite
30:			Grey to red, coarse ash
10			Grey fine-medium ash
10			Sandy brown loam (<i>paleosol</i>)
5			Single line of grey angular lithics
40			Sandy brown loam (<i>m-ash</i>)
30			Yellow to grey medium ash
20			Sandy yellow-brown loam (<i>m-ash</i>)
100			Pumiceous p-flow. Medium pumiceous ash matrix. 30% polyolithic lithics. Beds of medium grey ash.

60		Greasy brown silt loam (<i>paleosol</i>)
70		1cm: almost a single line of pumices and lithics, d-max 1cm
		1cm: Purplish/red fine-medium ash
		4cm: Normally graded, 50/50 pumice and lithic unit. Poorly sorted
		1cm: grey medium ash
30	M05-75	Brown, greasy silt loam (<i>paleosol</i>)
280		Pumiceous flow unit. Pumices d-max: 4cm. 25% monolithic 'typical' grey andesite, d max: 2.5cm, modal 1cm. lower 15cm could be fall with lithics 1.5cm, pumice 3cm
60		Sandy brown silt loam (<i>m-ash</i>)
10		Purplish medium ash
20		Sandy brown silt loam (<i>m-ash</i>)
240		Grey, medium ash. Reasonably well sorted, containing lenses of coarse ash to fine lapilli of sugary grey andesite.
30		1cm diameter pumices dispersed within a greasy silt loam (<i>paleosol/m-ash</i>)
320	M05-76	Shower bedded pumiceous fall. Pumices ~3cm, lithics 0.5cm. Monolithic lithics, dense almost black andesite. Sits on 0.5cm grey ash
30		Dark brown, greasy silt loam, well developed paleosol (<i>Paleosol</i>)
>40		Gravely, pumiceous flow unit.
Break in Section		Once again this outcrop covered by vegetation. However next part of the section is exposed to the west of the section just described. Thus I believe this description is continuous
160		Gravely fine lapilli flow unit. Containing a medium-coarse ash, pumiceous matrix and angular grey andesite (<1cm diameter)
50		Slightly yellow silt loam with distinctive rootlets highlighted by the incorporating grey ash from the underlying unit.
5		Grey med-fine ash
10		Yellow coarse-fine pumiceous lapilli
50:		Yellow medium/sandy ash (poorly sorted)
100-		: lensing pumiceous fall. Not well exposed. Pumices ~3.5cm light, almost white pumices). 10% monolithic, 'typical' Burrell like lithics; d-max: 1.5cm
200		Basal 2cm: yellow, pumiceous medium ash
50		Grey, coarse ash with 0.5cm pink fine ash base.
90		Mottled and iron stained grey medium ash (<i>m-ash/paleosol?</i>)
90		Highly iron stained very mottled red/yellow ash (<i>m-ash/paleosol?</i>)
60	M05-77	Coarse grey ash with a fine ash, pink top 0.5-1cm thick
50		Reddy brown sandy loam (<i>m-ash</i>)
150		Purplish grey medium ash, seemingly quite massive (well sorted)
40		Sandy brown loam (<i>m-ash/paleosol</i>)
15		Line of pumices and lithics (rounded).
40		Grey-purplish medium ash
20		Line of lithics and pumices
160		Dark grey, medium-coarse ash. Line of finer pinker ash

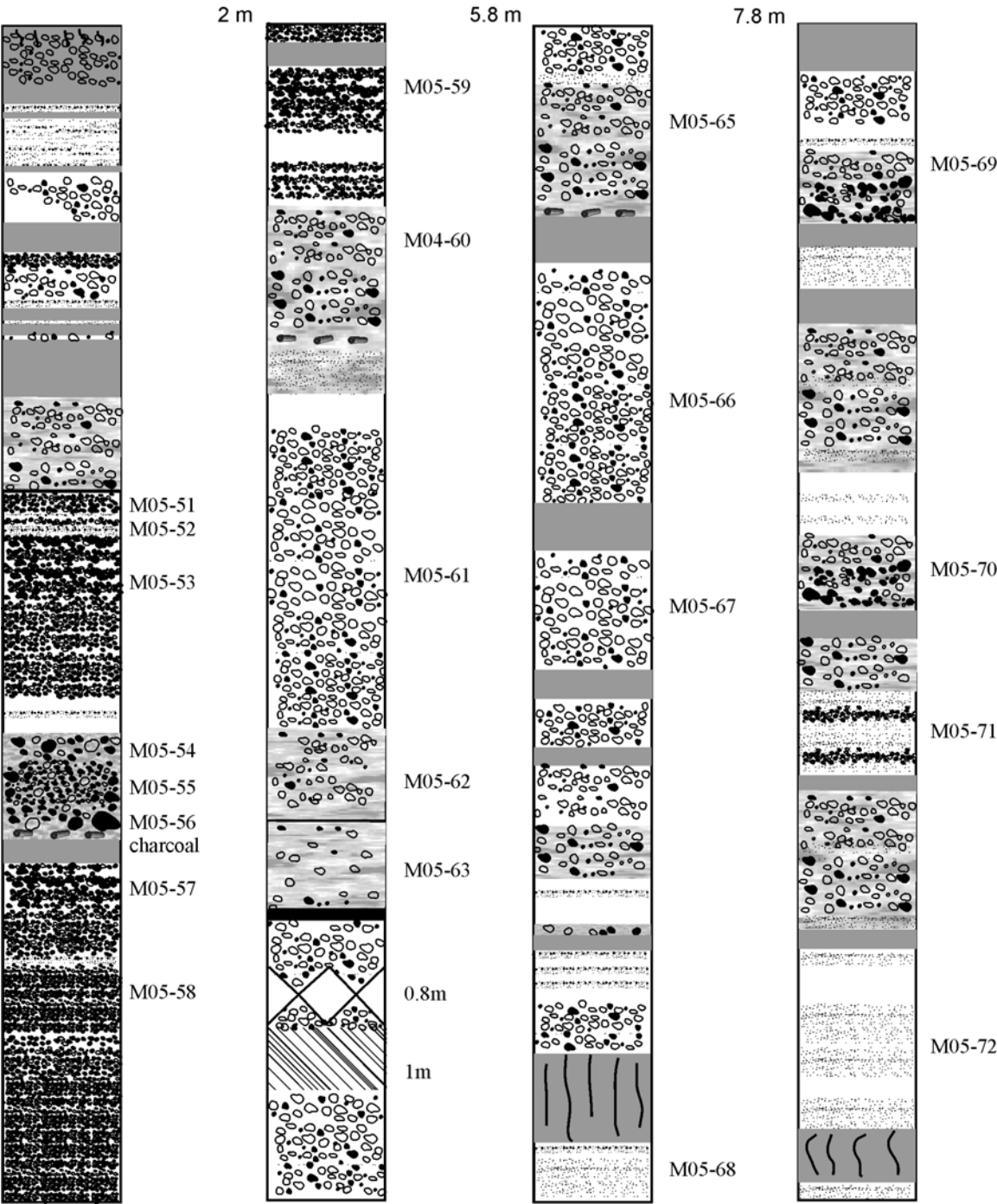
			~2cm at the base. Also darkest in the middle of the sub-unit
>40			Pumiceous fall highly iron stained. Pumices rounded with a d-max: 2cm. Lithics, typical grey andesite with a 0.5-1cm.
2.5m Break in Section			Section covered by vegetation for 2-2.5m. Then there is a very “fresh” looking pumiceous fall. Probably younger pumiceous fall deposited on a ledge in the outcrop.
120			<i>Unconformity</i> Gravely pumiceous p-flow. Silt/fine ash matrix.
100			Poly lithic clasts with some pumices 3cm, most <0.5m
10			Brown sandy-silt loam, with rare unevenly dispersed pumices ~0.5cm d (<i>paleosol/m-ash</i>)
3cm			Lensing coarse grey ash
100-250	M05-78	7900	Sandy brown loam (<i>m-ash</i>) Lensing p-flow with large block sized lithics and pumices near the base ~8-9cm Diameter. Normally graded into a 0.5cm-fine/medium lapilli. Unsorted pumiceous and lithic unit
70			Brown silt loam (<i>paleosols</i>)
130			Medium grey ash with molted iron staining.
20			Brown greasy silt loam (<i>paleosol</i>)
5-20			Pocketing grey medium ash (within paleosol)
60			Brown, greasy silt loam (<i>paleosol</i>)
60			Pocketing grey, medium ash with fine pink ash at base.
40			Brown/yellowish sandy loam (<i>not well defined p-sol?</i>)
120			Pocketing, mm bedded med-fine ash
20			Sandy brown loam
200	M05-79:		Pumiceous p-flow unit, 1-2cm lithics and clasts with a coarse pumiceous ash matrix. 3 flow units separated by 2cm fines sub-unit. Lithics 1cm. pumices ~3cm
30			Yellow brown silt loam (<i>m-ash/paleosol</i>)
20			Medium-coarse grey ash
10-50			Yellow/brown silt loam (<i>m-ash/paleosol</i>)
30			Medium grey ash
160			Molted and iron stained yellow/brown silt loam (<i>m-ash/paleosol/loess</i>)
10			Single line of sugary, almost pumiceous clasts, clasts are angular.
80			Molted and iron stained yellow/brown silt loam (<i>m-ash/paleosol/loess</i>)
5			Single line of sugary grey clasts
40			Iron molted silt loam (<i>m-ash/paleosol/loess</i>)
50			Medium grey/brown ash
510			Iron molted silt loam, indistinguishable tephras (<i>m-ash/paleosol/loess</i>)
50			Coarse ash to fine lapilli. Iron stained containing sugary grey andesite clasts, 0.5cm diameter.
40			Iron molted silt loam (<i>m-ash/paleosol/loess</i>)
520	M05-81		Almost massive creamy grey to slightly pink fine ash. Containing very rare white phenocrystic rich pumice clasts 2cm in diameter. <i>podsol?</i>
40			Well developed/solid iron pan.
10			Grey coarse ash.
120-	M05-80	9100	Lensing scoriaceous (black/dark grey) fall unit. 30%

180		grey, phenocrystic rich, andesite lithics. Reversely graded 2.5cm up to d max: 5cm clasts
40		Sandy yellowish silt loam (<i>m-ash</i>)
50		Pinkish grey medium ash
40		Sandy yellow-brown loam (<i>m-ash/paleosol</i>)
60		Pumiceous fall unit with lithics dominated at the base of the section. Monolithic grey andesite d-max 1.5cm, Pumices 2.5cm
70		Sandy brown loam
40		Lensing grey coarse ash, with a fine ash 1cm top.
20		Greasy brown sandy loam (<i>paleosol</i>)
20		Single line of yellow pumices
80		Sandy yellow/brown loam (<0.2cm) pumices and lithics throughout. (<i>m-ash</i>)
25		Grey coarse ash with 0.5cm fine ash top.
30		Sandy brown loam (<i>m-ash/paleosol</i>)
20		Purplish grey, medium ash
15		Sandy brown loam (<i>m-ash</i>)
20		White pumices and stealy grey lithics 0.5cm-1.5cm. Almost exists as a single line.
20		Grey coarse ash
20		Grey to pinkish medium coarse ash.
50		Lensing pumiceous fall deposit pumices. Yellow ~d-max 2cm. lithics, typical grey 0.5cm d-max.
60		Brown silt loam (<i>paleosol</i>)
20-80		Lensing grey and pinkish ash, mm bedded wavy contacts (wind dispersed) i.e. loess?
150		Brown silt loam (<i>paleosol</i>)
20		Almost single line of yellow pumices ~1.5-2cm. very weathered.
10		Silt loam (<i>m-ash</i>)
30		Purplish grey medium ash.
30		Brown silt loam (<i>paleosol</i>)
20		Lensing yellow/grey fine ash
20		Brown silt loam (<i>paleosol</i>)
10		Yellow-pinkish grey, fine ash
170	M05-82	Reversely graded pumiceous fall deposit. Lowermost 5cm is in a fine lapilli/coarse ash of mostly pumiceous origin. Grades up to 4cm pumices and grey dense andesite ~2cm d-max
50		Brown silt loam (<i>paleosol</i>)
30		Medium grey ash
30		Brown silt loam (<i>paleosol</i>)
40		Almost single line of 3-5cm grey pumices and lithics
50		Sandy brown loam (possibly same as over-and-underlying units. i.e. sub-unit?)
40		Bright yellow, very weathered pumices. Some up to 7cm diameter. Lithics 10% 2cm.
20cm		Greasy brown silt loam (<i>paleosol</i>).
80-120		Very yellow pumiceous fall deposit. Lensing. Very few lithics (<2%). Coarse pumiceous ash at the base.
10		Iron pan
80		50/50 pumice and lithic unit. Lithics are dark grey to black/ very steal grey. Lithics concentrated near the base.
280	M05-83	Well sorted 60% lithic unit. Almost shower bedded with

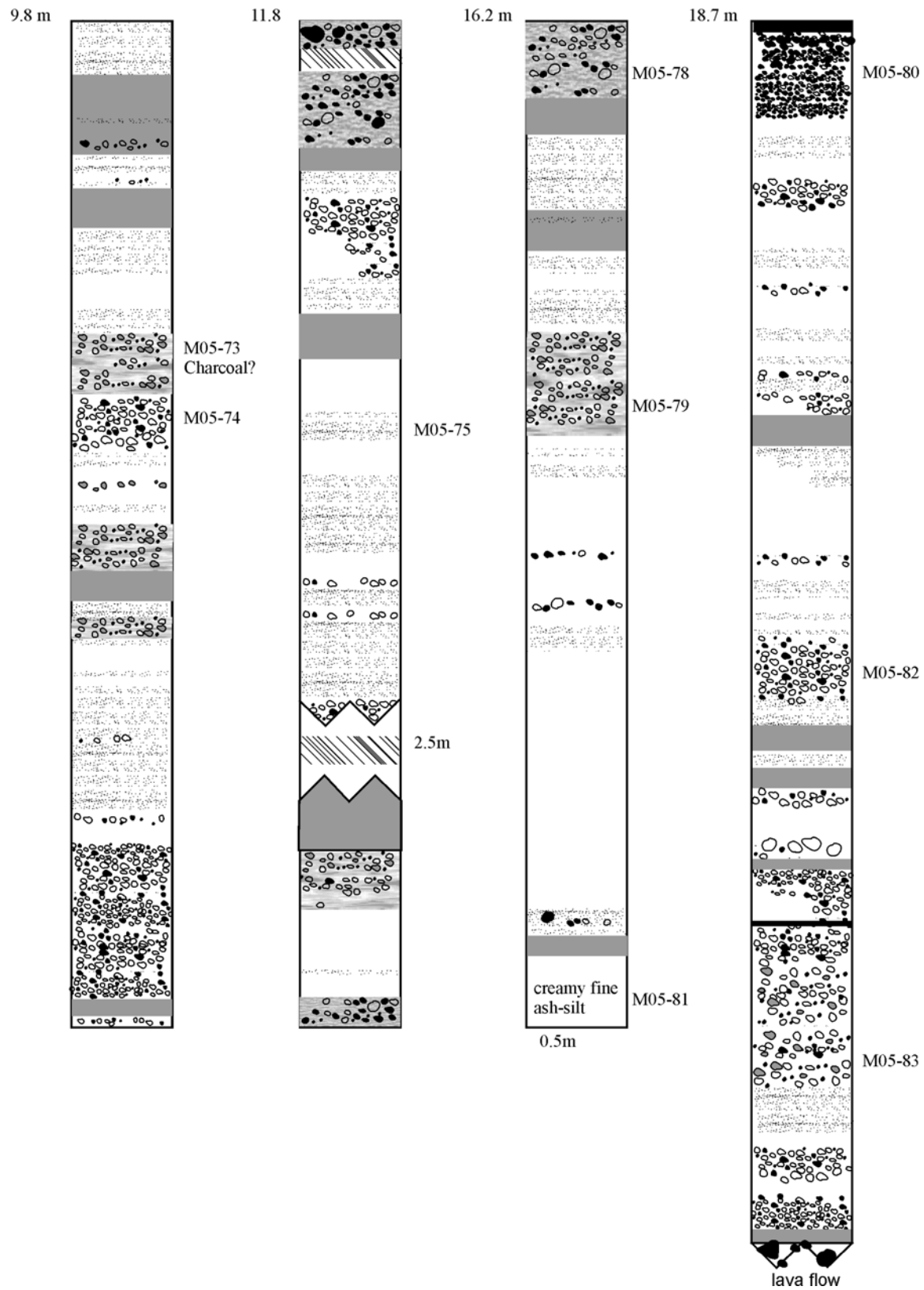
	40% pumices. Some lithics and pumice 4cm most 1.5-2cm. Almost scoriaceous clasts
100	Coarse ash, purplish base with rare 2cm lithics
20	Sandy yellow medium ash
100	2-2.5cm yellow pumices and 5% lithics.
20	Coarse ash, brown-yellow.
80	Yellow pumices 1-1.5cm with small black lithics <0.5cm.
20	Brown silt loam (<i>paleosol</i> ?)
>60	Auto-breccia? Coarse ash-fine lapilli grey diamicton with some lithics 1.5cm near the top.

Section 2: Waipuku Stream (part a)

E2605496
N6212007



Section 2: Waipuku Stream (part b)



Appendix 3.4:

Section 3: Maketawa stream

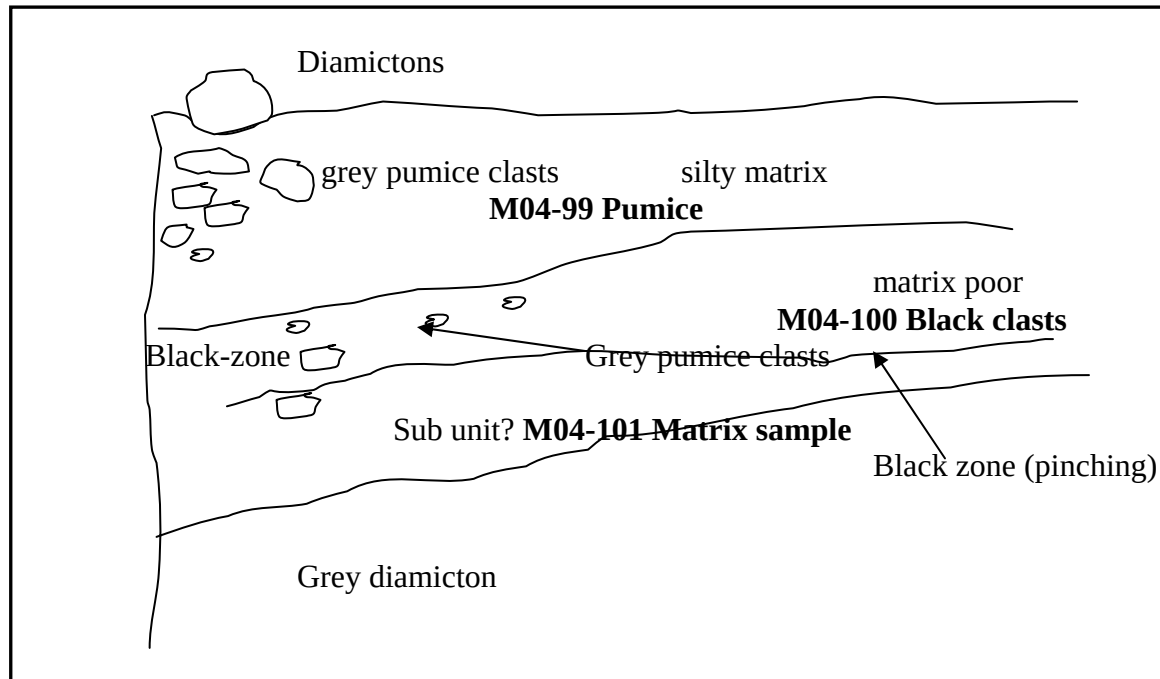
E2605103

N6212611

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
200			brown sandy silt loam sandy soil
80			Pumiceous lapilli d max c.3-5cm
400			Yellow-brown silt loam with two pumice tephras within it (inaccessible)
200			Large, coarse pumice lapilli, pumice d-max 12cm, modal 5cm. 15% lithic grey andesite.
300			Unexposed (pinching BAF seen further up stream)
20-30			Line of med lapilli (modal 6cm diameter) grey and brown pumice
100			Yellow-brown silt loam (<i>m-ash</i>)
20			Line of lithic/pumice med-coarse lapilli
100			Yellow brown silt loam (<i>m-ash</i>)
800	M04-90		Pumice coarse lapilli. Pumice d-max 40cm, modal 10-15cm, matrix poor, clast supported. Lithic poor at the top but richer at the base. Lithic 10-20cm D-max.
400			Clast supported BAF monolithic grey and some pumice throughout, ripped up from the base. 20cm d-max, mostly lapilli <5cm in size. Pumice rounded
<200			Pocketing med ash/surge beds. Fine purple surges, with beds of fine to coarse ash
10			Dark brown greasy (<i>paleosol</i>)
120			Grey med ash matrix diamicton. Pebbly with some pumices ripped up from lower unit (20% pumices)
700	M04-91	3600	Massive pumice fall unit. Coarse lapilli, d-max pumice: 25cm. Dense lithics mostly found at the top, d-max: 3-5cm.
20			Yellow brown silt loam (<i>m-ash</i>)
50			Coarse ash- fine lapilli lithic unit
10			Brown silt loam (<i>paleosol</i>)
150			Grey/brown (<i>m-ash</i>)
50			Med lapilli, 50% pale brown pumices, d-max: 3cm. 50% grey lithics d-max: 3cm.
100			Coarse grey ash, shower bedded (cm scale)
20			Yellow brown silt loam (<i>m-ash</i>)
80			Grey med ash
60			Yellow brown silt loam (<i>m-ash</i>)
600	M04-92	4200	Yellow brown pumice fine to coarse lapilli, reversely graded. Pumice d-max: 12cm. 5% dense grey angular lithics, d-max 2cm.
40			Brown greasy silt loam (<i>paleosol</i>)

100			Yellow brown silt loam (<i>m-ash</i>)
200			Grey and red lithic unit. 10% pumices in a coarse ash matrix
20			Pale brown silt loam (<i>paleosol</i>)
50			Yellow brown silt loam (<i>m-ash</i>)
<200	M04-93	5200	Pods of coarse pumice lapilli, pumice d-max: 15cm.
60			Yellow brown silt loam (<i>m-ash</i>)
80			Fine-med yellow brown pumice lapilli. Pumice d-max: 8cm. 10% lithics
70			Yellow brown silt loam (<i>m-ash</i>)
0-50			Pods of med yellow lapilli
30			Brown silt loam (<i>paleosol</i>)
<200			Lensing up to 20cm pumice lapilli d-max 5cm
100			Grey med ash (distal BAF?)
50	M04-94		Med pumice lapilli with pumices d-max. 5cm
20			Dark brown greasy paleosol
100			Grey brown silt/sandy loam (<i>m-ash</i>)
100			Grey med ash weakly bedded
30			Brown greasy silt loam (<i>paleosol</i>)
50			Pale brown pumice med lapilli, D-max 5cm
50			Yellow brown silt/sandy loam
0-200			Pods of pumice and lithic coarse lapilli with pebbles at the top
100			Creamy brown silt/sandy loam (medial ash)
+500			Orange stained pebbly-cobble sub-rounded diamicton. Clast rich and clast supported with pebbly and coarse sand matrix. Polyolithic including hydro altered clasts. Massive d-max: 30cm, modal 5-10cm.
3000			Large coarse diamicton. Upper 1m matrix rich (50/50). Largest clasts c. 1m down from top, also more clasts rich (80%) d-max: 3m diameter. Upper portion has 50cm-1m + grey andesite lithics within a grey lithic matrix
3000			Diamicton 40-50% clasts. Grey sandy matrix less clasts in body all at upper surface of the 2 units
>2500			Grey clast rich diamicton with reddish clasts. Sandy matrix but overall unit is matrix poor.
10-15m			Obscured
15-20m			2-3m thick boulder diamictons, sandy matrix and mostly monolithic, but some have up to 20% other lithologies. Sub-rounded clasts meter scale. Some units are clast supported and matrix poor, but most are c. 50/50 with sandy matrix supported.
50	M04-95		Lensing pumice lapilli
30-500			Boulder clast supported diamicton. Modal 20-60cm d-max: c. 1m. Matrix 10-20% brown sandy matrix with some silt content. Lenses of fluvial reworking
20			Grey brown silt loam (<i>paleosol</i>)
10			Pale yellow brown fine pumice lapilli (lensing)
80			Grey brown silt loam (<i>m-ash</i>)
20			Pale yellow brown fine pumice lapilli
80			Brown grey silt loam (<i>medial ash</i>)
200	M04-96	9300	Pale yellow brown and pale grey pumice lapilli d-max: 5cm. 5% weathered lithics.
10			Grey clay lenses
10-30			Lensing pale yellow brown and grey fine pumice lapilli
250	M04-97		Brown, shower bedded med-coarse ash

150	M04-98	9500	Pale yellow brown and grey fine-med pumice lapilli (d-max: 8cm) modal: 3cm. 10% sugary grey andesite more concentrated at the base d-max: 5cm
10			Brown silt loam (<i>paleosol</i>)
100			Grey bedded sandy ash
0-1m			Lensing grey friable diamicton, monolithic grey med-coarse sandy matrix. Boulder clasts up to 0.4m. 50/50 clasts/matrix.



P-flow unit: Unit 3m thick:

0.5m: Yellow and pale yellow, silty-clay matrix, 50% of unit (matrix supported). Soft weathered yellow and pale brown pumice clasts, d-max: 25cm.

1.2m: brown and pale brown sandy matrix, becoming less matrix rich with depth.
At base 60% clasts - top 40%. Modal 10-20 cm; angular grey clasts.

0.5m: Matrix poor, brown and pale brown matrix and clasts. Pumiceous med lapilli only – clast supported.

0.5m – 2cm pinching, dark grey and dense pumice zone, d-max: 25cm, clast rich and supported but with some matrix (med ash –fine lapilli)

0.4m pal brown and pale grey, clast sported pumice, d-max: 30cm. Matrix is med-fine ash, esp. near the base

20cm pale yellow/brown, pale yellow, pale grey fine pumice and brown silt loam matrix. Matrix supported with 50/50. Sharp contact onto grey diamicton, (which is sandy and fresh)

Below p-flow unit:

1.3m – 2m grey sandy matrix supported diamicton. Monolithic grey pebble at base, bulk has boulder clasts. d-max : 0.5m, 25% clasts, matrix coarse-med ash and fine lapilli grey sub-angular clasts.

<5% foreign lithics

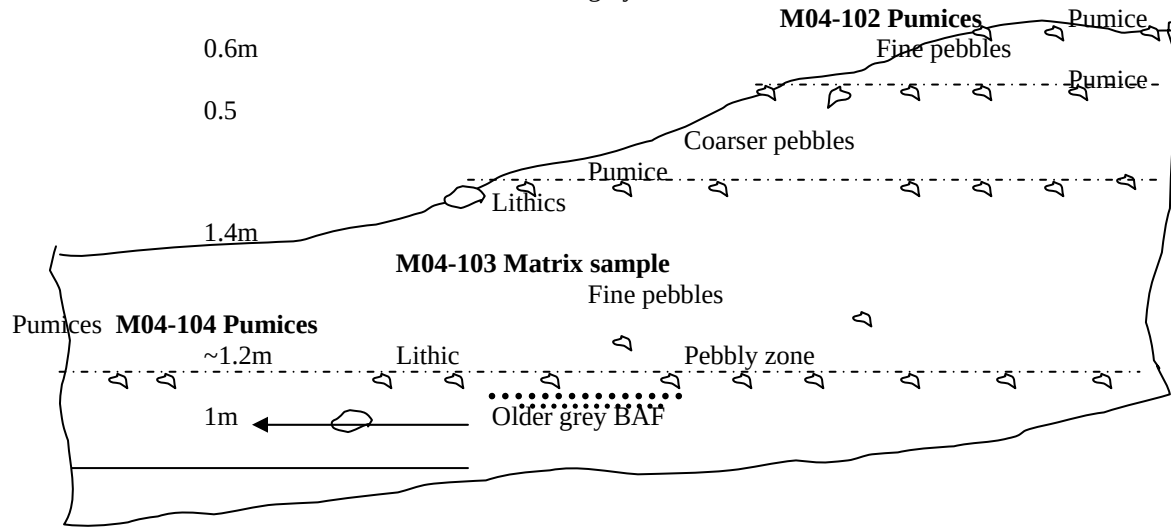
1-3 cm pinching pale pinkish grey fine ash

3m grey diamicton: Med coarse sandy matrix 50-60%. 40% clasts, boulder-pebbles. D-max: 0.6m. Bluff forming: 70% of the clasts are boulder 50% of the clasts <30cm.

2m Boulder diamicton 60-70% clasts. Some rare pumice grey med-coarse ash matrix, more matrix rich at the base.

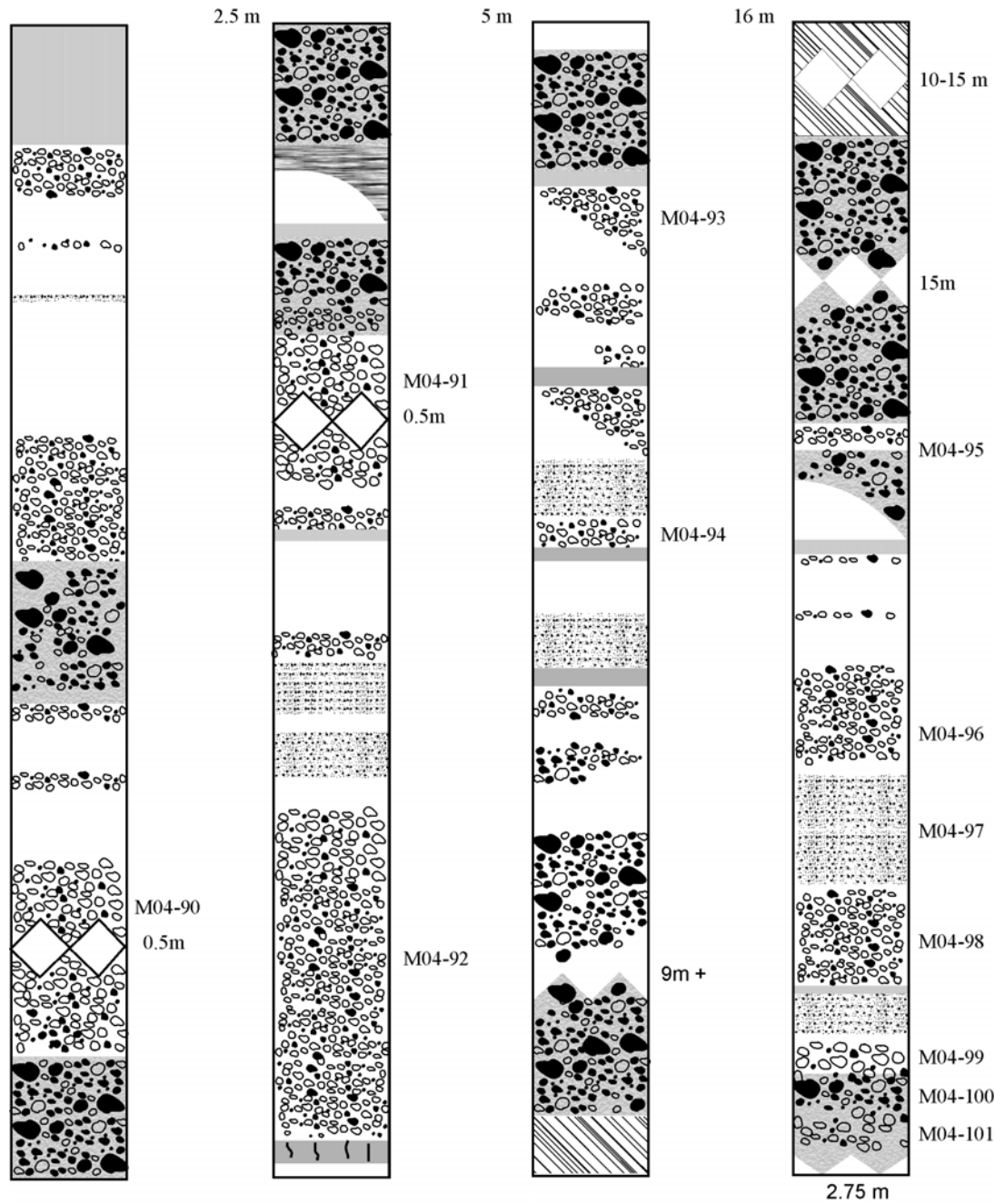
Angular unconformity cut onto pumice-bearing diamictons of very different character.

In other cases it is a conformable contact. With a fine grey ash c. 1cm thick



Section 3: Maketawa Stream

E260 5103
N621 2611



Sits on 6 m of Block- and Ash-flow deposits

Lowermost 1.4m of this section is laharic deposits
Samples M04-102 - 104 from these lahar deposits

Appendix 3.5:

Section 4: Little Maketawa Stream

E260 5145

N6212975

(Southern side) of the section

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
160	M04-51		Sandy grey med-coarse ash, distributed throughout the active 'top soil' of the section
180			Sandy brown loam with occasional lithics distributed throughout (possibly two individual units) (<i>m- ash</i>)
120	M04-52		Medium pumiceous lapilli, pinching between coarse ash and medium lapilli. Contains ~30% lithics of 20% grey lithics, 10% hydro-altered lithics. Also contains some banded pumices. Pumice d-max: 8cm (sampled). Lithic d-max: 3cm.
40			Greasy brown silt loam (<i>paleosol</i>)
70	M04-53		Well bedded (surge-like) pink, grey fine-med ash
50			Brown sandy to silt loam (<i>paleosol/m- ash</i>)
30	M04-54		Well bedded (surge-like) dark-grey fine-med ash
80			Greasy brown silt loam onto yellow-brown silt loam (<i>well developed paleosol</i>)
55	M04-55		2cm: Pocketing coarse grey-creamy ash
	M04-56		0.5cm: Coarse pumiceous ash
			3cm: pocketing purplish med-ash surge unit
120			Yellow-brown sandy-silt loam containing rare lithics, top 2cm contains a weakly developed paleosol (<i>m- ash</i>)
12cm	M04-57		Pocketing coarse pumiceous lapilli 20% grey lithics, reversely graded containing radially fractured pumices. Pumice d-max: 4cm, lithic d-max: 1cm.
20			Brown, greasy silt loam (<i>paleosol</i>)
100-150	M04-58		Bedded, (mm-scale) surge unit, med-coarse ash. Creamy-pink. Part of the underlying pumiceous tephra eruption.
180	M04-59		Shower bedded coarse-fine pumiceous lapilli. Coarser texture and more lithics near the top of the unit. Lithics are grey and hydro-altered. Pumice d-max: 9cm, lithic d-max: 4cm
70			Brown sandy-silty loam (<i>m- ash/paleosol</i>)
1cm	M04-60		Pocketing grey med ash with rare pumice fragments ~0.5cm in size.
140			Brown sandy-silty loam (<i>paleosol</i>)
220			Pale yellow silt loam, rare pumice and lithic lapilli (<i>m- ash</i>)
170-220	M04-61		Shower bedded, dark grey-black basaltic scoriaceous fine-med lapilli. d-max: 2cm

Description 2: North side of the out crop.

Section description, starting at the base of the sampled M04-59 unit

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
20	M04-59		Fine-med ash
13:			Coarse pumice lapilli
40	M04-62		Fine lapilli-med ash, 1cm sized pumice lapilli, 20% grey lithic
10:	M04-63		Basal grey fine ash
90			Brown greasy silt loam (<i>m- ash/paleosol</i>)
20			Pocketing med ash and fine pumiceous lapilli (spread throughout the medial ash for 3cm)
40			Greasy brown silt loam (<i>paleosol</i>)
40	M04-64		Pocketing coarse dark grey ash
5	M04-65		Fine-med pale grey/creamy ash
15	M04-66		Dark grey coarse ash
5			Iron pan
100			Sandy, pale brown silt loam, common lithics and pumices throughout (<i>m- ash</i>) sits on an iron pan 1cm thick
12cm	M04-67	Wk-16391	Grey, reversely graded diamicton, clasts 1-3cm supported by a
	M04-68	1130 ± 34	sandy grey matrix. Sits on charcoal bed of tussock
	Charcoal		
20			Greasy, dark brown silt loam (<i>well developed paleosol</i>)
15cm	M04-61		Shower bedded, dark grey/black basaltic fine-med lapilli
40			Greasy brown silt loam (<i>paleosol</i>)
300-500	M04-69	Wk-16390	Grey, sandy matrix supported diamicton, 15cm bedded (two
	M04-70	1739 ± 34	units?) sugary-grey monolithic clasts. Largest clasts near the
	Charcoal		top of the unit ~8cm. 1cm fine-grained base
20			Fine sandy yellow-brown loam (<i>m-ash</i>)
120	M04-71		Med-coarse pumiceous lapilli. V. dense pumices. Pumice d- max: 12cm
			30% mainly grey lithics, a few hydro-altered. Lithic d-max: 2cm
20			Sandy brown ash (<i>pos. m ash</i>)
450	M04-72		Clast supported polyolithic diamicton. Predominant clasts are grey, crystal rich. 10% pumices, and some basaltic looking clasts.
			Clast d-max: 30cm (largest clasts are the crystal rich clasts) modal: 0.5-1.5cm
10-220	M04-75		Coarse ash sized basal deposit. Erosion contact
			Surge-like deposit in places containing charcoal
300	M04-73		Matrix rich diamicton. More monolithic than the overlying unit but still contains hydro-alt and pumice clasts. Clasts similar in size to the overlying unit. Matrix: coarse ash/fine lapilli brown in colour.
30			Greasy brown silt loam (<i>well developed paleosol</i>)
70	M04-76		Shower bedded med-coarse lapilli. Scoriaceous grey to dark- grey clasts.
40:			Pumiceous, shower bedded lapilli, clasts grade up to the denser scoriaceous clasts
50	M04-77		Reversely graded dark grey, med-coarse lapilli.

60	M04-78		Red-yellow pumiceous lapilli
350:	M04-74	2500	70% dark grey basaltic looking material, 20% light grey (still basaltic) ~5-10% hydro-altered. Basaltic dark grey clast d-max: 18cm
20	M04-79		Light-grey fine-med ash.
120-150	M04-83		Shower bedded dense grey pumiceous lapilli, about 50/50 pumice and grey monolithic lithics.
270			Brown-yellow silt loam. Vertical cracks (<i>Very strongly developed paleosol</i>)
20			Dark red iron pan
250	M04-84	3600	Coarse pumiceous lapilli Pumice d-max: 20cm, 10-15% lithics d-max: 8cm Normally graded.
8cm			Yellow-brown silt loam (<i>medial ash-paleosol</i>)
3.5m			Grey sugary ash med-coarse matrix BAF. Large clasts sub-angular. Large clasts at the top (d-max: 0.5m) Pebbles are angular and monolith grey hard (dense) andesite. <1% black and <1% red. Clast supported (70% clasts) modal 2-5cm.

Description of large pumice p-flow unit

Below >50cm grey sandy matrix and sugary med coarse pale brown-grey boulder clasts up to c. 0.6m and pebbles and other cobbles grey lithic clasts, monolithic and 5% reddish stained clasts.

Upper 1-2cm yellow brown stained silt loam: Very weak weathering break.

Pods up to 5cm deep 30cm

Grey med-coarse well sorted ash up to 20cm brown grey matrix diamicton 50% clasts, coarse pebble-cobble, D-max: 15cm, modal pebble sized, angular grey clasts, coarser ones sub-rounded. 5% red or weathered clasts.

Sharpe contact on to 1.3m p-flow unit

30cm pale yellow brown standard pumice, poorly sorted, matrix poor and in some places-others pumice ash and fine lapilli. **M04-80 Pumices**

Up to 50cm progressively darker pink coloured (hematite), central part is the darkest pink.

M04-81 Matrix

Up to 30cm pale yellow brown and pink, matrix poor.

Middle portion has med ash/fine ash matrix between all clasts, but overall unit is clast supported.

<5% lithic clasts, up to 25cm in diameter, (grey and hornblendite/diorite) **M04-82 Lithics**

Middle matrix is 20-30%

D-max pumice 20cm, modal 2-10cm

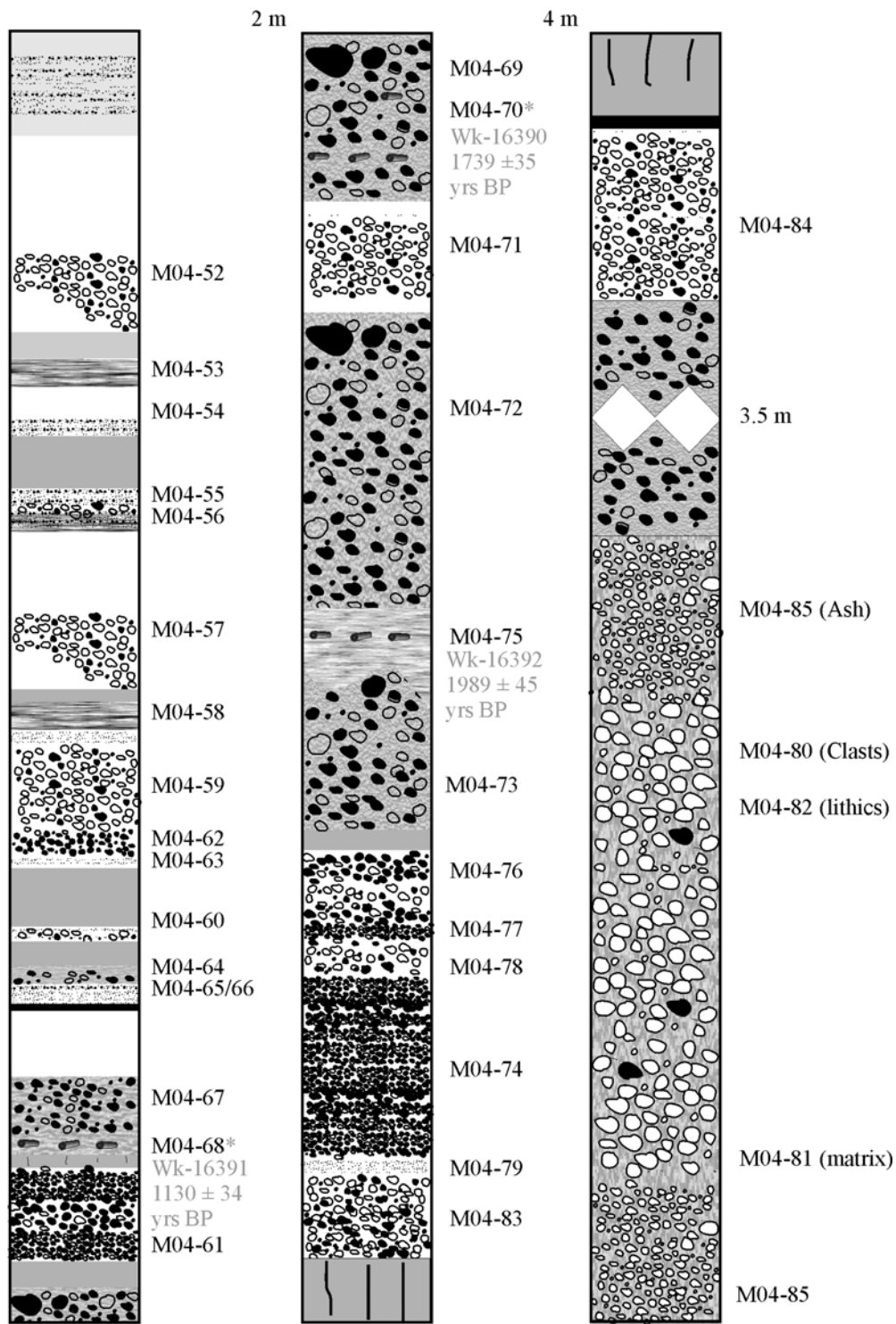
Upper portion includes matrix between clasts in many places. Upper portion is fine lapilli in hollows. Pinkish to grey pumice and lithics up to 5cm, med ash and up to fine ash **M04-85**

Pinkish-grey ash

Up to BAF (as described before)

Section 4: Little Maketawa Stream

E260 5145
N 6212975



Sits on diamicton deposits >10 m

* dates have been switched: mixed up sample number in radiocarbon dating

Appendix 3.6:

Section 5: North Egmont Road

E260 4686

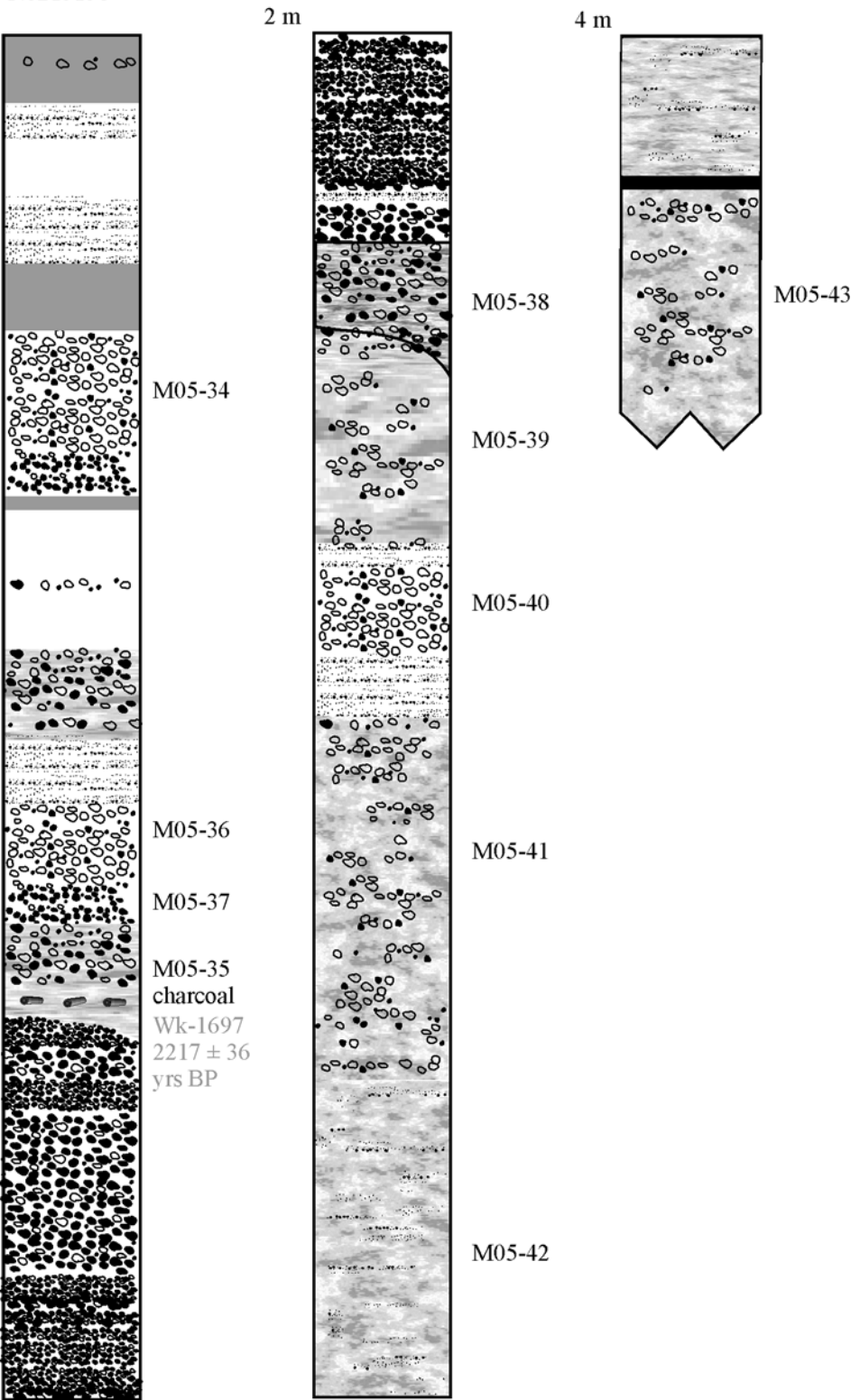
N621 5158

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
100			Sandy brown loam including pumice and lithic clasts d-max 0.5 cm Mixed into the root development
50			Yellow grey med-coarse ash
80			Yellow-brown silt loam (<i>m-ash</i>)
90			Med-coarse grey (slightly yellow) ash. Lensing slightly
100			Greasy brown silt loam (<i>paleosol</i>)
220	M05-34	1700	Reversely graded pumiceous fall deposit. Top pumices coated in a medium grey ash. Pumice d-max: 9cm (near top) model 3.5cm. Lithics d-max 3cm, model 1.5cm. Pumice d-max: 2cm (near base). Lithic d-max: 1cm
20			Dark brown, greasy silt loam (<i>paleosol</i>)
100			Sandy brown silt loam with rare lithics spread throughout (<i>m-ash</i>)
5-10			Single line of lithics. Angular, dense grey andesite.
100			Sandy brown silt loam (<i>paleosol</i>)
50			Polyolithic diamicton ~80% grey soft, sugary andesite, 5% red hydro-altered clasts and 5-10% black clasts. Dispersed within a coarse sandy ash – fine lapilli matrix (pumiceous)
80			Top of p-flow unit. Pumice and lithics (approx. 50/50) same lithics as describe above. Pumices and lithic d-max: 2cm
70			Coarse ash – fine lapilli (pumice and lithic free; matrix material only)
180	M05-36	2400	Reversely graded flow unit from coarse ash/fine lapilli to lithics and pumice 1-1.5cm diameter
120	M05-37	Wk-1697	Normally graded pumice dominated subunit (70% pumice)
	M05-35	2271 ± 36	pumice d-max: 3cm, lithic d-max: 1cm. same sandy pumiceous, fine lapilli matrix. Charcoal bearing
110	Charcoal		Shower bedded dark brown to black scoriaceous unit Normally graded from fine lapilli to med-coarse ash
40			Med-coarse ash to fine lapilli sub-unit
250			Normally graded from 3cm modal clasts at the base to fine lapilli top
300			Reversely graded sub-unit. Basal 0.5cm clasts (fine lapilli) to 4-5cm clasts at the top. More slightly red clasts
140			Reversely graded sub-unit. Basal 0.2cm (fine lapilli) clasts to 0.5-1cm clast
10			Grey medium ash
60			Lensing fine lapilli unit sits on a diffusive boundary
13cm	M05-38		Possibly part of the above unit; medium-coarse grey ash with

		dispersed lithic fragments 0.5-1cm
		Iron pan
Erosion boundary		
60		Pumices d-max 3-4cm in a sandy med-coarse ash matrix
240	M05-39	Mixture of pumice and lithics 2cm (d-max)dispersed in a coarse ash matrix (pumiceous matrix)
40		Yellow med ash
120	M05-40	Pumice d-max: 6-7cm, modal: 4cm. 5% lithics; d-max: 1cm
110		Coarse yellow-pumiceous ash with 0.5cm lithics
1200	M05-42	Whole unit reversely graded from a sandy grey to yellow
	M05-41	medium ash and pumiceous ash through to a matrix (coarse, pumiceous ash) supported. Pumices 2cm and lithics 1-2cm
	pumice	modals
		There is a boundary 55cm down which marks the onset of pumice clasts
2		Iron pan
>30cm	M05-43	Pumiceous, coarse ash-fine lapilli matrix supporting pumices and lithics (3cm modal). Coarser unit than the top of the overlying unit.

Section 5: North Egmont Road

E260 4686
N6215158



Appendix 3.7:

Section 6 North Egmont 2

E 260 1797

N 621 4621

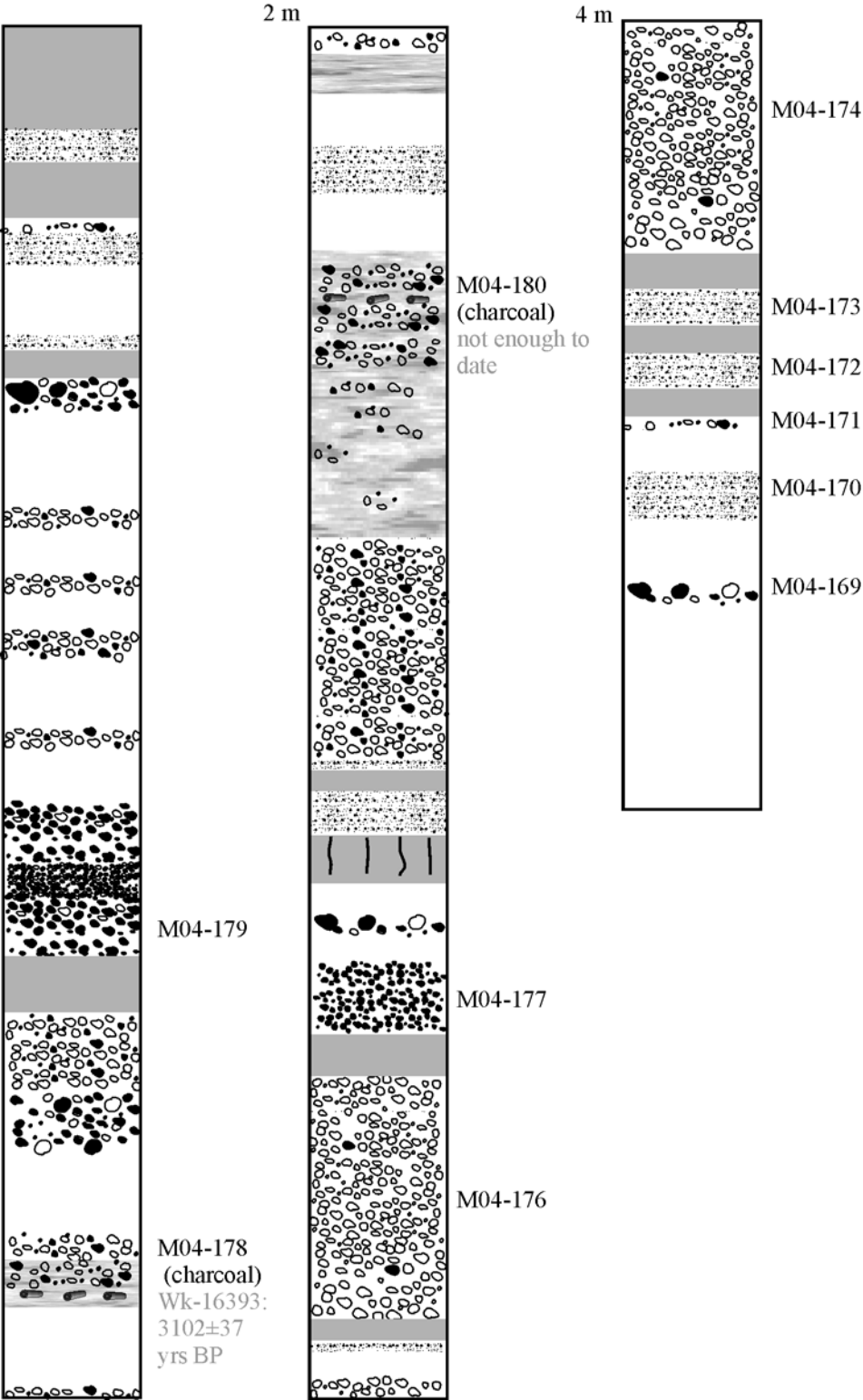
Sampled some of the older units but generally the upper units are similar to that seen at Section 7

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
150			Dark brown, sandy loam (<i>current soil</i>)
50			Pocketing grey med-fine ash
80			Dark brown, sandy loam (<i>current soil</i>)
20			Single grey lithic layer
50			Brown-grey fine ash
100			Brown silt loam (<i>m-ash</i>)
10-20			Pocketing coarse grey ash and monolithic fine lapilli
40			Brown silt loam (<i>m-ash/paleosol</i>)
50-100			Layer of lithic – dense andesite. d-max: 15cm. grey lithics 5cm d, also pumice clasts
150			Grey-brown silt loam (<i>m-ash</i>)
30			Pale brown, fine pumice lapilli
50			Grey-brown silt loam (<i>m-ash</i>)
20			Pale brown, fine pumice lapilli
50			Grey-brown, silt loam (<i>m-ash</i>)
50			Grey-yellow brown 50/50 pumice and lithic fine lapilli
100			Grey brown silt loam (<i>m-ash</i>)
40			Yellow brown, fine med pumiceous lapilli 10% grey lithics
80			Grey-brown silt loam (<i>m-ash</i>)
210	M04-179		3 distinctive units ~7cm each 7cm: dark grey scoriaceous fine lapilli, occasional coarse lapilli clasts 7cm: grey brown, med-coarse lapilli 7cm: dark grey, fine scoriaceous lapilli
80			Brown-yellow silt loam (<i>paleosol</i>)
100			Yellow sandy silt loam (<i>m-ash</i>)
100			Yellow silt loam (<i>m-ash</i>)
100			Med-coarse pumiceous lapilli D-max: 20cm, modal 1.5cm, 20% lithics
80	M04-178 charcoal	Wk – 16393: 3102 ± 37	Lithic rich (50/50) med lapilli with a coarse ash matrix. Weakly bedded (surge-like) clasts 1-2cm. contains charcoal
130			Yellow-brown silt loam (<i>medial ash</i>)
40			Dense pumice and lithic med lapilli. d-max: 4cm (pos. top of surge unit)

60			Bedded fine ash/med ash banded surge deposit.
80			Yellow-brown silt loam (<i>paleosol/m-ash</i>)
80			Coarse grey ash
90			Yellow-brown silt loam (<i>m-ash</i>)
180	M04-180		Bedded med-coarse ash and fine-med lapilli surge unit. Polyolithic with clasts up to d max 8 cm; also accidental pumices (also contains charcoal)
240			Laminated (mm scale) med ash; surge units 1-4cm beds with coarse lithic and pumices 0.5cm d
320			Coarse pumiceous lapilli. Pumice d-max: 17cm, modal: 8cm. Lithics (2 types of lithology) d-max: 4cm, modal: 0.8cm
20			Purple med ash
30			Dark-brown silt loam (<i>paleosol</i>)
60			Reddish/purple-grey coarse ash
70			Brown, greasy silt loam (<i>paleosol</i>)
40			Yellow sandy, silt loam (<i>m-ash</i>)
30			Single line of lithics (3cm d) onto 3cm pocketing purplish fine ash
40			Yellow-brown silt loam (<i>m-ash</i>)
100	M04-177	3800	Pumiceous fine-med lapilli. Pumice d-max: 2cm 30% monolithic d-max: 1.5cm
60			Brown, greasy silt loam (<i>paleosol</i>)
400	M04-176	4600	Med-coarse pumiceous lapilli. Pumice d-max: 8cm, modal 6cm. 10% lithics, monolithic (dense, light grey) D-max: 2.5cm. Coarsest at the base
30			Dark brown silt loam (<i>paleosol</i>)
10	M04-175		Pocketing pink-purplish ash
20			Yellow-brown silt loam (<i>m-ash/paleosol</i>)
400-500	M04-174		Coarse pumiceous lapilli. Many pumice bombs at the base of the deposit. Pumice d-max: 14cm, modal 6cm. 15% lithics, two major types of lithology (light grey phenocryst rich and dark grey) d-max: 5cm, modal 1.5cm
50			Brown, greasy silt loam (<i>paleosol</i>)
50	M04-173		Coarse, purplish grey ash
40			Brown, greasy silt loam (<i>paleosol</i>)
50	M04-172		Coarse purplish grey ash with fine lapilli
40			Greasy brown silt loam (<i>paleosol</i>)
20	M04-171		Single line of pumices 0.4 d
60			Yellow-brown greasy, silt loam (<i>m-ash/paleosol</i>)
80	M04-170		Coarse ash to fine lapilli, grey clasts
80			Yellow-brown silt loam (<i>m-ash</i>)
30	M04-169		Single line of pumice and lithics 0.5-1.2cm d
300			Yellow-brown silt loam (<i>m-ash</i>)

Section 6: North Egmont 1

E260 1797
N621 4621



Appendix 3.8:

Section 7 North Egmont 2

E 260 1361

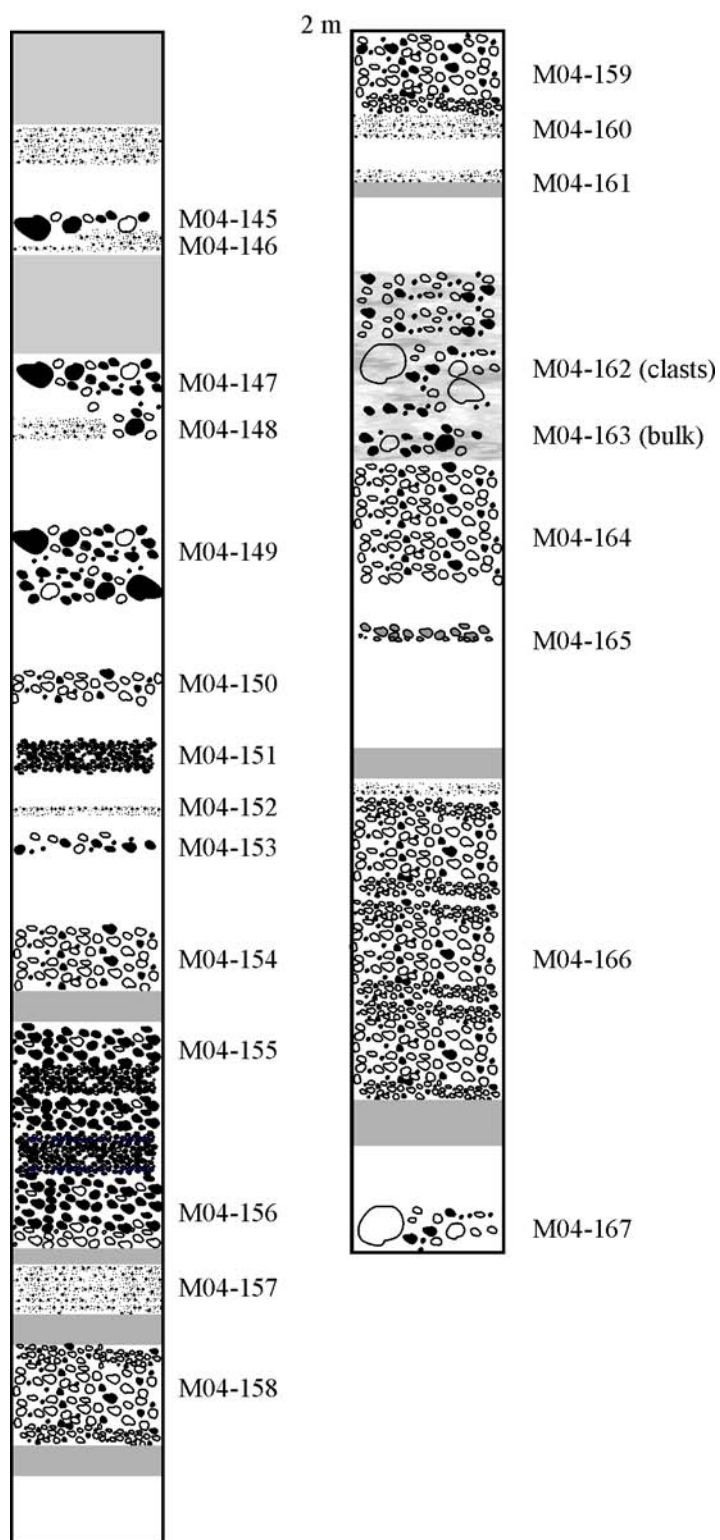
N 621 4667

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
120			Brown sandy loam (<i>current soil</i>)
50			Grey, cm-mm bedded med-fine ash
80			Brown sandy loam (<i>current soil</i>)
30-60	M04-145		1-3cm: Single layer of lithics and occasional pumice. Red/hydro-altered lithic d-max: 2cm. scoriaceous grey, plagioclase phenocryst rich lithics d-max: 3.5cm
30	M04-146		Lensing, grey med ash
130			Brown, greasy silt loam (<i>paleosol</i>)
50-130	M04-147 M04-148		Mixed clasts of dense grey angular clasts (2-6cm), very phenocryst rich yellow pumice (16cm) and light grey scoriaceous lithics (6cm). Between the clasts is a pocketing med grey ash, almost creamy grey in colour
110			Brown sandy silt loam (<i>m- ash</i>)
100	M04-149		Poly lithic unit dispersed within the silt loam. Hydro-altered clasts, black clasts, phenocryst grey clasts. D-modal 0.5-1cm
80			Sandy brown silt loam (<i>m- ash</i>).
50	M04-150	1850	Fine pumice lapilli unit dispersed within the silt loam. Rare lithic d-max ~1cm
60			Sandy brown silt loam (<i>m- ash</i>)
10-50	M04-151	1990	Lensing dark brown to black med-coarse ash. Reversely graded with a 0.5cm coarse ash top
40			Yellow-brown, sandy silt loam (<i>m-ash</i>)
20	M04-152		Pocketing creamy grey med ash with occasional pumice fragments
20			Yellow brown silt loam (<i>m-ash</i>)
30	M04-153		Single layer of poly lithic clasts
40			Yellow-brown silt loam (<i>m-ash</i>)
80	M04-154	2000	Fine pumiceous lapilli. Yellow, phenocryst rich pumices (not very vesicular)
40			Brown silt loam (<i>paleosol</i>)
80	M04-155	2500	Shower bedded dark grey (basaltic looking) lapilli Reversely graded, with the top 3cm containing a mixture of red and light grey scoriaceous clasts, 1.5cm in size. Lower 5cm all <0.3cm
70			Pumiceous/scoriaceous clasts 0.8cm
60			Coarser clasts
60	M04-156		Denser grey material, similar to the top 3cm of the deposit (except no red hydro-altered clasts)
20			Grey-yellow brown silt loam (<i>paleosol</i>)
70	M04-157		Yellow grey sandy med ash
40			Grey brown-yellow silt loam (<i>paleosol</i>)
130	M04-158	3000	Pumiceous med lapilli. Graded with the coarsest material (4cm

			clasts) within the middle of the unit. Pumice is concentrated near the top of the unit. Lowest 6cm 50/50 pumice/lithic. Poly lithic, modal 2cm d-max: 3.5cm.
40			Brown, greasy silt loam (<i>paleosol</i>)
90			Yellow-brown silt loam (<i>medial ash</i>)
160	M04-159		10cm: Lithic rich, coarse pumiceous lapilli (40% lithics) Pumice d-max: 8cm. seemingly monolithic; dark grey/black with obvious plagioclase phenocrysts.
60	M04-160		Coarse-med ash to fine lapilli surge unit. Pumice fragments ~1cm
40			Grey-yellow brown silt loam (<i>m-ash</i>)
20	M04-161		Purple med ash
20			Brown, greasy silt loam (<i>paleosol</i>)
100			Yellow-brown silt loam (<i>m-ash</i>)
100	M04-162		Course, mostly pumiceous surge (p-flow unit) Pumice d-max: 9cm (dense fractured pumice ~22cm) Lithics d-max: 2cm
130	M04-163		Sugary finely bedded at the top. d-max: 4-5cm, 0.5cm modal. Coarse and bomb-sized middle. Accidental clasts 10cm and pumice 6cm within a sandy grey matrix
170	M04-164	3400	Clast supported pumiceous coarse lapilli. 30% lithics (looks like mainly fall deposits) fractured pumices d-max: 13cm
30			Coarse ash base (pinkish colour)
50			Grey-brown sandy silt loam (<i>m-ash</i>)
20	M04-165		Single layer of grey clasts (rare pumices) 2-3cm d
130			Grey-brown, sandy silt loam (<i>m-ash</i>)
40			Brown, greasy silt loam (<i>paleosol</i>)
10			coarse grey ash
400	M04-166	4300	Shower bedded, coarse pumiceous lapilli. Pumice d-max: 14cm, modal 2cm. 15% monolithic lithics d-max: 5cm
60			Brown, greasy silt loam (<i>paleosol</i>)
70			Yellow-brown, sandy silt loam (<i>m- ash</i>)
110	M04-167		Large angular pumices ~25cm d

Section 7: North Egmont 2

E2601361
N6214667



Appendix 3.9:

Section 8a: Okahu gorge

E259 8902

N621 0856

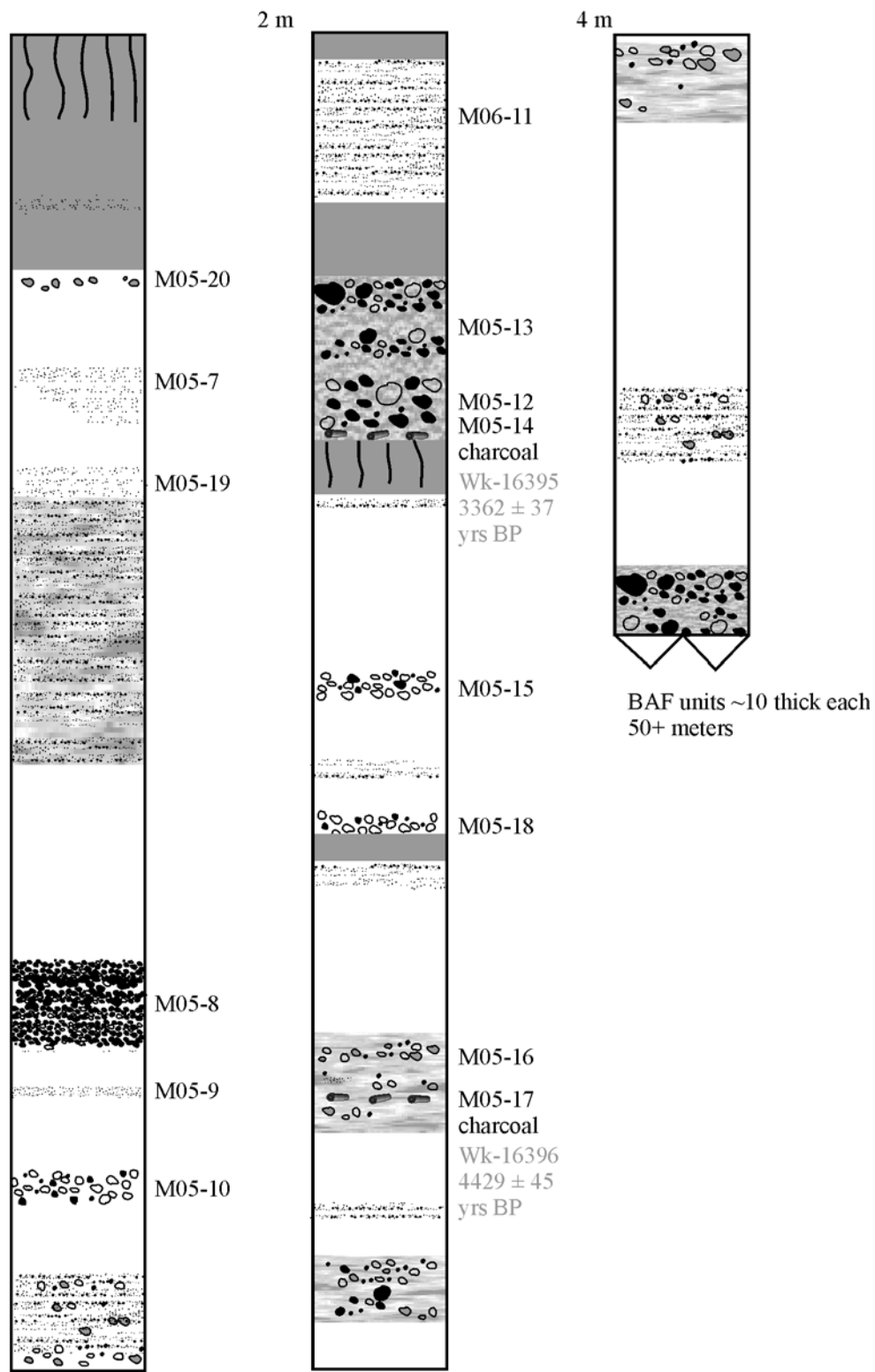
Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
250			Brown sandy loam (<i>top-soil</i>) indistinguishable tephras
0-70			Fine grey ash. Pocketing 5-7cm
90-140			Brown sandy loam (<i>m-ash, part of present top soil</i>)
0-15	M05-20		Lithic and ash layer. Single lithics and pocketing fine grey ash. d max: 1-1.5cm
100			Brown sandy loam (<i>m-ash, part of present top soil</i>)
40-80	M05-7		Pinching, poorly sorted fine diamicton, surge? Bedded, fine-coarse ash with lithics. Pinching units up to 8cm modal 6cm thick.
150			Brown sandy loam (<i>m-ash, part of present top soil</i>)
0-30	M05-19		Pocketing medium to fine grey ash up to 3cm thick
400			Med-coarse, sandy ash and rare lithics. Dune bedding (<i>m-ash?</i>)
300			Brown, silt loam (<i>paleosol – m-ash</i>)
150	M05-8	1800	Coarse ash – med lapilli shower-bedded unit. 4 units
	M05-8b		
40			Brown sandy/silt loam. (<i>m-ash</i>)
25	M05-9		Light grey coarse ash to fine lapilli. Shower bedded.
100			Brown silt loam (<i>m-ash</i>)
50	M05-10		Fine lapilli. Yellow-grey pumice and lithics <0.5cm d
110			Brown silt loam (<i>m-ash</i>)
160			Sandy grey fine lapilli sized lithics.
40			Dark brown silt loam (<i>paleosol</i>)
20			Single line of grey lithics
130			Dark brown silt loam (<i>paleosol</i>)
200	M05-11		Yellow/grey sandy, medium ash. Distinctive yellow colour with grey pockets of finer ash within the centre.
110			Dark brown silt loam (<i>paleosol</i>)
250	M05-12	WK	Bedded surge deposit. 5 beds' each 4-5cm thick.
	M05-13	16395:	5cm: d-max 2-3cm clasts, grey andesite.
	M05-14:	3362 ±	4cm: Finer, anti-dune unit d-max: 5mm
	Charcoal	37	3cm: Coarser unit (similar to top) 2cm: Finer (similar to above) 8cm: Coarse unit. Modal grey andesite ~ 4cm, d-max yrs BP
80			Dark brown silt loam, greasy (<i>paleosol</i>)
20			Fine-medium grey/yellow ash, pocketing.
260			Brown, sand – silt loam (<i>m-ash</i>)
50	M05-15	4300	Pumice unit. Fine lapilli. Pumice modal: 1-2cm d-max: 3cm. grey andesite lithics, modal: 0.5cm d-max: 1.5cm
90			Brown silt loam (<i>m-ash</i>)

30			Pocketing medium, grey ash
30			Brown silt loam (<i>m-ash</i>)
20-40	M05-18		Pumiceous medium lapilli. Pumice d-max: 2.5cm. monolithic; light-grey dense andesite, d-max: 1cm. approx. 30% lithics
40			Dark brown silt loam (<i>paleosol</i>)
40			Coarse grey ash, pocketing.
200			Dark brown/grey sandy/silt loam (<i>paleosol</i>)
150	M05-16	Wk-	Medium lapilli sized surge deposit. Channelling. Grey lithics 5-10%.
	M05-17:	16396	Juvenile with varied density (some almost pumice density)
	Charcoal	4429 ± 45	yellow/grey 90%. d-max: 2.5cm.
110			Brown silt loam (<i>m-ash</i>)
25			Fine-medium grey ash, pocketing.
60			Brown sandy, silt loam (<i>m-ash</i>)
100			Unusual poly lithic unit. 50% pumice, modal: 2cm, d-max: 6cm. 10% sugary grey andesite, d-max: 17cm
			Also contains dense grey andesite and red, hydro-thermally clasts d-max 3cm
80			Brown sandy silt loam (<i>m-ash</i>)
120			Reversely graded pumice. 50% lithic, surge unit. With a; 2-4cm: mainly floated pumice, modal: 4cm d-max: 7cm
			8cm: fine lapilli-sized predominately grey lithic material (surge like appearance) 0.5 – 1.5cm clasts
			2cm fine grey ash base
400			Dark brown silt loam (<i>m-ash</i>)
110			Shower bedded, separated into 2 reversely graded units, also pocketing pumice 50/50 lithic. Pumice d-max: 1.5cm. Lithic d-max: 0.8cm
180			Brown sandy/silt loam (<i>m-ash</i>)
20			Iron pan
50m+			10 or more units of generally matrix supported gravely diamictons with clasts up to 5m in diameter.

Section 8a: Okahu Stream

E2598902

N6210856



Appendix 3.10:

Section 8b: Skeet's Slide

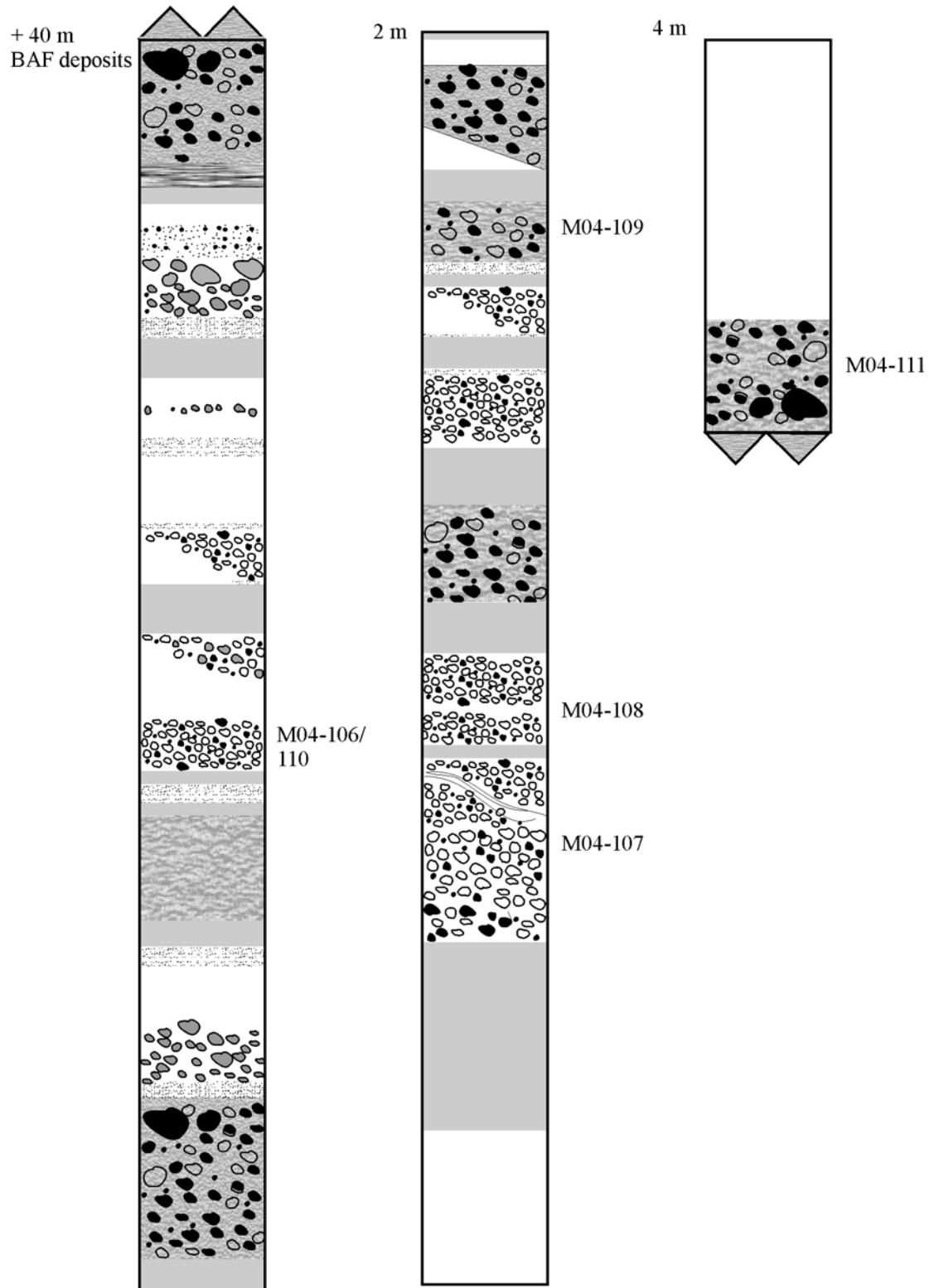
E2598502
N6211144

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
500			Matrix dominated diamicton, sandy grey matrix with clasts d-max 5cm
40			Brown med ash unit (surge)
20			Dark brown silt loam (<i>paleosol</i>)
40			Yellow-brown silt loam (<i>m-ash</i>)
60			Med-coarse grey ash
20-200			Lensing lithic layer, glassy grey andesite lithics
120			Coarse grey ash, lensing clast-supported layers. d-max: 20cm. clasts: light-grey crystalline, sugary andesite.
40			Grey fine ash
60			Dark-brown, greasy silt loam (<i>paleosol</i>)
50			Yellow-brown sandy loam with rare lithics (<i>m-ash</i>)
30			Single layer of grey lithics 1-3cm d
30			Light brown-yellow silt loam (<i>m-ash</i>)
30			Creamy-yellow med ash
100			Brown-yellow silt loam (<i>paleosol</i>)
80			1cm: Grey med ash with lithic(?) clasts ~1cm lensing med pumice lapilli ~10% lithics pumice d-max: ~3cm, lithic d-max: 1.5-2cm
20			Creamy fine ash
80			Brown-yellow silt loam (<i>paleosol</i>)
40-70			Lensing lithic (typical dense grey andesite) and pumice med lapilli (50/50) Pumice d-max: 2cm, Lithics d-max: 1.5-2cm
50			Brown sandy loam (<i>medial ash</i>)
80	M04- 106/110		Iron cemented med pumice lapilli. Pumice is very soft, pumice d-max: 5cm. 10% lithic, d-max:1.5cm
20			Brown silt loam (<i>paleosol</i>)
30			Pocketing creamy coarse ash
20			Brown silt loam (<i>paleosol</i>)
170			Grey med ash with a coarse ash layer in the centre
40			Dark brown silt loam (<i>paleosol</i>)
30			Creamy yellow coarse ash
100			Yellow silt loam (<i>m-ash</i>)
120			Lensing lithics layer, coarse ash to fine lapilli
250			Dense, glassy light grey lithics
60			Brown silt loam (<i>paleosol</i>)
40			Yellow brown silt loam (<i>m-ash</i>)
170-100			Pocketing/lensing clast supported diamicton. Clasts are of a varied

			composition (hydro-altered, sugary grey, pumice near the top)
50			Brown silt loam (<i>paleosol</i>)
100	M04-109	9300	Light grey sugary clasts diamicton and pumice, d-max lithics: 12cm
20			Fine ash, iron cemented
20			Brown silt loam (<i>paleosol</i>)
80			Lensing pumice med lapilli. Pumice D-max: 4cm, lithics D-max: 1cm
5			Finely bedded fine-med grey ash
5			Yellow-brown sandy silt loam (<i>paleosol</i>)
10			Brown, med ash
110			Yellow-grey pumiceous med lapilli. Pumice d-max: 4cm. Lithics 10%, Lithics are light grey with rare black, (basaltic looking) lithics. Lithic d-max: ~2cm
10			Yellow brown, sandy silt loam (<i>medial ash</i>)
90			Brown silt loam (<i>paleosol</i>)
160			Pebbly, sugary grey diamicton. Angular clasts d-max: 8cm. also contains rare pumices
80			Brown-yellow silt loam (<i>paleosol</i>)
80			Fine pumiceous lapilli. Very altered pumices d-max: 1-2cm
20			Yellow-brown silt loam (<i>paleosol</i>)
50			Fine pumiceous lapilli with 20-30% lithics. Lithics: dark grey, dense and angular. Pumice d-max: ~2cm, lithic d-max: 1.5cm
20			Brown-yellow silt loam (<i>paleosol</i>)
100			Reworked pumiceous lapilli cross bedded.
180	M04-108	9900	Coarse pumiceous lapilli. Pumice D-max: 12cm, modal 4cm. Dark grey lithics concentrated at the base, with more rounded, sugary grey lithics near the top
40			Med-brown ash
70			Yellow brown sandy, silt loam (<i>paleosol</i>)
50-130	M04-107		Lensing grey med. pumiceous lapilli, lithic rich (40%). Pumice D-max: ~2.5cm, light grey lithic D-max: ~1cm. Pumice sag structure in this unit
300-400			Brown-yellow sandy, silt loam (<i>paleosol</i>)
700			Yellow-brown sandy loam (<i>m-ash</i>)
2m+	M04-111	pumice	Clast supported light grey diamicton, within dense rounded pumices 40-60cm in size. Pumices concentrated near the top of the unit (60% of clasts), dense 75cm+ grey boulders concentrated near the base (70% of the clasts)

Section 8b: Skeet's Slide

E2598502
N6211144



Appendix 3.11:

Section 8c: Okahu Gorge

E2598840

N6211342

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
700	M04- 115		Coarse pumiceous lapilli, clast supported top, brown ash matrix supported base (pos. flow). Pumice d-max: 20cm. 20% lithics of which light grey dense lithics are the major component (17%) and dark grey to black the rest.
350			Brown silt loam (<i>m-ash/paleosol</i>)
100			Pocketing fine diamicton, polyolithic clasts (dense grey, sugary) Clast d-max: 5cm
40			Brown silt loam (<i>m-ash</i>)
40			Pocketing fine diamicton, polyolithic clasts (dense grey, sugary) Clast d-max: 5cm
30			Brown, greasy silt loam (<i>paleosol</i>)
120			Purple, grey coarse ash
50			Brown silt loam (<i>medial ash/paleosol</i>)
200			Coarse grey ash
70			Brown silt loam (<i>paleosol</i>)
40			Med pumiceous lapilli. Pumice d-max: 3cm. 30% light grey, sugary (phenocryst rich) lithic d-max: 1.5.
220			Grey coarse ash to fine lapilli
30			Brown, greasy silt loam (<i>paleosol</i>)
10-30			Single line of dark grey/back with distinct plagioclase phenocrysts. d-max:3cm
40			Coarse grey ash (iron cemented)
100-150	M04- 116	9300	Yellow med-coarse pumiceous lapilli. 5% lithics. Pumice d-max: 4cm.
80			Iron stained yellow sandy, silt loam (<i>medial ash</i>)
8m+			TRH lava flow

Section 8c: Okahu Gorge

E2598840
N6211342



Overlain by BAF deposits >50 m

M04-115
+ 0.5m

M04-116

Sits on lava flow

Appendix 3.12:

Section 9: Punehu Stream

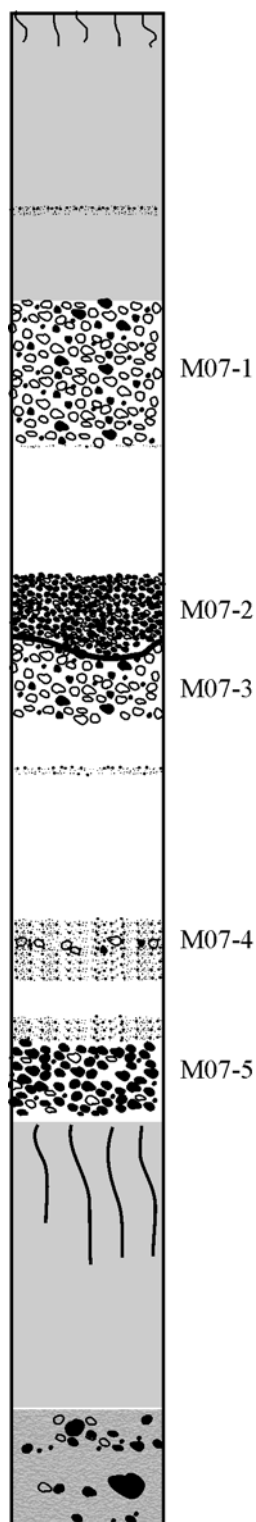
E2600850

N6205950

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
250	M07-1		Active top-soil. Brown - Humus, many rootlets. Sandy silt loam
15-20			Single line of pumiceous clasts 1.5-2 cm in diameter
50			Sandy silt loam (paleosol)
200			Yellow-orange coarse ash-fine lapilli. Poorly sorted (p-flow) with d-max 3 cm supported by a medium ash (<2 mm). Pumiceous clasts approx 20% concentrated near the top of the unit. Matrix comprised of steel-grey angular clasts. Slightly normally graded.
150	M07-2		Yellow-light brown sandy silt loam (medial ash)
110			20 grey fine-medium ash
			800 dark-grey medium to coarse ash scoriaceous clasts d-max:1.5-2 cm
120	M07-3	1400	10 lensing purple-grey fine ash sits on a wavy erosion surface to underlying unit
	M07-4		Reversely graded, poorly sorted pumiceous lapilli (p-flow) grey andesite (lithic) rich base (60%). Pumice d-max 2 cm. Grading up pumice rich top d-max:8 cm
50			Yellow sandy loam (medial ash)
10			Pocketing grey fine to medium ash
50			Yellow sandy loam (medial ash)
85			0.5 cm medium ash (grey – purple in colour) sits on: 8 cm steel-grey andesite and pumiceous fine lapilli. Andesite clasts d-max: 2.5 cm pumice d-max: 3 cm
40	M07-5	2500	Grey-yellow sandy loam (<i>m-ash</i>)
180			40: Pocketing steel-grey medium ash sits on: 140: angular dark grey coarse ash to fine lapilli. Some clasts are scoriaceous
50			Red-orange iron pan
500			Very light yellow silt loam (clay pan/pod sol?)

Section 9: Punehu Stream

E2600850
N6205950



Appendix 3.13:

Section 10: Otakehu Stream

E2602600
N6207450

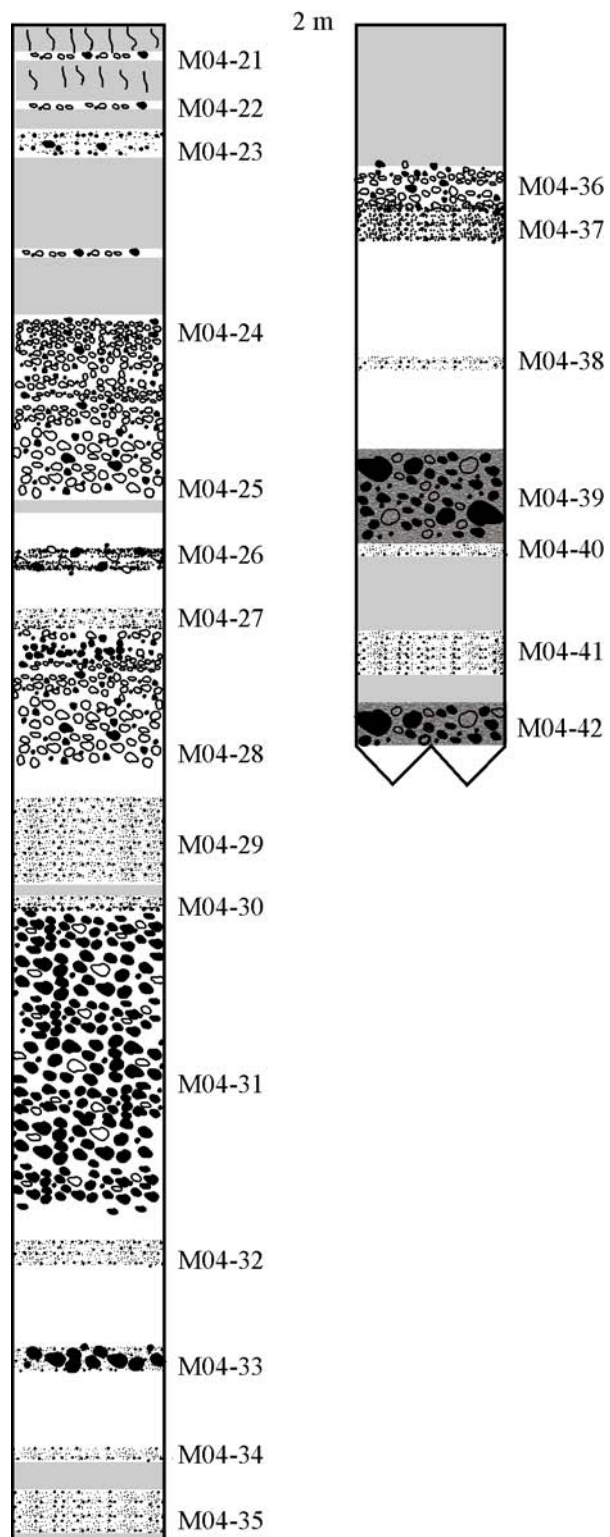
Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
40 10 60	M04-21		Sandy, dark brown top soil rich in organic material Single layer of pumice clasts, <1cm in size Greasy dark brown silt loam (still part of the current soil profile)
10 30	M04-22		Single layer of lithics, <1cm in size Greasy dark brown silt loam (still part of the current soil profile)
35 120 8 80 240	M04-23 M04-24 M04-25	2100	Pocketing light grey med-coarse ash, contains pumice clasts (<0.5cm) Greasy brown silt loam (<i>paleosol</i>) Pocketing grey coarse pumiceous ash Sandy dark brown loam (<i>paleosol</i>) Normally graded pumice lapilli, faintly shower bedded. Pumice d-max: 2cm grey lithic d-max: 1.5cm. 5% lithics, mostly near the base of the unit
20 40 ~30	M04-26		Pale brown greasy weakly developed paleosol Sandy pale brown/yellow loam (<i>m-ash</i>) Single layer of dark grey lithics and dark brown/black coarse pocketing ash. Unit also contains pumice clasts
60 30 190	M04-27 M04-28		Pale brown/yellow silt loam (<i>m-ash</i>). Pocketing pink/light grey med-coarse ash Pumiceous coarse lapilli, containing grey lithics. Considerably more lithics near the top of the unit. Pumice d-max: 7cm, lithic d-max: 4.5cm.
35 110 15 30 400	M04-29 M04-30 M04-31	2500	yellow brown silt loam (weakly developed paleosol) Grey, purplish med/coarse ash. Slightly normally graded Brown silt loam (<i>paleosol</i>) Coarse dark grey ash. Top portion of the underlying lapilli. Shower bedded basaltic coarse lapilli. Two distinct units, possibly three, units normally graded. Block sized clasts at base of the units (~12cm)
40 40 100 40	 M04-32 M04-33		Scattered basaltic fine lapilli throughout a greasy yellow/brown silt loam. (<i>m-ash</i>) Pocketing med black/grey lapilli Pale brown/yellow sandy loam (<i>m-ash</i>) Pocking coarse black/grey ash with occasional large glassy lithics. Lithic d-max: 13cm. Normally graded, containing grey lithics near the base.
110			Yellow/brown silt loam (<i>m-ash</i>)

20	M04-34		Pocketing black/grey coarse/medium ash
40			Grey/brown greasy silt loam (<i>paleosol</i>).
60	M04-35		Purplish, almost white sandy medium ash dispersed within the silt loam
200			Pale brown/yellow silt loam (<i>m-ash</i>)
60	M04-36	3600	Shower bedded fine-med lapilli, pocketing within a coarse brown/grey ash. No distinct top boundary.
50	M04-37		Grey coarse-med ash. Basal portion to the overlying lapilli unit.
150			Grey/brown sandy loam, no distinct tephra bed (<i>m-ash</i>)
20	M04-38		Pocketing pink-purplish ash. Contains the odd lithic and pumice clast d-max ~2cm
100			Pale brown sandy loam (<i>m-ash</i>)
130	M04-39	3800	Pumiceous/gravely med lapilli, no massively bedded.
20	M04-40		Pocketing med grey ash.
130			Brown greasy silt loam (<i>paleosol</i>)
70	M04-41		Purplish-pink med-coarse ash.
40			Brown greasy silt loam (<i>paleosol</i>)
<3m	M04-42		Diamicton unit, powdery lava boulders, up to 60cm, supported by a sandy grey matrix.

Section 10: Otakehu Stream

E2602600

N6207450



Appendix 3.14:

Section 11: Kaupokonui Stream

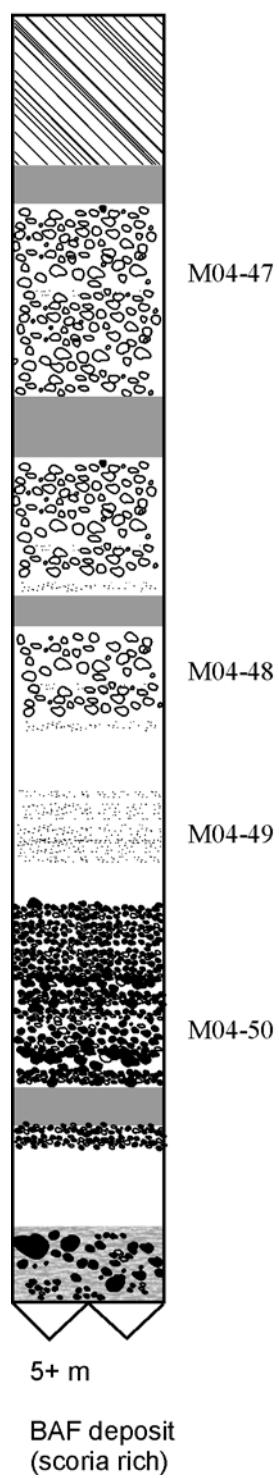
E2605769

N6207758

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
<200			Top of the section, mixed up due to fallen trees, thus un-described.
50	M04-47		Dark brown greasy silt loam (<i>paleosol</i>)
240			Slightly reversely graded yellow pumiceous med-coarse lapilli. Lowest 4cm of the unit is considerably more ash supported and finer than the top portion. Grey lithic (5%) dispersed throughout the unit, possibly slightly more in the upper 10cm. Pumice d-max: 2cm. Lithic d-max: 4.5cm
80			Dark brown, greasy silt loam with the odd pumice dispersed throughout it (from overlying unit) (<i>paleosol</i>)
70			Light brown sandy loam (<i>m-ash</i>)
140		1800	Pumiceous coarse lapilli, containing approximately 50% grey lithic clasts. Largest lithics and pumiceous near the base. Pumice d-max: 8cm (radially fractured, most pumices' ~3cm in size). Lithics d-max: 2cm.
20			Pink-purplish med ash.
35	M04-48:		Light brown, greasy silt loam (<i>paleosol</i>)
130			Pumiceous med lapilli. Reversely graded. Pumice d-max: 4cm. Lithic d-max: 1.5cm.
60	M04-49		Light brown sandy loam (<i>m-ash</i>)
100			Pocketing grey med ash containing lithics ~0.6cm in size
60	M04-50		Light brown sandy loam (<i>m-ash</i>)
250		2500	Shower bedded black med lapilli. Three units, each normally graded. Largest clast: 6.5cm.
50			Greasy light brown silt loam (<i>paleosol</i>)
30			Shower bedded black fine-med lapilli
100			Light brown sandy loam (<i>m-ash</i>)
>5m			Dark grey to black diamicton. Boulders up to 60cm supported by a sandy grey matrix.

E2605769
N2607758

E2605769
N2607758



Appendix 3.15:

Section 12: Willkie's Pool

E2604700
N6209000

The top 1-1.5 meters is difficult to describe. It is overgrown and by tree roots and shrubs. Therefore the following description starts the dominant basaltic scoria rich tephra.

Unit Depth (mm)	Sample Taken	Approx age (yrs BP) from correlation	Description
400			Black fine scoriaceous lapill, nearly cemented
100			Yellow-brown sandy silt loam (medial ash)
20-30			Single line of pumiceous fine-medium lapilli. 40 % grey andesite. Pumice d-max: 10mm. andesite d-max: 8mm
90			Yellow-brown sandy silt loam (<i>m-ash</i>)
470	M06-51		80 Poorly sorted pumiceous and grey, radially fractured andesite.
	M06-52		Noticeable plagioclase phenocryst sits on...
	charcoal		290 Orange-yellow medium ash-fine lapilli. Poorly sorted P-flow. (Contains charcoal)
			100 purple-brown poorly sorted medium-coarse ash
			10 Orange-red-brown iron pan
			50 well sorted medium pumiceous ash. Red-grey andesite
90			Purple-brown silt loam (<i>paleosol</i>)
400	M06-53	3700	Medium, well sorted pumiceous and grey andesite lapilli. d-max pumice 170, most 80-100mm. 40 % grey andesite. d-max: 40
100			Brown greasy silt loam (<i>paleosol</i>)
60			Pumiceous fine lapilli. Similar to overlying unit. 20 % grey andesite (mono-lithic) d-max lithic: 40mm. d-max pumice: 50mm
30			Brown greasy silt loam (<i>paleosol</i>)
200			100 medium sorted. Grey medium ash diamicton
			100 coarse grey ash, poorly sorted diamicton with clasts D-max 50mm. monolithic: crystalline grey andesite. Rare pumiceous clasts
60			Yellow-brown sandy silt loam (<i>m-ash</i>)
30			Reddish-orange iron pan
500			Well sorted pumiceous fine lapilli, ungraded d-max: 40mm. 2-5 % grey andesite lithics d-max: 25mm
40			Yellow-brown sandy silt loam (<i>medial ash</i>)
8			Pocketing light grey fine-medium ash
40			Yellow-brown sandy silt loam (<i>medial ash</i>)
280	M06-54		Poorly sorted pumiceous P-flow. Normally graded: fine lapilli to med-fine ash
110			Yellow-brown sandy silt loam (<i>medial ash</i>)
90			Yellow pumiceous fine-medium lapilli. Well sorted, ungraded.

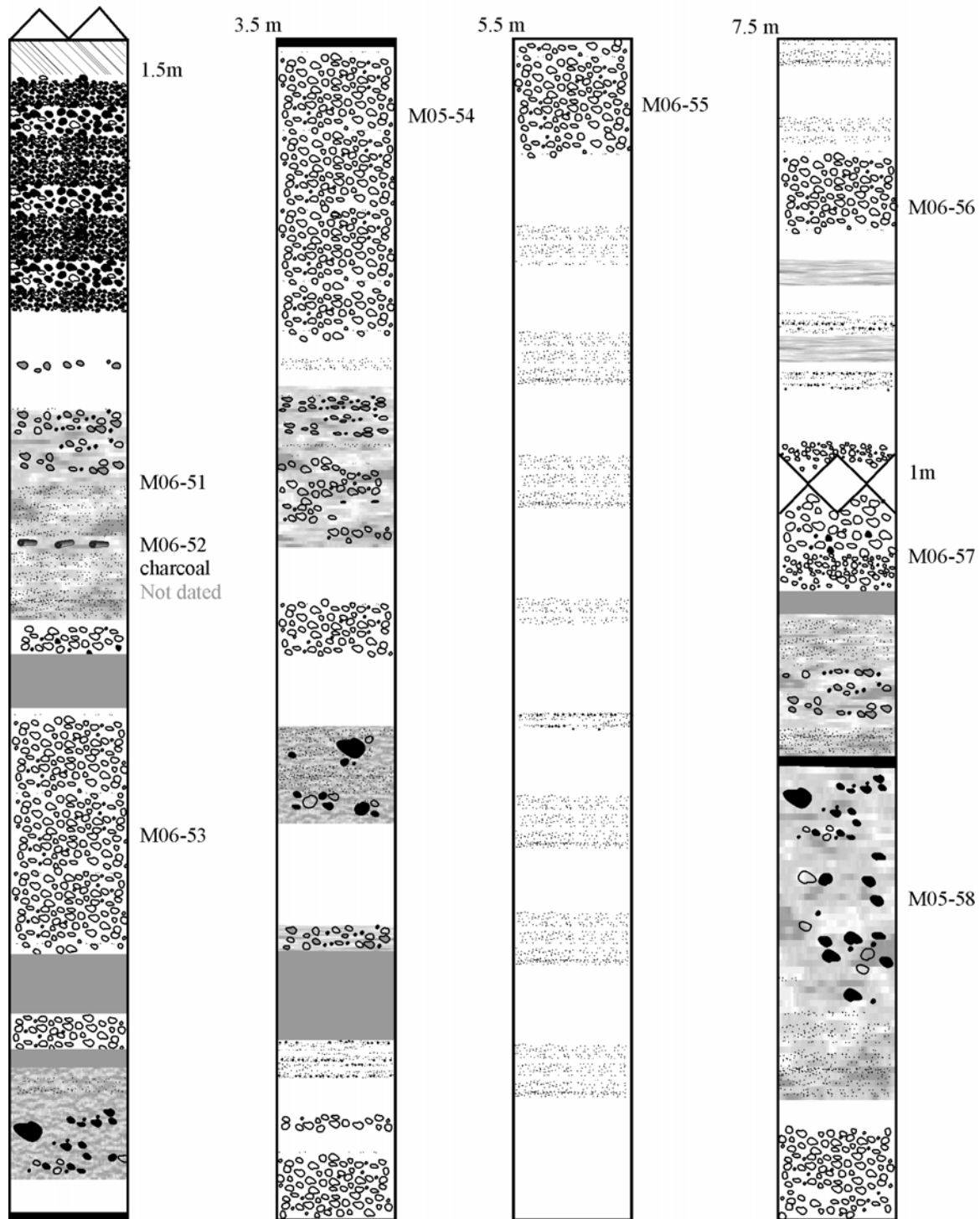
120			d-max: 25mm. 10-15 % monolithic-steal grey. d-max: 12mm
160			Yellow-brown sandy silt loam (medial ash)
170			Poorly sorted medium ash to fine lapilli. d-max: 15mm. Grey andesite with 40 mm wavy layers (co-ignimbrite; BAF surges)
60			Yellow-brown sandy silt loam (<i>medial ash</i>)
150			Poorly sorted medium ash pumiceous p-flow. Contains distinctive soft andesite clasts
60			Brown-yellow silt loam (paleosol-medial ash)
70			Dark grey medium ash, poorly sorted
10			Yellow-brown sandy silt loam (<i>m- ash</i>)
40			Single layer of yellow pumiceous clasts
280	M06-55	4300	Yellow-brown sandy silt loam (<i>m-ash</i>)
2200			Pumiceous coarse lapilli. d-max: 120mm most 60mm. 30 % dark grey andesite, distinct plagioclase phenocryst. d-max 50mm
150	M06-56		Alternating medial ash to brown paleosol and grey medium-fine ash poorly sorted (co-ignimbrite ash) 80-150 mm thick layers
10			Medium pumiceous lapilli; normally graded. Banded pumice clasts (yellow to dark brown/grey crystalline bands) d-max 40mm. 40 % glassy grey andesite. d-max: 10mm
30-40			Yellow-brown sandy silt loam (<i>m- ash</i>)
30			Well sorted grey medium ash, vesicles (co-ignimbrite surge)
1340	M06-57	6000	Yellow silt loam (weakly developed paleosol)
	lower unit		40 purple-grey medium ash
			50 purple-grey coarse-medium ash, vesicles (co-ignimbrite surge)
			50 grey-purple medium ash, slightly greasy and brown (weakly developed medial ash/paleosol?)
			1200 shower bedded pumiceous lapilli. 3 beds.
			300 pumiceous normally graded medium lapilli. d-max 60mm. 20 % grey crystalline, 2 mm vesicles, radially fractured, d-max: 40mm
			300 pumiceous reversely graded lapilli; d-max: 100mm 50 % grey andesite d-max 70mm
			600 reversely graded pumiceous lapilli. d-max: 40mm. 10 % grey andesite, d-max: 30mm
40			Brown greasy silt loam (<i>paleosol</i>)
240			60 normally graded grey medium ash to purple medium-fine ash
			50 medium ash, poorly sorted (co-ignimbrite surge)
			90 Pumice and grey andesite p-flow unit. Poorly sorted d-max: 20mm
			40 pink/purple fine-medium ash containing vesicles (co-ignimbrite surge. Dark grey 5 mm base)
2			Orange-red iron pan
50			Brown-yellow silt loam (<i>paleosol</i>)
560	M06-58	6100	140 Poorly sorted grey andesite diamicton (BAF) matrix supported (medium ash)
			320 grey-purple medium-fine poorly sorted ash.
			25 grey medium ash
			25 grey medium ash
			50 purple medium ash
60			Yellow-orange brown silt loam (<i>m-ash</i>)
1500	M06-59		Slightly reversely graded pumiceous fine-medium lapilli. Top 600mm 20 % grey andesite (monolithic) d-max: 20mm
			Middle 400mm: 40 % grey andesite d-max: 30mm Pumice D-max: 50mm
			Base: 5 % grey andesite. d-max: 20mm Pumice d-max: 40mm

			Banded pumice clasts (yellow to dark brown/grey crystalline bands)
80			Sandy yellow loam (<i>m-ash?</i>)
1730	M06-60		Shower bedded pumiceous lapilli: 250 fine pumiceous lapilli d-max: 20mm. 5 % grey andesite (lithics) 100 finely bedded medium-coarse pumiceous ash (surges?) 280 fine-medium pumiceous lapilli d-max: 40mm. 50 % dark grey andesite. d-max: 20mm Pumices clasts are dark yellow-brown (different to underlying or overlying units) 280 finely, mm-cm bedded medium coarse dark grey ash (surges) 600 reversely graded pumiceous medium lapilli. d-max: 120mm most ~50mm grey andesite clasts (lithics) concentrated near the base of the unit (30%) 220: 20mm thick beds of pumiceous surges. Two are poorly sorted with clasts d-max: ~20 mm
200			Yellow sandy loam (medial ash?)
300	M06-61		Shower bedded pumiceous medium lapilli. d-max: 80mm. 10% grey andesite lithics concentrated in the middle of the deposit. d-max: 15mm
30			Brown greasy silt loam (<i>paleosol</i>)
30			Mm bedded grey medium-fine ash
30			Brown-yellow silt loam (<i>weakly developed paleosol-medial ash</i>)
30			Mm bedded grey medium-fine ash
20			Brown, greasy silt loam (<i>paleosol</i>)
200			Cm bedded grey medium-coarse ash. Pumiceous base
80			Yellow-brown sandy silt loam (<i>m- ash</i>)
700	M06-62		200 Coarse pumiceous ash, poorly sorted p-flow. Basal pumiceous layer.
	M06-63		250-300 normally graded pumiceous medium-coarse lapilli. Pumice d-max 200mm. 50 % grey andesite at the base.
			250 coarse grey andesite ash; cm bedded containing charcoal.
260			Yellow-brown sandy silt loam (<i>m- ash</i>)
40			Dark brown silt loam (<i>paleosol</i>)
120			40 fine pumiceous lapilli
			120 grey-purple medium ash
20			Iron pan – (possible silt loam)
150			Non-graded yellow pumiceous fine lapilli. d-max: 30. grey andesite (5%)
120			Purple, medium ash (<i>m-ash?</i>)
450	M06-64	Wk-19166	350 normally graded yellow pumiceous lapilli. d-max 100mm.
	M06-65	7913 ± 62	5% grey andesite, d-max: 40mm.
	charcoal		100 cm bedded coarse ash, grey andesite with increasing pumice component near the top. Large charcoal fragments
20			Light brown sandy silt loam (<i>paleosol?</i>)
190			80 mm to cm bedded fine-medium ash. Grey to purple layers
			110 poorly sorted pumiceous medium lapilli. P-flow. Bedded on 2 cm scale. Grey andesite (lithic) rich
1000			Alternating deposits of grey medium-fine ash 10-20cm thick (co-ignimbrite ashes) and sandy yellow loam (<i>m-ash</i>)
300			4 distinct beds of poorly sorted grey-purple ash (co-ignimbrite ash) with some clasts 100 mm in diameter. Small pieces of charcoal within the sandy matrix
1300			Grads up to a purple sandy silt loam (medial ash) from a light-creamy grey silt loam (pod-sol like)

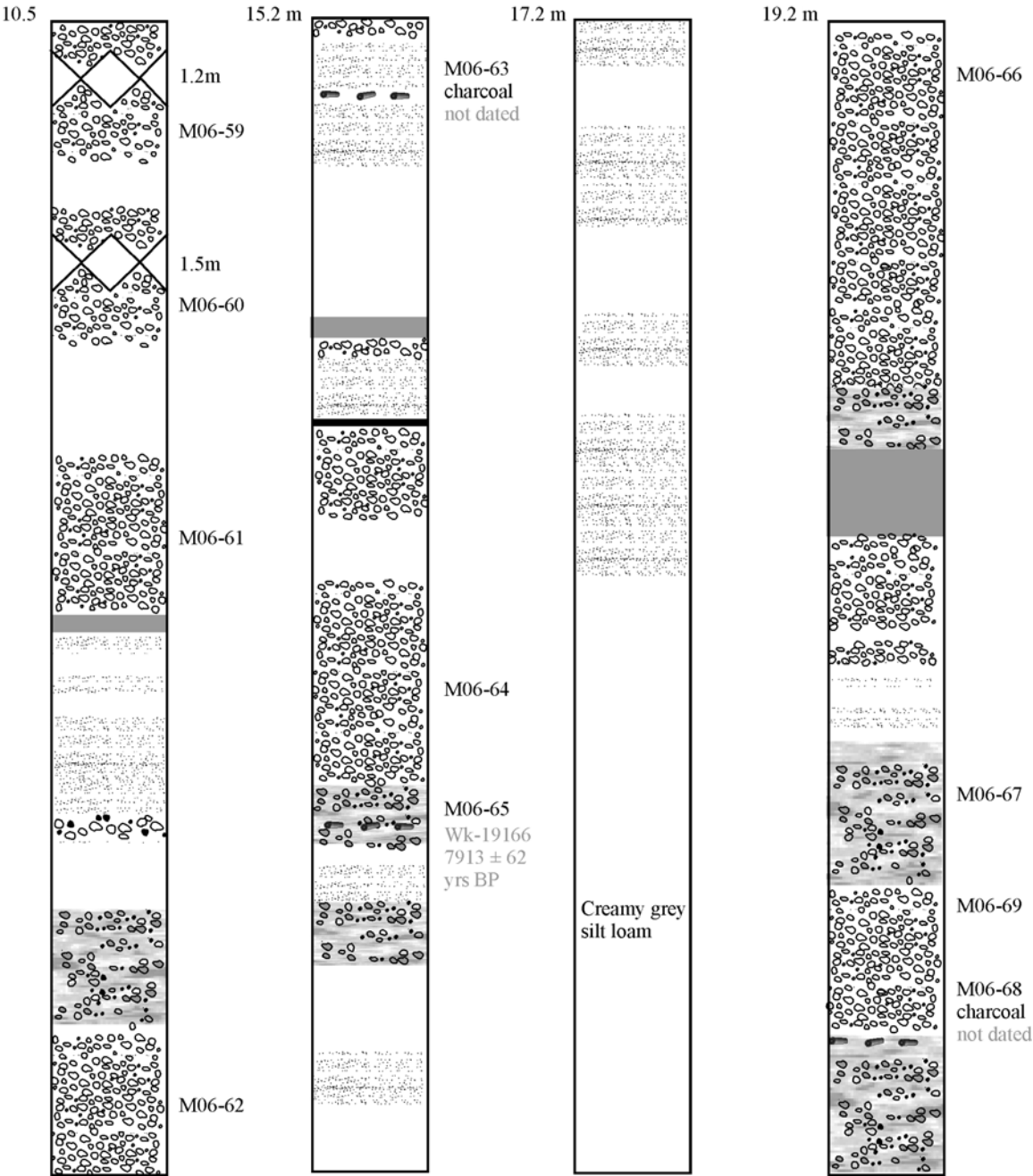
800	M06-66	9200	750 Coarse-medium pumiceous lapilli, normally graded with an increase of grey andesite (lithics) near the top of the deposit. Pumice d-max: 200mm
			50 Basal unit to pumiceous lapilli. Mm-cm bedded pumiceous coarse ash. P-flow surges.
0-150			Erosional contact to overlying unit. Light brown-yellow silt loam (<i>paleosol</i>)
180			Coarse – medium pumiceous lapilli. Distinctive orange-yellow colour. Non-graded. 2 % light grey andesite (lithics)
0-20			Light brown-yellow silt loam (<i>paleosol</i>)
30			Poorly sorted pumiceous lapilli (p-flow). 50 % light grey andesite and 50 % orange/yellow pumice. Cm scale bedded.
30			Light-brown sandy silt loam (<i>paleosol</i>)
20			Grey medium ash. Poorly sorted (co-ignimbrite ash)
30			Light brown-yellow silt loam (<i>paleosol</i>)
60			Grey medium ash. Poorly sorted (co-ignimbrite ash)
20			Light brown-yellow silt loam (<i>paleosol</i>)
2000	M06-67		5 units of pumiceous fall and pyroclastic flow/surge deposits
	M06-69		Top 3 units, mm bedded pumiceous ash grades to fine-medium lapilli. Each unit approximately 300 mm thick
	M06-68		Lower two units, each have 40mm basal sandy surge deposits. grades into coarse pumiceous lapilli with abundant amphibole xenoliths (20-60mm in length) yellow-orange pumice clasts and light grey andesite lithics. d-max lithic 180mm
	(charcoal)		Surge layers containing charcoal.
Base			Base of section is a very eroded lava flow covered in colluvium

Section 12: Wilkie Pools (part a)

N6209000
E2604700



Section12: Wilkies Pools (part b)



Appendix 4: Conical Discriminant Function Analysis

	E02-100	E02-101	E02-104	E02-106	E02-107	E02-109	E02-112	E02-78p	E02-79	E02-86	E02-89	E02-95	E02-97	E02-98
Rk-12	15.57	20.37	16.56	17.08	82.62	14.46	11.77	13.35	3.00	3.80	4.96	4.60	14.34	15.11
Rk-13	25.14	29.11	26.24	30.72	107.90	23.17	19.30	3.13	0.19	10.78	10.97	5.74	6.54	6.56
Rk-14	23.82	26.75	25.24	29.33	123.39	22.32	17.91	2.90	2.21	15.51	15.17	11.22	12.91	11.95
Rk-15	8.80	12.51	9.76	10.26	75.24	8.15	6.44	16.36	5.58	4.46	3.80	5.98	17.53	18.74
Rk-16	13.24	17.17	13.06	17.34	69.25	11.15	9.25	10.93	4.05	2.40	1.59	6.68	13.32	15.47
Rk-17	11.30	14.68	11.01	15.88	69.43	9.23	7.47	10.40	4.62	3.10	1.53	7.98	14.41	16.62
Rk-18	11.36	15.21	10.73	15.19	62.00	9.16	7.59	13.52	6.36	1.53	0.52	9.35	17.47	20.09
Rk-19	6.27	9.82	5.61	7.76	51.84	4.87	4.29	24.61	13.68	2.94	1.50	14.90	29.20	32.22
Rk-20	2.17	4.24	1.93	4.37	61.45	1.33	0.89	23.30	14.45	6.95	3.73	16.82	30.80	33.28
Rk-21	54.35	58.42	59.55	58.66	150.30	55.25	52.78	33.27	21.03	45.28	43.79	9.70	8.10	6.78
Rk-22	34.73	38.11	38.96	38.71	136.99	35.29	32.21	17.45	8.44	29.17	27.90	3.98	5.18	3.63
Rk-24	23.69	27.88	19.92	30.47	38.32	18.90	18.22	25.08	22.10	5.89	4.26	28.70	34.13	39.79
Rk-25	1.18	0.40	2.15	2.49	79.11	2.39	3.46	42.53	32.49	26.70	19.54	32.39	50.88	52.81
Rk-26	0.59	0.07	0.92	2.49	72.21	1.18	2.16	39.69	30.76	23.11	16.24	31.98	49.64	52.03
Rk-27	0.62	0.47	0.79	3.45	76.29	0.64	0.70	30.00	23.50	18.45	12.48	27.36	42.31	44.30
Rk-29	1.09	1.12	1.75	4.27	81.19	1.21	0.97	25.40	19.01	17.33	11.57	22.03	35.17	36.74
Rk-30	0.53	1.95	0.71	1.40	65.17	0.54	0.54	31.10	20.55	12.03	8.13	22.13	39.59	41.79
Rk-31	2.95	5.20	3.72	4.53	73.36	2.73	1.77	20.56	10.77	7.83	5.19	12.12	25.78	27.23
Rk-33	9.61	12.39	10.72	12.67	91.82	8.84	6.32	9.91	3.55	7.64	6.33	7.87	16.44	16.81
Rk-34	3.89	4.78	5.04	6.13	95.66	4.07	2.37	19.76	13.72	15.46	11.94	19.48	32.62	32.87
Rk-35	5.52	7.88	6.60	8.10	81.18	5.13	3.65	15.03	6.70	7.83	5.38	8.35	18.96	19.98
Rk-36	5.21	7.01	5.48	9.00	81.82	4.18	2.43	12.87	8.07	8.17	5.26	13.75	23.30	24.55
Rk-37	4.89	6.43	5.13	8.73	83.53	3.91	2.17	13.52	9.17	9.31	6.15	15.45	25.25	26.43
Rk-39	6.98	9.96	6.19	9.89	67.10	5.16	3.42	16.08	9.96	3.54	2.21	16.51	28.01	30.15
Rk-40	5.85	8.32	6.23	8.98	78.07	4.84	3.09	13.13	6.56	5.93	3.81	10.77	20.84	22.16
Rk-41	11.91	14.35	12.67	16.58	96.08	10.59	7.77	6.32	3.01	8.87	7.11	9.39	15.01	15.44
Rk-43	3.50	5.27	3.82	6.22	79.36	2.82	1.32	16.89	10.54	8.65	5.80	15.71	27.79	29.05
Rk-44	3.31	5.56	4.05	4.99	76.32	3.01	1.76	19.14	10.07	7.74	5.33	12.56	25.96	27.20
Rk-46	6.72	9.60	6.94	9.46	76.53	5.56	3.62	13.33	6.36	4.65	3.22	10.98	21.57	22.92
Rk-47	3.73	5.89	4.21	4.24	80.70	3.55	1.94	23.61	14.66	10.03	8.26	20.02	36.46	37.37
Rk-48	3.98	5.98	4.87	6.16	82.73	3.68	2.13	16.74	8.96	8.87	6.31	12.40	24.61	25.51
Rk-49	18.57	20.03	20.14	24.70	123.59	17.58	13.94	4.86	5.15	18.95	16.37	13.76	15.93	15.10
Rk-50	13.66	15.10	14.11	19.48	107.70	12.14	8.90	6.23	6.77	14.23	11.64	17.30	21.84	21.92
U05-0	7.39	10.31	6.10	11.41	49.83	5.20	4.78	20.32	13.10	3.46	0.70	15.63	25.75	29.40
U05-1	7.39	10.94	7.39	8.20	73.05	6.35	4.31	19.31	10.05	4.19	4.10	15.26	29.79	31.14
U05-10	18.72	23.14	20.53	21.18	84.49	18.07	16.25	16.25	4.51	8.92	8.51	0.73	7.83	8.85
U05-14	1.46	0.33	1.95	3.52	78.81	2.30	3.34	42.24	34.06	27.51	19.95	35.84	53.67	55.83
U05-16	2.75	4.59	3.34	0.66	69.85	3.61	3.60	42.72	28.34	16.75	14.05	29.39	52.66	54.35
U05-19	0.65	1.85	0.43	1.63	63.08	0.48	0.62	33.47	23.56	13.16	9.01	26.26	44.37	46.85
U05-22	1.41	2.29	0.71	4.84	63.12	0.42	0.33	25.50	19.38	11.39	6.51	23.75	37.13	39.93
U05-23	6.05	3.60	7.62	8.82	91.81	7.89	9.85	51.30	42.48	40.41	30.38	40.15	56.82	58.78
U05-24	1.25	3.03	2.12	0.69	66.61	1.94	2.17	35.53	21.81	13.54	10.05	20.46	39.91	41.83
U05-25	33.82	37.22	37.68	28.44	164.47	36.27	31.18	46.26	33.27	41.17	44.57	42.30	65.18	60.92
U05-27	2.66	4.32	1.56	4.81	59.51	1.46	1.05	28.22	20.92	9.44	6.04	26.63	42.46	45.31
U05-29	1.08	0.89	2.33	3.27	85.16	1.90	1.93	30.18	21.88	20.78	14.75	23.07	38.03	39.28
U05-3	30.01	33.31	30.78	37.52	120.36	27.49	23.03	0.62	2.12	15.76	15.36	11.36	8.78	8.54
U05-32	3.58	5.50	3.91	6.67	74.58	2.79	1.60	16.27	9.37	7.47	4.38	12.81	23.90	25.51
U05-33	6.23	7.95	6.52	10.72	83.27	5.05	3.27	11.06	7.05	8.52	5.35	12.59	20.55	21.83
U05-36	2.94	4.75	3.32	3.85	79.95	2.74	1.33	23.96	15.63	10.87	8.51	21.13	37.31	38.37
U05-4	36.02	38.56	35.74	46.83	119.05	32.34	28.21	0.68	6.96	20.68	18.55	18.04	10.33	11.17

	E02-100	E02-101	E02-104	E02-106	E02-107	E02-109	E02-112	E02-78p	E02-79	E02-86	E02-89	E02-95	E02-97	E02-98
U05-40	7.47	10.14	8.15	10.42	84.59	6.55	4.36	11.57	5.12	6.41	4.84	9.77	19.45	20.28
U05-41	7.03	9.35	7.23	10.92	81.20	5.72	3.71	10.84	5.98	6.37	4.16	11.64	20.28	21.55
U05-43	6.99	9.32	7.93	10.07	87.55	6.32	4.23	11.77	5.38	7.98	5.91	9.48	18.93	19.60
U05-44	6.08	7.38	6.34	11.03	85.32	4.92	3.21	11.27	8.18	10.22	6.46	14.19	21.69	22.97
U05-45	5.76	7.02	6.53	7.38	97.80	5.68	3.45	20.90	15.31	15.33	12.88	23.63	38.05	38.14
U05-46	5.56	7.07	5.81	10.07	82.90	4.44	2.78	11.94	8.06	9.17	5.70	13.69	21.98	23.31
U05-48	10.61	12.89	12.25	9.85	110.62	11.21	8.15	24.76	16.13	17.67	17.40	24.05	41.25	40.17
U05-51	6.29	8.32	6.83	9.55	87.50	5.42	3.26	12.32	7.21	8.50	6.26	13.41	23.38	24.14
U05-53	6.08	8.32	7.69	5.18	96.45	6.83	4.74	26.00	15.29	14.46	13.37	19.77	37.70	37.40
U05-56	13.22	15.42	14.43	17.84	105.85	12.23	9.09	6.22	3.37	11.82	10.02	10.26	15.67	15.49
U05-57	18.33	20.50	18.77	23.73	114.97	16.57	12.49	5.44	6.31	14.49	13.43	18.72	23.11	22.70
U05-59	5.40	7.22	5.54	9.19	81.98	4.28	2.44	12.87	8.37	8.10	5.32	14.71	24.38	25.63
U05-6	12.68	16.49	13.32	16.12	74.99	11.30	9.48	11.93	3.45	4.27	3.27	3.98	11.22	12.84
U05-60	4.41	5.77	4.95	7.76	87.35	3.79	2.03	14.97	10.11	10.91	7.67	16.23	26.97	27.85
U05-61	3.05	3.76	4.60	3.31	96.25	4.08	2.86	29.21	20.10	19.53	15.93	24.23	41.75	41.83
U05-63	13.93	15.84	14.40	19.32	105.68	12.37	9.02	5.79	5.45	12.36	10.42	15.59	20.51	20.59
U05-64	7.22	9.70	8.20	8.57	93.54	6.90	4.35	16.14	8.89	9.76	8.74	15.28	28.39	28.47
U05-66	2.43	4.42	2.02	3.20	48.25	2.06	3.04	37.54	24.69	11.17	7.11	23.07	41.14	44.66
U05-68	2.18	3.60	2.84	4.81	77.36	1.90	1.00	19.48	11.88	10.29	6.55	14.59	27.02	28.44
U05-69	4.31	6.16	4.67	7.76	78.42	3.44	1.99	14.43	8.50	7.85	4.80	12.84	23.07	24.48
U05-7	11.85	15.05	10.06	17.37	55.76	8.79	7.51	14.34	10.52	2.75	0.66	16.41	23.13	26.66
U05-71	9.37	10.64	9.20	15.72	88.36	7.56	5.48	8.06	7.65	10.80	7.02	15.71	20.47	21.87
U05-72	9.64	11.00	9.78	15.63	92.27	8.05	5.76	7.60	6.76	11.10	7.62	14.65	19.64	20.68
U05-73	9.15	11.41	10.69	10.36	105.24	9.21	6.27	16.00	9.08	13.17	12.21	15.84	28.63	27.97
U05-74	8.12	10.81	7.62	12.73	69.37	6.16	4.55	11.36	6.59	4.02	1.73	11.54	19.12	21.35
U05-75	10.42	13.20	10.88	13.72	92.49	9.16	6.22	9.40	4.96	7.34	6.47	12.70	21.51	21.93
U05-76	22.06	24.08	23.17	28.40	125.18	20.49	16.24	3.20	4.69	17.87	16.39	15.61	17.02	16.17
U05-78	6.09	7.67	8.23	5.82	104.66	7.21	5.15	24.95	15.09	17.80	15.75	19.02	35.61	34.90
U05-8	20.37	24.25	21.80	25.02	94.03	19.02	16.42	8.16	1.39	9.39	8.59	1.81	4.81	5.53
U05-81	10.08	11.61	11.90	9.41	115.50	11.03	8.20	27.71	19.61	21.84	20.62	27.77	45.56	44.31
U05-82	11.48	12.91	12.30	15.68	109.62	10.60	7.39	10.12	8.69	15.06	12.84	18.95	26.83	26.49
U05-83	17.98	20.46	19.98	20.08	128.06	17.85	13.55	12.21	8.12	18.37	18.42	17.79	27.25	25.42
U05-84	12.80	15.18	13.90	16.59	106.19	11.86	8.51	7.65	4.36	11.35	10.18	12.41	19.59	19.25
U05-85	20.49	22.50	22.08	25.61	128.31	19.51	15.24	5.41	5.24	18.62	17.39	15.47	19.08	17.77
U05-86	17.89	19.60	19.15	23.72	120.07	16.70	12.95	4.64	4.87	16.92	14.84	14.40	17.36	16.65
U05-88	18.79	20.83	19.66	25.21	114.13	17.11	13.43	2.96	3.58	14.63	12.71	12.94	14.62	14.38
U05-89	23.70	25.87	25.15	30.24	127.12	22.23	18.02	2.64	3.59	18.53	17.01	12.94	13.24	12.30
U05-9	33.03	37.59	36.28	36.39	109.83	32.92	30.75	20.67	8.55	21.64	21.06	1.18	3.97	4.04
U05-91	26.29	28.17	26.70	34.58	124.53	23.84	19.52	1.36	5.87	19.24	17.27	18.41	16.39	16.10
U05-93	19.14	21.47	19.54	25.88	108.10	17.02	13.38	2.31	3.29	12.54	10.85	13.09	14.34	14.56
U05-95	8.70	11.58	8.58	12.93	73.63	6.96	5.12	10.45	5.08	4.07	2.19	9.58	17.20	19.02
0.05th percentile	1.08	1.01	1.24	2.49	57.64	1.20	0.93	2.77	3.01	3.28	1.56	4.29	7.96	7.66

	M04-100	M04-102	M04-107	M04-108	M04-109	M04-111	M04-115	M04-116	M04-150	M04-151	M04-152	M04-154	M04-155	M04-156
Rk-12	6.57	7.09	6.57	6.01	10.95	14.22	9.97	12.63	14.78	5.60	3.96	6.83	5.12	7.76
Rk-13	2.44	3.65	2.94	2.67	3.83	5.72	3.54	11.19	3.47	16.57	8.69	8.43	4.20	2.88
Rk-14	1.56	1.63	4.14	3.77	0.74	1.42	1.91	6.31	3.60	22.28	13.04	12.44	10.38	8.03
Rk-15	6.96	7.26	6.82	6.75	11.71	15.22	9.92	11.30	17.98	3.03	1.76	6.79	6.39	9.65
Rk-16	4.75	5.86	2.99	2.91	11.00	14.28	7.50	11.24	12.23	4.80	1.99	2.03	4.18	6.19
Rk-17	3.88	4.83	2.26	2.33	9.93	12.98	6.23	9.40	11.76	5.30	1.93	1.80	5.10	6.80
Rk-18	6.03	6.90	3.93	3.81	13.40	16.77	9.19	11.12	15.19	3.96	2.30	1.52	6.46	9.10
Rk-19	12.23	12.29	10.32	10.23	20.96	24.88	16.32	13.85	27.10	1.96	3.70	5.47	13.26	18.17
Rk-20	10.19	9.74	9.49	9.83	16.95	20.20	12.94	9.63	25.75	4.42	4.14	7.52	15.38	19.29
Rk-21	33.31	37.42	33.18	34.71	30.34	35.41	32.21	54.97	30.81	35.41	24.92	43.59	12.95	12.51
Rk-22	15.80	18.10	17.33	18.23	12.91	16.37	15.13	30.25	16.26	23.93	14.16	27.60	6.69	5.85
Rk-24	18.34	19.89	12.37	12.08	31.94	35.50	22.69	23.15	27.36	13.83	13.91	3.34	20.23	23.25
Rk-25	23.74	22.26	24.90	26.35	28.07	31.27	24.71	18.49	45.20	15.79	14.77	26.05	32.85	37.32
Rk-26	21.58	20.19	22.11	23.40	27.00	30.09	22.87	16.31	42.49	14.23	13.44	22.10	31.35	35.72
Rk-27	14.58	13.23	15.47	16.43	19.24	21.66	15.71	9.90	32.64	13.15	10.90	16.64	26.17	29.24
Rk-29	11.52	10.57	12.56	13.60	15.12	17.58	12.23	8.86	27.57	11.80	8.33	15.13	21.19	23.64
Rk-30	15.10	13.97	15.31	15.79	21.34	24.62	17.83	11.93	33.93	6.80	7.53	13.61	21.97	26.72
Rk-31	8.32	7.88	8.71	9.03	13.00	16.17	10.68	8.90	22.64	4.40	3.13	9.04	12.28	15.74
Rk-33	2.54	2.39	3.82	3.78	4.90	7.10	4.20	5.37	11.36	8.68	4.20	7.41	7.78	8.86
Rk-34	7.73	6.17	10.50	10.80	9.46	11.06	8.83	4.32	22.05	13.58	9.70	14.87	20.04	21.70
Rk-35	5.23	5.23	5.76	6.12	8.72	11.65	6.98	7.88	16.58	5.39	2.20	7.88	8.32	10.60
Rk-36	3.55	3.05	4.30	4.51	7.32	9.35	5.06	3.65	14.79	8.87	4.84	6.58	12.23	13.59
Rk-37	3.88	3.18	4.90	5.13	7.44	9.29	5.26	3.13	15.53	10.06	5.87	7.49	13.91	15.15
Rk-39	6.13	5.53	5.76	5.38	12.77	15.13	9.34	5.60	18.62	6.96	5.91	4.03	14.23	16.91
Rk-40	3.88	3.65	4.24	4.33	8.16	10.65	5.93	5.34	14.98	6.29	3.21	5.57	9.69	11.65
Rk-41	0.79	0.82	1.96	1.98	2.82	4.49	1.82	3.93	7.56	11.92	5.62	6.58	8.02	7.84
Rk-43	5.77	4.88	6.78	6.94	9.87	12.05	7.69	4.42	19.16	8.27	5.58	8.28	14.87	17.08
Rk-44	7.31	6.70	8.06	8.25	11.65	14.50	9.64	7.35	21.28	5.37	3.79	8.84	12.70	15.82
Rk-46	4.15	3.83	4.47	4.32	8.85	11.34	6.66	5.44	15.33	6.02	3.63	5.06	9.96	12.18
Rk-47	10.14	8.40	12.07	11.81	14.43	16.60	13.08	6.12	26.54	9.47	9.16	12.49	20.75	24.22
Rk-48	5.79	5.11	7.02	7.23	9.18	11.65	7.65	5.77	18.74	7.13	4.37	9.17	12.51	14.87
Rk-49	1.68	1.52	4.56	4.80	0.23	0.80	0.98	4.69	5.56	22.75	12.51	14.09	12.70	10.17
Rk-50	1.13	0.43	3.39	3.38	2.01	2.49	1.36	1.18	7.74	19.60	11.50	9.96	15.14	13.56
U05-0	9.96	10.62	7.04	7.31	19.07	22.73	13.12	12.86	22.42	3.74	3.27	2.72	11.73	15.31
U05-1	8.16	7.14	8.86	8.20	13.91	16.45	11.98	7.10	22.04	6.42	6.77	7.39	15.18	18.74
U05-10	10.20	12.08	9.02	9.34	14.02	18.42	12.49	21.17	16.61	5.66	2.44	10.39	1.31	3.89
U05-14	23.64	21.97	24.74	26.18	28.27	31.07	24.44	17.21	45.07	18.01	16.53	25.84	35.37	39.40
U05-16	23.44	21.27	24.88	24.92	29.71	33.10	27.36	17.11	46.33	10.34	14.09	22.03	31.53	38.01
U05-19	16.79	15.39	16.93	17.37	23.65	26.74	19.67	12.19	36.60	8.56	9.71	14.56	25.60	30.48
U05-22	11.69	10.91	11.11	11.75	18.44	21.15	13.68	8.88	28.13	8.94	7.55	9.78	21.11	24.37
U05-23	31.93	30.88	33.05	35.49	34.83	38.19	31.08	27.51	53.34	24.95	21.41	36.75	40.33	44.04
U05-24	18.39	17.36	18.78	19.32	24.32	28.23	21.44	16.19	38.27	5.65	7.48	16.91	21.85	27.57
U05-25	32.97	28.42	42.35	40.50	28.86	28.92	36.41	23.76	49.74	43.18	42.68	50.70	51.25	53.87
U05-27	13.61	12.30	13.20	13.27	21.43	24.04	16.80	9.12	31.45	9.09	9.81	9.98	24.35	28.46
U05-29	14.87	13.77	16.39	17.60	17.81	20.56	15.49	11.93	32.34	12.67	9.68	19.46	23.45	26.49
U05-3	2.12	3.17	3.13	2.86	2.40	3.25	2.25	10.05	0.81	24.55	14.03	10.74	8.48	5.28
U05-32	5.58	5.27	5.78	6.13	10.20	12.87	7.44	6.21	18.22	6.05	3.28	6.77	11.63	14.00
U05-33	2.70	2.50	3.21	3.55	6.23	8.26	3.85	3.90	12.71	9.29	4.36	6.05	10.66	11.54
U05-36	10.26	8.52	12.09	11.97	14.61	16.73	12.94	5.92	26.89	9.94	9.30	12.64	21.50	24.84
U05-4	4.50	6.32	3.93	4.09	5.87	6.45	3.62	13.85	0.47	31.33	18.38	11.49	11.93	7.22
U05-40	3.11	2.80	4.03	3.98	6.52	8.79	5.09	4.81	13.33	7.47	3.91	6.32	9.21	10.80
U05-41	2.62	2.37	3.08	3.13	6.60	8.72	4.37	3.95	12.63	8.15	4.13	5.04	9.97	11.22
U05-43	3.18	2.91	4.31	4.44	5.99	8.26	4.76	5.02	13.38	7.96	3.81	7.44	9.15	10.55
U05-44	2.87	2.62	3.51	3.99	6.12	7.97	3.64	3.61	12.89	10.82	5.25	6.92	11.98	12.53

	M04-100	M04-102	M04-107	M04-108	M04-109	M04-111	M04-115	M04-116	M04-150	M04-151	M04-152	M04-154	M04-155	M04-156
U05-45	8.73	6.53	12.06	11.87	10.73	11.82	10.49	3.18	23.70	16.18	13.21	15.79	24.27	26.00
U05-46	3.15	2.86	3.71	4.11	6.72	8.71	4.22	3.82	13.66	9.63	4.73	6.54	11.71	12.64
U05-48	12.29	9.54	17.11	16.34	12.97	13.99	14.91	6.31	27.76	18.92	17.30	21.46	27.24	29.58
U05-51	3.26	2.52	4.68	4.69	6.29	8.11	4.89	3.02	14.28	9.84	5.80	7.64	12.60	13.83
U05-53	12.20	10.06	15.74	15.38	14.24	16.25	14.95	7.88	28.83	12.51	11.93	18.40	22.76	26.19
U05-56	1.00	0.79	3.04	3.07	1.66	2.98	1.60	3.69	7.37	14.78	7.57	9.34	9.53	8.82
U05-57	1.59	0.61	4.45	3.92	2.07	2.11	2.32	1.35	7.09	22.75	14.80	11.23	16.93	15.02
U05-59	3.55	2.92	4.38	4.51	7.40	9.29	5.14	3.15	14.89	9.43	5.48	6.56	13.08	14.39
U05-6	5.31	6.50	4.08	4.21	10.33	13.89	7.71	12.64	12.96	4.18	1.06	4.41	2.77	4.93
U05-60	4.69	3.73	6.26	6.51	7.62	9.39	5.96	3.19	17.06	10.88	6.73	9.46	15.36	16.69
U05-61	13.99	11.81	17.39	17.72	15.76	17.71	15.58	8.43	31.96	14.81	12.97	21.04	26.39	29.48
U05-63	0.82	0.18	2.95	2.78	1.99	2.64	1.45	1.38	7.32	18.06	10.59	8.93	13.68	12.42
U05-64	5.80	4.36	8.38	7.99	8.20	9.88	8.12	3.80	18.52	11.14	8.57	11.35	16.22	18.17
U05-66	20.57	20.26	18.65	19.33	29.64	34.13	24.12	19.66	40.32	4.19	6.97	13.40	21.97	28.22
U05-68	7.45	6.88	8.12	8.67	11.50	14.21	9.04	7.07	21.50	6.98	4.28	9.71	14.07	16.70
U05-69	4.46	4.10	4.93	5.24	8.57	10.96	6.09	5.01	16.32	7.27	3.79	6.67	11.54	13.39
U05-7	6.95	7.71	4.05	4.01	15.78	18.67	9.91	10.33	16.30	7.37	5.24	0.55	11.21	13.29
U05-71	1.64	1.58	2.01	2.42	4.88	6.28	2.08	2.89	9.53	13.92	6.98	5.92	12.25	11.71
U05-72	1.29	1.15	2.10	2.46	3.90	5.24	1.70	2.62	9.02	14.06	7.00	6.65	11.79	11.19
U05-73	6.13	4.48	9.71	9.32	6.91	8.24	7.98	3.92	18.23	14.38	10.75	14.65	17.62	18.97
U05-74	3.56	3.92	2.47	2.58	9.51	12.12	5.72	6.46	13.08	6.30	2.94	2.26	8.48	10.12
U05-75	2.18	1.45	3.83	3.41	4.97	6.45	4.17	2.60	11.34	11.55	7.27	6.97	11.88	12.60
U05-76	1.32	1.01	4.23	4.04	0.26	0.40	1.09	3.98	4.09	24.97	14.85	13.26	14.01	11.10
U05-78	11.62	9.60	15.63	15.62	12.18	14.05	13.40	7.86	27.39	14.35	12.05	20.42	22.26	24.93
U05-8	4.97	6.76	4.30	4.56	7.60	10.84	6.28	15.43	8.32	9.93	3.75	7.98	0.87	1.28
U05-81	14.27	11.20	19.62	19.07	14.25	15.05	16.36	6.88	30.79	21.86	19.71	24.96	31.15	33.33
U05-82	2.96	1.58	6.15	5.98	3.44	3.90	3.62	0.87	12.04	19.30	12.59	12.62	18.23	17.49
U05-83	5.77	4.02	10.68	9.97	4.10	4.41	6.94	4.26	14.06	23.05	16.76	18.88	19.82	19.20
U05-84	1.63	0.90	4.19	3.92	2.43	3.51	2.73	2.55	9.21	15.30	9.06	9.99	12.13	11.77
U05-85	2.24	1.52	5.93	5.67	0.51	0.70	2.18	3.84	6.48	24.44	15.05	15.33	15.18	12.79
U05-86	1.20	0.81	4.04	4.06	0.36	0.83	0.97	3.34	5.62	21.90	12.45	12.67	13.20	10.93
U05-88	0.42	0.46	2.38	2.38	0.53	1.22	0.37	3.91	3.82	20.46	11.07	10.00	10.86	8.58
U05-89	1.55	1.70	4.19	4.15	0.12	0.58	1.07	6.18	3.14	24.62	13.94	13.72	11.54	8.50
U05-9	17.81	20.88	16.81	17.61	18.90	23.72	18.76	34.32	19.69	15.84	9.49	21.83	2.81	4.07
U05-91	1.52	1.68	3.49	3.39	1.15	1.04	0.88	5.30	2.01	28.56	17.01	12.39	14.84	10.89
U05-93	0.10	0.30	1.41	1.31	1.27	2.04	0.40	3.89	3.25	19.49	10.55	7.83	10.25	8.09
U05-95	3.00	3.37	2.31	2.36	8.23	10.85	5.13	6.41	12.05	6.12	2.58	2.80	7.21	8.77
0.05th percentile	1.07	0.70	2.29	2.40	0.52	0.93	1.03	2.57	3.36	4.18	2.25	2.49	4.19	5.11

	M04-158	M04-159	M04-164	M04-166	M04-174	M04-176	M04-177	M04-192	M04-24	M04-28	M04-31	M04-36	M04-39	M04-51	M04-52
Rk-12	22.04	18.62	12.90	7.04	6.58	7.92	15.26	3.34	3.78	3.08	2.23	18.43	11.52	19.22	3.94
Rk-13	30.68	27.12	21.19	8.23	6.48	8.96	22.60	8.94	0.56	7.51	7.49	28.57	19.11	30.26	9.25
Rk-14	28.25	25.60	20.14	7.15	6.16	7.40	20.34	10.46	1.76	10.72	11.96	26.68	18.22	28.16	14.92
Rk-15	13.79	10.99	6.83	4.14	4.14	4.70	8.75	0.86	5.36	1.33	1.68	10.92	5.84	11.82	2.77
Rk-16	18.51	15.58	10.71	4.56	3.73	5.63	13.00	2.13	4.77	0.70	3.74	16.43	9.49	16.73	1.07
Rk-17	15.87	13.31	8.94	3.11	2.42	4.04	10.87	1.59	4.97	0.43	4.53	14.31	7.82	14.55	1.34
Rk-18	16.52	13.94	9.23	4.54	4.08	5.69	11.60	1.76	7.23	0.49	4.98	14.55	8.26	14.24	0.87
Rk-19	10.99	9.03	5.28	6.12	6.83	7.09	7.67	1.72	14.13	1.90	6.95	8.66	4.95	7.78	2.72
Rk-20	5.05	3.83	1.46	2.89	3.93	3.29	2.67	1.03	13.52	2.39	8.29	3.76	1.26	3.37	5.06
Rk-21	59.26	52.72	49.25	37.72	33.57	37.48	51.36	35.00	18.49	32.59	18.12	55.91	46.15	63.84	31.23
Rk-22	39.12	34.16	30.38	19.58	16.90	19.28	31.52	19.11	6.17	18.45	9.02	36.31	27.82	42.13	19.72
Rk-24	29.23	27.29	21.91	16.73	16.06	18.99	25.36	13.39	25.04	9.49	22.07	28.57	21.35	25.50	7.76
Rk-25	0.31	0.49	1.85	9.74	12.00	8.87	1.25	10.18	28.35	14.55	20.51	0.42	2.34	1.30	20.11
Rk-26	0.08	0.33	1.20	8.29	10.47	7.69	0.84	8.67	27.25	12.46	19.96	0.32	1.71	0.55	17.62
Rk-27	0.72	0.80	0.64	4.35	6.18	3.92	0.22	5.76	20.58	9.05	16.88	0.95	0.84	0.95	14.39
Rk-29	1.39	0.99	0.64	2.73	4.05	2.25	0.25	4.30	15.97	7.23	13.29	1.47	0.54	2.22	12.30
Rk-30	2.59	1.89	0.48	5.04	6.85	5.05	1.22	3.20	18.77	5.99	11.71	1.30	0.63	0.99	9.72
Rk-31	6.08	4.40	1.84	2.21	3.03	2.35	2.87	0.48	9.43	2.25	5.18	4.26	1.36	4.85	5.26
Rk-33	13.61	11.34	7.31	1.75	1.72	2.00	8.14	1.80	2.75	2.81	4.50	11.67	6.16	12.68	6.09
Rk-34	5.54	4.87	2.90	2.15	3.61	1.72	2.39	4.09	11.34	7.57	12.06	4.64	2.49	5.17	13.48
Rk-35	8.81	6.71	3.79	1.42	1.61	1.55	4.74	0.50	5.37	1.69	3.51	7.08	2.94	8.28	4.55
Rk-36	7.94	6.62	3.63	0.27	0.79	0.46	4.07	1.24	6.92	2.59	7.93	7.06	2.94	7.23	6.49
Rk-37	7.32	6.22	3.42	0.30	0.98	0.41	3.64	1.74	7.85	3.39	9.23	6.61	2.80	6.69	7.71
Rk-39	11.25	9.86	5.60	2.88	3.69	3.70	7.01	1.69	10.35	2.38	9.35	9.62	5.09	8.31	5.08
Rk-40	9.38	7.60	4.14	0.87	1.21	1.23	5.10	0.45	5.83	1.41	5.40	7.87	3.36	8.17	4.45
Rk-41	15.53	13.42	9.31	1.55	1.20	1.84	9.84	3.17	2.26	3.68	6.83	14.29	8.01	15.19	7.23
Rk-43	6.19	5.09	2.33	0.93	1.93	1.05	2.76	1.26	9.28	3.26	8.59	5.05	1.86	4.99	7.41
Rk-44	6.51	4.93	2.14	1.83	2.72	1.97	3.02	0.56	8.83	2.47	5.71	4.71	1.62	5.13	5.84
Rk-46	10.82	8.95	4.98	1.53	1.95	2.05	6.18	0.58	6.07	1.46	5.50	8.96	4.19	8.91	4.28
Rk-47	7.02	6.14	3.04	3.91	5.78	4.00	3.54	3.06	13.61	6.25	11.13	5.00	2.84	4.35	10.97
Rk-48	6.92	5.40	2.61	1.17	1.96	1.19	3.17	0.91	7.51	2.93	6.16	5.35	1.99	5.96	6.80
Rk-49	21.05	19.14	15.45	4.63	3.97	4.40	14.81	9.52	3.34	10.64	13.15	20.60	13.82	22.48	15.97
Rk-50	16.18	14.97	11.19	2.36	2.43	2.41	10.73	6.79	5.59	8.08	14.02	15.93	10.02	16.29	13.49
U05-0	11.27	9.47	6.12	4.90	5.00	5.97	8.30	2.18	13.46	1.28	8.56	10.15	5.67	9.28	1.86
U05-1	12.43	10.75	6.09	4.54	5.73	5.23	7.62	2.06	10.43	3.66	7.98	9.69	5.58	8.67	6.60
U05-10	24.40	20.15	15.68	10.00	8.46	10.65	18.27	5.74	4.27	4.46	0.52	21.13	14.00	23.87	3.92
U05-14	0.20	0.80	2.23	9.73	12.13	8.90	1.38	11.13	29.99	15.49	23.41	0.84	2.82	1.21	21.49
U05-16	5.43	4.97	3.35	11.23	14.12	11.12	4.15	7.77	26.62	12.17	16.76	3.00	3.85	2.20	16.62
U05-19	2.46	2.16	0.87	6.07	8.18	6.12	1.50	4.53	21.86	7.50	14.79	1.44	1.20	0.59	11.54
U05-22	2.81	2.45	1.09	3.16	4.52	3.34	1.57	3.30	17.80	5.09	13.91	2.72	1.16	1.98	8.87
U05-23	2.87	3.36	6.88	15.91	17.85	14.44	5.44	18.23	36.53	22.88	28.58	4.34	7.42	6.64	29.09
U05-24	3.67	2.54	1.27	7.35	9.18	7.25	2.30	4.01	19.79	7.12	10.19	1.64	1.40	1.99	10.40
U05-25	39.34	38.08	32.52	31.00	34.37	30.15	31.63	31.02	31.77	38.85	35.26	34.04	31.80	34.33	48.04
U05-27	5.17	4.90	2.54	5.18	7.06	5.64	3.41	4.13	20.25	6.19	15.64	4.32	2.75	2.54	9.90
U05-29	1.06	0.63	0.85	4.64	6.18	3.90	0.32	5.78	18.24	9.39	13.94	0.90	0.83	2.19	14.73
U05-3	34.84	31.72	25.74	9.92	7.98	10.57	26.44	13.31	2.36	11.77	13.89	33.70	23.51	35.16	14.57
U05-32	6.35	4.88	2.25	0.75	1.32	0.96	3.02	0.44	8.14	1.74	6.39	5.22	1.68	5.56	4.99
U05-33	8.83	7.36	4.42	0.09	0.28	0.29	4.85	1.45	5.84	2.39	7.57	8.17	3.60	8.63	6.08
U05-36	5.75	5.08	2.36	3.54	5.43	3.56	2.69	3.15	14.34	6.38	11.94	4.11	2.23	3.45	11.29
U05-4	39.82	37.00	31.49	13.36	10.70	14.21	32.04	18.72	7.25	15.66	21.28	40.28	29.19	41.50	18.00
U05-40	11.31	9.36	5.52	1.19	1.46	1.51	6.40	0.99	4.44	2.08	5.16	9.54	4.58	10.02	5.35
U05-41	10.43	8.76	5.14	0.58	0.81	0.96	5.92	1.07	5.32	1.87	6.68	9.23	4.29	9.39	5.18
U05-43	10.38	8.45	5.04	0.92	1.14	1.07	5.71	1.12	4.25	2.41	5.05	8.79	4.09	9.67	5.92
U05-44	8.14	6.90	4.34	0.01	0.23	0.10	4.48	2.13	6.66	3.21	9.02	7.88	3.55	8.40	7.29

	M04-158	M04-159	M04-164	M04-166	M04-174	M04-176	M04-177	M04-192	M04-24	M04-28	M04-31	M04-36	M04-39	M04-51	M04-52
U05-45	8.05	7.66	4.87	3.79	5.73	3.52	4.35	5.76	13.56	9.66	15.36	6.80	4.56	6.38	16.12
U05-46	7.89	6.59	3.89	0.03	0.34	0.17	4.20	1.58	6.68	2.70	8.28	7.39	3.14	7.80	6.59
U05-48	14.32	13.46	9.55	8.38	10.66	8.07	9.23	9.00	14.77	13.79	16.28	11.56	9.08	11.30	20.55
U05-51	9.38	7.98	4.59	0.69	1.31	0.84	4.96	1.69	6.15	3.37	7.91	8.13	3.82	8.34	7.61
U05-53	9.53	8.42	5.27	6.25	8.31	5.98	5.42	5.41	13.68	9.69	11.58	6.81	4.92	6.97	15.26
U05-56	16.58	14.53	10.52	2.22	1.92	2.28	10.65	4.67	2.22	5.69	8.14	15.37	9.15	16.62	9.99
U05-57	21.92	20.53	15.54	4.89	5.00	5.13	15.23	9.21	5.86	10.50	16.10	21.06	14.20	20.98	16.05
U05-59	8.18	6.97	3.85	0.38	1.00	0.60	4.26	1.48	7.34	2.90	8.68	7.31	3.19	7.27	6.94
U05-6	17.73	14.53	10.10	4.60	3.69	5.39	12.26	1.93	3.53	0.93	1.65	15.38	8.79	16.60	1.42
U05-60	6.62	5.63	3.06	0.58	1.48	0.52	3.06	2.18	8.47	4.38	9.73	5.84	2.49	6.09	9.18
U05-61	4.45	4.06	2.72	5.54	7.77	4.86	2.11	6.42	17.22	11.17	14.85	3.08	2.66	3.60	17.61
U05-63	17.04	15.59	11.38	2.42	2.44	2.60	11.22	6.08	4.63	7.20	12.52	16.37	10.15	16.66	12.19
U05-64	10.99	9.60	5.71	2.89	4.11	2.96	6.07	3.08	7.97	5.81	9.04	8.83	5.03	8.82	10.65
U05-66	4.98	3.87	2.57	8.96	10.44	9.37	4.33	4.69	23.48	6.25	12.11	3.49	2.85	3.03	7.92
U05-68	4.29	3.07	1.15	1.16	2.03	1.10	1.59	1.10	10.00	3.12	7.44	3.30	0.72	3.92	6.96
U05-69	7.04	5.60	2.84	0.39	0.90	0.58	3.44	0.72	7.26	2.02	6.83	6.03	2.19	6.38	5.56
U05-7	16.22	14.39	10.00	5.09	4.78	6.41	12.12	3.71	11.60	2.04	10.73	15.38	9.28	14.02	2.73
U05-71	11.46	10.26	7.28	0.61	0.49	0.85	7.34	3.83	6.47	4.26	11.42	11.66	6.34	11.91	8.34
U05-72	11.87	10.55	7.46	0.58	0.47	0.75	7.46	3.78	5.49	4.44	10.70	11.84	6.45	12.31	8.70
U05-73	12.70	11.29	7.47	3.89	5.12	3.72	7.41	4.92	7.73	8.19	10.29	10.49	6.65	10.97	13.78
U05-74	11.88	10.01	6.19	1.53	1.39	2.28	7.59	1.06	6.55	0.69	6.59	10.82	5.34	10.61	2.69
U05-75	14.57	12.84	8.26	2.03	2.44	2.42	8.88	2.93	4.68	4.20	8.34	12.83	7.25	12.75	8.23
U05-76	25.38	23.44	18.69	6.09	5.43	6.15	18.25	11.07	3.73	11.84	15.31	24.70	16.97	25.85	17.11
U05-78	8.66	7.57	5.14	5.68	7.52	5.08	4.80	6.04	12.66	10.55	11.64	6.42	4.69	7.40	16.67
U05-8	25.51	21.63	16.86	7.51	5.67	8.15	18.78	6.11	1.19	4.52	2.78	23.22	14.97	25.68	5.00
U05-81	12.84	12.41	9.30	9.16	11.73	8.55	8.45	10.75	17.53	16.25	19.26	10.55	8.98	10.46	23.89
U05-82	14.04	13.07	9.44	2.69	3.43	2.55	8.80	6.59	7.26	9.04	14.33	13.29	8.48	13.50	15.18
U05-83	22.00	20.33	15.47	7.50	8.30	7.26	14.97	10.39	6.95	13.60	14.73	19.71	14.18	20.52	20.05
U05-84	16.49	14.67	10.31	2.60	2.77	2.70	10.41	4.85	3.47	6.43	9.36	14.96	9.07	15.65	11.19
U05-85	23.82	21.93	17.34	6.07	5.79	5.94	16.75	10.66	3.98	12.27	14.60	22.72	15.71	24.04	18.04
U05-86	20.75	18.95	14.87	4.19	3.76	4.11	14.37	8.78	3.48	9.94	13.21	20.12	13.32	21.45	15.26
U05-88	22.03	20.00	15.58	4.10	3.31	4.27	15.47	8.22	2.67	8.53	12.24	21.43	13.95	22.59	13.01
U05-89	27.14	24.76	20.05	6.84	5.73	6.88	19.78	11.48	2.52	11.81	13.80	26.33	18.14	28.13	16.52
U05-9	38.72	33.25	28.94	20.18	17.30	20.55	31.54	16.22	7.56	14.08	5.22	35.26	26.56	40.30	12.76
U05-91	29.44	27.53	22.60	7.80	6.62	8.09	22.20	13.80	5.28	13.47	18.93	29.50	20.74	30.36	18.30
U05-93	22.74	20.67	15.91	4.10	3.23	4.51	16.10	7.84	2.88	7.62	12.26	22.15	14.29	22.87	11.58
U05-95	12.72	10.61	6.60	1.51	1.29	2.20	8.00	0.89	4.99	0.65	5.27	11.34	5.63	11.46	2.68
0.05th percentile															
	1.23	0.90	0.98	0.34	0.64	0.49	1.23	0.57	2.31	0.81	3.15	1.12	1.00	1.25	2.27

	M04-154	M04-155	M04-156	M04-158	M04-159	M04-164	M04-166	M04-174	M04-176	M04-177	M04-192	M04-24	M04-28	M04-31	M04-36	M04-39
Rk-12	6.83	5.12	7.76	22.04	18.62	12.90	7.04	6.58	7.92	15.26	3.34	3.78	3.08	2.23	18.43	11.52
Rk-13	8.43	4.20	2.88	30.68	27.12	21.19	8.23	6.48	8.96	22.60	8.94	0.56	7.51	7.49	28.57	19.11
Rk-14	12.44	10.38	8.03	28.25	25.60	20.14	7.15	6.16	7.40	20.34	10.46	1.76	10.72	11.96	26.68	18.22
Rk-15	6.79	6.39	9.65	13.79	10.99	6.83	4.14	4.14	4.70	8.75	0.86	5.36	1.33	1.68	10.92	5.84
Rk-16	2.03	4.18	6.19	18.51	15.58	10.71	4.56	3.73	5.63	13.00	2.13	4.77	0.70	3.74	16.43	9.49
Rk-17	1.80	5.10	6.80	15.87	13.31	8.94	3.11	2.42	4.04	10.87	1.59	4.97	0.43	4.53	14.31	7.82
Rk-18	1.52	6.46	9.10	16.52	13.94	9.23	4.54	4.08	5.69	11.60	1.76	7.23	0.49	4.98	14.55	8.26
Rk-19	5.47	13.26	18.17	10.99	9.03	5.28	6.12	6.83	7.09	7.67	1.72	14.13	1.90	6.95	8.66	4.95
Rk-20	7.52	15.38	19.29	5.05	3.83	1.46	2.89	3.93	3.29	2.67	1.03	13.52	2.39	8.29	3.76	1.26
Rk-21	43.59	12.95	12.51	59.26	52.72	49.25	37.72	33.57	37.48	51.36	35.00	18.49	32.59	18.12	55.91	46.15
Rk-22	27.60	6.69	5.85	39.12	34.16	30.38	19.58	16.90	19.28	31.52	19.11	6.17	18.45	9.02	36.31	27.82
Rk-24	3.34	20.23	23.25	29.23	27.29	21.91	16.73	16.06	18.99	25.36	13.39	25.04	9.49	22.07	28.57	21.35
Rk-25	26.05	32.85	37.32	0.31	0.49	1.85	9.74	12.00	8.87	1.25	10.18	28.35	14.55	20.51	0.42	2.34
Rk-26	22.10	31.35	35.72	0.08	0.33	1.20	8.29	10.47	7.69	0.84	8.67	27.25	12.46	19.96	0.32	1.71
Rk-27	16.64	26.17	29.24	0.72	0.80	0.64	4.35	6.18	3.92	0.22	5.76	20.58	9.05	16.88	0.95	0.84
Rk-29	15.13	21.19	23.64	1.39	0.99	0.64	2.73	4.05	2.25	0.25	4.30	15.97	7.23	13.29	1.47	0.54
Rk-30	13.61	21.97	26.72	2.59	1.89	0.48	5.04	6.85	5.05	1.22	3.20	18.77	5.99	11.71	1.30	0.63
Rk-31	9.04	12.28	15.74	6.08	4.40	1.84	2.21	3.03	2.35	2.87	0.48	9.43	2.25	5.18	4.26	1.36
Rk-33	7.41	7.78	8.86	13.61	11.34	7.31	1.75	1.72	2.00	8.14	1.80	2.75	2.81	4.50	11.67	6.16
Rk-34	14.87	20.04	21.70	5.54	4.87	2.90	2.15	3.61	1.72	2.39	4.09	11.34	7.57	12.06	4.64	2.49
Rk-35	7.88	8.32	10.60	8.81	6.71	3.79	1.42	1.61	1.55	4.74	0.50	5.37	1.69	3.51	7.08	2.94
Rk-36	6.58	12.23	13.59	7.94	6.62	3.63	0.27	0.79	0.46	4.07	1.24	6.92	2.59	7.93	7.06	2.94
Rk-37	7.49	13.91	15.15	7.32	6.22	3.42	0.30	0.98	0.41	3.64	1.74	7.85	3.39	9.23	6.61	2.80
Rk-39	4.03	14.23	16.91	11.25	9.86	5.60	2.88	3.69	3.70	7.01	1.69	10.35	2.38	9.35	9.62	5.09
Rk-40	5.57	9.69	11.65	9.38	7.60	4.14	0.87	1.21	1.23	5.10	0.45	5.83	1.41	5.40	7.87	3.36
Rk-41	6.58	8.02	7.84	15.53	13.42	9.31	1.55	1.20	1.84	9.84	3.17	2.26	3.68	6.83	14.29	8.01
Rk-43	8.28	14.87	17.08	6.19	5.09	2.33	0.93	1.93	1.05	2.76	1.26	9.28	3.26	8.59	5.05	1.86
Rk-44	8.84	12.70	15.82	6.51	4.93	2.14	1.83	2.72	1.97	3.02	0.56	8.83	2.47	5.71	4.71	1.62
Rk-46	5.06	9.96	12.18	10.82	8.95	4.98	1.53	1.95	2.05	6.18	0.58	6.07	1.46	5.50	8.96	4.19
Rk-47	12.49	20.75	24.22	7.02	6.14	3.04	3.91	5.78	4.00	3.54	3.06	13.61	6.25	11.13	5.00	2.84
Rk-48	9.17	12.51	14.87	6.92	5.40	2.61	1.17	1.96	1.19	3.17	0.91	7.51	2.93	6.16	5.35	1.99
Rk-49	14.09	12.70	10.17	21.05	19.14	15.45	4.63	3.97	4.40	14.81	9.52	3.34	10.64	13.15	20.60	13.82
Rk-50	9.96	15.14	13.56	16.18	14.97	11.19	2.36	2.43	2.41	10.73	6.79	5.59	8.08	14.02	15.93	10.02
U05-0	2.72	11.73	15.31	11.27	9.47	6.12	4.90	5.00	5.97	8.30	2.18	13.46	1.28	8.56	10.15	5.67
U05-1	7.39	15.18	18.74	12.43	10.75	6.09	4.54	5.73	5.23	7.62	2.06	10.43	3.66	7.98	9.69	5.58
U05-10	10.39	1.31	3.89	24.40	20.15	15.68	10.00	8.46	10.65	18.27	5.74	4.27	4.46	0.52	21.13	14.00
U05-14	25.84	35.37	39.40	0.20	0.80	2.23	9.73	12.13	8.90	1.38	11.13	29.99	15.49	23.41	0.84	2.82
U05-16	22.03	31.53	38.01	5.43	4.97	3.35	11.23	14.12	11.12	4.15	7.77	26.62	12.17	16.76	3.00	3.85
U05-19	14.56	25.60	30.48	2.46	2.16	0.87	6.07	8.18	6.12	1.50	4.53	21.86	7.50	14.79	1.44	1.20
U05-22	9.78	21.11	24.37	2.81	2.45	1.09	3.16	4.52	3.34	1.57	3.30	17.80	5.09	13.91	2.72	1.16
U05-23	36.75	40.33	44.04	2.87	3.36	6.88	15.91	17.85	14.44	5.44	18.23	36.53	22.88	28.58	4.34	7.42
U05-24	16.91	21.85	27.57	3.67	2.54	1.27	7.35	9.18	7.25	2.30	4.01	19.79	7.12	10.19	1.64	1.40
U05-25	50.70	51.25	53.87	39.34	38.08	32.52	31.00	34.37	30.15	31.63	31.02	31.77	38.85	35.26	34.04	31.80
U05-27	9.98	24.35	28.46	5.17	4.90	2.54	5.18	7.06	5.64	3.41	4.13	20.25	6.19	15.64	4.32	2.75
U05-29	19.46	23.45	26.49	1.06	0.63	0.85	4.64	6.18	3.90	0.32	5.78	18.24	9.39	13.94	0.90	0.83
U05-3	10.74	8.48	5.28	34.84	31.72	25.74	9.92	7.98	10.57	26.44	13.31	2.36	11.77	13.89	33.70	23.51
U05-32	6.77	11.63	14.00	6.35	4.88	2.25	0.75	1.32	0.96	3.02	0.44	8.14	1.74	6.39	5.22	1.68
U05-33	6.05	10.66	11.54	8.83	7.36	4.42	0.09	0.28	0.29	4.85	1.45	5.84	2.39	7.57	8.17	3.60
U05-36	12.64	21.50	24.84	5.75	5.08	2.36	3.54	5.43	3.56	2.69	3.15	14.34	6.38	11.94	4.11	2.23
U05-4	11.49	11.93	7.22	39.82	37.00	31.49	13.36	10.70	14.21	32.04	18.72	7.25	15.66	21.28	40.28	29.19
U05-40	6.32	9.21	10.80	11.31	9.36	5.52	1.19	1.46	1.51	6.40	0.99	4.44	2.08	5.16	9.54	4.58
U05-41	5.04	9.97	11.22	10.43	8.76	5.14	0.58	0.81	0.96	5.92	1.07	5.32	1.87	6.68	9.23	4.29
U05-43	7.44	9.15	10.55	10.38	8.45	5.04	0.92	1.14	1.07	5.71	1.12	4.25	2.41	5.05	8.79	4.09
U05-44	6.92	11.98	12.53	8.14	6.90	4.34	0.01	0.23	0.10	4.48	2.13	6.66	3.21	9.02	7.88	3.55

U05-45	M04-154	M04-155	M04-156	M04-158	M04-159	M04-164	M04-166	M04-174	M04-176	M04-177	M04-192	M04-24	M04-28	M04-31	M04-36	M04-39
U05-46	6.54	11.71	12.64	7.89	6.59	3.89	0.03	0.34	0.17	4.20	1.58	6.68	2.70	8.28	7.39	3.14
U05-48	21.46	27.24	29.58	14.32	13.46	9.55	8.38	10.66	8.07	9.23	9.00	14.77	13.79	16.28	11.56	9.08
U05-51	7.64	12.60	13.83	9.38	7.98	4.59	0.69	1.31	0.84	4.96	1.69	6.15	3.37	7.91	8.13	3.82
U05-53	18.40	22.76	26.19	9.53	8.42	5.27	6.25	8.31	5.98	5.42	5.41	13.68	9.69	11.58	6.81	4.92
U05-56	9.34	9.53	8.82	16.58	14.53	10.52	2.22	1.92	2.28	10.65	4.67	2.22	5.69	8.14	15.37	9.15
U05-57	11.23	16.93	15.02	21.92	20.53	15.54	4.89	5.00	5.13	15.23	9.21	5.86	10.50	16.10	21.06	14.20
U05-59	6.56	13.08	14.39	8.18	6.97	3.85	0.38	1.00	0.60	4.26	1.48	7.34	2.90	8.68	7.31	3.19
U05-6	4.41	2.77	4.93	17.73	14.53	10.10	4.60	3.69	5.39	12.26	1.93	3.53	0.93	1.65	15.38	8.79
U05-60	9.46	15.36	16.69	6.62	5.63	3.06	0.58	1.48	0.52	3.06	2.18	8.47	4.38	9.73	5.84	2.49
U05-61	21.04	26.39	29.48	4.45	4.06	2.72	5.54	7.77	4.86	2.11	6.42	17.22	11.17	14.85	3.08	2.66
U05-63	8.93	13.68	12.42	17.04	15.59	11.38	2.42	2.44	2.60	11.22	6.08	4.63	7.20	12.52	16.37	10.15
U05-64	11.35	16.22	18.17	10.99	9.60	5.71	2.89	4.11	2.96	6.07	3.08	7.97	5.81	9.04	8.83	5.03
U05-66	13.40	21.97	28.22	4.98	3.87	2.57	8.96	10.44	9.37	4.33	4.69	23.48	6.25	12.11	3.49	2.85
U05-68	9.71	14.07	16.70	4.29	3.07	1.15	1.16	2.03	1.10	1.59	1.10	10.00	3.12	7.44	3.30	0.72
U05-69	6.67	11.54	13.39	7.04	5.60	2.84	0.39	0.90	0.58	3.44	0.72	7.26	2.02	6.83	6.03	2.19
U05-7	0.55	11.21	13.29	16.22	14.39	10.00	5.09	4.78	6.41	12.12	3.71	11.60	2.04	10.73	15.38	9.28
U05-71	5.92	12.25	11.71	11.46	10.26	7.28	0.61	0.49	0.85	7.34	3.83	6.47	4.26	11.42	11.66	6.34
U05-72	6.65	11.79	11.19	11.87	10.55	7.46	0.58	0.47	0.75	7.46	3.78	5.49	4.44	10.70	11.84	6.45
U05-73	14.65	17.62	18.97	12.70	11.29	7.47	3.89	5.12	3.72	7.41	4.92	7.73	8.19	10.29	10.49	6.65
U05-74	2.26	8.48	10.12	11.88	10.01	6.19	1.53	1.39	2.28	7.59	1.06	6.55	0.69	6.59	10.82	5.34
U05-75	6.97	11.88	12.60	14.57	12.84	8.26	2.03	2.44	2.42	8.88	2.93	4.68	4.20	8.34	12.83	7.25
U05-76	13.26	14.01	11.10	25.38	23.44	18.69	6.09	5.43	6.15	18.25	11.07	3.73	11.84	15.31	24.70	16.97
U05-78	20.42	22.26	24.93	8.66	7.57	5.14	5.68	7.52	5.08	4.80	6.04	12.66	10.55	11.64	6.42	4.69
U05-8	7.98	0.87	1.28	25.51	21.63	16.86	7.51	5.67	8.15	18.78	6.11	1.19	4.52	2.78	23.22	14.97
U05-81	24.96	31.15	33.33	12.84	12.41	9.30	9.16	11.73	8.55	8.45	10.75	17.53	16.25	19.26	10.55	8.98
U05-82	12.62	18.23	17.49	14.04	13.07	9.44	2.69	3.43	2.55	8.80	6.59	7.26	9.04	14.33	13.29	8.48
U05-83	18.88	19.82	19.20	22.00	20.33	15.47	7.50	8.30	7.26	14.97	10.39	6.95	13.60	14.73	19.71	14.18
U05-84	9.99	12.13	11.77	16.49	14.67	10.31	2.60	2.77	2.70	10.41	4.85	3.47	6.43	9.36	14.96	9.07
U05-85	15.33	15.18	12.79	23.82	21.93	17.34	6.07	5.79	5.94	16.75	10.66	3.98	12.27	14.60	22.72	15.71
U05-86	12.67	13.20	10.93	20.75	18.95	14.87	4.19	3.76	4.11	14.37	8.78	3.48	9.94	13.21	20.12	13.32
U05-88	10.00	10.86	8.58	22.03	20.00	15.58	4.10	3.31	4.27	15.47	8.22	2.67	8.53	12.24	21.43	13.95
U05-89	13.72	11.54	8.50	27.14	24.76	20.05	6.84	5.73	6.88	19.78	11.48	2.52	11.81	13.80	26.33	18.14
U05-9	21.83	2.81	4.07	38.72	33.25	28.94	20.18	17.30	20.55	31.54	16.22	7.56	14.08	5.22	35.26	26.56
U05-91	12.39	14.84	10.89	29.44	27.53	22.60	7.80	6.62	8.09	22.20	13.80	5.28	13.47	18.93	29.50	20.74
U05-93	7.83	10.25	8.09	22.74	20.67	15.91	4.10	3.23	4.51	16.10	7.84	2.88	7.62	12.26	22.15	14.29
U05-95	2.80	7.21	8.77	12.72	10.61	6.60	1.51	1.29	2.20	8.00	0.89	4.99	0.65	5.27	11.34	5.63

	M04-51	M04-52	M04-53	M04-54	M04-56	M04-57	M04-59	M04-60	M04-61	M04-64	M04-66	M04-67	M04-69	M04-71	M04-72	M04-73
Rk-12	19.22	3.94	2.89	6.33	3.11	3.71	4.93	9.05	5.46	9.34	3.43	0.77	3.92	5.49	3.52	2.16
Rk-13	30.26	9.25	10.85	17.55	10.61	7.69	5.68	1.60	8.85	2.64	0.99	4.33	12.34	6.61	14.45	9.48
Rk-14	28.16	14.92	14.22	21.54	12.55	9.29	6.24	2.24	13.69	0.95	0.77	8.11	14.85	11.03	17.72	12.65
Rk-15	11.82	2.77	1.51	3.66	1.03	1.84	3.27	11.17	4.49	11.29	4.89	0.79	1.87	5.57	1.96	0.74
Rk-16	16.73	1.07	1.79	4.68	2.33	1.31	2.03	6.62	6.69	8.26	4.54	1.08	2.66	1.17	4.28	1.45
Rk-17	14.55	1.34	1.91	4.71	2.07	0.68	1.06	6.17	7.37	7.55	4.47	1.60	2.48	1.10	4.72	1.56
Rk-18	14.24	0.87	0.88	2.92	1.51	0.84	2.11	8.73	8.66	10.10	6.40	2.03	1.46	1.11	3.19	0.89
Rk-19	7.78	2.72	0.46	0.18	0.66	1.99	4.93	18.05	11.65	18.28	12.37	4.99	0.22	5.52	0.98	0.78
Rk-20	3.37	5.06	2.29	2.30	1.07	1.66	3.41	17.16	12.11	16.36	11.42	6.36	1.33	7.53	3.18	2.17
Rk-21	63.84	31.23	40.62	48.16	40.02	38.12	35.86	29.92	11.85	36.18	26.17	22.46	44.06	37.27	42.86	36.47
Rk-22	42.13	19.72	24.69	31.91	23.18	21.29	18.83	14.84	5.53	17.70	10.55	10.94	26.83	22.96	26.77	21.30
Rk-24	25.50	7.76	8.91	9.23	11.65	9.53	11.77	19.86	28.19	23.13	23.02	15.81	9.52	4.76	13.58	10.67
Rk-25	1.30	20.11	15.90	14.23	11.91	13.10	14.36	35.11	22.52	32.56	26.04	20.67	13.27	25.74	15.74	14.94
Rk-26	0.55	17.62	13.48	11.77	10.00	10.84	12.20	32.44	22.65	30.13	24.57	19.22	10.94	22.19	13.82	12.90
Rk-27	0.95	14.39	10.35	10.06	7.10	7.01	7.53	24.00	19.86	21.49	17.65	15.03	8.12	16.83	11.48	9.79
Rk-29	2.22	12.30	9.36	9.97	6.15	5.67	5.66	19.84	15.35	17.91	13.88	11.85	7.55	14.75	10.74	8.42
Rk-30	0.99	9.72	5.38	4.44	3.28	4.84	7.01	24.23	15.62	22.24	16.13	10.59	3.75	13.70	5.20	5.14
Rk-31	4.85	5.26	2.64	3.67	1.02	1.80	3.06	14.87	8.11	13.82	7.98	4.15	1.95	8.34	3.05	1.94
Rk-33	12.68	6.09	4.38	8.18	2.90	2.09	1.64	6.36	6.93	5.32	1.63	2.38	4.39	6.32	5.98	3.29
Rk-34	5.17	13.48	8.81	11.03	5.49	5.27	4.81	15.46	15.01	11.97	8.47	10.03	7.22	14.51	9.62	7.75
Rk-35	8.28	4.55	3.20	5.54	1.65	1.50	1.84	10.22	5.57	9.75	4.63	2.36	2.96	6.73	4.35	2.16
Rk-36	7.23	6.49	4.09	6.64	2.28	1.15	0.83	8.82	10.98	7.40	4.85	5.02	3.35	6.28	6.17	3.45
Rk-37	6.69	7.71	4.92	7.43	2.85	1.65	1.19	9.53	12.38	7.73	5.48	6.17	3.97	7.30	7.01	4.28
Rk-39	8.31	5.08	1.65	3.19	1.09	0.89	2.08	11.43	14.48	10.06	7.37	5.55	1.09	4.53	3.27	1.90
Rk-40	8.17	4.45	2.42	4.83	1.12	0.57	0.84	8.73	8.50	7.84	4.21	2.99	2.05	5.03	4.05	1.80
Rk-41	15.19	7.23	6.21	10.84	4.70	2.60	1.17	3.64	9.06	2.81	1.05	3.69	6.27	5.64	9.01	5.14
Rk-43	4.99	7.41	3.94	5.71	1.93	1.66	1.98	12.24	12.12	10.20	6.77	6.06	2.90	8.15	5.21	3.40
Rk-44	5.13	5.84	2.79	4.16	1.07	1.68	2.71	13.81	8.89	12.34	7.05	4.30	2.05	8.27	3.29	2.11
Rk-46	8.91	4.28	1.81	4.18	0.81	0.55	1.15	8.92	9.17	7.87	4.17	2.86	1.53	4.70	3.22	1.38
Rk-47	4.35	10.97	5.00	5.98	2.80	4.13	5.50	18.37	15.98	14.78	10.03	8.92	3.58	12.73	4.70	4.69
Rk-48	5.96	6.80	3.83	5.85	1.80	1.88	2.24	11.98	9.04	10.26	5.69	4.50	3.05	8.51	4.68	2.96
Rk-49	22.48	15.97	15.28	21.94	12.53	8.85	5.26	3.83	13.99	2.21	2.29	9.68	15.19	12.68	19.06	13.45
Rk-50	16.29	13.49	11.15	16.43	8.73	5.52	2.88	4.60	16.69	2.28	3.08	9.44	10.53	9.63	14.78	10.14
U05-0	9.28	1.86	1.49	1.74	1.85	1.37	3.25	14.42	12.55	15.80	12.10	5.55	1.36	2.87	3.84	1.86
U05-1	8.67	6.60	1.83	3.29	1.05	2.29	4.14	14.30	13.37	12.03	7.37	5.25	1.29	7.60	1.90	1.86
U05-10	23.87	3.92	6.61	10.11	6.91	6.99	7.84	11.35	0.90	14.24	6.56	1.04	8.28	7.70	7.78	5.11
U05-14	1.21	21.49	16.94	15.29	12.85	13.47	14.41	35.13	25.85	32.25	27.06	22.68	14.05	25.95	17.35	16.20
U05-16	2.20	16.62	9.28	7.24	6.81	10.54	14.08	34.94	22.05	31.07	22.85	16.45	7.16	22.41	6.94	9.19
U05-19	0.59	11.54	6.52	5.16	4.36	5.90	8.20	26.51	19.31	24.10	18.58	13.15	4.59	15.08	6.43	6.54
U05-22	1.98	8.87	5.74	5.45	3.83	3.50	4.57	19.55	17.73	18.21	14.98	11.15	4.11	10.28	7.46	5.73
U05-23	6.64	29.09	26.81	25.07	21.73	21.84	21.97	43.67	28.22	41.97	35.43	29.80	23.85	35.74	27.49	25.14
U05-24	1.99	10.40	6.14	4.80	4.03	6.70	9.54	27.94	13.62	26.16	17.84	10.51	4.69	16.45	4.86	5.61
U05-25	34.33	48.04	34.97	39.47	30.33	34.55	35.06	43.28	41.30	33.25	26.11	34.45	33.21	50.16	30.44	33.32
U05-27	2.54	9.90	4.94	4.20	3.47	4.13	6.14	22.08	21.16	19.80	16.35	12.33	3.23	11.07	5.84	5.44
U05-29	2.19	14.73	11.50	11.70	7.83	8.07	8.34	24.09	15.50	21.91	16.44	13.58	9.53	18.74	12.07	10.27
U05-3	35.16	14.57	16.27	24.25	15.60	10.99	7.48	0.48	15.16	1.04	2.23	9.21	17.58	9.24	21.31	14.88
U05-32	5.56	4.99	2.91	4.57	1.30	0.88	1.33	11.34	9.28	10.44	6.49	4.30	2.21	6.31	4.44	2.29
U05-33	8.63	6.08	4.57	7.52	2.83	1.17	0.45	7.26	10.10	6.37	4.20	4.61	4.02	5.54	7.15	3.81
U05-36	3.45	11.29	5.47	6.30	3.09	4.16	5.36	18.68	16.63	15.15	10.73	9.64	3.90	12.94	5.43	5.16
U05-4	41.50	18.00	22.05	30.41	21.74	14.85	10.18	1.23	21.94	3.33	7.47	15.08	23.45	10.29	29.48	20.88
U05-40	10.02	5.35	3.12	6.17	1.73	1.15	1.14	7.61	8.19	6.42	2.84	2.76	2.88	5.63	4.65	2.34
U05-41	9.39	5.18	3.26	6.19	1.91	0.71	0.44	7.00	9.82	6.01	3.50	3.62	2.88	4.64	5.47	2.67
U05-43	9.67	5.92	3.99	7.13	2.28	1.56	1.27	7.81	7.52	6.66	2.92	2.99	3.68	6.53	5.56	2.99
U05-44	8.40	7.29	5.85	8.84	3.81	1.78	0.71	7.61	11.34	6.60	4.94	5.91	5.11	6.46	8.73	5.02

	M04-51	M04-52	M04-53	M04-54	M04-56	M04-57	M04-59	M04-60	M04-61	M04-64	M04-66	M04-67	M04-69	M04-71	M04-72	M04-73
U05-45	6.38	16.12	9.61	11.90	6.37	6.51	6.30	16.94	19.77	12.21	9.44	12.38	7.81	16.07	10.08	8.95
U05-46	7.80	6.59	4.91	7.66	3.01	1.35	0.63	8.05	10.83	7.02	4.91	5.30	4.20	6.11	7.49	4.16
U05-48	11.30	20.55	12.26	15.06	8.95	10.58	10.96	20.89	21.33	14.89	10.36	14.09	10.66	21.45	11.05	11.38
U05-51	8.34	7.61	4.57	7.54	2.62	1.73	1.34	8.55	11.15	6.56	3.87	5.03	3.86	7.27	6.28	3.83
U05-53	6.97	15.26	8.37	10.02	5.45	7.53	8.69	20.96	15.92	16.37	10.27	10.46	6.93	18.07	6.99	7.49
U05-56	16.62	9.99	8.61	13.83	6.58	4.33	2.36	3.97	10.03	2.56	0.95	5.13	8.56	8.21	11.33	7.26
U05-57	20.98	16.05	12.77	18.85	10.62	7.53	4.85	4.50	19.64	1.46	2.78	10.86	12.36	11.09	16.20	11.89
U05-59	7.27	6.94	4.21	6.77	2.39	1.25	0.93	8.91	12.02	7.25	4.98	5.50	3.40	6.40	6.30	3.66
U05-6	16.60	1.42	2.49	5.53	2.62	2.01	2.65	7.39	3.61	9.12	4.03	0.19	3.44	2.93	4.43	1.67
U05-60	6.09	9.18	5.84	8.31	3.39	2.48	1.99	10.92	12.78	8.61	5.97	6.99	4.72	9.21	7.55	5.06
U05-61	3.60	17.61	11.29	12.27	7.45	8.76	9.29	23.84	18.17	19.36	13.90	13.90	9.20	20.73	10.60	10.22
U05-63	16.66	12.19	9.81	15.07	7.70	4.84	2.55	4.06	15.44	1.85	2.19	8.06	9.38	8.56	13.15	8.86
U05-64	8.82	10.65	5.60	8.45	3.39	3.78	3.98	12.20	13.13	8.82	4.97	6.57	4.71	11.07	5.96	4.86
U05-66	3.03	7.92	5.16	2.77	4.21	6.35	9.85	29.33	16.04	29.24	21.72	11.58	3.94	13.45	4.93	5.31
U05-68	3.92	6.96	4.42	5.70	2.24	2.15	2.61	14.21	10.01	12.87	8.30	5.93	3.39	9.15	5.53	3.61
U05-69	6.38	5.56	3.45	5.58	1.72	0.95	0.98	9.92	9.67	8.84	5.50	4.42	2.76	6.22	5.26	2.78
U05-7	14.02	2.73	2.65	4.27	3.36	1.58	2.51	9.78	15.18	11.13	9.84	6.13	2.79	1.01	6.21	3.20
U05-71	11.91	8.34	7.49	11.28	5.68	2.53	0.73	5.23	13.80	4.50	4.62	7.21	6.92	5.66	11.45	6.79
U05-72	12.31	8.70	7.65	11.72	5.69	2.72	0.84	4.89	12.96	3.92	3.71	6.75	7.12	6.22	11.35	6.79
U05-73	10.97	13.78	8.44	12.02	5.67	5.93	5.53	12.56	13.92	8.58	4.78	8.07	7.49	14.09	8.66	7.33
U05-74	10.61	2.69	2.01	4.40	1.56	0.11	0.34	7.12	9.91	7.45	5.12	3.19	1.96	2.02	4.80	1.79
U05-75	12.75	8.23	4.97	8.88	3.47	2.42	1.84	6.38	12.15	4.22	2.19	4.79	4.64	6.67	6.83	4.34
U05-76	25.85	17.11	15.81	23.01	13.51	9.59	5.96	2.80	17.15	0.81	2.02	10.75	15.87	12.27	19.86	14.32
U05-78	7.40	16.67	10.56	12.76	7.01	8.48	8.79	20.23	14.77	15.77	9.82	10.98	9.06	19.63	9.55	9.20
U05-8	25.68	5.00	7.93	13.01	7.90	6.06	5.23	4.91	3.12	7.38	2.92	1.55	9.52	5.61	10.74	6.41
U05-81	10.46	23.89	15.15	17.76	11.14	12.65	12.69	23.79	24.00	17.23	12.87	17.22	13.11	24.98	13.92	14.11
U05-82	13.50	15.18	11.06	15.75	8.15	6.09	4.04	8.01	17.58	4.44	4.09	10.30	10.03	12.41	13.46	10.03
U05-83	20.52	20.05	14.69	20.55	11.65	10.77	8.86	10.58	18.07	5.95	3.91	11.65	14.08	18.06	15.63	13.21
U05-84	15.65	11.19	8.33	13.32	6.22	4.53	2.92	5.37	12.20	2.97	1.36	6.04	8.04	9.24	10.49	7.19
U05-85	24.04	18.04	15.71	22.66	13.00	9.91	6.59	4.70	16.53	1.93	2.06	10.70	15.56	14.22	18.83	14.06
U05-86	21.45	15.26	13.83	20.28	11.29	7.86	4.60	3.58	14.83	1.58	1.88	9.30	13.66	11.61	17.43	12.28
U05-88	22.59	13.01	12.50	18.95	10.57	6.82	3.70	1.90	13.91	0.77	1.39	8.01	12.65	8.97	16.59	11.14
U05-89	28.13	16.52	16.42	23.95	14.28	10.23	6.44	2.23	14.80	1.07	1.70	9.84	16.85	12.22	20.59	14.66
U05-9	40.30	12.76	18.79	24.18	18.99	18.17	17.73	16.47	2.66	21.22	12.44	7.41	21.45	17.48	20.51	16.15
U05-91	30.36	18.30	18.34	26.06	16.49	11.17	6.85	1.60	20.66	0.51	3.70	13.19	18.61	11.62	23.86	17.06
U05-93	22.87	11.58	11.28	17.54	9.83	5.96	3.09	1.20	14.40	0.44	1.47	7.54	11.55	7.05	15.66	10.21
U05-95	11.46	2.68	2.00	4.77	1.48	0.21	0.35	6.35	8.34	6.60	3.80	2.23	2.10	2.29	4.52	1.59

	M04-74	M04-76	M04-80	M04-84	M04-91	M04-92	M04-93	M04-96	M04-98	M04-99	M05-12 hp	M05-12sp	M05-13	M05-15	M05-18	M05-34
Rk-12	4.73	9.82	19.22	21.31	10.61	6.46	17.66	10.22	6.06	9.17	14.64	9.82	11.82	5.21	5.87	3.80
Rk-13	9.55	9.09	26.87	31.42	17.21	10.91	20.42	3.20	0.51	7.84	28.36	22.71	21.17	6.97	4.58	9.96
Rk-14	15.92	15.18	25.16	29.12	15.58	10.51	12.61	0.42	0.43	3.80	28.43	23.93	20.05	6.23	4.55	11.54
Rk-15	4.52	11.44	11.62	13.15	5.68	3.20	16.28	12.50	8.23	9.10	8.32	5.02	6.10	2.90	4.66	1.04
Rk-16	6.03	12.42	15.24	18.87	8.47	4.14	23.49	10.78	6.28	9.24	15.46	11.33	10.84	3.52	2.89	2.47
Rk-17	7.21	13.91	12.77	16.47	6.75	2.88	22.24	10.14	6.15	8.02	14.47	10.92	9.33	2.37	1.81	1.89
Rk-18	7.76	16.07	13.41	16.85	7.14	3.35	24.29	13.06	8.69	9.64	13.80	10.18	9.41	3.58	3.34	1.94
Rk-19	10.68	23.02	8.93	10.56	4.51	3.05	23.95	21.31	16.81	13.14	6.99	4.87	5.01	5.21	7.39	1.46
Rk-20	12.89	24.57	3.64	5.00	0.96	0.84	18.27	18.79	15.71	10.08	4.46	3.71	1.56	2.67	5.40	0.76
Rk-21	13.51	4.47	55.59	58.83	49.79	43.12	54.66	35.16	25.07	48.72	50.36	42.98	48.82	36.23	35.09	36.17
Rk-22	7.85	2.00	36.11	38.90	29.46	24.18	29.84	16.37	10.24	25.47	33.23	27.37	29.85	18.33	17.85	20.19
Rk-24	25.15	38.73	24.85	30.89	18.79	13.68	50.36	29.59	24.66	23.28	30.33	26.79	23.49	16.21	13.56	13.30
Rk-25	26.33	39.49	0.94	0.11	3.85	8.09	21.20	34.03	31.90	21.32	3.68	6.46	2.24	10.79	16.76	9.49
Rk-26	25.93	39.81	0.36	0.14	2.68	6.35	21.74	32.18	30.17	19.25	3.95	6.48	1.78	9.31	14.59	7.99
Rk-27	23.05	35.17	0.46	1.11	0.83	3.18	16.53	23.30	22.24	12.35	5.05	6.71	1.25	5.18	9.18	5.34
Rk-29	18.68	28.63	0.87	1.81	0.76	2.39	14.80	19.35	17.84	10.68	5.16	6.15	1.23	3.45	6.94	4.06
Rk-30	17.13	30.24	2.07	2.12	0.83	2.49	17.06	24.16	21.59	12.99	2.01	2.48	0.31	5.01	9.43	2.73
Rk-31	9.36	18.52	4.78	5.68	1.38	1.01	13.65	15.14	12.06	8.46	3.94	2.65	1.51	1.72	4.68	0.40
Rk-33	8.40	13.11	11.46	13.64	5.06	2.45	10.49	5.80	3.83	3.75	11.73	8.79	6.96	0.94	1.87	2.24
Rk-34	18.26	26.21	4.90	5.55	1.58	2.28	6.56	12.05	12.20	4.90	7.17	7.08	2.69	2.19	5.44	4.16
Rk-35	7.03	13.61	7.07	8.69	2.83	1.38	13.10	10.78	7.64	6.89	6.98	4.90	3.60	0.89	2.80	0.66
Rk-36	12.83	20.41	6.15	8.44	1.69	0.33	11.77	8.77	7.47	3.67	9.29	7.83	3.88	0.10	1.38	1.42
Rk-37	14.51	22.31	5.67	7.88	1.45	0.41	11.06	9.02	8.17	3.44	9.34	8.20	3.72	0.25	1.68	1.90
Rk-39	14.59	25.08	9.08	11.47	3.13	1.18	16.15	12.35	10.69	5.28	10.40	8.37	5.55	2.19	3.31	1.74
Rk-40	9.67	17.17	7.41	9.55	2.36	0.55	12.90	9.26	7.02	4.66	8.59	6.50	4.10	0.34	1.67	0.63
Rk-41	10.86	14.58	13.01	16.20	6.35	3.08	11.83	3.53	2.24	2.66	16.00	12.97	9.46	1.02	0.80	3.75
Rk-43	13.94	22.92	4.82	6.33	0.79	0.29	10.84	11.45	10.24	4.61	6.75	5.78	2.30	0.71	2.96	1.30
Rk-44	10.25	19.16	5.20	6.17	1.27	0.79	11.95	13.47	11.00	6.90	4.66	3.31	1.76	1.31	4.12	0.54
Rk-46	9.90	17.80	8.74	10.84	2.93	0.85	12.97	9.31	7.14	4.48	9.10	6.70	4.75	0.78	2.07	0.77
Rk-47	17.52	28.36	6.24	6.38	1.60	2.09	8.66	15.44	14.91	6.09	5.22	4.60	2.23	3.29	7.04	2.96
Rk-48	10.86	18.69	5.57	6.76	1.43	0.78	10.15	11.08	9.20	5.35	5.98	4.61	2.33	0.75	3.24	1.00
Rk-49	17.57	17.55	18.63	22.27	11.81	8.37	10.88	1.74	2.18	3.60	24.46	21.58	15.88	4.49	3.61	10.43
Rk-50	19.66	23.34	13.91	17.46	7.35	4.61	9.92	2.71	3.82	1.02	20.41	18.31	11.73	2.33	1.81	7.44
U05-0	11.89	23.47	8.64	11.83	4.97	2.75	28.28	19.73	15.20	12.92	10.84	8.79	6.81	4.56	5.16	2.01
U05-1	13.35	23.61	10.70	11.78	3.89	2.40	12.46	13.30	11.62	5.89	8.31	6.00	5.17	3.32	5.68	2.11
U05-10	0.51	3.17	21.34	23.83	14.96	10.49	26.74	15.42	8.46	17.41	16.90	11.77	15.09	8.48	8.83	6.20
U05-14	29.85	43.64	0.79	0.38	3.82	8.13	21.83	34.03	32.70	20.65	5.41	8.56	2.92	11.03	16.63	10.43
U05-16	23.33	38.64	5.78	3.89	4.11	7.23	16.60	32.14	30.19	17.86	1.66	2.65	2.16	10.71	17.26	7.11
U05-19	20.83	35.21	2.06	2.12	1.09	3.14	18.33	26.30	24.26	13.78	2.84	3.78	0.82	6.19	10.73	3.97
U05-22	19.47	32.18	1.69	3.38	0.59	1.40	19.70	21.01	19.10	10.78	6.08	6.62	1.83	3.64	6.34	2.93
U05-23	33.70	45.54	3.93	3.24	10.21	15.59	30.51	43.48	40.78	31.52	9.82	13.86	8.08	17.90	24.12	17.46
U05-24	14.94	27.81	3.43	2.57	2.44	4.47	17.99	27.63	23.98	16.58	0.46	0.73	0.60	7.02	12.39	3.48
U05-25	44.55	49.79	40.12	36.33	29.18	30.44	4.94	28.04	32.48	20.50	29.77	27.99	28.54	28.61	35.39	31.57
U05-27	22.03	36.51	4.09	5.30	1.49	2.26	19.17	22.59	21.24	10.66	6.48	6.76	2.75	5.18	8.28	3.71
U05-29	19.21	29.16	1.01	1.08	1.74	4.21	14.89	22.87	21.01	13.70	3.89	5.27	1.17	5.36	9.88	5.45
U05-3	16.69	14.85	30.76	36.39	20.64	13.81	21.76	1.54	0.53	7.32	36.04	30.55	26.28	9.06	5.43	14.54
U05-32	10.78	19.36	4.71	6.56	1.11	0.18	13.90	12.10	9.70	6.20	6.52	5.21	2.41	0.54	2.44	0.46
U05-33	12.05	18.72	6.81	9.56	2.42	0.64	13.04	7.85	6.30	3.87	10.76	9.08	4.89	0.02	0.77	1.69
U05-36	18.43	29.52	5.05	5.30	1.05	1.81	9.19	15.97	15.54	6.30	5.04	4.77	1.78	3.14	6.88	3.01
U05-4	23.67	21.53	34.98	42.68	25.91	18.15	33.25	5.27	4.16	12.25	45.75	40.41	33.33	13.25	7.57	20.00
U05-40	9.46	15.85	9.29	11.38	3.40	1.25	11.03	7.34	5.45	3.68	9.91	7.43	5.27	0.49	1.69	1.29
U05-41	11.17	18.13	8.27	10.91	2.87	0.70	12.72	7.46	5.80	3.42	10.82	8.65	5.31	0.17	0.90	1.34
U05-43	9.22	15.08	8.49	10.49	3.20	1.33	10.59	7.41	5.46	4.04	9.48	7.23	4.87	0.37	1.73	1.43
U05-44	13.70	20.31	6.22	9.09	2.36	0.84	13.19	8.11	6.88	3.99	11.34	10.03	5.02	0.18	0.89	2.37

	M04-74	M04-76	M04-80	M04-84	M04-91	M04-92	M04-93	M04-96	M04-98	M04-99	M05-12 hp	M05-12sp	M05-13	M05-15	M05-18	M05-34
U05-45	22.70	31.68	7.45	7.90	2.69	3.36	4.96	12.09	13.53	3.68	9.20	9.06	4.33	3.56	6.91	5.86
U05-46	12.94	19.97	6.00	8.66	2.00	0.53	12.99	8.54	7.13	4.06	10.30	8.92	4.42	0.07	1.00	1.79
U05-48	23.90	31.94	14.01	13.18	7.06	7.62	2.07	13.39	15.23	5.36	11.23	10.26	7.85	7.32	11.65	9.22
U05-51	13.06	20.02	7.66	9.66	2.34	0.88	9.32	7.39	6.56	2.64	9.84	8.13	4.52	0.31	1.74	1.95
U05-53	18.09	27.18	9.23	8.28	4.00	4.93	4.75	15.61	15.53	7.09	5.80	5.03	3.78	5.33	10.04	5.43
U05-56	12.44	15.02	14.25	17.22	7.42	4.33	9.70	2.63	2.00	2.36	17.36	14.42	10.56	1.71	1.65	5.34
U05-57	22.18	25.18	19.40	23.01	10.69	7.14	9.15	1.42	3.36	0.43	24.77	21.88	15.66	4.40	3.49	10.04
U05-59	13.84	21.67	6.39	8.71	1.72	0.37	11.45	8.63	7.63	3.24	9.69	8.27	4.09	0.20	1.45	1.67
U05-6	3.40	8.59	14.75	17.76	8.53	4.58	21.83	11.00	5.96	10.28	13.62	9.51	9.99	3.51	3.53	2.28
U05-60	15.26	23.00	5.27	7.01	1.27	0.73	9.32	9.51	8.96	3.54	8.48	7.63	3.20	0.54	2.51	2.33
U05-61	21.61	31.42	4.64	3.76	2.35	4.68	6.72	19.00	19.12	9.21	4.55	5.36	1.99	5.50	10.63	6.26
U05-63	17.95	21.66	14.65	18.11	7.46	4.40	9.75	2.27	3.05	0.78	19.96	17.45	11.70	2.13	1.61	6.75
U05-64	14.94	22.38	9.72	10.55	3.38	2.48	5.75	8.76	8.62	2.86	9.03	7.30	4.86	2.05	4.63	3.33
U05-66	16.22	31.31	4.10	4.43	3.84	5.22	28.06	32.52	27.56	20.64	2.95	3.13	2.61	8.84	13.16	3.99
U05-68	12.09	20.99	3.12	4.36	0.57	0.59	12.92	14.22	11.97	7.43	4.82	4.19	1.25	1.13	3.86	1.04
U05-69	11.38	19.31	5.32	7.39	1.36	0.21	12.81	10.34	8.39	4.98	7.75	6.35	3.04	0.21	1.80	0.82
U05-7	14.37	24.53	12.92	17.36	7.38	3.70	28.68	15.18	11.72	10.18	17.17	14.32	10.96	4.68	3.63	3.79
U05-71	16.16	21.93	9.05	12.95	4.47	2.04	15.36	6.31	5.62	3.38	16.30	14.62	8.35	0.90	0.38	4.22
U05-72	15.44	20.58	9.54	13.19	4.63	2.18	13.60	5.32	4.76	2.82	16.06	14.24	8.33	0.75	0.40	4.22
U05-73	16.37	22.32	11.62	12.19	4.99	4.19	3.51	7.74	8.25	2.77	10.82	9.07	6.44	3.05	5.78	5.29
U05-74	10.36	18.33	9.22	12.62	3.99	1.13	19.15	10.01	7.18	5.99	12.31	9.77	6.72	1.12	1.10	1.25
U05-75	13.54	19.43	12.41	14.82	5.03	2.41	9.01	4.80	4.41	1.41	13.89	11.18	7.94	1.23	1.88	3.39
U05-76	20.19	20.18	22.57	26.69	14.01	9.70	11.45	0.41	1.59	2.56	28.49	25.00	19.01	5.68	4.05	12.09
U05-78	17.87	25.34	8.52	7.63	4.18	5.36	3.84	14.62	14.62	7.29	6.28	5.80	3.89	5.07	9.77	6.13
U05-8	3.49	4.35	22.03	25.84	14.75	9.38	23.93	8.50	3.35	12.16	21.61	16.38	16.85	6.35	5.11	6.84
U05-81	27.38	35.66	12.96	11.80	7.14	8.64	1.72	15.50	17.93	6.60	11.26	11.14	7.75	8.45	13.32	10.91
U05-82	20.73	25.51	12.39	14.73	5.93	4.30	5.92	4.24	5.90	0.71	16.94	15.38	9.44	2.49	3.34	7.13
U05-83	21.07	23.49	20.51	21.76	11.53	9.38	2.77	4.07	6.07	2.31	20.57	17.83	14.32	6.44	7.94	11.17
U05-84	14.47	18.05	14.38	16.87	6.92	4.17	7.30	2.80	2.96	1.21	16.62	13.84	10.02	1.92	2.35	5.48
U05-85	19.81	20.03	21.47	24.67	13.01	9.43	8.05	0.92	2.33	2.26	25.72	22.51	17.23	5.52	4.90	11.64
U05-86	18.06	18.95	18.30	21.89	10.92	7.45	9.89	1.24	2.02	2.26	23.79	20.87	15.18	3.93	3.08	9.65
U05-88	16.56	17.51	19.14	23.36	11.47	7.25	12.92	1.01	1.14	2.67	24.99	21.59	16.09	3.78	2.20	9.12
U05-89	17.79	16.51	24.13	28.43	15.65	10.88	13.47	0.62	0.92	4.31	29.59	25.63	20.40	6.37	4.46	12.57
U05-9	2.86	0.12	35.18	38.21	28.68	22.81	37.83	21.55	12.86	29.18	30.07	23.57	28.40	18.55	17.95	17.03
U05-91	23.55	23.08	25.99	31.50	17.27	11.94	17.55	0.93	2.16	4.25	34.85	31.06	23.59	7.66	4.51	14.92
U05-93	16.51	18.15	19.56	24.20	11.55	6.91	14.97	1.21	1.11	2.67	25.71	22.08	16.54	3.72	1.69	8.72
U05-95	8.85	15.89	10.07	13.26	4.38	1.35	17.48	8.71	5.83	5.48	12.19	9.34	6.90	0.93	1.01	1.16

	M05-37	M05-39	M05-40	M05-43	M05-61	M05-67	M05-69	M05-70	M05-74	M05-75	M05-78	M05-78 dk pumice	M05-8	M05-80	M05-80 dk	M06-52
Rk-12	9.25	21.85	20.03	2.23	21.52	9.93	1.96	7.32	6.87	8.68	3.79	1.42	10.95	10.21	8.58	15.76
Rk-13	8.58	30.57	27.56	6.53	30.13	18.25	4.99	7.88	5.22	9.45	5.50	5.81	2.79	4.92	4.01	20.10
Rk-14	12.65	27.83	25.58	10.56	27.98	17.66	5.98	7.02	2.97	7.38	4.98	7.73	6.48	1.23	0.82	14.16
Rk-15	9.31	13.63	12.24	1.14	13.36	4.85	1.03	4.74	5.83	5.91	2.57	0.23	13.95	11.00	9.75	11.43
Rk-16	3.29	19.21	16.20	2.32	17.82	8.18	1.25	4.17	5.54	5.88	2.69	1.19	7.41	10.03	9.02	18.43
Rk-17	2.84	16.64	13.66	2.69	15.23	6.75	0.89	2.70	4.28	4.20	1.87	1.08	7.56	8.87	8.15	16.59
Rk-18	3.03	17.48	14.46	3.29	15.81	6.75	1.43	4.05	6.18	5.56	2.80	1.43	9.90	11.53	10.59	18.61
Rk-19	8.32	11.86	9.89	5.41	10.40	3.35	3.43	6.17	9.93	7.13	4.99	2.82	20.86	17.83	16.79	16.50
Rk-20	9.99	5.64	4.24	6.11	4.69	0.54	3.01	3.28	6.79	3.62	3.41	2.83	21.92	14.36	13.96	9.99
Rk-21	43.55	56.88	55.32	20.01	58.77	48.09	33.42	39.71	38.05	44.49	37.36	29.88	25.87	40.13	38.26	47.54
Rk-22	28.01	37.16	35.94	9.89	38.83	29.05	16.87	21.15	18.53	24.05	18.88	15.08	14.73	19.43	18.10	25.81
Rk-24	3.82	32.31	26.74	18.41	28.01	18.63	13.34	14.42	19.63	16.38	14.74	14.41	18.59	26.98	26.44	42.08
Rk-25	28.96	0.10	0.71	17.68	0.42	3.50	15.02	11.51	16.59	10.89	14.18	14.31	43.62	26.62	27.11	8.27
Rk-26	24.79	0.29	0.33	16.81	0.08	2.48	13.17	9.62	14.88	9.02	12.30	12.82	40.48	24.80	25.32	9.13
Rk-27	18.82	1.03	0.55	13.67	0.69	1.29	8.67	5.25	9.02	4.56	7.41	9.04	31.86	16.91	17.44	6.43
Rk-29	17.00	1.43	0.89	10.41	1.35	1.22	6.69	3.73	6.81	3.41	5.65	6.87	26.95	13.91	14.34	5.11
Rk-30	16.79	2.84	2.43	9.60	2.41	0.23	6.28	5.99	9.93	5.77	6.38	5.84	30.77	18.50	18.20	7.98
Rk-31	11.63	6.02	5.17	3.73	5.83	0.92	1.90	3.04	5.21	3.44	2.42	1.42	19.81	11.63	11.01	6.76
Rk-33	9.07	13.35	11.89	3.26	13.33	5.57	0.59	2.18	1.56	2.66	0.65	0.96	10.73	4.39	3.74	7.51
Rk-34	17.12	5.15	4.95	9.93	5.60	2.56	4.56	3.14	3.49	2.23	3.18	5.35	23.68	7.77	7.85	1.81
Rk-35	9.84	8.61	7.42	2.16	8.53	2.70	0.93	2.15	3.33	2.87	1.42	0.60	14.38	8.39	7.78	7.07
Rk-36	8.08	8.23	6.60	5.61	7.68	2.49	1.05	0.47	1.39	0.51	0.43	1.86	14.17	5.65	5.54	6.61
Rk-37	8.98	7.61	6.08	6.75	7.10	2.42	1.59	0.52	1.39	0.34	0.68	2.57	15.43	5.60	5.61	5.94
Rk-39	6.16	12.15	9.99	7.15	10.80	3.47	1.49	2.54	4.11	2.60	1.49	2.39	16.06	9.09	8.55	11.96
Rk-40	7.36	9.60	7.95	3.60	9.05	2.66	0.32	1.12	2.13	1.53	0.39	0.67	13.17	6.67	6.19	7.90
Rk-41	7.43	15.54	13.48	4.99	15.21	7.53	1.17	1.58	0.55	2.04	0.66	2.20	7.85	2.39	2.07	9.17
Rk-43	10.37	6.39	5.23	6.42	5.99	1.32	1.71	1.36	2.66	1.13	1.15	2.32	18.36	7.68	7.48	5.45
Rk-44	11.39	6.45	5.59	4.21	6.29	1.09	1.56	2.58	4.24	2.77	1.81	1.38	19.16	10.03	9.46	5.98
Rk-46	7.08	11.10	9.39	3.86	10.45	3.15	0.22	1.68	2.49	2.04	0.43	0.62	13.30	6.87	6.22	8.82
Rk-47	15.77	6.96	6.67	9.51	6.93	1.81	3.88	4.67	5.67	3.79	3.37	4.36	26.05	11.00	10.49	4.78
Rk-48	11.42	6.76	5.89	4.54	6.74	1.63	1.40	1.91	2.91	1.96	1.27	1.52	17.68	7.85	7.43	4.83
Rk-49	14.02	20.58	18.74	11.00	20.94	14.15	6.21	4.82	1.81	4.87	4.48	7.99	9.31	1.18	1.37	9.73
Rk-50	10.30	16.35	14.28	11.25	16.01	9.71	4.07	2.15	0.26	1.69	2.07	6.30	10.85	0.79	1.10	8.43
U05-0	4.32	12.66	9.67	6.02	10.56	4.41	3.53	4.40	8.69	5.72	4.65	3.47	16.19	16.37	15.84	19.33
U05-1	10.51	12.73	11.50	6.78	12.10	3.77	1.94	4.75	5.50	4.58	2.35	2.32	19.72	10.28	9.27	9.87
U05-10	12.10	23.88	21.91	0.79	23.80	13.52	5.39	10.73	11.54	13.43	8.24	3.57	10.73	16.25	14.59	20.86
U05-14	28.44	0.29	0.61	20.01	0.31	3.91	15.77	11.21	16.36	10.30	14.40	15.61	44.11	26.18	26.96	8.97
U05-16	26.77	5.24	6.08	15.46	5.43	2.97	11.54	12.75	16.42	11.77	11.82	10.74	43.45	25.60	24.90	9.01
U05-19	17.78	2.95	2.47	12.31	2.30	0.66	7.78	6.87	11.16	6.36	7.57	7.64	33.61	20.02	19.88	9.08
U05-22	11.73	3.71	2.19	10.67	2.52	0.84	5.64	3.39	7.50	3.24	5.01	6.11	25.50	15.38	15.63	10.09
U05-23	38.81	2.41	3.26	25.11	3.10	10.02	24.23	18.15	24.33	17.82	22.97	23.15	52.24	35.41	36.55	13.67
U05-24	20.72	3.47	3.68	8.88	3.54	1.11	7.73	8.82	12.92	8.87	8.57	6.43	34.20	22.20	21.52	8.47
U05-25	56.56	36.65	39.90	36.71	40.01	30.21	28.48	33.43	26.65	30.13	26.82	29.46	57.31	25.40	23.88	13.65
U05-27	12.69	6.22	4.81	12.71	4.86	1.59	6.21	5.23	9.02	4.67	5.72	6.89	28.62	16.77	16.69	11.53
U05-29	21.77	0.69	0.83	11.44	1.12	1.84	8.86	6.15	9.42	5.79	8.01	8.52	31.71	17.14	17.48	4.51
U05-3	9.93	34.97	31.42	12.08	34.33	22.83	8.14	9.12	5.43	10.29	7.50	10.08	2.37	3.37	3.00	22.62
U05-32	8.63	6.61	5.16	4.30	6.05	1.29	1.19	1.16	3.08	1.50	1.16	1.37	16.15	8.71	8.42	7.22
U05-33	7.14	9.15	7.25	5.14	8.53	3.33	1.04	0.21	1.08	0.50	0.43	1.87	12.04	5.10	5.06	7.55
U05-36	15.74	5.78	5.44	10.04	5.68	1.38	4.20	4.28	5.61	3.36	3.49	4.76	26.51	11.20	10.88	4.58
U05-4	9.09	40.79	35.80	18.07	39.12	28.83	13.23	11.75	9.08	13.37	12.04	15.90	1.68	7.06	7.35	31.92
U05-40	8.14	11.32	9.80	3.63	11.02	3.84	0.27	1.51	1.62	1.83	0.27	0.71	12.24	5.25	4.67	7.35
U05-41	6.46	10.77	8.84	4.58	10.09	3.59	0.39	0.61	1.20	0.92	0.08	1.17	11.55	5.02	4.71	8.30
U05-43	9.15	10.23	8.88	3.50	10.13	3.68	0.59	1.41	1.55	1.76	0.49	0.93	12.60	5.25	4.77	6.34

	M05-37	M05-39	M05-40	M05-43	M05-61	M05-67	M05-69	M05-70	M05-74	M05-75	M05-78	M05-78 dk pumice	M05-8	M05-80	M05-80 dk	M06-52
U05-44	7.79	8.49	6.59	6.29	7.88	3.50	1.79	0.13	1.08	0.30	0.85	2.79	12.73	5.08	5.25	7.27
U05-46	7.65	8.23	6.41	5.71	7.61	2.95	1.38	0.18	1.25	0.37	0.64	2.25	13.12	5.48	5.53	7.16
U05-48	25.22	13.38	14.16	15.44	14.53	8.01	8.15	9.61	7.41	7.75	6.78	9.20	31.06	9.68	9.04	3.00
U05-51	9.36	9.45	8.08	5.90	9.17	3.24	1.04	1.00	1.07	0.84	0.34	1.94	14.39	4.57	4.33	5.60
U05-53	22.25	8.68	9.39	10.81	9.64	4.14	5.95	7.66	7.25	6.48	5.42	6.11	29.77	11.60	10.86	2.57
U05-56	10.15	16.29	14.56	6.40	16.37	8.90	2.31	2.44	0.59	2.65	1.44	3.49	8.94	1.62	1.38	7.89
U05-57	11.78	22.04	19.91	13.69	21.74	13.32	5.31	4.48	1.20	3.76	3.23	7.96	11.03	0.21	0.27	10.57
U05-59	8.08	8.53	6.87	6.28	7.92	2.63	1.17	0.51	1.31	0.42	0.41	2.14	14.49	5.42	5.33	6.67
U05-6	5.87	17.91	15.49	0.73	17.13	7.93	1.40	4.72	5.88	6.60	3.10	0.76	8.26	10.49	9.37	16.33
U05-60	11.18	6.68	5.57	7.37	6.49	2.25	2.18	1.04	1.69	0.65	1.13	3.10	17.51	5.87	5.89	4.37
U05-61	24.33	3.71	4.53	13.13	4.65	2.79	8.13	7.12	8.04	5.80	6.90	8.36	33.42	13.66	13.59	1.31
U05-63	9.49	17.19	15.09	10.06	16.83	9.60	3.24	2.20	0.18	1.86	1.57	5.31	9.93	0.67	0.75	8.79
U05-64	14.04	10.64	10.10	7.72	10.91	4.08	2.33	3.55	2.73	2.86	1.67	3.12	19.37	5.83	5.25	4.10
U05-66	16.70	5.70	4.70	10.07	4.58	2.22	9.02	9.73	15.84	10.42	10.36	7.71	33.60	26.77	26.18	16.06
U05-68	11.79	4.32	3.39	5.36	4.10	0.68	2.47	1.92	4.09	2.05	2.26	2.46	19.86	10.24	10.07	5.45
U05-69	8.33	7.28	5.75	4.65	6.76	1.82	1.02	0.73	2.16	0.97	0.73	1.46	14.93	7.13	6.92	6.79
U05-7	1.40	17.95	14.14	7.80	15.43	7.64	3.40	3.94	6.98	5.16	3.99	4.29	11.23	12.67	12.27	21.98
U05-71	6.10	12.13	9.54	8.22	11.12	6.17	2.58	0.26	0.74	0.46	1.25	4.22	9.94	3.71	4.09	10.17
U05-72	6.96	12.32	9.97	7.76	11.57	6.32	2.35	0.37	0.38	0.53	1.04	3.91	9.82	2.96	3.25	9.05
U05-73	17.31	11.98	11.83	9.18	12.74	5.97	3.72	4.81	2.98	3.88	2.72	4.61	20.47	5.10	4.57	2.90
U05-74	3.38	12.75	10.03	4.23	11.34	4.38	0.67	1.14	2.90	2.02	0.91	1.30	10.01	7.68	7.30	13.31
U05-75	8.65	14.66	12.99	6.63	14.31	6.15	1.05	2.05	0.90	1.87	0.40	2.31	11.88	2.93	2.45	7.76
U05-76	13.14	25.16	22.90	13.12	25.20	16.69	6.74	5.86	2.03	5.71	4.84	9.09	8.25	0.29	0.37	12.41
U05-78	23.83	7.52	8.44	10.75	8.86	4.56	6.60	7.35	6.69	6.23	5.76	6.71	29.26	10.71	10.22	0.93
U05-8	8.58	25.27	22.61	2.19	24.92	14.58	4.19	7.68	7.18	10.02	5.84	3.63	4.84	9.70	8.58	19.73
U05-81	28.69	11.77	12.93	18.11	13.16	8.33	10.34	10.60	8.57	8.41	8.46	11.50	35.03	11.08	10.74	1.90
U05-82	13.81	13.87	12.65	11.95	14.00	8.09	4.35	2.89	0.82	1.91	2.27	6.40	15.72	1.67	1.84	5.10
U05-83	20.94	20.98	20.66	13.79	22.10	13.45	7.06	8.23	3.84	7.05	5.40	8.77	18.90	2.84	2.35	5.77
U05-84	11.29	16.19	14.74	7.73	16.33	8.46	2.37	2.83	0.62	2.58	1.30	3.78	11.31	1.44	1.12	6.76
U05-85	15.80	23.23	21.67	12.82	23.76	15.48	6.66	6.24	2.13	5.81	4.79	8.75	11.08	0.52	0.48	9.47
U05-86	12.83	20.44	18.53	11.03	20.61	13.29	5.34	4.23	1.17	4.08	3.57	7.31	9.30	0.51	0.63	9.46
U05-88	9.87	22.01	19.53	9.96	21.76	13.71	4.64	3.83	1.15	4.07	3.20	6.59	6.46	0.66	0.71	12.10
U05-89	13.40	26.75	24.41	11.89	26.92	18.09	7.13	6.72	2.88	7.04	5.66	9.09	6.72	1.14	1.10	13.91
U05-9	22.72	37.43	35.45	6.31	38.11	27.02	15.17	21.37	21.07	25.19	18.74	12.51	13.78	24.54	22.69	31.54
U05-91	11.32	29.75	26.48	16.01	29.11	20.43	8.85	6.95	3.33	7.09	6.69	11.76	6.00	1.14	1.51	18.09
U05-93	7.60	23.03	20.12	9.82	22.37	13.76	4.17	3.53	1.20	3.91	2.88	6.23	5.16	0.90	0.91	14.08
U05-95	4.04	13.33	10.82	3.27	12.21	4.70	0.25	1.29	2.49	2.20	0.62	0.73	9.25	6.81	6.29	12.35

	M06-54	M06-55	M06-56	M06-57	M06-58	M06-60	M06-62	M06-64	M06-66	M06-69	M07-1	M07-1dk	M07-2	M07-3	M07-4	M07-5
Rk-12	9.16	12.42	29.23	10.13	11.66	6.12	7.17	5.48	7.55	8.82	3.16	6.05	2.98	2.78	6.37	10.05
Rk-13	9.10	7.47	35.97	13.39	7.10	7.30	3.90	6.48	3.84	2.05	8.27	3.96	7.84	6.71	16.48	3.54
Rk-14	7.77	3.65	32.72	10.83	2.91	6.58	2.35	6.85	1.68	0.91	9.58	7.02	10.80	10.32	19.70	6.91
Rk-15	6.28	10.93	19.73	5.73	10.57	3.73	6.89	3.31	7.00	9.87	0.98	5.07	0.90	1.89	2.81	12.14
Rk-16	5.38	10.16	24.00	8.84	10.45	3.63	5.11	2.50	6.40	7.27	1.83	2.66	1.18	4.10	4.50	10.58
Rk-17	3.66	8.27	20.66	7.05	8.72	2.34	3.98	1.39	5.21	6.43	1.28	2.15	0.89	4.58	4.14	11.13
Rk-18	5.15	11.21	22.01	8.62	11.61	3.57	5.98	2.53	7.71	9.32	1.45	4.00	1.10	5.56	3.05	14.43
Rk-19	7.34	16.22	16.76	7.95	16.49	5.47	11.19	4.93	12.92	17.30	1.76	9.51	2.07	7.91	0.36	24.11
Rk-20	3.94	11.17	9.09	3.18	11.56	2.86	8.64	2.98	9.50	14.79	1.15	8.61	2.15	8.20	1.00	23.68
Rk-21	42.60	40.42	63.87	40.66	40.22	38.16	37.18	35.58	33.03	29.82	36.21	21.83	30.51	16.61	43.42	8.30
Rk-22	23.29	20.20	43.59	21.70	19.62	19.90	18.32	18.68	14.96	13.43	19.70	10.72	16.81	7.28	27.83	1.97
Rk-24	14.82	25.65	34.35	24.44	27.41	14.78	17.81	12.73	22.79	23.55	12.47	15.36	11.89	23.80	11.53	34.70
Rk-25	11.57	18.89	1.38	5.14	19.53	11.28	20.77	12.60	19.63	28.77	11.06	21.00	12.87	18.88	9.87	39.17
Rk-26	9.57	17.40	1.33	4.68	18.20	9.52	18.60	10.66	18.18	26.87	9.33	19.29	11.22	18.60	8.05	38.70
Rk-27	5.13	11.00	2.28	2.05	11.62	5.23	11.99	6.38	11.81	19.09	6.03	14.47	8.20	15.43	6.77	31.90
Rk-29	3.78	8.47	2.98	0.79	9.01	3.64	9.46	4.56	8.82	15.17	4.62	10.84	6.25	11.65	6.35	25.42
Rk-30	6.59	14.29	6.30	3.31	14.49	5.46	12.90	6.17	13.18	20.31	3.58	13.76	5.22	11.38	2.52	30.33
Rk-31	4.00	9.29	10.46	1.97	9.23	2.34	7.21	2.60	7.11	11.97	0.72	7.04	1.56	4.78	1.86	18.17
Rk-33	3.17	4.44	18.33	3.35	4.01	1.51	2.38	1.70	2.04	4.31	1.56	4.01	2.45	3.69	6.51	9.76
Rk-34	3.45	5.21	8.59	0.56	4.83	2.72	6.02	4.16	5.12	10.66	4.04	11.04	6.65	10.46	8.10	21.87
Rk-35	3.15	6.69	13.03	2.03	6.61	1.49	4.71	1.52	4.30	7.78	0.64	4.06	1.05	2.82	3.46	12.22
Rk-36	0.88	3.79	11.46	1.35	3.89	0.21	2.53	0.64	2.77	6.32	0.97	5.12	2.43	6.96	4.76	15.85
Rk-37	0.81	3.51	10.58	1.08	3.61	0.32	2.68	0.93	2.87	6.70	1.44	6.02	3.20	8.12	5.40	17.27
Rk-39	3.17	8.49	16.37	5.18	8.51	2.16	4.97	2.31	6.63	10.22	1.18	8.12	2.86	9.53	3.15	21.59
Rk-40	1.88	5.45	13.72	2.28	5.43	0.64	3.17	0.77	3.49	6.74	0.27	4.42	1.24	4.86	3.40	14.19
Rk-41	2.23	2.37	19.52	4.07	2.20	1.23	0.75	1.35	0.63	1.99	2.68	3.20	3.65	5.67	9.02	8.84
Rk-43	1.84	5.59	9.97	1.11	5.54	0.98	4.39	1.65	4.58	9.17	1.11	7.43	2.92	7.78	3.91	19.41
Rk-44	3.47	8.10	10.95	1.70	7.92	1.91	6.18	2.32	6.11	10.84	0.68	7.16	1.86	5.24	2.43	18.03
Rk-46	2.55	6.33	15.76	3.26	6.16	1.11	3.46	1.23	4.06	7.23	0.30	5.21	1.43	5.25	3.27	15.05
Rk-47	5.38	9.72	11.95	2.89	9.08	3.94	8.29	5.17	8.46	14.47	2.94	13.38	5.69	10.72	4.75	26.32
Rk-48	2.67	6.05	11.01	1.07	5.82	1.31	4.74	1.87	4.42	8.81	0.94	6.52	2.30	5.35	3.81	16.40
Rk-49	5.10	1.16	23.70	6.75	0.85	4.69	1.85	5.33	0.61	1.15	8.88	6.41	10.32	10.74	18.72	8.53
Rk-50	2.15	0.40	19.04	4.57	0.26	2.19	0.53	3.02	0.42	2.08	5.95	6.91	8.22	12.12	14.14	13.96
U05-0	5.10	13.70	15.64	8.04	14.68	4.22	9.06	3.28	11.22	14.48	2.05	6.56	1.89	9.12	1.54	22.10
U05-1	5.84	10.79	18.75	5.74	10.13	3.88	7.06	4.36	8.11	12.37	1.72	10.71	3.68	8.39	3.41	22.20
U05-10	12.84	16.65	30.49	13.03	16.50	9.53	11.56	7.98	11.00	11.45	6.15	4.28	3.84	0.73	8.78	5.58
U05-14	10.95	18.16	0.79	5.40	18.98	11.22	20.40	12.69	19.63	28.81	11.82	21.98	14.08	21.64	10.99	41.74
U05-16	13.68	22.19	10.51	7.64	21.64	11.73	20.65	13.14	20.70	29.78	8.29	23.59	10.97	16.88	5.81	41.07
U05-19	7.27	15.48	5.98	4.25	15.78	6.47	14.23	7.35	14.87	22.47	4.80	16.15	6.89	14.50	3.41	34.68
U05-22	3.42	10.56	5.31	2.96	11.38	3.41	9.51	3.88	10.49	16.49	3.32	11.00	4.94	13.23	3.48	29.02
U05-23	17.81	24.71	1.52	10.00	26.02	18.26	28.83	19.54	26.60	36.22	19.53	26.52	20.62	25.87	18.62	44.73
U05-24	9.86	18.11	8.02	4.76	18.05	7.93	16.37	8.55	16.09	23.68	4.72	15.46	5.87	10.07	2.71	30.51
U05-25	35.12	30.59	47.85	26.22	26.65	31.25	31.34	35.05	28.49	35.45	30.66	46.83	36.79	34.13	38.10	47.88
U05-27	5.43	13.32	9.03	5.17	13.73	5.04	11.20	5.74	12.83	19.26	3.95	14.68	6.31	15.61	3.41	33.89
U05-29	6.36	11.20	2.61	1.48	11.59	5.87	12.70	6.97	11.42	18.59	6.38	13.37	7.93	12.17	7.56	27.41
U05-3	9.80	5.95	39.07	15.83	5.75	8.96	3.54	8.40	3.59	0.92	12.25	6.12	12.44	12.43	22.82	5.52
U05-32	1.77	6.25	10.04	1.40	6.46	0.78	4.52	0.99	4.74	8.85	0.43	5.23	1.41	5.71	2.69	16.75
U05-33	0.59	3.10	12.02	1.60	3.36	0.04	1.90	0.27	2.08	5.05	1.17	3.76	2.28	6.46	5.43	13.73
U05-36	4.82	9.30	10.18	2.37	8.84	3.67	8.26	4.93	8.44	14.63	3.05	13.31	5.82	11.36	4.81	27.05
U05-4	11.79	8.15	42.30	21.11	8.96	12.29	6.01	11.17	6.87	2.88	17.39	7.53	17.01	19.45	28.70	9.08
U05-40	2.37	4.81	15.97	2.67	4.53	0.92	2.60	1.15	2.67	5.55	0.74	4.54	1.85	4.54	4.75	12.58
U05-41	1.19	3.96	14.47	2.46	4.00	0.29	1.94	0.46	2.39	5.17	0.71	4.09	1.89	5.95	4.74	13.72
U05-43	2.23	4.31	14.59	1.97	4.08	0.85	2.67	1.13	2.37	5.38	0.98	4.21	1.98	4.16	5.21	11.80
U05-44	0.32	2.54	10.77	1.32	2.93	0.09	1.94	0.43	2.02	5.12	1.84	4.12	3.08	7.64	6.41	14.56

	M06-54	M06-55	M06-56	M06-57	M06-58	M06-60	M06-62	M06-64	M06-66	M06-69	M07-1	M07-1 dk	M07-2	M07-3	M07-4	M07-5
U05-45	4.80	6.24	11.88	2.38	5.50	4.07	6.73	5.91	6.33	12.10	5.41	14.73	9.02	14.01	9.78	26.46
U05-46	0.47	3.13	10.86	1.28	3.45	0.06	2.20	0.38	2.36	5.62	1.32	4.24	2.55	7.09	5.45	14.85
U05-48	10.45	10.62	20.01	6.26	8.89	8.52	10.54	10.76	9.57	15.53	8.66	20.12	12.78	15.28	13.51	28.47
U05-51	1.53	3.53	13.36	1.61	3.30	0.60	2.32	1.23	2.35	5.82	1.36	5.96	3.13	6.92	5.77	15.40
U05-53	8.67	11.17	14.96	3.92	9.87	6.55	10.50	8.24	9.57	15.93	5.46	16.44	8.51	10.86	8.25	26.04
U05-56	3.05	1.79	20.37	4.23	1.41	2.06	0.97	2.48	0.33	1.71	4.17	4.41	5.44	6.61	11.56	8.65
U05-57	4.63	1.69	25.84	7.77	1.07	4.36	1.20	5.36	1.32	2.33	8.08	9.64	10.88	14.43	17.34	15.13
U05-59	0.87	3.71	11.76	1.52	3.78	0.27	2.45	0.78	2.81	6.40	1.14	5.69	2.82	7.73	5.03	16.77
U05-6	6.17	10.39	23.15	7.94	10.50	3.98	5.85	2.89	6.29	7.40	1.91	2.16	0.90	1.76	4.66	8.04
U05-60	1.34	3.68	9.83	0.65	3.63	0.77	3.35	1.62	3.19	7.50	1.96	7.19	3.96	8.45	6.00	18.16
U05-61	7.59	10.52	7.81	2.05	9.85	6.43	11.72	8.31	10.40	17.80	6.68	17.02	9.73	13.37	9.14	29.23
U05-63	2.38	0.89	20.50	4.89	0.61	2.09	0.38	2.82	0.39	1.86	5.24	6.47	7.38	10.90	13.17	13.00
U05-64	4.36	5.96	16.08	2.81	5.06	2.78	4.66	3.92	4.39	8.71	2.76	10.21	5.30	8.28	7.05	18.87
U05-66	10.60	21.74	9.08	8.02	22.47	9.17	18.52	9.01	19.59	26.70	5.32	15.34	5.70	12.60	1.49	34.10
U05-68	2.48	6.98	7.55	0.68	7.16	1.51	6.09	1.99	5.85	10.83	1.27	6.87	2.44	6.50	3.24	18.82
U05-69	1.26	4.92	10.61	1.23	5.08	0.41	3.45	0.70	3.62	7.41	0.60	4.89	1.74	5.98	3.64	15.82
U05-7	4.42	11.29	20.67	9.95	12.27	3.99	6.38	2.98	9.08	10.78	3.09	5.83	3.25	11.20	4.61	20.32
U05-71	0.20	1.53	13.76	3.12	2.11	0.47	0.90	0.67	1.37	3.42	3.25	3.87	4.54	9.89	9.03	14.11
U05-72	0.43	1.15	14.37	2.85	1.54	0.48	0.64	0.78	0.84	2.86	3.23	3.86	4.58	9.11	9.38	12.97
U05-73	5.62	5.55	17.65	3.28	4.39	3.96	5.09	5.40	4.18	8.42	4.61	11.57	7.40	9.12	10.12	18.26
U05-74	1.74	6.32	16.02	4.64	6.81	0.95	3.05	0.50	4.31	6.53	0.68	3.21	1.13	6.34	3.55	14.41
U05-75	2.73	3.62	19.46	4.03	3.07	1.54	1.62	2.12	1.93	4.35	2.31	6.48	4.26	7.59	7.84	14.08
U05-76	6.11	1.63	28.74	9.29	1.13	5.74	1.60	6.40	0.96	0.80	10.08	7.97	11.97	13.18	20.66	9.97
U05-78	8.23	9.50	13.14	2.80	8.31	6.33	10.02	8.11	8.36	14.60	6.22	15.41	9.06	10.30	9.97	23.57
U05-8	9.24	10.47	30.63	11.67	10.47	6.93	6.42	5.59	6.04	5.25	6.04	1.88	4.35	2.32	11.45	2.55
U05-81	11.21	11.04	17.71	6.04	9.38	9.63	12.15	12.22	10.79	17.53	10.51	22.43	15.00	17.82	15.51	31.61
U05-82	3.01	1.43	17.37	3.50	0.87	2.68	1.94	4.04	1.49	4.45	5.87	9.69	8.83	12.49	13.45	17.24
U05-83	9.00	5.19	27.14	7.78	3.58	7.39	5.30	9.08	3.97	6.56	9.69	14.32	12.95	13.05	18.56	16.70
U05-84	3.45	2.22	20.83	4.27	1.54	2.35	1.31	3.12	0.85	2.80	4.24	6.62	6.22	8.00	11.49	11.64
U05-85	6.65	2.01	27.51	8.18	1.17	5.90	2.33	6.90	1.23	1.89	9.82	9.29	12.04	12.44	20.13	10.84
U05-86	4.50	0.95	23.84	6.52	0.54	4.08	1.22	4.80	0.37	1.07	8.01	6.77	9.81	11.05	17.58	9.82
U05-88	4.14	1.25	25.27	7.45	1.06	3.75	0.68	4.05	0.30	0.30	7.39	5.12	8.70	10.36	16.67	8.41
U05-89	7.16	2.48	30.48	10.28	2.04	6.53	2.23	6.86	1.29	0.53	10.63	6.78	11.81	11.64	21.35	7.02
U05-9	23.92	25.22	44.42	23.62	25.06	19.99	20.47	17.79	18.46	16.91	16.97	9.10	12.91	4.82	21.58	3.40
U05-91	6.89	2.26	32.13	12.55	2.25	7.21	1.99	7.49	2.00	0.64	12.56	8.11	14.14	16.70	23.88	10.82
U05-93	3.82	1.67	26.20	8.21	1.63	3.52	0.40	3.60	0.58	0.27	6.90	4.65	8.10	10.68	15.78	8.91
U05-95	2.05	5.95	17.17	4.48	6.23	0.95	2.69	0.53	3.62	5.64	0.55	2.78	0.93	4.98	3.84	12.37

	Rk-12	Rk-13	Rk-14	Rk-15	Rk-16	Rk-17	Rk-18	Rk-19	Rk-20	Rk-21	Rk-22	Rk-23	Rk-24	Rk-25	Rk-26	Rk-27
Rk-12	0.00	4.36	7.38	1.06	1.81	2.62	2.66	5.42	7.43	27.20	13.62	16.18	16.89	23.64	21.96	17.02
Rk-13	4.36	0.00	1.75	6.92	4.60	4.94	7.01	15.13	15.45	21.69	8.88	13.24	22.01	33.52	31.63	24.00
Rk-14	7.38	1.75	0.00	9.33	8.37	7.97	10.73	18.35	16.24	28.78	11.99	20.63	28.38	30.81	29.35	21.28
Rk-15	1.06	6.92	9.33	0.00	1.76	1.95	2.00	2.76	3.34	29.09	14.99	18.34	16.02	14.98	13.71	10.30
Rk-16	1.81	4.60	8.37	1.76	0.00	0.18	0.31	3.60	5.19	30.17	16.59	18.44	9.11	21.12	18.64	13.92
Rk-17	2.62	4.94	7.97	1.95	0.18	0.00	0.34	3.40	4.13	31.80	17.36	20.16	8.87	18.54	16.09	11.53
Rk-18	2.66	7.01	10.73	2.00	0.31	0.34	0.00	2.07	3.76	35.82	21.01	22.91	6.96	19.18	16.43	12.21
Rk-19	5.42	15.13	18.35	2.76	3.60	3.40	2.07	0.00	1.36	46.04	29.36	31.77	9.04	12.70	10.33	8.23
Rk-20	7.43	15.45	16.24	3.34	5.19	4.13	3.76	1.36	0.00	46.37	28.12	33.58	13.15	6.45	4.77	2.98
Rk-21	27.20	21.69	28.78	29.09	30.17	31.80	35.82	46.04	46.37	0.00	4.01	1.78	64.71	59.55	61.29	56.47
Rk-22	13.62	8.88	11.99	14.99	16.59	17.36	21.01	29.36	28.12	4.01	0.00	2.63	47.73	39.74	40.78	35.26
Rk-24	16.89	22.01	28.38	16.02	9.11	8.87	6.96	9.04	13.15	64.71	47.73	46.59	0.00	34.17	28.70	24.20
Rk-25	23.64	33.52	30.81	14.98	21.12	18.54	19.18	12.70	6.45	59.55	39.74	49.55	34.17	0.00	0.32	1.57
Rk-26	21.96	31.63	29.35	13.71	18.64	16.09	16.43	10.33	4.77	61.29	40.78	50.09	28.70	0.32	0.00	0.81
Rk-27	17.02	24.00	21.28	10.30	13.92	11.53	12.21	8.23	2.98	56.47	35.26	45.13	24.20	1.57	0.81	0.00
Rk-29	14.10	19.40	17.11	8.08	11.49	9.32	10.49	7.95	2.78	47.47	28.13	37.50	24.32	2.21	1.73	0.43
Rk-30	11.65	21.90	21.33	6.10	10.12	8.70	8.26	3.55	0.92	52.89	33.23	40.30	19.77	3.17	2.16	1.57
Rk-31	5.01	11.92	12.28	1.63	4.56	3.77	3.99	2.49	0.80	37.74	20.84	26.77	17.70	6.96	6.00	3.82
Rk-33	2.42	4.10	3.88	1.63	2.89	2.44	3.67	6.22	4.73	29.79	13.35	20.03	19.26	15.18	14.00	9.21
Rk-34	10.26	14.29	10.56	6.36	10.29	8.58	9.93	8.72	3.97	45.64	24.50	35.49	26.74	6.30	5.82	2.77
Rk-35	3.42	7.50	8.06	1.03	3.08	2.45	3.32	3.97	2.27	30.36	14.93	20.66	18.24	9.97	9.08	5.90
Rk-36	5.62	8.33	7.29	3.07	4.02	2.81	3.78	4.65	2.08	39.60	20.73	28.51	15.99	9.79	8.24	4.32
Rk-37	6.73	9.36	7.72	3.89	5.04	3.65	4.70	5.32	2.27	41.86	22.19	30.71	17.03	9.13	7.63	3.75
Rk-39	5.00	10.65	11.03	3.24	3.26	2.55	2.13	2.01	1.79	48.56	28.36	34.32	9.83	13.57	10.94	6.91
Rk-40	3.44	7.15	7.30	1.44	2.45	1.70	2.32	3.21	1.78	36.12	18.66	24.92	14.65	11.11	9.54	5.71
Rk-41	3.96	2.96	2.30	3.51	3.32	2.60	4.31	8.42	6.43	30.74	13.78	21.11	18.61	17.74	16.20	10.51
Rk-43	6.39	11.15	9.77	3.23	5.29	4.05	4.64	3.97	1.31	43.43	23.68	31.81	17.25	7.63	6.26	3.03
Rk-44	4.79	11.14	10.95	1.71	4.55	3.72	4.03	2.83	0.98	38.76	21.01	27.62	17.90	7.49	6.45	3.85
Rk-46	2.79	7.09	7.44	1.26	2.16	1.62	1.92	2.73	1.95	37.77	19.88	25.85	13.68	12.62	10.82	6.76
Rk-47	7.95	15.96	13.70	4.68	8.66	7.57	7.46	4.63	2.24	51.69	29.76	38.82	21.32	7.81	6.62	3.89
Rk-48	4.97	9.78	8.87	2.09	4.79	3.83	4.58	4.17	1.71	37.48	19.42	26.93	19.37	7.98	7.05	3.95
Rk-49	10.17	4.37	1.28	10.01	9.92	8.68	11.98	18.36	14.01	30.36	12.86	23.25	30.37	23.29	22.40	15.47
Rk-50	9.34	6.10	2.76	8.46	7.99	6.49	8.81	13.24	9.32	40.76	20.14	30.83	22.84	18.77	17.06	10.61
U05-0	7.11	13.71	17.28	4.27	2.81	2.20	1.42	1.12	1.96	45.27	29.17	31.32	5.44	13.89	11.00	8.35
U05-1	3.77	11.44	11.49	2.41	4.47	4.19	3.52	2.38	2.52	47.19	27.06	33.27	14.76	13.90	11.88	8.13
U05-10	2.70	5.73	11.08	3.04	3.58	4.55	5.32	9.22	11.09	14.67	7.09	6.88	21.56	25.66	24.81	20.91
U05-14	25.59	34.77	31.39	16.71	22.18	19.27	19.95	13.55	6.85	64.87	43.48	54.17	33.24	0.28	0.24	1.22
U05-16	16.06	30.63	29.01	10.15	16.97	15.76	14.49	6.86	4.42	64.28	42.36	50.53	28.34	5.00	4.44	4.75
U05-19	14.05	24.84	23.81	8.08	11.97	10.31	9.66	4.28	1.43	59.49	38.32	45.98	19.69	3.20	1.93	1.47
U05-22	12.81	19.84	19.13	7.36	8.86	6.97	6.97	4.06	0.97	54.85	34.42	41.84	14.82	4.49	2.69	1.16
U05-23	35.06	42.96	39.73	24.32	30.92	27.56	29.36	22.95	14.22	61.51	43.77	54.38	46.42	2.22	3.48	5.88
U05-24	11.66	23.71	23.88	6.00	11.48	10.43	9.81	4.26	2.07	49.28	31.46	37.54	23.88	3.53	3.13	3.32
U05-25	28.10	35.97	27.13	28.31	39.31	39.09	39.99	37.22	33.15	72.76	45.63	62.25	71.27	37.65	38.76	33.49
U05-27	12.57	21.82	21.00	7.79	9.59	8.02	7.16	3.23	1.29	62.53	40.02	47.46	13.71	6.87	4.59	2.83
U05-29	16.06	22.59	20.06	9.37	14.30	12.12	13.36	9.77	4.09	47.13	28.44	38.05	29.63	1.20	1.37	0.89
U05-3	9.20	1.12	1.26	12.11	8.39	8.21	11.07	21.02	20.09	27.17	12.49	18.93	25.30	38.40	36.16	27.22
U05-32	5.34	9.97	9.93	2.19	3.69	2.63	3.21	2.99	0.89	38.51	20.88	27.40	15.24	7.87	6.49	3.52
U05-33	5.63	7.09	6.37	3.24	3.58	2.37	3.62	5.38	2.75	36.71	18.76	26.19	15.77	10.86	9.30	5.14
U05-36	9.02	16.78	14.30	5.27	9.13	7.82	7.82	4.85	1.99	52.79	30.65	40.01	21.24	6.60	5.42	2.89
U05-4	16.50	4.89	5.69	19.07	12.15	11.42	14.78	26.73	25.35	33.05	18.80	24.67	24.11	44.66	41.56	32.02
U05-40	2.79	5.72	5.51	1.43	2.63	2.03	2.86	4.40	2.98	34.23	16.76	23.44	16.65	12.97	11.53	7.17
U05-41	4.00	6.26	5.97	2.29	2.60	1.71	2.58	4.30	2.59	37.06	18.97	25.82	14.36	12.49	10.71	6.29
U05-43	3.42	5.91	5.43	1.69	3.24	2.50	3.63	5.21	3.18	32.38	15.37	22.39	18.53	11.86	10.73	6.58
U05-44	7.20	8.03	6.79	4.41	4.69	3.21	4.71	6.50	3.20	38.06	19.70	27.80	16.84	10.23	8.73	4.61

	Rk-12	Rk-13	Rk-14	Rk-15	Rk-16	Rk-17	Rk-18	Rk-19	Rk-20	Rk-21	Rk-22	Rk-23	Rk-24	Rk-25	Rk-26	Rk-27
U05-45	11.26	16.00	11.30	7.98	11.99	10.33	11.25	9.63	5.23	53.99	30.08	42.21	27.18	8.97	8.05	4.37
U05-46	6.42	8.07	7.09	3.68	4.18	2.82	4.09	5.50	2.56	38.20	19.87	27.63	16.12	9.89	8.36	4.39
U05-48	11.30	17.59	12.35	9.37	15.34	14.35	15.01	13.03	9.43	54.61	30.35	42.93	35.11	14.48	14.06	9.93
U05-51	5.02	7.60	6.04	3.00	4.45	3.38	4.42	5.48	2.93	39.25	19.90	28.27	18.11	11.06	9.65	5.34
U05-53	8.89	16.96	13.57	5.97	12.00	11.11	11.43	8.47	5.42	48.89	27.21	37.55	30.45	9.47	9.20	6.41
U05-56	5.24	3.25	1.56	4.87	5.29	4.45	6.62	11.08	8.29	30.28	12.93	21.49	23.11	18.57	17.40	11.43
U05-57	9.47	5.74	1.99	10.02	9.33	8.18	10.37	15.63	12.47	43.68	21.89	33.01	24.77	24.69	22.69	15.10
U05-59	5.89	8.61	7.33	3.40	4.27	3.03	3.94	4.76	2.19	41.46	21.95	30.02	15.80	10.11	8.44	4.39
U05-6	1.30	4.22	7.96	1.00	0.49	0.77	1.26	4.40	5.52	24.14	12.16	14.01	13.31	19.72	17.99	13.74
U05-60	7.44	10.42	8.15	4.32	6.32	4.84	6.01	6.14	2.57	42.42	22.36	31.63	19.81	8.11	6.93	3.27
U05-61	13.88	21.30	16.94	8.80	15.07	13.29	14.18	10.33	5.13	52.16	30.13	41.80	32.89	4.29	4.41	2.72
U05-63	7.64	4.98	2.17	7.23	6.77	5.55	7.63	12.09	8.89	39.34	19.12	29.11	21.61	19.60	17.81	11.26
U05-64	5.31	9.86	7.36	3.64	6.85	6.04	6.72	6.58	4.20	43.09	22.27	31.64	22.83	12.04	10.96	6.71
U05-66	13.57	26.34	28.73	7.58	10.68	9.65	8.29	2.72	1.93	54.41	37.42	40.87	16.15	5.75	4.28	4.84
U05-68	7.24	12.58	11.83	3.21	5.84	4.53	5.26	4.05	1.03	39.82	21.91	29.29	18.83	5.36	4.45	2.17
U05-69	5.33	8.92	8.45	2.46	3.72	2.59	3.41	3.79	1.43	38.20	20.19	27.27	15.74	8.69	7.28	3.87
U05-7	7.06	10.56	13.76	5.69	2.25	1.67	1.20	3.21	4.39	46.65	29.46	32.13	3.49	19.75	16.14	11.74
U05-71	8.47	6.99	5.65	6.35	5.04	3.46	5.25	8.62	5.35	39.61	20.79	29.10	15.67	14.25	12.23	7.10
U05-72	7.80	6.20	4.61	5.92	5.08	3.59	5.50	9.00	5.65	37.76	19.09	27.66	17.33	14.46	12.66	7.41
U05-73	6.61	9.99	6.47	5.15	9.09	8.21	9.42	9.80	6.61	41.75	20.78	31.39	28.26	13.48	12.86	8.25
U05-74	4.09	6.79	8.31	2.47	1.23	0.52	0.91	2.88	2.43	37.81	20.95	25.62	9.07	14.49	12.06	7.79
U05-75	3.83	5.34	3.87	3.35	4.05	3.37	4.36	6.77	5.16	39.05	19.36	27.57	17.94	16.60	14.81	9.29
U05-76	10.26	3.83	0.60	11.25	10.19	9.14	12.21	19.41	15.87	34.64	15.76	26.28	29.03	28.12	26.61	18.62
U05-78	10.17	16.49	12.47	6.79	13.15	11.98	13.07	10.77	6.47	44.58	23.81	34.97	34.29	8.40	8.69	5.95
U05-8	3.03	1.71	5.50	4.09	2.85	3.35	4.98	11.25	12.01	15.48	6.01	7.86	20.25	27.66	26.34	20.76
U05-81	14.77	20.94	14.56	11.87	18.59	17.15	18.14	15.47	10.55	58.14	32.98	46.99	39.26	12.74	12.68	9.00
U05-82	9.51	8.50	4.14	8.15	9.54	8.02	10.06	12.73	8.42	44.30	22.22	34.05	26.04	15.94	14.67	8.82
U05-83	9.30	8.58	3.70	9.70	12.95	12.18	14.33	17.57	13.95	41.17	19.60	31.89	35.73	23.14	22.53	15.86
U05-84	5.27	4.46	2.02	5.03	6.04	5.22	7.05	10.67	7.98	35.29	16.08	25.51	23.54	18.36	17.08	11.03
U05-85	9.84	4.74	0.86	10.55	10.99	9.99	12.98	19.14	15.25	34.69	15.34	26.60	32.05	25.97	24.93	17.38
U05-86	9.24	4.20	1.01	9.30	9.08	7.90	10.85	16.84	12.92	33.41	14.78	25.26	28.12	23.11	21.91	14.84
U05-88	8.16	2.80	0.75	8.64	7.25	6.26	9.01	15.68	12.63	31.96	14.27	23.37	24.27	24.81	23.18	15.88
U05-89	9.86	2.73	0.37	11.12	9.90	9.07	12.37	20.36	17.10	28.93	12.15	21.63	30.18	29.80	28.52	20.53
U05-9	10.40	9.54	16.23	11.81	12.20	13.64	15.76	22.84	24.56	4.38	2.54	0.74	37.17	39.67	39.83	35.35
U05-91	13.20	4.37	1.69	14.57	11.28	10.07	13.35	22.22	18.86	37.31	18.59	28.59	27.02	33.09	30.88	22.10
U05-93	7.62	2.46	1.07	8.36	6.09	5.19	7.61	14.44	12.11	33.58	15.79	24.10	20.73	25.88	23.78	16.31
U05-95	2.93	5.40	6.87	1.71	0.91	0.38	0.91	3.22	2.83	34.52	18.22	22.91	10.72	15.12	12.94	8.49

	Rk-29	Rk-30	Rk-31	Rk-32	Rk-33	Rk-34	Rk-35	Rk-36	Rk-37	Rk-39	Rk-40	Rk-41	Rk-43	Rk-44	Rk-46	Rk-47
Rk-12	14.10	11.65	5.01	8.04	2.42	10.26	3.42	5.62	6.73	5.00	3.44	3.96	6.39	4.79	2.79	7.95
Rk-13	19.40	21.90	11.92	11.21	4.10	14.29	7.50	8.33	9.36	10.65	7.15	2.96	11.15	11.14	7.09	15.96
Rk-14	17.11	21.33	12.28	14.22	3.88	10.56	8.06	7.29	7.72	11.03	7.30	2.30	9.77	10.95	7.44	13.70
Rk-15	8.08	6.10	1.63	4.90	1.63	6.36	1.03	3.07	3.89	3.24	1.44	3.51	3.23	1.71	1.26	4.68
Rk-16	11.49	10.12	4.56	7.66	2.89	10.29	3.08	4.02	5.04	3.26	2.45	3.32	5.29	4.55	2.16	8.66
Rk-17	9.32	8.70	3.77	7.34	2.44	8.58	2.45	2.81	3.65	2.55	1.70	2.60	4.05	3.72	1.62	7.57
Rk-18	10.49	8.26	3.99	9.08	3.67	9.93	3.32	3.78	4.70	2.13	2.32	4.31	4.64	4.03	1.92	7.46
Rk-19	7.95	3.55	2.49	10.68	6.22	8.72	3.97	4.65	5.32	2.01	3.21	8.42	3.97	2.83	2.73	4.63
Rk-20	2.78	0.92	0.80	8.76	4.73	3.97	2.27	2.08	2.27	1.79	1.78	6.43	1.31	0.98	1.95	2.24
Rk-21	47.47	52.89	37.74	16.49	29.79	45.64	30.36	39.60	41.86	48.56	36.12	30.74	43.43	38.76	37.77	51.69
Rk-22	28.13	33.23	20.84	8.15	13.35	24.50	14.93	20.73	22.19	28.36	18.66	13.78	23.68	21.01	19.88	29.76
Rk-24	24.32	19.77	17.70	28.21	19.26	26.74	18.24	15.99	17.03	9.83	14.65	18.61	17.25	17.90	13.68	21.32
Rk-25	2.21	3.17	6.96	14.03	15.18	6.30	9.97	9.79	9.13	13.57	11.11	17.74	7.63	7.49	12.62	7.81
Rk-26	1.73	2.16	6.00	14.46	14.00	5.82	9.08	8.24	7.63	10.94	9.54	16.20	6.26	6.45	10.82	6.62
Rk-27	0.43	1.57	3.82	12.63	9.21	2.77	5.90	4.32	3.75	6.91	5.71	10.51	3.03	3.85	6.76	3.89
Rk-29	0.00	2.00	2.69	8.88	6.65	1.84	3.84	2.98	2.58	6.49	4.13	7.74	2.20	2.74	5.32	3.81
Rk-30	2.00	0.00	1.67	10.83	7.58	3.65	4.17	4.04	3.92	4.37	4.11	10.08	2.36	1.92	4.48	2.07
Rk-31	2.69	1.67	0.00	5.54	2.42	2.53	0.62	1.43	1.70	2.51	0.91	4.32	0.85	0.09	1.19	1.77
Rk-33	6.65	7.58	2.42	6.16	0.00	3.52	0.87	1.26	1.69	3.29	0.77	0.52	2.03	1.92	0.91	4.18
Rk-34	1.84	3.65	2.53	10.27	3.52	0.00	2.90	1.71	1.30	4.96	2.72	4.47	1.11	1.92	3.36	1.63
Rk-35	3.84	4.17	0.62	3.75	0.87	2.90	0.00	1.05	1.47	3.11	0.48	2.10	1.26	0.59	0.89	3.29
Rk-36	2.98	4.04	1.43	7.96	1.26	1.71	1.05	0.00	0.06	1.66	0.32	1.54	0.31	0.99	0.66	2.36
Rk-37	2.58	3.92	1.70	8.86	1.69	1.30	1.47	0.06	0.00	1.92	0.63	1.88	0.27	1.19	1.04	2.18
Rk-39	6.49	4.37	2.51	12.85	3.29	4.96	3.11	1.66	1.92	0.00	1.30	4.04	1.56	2.06	0.83	2.48
Rk-40	4.13	4.11	0.91	6.64	0.77	2.72	0.48	0.32	0.63	1.30	0.00	1.51	0.60	0.63	0.13	2.48
Rk-41	7.74	10.08	4.32	7.94	0.52	4.47	2.10	1.54	1.88	4.04	1.51	0.00	2.94	3.60	1.77	6.13
Rk-43	2.20	2.36	0.85	8.73	2.03	1.11	1.26	0.31	0.27	1.56	0.60	2.94	0.00	0.47	0.87	1.06
Rk-44	2.74	1.92	0.09	6.35	1.92	1.92	0.59	0.99	1.19	2.06	0.63	3.60	0.47	0.00	0.83	1.26
Rk-46	5.32	4.48	1.19	7.92	0.91	3.36	0.89	0.66	1.04	0.83	0.13	1.77	0.87	0.83	0.00	2.32
Rk-47	3.81	2.07	1.77	12.78	4.18	1.63	3.29	2.36	2.18	2.48	2.48	6.13	1.06	1.26	2.32	0.00
Rk-48	2.57	2.78	0.44	6.30	1.27	1.22	0.47	0.55	0.67	2.38	0.48	2.53	0.30	0.18	0.81	1.42
Rk-49	11.72	17.69	10.40	11.90	3.74	7.03	6.71	5.44	5.49	10.96	6.37	2.02	7.61	9.23	7.20	11.90
Rk-50	8.32	12.49	7.52	13.80	2.89	4.31	5.30	2.65	2.49	6.01	3.83	1.34	4.13	6.29	4.29	7.33
U05-0	7.84	5.24	3.80	10.77	6.69	9.86	4.57	4.32	4.98	2.32	3.40	7.60	4.51	4.16	3.28	7.11
U05-1	7.57	4.30	2.20	12.67	3.12	4.66	3.06	2.64	2.96	0.89	1.80	4.90	1.96	1.71	1.08	1.42
U05-10	16.65	15.80	7.79	3.55	5.51	15.30	5.15	9.67	11.18	11.28	6.97	7.17	11.10	8.31	7.10	14.87
U05-14	2.25	3.62	7.98	16.64	16.17	6.46	11.14	9.90	9.07	13.49	11.68	18.22	7.81	8.35	13.20	8.13
U05-16	6.03	1.74	4.96	17.40	12.68	6.54	8.87	9.10	8.82	8.34	8.91	16.66	6.11	5.13	8.84	3.14
U05-19	2.47	0.21	2.85	13.87	9.43	4.39	5.86	4.98	4.71	4.81	5.34	11.84	3.08	3.03	5.65	2.47
U05-22	1.62	1.21	2.65	12.16	7.40	3.91	4.55	2.86	2.65	3.34	3.60	8.42	2.02	2.73	4.15	3.35
U05-23	6.05	10.08	14.40	17.28	23.60	12.67	17.03	17.26	16.41	24.21	19.36	25.75	15.37	15.31	21.94	17.25
U05-24	3.44	0.62	2.07	9.50	8.73	5.17	4.71	6.09	6.16	6.65	5.57	12.20	4.06	2.59	5.94	3.20
U05-25	32.10	30.55	27.02	40.87	23.89	19.82	27.48	27.34	26.69	29.70	27.41	27.37	24.98	24.94	26.40	18.77
U05-27	3.97	1.43	3.45	16.47	8.54	5.05	6.09	3.98	3.76	2.44	4.40	10.05	2.61	3.32	4.32	2.43
U05-29	0.40	2.38	3.47	8.68	8.37	2.53	4.91	4.85	4.42	9.11	5.93	10.12	3.66	3.69	7.30	4.77
U05-3	22.47	27.15	16.63	16.65	6.80	16.60	11.42	10.57	11.33	13.83	10.29	4.25	14.08	15.40	10.42	19.88
U05-32	2.34	2.46	0.46	6.30	1.79	2.15	0.59	0.37	0.56	1.69	0.31	2.73	0.33	0.35	0.69	2.15
U05-33	3.43	5.18	1.95	7.17	1.16	2.37	1.09	0.14	0.27	2.26	0.47	1.09	0.82	1.54	0.95	3.61
U05-36	2.93	1.65	1.77	12.78	4.54	1.32	3.39	2.19	1.93	2.62	2.56	6.33	0.90	1.29	2.56	0.08
U05-4	27.23	33.84	23.20	22.31	12.70	23.25	17.31	15.09	15.83	18.70	15.46	8.51	19.64	22.02	15.99	27.86
U05-40	5.24	5.49	1.48	6.87	0.25	2.78	0.62	0.56	0.90	1.84	0.18	0.90	1.00	1.03	0.24	2.78
U05-41	4.63	5.31	1.78	7.82	0.75	2.86	1.00	0.21	0.46	1.37	0.17	0.92	0.80	1.31	0.32	3.08
U05-43	4.47	5.43	1.40	5.76	0.22	2.30	0.39	0.53	0.82	2.64	0.30	0.85	1.00	1.00	0.59	3.04
U05-44	2.96	5.44	2.50	7.70	1.77	2.22	1.62	0.30	0.31	2.95	0.97	1.44	1.03	2.06	1.63	4.08

	Rk-29	Rk-30	Rk-31	Rk-32	Rk-33	Rk-34	Rk-35	Rk-36	Rk-37	Rk-39	Rk-40	Rk-41	Rk-43	Rk-44	Rk-46	Rk-47
U05-45	4.01	4.83	4.11	15.36	4.72	0.70	4.92	2.73	2.18	4.70	3.86	5.67	1.82	3.14	4.04	1.21
U05-46	2.86	4.72	1.92	7.46	1.52	2.06	1.25	0.12	0.18	2.35	0.60	1.45	0.69	1.52	1.15	3.41
U05-48	9.22	8.63	6.85	18.73	6.43	3.21	7.59	6.38	5.93	7.91	6.85	8.34	5.02	5.63	6.53	2.64
U05-51	3.84	4.82	1.74	8.60	0.83	1.45	1.19	0.19	0.24	1.91	0.45	1.20	0.45	1.12	0.65	2.03
U05-53	5.75	4.46	3.33	13.14	4.91	1.96	4.50	4.46	4.23	5.86	4.48	7.43	2.92	2.68	4.38	1.02
U05-56	8.38	11.64	5.49	8.67	0.90	4.34	2.93	2.30	2.53	5.78	2.53	0.26	3.76	4.60	2.93	6.88
U05-57	12.66	16.23	10.25	18.02	3.95	6.60	7.67	4.68	4.56	7.21	5.66	2.27	6.29	8.65	5.65	8.89
U05-59	3.18	4.14	1.67	8.96	1.44	1.70	1.38	0.03	0.05	1.46	0.43	1.64	0.30	1.15	0.70	2.18
U05-6	10.78	9.94	3.89	4.63	2.28	9.59	2.15	4.19	5.27	4.67	2.45	3.16	5.38	4.04	2.42	8.74
U05-60	2.13	3.65	1.69	8.93	1.90	0.63	1.60	0.28	0.12	2.60	0.98	2.32	0.26	1.14	1.45	1.77
U05-61	2.45	3.09	3.66	12.71	6.95	0.98	5.25	4.60	4.03	7.73	5.56	9.10	2.94	3.22	6.20	1.87
U05-63	8.88	12.32	6.99	13.31	2.20	4.50	4.75	2.45	2.42	5.24	3.29	0.90	3.91	5.78	3.54	6.86
U05-64	5.46	5.23	2.41	11.14	1.67	1.48	2.37	1.62	1.58	2.83	1.67	2.86	1.22	1.60	1.53	1.09
U05-66	5.54	1.56	3.83	11.92	11.84	9.49	6.94	7.88	8.17	6.60	7.11	14.96	6.09	4.69	7.36	6.24
U05-68	1.15	1.65	0.43	6.11	2.70	1.41	0.93	0.86	0.89	2.96	1.06	3.97	0.46	0.40	1.67	1.93
U05-69	2.53	3.21	0.82	6.69	1.38	1.86	0.64	0.11	0.25	1.72	0.22	2.00	0.27	0.57	0.61	2.28
U05-7	10.90	9.13	6.28	14.13	6.57	11.47	6.09	4.64	5.30	2.27	3.95	6.28	5.64	6.19	3.60	9.03
U05-71	5.27	8.59	4.89	10.30	2.69	4.13	3.38	1.19	1.20	3.79	2.11	1.43	2.54	4.24	2.75	6.47
U05-72	5.36	8.79	4.70	9.72	2.08	3.65	3.01	1.08	1.10	3.99	1.94	0.94	2.42	3.99	2.56	6.15
U05-73	6.57	7.38	3.91	11.84	2.16	1.64	3.40	2.73	2.60	5.08	2.99	3.23	2.44	2.92	2.99	2.26
U05-74	6.29	6.07	2.60	8.41	2.16	5.77	1.93	1.23	1.73	1.18	0.81	2.20	2.07	2.39	0.84	5.06
U05-75	7.43	8.04	3.58	11.04	0.77	3.32	2.41	1.22	1.40	2.21	1.19	0.83	1.86	2.66	1.00	3.35
U05-76	14.97	20.35	12.49	15.97	4.55	8.95	8.60	6.56	6.64	10.91	7.42	2.44	8.95	11.00	7.82	12.99
U05-78	4.76	5.27	3.70	11.23	4.75	1.29	4.29	4.47	4.16	7.70	4.85	6.96	3.22	3.07	5.22	2.09
U05-8	16.21	17.69	8.72	5.18	3.83	13.77	5.04	7.75	9.03	10.24	5.94	3.87	10.06	8.71	6.20	15.00
U05-81	8.53	8.87	7.97	20.06	8.21	2.98	8.98	7.40	6.70	9.91	8.41	10.09	5.81	6.72	8.39	3.33
U05-82	7.00	10.32	6.38	14.35	2.84	2.43	4.96	2.45	2.11	5.66	3.66	2.11	3.15	5.10	4.00	4.86
U05-83	13.17	15.80	9.85	17.00	4.27	5.47	7.75	6.51	6.35	9.96	7.02	4.29	7.09	8.27	6.95	7.49
U05-84	8.46	10.87	5.33	10.87	1.01	3.59	3.29	2.20	2.31	4.92	2.49	0.64	3.24	4.26	2.61	5.31
U05-85	13.84	18.84	11.39	15.24	4.02	7.34	7.87	6.23	6.23	10.84	7.05	2.53	8.14	9.89	7.44	11.24
U05-86	11.46	16.62	9.70	12.96	3.21	6.39	6.35	4.68	4.70	9.27	5.57	1.57	6.67	8.43	6.14	10.42
U05-88	12.40	17.18	9.82	12.65	3.08	7.73	6.26	4.65	4.86	8.57	5.27	1.22	6.96	8.64	5.73	11.31
U05-89	16.26	22.02	13.18	14.19	4.74	10.47	8.72	7.55	7.82	12.48	8.09	2.65	10.26	11.86	8.63	14.98
U05-9	28.84	30.49	18.88	6.73	13.79	27.19	13.97	20.79	22.75	25.34	17.51	15.12	23.43	19.66	18.22	29.36
U05-91	18.32	24.59	16.18	19.40	7.19	12.82	11.69	8.77	8.90	12.94	9.87	4.01	11.90	14.62	10.34	17.35
U05-93	13.03	17.18	9.89	13.48	3.23	8.59	6.44	4.56	4.86	7.55	5.03	1.22	6.97	8.73	5.31	11.46
U05-95	6.62	6.50	2.37	7.34	1.32	5.46	1.39	1.15	1.70	1.44	0.55	1.50	2.04	2.13	0.56	4.93

	Rk-48	Rk-49	Rk-50	U05-0	U05-1	U05-10	U05-14	U05-16	U05-19	U05-22	U05-23	U05-24	U05-25	U05-27	U05-29	U05-3
Rk-12	4.97	10.17	9.34	7.11	3.77	2.70	25.59	16.06	14.05	12.81	35.06	11.66	28.10	12.57	16.06	9.20
Rk-13	9.78	4.37	6.10	13.71	11.44	5.73	34.77	30.63	24.84	19.84	42.96	23.71	35.97	21.82	22.59	1.12
Rk-14	8.87	1.28	2.76	17.28	11.49	11.08	31.39	29.01	23.81	19.13	39.73	23.88	27.13	21.00	20.06	1.26
Rk-15	2.09	10.01	8.46	4.27	2.41	3.04	16.71	10.15	8.08	7.36	24.32	6.00	28.31	7.79	9.37	12.11
Rk-16	4.79	9.92	7.99	2.81	4.47	3.58	22.18	16.97	11.97	8.86	30.92	11.48	39.31	9.59	14.30	8.39
Rk-17	3.83	8.68	6.49	2.20	4.19	4.55	19.27	15.76	10.31	6.97	27.56	10.43	39.09	8.02	12.12	8.21
Rk-18	4.58	11.98	8.81	1.42	3.52	5.32	19.95	14.49	9.66	6.97	29.36	9.81	39.99	7.16	13.36	11.07
Rk-19	4.17	18.36	13.24	1.12	2.38	9.22	13.55	6.86	4.28	4.06	22.95	4.26	37.22	3.23	9.77	21.02
Rk-20	1.71	14.01	9.32	1.96	2.52	11.09	6.85	4.42	1.43	0.97	14.22	2.07	33.15	1.29	4.09	20.09
Rk-21	37.48	30.36	40.76	45.27	47.19	14.67	64.87	64.28	59.49	54.85	61.51	49.28	72.76	62.53	47.13	27.17
Rk-22	19.42	12.86	20.14	29.17	27.06	7.09	43.48	42.36	38.32	34.42	43.77	31.46	45.63	40.02	28.44	12.49
Rk-24	19.37	30.37	22.84	5.44	14.76	21.56	33.24	28.34	19.69	14.82	46.42	23.88	71.27	13.71	29.63	25.30
Rk-25	7.98	23.29	18.77	13.89	13.90	25.66	0.28	5.00	3.20	4.49	2.22	3.53	37.65	6.87	1.20	38.40
Rk-26	7.05	22.40	17.06	11.00	11.88	24.81	0.24	4.44	1.93	2.69	3.48	3.13	38.76	4.59	1.37	36.16
Rk-27	3.95	15.47	10.61	8.35	8.13	20.91	1.22	4.75	1.47	1.16	5.88	3.32	33.49	2.83	0.89	27.22
Rk-29	2.57	11.72	8.32	7.84	7.57	16.65	2.25	6.03	2.47	1.62	6.05	3.44	32.10	3.97	0.40	22.47
Rk-30	2.78	17.69	12.49	5.24	4.30	15.80	3.62	1.74	0.21	1.21	10.08	0.62	30.55	1.43	2.38	27.15
Rk-31	0.44	10.40	7.52	3.80	2.20	7.79	7.98	4.96	2.85	2.65	14.40	2.07	27.02	3.45	3.47	16.63
Rk-33	1.27	3.74	2.89	6.69	3.12	5.51	16.17	12.68	9.43	7.40	23.60	8.73	23.89	8.54	8.37	6.80
Rk-34	1.22	7.03	4.31	9.86	4.66	15.30	6.46	6.54	4.39	3.91	12.67	5.17	19.82	5.05	2.53	16.60
Rk-35	0.47	6.71	5.30	4.57	3.06	5.15	11.14	8.87	5.86	4.55	17.03	4.71	27.48	6.09	4.91	11.42
Rk-36	0.55	5.44	2.65	4.32	2.64	9.67	9.90	9.10	4.98	2.86	17.26	6.09	27.34	3.98	4.85	10.57
Rk-37	0.67	5.49	2.49	4.98	2.96	11.18	9.07	8.82	4.71	2.65	16.41	6.16	26.69	3.76	4.42	11.33
Rk-39	2.38	10.96	6.01	2.32	0.89	11.28	13.49	8.34	4.81	3.34	24.21	6.65	29.70	2.44	9.11	13.83
Rk-40	0.48	6.37	3.83	3.40	1.80	6.97	11.68	8.91	5.34	3.60	19.36	5.57	27.41	4.40	5.93	10.29
Rk-41	2.53	2.02	1.34	7.60	4.90	7.17	18.22	16.66	11.84	8.42	25.75	12.20	27.37	10.05	10.12	4.25
Rk-43	0.30	7.61	4.13	4.51	1.96	11.10	7.81	6.11	3.08	2.02	15.37	4.06	24.98	2.61	3.66	14.08
Rk-44	0.18	9.23	6.29	4.16	1.71	8.31	8.35	5.13	3.03	2.73	15.31	2.59	24.94	3.32	3.69	15.40
Rk-46	0.81	7.20	4.29	3.28	1.08	7.10	13.20	8.84	5.65	4.15	21.94	5.94	26.40	4.32	7.30	10.42
Rk-47	1.42	11.90	7.33	7.11	1.42	14.87	8.13	3.14	2.47	3.35	17.25	3.20	18.77	2.43	4.77	19.88
Rk-48	0.00	6.98	4.56	5.18	2.16	8.54	8.71	6.43	3.97	3.20	15.43	3.74	23.57	4.13	3.61	13.29
Rk-49	6.98	0.00	1.34	16.65	12.08	12.95	23.50	25.60	19.82	15.11	29.38	20.43	27.87	18.21	14.04	3.44
Rk-50	4.56	1.34	0.00	11.66	7.61	14.64	18.23	19.30	13.64	9.52	26.29	16.00	26.49	11.21	11.11	5.32
U05-0	5.18	16.65	11.66	0.00	4.60	9.81	14.12	11.14	5.86	3.57	22.72	7.11	45.99	3.90	10.46	18.16
U05-1	2.16	12.08	7.61	4.60	0.00	10.59	14.50	6.26	5.05	5.21	25.57	5.46	22.16	3.57	9.44	15.76
U05-10	8.54	12.95	14.64	9.81	10.59	0.00	28.58	22.50	19.22	17.07	33.66	14.62	40.90	19.35	17.85	11.53
U05-14	8.71	23.50	18.23	14.12	14.50	28.58	0.00	5.80	3.25	4.04	2.52	4.77	39.29	6.31	1.66	38.83
U05-16	6.43	25.60	19.30	11.14	6.26	22.50	5.80	0.00	1.65	5.28	13.64	1.38	24.98	3.81	5.53	37.38
U05-19	3.97	19.82	13.64	5.86	5.05	19.22	3.25	1.65	0.00	1.09	10.34	1.28	32.00	0.93	3.02	29.86
U05-22	3.20	15.11	9.52	3.57	5.21	17.07	4.04	5.28	1.09	0.00	10.76	3.40	37.09	0.87	3.09	23.25
U05-23	15.43	29.38	26.29	22.72	25.57	33.66	2.52	13.64	10.34	10.76	0.00	10.29	51.41	15.71	4.23	47.34
U05-24	3.74	20.43	16.00	7.11	5.46	14.62	4.77	1.38	1.28	3.40	10.29	0.00	29.72	3.66	3.02	30.39
U05-25	23.57	27.87	26.49	45.99	22.16	40.90	39.29	24.98	32.00	37.09	51.41	29.72	0.00	33.50	31.25	39.47
U05-27	4.13	18.21	11.21	3.90	3.57	19.35	6.31	3.81	0.93	0.87	15.71	3.66	33.50	0.00	5.71	25.74
U05-29	3.61	14.04	11.11	10.46	9.44	17.85	1.66	5.53	3.02	3.09	4.23	3.02	31.25	5.71	0.00	26.44
U05-3	13.29	3.44	5.32	18.16	15.76	11.53	38.83	37.38	29.86	23.25	47.34	30.39	39.47	25.74	26.44	0.00
U05-32	0.35	7.90	4.93	3.07	2.43	8.42	8.34	7.08	3.47	2.01	15.04	3.85	29.30	3.15	3.79	13.37
U05-33	0.96	4.50	2.26	4.45	3.65	8.84	10.99	11.16	6.31	3.53	17.80	7.36	29.82	5.19	5.45	9.01
U05-36	1.42	11.92	7.20	6.95	1.94	15.74	6.75	3.01	1.92	2.58	15.39	2.99	20.29	1.97	3.89	20.46
U05-4	19.63	7.06	8.62	20.91	23.27	17.68	44.17	47.35	36.25	27.00	52.02	38.70	56.83	30.77	32.35	2.00
U05-40	0.65	5.05	3.11	4.88	1.92	6.57	13.68	10.18	6.94	5.19	21.62	6.87	24.59	5.91	7.04	8.62
U05-41	0.90	5.07	2.56	3.91	2.33	7.94	12.76	10.74	6.47	4.05	20.76	7.33	28.00	4.97	6.81	8.57
U05-43	0.50	4.41	2.96	5.56	2.74	6.49	12.65	10.33	7.00	5.18	19.58	6.67	24.71	6.45	6.00	8.72
U05-44	1.32	4.31	2.06	5.18	4.69	10.33	10.15	11.73	6.45	3.40	16.46	7.88	30.89	5.41	4.98	9.49

U05-45	2.42	8.55	4.68	11.44	4.00	19.00	8.74	6.52	5.14	5.15	17.35	6.84	16.00	4.92	5.11	17.94
U05-46	0.94	4.85	2.40	4.53	3.83	9.72	9.91	10.60	5.73	3.03	16.54	6.97	29.99	4.73	4.80	9.94
U05-48	4.90	11.18	8.02	17.13	5.00	20.42	14.99	8.04	9.37	11.06	25.01	9.57	7.85	9.57	9.78	20.45
U05-51	0.53	4.65	2.16	5.73	2.28	9.73	11.30	9.31	5.88	4.09	19.19	6.73	23.36	4.87	5.64	9.77
U05-53	2.52	11.85	8.68	12.37	3.24	15.75	10.41	4.23	5.35	7.27	18.80	4.65	12.03	6.41	5.87	21.21
U05-56	3.18	1.00	1.00	10.46	6.30	8.56	19.08	18.08	13.55	10.16	26.16	13.72	24.76	12.07	10.53	4.06
U05-57	6.74	2.02	0.66	14.63	8.21	16.52	24.13	22.48	17.43	13.40	34.24	19.95	23.46	14.08	15.90	4.57
U05-59	0.69	5.56	2.49	4.46	2.47	10.49	10.08	9.05	4.96	2.86	17.90	6.37	26.79	3.74	5.17	10.69
U05-6	4.20	9.12	8.43	4.19	5.15	1.62	21.35	16.49	12.25	9.65	28.45	10.41	37.06	11.05	12.83	8.58
U05-60	0.55	5.55	2.70	6.25	3.21	12.04	8.13	7.95	4.45	2.85	15.11	5.65	24.20	3.99	3.62	12.48
U05-61	2.92	12.62	9.25	13.06	6.25	19.43	4.75	3.72	3.61	5.05	10.56	3.69	17.55	5.63	2.15	24.94
U05-63	4.19	1.45	0.12	10.89	6.50	13.06	19.27	18.83	13.58	9.70	27.91	15.57	25.36	11.01	11.72	4.62
U05-64	1.10	6.56	3.82	8.61	1.68	11.71	12.57	7.53	6.26	6.03	21.64	6.53	15.92	5.66	6.78	12.69
U05-66	6.45	25.52	19.56	4.10	7.07	15.96	6.55	3.78	1.80	2.90	12.77	1.63	42.90	3.07	5.99	33.30
U05-68	0.39	8.82	5.92	4.51	3.39	10.05	5.90	5.66	2.60	1.71	11.54	2.72	28.15	3.17	2.02	16.21
U05-69	0.34	6.48	3.73	3.66	2.57	8.68	9.03	8.11	4.23	2.42	15.87	4.86	28.38	3.66	4.15	11.78
U05-7	6.72	14.20	9.29	1.04	5.36	11.01	19.43	16.38	9.70	5.90	29.75	12.19	47.24	6.00	14.65	13.35
U05-71	3.18	3.53	1.30	6.19	6.43	11.98	13.71	16.22	9.54	5.20	20.70	11.95	34.64	7.38	8.05	7.25
U05-72	2.83	2.65	0.87	6.95	6.20	11.31	14.11	16.12	9.90	5.80	21.01	11.90	32.05	7.96	7.96	6.52
U05-73	2.02	5.47	3.67	12.11	3.45	12.99	14.13	9.54	8.65	8.46	22.64	8.54	13.01	8.43	7.62	12.36
U05-74	2.40	7.92	4.76	1.68	3.03	7.31	14.68	12.50	7.14	4.08	23.10	8.31	36.15	4.95	9.00	9.49
U05-75	1.89	4.01	1.76	7.18	2.31	9.62	16.85	12.63	9.27	7.13	26.47	10.21	21.70	7.22	9.80	7.05
U05-76	8.66	0.55	1.32	17.66	12.11	14.78	28.02	28.25	22.31	17.25	36.06	23.73	27.49	19.42	18.04	2.29
U05-78	2.52	9.76	7.79	14.17	5.26	15.62	9.43	5.85	6.45	7.88	15.90	5.38	12.57	8.22	4.52	20.20
U05-8	8.10	7.22	9.18	10.23	10.79	1.43	29.70	26.15	20.91	16.86	35.42	18.09	40.34	19.62	18.40	5.01
U05-81	5.83	12.13	8.91	19.49	7.10	23.88	13.05	8.06	9.42	11.27	22.05	9.91	8.10	10.24	8.72	23.46
U05-82	3.51	2.44	0.61	12.58	6.12	15.99	15.57	15.15	11.29	8.67	23.96	13.28	19.80	9.64	9.15	8.41
U05-83	6.44	3.75	3.52	19.54	8.15	16.50	23.68	18.86	17.51	16.19	32.98	17.58	11.63	16.33	14.77	9.14
U05-84	2.91	1.76	0.95	10.83	4.91	10.33	18.72	16.08	12.48	9.84	27.13	13.04	20.44	10.80	10.62	5.35
U05-85	7.60	0.60	1.47	18.47	11.09	14.74	26.15	25.42	20.84	16.86	34.00	21.63	22.14	18.73	16.31	3.77
U05-86	6.31	0.17	0.73	15.41	10.30	13.20	23.15	23.99	18.50	14.06	30.26	19.57	25.98	16.42	14.02	3.31
U05-88	6.68	0.50	0.94	13.65	10.14	11.68	24.82	25.39	19.11	14.06	32.33	20.33	30.02	16.42	15.40	1.96
U05-89	9.50	0.52	2.35	18.41	13.65	12.79	30.12	30.64	24.44	19.06	37.13	24.96	30.14	21.87	19.18	1.48
U05-9	19.28	18.45	24.12	22.76	24.39	3.13	43.76	39.51	35.43	32.02	45.35	28.18	53.74	36.62	29.51	15.33
U05-91	12.09	1.77	2.38	18.77	15.63	17.45	32.45	34.48	26.43	19.67	40.81	29.03	36.58	22.30	22.31	1.68
U05-93	6.95	1.31	1.14	12.09	9.53	11.48	25.73	25.70	18.96	13.61	34.10	20.64	32.49	15.62	16.47	1.64
U05-95	2.03	6.81	4.32	2.41	2.78	5.91	15.59	12.73	7.85	4.98	23.85	8.40	33.59	5.89	9.15	8.24

	U05-32	U05-33	U05-36	U05-4	U05-40	U05-41	U05-43	U05-44	U05-45	U05-46	U05-48	U05-51	U05-53	U05-56	U05-57	U05-59
Rk-12	5.34	5.63	9.02	16.50	2.79	4.00	3.42	7.20	11.26	6.42	11.30	5.02	8.89	5.24	9.47	5.89
Rk-13	9.97	7.09	16.78	4.89	5.72	6.26	5.91	8.03	16.00	8.07	17.59	7.60	16.96	3.25	5.74	8.61
Rk-14	9.93	6.37	14.30	5.69	5.51	5.97	5.43	6.79	11.30	7.09	12.35	6.04	13.57	1.56	1.99	7.33
Rk-15	2.19	3.24	5.27	19.07	1.43	2.29	1.69	4.41	7.98	3.68	9.37	3.00	5.97	4.87	10.02	3.40
Rk-16	3.69	3.58	9.13	12.15	2.63	2.60	3.24	4.69	11.99	4.18	15.34	4.45	12.00	5.29	9.33	4.27
Rk-17	2.63	2.37	7.82	11.42	2.03	1.71	2.50	3.21	10.33	2.82	14.35	3.38	11.11	4.45	8.18	3.03
Rk-18	3.21	3.62	7.82	14.78	2.86	2.58	3.63	4.71	11.25	4.09	15.01	4.42	11.43	6.62	10.37	3.94
Rk-19	2.99	5.38	4.85	26.73	4.40	4.30	5.21	6.50	9.63	5.50	13.03	5.48	8.47	11.08	15.63	4.76
Rk-20	0.89	2.75	1.99	25.35	2.98	2.59	3.18	3.20	5.23	2.56	9.43	2.93	5.42	8.29	12.47	2.19
Rk-21	38.51	36.71	52.79	33.05	34.23	37.06	32.38	38.06	53.99	38.20	54.61	39.25	48.89	30.28	43.68	41.46
Rk-22	20.88	18.76	30.65	18.80	16.76	18.97	15.37	19.70	30.08	19.87	30.35	19.90	27.21	12.93	21.89	21.95
Rk-24	15.24	15.77	21.24	24.11	16.65	14.36	18.53	16.84	27.18	16.12	35.11	18.11	30.45	23.11	24.77	15.80
Rk-25	7.87	10.86	6.60	44.66	12.97	12.49	11.86	10.23	8.97	9.89	14.48	11.06	9.47	18.57	24.69	10.11
Rk-26	6.49	9.30	5.42	41.56	11.53	10.71	10.73	8.73	8.05	8.36	14.06	9.65	9.20	17.40	22.69	8.44
Rk-27	3.52	5.14	2.89	32.02	7.17	6.29	6.58	4.61	4.37	4.39	9.93	5.34	6.41	11.43	15.10	4.39
Rk-29	2.34	3.43	2.93	27.23	5.24	4.63	4.47	2.96	4.01	2.86	9.22	3.84	5.75	8.38	12.66	3.18
Rk-30	2.46	5.18	1.65	33.84	5.49	5.31	5.43	5.44	4.83	4.72	8.63	4.82	4.46	11.64	16.23	4.14
Rk-31	0.46	1.95	1.77	23.20	1.48	1.78	1.40	2.50	4.11	1.92	6.85	1.74	3.33	5.49	10.25	1.67
Rk-33	1.79	1.16	4.54	12.70	0.25	0.75	0.22	1.77	4.72	1.52	6.43	0.83	4.91	0.90	3.95	1.44
Rk-34	2.15	2.37	1.32	23.25	2.78	2.86	2.30	2.22	0.70	2.06	3.21	1.45	1.96	4.34	6.60	1.70
Rk-35	0.59	1.09	3.39	17.31	0.62	1.00	0.39	1.62	4.92	1.25	7.59	1.19	4.50	2.93	7.67	1.38
Rk-36	0.37	0.14	2.19	15.09	0.56	0.21	0.53	0.30	2.73	0.12	6.38	0.19	4.46	2.30	4.68	0.03
Rk-37	0.56	0.27	1.93	15.83	0.90	0.46	0.82	0.31	2.18	0.18	5.93	0.24	4.23	2.53	4.56	0.05
Rk-39	1.69	2.26	2.62	18.70	1.84	1.37	2.64	2.95	4.70	2.35	7.91	1.91	5.86	5.78	7.21	1.46
Rk-40	0.31	0.47	2.56	15.46	0.18	0.17	0.30	0.97	3.86	0.60	6.85	0.45	4.48	2.53	5.66	0.43
Rk-41	2.73	1.09	6.33	8.51	0.90	0.92	0.85	1.44	5.67	1.45	8.34	1.20	7.43	0.26	2.27	1.64
Rk-43	0.33	0.82	0.90	19.64	1.00	0.80	1.00	1.03	1.82	0.69	5.02	0.45	2.92	3.76	6.29	0.30
Rk-44	0.35	1.54	1.29	22.02	1.03	1.31	1.00	2.06	3.14	1.52	5.63	1.12	2.68	4.60	8.65	1.15
Rk-46	0.69	0.95	2.56	15.99	0.24	0.32	0.59	1.63	4.04	1.15	6.53	0.65	4.38	2.93	5.65	0.70
Rk-47	2.15	3.61	0.08	27.86	2.78	3.08	3.04	4.08	1.21	3.41	2.64	2.03	1.02	6.88	8.89	2.18
Rk-48	0.35	0.96	1.42	19.63	0.65	0.90	0.50	1.32	2.42	0.94	4.90	0.53	2.52	3.18	6.74	0.69
Rk-49	7.90	4.50	11.92	7.06	5.05	5.07	4.41	4.31	8.55	4.85	11.18	4.65	11.85	1.00	2.02	5.56
Rk-50	4.93	2.26	7.20	8.62	3.11	2.56	2.96	2.06	4.68	2.40	8.02	2.16	8.68	1.00	0.66	2.49
U05-0	3.07	4.45	6.95	20.91	4.88	3.91	5.56	5.18	11.44	4.53	17.13	5.73	12.37	10.46	14.63	4.46
U05-1	2.43	3.65	1.94	23.27	1.92	2.33	2.74	4.69	4.00	3.83	5.00	2.28	3.24	6.30	8.21	2.47
U05-10	8.42	8.84	15.74	17.68	6.57	7.94	6.49	10.33	19.00	9.72	20.42	9.73	15.75	8.56	16.52	10.49
U05-14	8.34	10.99	6.75	44.17	13.68	12.76	12.65	10.15	8.74	9.91	14.99	11.30	10.41	19.08	24.13	10.08
U05-16	7.08	11.16	3.01	47.35	10.18	10.74	10.33	11.73	6.52	10.60	8.04	9.31	4.23	18.08	22.48	9.05
U05-19	3.47	6.31	1.92	36.25	6.94	6.47	7.00	6.45	5.14	5.73	9.37	5.88	5.35	13.55	17.43	4.96
U05-22	2.01	3.53	2.58	27.00	5.19	4.05	5.18	3.40	5.15	3.03	11.06	4.09	7.27	10.16	13.40	2.86
U05-23	15.04	17.80	15.39	52.02	21.62	20.76	19.58	16.46	17.35	16.54	25.01	19.19	18.80	26.16	34.24	17.90
U05-24	3.85	7.36	2.99	38.70	6.87	7.33	6.67	7.88	6.84	6.97	9.57	6.73	4.65	13.72	19.95	6.37
U05-25	29.30	29.82	20.29	56.83	24.59	28.00	24.71	30.89	16.00	29.99	7.85	23.36	12.03	24.76	23.46	26.79
U05-27	3.15	5.19	1.97	30.77	5.91	4.97	6.45	5.41	4.92	4.73	9.57	4.87	6.41	12.07	14.08	3.74
U05-29	3.79	5.45	3.89	32.35	7.04	6.81	6.00	4.98	5.11	4.80	9.78	5.64	5.87	10.53	15.90	5.17
U05-3	13.37	9.01	20.46	2.00	8.62	8.57	8.72	9.49	17.94	9.94	20.45	9.77	21.21	4.06	4.57	10.69
U05-32	0.00	0.61	1.98	18.33	0.87	0.66	0.81	0.92	3.64	0.57	7.40	0.82	4.41	3.86	7.55	0.52
U05-33	0.61	0.00	3.39	12.82	0.67	0.22	0.54	0.10	3.80	0.03	7.88	0.43	5.86	1.82	4.42	0.23
U05-36	1.98	3.39	0.00	27.92	3.02	3.11	3.18	3.70	1.08	3.11	3.13	2.05	1.36	7.09	9.11	2.02
U05-4	18.33	12.82	27.92	0.00	14.31	13.02	14.36	12.82	25.34	13.67	31.05	15.15	31.40	8.77	8.68	15.21
U05-40	0.87	0.67	3.02	14.31	0.00	0.24	0.11	1.24	3.71	0.91	5.92	0.35	4.14	1.61	4.41	0.65
U05-41	0.66	0.22	3.11	13.02	0.24	0.00	0.38	0.59	3.81	0.37	7.12	0.30	5.28	1.82	4.14	0.25
U05-43	0.81	0.54	3.18	14.36	0.11	0.38	0.00	0.98	3.64	0.73	6.04	0.36	4.11	1.36	4.60	0.70
U05-44	0.92	0.10	3.70	12.82	1.24	0.59	0.98	0.00	3.77	0.05	8.37	0.69	6.42	2.05	4.48	0.39
U05-45	3.64	3.80	1.08	25.34	3.71	3.81	3.64	3.77	0.00	3.50	1.57	2.07	1.49	5.51	5.93	2.45

U05-46	0.57	0.03	3.11	13.67	0.91	0.37	0.73	0.05	3.50	0.00	7.80	0.48	5.73	2.18	4.74	0.21
	U05-32	U05-33	U05-36	U05-4	U05-40	U05-41	U05-43	U05-44	U05-45	U05-46	U05-48	U05-51	U05-53	U05-56	U05-57	U05-59
U05-51	0.82	0.43	2.05	15.15	0.35	0.30	0.36	0.69	2.07	0.48	4.73	0.00	3.44	1.67	3.62	0.17
U05-53	4.41	5.86	1.36	31.40	4.14	5.28	4.11	6.42	1.49	5.73	0.94	3.44	0.00	7.36	9.75	4.36
U05-56	3.86	1.82	7.09	8.77	1.61	1.82	1.36	2.05	5.51	2.18	7.66	1.67	7.36	0.00	1.74	2.41
U05-57	7.55	4.42	9.11	8.68	4.41	4.14	4.60	4.48	5.93	4.74	7.86	3.62	9.75	1.74	0.00	4.35
U05-59	0.52	0.23	2.02	15.21	0.65	0.25	0.70	0.39	2.45	0.21	6.04	0.17	4.36	2.41	4.35	0.00
U05-6	3.58	3.68	9.26	13.34	2.44	2.89	2.69	4.80	12.00	4.30	14.71	4.47	11.00	4.76	10.13	4.64
U05-60	0.78	0.61	1.51	17.66	1.15	0.89	0.95	0.60	1.46	0.47	4.79	0.31	3.26	2.71	4.82	0.27
U05-61	4.36	5.84	1.56	33.60	5.82	6.31	5.24	5.74	1.48	5.34	3.10	4.24	1.40	8.91	11.95	4.60
U05-63	4.62	2.13	6.91	8.40	2.48	2.12	2.48	2.14	4.72	2.36	7.51	1.85	8.13	0.69	0.46	2.30
U05-64	2.26	2.39	1.42	20.45	1.21	1.80	1.37	2.91	1.16	2.46	1.81	0.81	1.26	3.01	4.47	1.49
U05-66	5.09	8.96	5.80	39.24	9.24	8.86	9.42	9.55	11.48	8.56	16.43	9.43	10.15	17.69	24.19	8.16
U05-68	0.29	1.24	1.62	21.71	1.71	1.59	1.39	1.38	3.14	1.05	6.89	1.33	3.70	4.86	9.04	1.06
U05-69	0.08	0.27	2.11	16.53	0.61	0.36	0.53	0.50	3.22	0.24	6.93	0.44	4.41	2.93	6.11	0.23
U05-7	4.44	4.46	8.96	14.76	5.03	3.72	6.00	5.16	12.35	4.71	18.20	5.82	14.79	9.01	11.20	4.59
U05-71	2.43	0.69	6.04	9.13	2.28	1.22	2.13	0.47	5.49	0.71	10.78	1.63	9.45	2.04	3.35	1.19
U05-72	2.41	0.61	5.82	8.99	1.89	1.08	1.69	0.43	4.97	0.67	9.65	1.30	8.57	1.32	2.70	1.10
U05-73	3.76	3.44	2.63	20.73	2.13	3.00	2.06	3.86	1.34	3.53	1.27	1.55	1.39	2.78	4.05	2.62
U05-74	1.27	1.07	5.05	12.61	1.32	0.69	1.73	1.59	7.04	1.28	11.50	1.85	8.70	3.88	6.68	1.31
U05-75	2.40	1.40	3.70	12.69	0.62	0.76	0.95	1.93	3.22	1.68	4.87	0.59	4.55	1.21	2.05	1.08
U05-76	9.57	5.69	13.22	5.77	5.85	5.78	5.62	5.66	9.49	6.16	11.61	5.49	13.25	1.51	0.95	6.48
U05-78	4.59	5.57	2.25	29.99	4.39	5.54	3.91	5.83	1.61	5.38	1.47	3.49	0.51	6.40	9.39	4.51
U05-8	7.86	6.52	15.68	9.19	5.19	5.94	5.08	7.58	17.00	7.41	19.30	7.68	16.24	4.75	10.43	8.38
U05-81	8.47	8.97	3.57	34.01	7.59	8.66	7.42	9.14	1.51	8.70	0.36	5.82	1.36	9.09	9.28	7.05
U05-82	4.52	2.58	4.82	13.59	2.87	2.72	2.71	2.44	2.23	2.60	4.36	1.63	5.28	1.53	1.12	2.22
U05-83	8.90	6.86	8.12	17.46	5.19	6.30	5.09	7.23	4.61	7.19	3.37	4.56	5.51	2.94	2.48	6.29
U05-84	3.89	2.10	5.63	10.99	1.48	1.81	1.45	2.42	3.87	2.42	5.23	1.30	5.54	0.33	1.14	2.15
U05-85	9.08	5.66	11.56	8.75	5.34	5.69	5.02	5.69	7.69	6.09	8.80	4.88	10.57	1.31	1.04	6.16
U05-86	7.20	3.95	10.52	7.16	4.27	4.24	3.88	3.86	7.29	4.30	9.66	3.81	10.62	0.72	1.03	4.68
U05-88	7.08	3.74	11.45	4.94	4.11	3.88	3.89	3.76	8.80	4.18	11.71	4.01	12.29	0.77	1.22	4.68
U05-89	10.37	6.39	15.28	4.83	6.42	6.54	6.03	6.44	11.74	6.98	13.87	6.53	15.02	1.69	2.19	7.64
U05-9	19.57	18.97	30.42	21.26	16.42	18.47	15.65	20.51	33.00	20.20	34.00	20.67	28.75	15.82	26.31	22.09
U05-91	12.21	7.46	17.40	2.85	8.45	7.71	8.34	7.27	13.53	7.98	17.21	8.07	18.92	3.36	2.06	8.65
U05-93	6.95	3.63	11.61	4.02	4.03	3.58	4.06	3.76	9.45	4.12	12.75	4.09	13.19	1.16	1.30	4.53
U05-95	1.24	0.95	5.06	12.01	0.80	0.48	1.14	1.57	6.79	1.25	10.52	1.52	7.92	2.95	5.98	1.27

	U05-6	U05-60	U05-61	U05-63	U05-64	U05-66	U05-68	U05-69	U05-7	U05-71	U05-72	U05-73	U05-74	U05-75	U05-76	U05-78
Rk-12	1.30	7.44	13.88	7.64	5.31	13.57	7.24	5.33	7.06	8.47	7.80	6.61	4.09	3.83	10.26	10.17
Rk-13	4.22	10.42	21.30	4.98	9.86	26.34	12.58	8.92	10.56	6.99	6.20	9.99	6.79	5.34	3.83	16.49
Rk-14	7.96	8.15	16.94	2.17	7.36	28.73	11.83	8.45	13.76	5.65	4.61	6.47	8.31	3.87	0.60	12.47
Rk-15	1.00	4.32	8.80	7.23	3.64	7.58	3.21	2.46	5.69	6.35	5.92	5.15	2.47	3.35	11.25	6.79
Rk-16	0.49	6.32	15.07	6.77	6.85	10.68	5.84	3.72	2.25	5.04	5.08	9.09	1.23	4.05	10.19	13.15
Rk-17	0.77	4.84	13.29	5.55	6.04	9.65	4.53	2.59	1.67	3.46	3.59	8.21	0.52	3.37	9.14	11.98
Rk-18	1.26	6.01	14.18	7.63	6.72	8.29	5.26	3.41	1.20	5.25	5.50	9.42	0.91	4.36	12.21	13.07
Rk-19	4.40	6.14	10.33	12.09	6.58	2.72	4.05	3.79	3.21	8.62	9.00	9.80	2.88	6.77	19.41	10.77
Rk-20	5.52	2.57	5.13	8.89	4.20	1.93	1.03	1.43	4.39	5.35	5.65	6.61	2.43	5.16	15.87	6.47
Rk-21	24.14	42.42	52.16	39.34	43.09	54.41	39.82	38.20	46.65	39.61	37.76	41.75	37.81	39.05	34.64	44.58
Rk-22	12.16	22.36	30.13	19.12	22.27	37.42	21.91	20.19	29.46	20.79	19.09	20.78	20.95	19.36	15.76	23.81
Rk-24	13.31	19.81	32.89	21.61	22.83	16.15	18.83	15.74	3.49	15.67	17.33	28.26	9.07	17.94	29.03	34.29
Rk-25	19.72	8.11	4.29	19.60	12.04	5.75	5.36	8.69	19.75	14.25	14.46	13.48	14.49	16.60	28.12	8.40
Rk-26	17.99	6.93	4.41	17.81	10.96	4.28	4.45	7.28	16.14	12.23	12.66	12.86	12.06	14.81	26.61	8.69
Rk-27	13.74	3.27	2.72	11.26	6.71	4.84	2.17	3.87	11.74	7.10	7.41	8.25	7.79	9.29	18.62	5.95
Rk-29	10.78	2.13	2.45	8.88	5.46	5.54	1.15	2.53	10.90	5.27	5.36	6.57	6.29	7.43	14.97	4.76
Rk-30	9.94	3.65	3.09	12.32	5.23	1.56	1.65	3.21	9.13	8.59	8.79	7.38	6.07	8.04	20.35	5.27
Rk-31	3.89	1.69	3.66	6.99	2.41	3.83	0.43	0.82	6.28	4.89	4.70	3.91	2.60	3.58	12.49	3.70
Rk-33	2.28	1.90	6.95	2.20	1.67	11.84	2.70	1.38	6.57	2.69	2.08	2.16	2.16	0.77	4.55	4.75
Rk-34	9.59	0.63	0.98	4.50	1.48	9.49	1.41	1.86	11.47	4.13	3.65	1.64	5.77	3.32	8.95	1.29
Rk-35	2.15	1.60	5.25	4.75	2.37	6.94	0.93	0.64	6.09	3.38	3.01	3.40	1.93	2.41	8.60	4.29
Rk-36	4.19	0.28	4.60	2.45	1.62	7.88	0.86	0.11	4.64	1.19	1.08	2.73	1.23	1.22	6.56	4.47
Rk-37	5.27	0.12	4.03	2.42	1.58	8.17	0.89	0.25	5.30	1.20	1.10	2.60	1.73	1.40	6.64	4.16
Rk-39	4.67	2.60	7.73	5.24	2.83	6.60	2.96	1.72	2.27	3.79	3.99	5.08	1.18	2.21	10.91	7.70
Rk-40	2.45	0.98	5.56	3.29	1.67	7.11	1.06	0.22	3.95	2.11	1.94	2.99	0.81	1.19	7.42	4.85
Rk-41	3.16	2.32	9.10	0.90	2.86	14.96	3.97	2.00	6.28	1.43	0.94	3.23	2.20	0.83	2.44	6.96
Rk-43	5.38	0.26	2.94	3.91	1.22	6.09	0.46	0.27	5.64	2.54	2.42	2.44	2.07	1.86	8.95	3.22
Rk-44	4.04	1.14	3.22	5.78	1.60	4.69	0.40	0.57	6.19	4.24	3.99	2.92	2.39	2.66	11.00	3.07
Rk-46	2.42	1.45	6.20	3.54	1.53	7.36	1.67	0.61	3.60	2.75	2.56	2.99	0.84	1.00	7.82	5.22
Rk-47	8.74	1.77	1.87	6.86	1.09	6.24	1.93	2.28	9.03	6.47	6.15	2.26	5.06	3.35	12.99	2.09
Rk-48	4.20	0.55	2.92	4.19	1.10	6.45	0.39	0.34	6.72	3.18	2.83	2.02	2.40	1.89	8.66	2.52
Rk-49	9.12	5.55	12.62	1.45	6.56	25.52	8.82	6.48	14.20	3.53	2.65	5.47	7.92	4.01	0.55	9.76
Rk-50	8.43	2.70	9.25	0.12	3.82	19.56	5.92	3.73	9.29	1.30	0.87	3.67	4.76	1.76	1.32	7.79
U05-0	4.19	6.25	13.06	10.89	8.61	4.10	4.51	3.66	1.04	6.19	6.95	12.11	1.68	7.18	17.66	14.17
U05-1	5.15	3.21	6.25	6.50	1.68	7.07	3.39	2.57	5.36	6.43	6.20	3.45	3.03	2.31	12.11	5.26
U05-10	1.62	12.04	19.43	13.06	11.71	15.96	10.05	8.68	11.01	11.98	11.31	12.99	7.31	9.62	14.78	15.62
U05-14	21.35	8.13	4.75	19.27	12.57	6.55	5.90	9.03	19.43	13.71	14.11	14.13	14.68	16.85	28.02	9.43
U05-16	16.49	7.95	3.72	18.83	7.53	3.78	5.66	8.11	16.38	16.22	16.12	9.54	12.50	12.63	28.25	5.85
U05-19	12.25	4.45	3.61	13.58	6.26	1.80	2.60	4.23	9.70	9.54	9.90	8.65	7.14	9.27	22.31	6.45
U05-22	9.65	2.85	5.05	9.70	6.03	2.90	1.71	2.42	5.90	5.20	5.80	8.46	4.08	7.13	17.25	7.88
U05-23	28.45	15.11	10.56	27.91	21.64	12.77	11.54	15.87	29.75	20.70	21.01	22.64	23.10	26.47	36.06	15.90
U05-24	10.41	5.65	3.69	15.57	6.53	1.63	2.72	4.86	12.19	11.95	11.90	8.54	8.31	10.21	23.73	5.38
U05-25	37.06	24.20	17.55	25.36	15.92	42.90	28.15	28.38	47.24	34.64	32.05	13.01	36.15	21.70	27.49	12.57
U05-27	11.05	3.99	5.63	11.01	5.66	3.07	3.17	3.66	6.00	7.38	7.96	8.43	4.95	7.22	19.42	8.22
U05-29	12.83	3.62	2.15	11.72	6.78	5.99	2.02	4.15	14.65	8.05	7.96	7.62	9.00	9.80	18.04	4.52
U05-3	8.58	12.48	24.94	4.62	12.69	33.30	16.21	11.78	13.35	7.25	6.52	12.36	9.49	7.05	2.29	20.20
U05-32	3.58	0.78	4.36	4.62	2.26	5.09	0.29	0.08	4.44	2.43	2.41	3.76	1.27	2.40	9.57	4.59
U05-33	3.68	0.61	5.84	2.13	2.39	8.96	1.24	0.27	4.46	0.69	0.61	3.44	1.07	1.40	5.69	5.57
U05-36	9.26	1.51	1.56	6.91	1.42	5.80	1.62	2.11	8.96	6.04	5.82	2.63	5.05	3.70	13.22	2.25
U05-4	13.34	17.66	33.60	8.40	20.45	39.24	21.71	16.53	14.76	9.13	8.99	20.73	12.61	12.69	5.77	29.99
U05-40	2.44	1.15	5.82	2.48	1.21	9.24	1.71	0.61	5.03	2.28	1.89	2.13	1.32	0.62	5.85	4.39
U05-41	2.89	0.89	6.31	2.12	1.80	8.86	1.59	0.36	3.72	1.22	1.08	3.00	0.69	0.76	5.78	5.54
U05-43	2.69	0.95	5.24	2.48	1.37	9.42	1.39	0.53	6.00	2.13	1.69	2.06	1.73	0.95	5.62	3.91
U05-44	4.80	0.60	5.74	2.14	2.91	9.55	1.38	0.50	5.16	0.47	0.43	3.86	1.59	1.93	5.66	5.83
U05-45	12.00	1.46	1.48	4.72	1.16	11.48	3.14	3.22	12.35	5.49	4.97	1.34	7.04	3.22	9.49	1.61

	U05-6	U05-60	U05-61	U05-63	U05-64	U05-66	U05-68	U05-69	U05-7	U05-71	U05-72	U05-73	U05-74	U05-75	U05-76	U05-78
U05-46	4.30	0.47	5.34	2.36	2.46	8.56	1.05	0.24	4.71	0.71	0.67	3.53	1.28	1.68	6.16	5.38
U05-48	14.71	4.79	3.10	7.51	1.81	16.43	6.89	6.93	18.20	10.78	9.65	1.27	11.50	4.87	11.61	1.47
U05-51	4.47	0.31	4.24	1.85	0.81	9.43	1.33	0.44	5.82	1.63	1.30	1.55	1.85	0.59	5.49	3.49
U05-53	11.00	3.26	1.40	8.13	1.26	10.15	3.70	4.41	14.79	9.45	8.57	1.39	8.70	4.55	13.25	0.51
U05-56	4.76	2.71	8.91	0.69	3.01	17.69	4.86	2.93	9.01	2.04	1.32	2.78	3.88	1.21	1.51	6.40
U05-57	10.13	4.82	11.95	0.46	4.47	24.19	9.04	6.11	11.20	3.35	2.70	4.05	6.68	2.05	0.95	9.39
U05-59	4.64	0.27	4.60	2.30	1.49	8.16	1.06	0.23	4.59	1.19	1.10	2.62	1.31	1.08	6.48	4.51
U05-6	0.00	6.24	13.85	7.23	6.61	10.74	5.29	3.67	4.46	5.74	5.49	8.35	2.11	4.42	10.14	11.50
U05-60	6.24	0.00	2.85	2.71	1.25	8.41	0.79	0.46	6.94	1.79	1.57	1.97	2.68	1.65	6.92	2.98
U05-61	13.85	2.85	0.00	9.43	3.11	8.85	2.81	4.42	16.37	8.91	8.31	3.24	9.87	6.92	15.24	0.90
U05-63	7.23	2.71	9.43	0.00	3.26	19.05	5.82	3.48	8.49	1.47	0.98	3.21	4.16	1.14	1.21	7.56
U05-64	6.61	1.25	3.11	3.26	0.00	10.73	2.52	1.91	9.13	4.51	3.85	0.36	4.28	1.03	7.13	1.74
U05-66	10.74	8.41	8.85	19.05	10.73	0.00	4.62	6.42	8.94	13.09	13.73	14.17	7.80	13.20	28.58	11.72
U05-68	5.29	0.79	2.81	5.82	2.52	4.62	0.00	0.45	6.70	3.40	3.31	3.79	2.72	3.56	11.11	3.50
U05-69	3.67	0.46	4.42	3.48	1.91	6.42	0.45	0.00	4.55	1.73	1.65	3.19	1.18	1.77	7.94	4.43
U05-7	4.46	6.94	16.37	8.49	9.13	8.94	6.70	4.55	0.00	4.86	5.64	12.48	1.32	6.06	13.99	16.75
U05-71	5.74	1.79	8.91	1.47	4.51	13.09	3.40	1.73	4.86	0.00	0.08	5.48	1.91	2.30	4.25	8.84
U05-72	5.49	1.57	8.31	0.98	3.85	13.73	3.31	1.65	5.64	0.08	0.00	4.52	2.14	1.82	3.38	7.82
U05-73	8.35	1.97	3.24	3.21	0.36	14.17	3.79	3.19	12.48	5.48	4.52	0.00	6.37	1.61	6.13	1.30
U05-74	2.11	2.68	9.87	4.16	4.28	7.80	2.72	1.18	1.32	1.91	2.14	6.37	0.00	2.33	8.47	9.52
U05-75	4.42	1.65	6.92	1.14	1.03	13.20	3.56	1.77	6.06	2.30	1.82	1.61	2.33	0.00	3.85	5.02
U05-76	10.14	6.92	15.24	1.21	7.13	28.58	11.11	7.94	13.99	4.25	3.38	6.13	8.47	3.85	0.00	11.83
U05-78	11.50	2.98	0.90	7.56	1.74	11.72	3.50	4.43	16.75	8.84	7.82	1.30	9.52	5.02	11.83	0.00
U05-8	1.59	10.06	19.58	7.99	10.39	19.71	9.91	7.48	9.36	7.79	7.16	11.16	5.67	6.84	8.21	15.60
U05-81	17.72	5.27	2.35	8.76	2.88	17.35	7.41	7.97	21.03	11.76	10.63	2.06	13.62	6.61	13.08	1.38
U05-82	9.68	1.88	5.96	0.69	2.05	17.98	4.98	3.46	11.11	2.50	1.86	1.65	5.75	1.48	2.61	4.60
U05-83	12.13	5.68	8.53	3.05	3.10	25.00	9.42	7.64	17.94	7.81	6.41	1.64	10.69	3.17	3.44	4.86
U05-84	5.81	2.33	7.60	0.54	1.79	17.43	4.85	2.96	9.35	2.57	1.80	1.54	4.24	0.58	1.83	5.08
U05-85	10.47	6.15	12.65	1.32	5.63	27.58	10.18	7.53	15.53	4.93	3.84	4.31	9.09	3.43	0.33	9.09
U05-86	8.72	4.82	11.86	0.72	5.38	24.40	8.29	5.80	12.74	3.03	2.21	4.51	6.98	2.90	0.27	9.06
U05-88	7.25	5.34	13.90	0.78	6.18	24.03	8.63	5.73	10.57	2.57	1.93	5.75	5.80	2.86	0.33	11.04
U05-89	9.37	8.19	17.13	2.15	8.55	29.84	12.00	8.77	14.86	5.06	4.10	7.45	9.05	4.88	0.30	13.23
U05-9	8.50	23.61	32.67	22.48	23.59	30.90	21.29	19.59	23.85	22.01	20.83	23.83	18.17	20.29	21.21	26.92
U05-91	11.98	9.68	20.62	2.41	10.99	32.47	14.35	10.38	13.85	4.79	4.23	10.36	9.55	6.14	0.75	17.47
U05-93	6.60	5.61	15.13	0.87	6.54	23.36	8.87	5.65	8.65	2.29	1.84	6.55	4.87	2.72	0.76	12.40
U05-95	1.42	2.55	9.54	3.62	3.62	8.60	2.68	1.10	2.06	2.01	2.04	5.40	0.13	1.76	7.37	8.57

	U05-8	U05-81	U05-82	U05-83	U05-84	U05-85	U05-86	U05-88	U05-89	U05-9	U05-91	U05-93	U05-95
RK-12	3.03	14.77	9.51	9.30	5.27	9.84	9.24	8.16	9.86	10.40	13.20	7.62	2.93
RK-13	1.71	20.94	8.50	8.58	4.46	4.74	4.20	2.80	2.73	9.54	4.37	2.46	5.40
RK-14	5.50	14.56	4.14	3.70	2.02	0.86	1.01	0.75	0.37	16.23	1.69	1.07	6.87
RK-15	4.09	11.87	8.15	9.70	5.03	10.55	9.30	8.64	11.12	11.81	14.57	8.36	1.71
RK-16	2.85	18.59	9.54	12.95	6.04	10.99	9.08	7.25	9.90	12.20	11.28	6.09	0.91
RK-17	3.35	17.15	8.02	12.18	5.22	9.99	7.90	6.26	9.07	13.64	10.07	5.19	0.38
RK-18	4.98	18.14	10.06	14.33	7.05	12.98	10.85	9.01	12.37	15.76	13.35	7.61	0.91
RK-19	11.25	15.47	12.73	17.57	10.67	19.14	16.84	15.68	20.36	22.84	22.22	14.44	3.22
RK-20	12.01	10.55	8.42	13.95	7.98	15.25	12.92	12.63	17.10	24.56	18.86	12.11	2.83
RK-21	15.48	58.14	44.30	41.17	35.29	34.69	33.41	31.96	28.93	4.38	37.31	33.58	34.52
RK-22	6.01	32.98	22.22	19.60	16.08	15.34	14.78	14.27	12.15	2.54	18.59	15.79	18.22
RK-24	20.25	39.26	26.04	35.73	23.54	32.05	28.12	24.27	30.18	37.17	27.02	20.73	10.72
RK-25	27.66	12.74	15.94	23.14	18.36	25.97	23.11	24.81	29.80	39.67	33.09	25.88	15.12
RK-26	26.34	12.68	14.67	22.53	17.08	24.93	21.91	23.18	28.52	39.83	30.88	23.78	12.94
RK-27	20.76	9.00	8.82	15.86	11.03	17.38	14.84	15.88	20.53	35.35	22.10	16.31	8.49
RK-29	16.21	8.53	7.00	13.17	8.46	13.84	11.46	12.40	16.26	28.84	18.32	13.03	6.62
RK-30	17.69	8.87	10.32	15.80	10.87	18.84	16.62	17.18	22.02	30.49	24.59	17.18	6.50
RK-31	8.72	7.97	6.38	9.85	5.33	11.39	9.70	9.82	13.18	18.88	16.18	9.89	2.37
RK-33	3.83	8.21	2.84	4.27	1.01	4.02	3.21	3.08	4.74	13.79	7.19	3.23	1.32
RK-34	13.77	2.98	2.43	5.47	3.59	7.34	6.39	7.73	10.47	27.19	12.82	8.59	5.46
RK-35	5.04	8.98	4.96	7.75	3.29	7.87	6.35	6.26	8.72	13.97	11.69	6.44	1.39
RK-36	7.75	7.40	2.45	6.51	2.20	6.23	4.68	4.65	7.55	20.79	8.77	4.56	1.15
RK-37	9.03	6.70	2.11	6.35	2.31	6.23	4.70	4.86	7.82	22.75	8.90	4.86	1.70
RK-39	10.24	9.91	5.66	9.96	4.92	10.84	9.27	8.57	12.48	25.34	12.94	7.55	1.44
RK-40	5.94	8.41	3.66	7.02	2.49	7.05	5.57	5.27	8.09	17.51	9.87	5.03	0.55
RK-41	3.87	10.09	2.11	4.29	0.64	2.53	1.57	1.22	2.65	15.12	4.01	1.22	1.50
RK-43	10.06	5.81	3.15	7.09	3.24	8.14	6.67	6.96	10.26	23.43	11.90	6.97	2.04
RK-44	8.71	6.72	5.10	8.27	4.26	9.89	8.43	8.64	11.86	19.66	14.62	8.73	2.13
RK-46	6.20	8.39	4.00	6.95	2.61	7.44	6.14	5.73	8.63	18.22	10.34	5.31	0.56
RK-47	15.00	3.33	4.86	7.49	5.31	11.24	10.42	11.31	14.98	29.36	17.35	11.46	4.93
RK-48	8.10	5.83	3.51	6.44	2.91	7.60	6.31	6.68	9.50	19.28	12.09	6.95	2.03
RK-49	7.22	12.13	2.44	3.75	1.76	0.60	0.17	0.50	0.52	18.45	1.77	1.31	6.81
RK-50	9.18	8.91	0.61	3.52	0.95	1.47	0.73	0.94	2.35	24.12	2.38	1.14	4.32
U05-0	10.23	19.49	12.58	19.54	10.83	18.47	15.41	13.65	18.41	22.76	18.77	12.09	2.41
U05-1	10.79	7.10	6.12	8.15	4.91	11.09	10.30	10.14	13.65	24.39	15.63	9.53	2.78
U05-10	1.43	23.88	15.99	16.50	10.33	14.74	13.20	11.68	12.79	3.13	17.45	11.48	5.91
U05-14	29.70	13.05	15.57	23.68	18.72	26.15	23.15	24.82	30.12	43.76	32.45	25.73	15.59
U05-16	26.15	8.06	15.15	18.86	16.08	25.42	23.99	25.39	30.64	39.51	34.48	25.70	12.73
U05-19	20.91	9.42	11.29	17.51	12.48	20.84	18.50	19.11	24.44	35.43	26.43	18.96	7.85
U05-22	16.86	11.27	8.67	16.19	9.84	16.86	14.06	14.06	19.06	32.02	19.67	13.61	4.98
U05-23	35.42	22.05	23.96	32.98	27.13	34.00	30.26	32.33	37.13	45.35	40.81	34.10	23.85
U05-24	18.09	9.91	13.28	17.58	13.04	21.63	19.57	20.33	24.96	28.18	29.03	20.64	8.40
U05-25	40.34	8.10	19.80	11.63	20.44	22.14	25.98	30.02	30.14	53.74	36.58	32.49	33.59
U05-27	19.62	10.24	9.64	16.33	10.80	18.73	16.42	16.42	21.87	36.62	22.30	15.62	5.89
U05-29	18.40	8.72	9.15	14.77	10.62	16.31	14.02	15.40	19.18	29.51	22.31	16.47	9.15
U05-3	5.01	23.46	8.41	9.14	5.35	3.77	3.31	1.96	1.48	15.33	1.68	1.64	8.24
U05-32	7.86	8.47	4.52	8.90	3.89	9.08	7.20	7.08	10.37	19.57	12.21	6.95	1.24
U05-33	6.52	8.97	2.58	6.86	2.10	5.66	3.95	3.74	6.39	18.97	7.46	3.63	0.95
U05-36	15.68	3.57	4.82	8.12	5.63	11.56	10.52	11.45	15.28	30.42	17.40	11.61	5.06
U05-4	9.19	34.01	13.59	17.46	10.99	8.75	7.16	4.94	4.83	21.26	2.85	4.02	12.01
U05-40	5.19	7.59	2.87	5.19	1.48	5.34	4.27	4.11	6.42	16.42	8.45	4.03	0.80
U05-41	5.94	8.66	2.72	6.30	1.81	5.69	4.24	3.88	6.54	18.47	7.71	3.58	0.48
U05-43	5.08	7.42	2.71	5.09	1.45	5.02	3.88	3.89	6.03	15.65	8.34	4.06	1.14
U05-44	7.58	9.14	2.44	7.23	2.42	5.69	3.86	3.76	6.44	20.51	7.27	3.76	1.57
U05-45	17.00	1.51	2.23	4.61	3.87	7.69	7.29	8.80	11.74	33.00	13.53	9.45	6.79

	U05-8	U05-81	U05-82	U05-83	U05-84	U05-85	U05-86	U05-88	U05-89	U05-9	U05-91	U05-93	U05-95
U05-46	7.41	8.70	2.60	7.19	2.42	6.09	4.30	4.18	6.98	20.20	7.98	4.12	1.25
U05-48	19.30	0.36	4.36	3.37	5.23	8.80	9.66	11.71	13.87	34.00	17.21	12.75	10.52
U05-51	7.68	5.82	1.63	4.56	1.30	4.88	3.81	4.01	6.53	20.67	8.07	4.09	1.52
U05-53	16.24	1.36	5.28	5.51	5.54	10.57	10.62	12.29	15.02	28.75	18.92	13.19	7.92
U05-56	4.75	9.09	1.53	2.94	0.33	1.31	0.72	0.77	1.69	15.82	3.36	1.16	2.95
U05-57	10.43	9.28	1.12	2.48	1.14	1.04	1.03	1.22	2.19	26.31	2.06	1.30	5.98
U05-59	8.38	7.05	2.22	6.29	2.15	6.16	4.68	4.68	7.64	22.09	8.65	4.53	1.27
U05-6	1.59	17.72	9.68	12.13	5.81	10.47	8.72	7.25	9.37	8.50	11.98	6.60	1.42
U05-60	10.06	5.27	1.88	5.68	2.33	6.15	4.82	5.34	8.19	23.61	9.68	5.61	2.55
U05-61	19.58	2.35	5.96	8.53	7.60	12.65	11.86	13.90	17.13	32.67	20.62	15.13	9.54
U05-63	7.99	8.76	0.69	3.05	0.54	1.32	0.72	0.78	2.15	22.48	2.41	0.87	3.62
U05-64	10.39	2.88	2.05	3.10	1.79	5.63	5.38	6.18	8.55	23.59	10.99	6.54	3.62
U05-66	19.71	17.35	17.98	25.00	17.43	27.58	24.40	24.03	29.84	30.90	32.47	23.36	8.60
U05-68	9.91	7.41	4.98	9.42	4.85	10.18	8.29	8.63	12.00	21.29	14.35	8.87	2.68
U05-69	7.48	7.97	3.46	7.64	2.96	7.53	5.80	5.73	8.77	19.59	10.38	5.65	1.10
U05-7	9.36	21.03	11.11	17.94	9.35	15.53	12.74	10.57	14.86	23.85	13.85	8.65	2.06
U05-71	7.79	11.76	2.50	7.81	2.57	4.93	3.03	2.57	5.06	22.01	4.79	2.29	2.01
U05-72	7.16	10.63	1.86	6.41	1.80	3.84	2.21	1.93	4.10	20.83	4.23	1.84	2.04
U05-73	11.16	2.06	1.65	1.64	1.54	4.31	4.51	5.75	7.45	23.83	10.36	6.55	5.40
U05-74	5.67	13.62	5.75	10.69	4.24	9.09	6.98	5.80	9.05	18.17	9.55	4.87	0.13
U05-75	6.84	6.61	1.48	3.17	0.58	3.43	2.90	2.86	4.88	20.29	6.14	2.72	1.76
U05-76	8.21	13.08	2.61	3.44	1.83	0.33	0.27	0.33	0.30	21.21	0.75	0.76	7.37
U05-78	15.60	1.38	4.60	4.86	5.08	9.09	9.06	11.04	13.23	26.92	17.47	12.40	8.57
U05-8	0.00	22.55	11.42	12.44	6.62	8.87	7.49	5.92	6.47	4.36	9.49	5.66	4.38
U05-81	22.55	0.00	4.88	4.39	6.63	10.00	10.77	13.31	15.55	37.78	18.94	14.69	12.73
U05-82	11.42	4.88	0.00	1.96	0.81	1.91	1.63	2.48	4.06	26.68	4.89	3.02	5.18
U05-83	12.44	4.39	1.96	0.00	1.68	1.78	2.90	4.30	4.57	25.45	7.18	5.39	9.17
U05-84	6.62	6.63	0.81	1.68	0.00	1.29	1.08	1.41	2.54	19.12	4.15	1.77	3.32
U05-85	8.87	10.00	1.91	1.78	1.29	0.00	0.31	0.89	0.75	21.36	2.07	1.67	7.78
U05-86	7.49	10.77	1.63	2.90	1.08	0.31	0.00	0.28	0.58	19.92	1.51	0.87	5.97
U05-88	5.92	13.31	2.48	4.30	1.41	0.89	0.28	0.00	0.45	18.20	0.92	0.19	4.92
U05-89	6.47	15.55	4.06	4.57	2.54	0.75	0.58	0.45	0.00	17.42	0.97	0.97	7.74
U05-9	4.36	37.78	26.68	25.45	19.12	21.36	19.92	18.20	17.42	0.00	23.71	18.67	15.90
U05-91	9.49	18.94	4.89	7.18	4.15	2.07	1.51	0.92	0.97	23.71	0.00	0.88	8.76
U05-93	5.66	14.69	3.02	5.39	1.77	1.67	0.87	0.19	0.97	18.67	0.88	0.00	4.18
U05-95	4.38	12.73	5.18	9.17	3.32	7.78	5.97	4.92	7.74	15.90	8.76	4.18	

Appendix 5: EMP analysis:

Sample preparation

Dense rock clasts of lapilli size or greater were sliced into 1 cm thick tablets to fit petrographic slides (27×46 mm) using a Struers Discoplan-TS or a coarse rock saw. Progressively finer silicon carbide grits (200 to 1000 grit) were used to grind the basal surface of the rock samples. A two component epoxy (EpoTek) was used to impregnate the samples and, if porous, to glue them onto the pre-roughened glass slide surface. After 24 hrs the tablets were cut close to the slide and the thin-section was ground to approximately 30 µm thickness using varying sizes of silicon carbide. For electron microprobe and scanning electron microscope studies, thin sections were polished using a Struers Planapol-3 and increasingly finer grades of diamond paste (6, 3, and 1 µm).

For phenocryst mineral separates; pumice clasts were carefully crushed with a mortar and pestle and then sieved. Phenocrysts separates (i.e. clinopyroxene, plagioclase, amphibole) were isolated under a bi-focal microscope from the 125-250 µm fraction. Titanomagnetite microphenocrysts were isolated from the 63-125 µm fraction using a hand-magnet. Mineral separates were mounted in (EpoTek) resin and polished for electron microprobe and scanning electron microscope analyses.

Electron microprobe

Glass and mineral compositions were determined by energy dispersive spectrometry methods using a Jeol JXA-840A electron microprobe at the University of Auckland. The analytical spectra were collected using a Princeton Gamma Tech Prism 2000 Si(Li) EDS X-ray detector. An accelerating voltage of 15kV, beam current of 600pA and 100 seconds live time count were used. A 2 µm focused beam was used for mineral analyses. For line scan analyses across crystal separates a 2 µm focused beam and 10 sec live-time count was used.

Calibration of mineral analyses used a suite of AstimexTM mineral standards. The following elements are above detection limits (in brackets) SiO₂ (<± 0.13%), TiO₂ (<± 0.10%), Al₂O₃ (<± 0.75%), FeO (<± 2.5%), MnO (<± 25%), MgO (<± 10%), CaO (<± 2.5%), Na₂O (<± 1.5%), K₂O (<± 2%), Cl (<± 10%). The error associated with analyses depends on elemental abundance and are reduced at higher concentrations. Appropriate minerals standards were used for each of the studied mineral separates.

Titanomagnetite analyses were standardised AstimexTM magnetite standards. A calibration factor was employed to correct FeO (total) and this factor was assumed to be constant throughout the analysis period (R. Sims pers. comm. 2005)

Detection limits for EMP analysis are given Table A. 4.1. As part of an inter-laboratory EMPA project (64 participating laboratories) basaltic glass was analysed with deviation from its accepted composition listed in Table A.4.1 (R. Sims, unpubl. data).

Table A. 5.1. Detection limit of element oxides measured at the EMP (University of Auckland) including the deviation to a reference glass composition.

Detection limit	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	SO ₃	Cl	Cr ₂ O ₃	NiO
1σ [wt.%]	0.11	0.08	0.06	0.07	0.07	0.07	0.04	0.11	0.03	0.07	0.06	0.03	0.06	0.10
3σ [wt.%]	0.32	0.23	0.18	0.20	0.20	0.21	0.13	0.32	0.10	0.20	0.19	0.08	0.17	0.30
International Round-Robin Inter-lab EPMA project (64 participating labs): Difference to reference values of re-fused basaltic glass composition														
	SiO ₂	TiO ₂	Al ₂ O ₃	FeO	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅				
	-0.18	0.12	-0.05	-0.04	-0.01	0.17	-0.02	0.05	0.02	0.01				

Note: CR and CRB sample no. refer to the Curtis Ridge eruption deposit (i.e. CR for unit 1 and CRB for basalt; unit 2). Samples from Pembroke Road (section 1) taken during a separate field season. Therefore these samples refer to unit E02-83 in stratigraphic section 1.

Plagioclase:

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 6658 M04-61 plag 1	59.43	0.81	18.00	5.23	0.39	1.35	4.59	4.46	3.67	0.45	0.13	0.23	0.02	0.00	0.00	98.76
ID = 6661 M04-61 plag 2	48.12	0.17	31.71	2.11	0.00	0.01	15.23	2.47	0.18	0.00	0.00	0.04	0.12	0.00	0.14	100.30
ID = 6663 M04-61 plag 3	47.55	0.11	31.39	2.13	0.00	0.00	15.20	2.32	0.17	0.00	0.01	0.03	0.00	0.03	0.00	98.94
ID = 6822 M04-155 plag 1	49.53	0.23	29.97	1.64	0.16	0.13	14.08	3.15	0.26	0.00	0.14	0.01	0.00	0.14	0.10	99.54
ID = 6825 M04-155 plag 2	53.77	0.21	25.84	2.35	0.00	0.36	9.93	4.39	1.03	0.00	0.06	0.03	0.00	0.05	0.06	98.08
ID = 6832 M04-155 plag 3	50.29	0.09	29.78	1.27	0.12	0.00	13.40	3.69	0.30	0.00	0.00	0.00	0.00	0.03	0.03	99.00
ID = 6834 M04-155 plag 4	56.07	0.81	15.91	8.01	0.25	2.31	5.12	4.56	3.51	0.45	0.10	0.26	0.00	0.08	0.11	97.55
ID = 6841 M04-156 plag 1	60.58	0.80	17.20	4.78	0.10	1.09	3.63	4.59	3.99	0.75	0.00	0.18	0.07	0.06	0.00	97.82
ID = 6993 M04-177 plag 1	56.33	0.00	26.24	0.50	0.13	0.09	9.25	6.06	0.41	0.00	0.03	0.05	0.00	0.02	0.06	99.17
ID = 7002 M04-177 plag 1	57.76	0.07	25.26	0.33	0.00	0.00	8.14	6.86	0.53	0.14	0.00	0.06	0.00	0.06	0.00	99.21
ID = 7003 M04-177 plag 1b	56.40	0.05	26.32	0.37	0.00	0.00	9.07	5.93	0.49	0.00	0.00	0.00	0.00	0.11	0.03	98.77
ID = 7004 M04-177 plag 1c	55.78	0.01	26.63	0.44	0.00	0.15	9.54	6.02	0.37	0.00	0.10	0.00	0.05	0.07	0.00	99.16
ID = 7005 M04-177 plag 1d	54.49	0.00	27.46	0.26	0.11	0.01	10.56	5.46	0.38	0.00	0.00	0.00	0.03	0.04	0.15	98.95
ID = 7006 M04-177 plag 1e	53.49	0.05	27.83	0.42	0.00	0.00	11.14	4.82	0.33	0.02	0.00	0.03	0.07	0.18	0.00	98.38
ID = 7007 M04-177 plag 1f	55.58	0.10	26.80	0.23	0.00	0.07	9.68	5.88	0.52	0.00	0.11	0.00	0.00	0.15	0.00	99.12
ID = 7008 M04-177 plag 1g	47.39	0.07	32.03	0.45	0.08	0.03	15.73	2.08	0.12	0.00	0.02	0.00	0.00	0.02	0.00	98.02
ID = 7009 M04-177 plag 1h	53.91	0.07	27.87	0.36	0.03	0.01	10.92	5.36	0.34	0.00	0.06	0.00	0.00	0.10	0.00	99.03
ID = 7010 M04-177 plag 1i	46.54	0.10	32.52	0.61	0.00	0.05	16.54	1.86	0.10	0.00	0.00	0.00	0.00	0.11	0.08	98.51
ID = 7011 M04-177 plag 1j	55.09	0.00	26.68	0.41	0.00	0.03	9.70	5.81	0.40	0.00	0.00	0.00	0.01	0.00	0.00	98.13
ID = 1494-M04-24-plag1	54.00	0.03	28.40	0.59	0.00	0.04	11.67	4.57	0.50	0.00	0.00	0.00		0.00	0.00	99.81
ID = 1495-M04-24-plag2-a	53.68	0.12	27.66	0.49	0.02	0.01	10.99	4.94	0.52	0.00	0.09	0.00		0.01	0.00	98.53
ID = 1496-M04-24-plag2-b	53.03	0.06	27.69	0.47	0.00	0.01	11.20	4.80	0.48	0.00	0.05	0.05		0.00	0.00	97.86
ID = 1497-M04-24-plag2-c	55.78	0.02	26.99	0.55	0.00	0.15	9.79	5.68	0.56	0.00	0.00	0.01		0.12	0.00	99.66
ID = 1498-M04-24-plag2-d	56.29	0.07	26.86	0.48	0.00	0.09	9.79	5.79	0.58	0.00	0.14	0.02		0.00	0.00	100.12
ID = 1499-M04-24-plag2-e	54.88	0.13	27.30	0.55	0.00	0.00	10.34	5.23	0.57	0.00	0.13	0.00		0.19	0.09	99.42
ID = 1500-M04-24-plag2-f	53.88	0.09	28.27	0.66	0.01	0.22	11.48	4.62	0.50	0.00	0.00	0.00		0.01	0.00	99.76
ID = 1501-M04-24-plag2-g	54.17	0.13	27.94	0.60	0.06	0.09	11.25	4.89	0.53	0.00	0.09	0.00		0.12	0.08	99.96
ID = 1502-M04-24-plag2-h	56.26	0.08	26.57	0.51	0.00	0.09	9.55	5.83	0.57	0.00	0.04	0.00		0.06	0.00	99.57
ID = 1503-M04-24-plag2-i	54.85	0.01	27.65	0.51	0.05	0.17	10.95	5.23	0.47	0.00	0.04	0.06		0.08	0.00	100.07

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 1504-M04-24-plag2-j	54.07	0.13	28.17	0.50	0.00	0.00	11.31	4.69	0.46	0.00	0.13	0.00		0.01	0.00	99.49
ID = 1505-M04-24-plag2-k	54.19	0.06	28.00	0.71	0.00	0.16	11.25	4.97	0.52	0.00	0.01	0.00		0.10	0.00	99.97
ID = 1506-M04-24-plag2-l	54.15	0.10	27.85	0.44	0.04	0.06	11.00	4.91	0.44	0.00	0.00	0.00		0.10	0.03	99.13
ID = 1507-M04-24-plag2-m	53.44	0.15	28.49	0.62	0.00	0.10	11.56	4.39	0.42	0.00	0.00	0.00		0.05	0.08	99.31
ID = 1508-M04-24-plag2-n	53.84	0.06	28.09	0.61	0.00	0.16	11.41	4.98	0.48	0.00	0.02	0.04		0.02	0.09	99.81
ID = 1509-M04-24-plag2-o	54.33	0.07	28.19	0.49	0.01	0.00	11.20	4.94	0.47	0.00	0.00	0.00		0.08	0.00	99.79
ID = 1510-M04-24-plag2-p	53.52	0.01	28.76	0.61	0.00	0.00	11.84	4.73	0.34	0.00	0.11	0.02		0.01	0.00	99.95
ID = 1511-M04-24-plag2-q	52.02	0.00	29.76	0.56	0.00	0.04	13.01	3.94	0.30	0.00	0.04	0.00		0.06	0.05	99.78
ID = 1512-M04-24-plag2-r	53.16	0.08	28.76	0.54	0.00	0.13	11.73	4.65	0.44	0.00	0.09	0.01		0.13	0.00	99.74
ID = 1513-M04-24-plag2-s	53.05	0.06	28.14	0.53	0.00	0.03	11.65	4.67	0.42	0.00	0.07	0.00		0.07	0.00	98.71
ID = 1514-M04-24-plag2-t	53.45	0.13	28.44	0.54	0.00	0.02	11.54	4.71	0.43	0.00	0.00	0.02		0.12	0.11	99.52
ID = 1515-M04-24-plag2-u	54.68	0.06	27.61	0.54	0.04	0.27	10.89	5.06	0.42	0.00	0.00	0.04		0.05	0.00	99.66
ID = 1516-M04-24-plag2-v	54.08	0.19	28.32	0.47	0.07	0.00	11.41	4.80	0.48	0.00	0.06	0.03		0.09	0.11	100.13
ID = 1517-M04-24-plag	51.51	0.06	29.63	0.52	0.06	0.04	12.85	3.88	0.34	0.00	0.06	0.01		0.00	0.00	98.98
ID = 1518-M04-24-plagx	50.43	0.00	30.77	0.48	0.00	0.04	14.02	3.27	0.31	0.00	0.07	0.00		0.07	0.06	99.54
ID = 1519-M04-24-plag-y	52.80	0.00	29.23	0.50	0.00	0.00	12.75	4.17	0.43	0.00	0.04	0.04		0.00	0.00	99.97
ID = 1520-M04-24-plag-z	51.25	0.05	30.28	0.62	0.01	0.11	13.44	3.66	0.28	0.00	0.00	0.00		0.01	0.00	99.71
ID = 1521-M04-24-plag-aa	53.77	0.11	28.46	0.44	0.01	0.06	11.51	4.73	0.42	0.00	0.01	0.00		0.00	0.00	99.53
ID = 1522-M04-24-plag-ab	52.68	0.10	29.16	0.51	0.00	0.06	12.33	4.20	0.35	0.00	0.00	0.04		0.06	0.00	99.50
ID = 1523-M04-24-plag-ac	53.05	0.14	29.02	0.42	0.10	0.06	12.00	4.51	0.37	0.00	0.00	0.00		0.08	0.04	99.80
ID = 1524-M04-24-plag-ad	51.70	0.06	30.18	0.60	0.00	0.14	13.17	3.72	0.42	0.00	0.00	0.00		0.07	0.00	100.06
ID = 1525-M04-24-plag-ae	51.86	0.04	29.32	0.50	0.00	0.03	12.80	4.25	0.35	0.00	0.00	0.02		0.00	0.05	99.23
ID = 1526-M04-24-plag-af	52.59	0.00	29.30	0.33	0.12	0.11	12.87	4.31	0.35	0.00	0.02	0.00		0.03	0.00	100.04
ID = 1527-E02-173-plag-3	58.17	0.02	25.59	0.38	0.00	0.01	8.30	6.53	0.70	0.00	0.00	0.00		0.09	0.01	99.79
ID = 1528-E02-173-plag-3b	55.90	0.20	27.01	0.15	0.00	0.05	9.83	5.76	0.56	0.00	0.05	0.00		0.00	0.03	99.55
ID = 1529-E02-173-plag-3c	56.00	0.14	26.83	0.34	0.00	0.00	9.41	5.70	0.67	0.00	0.00	0.02		0.02	0.00	99.14
ID = 1530-E02-173-plag-3d	56.20	0.02	26.84	0.29	0.00	0.13	9.36	5.80	0.64	0.00	0.00	0.00		0.00	0.00	99.29
ID = 1531-E02-173-plag-3e	57.57	0.07	26.92	0.37	0.05	0.00	9.25	6.06	0.60	0.00	0.01	0.06		0.02	0.00	100.99
ID = 1534-E02-173-plag 3f	54.52	0.01	28.19	0.27	0.00	0.01	10.84	5.17	0.48	0.00	0.00	0.01		0.01	0.00	99.52
ID = 1535-E02-173-plag 3h	50.29	0.00	30.95	0.17	0.00	0.04	14.50	3.18	0.24	0.00	0.02	0.00		0.11	0.00	99.52
ID = 1536-E02-173-plag 3i	54.41	0.19	27.99	0.34	0.00	0.00	10.88	5.25	0.50	0.00	0.00	0.01		0.00	0.11	99.69
ID = 1537-E02-173-plag 3j	49.38	0.13	31.80	0.35	0.10	0.08	15.41	2.90	0.23	0.00	0.01	0.02		0.01	0.22	100.65
ID = 1538-E02-173-plag 3k	56.13	0.13	27.13	0.75	0.00	0.01	9.85	5.84	0.59	0.00	0.06	0.00		0.01	0.00	100.50
ID = 1539-E02-173-plag 3l	54.12	0.14	28.67	0.34	0.00	0.03	11.53	4.89	0.43	0.00	0.04	0.02		0.07	0.00	100.29
ID = 1541-E02-173-plag 3m	56.47	-0.07	26.90	0.44	0.00	0.01	9.44	5.79	0.63		0.13	0.00		0.06	0.00	99.81
ID = 1542-E02-173-plag 3n	56.68	0.10	26.96	0.39	0.01	0.04	9.72	5.82	0.65		0.01	0.01		0.04	0.00	100.44
ID = 1543-E02-173-plag 4	52.07	0.04	29.32	0.45	0.07	0.14	12.62	4.40	0.31		0.00	0.05		0.00	0.00	99.48
ID = 1544-E02-173-plag 4b	52.97	0.12	28.84	0.53	0.00	0.13	12.43	4.17	0.35		0.00	0.00		0.01	0.11	99.67

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 1545-E02-173-plag 4c	52.24	0.00	29.26	0.50	0.10	0.08	12.62	4.31	0.25		0.02	0.03		0.07	0.00	99.49
ID = 1546-E02-173-plag 4d	52.52	0.00	29.09	0.59	0.08	0.16	12.29	4.39	0.30		0.00	0.00		0.00	0.00	99.43
ID = 1548-E02-173-plag 4e	52.86	0.07	29.49	0.44	0.00	0.00	12.64	4.14	0.24		0.06	0.00		0.02	0.00	99.97
ID = 1549-E02-173-plag 1	54.41	0.12	27.97	0.58	0.00	0.01	11.06	5.01	0.46	0.00	0.00	0.03		0.01	0.10	99.77
ID = 1550-E02-173-plag 1b	54.08	0.14	27.87	0.73	0.00	0.12	11.15	5.08	0.46		0.04	0.00		0.00	0.06	99.73
ID = 1551-E02-173-plag 1c	53.91	0.00	27.97	0.66	0.00	0.21	11.00	4.94	0.45	0.00	0.00	0.00		0.16	0.00	99.31
ID = 1552-E02-173-plag 1d	51.19	0.01	30.35	0.73	0.00	0.14	14.05	3.35	0.31	0.00	0.06	0.02		0.20	0.10	100.52
ID = 1553-E02-173-plag 1e	52.27	0.03	29.30	0.58	0.00	0.00	12.55	4.08	0.34	0.00	0.15	0.00		0.00	0.00	99.31
ID = 1556-M04-24 plag 1f	54.10	0.02	28.29	0.57	0.00	0.01	11.31	4.67	0.51	0.00	0.06	0.00		0.05	0.00	99.61
ID = 1557-M04-24 plag 1g	53.15	0.12	28.29	0.50	0.00	0.00	11.72	4.56	0.45	0.00	0.01	0.00		0.00	0.00	98.83
ID = 1558-M04-24 plag 1h	53.93	0.02	28.24	0.56	0.00	0.11	11.30	5.20	0.51	0.00	0.08	0.00		0.08	0.00	100.04
ID = 1560-M04-24 plag 1j	53.26	0.04	28.88	0.50	0.02	0.10	12.10	4.56	0.45	0.00	0.04	0.00		0.06	0.04	100.05
ID = 1561-M04-24 plag 1k	53.58	0.28	28.47	0.40	0.00	0.01	11.70	4.62	0.39	0.00	0.13	0.00		0.01	0.00	99.60
ID = 1562-M04-24 plag 1l	52.47	0.11	28.90	0.56	0.00	0.09	12.15	4.42	0.42	0.00	0.00	0.01		0.17	0.04	99.35
ID = 1563-M04-24 plag 1m	54.89	0.17	27.97	0.47	0.00	0.00	11.23	5.15	0.52	0.00	0.05	0.00		0.10	0.18	100.74
ID = 1564-M04-24 plag 1n	53.36	0.02	28.31	0.42	0.07	0.04	11.79	4.70	0.41	0.00	0.00	0.00		0.04	0.00	99.17
ID = 1565-M04-24 plag 1o	53.23	0.14	29.42	0.59	0.00	0.17	12.31	4.39	0.41	0.00	0.00	0.00		0.07	0.07	100.81
ID = 1566-M04-24 plag 1p	51.96	0.08	29.79	0.48	0.00	0.14	12.98	3.99	0.34	0.00	0.00	0.00		0.05	0.00	99.81
ID = 1567-M04-24 plag 1q	53.68	0.08	27.84	0.83	0.04	0.19	11.34	4.42	0.63	0.00	0.10	0.03		0.03	0.00	99.22
ID = 1568-M04-24 plag 1r	52.98	0.09	28.94	0.48	0.03	0.01	12.21	4.56	0.35	0.00	0.03	0.02		0.05	0.17	99.93
ID = 1569-M04-24 plag 1s	53.08	0.02	29.13	0.58	0.00	0.04	12.25	4.39	0.36	0.00	0.04	0.00		0.00	0.14	100.04
ID = 1570-M04-24 plag 1t	53.33	0.00	28.75	0.59	0.00	0.12	12.15	4.58	0.40	0.00	0.01	0.00		0.00	0.00	99.93
ID = 1752 M04-74 plag 1	46.20	0.12	33.30	0.63		0.04	17.73	1.48	0.17	0.13	0.12	0.00		0.10	0.00	100.03
ID = 1753 M04-74 plag 1b	47.13	0.03	32.77	0.65		0.04	16.77	1.96	0.17	0.00	0.00	0.00		0.04	0.11	99.68
ID = 1754 M04-74 plag 2	46.61	0.00	32.87	0.71	0.00	0.08	16.91	1.47	0.16	0.00	0.09	0.00		0.06	0.00	98.97
ID = 1763 M04-74 plag 4	45.45	0.00	34.01	0.75	0.00	0.00	18.08	1.06	0.07	0.00	0.00	0.01		0.12	0.03	99.58
ID = 1767 M04-74 plag 5b	45.12	0.06	33.99	0.53	0.09	0.10	18.09	0.79	0.12	0.00	0.00	0.03		0.00	0.00	98.92
ID = 1771 M04-74 plag 6	45.95	0.01	33.54	0.50	0.00	0.01	17.73	1.22	0.11	0.00	0.01	0.00		0.01	0.00	99.10
ID = 1772 M04-74 plag 7	45.01	0.11	33.93	0.76	0.00	0.00	18.38	1.09	0.16	0.00	0.04	0.02		0.07	0.00	99.57
ID = 1777 M04-74 Plag 8	47.25	0.05	32.72	0.60	0.03	0.00	17.03	1.73	0.15	0.07	0.01	0.01		0.00	0.00	99.66
ID = 1778 M04-74 Plag 8b	47.38	0.08	32.45	0.54	0.00	0.06	16.79	1.88	0.13	0.00	0.04	0.00		0.07	0.08	99.51
ID = 1779 M04-74 Plag 8c	47.11	0.04	32.71	0.50	0.00	0.05	17.15	1.70	0.09	0.05	0.00	0.01		0.05	0.00	99.47
ID = 1780 M04-74 Plag 8d	47.15	0.00	32.64	0.58	0.05	0.06	16.84	1.96	0.04	0.00	0.09	0.02		0.07	0.09	99.60
ID = 1781 M04-74 Plag 9	44.49	0.01	33.90	0.34	0.00	0.00	18.33	0.85	0.10	0.00	0.00	0.02		0.11	0.00	98.16
ID = 1782 M04-74 Plag 9b	46.40	0.00	32.93	0.51	0.00	0.00	16.96	1.66	0.12	0.00	0.02	0.03		0.09	0.00	98.73
ID = 1786 M04-74 plag 10	48.91	0.15	31.41	0.63	0.00	0.01	15.23	2.70	0.14	0.00	0.01	0.02		0.04	0.00	99.25
ID = 1845 M04-59 plag 1	53.09	0.15	28.11	1.09	0.05	0.28	12.00	4.46	0.35	0.05	0.06	0.00		0.00	0.00	99.70
ID = 1850 M04-59 plag 2	50.17	0.04	31.13	0.70	0.11	0.00	14.73	3.19	0.20	0.01	0.06	0.04		0.04	0.00	100.42

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 1854 M04-59 plag 3	46.24	0.21	32.63	1.86	0.08	0.11	17.08	1.52	0.13	0.01	0.06	0.07		0.01	0.00	100.00
ID = 1856 M04-59 plag 5	49.78	0.04	31.04	0.60	0.00	0.13	14.83	3.05	0.22	0.00	0.05	0.00		0.04	0.11	99.89
ID = 1858 M04-59 plag 6	52.78	0.14	29.02	0.87	0.00	0.16	12.34	4.50	0.30	0.00	0.00	0.00		0.06	0.00	100.18
ID = 1863 M04-59 plag 7	49.73	0.07	31.27	0.69	0.00	0.13	14.93	2.73	0.17	0.00	0.00	0.00		0.08	0.00	99.81
ID = 1865 M04-59 plag 7	52.63	0.06	29.12	0.66	0.00	0.00	12.35	4.51	0.33	0.00	0.00	0.00		0.01	0.00	99.68
ID = 1866 M04-59 plag 7b	50.94	0.00	30.44	0.55	0.06	0.16	14.20	3.28	0.26	0.00	0.00	0.02		0.00	0.00	99.91
ID = 1868 M04-59 plag 7c	50.35	0.02	30.63	0.51	0.00	0.00	14.16	3.25	0.23	0.00	0.00	0.05		0.00	0.00	99.20
ID = 1869 M04-59 plag 7d	50.41	0.17	30.77	0.58	0.00	0.09	14.24	3.39	0.21	0.04	0.02	0.00		0.05	0.00	99.97
ID = 1871 M04-59 plag e	48.95	0.08	31.58	0.57	0.00	0.09	15.28	2.82	0.10	0.00	0.00	0.00		0.03	0.00	99.50
ID = 1872 M04-59 plag f	50.30	0.07	30.71	0.60	0.00	0.22	14.48	3.25	0.22	0.00	0.00	0.00		0.11	0.00	99.96
ID = 1874 M04-59 plag 7g	52.73	0.06	28.64	0.44	0.00	0.06	12.01	4.58	0.40	0.01	0.01	0.05		0.04	0.11	99.15
ID = 1875 M04-59 plag 7h	47.35	0.05	28.90	0.76	0.11	0.12	12.64	3.23	0.24	0.08	0.10	0.21		0.06	0.00	93.85
ID = 1876 M04-59 plag 8	47.76	0.00	31.97	0.73	0.00	0.00	15.97	2.38	0.19	0.00	0.00	0.00		0.00	0.00	99.00
ID = 1877 M04-59 plag 8b	48.01	0.05	32.19	0.57	0.00	0.00	15.79	2.30	0.19	0.00	0.06	0.01		0.13	0.00	99.30
ID = 1880 M04-59 plag 8c	47.69	0.11	32.65	0.60	0.00	0.00	16.25	2.30	0.17	0.00	0.00	0.03		0.04	0.00	99.84
ID = 1881 M04-59 plag 8d	46.42	0.00	32.70	0.55	0.07	0.01	16.91	1.67	0.15	0.00	0.04	0.00		0.00	0.00	98.52
ID = 1882 M04-59 plag 8e	53.15	0.03	28.74	0.59	0.08	0.06	11.94	4.32	0.43	0.00	0.02	0.00		0.00	0.02	99.39
ID = 1883 M04-59 plag 8f	54.23	0.01	28.16	0.72	0.04	0.05	11.31	4.87	0.53	0.00	0.06	0.00		0.14	0.00	100.12
ID = 1884 M04-59 plag 8g	52.04	0.10	29.74	0.82	0.00	0.12	13.31	3.94	0.32	0.00	0.05	0.00		0.00	0.04	100.48
ID = 1887 M04-59 plag 8h	54.46	0.02	28.46	0.78	0.05	0.09	11.70	4.95	0.32	0.00	0.03	0.00		0.14	0.00	101.00
ID = 9183 RK-8 plag 1	54.86	0.00	27.17	0.37	0.02	0.00	9.96	5.45	0.51		0.02					98.36
ID = 9184 RK-8 plag 1a	55.38	0.06	27.10	0.38	0.00	0.13	9.96	5.44	0.57					0.00	0.14	99.16
ID = 9185 RK-8 plag 1b	55.26	0.08	27.34	0.43		0.02	10.20	5.47	0.54		0.06	0.02			0.12	99.54
ID = 9186 RK-8 plag 1c	54.06	0.08	27.63	0.38		0.01	10.63	5.17	0.45		0.07			0.03		98.51
ID = 9187 RK-8 plag 1d	54.04	0.13	28.21	0.62		0.04	11.00	4.81	0.44					0.08		99.37
ID = 9188 RK-8 plag 1e	49.44	0.10	31.19	0.49	0.00	0.00	14.58	2.99	0.26		0.02	0.06		0.17	0.17	99.47
ID = 9189 RK-8 plag 1f	50.49		30.55	0.44	0.09	0.00	13.91	3.31	0.28		0.05	0.02				99.14
ID = 9190 RK-8 plag 1g	50.39		30.55	0.39	0.13		13.95	3.19	0.29	0.01				0.00		98.90
ID = 9191 RK-8 plag 1h	50.30		30.20	0.47		0.03	13.75	3.29	0.26			0.04				98.34
ID = 9192 RK-8 plag 1i	51.00	0.08	29.83	0.52	0.06		13.28	3.66	0.38		0.00	0.00		0.12	0.20	99.13
ID = 9193 RK-8 plag 1j	48.48	0.03	31.55	0.53	0.12		15.14	2.53	0.22			0.02		0.02		98.64
ID = 9794 RK-8 plag 1k	48.73	0.10	31.56	0.48	0.00		15.29	2.71	0.23		0.04	0.01		0.08		99.23
ID = 9795 RK-8 plag 1l	48.32		31.55	0.49			15.42	2.42	0.29			0.05		0.12		98.66
ID = 9796 RK-8 plag 1m	66.73	0.50	15.19	2.49	0.10	0.63	1.67	3.58	5.26	0.09	0.06	0.37		0.00	0.21	96.88
ID = 9798 RK-8 plag 1o	53.76		27.56	0.37		0.12	10.66	4.49	0.62					0.09		97.67
ID = 9799 RK-8 plag 1p	61.89	0.34	19.60	1.82	0.22	0.49	5.00	4.55	3.76		0.03	0.28			0.05	98.03
ID = 9800 RK-8 plag 1q	50.07	0.07	30.33	0.33			13.58	3.57	0.33		0.19			0.05	0.04	98.56
ID = 9801 RK-8 plag 1r	62.17	0.36	19.14	1.72	0.09	0.45	5.03	3.94	3.87		0.14	0.28		0.01	0.00	97.20

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 9802 RK-8 plag 1s	50.33	0.01	30.12	0.58	0.01	0.05	13.43	3.67	0.31		0.10	0.07		0.09	0.14	98.91
ID = 9803 RK-8 plag 1t	51.46	0.01	30.15	0.46	0.07	0.06	13.12	3.78	0.38					0.15	0.12	99.76
ID = 9804 RK-8 plag 1u	50.84	0.00	29.85	0.45	0.02		13.23	3.55	0.37		0.06	0.03		0.00	0.19	98.59
ID = 9805 RK-8 plag 1v	48.31	0.12	32.14	0.56	0.00	0.07	15.63	2.31	0.30		0.02	0.03		0.00	0.05	99.54
ID = 9806 RK-8 plag 1w	65.34	0.52	15.91	2.32	0.04	0.63	2.34	4.43	5.06	0.08	0.06	0.34		0.01	0.21	97.29
ID = 9818 CR cpx 3 plag	53.20	0.04	28.74	0.69	0.13	0.17	11.92	4.43	0.34		0.00	0.04		0.04	0.04	99.78
ID = 9823 CRB plag 1	45.03	0.04	34.31	0.44	0.04		18.70	0.77	0.12	0.02	0.07			0.00	0.00	99.54
ID = 9824 CRB amp 2	44.77		34.39	0.54	0.09		18.34	0.66	0.10	0.05				0.00	0.10	99.04
ID = 9825 CRB amp 2a	44.65		34.05	0.51	0.09	0.00	18.35	0.69	0.12			0.02		0.17	0.10	98.75
ID = 9853 Rk-18 plag 1	48.55	0.00	31.25	0.49	0.00	0.07	15.20	2.72	0.19	0.00	0.07	0.00		0.07	0.00	98.61
ID = 9854 Rk-18 plag 1 2	54.61	0.00	27.91	0.30	0.00	0.12	10.84	4.97	0.40	0.00	0.04	0.01		0.01	0.05	99.26
ID = 9855 Rk-18 plag 1 3	51.03	0.03	29.97	0.65	0.13	0.16	13.40	3.72	0.28	0.00	0.00	0.06		0.00	0.20	99.63
ID = 9856 Rk-18 plag 1 4	54.77	0.13	27.78	0.30	0.00	0.06	10.72	5.19	0.42	0.00	0.00	0.00		0.03	0.00	99.40
ID = 9857 Rk-18 plag 1 5	50.21	0.00	30.68	0.44	0.04	0.07	13.92	3.41	0.23	0.00	0.00	0.02		0.08	0.08	99.18
ID = 9858 Rk-18 plag 1 6	48.66	0.01	31.81	0.44	0.02	0.00	15.25	2.46	0.19	0.00	0.02	0.02		0.05	0.00	98.93
ID = 9859 Rk-18 plag 1 7	50.97	0.02	30.02	0.66	0.00	0.00	13.67	3.37	0.39	0.00	0.12	0.00		0.15	0.15	99.52
ID = 9860 Rk-18 plag 1 8	53.21	0.05	28.54	0.42	0.00	0.00	11.62	4.50	0.38	0.00	0.00	0.00		0.07	0.00	98.79
ID = 9861 Rk-18 plag 1 9	52.27	0.00	29.00	0.43	0.04	0.01	12.07	4.50	0.28	0.00	0.00	0.02		0.06	0.21	98.89
ID = 9862 Rk-18 plag 1 10	55.96	0.00	27.17	0.40	0.05	0.00	9.98	5.56	0.51	0.00	0.00	0.04		0.00	0.04	99.71
ID = 9863 Rk-18 plag 1 11	56.90	0.08	26.24	0.32	0.02	0.12	8.78	5.95	0.61	0.00	0.02	0.00		0.04	0.00	99.08
ID = 9864 Rk-18 plag 1 12	56.29	0.10	26.48	0.48	0.00	0.01	9.35	6.01	0.54	0.00	0.04	0.00		0.10	0.04	99.44
ID = 9869 Rk-20 plag 1 1	54.64	0.00	27.27	0.42	0.15	0.01	10.14	5.24	0.51	0.00	0.00	0.00		0.00	0.06	98.44
ID = 9872 Rk-20 amp plag 2 1	55.31	0.02	27.47	0.71	0.00	0.00	10.39	5.44	0.48	0.00	0.10	0.00		0.01	0.00	99.93
ID = 10092EB-1b	44.77	0.00	34.40	0.43	0.00	0.01	18.62	0.80	0.14	0.00	0.03	0.00		0.15	0.02	99.37
ID = 10093EB-1b 2	44.84	0.06	34.47	0.34	0.01	0.00	18.47	0.81	0.19	0.00	0.07	0.01		0.00	0.15	99.42
ID = 10094 EB-1b 3	44.99	0.00	34.24	0.59	0.00	0.00	18.80	0.91	0.07	0.00	0.11	0.06		0.05	0.00	99.82
ID = 10100 CR plag 2a	56.11	0.00	26.08	0.32	0.10	0.00	8.72	6.10	0.65	0.00	0.00	0.00		0.00	0.08	98.16
ID = 10101 CR plag 2b	55.85	0.00	26.51	0.37	0.05	0.00	9.42	5.92	0.57	0.10	0.04	0.00		0.15	0.00	98.98
ID = 10102 CR plag 2c	56.15	0.09	26.74	0.26	0.15	0.00	9.38	5.77	0.53	0.01	0.12	0.05		0.06	0.00	99.31
ID = 10103 CR plag 2d	55.85	0.00	27.06	0.30	0.00	0.00	9.59	5.73	0.51	0.00	0.00	0.00		0.03	0.05	99.12
ID = 10104 CR plag 2e	55.55	0.07	27.09	0.23	0.20	0.00	9.63	5.53	0.58	0.00	0.00	0.04		0.11	0.03	99.06
ID = 10105 CR plag 2f	56.77	0.10	26.17	0.20	0.01	0.00	8.86	5.89	0.63	0.00	0.00	0.06		0.00	0.03	98.72
ID = 10106 CR plag 2g	54.92	0.03	27.06	0.37	0.00	0.00	9.98	5.60	0.51	0.00	0.00	0.03		0.00	0.00	98.50
ID = 10107 CR plag 2h	55.38	0.09	27.56	0.25	0.14	0.07	10.26	5.36	0.50	0.00	0.00	0.02		0.07	0.12	99.82
ID = 10107 CR plag 2i	55.42	0.03	26.65	0.23	0.12	0.00	9.79	5.61	0.60	0.00	0.05	0.05		0.02	0.04	98.61
ID = 10109 CR plag 2j	55.50	0.00	27.14	0.29	0.10	0.00	9.73	5.65	0.57	0.00	0.00	0.00		0.07	0.23	99.28
ID = 10110 CR plag 2k	55.06	0.00	27.31	0.19	0.00	0.00	10.43	5.21	0.51	0.00	0.00	0.00		0.10	0.09	98.90

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 10113 Rk 15 plag 1a	54.25	0.04	26.35	0.64	0.00	0.03	9.74	5.15	0.63	0.00	0.02	0.07		0.04	0.00	96.96
ID = 10114 Rk 15 plag 1b	52.11	0.00	28.35	0.61	0.13	0.04	11.98	4.39	0.47	0.00	0.10	0.00		0.05	0.04	98.27
ID = 10115 Rk 15 plag 1c	52.09	0.02	28.53	0.44	0.08	0.04	12.20	4.17	0.44	0.00	0.00	0.03		0.03	0.00	98.07
ID = 10116 Rk 15 plag 1d	52.46	0.04	28.80	0.59	0.00	0.14	12.02	4.20	0.43	0.00	0.00	0.01		0.01	0.00	98.70
ID = 10117 Rk 15 plag 1e	53.18	0.08	27.89	0.62	0.00	0.00	11.12	4.70	0.58	0.00	0.00	0.01		0.16	0.00	98.34
ID = 10118 Rk 15 plag 1f	46.12	0.08	32.38	0.66	0.00	0.00	16.72	1.47	0.17	0.00	0.00	0.00		0.00	0.14	97.74
ID = 10119 Rk 15 plag 1g	47.57	0.09	31.98	0.67	0.00	0.01	16.49	1.83	0.35	0.00	0.00	0.00		0.01	0.06	99.06
ID = 10120 Rk 15 plag 1h	58.20	0.12	24.62	0.66	0.00	0.00	7.27	6.29	1.55	0.00	0.00	0.00		0.00	0.00	98.71
ID = 10121 Rk 15 plag 1i	61.82	0.89	18.48	2.32	0.19	0.49	3.34	6.15	4.13	0.54	0.00	0.32		0.00	0.00	98.67
ID = 10122 Rk 15 plag 1j	44.16	0.00	34.41	0.55	0.02	0.00	18.80	0.83	0.15	0.00	0.19	0.00		0.09	0.13	99.33
ID = 10123 Rk 15 plag 1k	44.22	0.01	34.07	0.25	0.00	0.00	18.56	0.84	0.17	0.00	0.00	0.00		0.10	0.03	98.25
ID = 10124 Rk 15 plag 1l	45.92	0.00	33.86	0.34	0.00	0.00	17.44	1.23	0.16	0.00	0.00	0.00		0.01	0.21	99.17
ID = 10125 Rk 15 plag 1m	44.73	0.07	34.15	0.34	0.06	0.00	18.25	0.82	0.16	0.00	0.06	0.02		0.15	0.00	98.81
ID = 10126 Rk 15 plag 1n	45.52	0.00	33.42	0.28	0.00	0.00	17.66	1.27	0.19	0.00	0.05	0.02		0.00	0.14	98.55
ID = 10127 Rk 15 plag 1o	44.60	0.00	34.15	0.35	0.06	0.00	18.20	0.88	0.12	0.18	0.00	0.00		0.00	0.00	98.54
ID = 10128 Rk 15 plag 1p	44.75	0.00	33.84	0.37	0.00	0.00	17.97	0.89	0.16	0.00	0.00	0.06		0.08	0.25	98.37
ID = 10129 Rk 15 plag 1q	45.80	0.00	33.24	0.47	0.02	0.00	17.28	1.40	0.20	0.00	0.10	0.07		0.07	0.19	98.84
ID = 10130 Rk 15 plag 1r	46.23	0.03	32.82	0.60	0.01	0.00	17.00	1.70	0.17	0.00	0.00	0.01		0.10	0.00	98.67
ID = 10131 Rk 15 plag 1s	44.49	0.00	34.01	0.37	0.00	0.00	18.34	0.72	0.20	0.00	0.00	0.02		0.06	0.21	98.42
ID = 10132 Rk 15 plag 1t	46.97	0.00	32.85	0.43	0.01	0.00	16.29	2.07	0.22	0.00	0.00	0.00		0.04	0.16	99.04
ID = 10133 Rk 14 plag 1a	60.95	0.78	14.66	5.07	0.08	2.10	3.94	4.04	3.71	0.67	0.36	0.32		0.04	0.00	96.72
ID = 10134 Rk 14 plag 1b	49.61	0.04	30.57	0.48	0.01	0.07	14.05	3.25	0.31	0.00	0.00	0.00		0.00	0.00	98.39
ID = 10135 Rk 14 plag 1c	52.17	0.29	26.46	1.47	0.12	0.66	12.40	2.92	1.16	0.04	0.08	0.05		0.00	0.00	97.82
ID = 10136 Rk 14 plag 1d	60.55	0.98	13.56	6.16	0.23	2.51	3.41	3.24	3.88	0.46	0.60	0.39		0.00	0.18	96.15
ID = 10137 Rk 14 plag 1e	50.41	0.04	30.24	0.64	0.06	0.00	13.59	3.50	0.27	0.00	0.00	0.00		0.00	0.00	98.75
ID = 10138 Rk 14 plag 1f	51.76	0.13	28.73	0.72	0.06	0.25	12.65	3.89	0.58	0.00	0.04	0.06		0.08	0.00	98.95
ID = 10139 Rk 14 plag 1g	51.46	0.02	29.22	0.52	0.03	0.00	12.66	4.21	0.37	0.00	0.00	0.01		0.04	0.10	98.64
ID = 10140 Rk 14 plag 1h	53.60	0.34	24.49	2.51	0.03	0.78	10.27	3.77	1.56	0.14	0.22	0.09		0.08	0.00	97.88
ID = 10141 Rk 14 plag 1i	49.10	0.08	31.01	0.56	0.00	0.00	14.61	2.78	0.23	0.00	0.00	0.00		0.03	0.16	98.56
ID = 10142 Rk 14 plag 1j	48.19	0.01	29.49	0.44	0.00	0.01	13.71	2.99	0.23	0.00	0.07	0.05		0.00	0.00	95.19
ID = 10143 Rk 14 plag 1k	49.77	0.10	30.41	0.50	0.04	0.02	13.81	3.46	0.23	0.00	0.10	0.00		0.00	0.00	98.44
ID = 10144 Rk 14 plag 1l	52.51	0.25	26.55	1.54	0.00	0.36	11.25	3.59	1.11	0.00	0.02	0.07		0.11	0.11	97.47
ID = 10145 Rk 14 plag 1m	57.98	0.75	16.92	4.18	0.21	1.57	5.14	3.87	2.66	0.49	0.25	0.23		0.00	0.06	94.31
ID = 10146 Rk 14 plag 1n	49.19	0.00	31.32	0.57	0.08	0.00	14.80	2.72	0.28	0.00	0.00	0.01		0.00	0.05	99.02
ID = 10155 Rk-9 plag	42.78	2.07	11.43	9.79	0.22	15.65	11.46	2.24	0.99	0.06	0.00	0.04		0.06	0.07	96.86
ID = 10159 Rk-16 amp plag1b	50.58	0.03	30.62	0.75	0.11	0.00	13.93	3.35	0.25	0.01	0.00	0.00		0.08	0.06	99.77
ID = 10162 Rk-16 amp plag2	47.97	0.00	31.48	0.70	0.00	0.00	15.08	2.45	0.25	0.00	0.00	0.07		0.00	0.00	98.00

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 10169 Rk-20 plag 2a	50.69	0.06	29.66	0.38	0.07	0.00	13.28	3.65	0.29	0.00	0.02	0.01		0.00	0.08	98.19
ID = 10170 Rk-20 plag 2b	51.27	0.16	30.15	0.61	0.00	0.01	13.68	3.42	0.55	0.04	0.18	0.02		0.09	0.00	100.18
ID = 10171 Rk-20 plag 2c	49.82	0.02	30.53	0.62	0.04	0.02	14.46	2.62	0.50	0.02	0.00	0.01		0.03	0.03	98.72
ID = 10172 Rk-20 plag 2d	51.36	0.00	30.33	0.47	0.00	0.07	13.36	3.61	0.23	0.00	0.13	0.02		0.05	0.16	99.79
ID = 10173 Rk-20 plag 2e	50.62	0.00	30.13	0.34	0.12	0.00	13.26	3.59	0.29	0.00	0.00	0.03		0.00	0.00	98.38
ID = 10174 Rk-20 plag 2f	51.18	0.09	30.04	0.38	0.11	0.00	13.29	3.77	0.29	0.00	0.06	0.00		0.01	0.06	99.28
ID = 10176 Rk-22 plag 1a	55.94	0.14	25.18	0.58	0.02	0.03	8.44	6.09	0.61	0.00	0.01	0.00		0.20	0.06	97.30
ID = 10177 Rk-22 plag 1b	47.01	0.05	31.50	0.64	0.00	0.01	15.73	2.17	0.27	0.00	0.01	0.00		0.09	0.00	97.48
ID = 10178 Rk-22 plag 1c	46.81	0.03	32.25	0.60	0.01	0.00	16.31	1.93	0.22	0.00	0.02	0.02		0.07	0.13	98.40
ID = 10179 Rk-22 plag 1d	52.32	0.04	29.18	0.49	0.00	0.00	12.46	4.18	0.43	0.00	0.07	0.04		0.00	0.00	99.21
ID = 10180 Rk-22 plag 1e	58.00	0.13	24.70	0.64	0.00	0.00	7.27	6.76	0.96	0.00	0.00	0.04		0.00	0.07	98.57
ID = 10181 Rk-22 plag 1f	50.64	0.08	30.15	0.94	0.00	0.12	13.81	3.18	0.56	0.00	0.05	0.00		0.06	0.12	99.71
ID = 10178 Rk-22 plag 2	53.50	0.12	28.75	0.41	0.02	0.01	11.90	4.29	0.45		0.02			0.11		99.58
ID = 10179 Rk-22 plag 2b	52.65	0.01	29.11	0.72	0.09	0.03	12.42	4.15	0.41		0.11	0.06		0.13	0.00	99.89
ID = 10187 Rk-25 cpx 1 plag	56.17	0.06	26.63	0.44	0.08	0.06	9.42	5.67	0.48	0.00	0.00	0.00		0.07	0.09	99.17
ID = 10188 Rk-25 cpx 1 plag 2	59.93	0.18	22.53	0.85	0.00	0.01	7.02	5.21	1.56	0.00	0.07	0.10		0.03	0.00	97.49
ID = 10191 Rk-25 cpx 1 plag 4	54.05	0.01	28.09	0.62	0.00	0.00	11.17	4.69	0.36	0.00	0.05	0.00		0.00	0.00	99.04
ID = 10192 Rk-26 plag 1	52.79	0.00	29.32	0.28	0.16	0.03	12.15	4.42	0.35	0.00	0.00	0.00		0.00	0.00	99.50
ID = 229 M05-69L plag micro	53.48		28.27	0.57		0.05	11.71	4.72	0.51	0.07		0.03		0.05		99.46
ID = 230 M05-69L plag micro	58.58	0.08	25.20	0.36	0.07	0.00	7.91	6.39	0.75	0.00				0.16	0.05	99.55
ID = 231 M05-69L plag micro3	55.25	0.02	27.35	0.49	0.03	0.00	10.65	5.32	0.49	0.00	0.04	0.03		0.08		99.75
ID = 2774 M05-69p plag 1	52.59	0.00	32.16	0.55	0.01	0.06	15.16	3.35	0.27	0.05	0.00	0.00		0.14	0.02	104.36
ID = 2775 M05-69p groundmass plag	53.97	0.10	29.80	1.08	0.06	0.06	13.56	3.90	0.32	0.00	0.05	0.00		0.15	0.00	103.05
ID = 2776 M05-69p groundmass plag 2	47.35	0.09	31.55	0.83	0.00	0.06	15.60	2.25	0.24	0.00	0.00	0.00		0.04	0.05	98.06
ID = 2777 M05-69p groundmass plag 3	51.39	0.00	28.33	0.93	0.11	0.05	12.58	4.02	0.43	0.00	0.02	0.04		0.17	0.00	98.07
ID = 2778 M05-69p groundmass plag 4	53.12	0.15	25.87	1.43	0.01	0.21	10.78	4.39	0.86	0.00	0.12	0.17		0.05	0.04	97.20
ID = 2779 M05-69p groundmass plag 5	46.53	0.00	31.94	0.82	0.03	0.00	16.39	2.00	0.22	0.00	0.00	0.00		0.12	0.00	98.05
ID = 2781 M05-69p amp 3 plag	54.73	0.00	26.04	0.47	0.09	0.00	9.24	5.48	0.64	0.00	0.00	0.03		0.00	0.05	96.77
ID = 2869 M04-158 plag 1	46.54	0.02	31.37	0.53	0.05	0.04	15.72	2.11	0.18	0.00	0.02	0.00		0.13	0.00	96.71
ID = 2872 M04-166 amp plag 1	53.89	0.07	27.17	0.73	0.05	0.00	10.63	5.28	0.41	0.00	0.10	0.00		0.05	0.11	98.49
ID = 2872 M04-166 amp	53.89	0.07	27.17	0.73	0.05	0.00	10.63	5.28	0.41	0.00	0.10	0.00		0.05	0.11	98.49
ID = 2874 M04-174 amp plag1	53.02	0.12	28.42	0.67	0.05	0.01	11.82	4.67	0.42	0.00	0.00	0.04		0.01	0.17	99.42
ID = 2876 M04-174 amp plag2	53.25	0.00	28.12	0.64	0.00	0.01	11.04	4.75	0.31	0.00	0.08	0.01		0.04	0.00	98.25
ID = 2880 M04-174 amp plag 3	51.62	0.05	28.82	0.57	0.04	0.05	12.01	4.39	0.29	0.00	0.00	0.02		0.00	0.10	97.96

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
ID = 2882 M04-174 amp plag 3b	54.04	0.09	27.44	0.58	0.00	0.13	10.22	5.39	0.47	0.10	0.06	0.03		0.08	0.09	98.72
ID = 2884 M04-174 amp plag 4	53.15	0.00	27.69	0.86	0.02	0.01	10.84	5.02	0.39	0.00	0.00	0.03		0.04	0.09	98.14
ID = 2887 M04-174 amp plag 5	55.05	0.05	26.69	0.85	0.08	0.05	9.82	5.65	0.48	0.04	0.00	0.01		0.12	0.00	98.89
ID = 2890 M04-176 amp plag 1	52.42	0.04	29.97	0.93	0.08	0.06	13.09	4.12	0.35	0.00	0.00	0.00		0.09	0.07	101.22
ID = 2892 M04-176 amp plag 2amp	47.49	0.05	31.96	0.77	0.00	0.00	15.79	2.29	0.16	0.00	0.02	0.02		0.03	0.00	98.58
ID = 2894 M04-176 amp plag 3	47.28	0.06	32.51	0.80	0.06	0.10	16.22	2.05	0.16	0.00	0.00	0.00		0.02	0.04	99.30
ID = 2896 M04-176 amp plag 4	48.78	0.03	31.32	0.59	0.00	0.15	14.49	2.96	0.18	0.09	0.00	0.00		0.05	0.02	98.66
ID = 2898 M04-176 amp plag 5	53.39	0.05	27.51	0.72	0.07	0.07	10.92	5.04	0.35	0.00	0.00	0.00		0.12	0.00	98.24
ID = 2902 M04-177 amp2 plag1	49.56	0.00	31.15	0.61	0.00	0.00	14.44	3.19	0.13	0.00	0.00	0.00		0.16	0.00	99.24
ID = 2904 M04-177 amp2 plag2	54.09	0.02	27.79	0.44	0.03	0.04	10.51	5.42	0.37	0.00	0.00	0.00		0.03	0.00	98.74

Clinopyroxene:

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
10753_E03_61a_cpx1a	48.49	0.91	6.15	7.87	0.15	13.17	22.61	0.3	0.04	0	0.04	0		0.07	0.16	99.96
10754_E03_61a_cpx1b	52.37	0.61	1.88	7.35	0.35	16.16	20.85	0.07	0	0	0.06	0		0.13	0.06	99.89
10759_E03_61a_cpx2	52.28	0.42	1.96	7.48	0.36	15.04	20.86	0.33	0	0.01	0	0		0.12	0.08	98.94
10761_E03_61a_cpx3	51.34	0.57	3.71	5.68	0.28	15.36	22.63	0.12	0.08	0	0.13	0.04		0.43	0.07	100.4
10762_E03_61a_cpx4	50.99	0.6	3.96	5.95	0	15.16	22.71	0.08	0.06	0	0.06	0.09		0.5	0.23	100.4
10763_E03_61a_cpx5	47.91	0.93	6.25	9.17	0.07	12.01	22.04	0.05	0	0	0.05	0		0.11	0	98.59
1971 Egmont B cpx 2	47.28	1.26	6.09	9.34	0.29	11.88	22.64	0.21	0	0.04	0	0.08		0.1	0.05	99.26
1971 Egmont B cpx 2	47.28	1.26	6.09	9.34	0.29	11.88	22.64	0.21	0	0.04	0	0.08		0.1	0.05	99.26
1972 Egmont B cpx 3a	46.96	1.28	7.83	8.12	0.07	11.83	23.06	0.18	0	0.08	0.04	0.01		0	0.02	99.48
1973 Egmont B cpx 3b	45.81	1.52	7.72	8.94	0.04	12.02	22.51	0.18	0	0	0	0		0.17	0.01	98.92
1979 Egmont B cpx 4	47.72	1.03	6.45	7.38	0.06	13.16	22.97	0.31	0.05	0	0	0.01		0.12	0	99.26
1986 Egmont B cpx 4	47.79	1.01	6.3	7.54	0	13.01	22.99	0.2	0.04	0	0.04	0		0.12	0	99.04
4188 Pyx 1	52.07	0.27	1.39	7.74	0.39	14.91	21.73	0.41	0.03	0	0	0.03	0.04	0.16	0	99.17
6647 M04-61 pyx 1	48.2	1.06	4.5	9.16	0.5	12.84	21.25	0.53	0.06	0	0	0	0.16	0.12	0.06	98.44
6655 M04-61 pyx 3	48.64	0.87	5.25	8.24	0.21	13.16	22.07	0.14	0.06	0	0	0.06	0.14	0.07	0.01	98.92
6650 M04-61 pyx 2	46.21	1.32	7.44	8.63	0.12	12.16	22.17	0.29	0.07	0	0.1	0.07	0.1	0	0	98.68
6673 M04-71 pyx 1	52.34	0.47	1.64	8.59	0.55	15.27	21.15	0.53	0.08	0	0	0.02	0.01	0.14	0	100.8
6695 M04-74 pyx 1	48.11	1.33	5.04	8.66	0.57	13.16	20.85	0.44	0.04	0.01	0.07	0.05	0.07	0.07	0	98.47
6712 M04-76 pyx 1	48.51	1.06	4.92	8.38	0.38	13.69	21.22	0.52	0	0	0.09	0.02	0.14	0.14	0	99.07
6774 M04-150 pyx 1	51.49	0.71	2.51	7.89	0.36	15.87	19.9	0.33	0.03	0	0	0.02	0.03	0.12	0	99.26
6844 M04-156 pyx 1	49.24	1.08	4.86	8.9	0.22	14.07	21.14	0.27	0.1	0.02	0	0	0.08	0.23	0.09	100.3
6973 M04-177 Pyx 1	52.46	0.4	1.89	7.33	0.65	14.78	21.84	0.33	0.1	0	0	0	0	0.11	0.09	99.98
6974 M04-177 Pyx 1b	52.32	0.38	1.38	7.23	0.63	15.1	21.6	0.35	0.01	0	0	0	0.12	0.26	0	99.38
6975 M04-177 Pyx 1c	51.99	0.44	1.68	7.1	0.48	15.09	21.52	0.44	0.08	0.01	0	0	0.04	0.12	0	98.99
6976 M04-177 Pyx 1d	52.01	0.55	2.15	7.67	0.58	15.15	21.22	0.44	0.01	0.01	0.08	0	0.04	0.03	0.14	100.1
6977 M04-177 Pyx 1e	52.13	0.36	1.53	7.14	0.73	15.11	20.88	0.28	0.06	0	0	0	0.1	0.06	0.15	98.53
6978 M04-177 Pyx 1f	51.75	0.53	1.68	7.28	0.65	15.17	21.3	0.36	0.04	0.05	0.02	0	0.08	0.13	0	99.04
6979 M04-177 Pyx 1g	52.25	0.49	1.69	7.11	0.7	15.27	21.71	0.44	0.08	0	0	0	0.01	0.08	0	99.83
6980 M04-177 Pyx 1h	51.41	0.63	1.73	7.18	0.85	14.53	21.49	0.44	0.1	0	0	0.05	0.01	0.14	0	98.56
6987 M04-177 pyx 2	50.97	0.63	2.34	7.83	0.59	13.92	21.77	0.38	0.07	0.02	0	0.04	0	0.07	0	98.63

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
6988 M04-177 pyx 2b	50.89	0.48	2.24	7.06	0.49	14.55	21.64	0.43	0.08	0	0	0.01	0.13	0.05	0	98.05
6989 M04-177 pyx 2c	51.37	0.53	2.41	7.73	0.56	14.96	21.19	0.45	0.07	0.07	0	0.04	0.09	0.11	0.07	99.65
6992 M04-177 pyx 2d	52.18	0.35	1.49	7.26	0.64	15.25	20.78	0.28	0.06	0	0	0.01	0.09	0	0	98.39
7133 M04-102H pyx 1	54.15	0.26	1.21	14.51	0.97	26.71	1.15	0.26	0.03	0	0.14	0.07	0	0	0	99.46
1629 M04-28 Cpx 1	52.06	0.45	2.07	7.84	0.42	14.2	22.24	0.36	0	0	0	0.02		0.23	0.05	99.94
1633 M04-28 Cpx 1b	50.35	0.76	3.31	8.82	0.46	13.32	21.87	0.57	0.03	0	0	0.05		0.13	0.23	99.9
1636 M04-28 Cpx 1c	52.04	0.42	2.05	8.67	0.88	14.13	22.16	0.35	0.11	0	0	0.05		0	0.04	100.9
1640 M04-28 Cpx 1d	52.76	0.49	1.25	8.02	0.95	14.73	21.91	0.47	0.09	0.05	0	0		0.11	0.08	100.9
1641 M04-28 Cpx 1e	52.32	0.39	1.59	8.24	0.77	14.25	21.89	0.57	0.01	0	0.06	0.05		0.05	0.02	100.2
1750 M04-74 pyx 1	48.01	0.882	5.823	7.757	0.15	13.28	22.88	0.371	0.06	0	0	0.03		0.11	0	99.35
1756 M04-74 pyx 3	52.38	0.441	2.115	7.747	0.411	15.39	21.4	0.15	0.03	0.05	0	0		0.09	0	100.2
1761 M04-74 pyx 4	48.74	1.032	5.913	7.116	0	13.68	23.09	0.291	0	0.02	0.07	0.01		0.21	0	100.2
1764 M04-74 pyx 5	48.87	1.163	5.572	8.158	0.12	13.24	22.21	0.251	0	0	0.01	0.05		0.2	0.07	99.91
1775 M04-74 pyx 6	48.44	0.972	5.853	8.93	0.371	12.61	22.57	0.561	0.05	0.15	0.05	0.03		0.13	0	100.7
1784 M04-74 pyx 7	49.32	1.112	4.68	7.978	0.281	13.6	22	0.371	0.02	0.01	0	0.05		0.07	0	99.49
1785 M04-74 pyx 8	51.9	0.441	2.646	4.751	0.16	15.88	23.18	0.07	0.02	0	0	0		0.301	0.04	99.39
1787 M04-74 pyx 8b	49.4	1.032	4.831	8.86	0.22	13.3	21.88	0.531	0.05	0	0.11	0.03		0.231	0	100.5
1788 M04-74 pyx 8c	49.1	0.932	5.081	8.048	0.301	13.45	22.14	0.391	0.08	0.05	0.02	0		0.15	0	99.74
1848 M04-59 cpx 1	49.3	1.815	4.582	6.117	0.361	15.04	21.98	0.391	0.07	0	0.02	0.06		0.13	0	99.87
1849 M04-59 cpx 2	52.38	0.872	2.196	5.645	0.311	16.5	21.89	0.642	0	0	0.06	0.09		0.1	0	100.7
1855 M04-59 pyx 3	48.69	2.216	5.214	6.949	0.361	14.47	22.24	0.822	0.09	0	0	0		0.03	0.02	101.1
1859 M04-59 cpx 4	50.37	1.564	3.479	6.076	0.291	16.07	21.7	0.471	0.1	0	0	0.14		0.06	0.05	100.4
1862 M04-59 cpx 5	51.4	0.521	2.978	7.33	0.381	15.08	21.55	0.421	0	0.06	0	0.06		0.09	0	99.87
9830 CRB cpx 2 1	47.58	1.09	6.24	7.22	0.18	12.98	22.65	0.14	0.08	0.23		0.04		0.11	0.15	98.69
9831 CRB cpx 2 2	47.72	1.07	6.67	7.54	0.04	12.87	22.86	0.17	0.07	0				0.06	0	99.07
9833 CRB cpx 2 3	47.13	0.96	6.65	7.62	0.27	12.62	22.92	0.15	0.09			0.01		0.25	0.11	98.78
9832 CRB cpx 2 3	47.13	0.96	6.65	7.62	0.27	12.62	22.92	0.15	0.09			0.01		0.25	0.11	98.78
9833 CRB cpx 2 4	47.33	1.09	6.18	7.61	0.21	12.73	22.42	0.18	0.03	0.02		0.04		0.09	0	97.93
9834 CRB cpx 2 5	47.6	0.94	6.37	7.46	0.17	12.87	22.81	0.18	0.1	0.01		0.02		0.02	0.03	98.58
9835 CRB cpx 2 6	49.56	0.7	4.62	7.83	0.23	13.63	22.34	0.27	0.13	0.04	0.1	0.01		0.09		99.55
9836 CRB cpx 2 7	49.64	0.7	4.31	7.81	0.22	13.75	22.14	0.22	0.06		0.04			0.2	0.1	99.19
9837 CRB cpx 2 8	48.91	0.93	5.12	8.14	0.17	13.19	22	0.38	0.09	0		0.02		0.11		99.06
9838 CRB cpx 2 9	48.75	0.94	5.23	8.26	0.17	13.03	22.14	0.48	0.16		0.08	0.07		0.11	0.05	99.47
9839 CRB cpx 2 10	49.67	0.72	4.24	7.75	0.32	13.76	22.38	0.24	0.02	0.13	0.11	0.02		0.07		99.43

Analysis no	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
9840 CRB cpx 2 11	47.91	1.02	6.71	7.99	0.16	12.87	22.63	0.37	0.1			0.02		0.12		99.9
9841 CRB cpx 2 12	46.89	1.21	7.41	8.07	0.11	12.57	22.66	0.2	0.09					0.09	0.21	99.51
9842 CRB cpx 2 13	47.03	1.2	7.52	7.91	0.27	12.46	22.51	0.09	0.03			0.08		0.11		99.21
9843 CRB cpx 2 14	46.81	1.33	7.38	7.64	0.04	12.61	22.76	0.14	0.08			0.01		0.06		98.86
9844 CRB cpx 2 15	47.44	1.12	6.84	7.56	0.11	12.91	22.63	0.09	0.1	0.12	0.11	0.05		0.21	0.13	99.42
9845 CRB cpx 2 16	48.04	1.2	6.36	7.34	0.01	13.3	22.91	0.24	0.08			0.02		0.13		99.63
9874 Rk-20 amp cpx 1	52.08	0.63	2.26	8.42	0.74	14.4	21.2	0.47	0.15	0.02	0.07	0.04		0.19	0	100.7
9876 Rk-21 cpx 1	48.95	0.9	6.09	7.34	0.21	13.55	22.45	0.34	0.07	0.15	0	0.03		0.12	0	100.2
9877 Rk-21 cpx 1b	49.11	0.79	5.09	7.95	0.17	13.23	22.03	0.37	0.05	0.06	0.01	0.02		0.14	0	99.02
10147 Rk 13 pyx 1a	54.05	0.13	0.84	14.2	0.9	26.79	1.29	0	0.06	0	0	0.03		0	0.16	98.45
10148 Rk 13 pyx 1b	54.59	0.06	0.61	14.37	0.96	26.69	1.57	0	0.06	0.15	0	0.01		0.17	0.12	99.36
10149 Rk 13 pyx 1c	54.77	0.21	0.56	14.85	0.85	26.78	1.45	0.04	0	0	0	0.05		0.06	0	99.62
10150 Rk 13 pyx 1d	54.47	0.2	0.76	14.82	0.81	26.97	1.46	0	0.05	0	0	0		0.15	0.04	99.73
10151 Rk 13 pyx 1e	54.11	0.37	1.36	14.84	0.85	26.17	1.32	0	0.03	0.07	0.01	0		0.05	0.14	99.32
10166 Rk-16 amp cpx	51.95	0.39	1.89	7.36	0.59	15.34	20.82	0.24	0.08	0.01	0.02	0.04		0.2	0.01	98.94
10182 Rk-22 plag cpx	50.25	0.7	2.02	8.77	0.74	14.52	18.85	0.41	0.09	0.05	0	0.12		0.02	0	96.54
10184 Rk-25 cpx 1 core	52.38	0.41	2.48	4.62	0.03	15.96	22.83	0.12	0.11	0.16	0.02	0.07		0.53	0.27	99.99
10185 Rk-25 cpx 1 core 2	52.16	0.49	2.87	7.28	0.34	14.81	22.05	0.05	0.07	0.04	0.09	0		0.09	0	100.3
10186 Rk-25 cpx 1 core 3	52.78	0.39	1.55	7.34	0.65	14.72	21.99	0.23	0.11	0.11	0.14	0		0.06	0	100.1
221 M05-69L cpx 1	50.12	0.93	4.6	8.44	0.22	13.5	22.26	0.32	0.15	0	0	0.06		0.16	0.06	100.8
222 M05-69L cpx 1a	51.35	0.64	3	7.83	0.2	14.19	22.99	0.36	0.11	0.15	0.08	0		0	0.05	101
223 M05-69L cpx 1b	51.64	0.63	2.28	7.3	0.28	14.73	22.14	0.18	0.14	0.24	0	0		0.24	0	99.8
228 M05-69L cpx 2	51.26	0.44	2.52	7.96	0.29	14.14	22.67	0.26	0.07	0.13	0.04	0.03		0.15	0.06	100

Amphibole:

Analysis ID	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
10751_E03_61a_hb1	40.94	2.6	14.01	12.52	0.21	13.32	11.85	2.35	0.95	0	0.1	0		0.1	0	98.95
10752_E03_61a_hb2	40.36	2.4	13.96	11.89	0.13	13.27	11.95	2.57	1.01	0	0	0.06		0	0	97.6
10758_E03_61a_hb3	41.05	2.17	13.73	10.01	0.07	14.64	11.85	2.21	1.07	0	0	0.03		0.03	0	96.86
10766_E03_61a_hb4	40.36	2.6	13.95	11.09	0.12	13.95	11.88	2.2	1.09	0	0.01	0.09		0	0	97.34
1975 Egmont B horn 1	44.6	1.02	9.76	14.64	0.31	13.3	11.31	2.22	0.46	0	0	0.06		0.13	0.12	97.93
1978 Egmont B horn 2	39.69	2.42	14.75	11	0.15	13.47	12.37	2.12	1.05	0.05	0.07	0.03		0.16	0	97.33
6936 M04-177H amp 1	43.11	3.22	9.97	11.13	0.38	14.17	10.96	2.25	0.95	0	0	0.14	0.17	0.08	0	96.53
6938 M04-177H amp 1b	43.43	3.16	9.89	11.39	0.51	14.28	11.08	2.58	0.85	0.16	0.09	0.09	0.05	0.06	0	97.62
6939 M04-177H amp 1c	42.86	3.12	10.29	11.81	0.46	13.67	11.19	2.3	0.97	0	0	0.13	0.17	0.01	0	96.98
6941 M04-177H amp 2	43.12	3.21	10.53	11.76	0.33	13.94	11.11	2.52	0.95	0	0	0.07	0.03	0.07	0	97.64
6944 M04-177H amp 2b	41.68	2.69	12.26	12.33	0.26	13.01	11.36	2.57	0.98	0	0	0.02	0.14	0.07	0.08	97.45
6945 M04-177H amp 2c	41.8	2.9	11.43	12.2	0.38	13.15	11.37	2.51	0.99	0.16	0.01	0	0	0	0	96.9
6946 M04-177H amp 2d	42.34	3.12	10.84	11.62	0.34	14.08	11.38	2.5	1.01	0.02	0.05	0.06	0	0	0.05	97.41
6947 M04-177H amp 2e	42.29	3.17	10.49	11.2	0.29	13.96	11.24	2.12	0.93	0	0.04	0.07	0.11	0.08	0	95.99
6949 M04-177H amp 3	43	2.8	10.1	11.85	0.45	13.76	11.29	2.21	0.96	0.06	0.04	0.11	0.1	0.11	0.06	96.9
6950 M04-177H amp 3b	41.93	2.99	11.2	12.53	0.32	12.65	11.32	2.41	0.97	0.08	0.15	0.13	0.02	0	0	96.7
6951 M04-177H amp 3c	42.87	3.01	9.98	11.55	0.45	13.8	11.06	2.26	0.95	0.02	0.11	0.13	0.04	0	0	96.23
6952 M04-177H amp 3d	40.68	2.57	12.35	12.39	0.25	12.55	11.6	2.53	0.94	0.06	0	0.05	0.08	0	0.16	96.21
6953 M04-177H amp 3e	40.64	2.77	12.27	12.46	0.26	12.76	11.36	2.66	1.03	0	0	0.04	0.16	0.08	0	96.49
6954 M04-177H amp 3f	42.96	3.08	10.14	11.68	0.37	13.93	11.12	2.21	0.99	0.08	0.1	0.05	0.05	0.04	0.02	96.82
6957 M04-177H amp 3g	42.16	3.19	10.76	11.73	0.29	13.73	11.17	2.39	1.02	0	0	0.05	0	0.01	0	96.5
6958 M04-177H amp 3h	41.57	3.05	11.12	12.26	0.19	13.28	11.52	2.38	0.99	0.04	0.07	0.07	0.11	0.12	0	96.77
7062 M04-189H amp 1	40.65	2.9	12.56	12.31	0.06	12.96	11.37	2.25	1.07	0	0	0.08	0.11	0	0	96.32
7063 M04-189H amp 1b	39.88	2.71	13.02	12.41	0.14	12.63	11.8	2.1	1.18	0	0.16	0.09	0.16	0.13	0.12	96.53
7064 M04-189H amp 1c	40.47	2.75	12.53	11.85	0.27	13.26	11.57	2.26	1.09	0.06	0.07	0	0.04	0.05	0.06	96.33
7065 M04-189H amp 1d	40.72	2.61	12.5	11.76	0.14	13.62	11.59	2.53	1.14	0	0.07	0.03	0.18	0	0	96.89
7066 M04-189H amp 1e	40.84	2.76	12.55	12.01	0.25	13.43	11.67	2.56	1.11	0	0.04	0.07	0	0	0.05	97.34
7067 M04-189H amp 2	40.8	2.94	11.99	11.98	0.35	13.19	11.42	2.48	1.03	0	0	0.07	0.19	0	0.05	96.49
7068 M04-189H amp 2b	40.57	2.62	13.38	12.31	0.11	13.07	11.58	2.43	1.19	0	0	0.02	0.06	0.05	0.12	97.51
7069 M04-189H amp 2c	40.51	2.43	12.7	11.15	0.02	13.8	11.57	2.12	1.18	0	0.05	0.07	0	0.13	0	95.73

Analysis ID	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
7070 M04-189H amp 2d	41.06	2.46	12.81	11.16	0.09	14.24	11.59	2.31	1.15	0	0	0.05	0.21	0.03	0	97.16
7071 M04-189H amp 2e	40.2	2.75	12.91	11.84	0.18	13.14	11.54	2.44	1.13	0	0.11	0.06	0.06	0.02	0.05	96.43
7105 M04-57H Amp 1	41.41	2.96	11.49	11.58	0.17	13.29	11.04	2.46	1	0	0.05	0.09	0	0.01	0	95.55
7106 M04-57H Amp 1b	40.45	3.31	11.91	11.74	0.28	13.28	11.46	2.54	1.07	0	0	0.12	0.08	0	0.04	96.28
7107 M04-57H Amp 1c	42.63	2.84	11.11	11.43	0.24	13.88	11.32	2.47	0.99	0.05	0	0.05	0.06	0	0.1	97.17
7108 M04-57H Amp 2	40.21	2.88	12.17	12.37	0.18	12.83	11.4	2.52	1.12	0	0.13	0.03	0.12	0.06	0.07	96.09
7109 M04-57H Amp 2b	40.64	2.74	12.83	12.2	0.2	12.96	11.81	2.47	1.12	0.01	0.12	0.02	0.09	0.04	0.15	97.4
7110 M04-57H Amp 2c	40.48	2.68	12.44	12.21	0.12	13.39	11.64	2.4	1.16	0	0	0.07	0	0.06	0	96.65
7111 M04-57H Amp 2d	40.62	2.77	12.72	11.97	0.18	13.06	11.63	2.26	1.17	0	0	0.04	0.08	0.09	0	96.59
7112 M04-57H Amp 2e	40.22	2.76	13.02	11.86	0.16	13.24	11.56	2.33	1.14	0	0	0.06	0.22	0	0	96.57
7113 M04-57H Amp 2f	40.29	2.55	12.76	11.81	0.13	12.73	11.76	2.42	1.15	0	0.04	0.05	0.14	0.04	0	95.87
7114 M04-57H Amp 2g	40.8	2.74	12.54	12.2	0.03	12.91	11.51	2.32	1.15	0	0.14	0.07	0.14	0.02	0	96.57
7115 M04-57H Amp 2h	40.31	2.67	13.11	12.3	0.21	13.07	11.68	2.18	1.19	0	0.06	0.02	0.14	0	0.12	97.06
7116 M04-57H Amp 2i	40.53	2.6	12.96	11.69	0.14	13.25	11.57	2.33	1.14	0	0.08	0.09	0.14	0	0.16	96.68
7120 M04-57H amp 2	41.53	2.71	11.33	12.18	0.21	13.51	11.66	2.29	1.01	0.01	0	0.02	0.12	0.18	0	96.76
7121 M04-57H amp 2b	41.76	3.1	10.95	11.95	0.42	13.43	11.15	2.21	1.14	0	0.01	0.16	0.08	0.03	0	96.39
7122 M04-57H amp 2c	40.94	3.1	11.5	11.53	0.21	13.59	11.28	2.36	1.07	0	0	0.03	0.11	0.08	0	95.8
7123 M04-57H amp 2d	41.44	3.3	11.68	11.74	0.37	13.68	11.39	2.59	1.13	0.05	0.05	0.13	0.09	0.02	0.15	97.81
7124 M04-102H amp 1	42.62	3.07	10.56	11.48	0.28	14.25	10.98	2.21	0.98	0.01	0	0.1	0.1	0.03	0	96.67
7125 M04-102H amp 1b	42.67	3.21	10.57	11.45	0.47	14.3	11	2.45	0.99	0.01	0.08	0.14	0.19	0	0	97.53
7126 M04-102H amp 1c	41.95	3.56	10.86	10.94	0.16	14.35	11.08	2.36	0.98	0	0	0.09	0.08	0.04	0	96.45
7129 M04-102H amp 1e	41.86	3.38	10.72	10.86	0.29	14.25	11.08	2.47	0.96	0	0	0.04	0.13	0	0	96.04
7130 M04-102H amp 1f	42.26	3.52	10.81	10.76	0.37	14.27	11.23	2.52	1.01	0	0.05	0.1	0	0	0	96.9
7136 M04-102H amp 2	41.65	3.61	10.56	10.91	0.15	14.17	10.85	2.59	1.07	0	0	0.11	0.1	0.1	0.18	96.05
7137 M04-102H amp 2b	42.27	3.37	10.68	10.78	0.26	14.01	11.18	2.46	0.98	0.15	0.13	0.09	0.12	0.18	0.17	96.83
7138 M04-102H amp 2c	41.77	3.27	10.99	11.21	0.25	14.12	10.75	2.34	1.01	0	0.05	0.08	0	0.08	0	95.92
7141 M04-102H amp 2	43.53	2.47	9.88	10.27	0.25	14.95	11.14	2.53	0.83	0.07	0	0.08	0	0.21	0	96.21
7142 M04-102H amp 2e	41.84	3.67	10.65	10.95	0.26	14.29	11.04	2.51	1	0	0	0.09	0.13	0.05	0	96.48
7143 M04-102H amp 2f	41.98	3.61	10.51	11.01	0.3	14.29	11.03	2.45	1.09	0	0.11	0.11	0.19	0.01	0	96.69
7144 M04-102H glass 4	64.63	0.77	15.68	2.59	0.11	0.55	2.09	4.28	4.99	0.28	0	0.35	0	0	0.07	96.39
7145 M04-102H amp 2g	42.3	3.65	10.72	10.9	0.39	14.18	10.81	2.48	1.03	0.04	0	0.12	0.12	0.02	0.01	96.77
7146 M04-102H amp 2h	42.08	3.59	10.75	10.52	0.26	14.11	11.07	2.61	0.95	0	0	0.04	0.12	0.12	0	96.22
7149 M04-102H amp 1i	41.75	3.8	10.89	11.26	0.31	14.09	11.04	2.36	1	0.09	0.01	0.08	0.01	0	0	96.69

Analysis ID	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
7150 M04-102H amp 3	41	2.48	11.52	12.75	0.25	12.78	11.39	2.46	0.93	0.05	0	0.03	0.08	0.11	0.13	95.96
7151 M04-102H amp 3b	41.36	2.52	11.7	13.05	0.32	12.86	11.42	2.35	0.86	0	0.06	0.08	0.1	0.05	0.16	96.89
7152 M04-102H amp 3c	41.8	3.21	10.86	12.11	0.41	13.6	11.04	2.48	1.02	0	0.03	0.13	0.19	0.03	0	96.91
7161 M04-80 Amp 1b	43.11	2.82	9.64	11.71	0.65	13.81	10.99	2.27	0.92	0	0	0.09	0.01	0.06	0.01	96.09
7162 M04-80 Amp 1c	43.12	2.9	9.42	11.68	0.6	13.82	11	2.24	0.99	0	0.02	0.06	0	0	0.01	95.86
7163 M04-80 Amp 1d	42.16	2.97	10.46	13.09	0.48	12.8	11.13	2.08	1.05	0	0	0.04	0.05	0.04	0.09	96.44
7164 M04-80 Amp 1e	42.82	2.78	9.95	12.6	0.47	13.29	11.15	2.23	0.96	0	0.01	0.05	0.06	0.07	0	96.44
1572-M04-24 amp 1a	40.533	2.6492	12.984	12.269	0.2921	13.357	11.554	2.5585	0.9972	0	0.0403	0		0.0504	0	97.284
1573-M04-24 amp 1b	41.017	2.6995	13.004	11.433	0.1712	13.84	11.795	2.216	0.9972	0	0.1007	0.0101		0.1007	0	97.385
1574-M04-24 amp 1c	41.138	2.77	12.863	11.856	0.1914	14.011	11.876	2.3168	0.9771	0	0.1914	0		0	0.0403	98.231
1575-M04-24 amp 1d	41.41	2.7096	12.682	11.765	0.2417	14.162	11.755	2.2261	1.0174	0		0.0101		0.0302	0	98.009
1578-M04-24 amp1e	41.259	2.629	13.165	11.987	0.2015	13.911	11.805	2.2664	1.0274	0	0	0.0302		0.0101	0.1209	98.412
1605 M04-28 Amp 1	41.9	3	11.11	13.75	0.29	12.36	11.01	2.36	1.26	0	0.08	0.09		0.02	0	97.23
1606 M04-28 Amp 1b	42.62	3.01	10.5	12.75	0.44	13.29	11.39	2.51	1.02	0	0.07	0.1		0	0.13	97.83
1608 M04-28 Amp 1d	42.91	2.91	10.2	13.46	0.42	12.94	11.19	2.55	1.09	0	0.11	0.15		0.01	0	97.94
1609 M04-28 Amp 1e	42.82	3.08	10.34	13.32	0.5	13.02	11.16	2.2	1.11	0	0.06	0.12		0.1	0.02	97.85
1612 M04-28 Amp 1f	41.87	2.98	11.32	13.7	0.37	12.75	11.42	2.05	1.21	0.02	0	0.12		0	0	97.81
1613 M04-28 Amp 1h	42.92	2.98	10.51	11.76	0.26	14.02	11.45	1.99	1.08	0.07	0.01	0.08		0	0	97.13
1614 M04-28 Amp 1h	40.97	2.28	12.89	12.04	0.18	13.64	11.58	2.55	1.1	0.03	0.08	0		0.01	0.08	97.43
1615 M04-28 Amp 1i	41.99	2.51	11.5	12.93	0.26	13.22	11.28	2.31	0.96	0.07	0.15	0.17		0	0	97.35
1617 M04-28 Amp 2	41.87	3.12	11.41	14.53	0.39	12.13	11.25	2.36	1.03	0	0.1	0.14		0.06	0.19	98.58
1619 M04-28 Amp 2b	41.97	2.92	11.43	13.93	0.41	12.7	11.23	2.38	1.31	0	0.02	0.1		0.08	0	98.48
1620 M04-28 Amp 2c	42.12	2.99	11.24	13.6	0.42	12.41	11.19	2.31	1.33	0	0.06	0.12		0.14	0	97.93
1624 M04-28 Amp 2d	42.09	3.12	10.97	14.4	0.57	12.31	11.21	2.05	1.4	0	0	0.21		0.06	0	98.39
1627 M04-28 Amp 2e	41.71	3.04	11.22	14.1	0.38	12.42	11.2	2.44	1.3	0.01	0	0.16		0.06	0.01	98.05
1642 M04-28 Amp 3	42.67	2.74	10.71	13.59	0.32	12.88	11.18	2.38	1.06	0	0	0.16		0.17	0.15	98.01
1643 M04-28 Amp 3b	42.47	2.95	10.48	13.01	0.37	12.65	11.39	2.31	1.13	0.16	0.07	0.06		0.06	0.01	97.12
1646 E02-117 Amp 1	39.82	2.28	14.82	11.59	0.15	13.23	12.3	2.21	1.12	0	0	0.01		0.02	0	97.55
1768 M04-74 amp 1	40.63	2.6058	13.56	11.636	0.0702	13.49	11.856	2.2349	1.0523	0	0.1804	0.0501		0.0401	0.1503	97.556
1769 M04-74 amp 1b	40.85	2.3853	13.961	11.385	0.1102	13.54	12.167	2.245	1.0924	0	0.0702	0.02		0.0702	0	97.896
1770 M04-74 amp 1c	41.101	2.4554	13.229	12.688	0.1904	13.6	11.946	2.5456	1.0423	0.0401	0.0702	0		0.0902	0	98.999
1783 M04-74 Amp 1d	42.133	2.8262	11.676	12.217	0.2305	13.66	11.566	2.4655	0.8218	0	0.01	0.0702		0.0301	0	97.706
1773 M04-74 Amp 2	41.091	2.1648	13.881	10.183	0.0902	14.903	12.227	2.4554	1.1726	0	0.0501	0.0601		0.0401	0.0702	98.388

Analysis ID	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
1844 M04-59 amp 1	41.613	2.9079	12.494	12.434	0.1705	13.828	11.511	2.5269	0.9526	0	0.1504	0.01		0.1504	0	98.748
1846 M04-59 amp 1b	41.773	2.8377	12.434	12.113	0.3209	13.878	11.682	2.5469	0.9927	0	0	0.0902		0.1003	0	98.768
1847 M04-59 amp 1c	42.124	3.4995	11.551	10.138	0.1805	15.091	11.23	2.4867	0.9225	0	0	0.0802		0.2206	0	97.525
9846 Rk-9 plag amp inc	41.56	2.33	13.16	11.42	0.08	13.97	11.87	2.17	1.13		0	0.04		0.06	0.04	97.83
9847 Rk-17 amp 1 1	40.81	2.21	12.73	11.18	0.28	13.6	11.43	2.42	1.02	0.02		0.09			0.08	95.87
9848 Rk-17 amp 1 2	41.85	2.61	12.04	13.27	0.51	13	11.29	2.34	1.18	0.06	0	0.11		0	0.01	98.27
9849 Rk-17 amp 1 3	42.29	2.91	11.29	13.07	0.32	12.85	11.2	2.31	1.21	0	0.06	0.19		0	0	97.7
9850 Rk-17 amp 1 4	42.03	2.26	12.14	12.24	0.29	13.54	11.52	2.32	1.06	0	0	0.09		0.01	0.06	97.56
9851 Rk-17 amp 1 5	41.88	2.63	11.21	12.97	0.26	12.93	11.29	2.39	1.27	0.02	0	0.19		0.05	0	97.09
9865 Rk-18 amp 1	41.05	3.07	13.06	12.21	0.27	12.94	11.84	2.32	0.93	0	0.07	0.04		0	0.14	97.94
9866 Rk-18 amp 2	40.55	2.94	12.88	12.39	0.21	12.96	11.5	2.49	1.03	0	0	0.07		0	0	97.02
9870 Rk-20 amp 1	42.53	3.09	10.94	11.69	0.43	13.75	11.24	2.24	1.15	0	0	0.14		0	0	97.2
10160 Rk-16 amp amp1	41.27	3.12	12.35	11.79	0.32	13.39	11.46	2.18	1.14	0.15	0.1	0.08		0.01	0	97.36
10161 Rk-16 amp amp1b	41.34	3	12.22	11.62	0.31	13.59	11.29	2.45	0.98	0	0.07	0.08		0.08	0	97.03
10163 Rk-16 amp amp1c	40.87	3.18	12.65	12.21	0.34	13.01	11.44	2.36	0.92	0.01	0.02	0.09		0	0.03	97.13
226 M05-69L amp 1	42.49	3.34	10.81	11.02	0.3	14.06	11.29	2.23	0.96	0.07		0.09		0.1		96.76
227 M05-69L amp1b	42.55	3.43	10.42	11.31	0.29	14.32	11.35	2.28	1	0.14		0.09		0.14	0.08	97.4
233 M05-69L amp2	41	2.8	12.3	12.76	0.28	12.8	11.67	2.11	1.1		0.07	0.1		0.09		97.08
10155 Rk-9 cpx	43.18	2.09	11.53	9.87	0.22	15.77	11.57	2.26	1	0.06	0	0.04		0.07	0.07	97.73
10156 Rk-9 cpx 1 rim	41.62	2.85	11.73	13.35	0.33	12.56	11.49	2.04	1.26	0	0	0.12		0	0	97.35
2875 M04-174 amp plag1amp	42.71	3.37	10.73	11.52	0.34	14.19	11.27	2.45	0.95	0.11	0.02	0.12		0	0	97.78
2877 M04-174 amp plag2amp	42.22	3.09	10.71	11.11	0.17	13.86	11.05	2.36	1.04	0	0.02	0.12		0.02	0	95.77
2878 M04-174 amp plag2amp2	39.95	2.81	12.7	12.48	0.27	12.8	11.38	2.32	0.92	0	0	0.09		0.09	0	95.81
2881 M04-174 amp plag 3amp	41.9	3.01	10.06	10.94	0.29	14.22	10.89	2.25	0.9	0	0.09	0.09		0.05	0.05	94.74
2885 M04-174 amp plag 4amp	42	3.14	10.24	11.45	0.34	13.88	10.8	2.21	1.02	0.17	0.08	0.14		0.07	0.13	95.67
2888 M04-174 amp plag 5 amp	42.9	3.29	10.11	12.31	0.4	13.58	10.85	2.22	0.94	0	0	0.08		0	0	96.68
2891 M04-176 amp plag 1amp	42.42	3.24	10.55	11.5	0.39	13.73	11.17	2.4	0.99	0.07	0.01	0.18		0.14	0	96.79
2892 M04-176 amp plag 2amp	47.49	0.05	31.96	0.77	0	0	15.79	2.29	0.16	0	0.02	0.02		0.03	0	98.58
2893 M04-176 amp plag 2amp	43.16	3.11	10.45	10.68	0.37	14.51	11.16	2.25	0.98	0	0	0.1		0.12	0	96.89
2895 M04-176 amp plag 3amp	41.29	3.47	11.55	11.65	0.33	13.76	11.23	2.59	0.98	0	0	0.09		0.08	0.1	97.12
2897 M04-176 amp plag 4amp	43.44	2.55	13.03	10.43	0.29	15.21	11.43	2.8	0.83	0.01	0	0.02		0.14	0	100.18
2899 M04-176 amp plag 5amp	40.41	3.39	12	11.94	0.4	13.14	11.29	2.53	0.94	0.01	0	0.08		0	0.24	96.37
2900 M04-176 amp b	41.59	3.38	11.01	11.4	0.35	13.25	11.33	2.38	0.98	0.08	0	0.07		0.13	0	95.95

Analysis ID	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
2901 M04-176 amp c	41.91	3.33	10.53	11.02	0.37	13.79	11.07	2.39	0.97	0.12	0.04	0.07		0.16	0	95.77
2903 M04-177 amp2 plag1amp	42.47	3.26	10.38	11.64	0.3	13.45	11.21	2.35	0.95	0.03	0	0.14		0.12	0.04	96.34
2873 M04-166 amp1 plag 1	41.84	3.22	10.21	10.9	0.47	13.81	11.2	2.11	0.97	0.02	0.14	0.07		0.04	0	95
2780 M05-69p amp 3	39.36	2.72	13.18	11.71	0.24	12.87	11.53	2.23	1.09	0	0	0.08		0	0	95.01

Glass:

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M06-64	67.80	0.51	15.94	2.33	0.11	0.81	2.13	5.24	4.38	0.31	0.12	0.31	0.00	0.00	100.00
M06-64	67.99	0.44	16.04	2.45	0.12	0.81	2.17	5.11	4.36	0.24	0.00	0.36	0.00	0.00	100.00
M06-64	68.17	0.56	15.89	2.29	0.11	0.66	1.92	5.24	4.42	0.25	0.00	0.41	0.00	0.19	100.00
M06-64	68.38	0.50	15.73	2.22	0.12	0.63	1.85	5.31	4.45	0.31	0.00	0.35	0.07	0.23	100.00
M06-64	68.09	0.57	15.78	2.45	0.08	0.63	2.13	5.10	4.44	0.32	0.01	0.36	0.00	0.04	100.00
M06-64	68.09	0.57	15.78	2.45	0.08	0.63	2.13	5.10	4.44	0.32	0.01	0.36	0.00	0.04	100.00
M06-64	67.82	0.52	15.82	2.58	0.23	0.75	2.23	5.16	4.31	0.26	0.00	0.38	0.00	0.04	100.00
M06-66	67.41	0.63	15.66	2.45	0.18	1.14	2.26	5.19	4.51	0.37	0.00	0.29	0.00	0.02	100.00
M06-66	67.61	0.75	15.94	2.72	0.13	0.80	2.31	4.78	4.52	0.14	0.04	0.32	0.00	0.00	100.00
M06-66	64.97	0.73	16.69	3.09	0.24	1.13	2.62	5.25	4.45	0.56	0.09	0.32	0.00	0.00	100.00
M06-66	65.23	0.52	16.81	3.12	0.17	1.08	2.80	5.25	4.46	0.31	0.10	0.25	0.00	0.00	100.00
M06-66	65.10	0.65	16.68	3.22	0.23	1.02	2.61	5.36	4.40	0.38	0.01	0.29	0.00	0.04	100.00
M06-66	65.11	0.81	16.74	3.13	0.19	1.02	2.76	5.16	4.55	0.32	0.00	0.32	0.00	0.02	100.00
M06-66	65.11	0.60	16.72	3.10	0.07	1.11	2.62	5.39	4.51	0.39	0.00	0.37	0.09	0.00	100.00
M06-66	65.01	0.65	16.78	3.19	0.15	1.00	2.78	5.01	4.44	0.33	0.00	0.39	0.02	0.28	100.00
M06-66	65.04	0.66	16.92	3.14	0.09	1.09	2.70	5.38	4.41	0.40	0.00	0.26	0.00	0.00	100.00
M06-66	64.23	0.70	17.16	3.08	0.12	1.08	3.20	5.41	3.98	0.40	0.06	0.33	0.00	0.32	100.00
M06-66	64.19	0.63	17.75	2.87	0.04	0.97	3.49	5.20	3.98	0.35	0.07	0.31	0.00	0.18	100.00
M06-66	65.09	0.81	16.69	3.29	0.04	1.16	2.72	5.24	4.38	0.36	0.00	0.31	0.00	0.00	100.00
M04-57	65.91	0.41	18.24	1.84	0.14	0.45	3.49	5.05	4.17	0.07	0.15	0.26	0.00	0.00	100.00
M04-57	64.43	0.52	17.89	2.57	0.00	0.74	3.86	5.01	4.23	0.22	0.00	0.33	0.00	0.22	100.00
M06-54	69.17	0.43	15.52	2.13	0.15	0.58	1.73	4.88	4.82	0.16	0.01	0.40	0.03	0.00	100.00
M06-54	68.60	0.50	15.67	2.26	0.10	0.53	1.94	4.81	4.81	0.34	0.09	0.44	0.00	0.00	100.00
M06-54	69.18	0.58	15.57	2.00	0.16	0.46	1.63	5.05	4.94	0.01	0.04	0.45	0.00	0.00	100.00
M06-54	68.72	0.53	15.62	2.04	0.11	0.55	1.72	5.08	4.80	0.34	0.01	0.43	0.01	0.04	100.00
M06-54	68.57	0.51	15.60	2.16	0.23	0.41	1.77	5.22	4.75	0.19	0.17	0.35	0.00	0.08	100.00
M06-54	68.98	0.47	15.74	2.10	0.09	0.33	1.63	5.00	4.82	0.32	0.02	0.42	0.00	0.11	100.00
M06-54	68.76	0.54	15.28	1.86	0.11	0.56	1.63	5.20	5.00	0.24	0.14	0.44	0.08	0.14	100.00
M06-54	69.21	0.43	15.50	2.07	0.07	0.39	1.61	5.07	4.91	0.22	0.00	0.39	0.07	0.11	100.00
M06-54	69.36	0.55	15.78	1.89	0.26	0.53	1.62	4.62	4.86	0.05	0.00	0.46	0.00	0.00	100.00
M06-54	68.74	0.71	15.54	2.05	0.11	0.35	1.69	5.33	4.94	0.00	0.04	0.42	0.08	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M06-55	68.46	0.67	15.51	2.25	0.06	0.63	1.76	5.13	4.91	0.01	0.09	0.28	0.00	0.23	100.00
M06-55	68.65	0.67	15.54	2.25	0.12	0.59	1.71	4.69	4.98	0.22	0.16	0.40	0.00	0.01	100.00
M06-55	68.55	0.66	15.73	2.06	0.14	0.59	1.77	4.91	4.92	0.20	0.11	0.35	0.00	0.00	100.00
M06-55	68.72	0.69	15.41	2.10	0.21	0.51	1.78	5.07	4.95	0.25	0.00	0.31	0.00	0.00	100.00
M06-55	68.66	0.67	15.51	1.99	0.17	0.54	1.79	4.88	4.92	0.35	0.19	0.34	0.00	0.00	100.00
M06-55	68.46	0.63	15.65	2.37	0.16	0.64	1.71	4.87	4.97	0.17	0.04	0.32	0.00	0.02	100.00
M06-55	68.53	0.64	15.64	2.25	0.18	0.69	1.83	5.11	4.81	0.01	0.00	0.32	0.00	0.00	100.00
M06-55	67.49	0.74	16.20	2.34	0.21	0.71	1.82	5.11	4.81	0.00	0.00	0.35	0.00	0.19	100.00
M06-55	68.61	0.64	15.59	2.04	0.27	0.55	1.81	4.84	4.82	0.35	0.00	0.32	0.00	0.14	100.00
M06-55	64.91	0.72	15.78	2.98	0.06	1.77	4.10	4.70	4.16	0.39	0.07	0.27	0.09	0.00	100.00
M06-55	68.78	0.59	15.44	2.23	0.14	0.57	1.72	4.89	5.04	0.13	0.02	0.33	0.03	0.07	100.00
M06-56	61.08	0.98	15.58	4.60	0.29	3.03	6.12	4.38	3.06	0.50	0.00	0.27	0.05	0.06	100.00
M06-56	66.40	0.74	15.40	3.37	0.15	0.83	2.05	4.66	5.13	0.61	0.07	0.34	0.00	0.25	100.00
M06-56	63.43	0.75	17.56	3.00	0.11	1.09	4.40	4.68	3.82	0.47	0.11	0.27	0.01	0.29	100.00
M06-56	64.18	0.59	17.78	2.76	0.14	1.09	3.92	5.10	3.69	0.39	0.02	0.19	0.00	0.14	100.00
M06-56	66.19	0.61	16.22	3.14	0.16	0.92	3.03	4.85	4.25	0.29	0.00	0.34	0.00	0.00	100.00
M06-56	64.51	0.76	15.41	3.58	0.32	2.14	4.07	4.29	4.13	0.36	0.13	0.26	0.04	0.00	100.00
M06-56	64.20	0.72	18.25	2.62	0.04	0.90	4.27	4.85	3.42	0.42	0.00	0.23	0.09	0.00	100.00
M06-56	66.12	0.57	16.88	2.38	0.18	0.90	3.10	4.91	4.13	0.22	0.11	0.21	0.00	0.27	100.00
M06-56	64.51	0.72	16.32	3.26	0.25	1.37	4.15	4.44	4.29	0.40	0.00	0.29	0.00	0.00	100.00
M06-56	64.72	0.63	17.57	2.84	0.12	0.83	3.68	4.98	3.94	0.40	0.01	0.27	0.00	0.00	100.00
M06-56	63.27	0.71	17.61	2.80	0.04	1.44	5.22	4.58	3.63	0.40	0.00	0.23	0.03	0.01	100.00
M06-56	64.77	0.63	18.21	2.23	0.08	0.66	3.89	4.94	3.89	0.37	0.00	0.27	0.03	0.00	100.00
M06-56	65.35	0.72	16.73	2.64	0.14	1.20	3.58	4.79	4.23	0.36	0.00	0.23	0.01	0.01	100.00
M06-57	69.70	0.53	15.19	1.72	0.14	0.48	1.58	5.06	4.82	0.15	0.11	0.35	0.00	0.17	100.00
M06-57	69.98	0.48	15.00	1.95	0.09	0.59	1.77	4.92	4.71	0.00	0.00	0.42	0.00	0.10	100.00
M06-57	69.96	0.51	15.13	1.83	0.07	0.44	1.70	4.95	4.65	0.31	0.00	0.36	0.00	0.08	100.00
M06-57	69.63	0.47	15.07	2.04	0.19	0.43	1.78	4.80	4.74	0.16	0.10	0.37	0.04	0.14	100.00
M06-57	70.27	0.47	15.18	1.70	0.07	0.37	1.67	4.89	4.76	0.11	0.00	0.39	0.00	0.10	100.00
M06-57	69.83	0.46	15.07	1.92	0.16	0.53	1.83	5.02	4.71	0.07	0.00	0.35	0.00	0.03	100.00
M06-57	69.31	0.62	15.42	2.14	0.28	0.48	1.80	4.71	4.70	0.04	0.00	0.39	0.01	0.09	100.00
M06-57	69.69	0.46	15.28	1.91	0.07	0.46	1.68	4.97	4.71	0.25	0.00	0.35	0.04	0.12	100.00
M06-57	69.00	0.56	15.35	1.98	0.15	0.50	1.93	4.98	4.76	0.31	0.04	0.34	0.03	0.05	100.00
M06-57	69.65	0.52	15.33	1.93	0.13	0.59	1.71	4.78	4.76	0.18	0.00	0.33	0.08	0.00	100.00
M06-57	70.04	0.43	15.16	1.70	0.10	0.43	1.63	4.95	4.74	0.18	0.15	0.36	0.00	0.13	100.00
M06-57	69.94	0.45	15.07	1.90	0.19	0.43	1.68	4.85	4.84	0.13	0.11	0.33	0.06	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M06-57	69.78	0.48	15.23	1.95	0.05	0.40	1.74	4.86	4.69	0.19	0.13	0.38	0.00	0.08	100.00
M06-57	69.64	0.59	15.12	1.88	0.22	0.51	1.69	4.89	4.76	0.10	0.15	0.34	0.10	0.00	100.00
M06-57	70.47	0.49	14.98	1.81	0.17	0.43	1.62	4.82	4.87	0.00	0.00	0.35	0.00	0.00	100.00
M06-57	69.75	0.65	15.06	1.89	0.05	0.37	1.63	5.03	4.58	0.24	0.04	0.36	0.00	0.33	100.00
M06-58	65.06	0.62	17.55	2.39	0.14	0.71	3.89	4.89	4.08	0.11	0.00	0.32	0.01	0.22	100.00
M06-58	66.73	0.57	17.02	2.10	0.11	0.50	2.79	5.03	4.57	0.15	0.02	0.17	0.00	0.21	100.00
M06-58	62.10	0.96	16.61	4.93	0.18	1.60	4.69	4.67	3.54	0.43	0.00	0.28	0.03	0.00	100.00
M06-58	61.16	0.95	15.47	4.96	0.27	2.78	5.83	4.38	3.43	0.40	0.00	0.23	0.00	0.15	100.00
M06-58	67.04	0.95	15.22	2.59	0.18	1.28	2.46	4.74	4.65	0.35	0.00	0.36	0.01	0.16	100.00
M06-58	60.23	0.87	17.27	4.23	0.12	2.18	6.49	4.63	2.92	0.63	0.02	0.22	0.01	0.16	100.00
M06-58	58.43	0.97	17.19	4.97	0.23	3.05	8.09	3.91	2.74	0.19	0.00	0.18	0.06	0.01	100.00
M06-58	59.74	0.50	20.26	3.06	0.20	1.38	6.86	4.53	2.84	0.43	0.01	0.20	0.00	0.00	100.00
M06-58	62.61	0.97	16.25	4.87	0.31	1.64	4.44	4.46	3.69	0.41	0.05	0.31	0.01	0.00	100.00
M06-58	62.65	0.88	15.97	4.24	0.31	1.87	4.79	4.84	3.66	0.51	0.00	0.28	0.00	0.00	100.00
M06-58	64.43	0.61	17.40	2.56	0.21	0.90	3.74	5.09	4.02	0.42	0.00	0.30	0.07	0.26	100.00
M06-58	65.06	0.61	17.63	2.44	0.11	0.77	3.90	4.77	4.07	0.20	0.14	0.27	0.00	0.05	100.00
M06-60	63.22	0.40	19.41	1.90	0.22	0.55	4.85	5.43	3.25	0.17	0.16	0.31	0.04	0.08	100.00
M06-60	63.15	0.36	19.60	2.02	0.12	0.49	5.25	5.03	3.51	0.02	0.08	0.30	0.00	0.06	100.00
M06-60	65.27	0.55	18.02	2.25	0.05	0.67	3.56	5.16	3.88	0.14	0.00	0.38	0.01	0.06	100.00
M06-60	65.77	0.58	17.34	2.22	0.11	0.65	3.24	5.43	3.97	0.25	0.02	0.33	0.00	0.08	100.00
M06-61	71.73	0.44	14.61	1.40	0.19	0.17	1.37	4.80	4.65	0.27	0.00	0.36	0.00	0.10	100.00
M06-61	70.31	0.37	16.17	1.15	0.05	0.16	2.72	5.02	3.60	0.10	0.00	0.28	0.06	0.04	100.00
M06-61	71.95	0.32	14.39	1.56	0.19	0.30	1.36	4.96	4.46	0.17	0.01	0.44	0.00	0.04	100.00
M06-61	72.00	0.46	14.49	1.33	0.17	0.30	1.30	4.71	4.63	0.09	0.00	0.45	0.01	0.11	100.00
M06-61	67.54	0.66	15.70	2.54	0.24	0.73	2.16	5.00	4.69	0.02	0.00	0.48	0.13	0.13	100.00
M06-62	67.54	0.66	15.70	2.54	0.24	0.73	2.16	5.00	4.69	0.02	0.00	0.48	0.13	0.13	100.00
M06-62	68.19	0.57	15.71	2.38	0.10	0.71	2.22	5.01	4.60	0.11	0.02	0.35	0.09	0.00	100.00
M06-62	67.68	0.60	15.53	2.61	0.20	0.81	2.24	5.04	4.58	0.40	0.00	0.39	0.00	0.00	100.00
M06-62	66.48	0.53	16.43	2.66	0.16	0.83	2.95	5.05	4.38	0.35	0.01	0.35	0.00	0.00	100.00
M06-62	67.81	0.58	15.71	2.60	0.11	0.72	2.19	4.99	4.68	0.07	0.08	0.35	0.00	0.14	100.00
M06-62	67.54	0.50	15.85	2.73	0.06	0.92	2.28	5.08	4.64	0.15	0.00	0.38	0.00	0.00	100.00
M06-62	66.71	0.60	15.09	2.86	0.12	1.52	3.08	4.66	4.46	0.44	0.00	0.35	0.06	0.09	100.00
M06-62	67.75	0.79	15.71	2.56	0.17	0.81	2.25	4.71	4.62	0.37	0.04	0.38	0.00	0.00	100.00
M06-62	66.60	0.55	16.71	2.57	0.10	0.76	2.95	5.13	4.11	0.16	0.00	0.35	0.02	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M06-62	67.43	0.67	15.66	2.74	0.02	0.78	2.12	4.99	4.75	0.18	0.06	0.33	0.05	0.22	100.00
M04-71	64.45	0.60	16.68	3.15	0.17	1.09	3.98	4.82	4.01	0.36	0.13	0.37	0.07	0.10	100.00
M04-71	65.33	0.56	16.83	3.22	0.16	1.05	3.13	5.18	3.90	0.27	0.00	0.35	0.00	0.03	100.00
M04-71	64.11	0.56	17.67	2.99	0.17	1.03	3.80	5.38	3.57	0.10	0.00	0.35	0.05	0.22	100.00
M04-71	65.07	0.60	16.72	3.11	0.21	1.17	3.04	5.33	3.97	0.41	0.10	0.38	0.00	0.00	100.00
M04-71	65.53	0.56	16.71	3.00	0.15	1.03	3.04	5.23	4.11	0.35	0.07	0.29	0.00	0.00	100.00
M04-71	64.95	0.57	16.54	3.27	0.22	1.18	3.19	5.21	4.06	0.31	0.05	0.37	0.00	0.09	100.00
M04-71	65.43	0.59	16.80	3.02	0.09	1.24	3.14	5.11	3.95	0.34	0.06	0.29	0.04	0.00	100.00
M04-71	63.76	0.58	17.39	3.23	0.00	1.14	4.07	5.12	3.55	0.49	0.14	0.35	0.12	0.07	100.00
M04-71	64.92	0.58	16.76	3.15	0.10	1.16	3.16	5.26	3.90	0.27	0.17	0.41	0.00	0.21	100.00
M04-71	65.03	0.60	16.92	3.22	0.19	1.19	3.12	5.01	3.91	0.37	0.16	0.34	0.01	0.00	100.00
M04-71	64.32	0.56	16.99	3.41	0.13	1.35	3.54	5.10	3.84	0.20	0.12	0.34	0.00	0.07	100.00
M04-80	71.14	0.38	14.96	1.61	0.29	0.34	1.49	4.61	4.84	0.00	0.00	0.33	0.00	0.08	100.00
M04-80	71.45	0.39	14.75	1.55	0.11	0.35	1.68	4.52	4.71	0.25	0.00	0.42	0.00	0.03	100.00
M04-80	71.38	0.46	14.72	1.57	0.13	0.22	1.60	4.76	4.64	0.09	0.08	0.30	0.00	0.08	100.00
M04-80	71.43	0.44	14.75	1.47	0.14	0.25	1.61	4.82	4.58	0.13	0.05	0.38	0.00	0.03	100.00
M04-80	71.37	0.38	14.65	1.68	0.17	0.24	1.60	4.62	4.77	0.08	0.07	0.35	0.00	0.05	100.00
M04-80	70.86	0.45	14.63	1.66	0.15	0.38	1.56	4.80	4.69	0.19	0.02	0.41	0.03	0.18	100.00
M04-80	71.09	0.46	14.85	1.47	0.16	0.37	1.67	4.56	4.79	0.00	0.04	0.36	0.01	0.18	100.00
M04-80	71.25	0.40	14.76	1.66	0.19	0.31	1.63	4.48	4.70	0.15	0.05	0.35	0.00	0.10	100.00
M04-90	71.09	0.52	14.61	1.59	0.23	0.35	1.68	4.57	4.78	0.10	0.00	0.40	0.01	0.08	100.00
M04-90	68.62	0.38	16.83	1.27	0.24	0.32	2.79	5.15	3.85	0.26	0.06	0.15	0.02	0.04	100.00
M04-90	66.70	0.39	11.49	3.27	0.43	3.78	6.61	3.65	3.47	0.13	0.00	0.28	0.00	0.00	100.00
M04-90	71.07	0.44	14.95	1.51	0.09	0.34	1.59	5.03	4.41	0.22	0.07	0.21	0.00	0.12	100.00
M04-90	70.49	0.51	15.05	1.67	0.14	0.54	2.06	4.52	4.52	0.18	0.00	0.28	0.00	0.12	100.00
M04-90	71.17	0.44	14.69	1.64	0.07	0.31	1.53	4.78	4.72	0.21	0.00	0.27	0.16	0.03	100.00
M04-100	70.31	0.39	14.95	1.55	0.09	0.31	2.20	4.53	4.64	0.72	0.10	0.25	0.00	0.04	100.00
M04-90	71.48	0.46	14.73	1.63	0.24	0.24	1.57	4.52	4.86	0.07	0.00	0.29	0.01	0.00	100.00
M04-90	71.48	0.46	14.73	1.63	0.24	0.24	1.57	4.52	4.86	0.07	0.00	0.29	0.01	0.00	100.00
M04-90	70.91	0.44	14.83	1.64	0.12	0.37	1.73	4.52	4.67	0.14	0.11	0.35	0.04	0.12	100.00
M04-90	71.10	0.43	14.80	1.37	0.18	0.29	1.31	5.06	4.75	0.34	0.00	0.33	0.00	0.11	100.00
M04-90	71.63	0.49	14.80	1.54	0.12	0.29	1.56	4.53	4.66	0.08	0.09	0.28	0.00	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M04-91	69.49	0.30	16.08	1.58	0.03	0.25	2.04	5.55	4.19	0.07	0.00	0.35	0.05	0.05	100.00
M04-91	70.53	0.43	15.35	1.54	0.13	0.38	1.68	5.05	4.56	0.06	0.00	0.35	0.03	0.00	100.00
M04-91	69.67	0.38	15.95	1.70	0.14	0.31	2.13	5.01	4.24	0.04	0.14	0.34	0.00	0.00	100.00
M04-96	64.87	0.81	16.13	3.44	0.25	1.20	2.89	5.23	4.39	0.35	0.04	0.34	0.00	0.03	100.00
M04-96	65.06	0.75	16.25	3.68	0.16	1.09	2.71	5.22	4.34	0.40	0.02	0.42	0.00	0.00	100.00
M04-96	64.86	0.81	16.28	3.55	0.18	1.05	2.71	5.39	4.44	0.28	0.00	0.37	0.00	0.09	100.00
M04-96	64.38	0.79	16.26	3.72	0.18	1.22	2.77	5.24	4.41	0.49	0.00	0.37	0.14	0.12	100.00
M04-96	64.46	0.72	16.36	3.82	0.16	1.15	2.70	5.52	4.53	0.39	0.00	0.37	0.00	0.00	100.00
M04-96	63.64	0.68	16.99	3.77	0.05	1.15	3.20	5.41	4.08	0.58	0.01	0.39	0.00	0.09	100.00
M04-96	64.39	0.73	16.59	3.70	0.18	1.26	3.07	5.54	4.18	0.25	0.00	0.32	0.04	0.00	100.00
M04-96	63.58	0.73	17.50	3.52	0.11	1.03	3.64	5.40	3.77	0.42	-0.10	0.33	0.01	0.06	100.00
M04-96	64.70	0.79	16.27	3.78	0.19	1.12	2.63	5.40	4.41	0.42	0.00	0.39	0.00	0.00	100.00
M04-96	65.00	0.67	16.11	3.65	0.16	1.11	2.57	5.19	4.50	0.42	0.05	0.36	0.12	0.08	100.00
M04-96	64.74	0.85	16.26	3.69	0.15	1.16	2.79	5.29	4.45	0.36	0.00	0.39	0.03	0.00	100.00
M04-96	65.07	0.78	16.45	3.56	0.26	0.98	2.70	4.96	4.54	0.32	0.00	0.36	0.02	0.06	100.00
M04-98	64.12	0.86	16.66	3.82	0.18	1.28	3.10	5.25	4.14	0.30	0.00	0.38	0.00	0.00	100.00
M04-98	64.60	0.72	16.87	3.47	0.17	1.23	2.77	5.32	4.30	0.22	0.01	0.33	0.00	0.00	100.00
M04-98	64.91	0.79	16.62	3.56	0.06	0.95	2.70	5.33	4.38	0.20	0.02	0.38	0.04	0.03	100.00
M04-98	64.01	0.74	16.60	3.65	0.19	1.25	3.05	5.30	4.28	0.44	0.01	0.37	0.03	0.10	100.00
M04-98	63.82	0.78	16.64	3.83	0.14	1.52	3.46	5.23	4.06	0.23	0.01	0.37	0.00	0.00	100.00
M04-98	63.45	0.89	16.26	4.19	0.18	1.84	3.64	4.94	3.97	0.36	0.00	0.34	0.00	0.04	100.00
M04-98	64.34	0.82	16.44	3.61	0.36	1.18	2.99	5.07	4.24	0.34	0.12	0.42	0.00	0.11	100.00
M04-98	63.44	0.76	16.09	4.08	0.12	1.74	3.45	5.19	4.28	0.40	0.00	0.39	0.02	0.05	100.00
M04-98	63.03	0.76	17.45	3.58	0.22	1.17	3.83	5.39	3.68	0.34	0.12	0.34	0.03	0.08	100.00
M04-98	64.92	0.63	16.60	3.72	0.12	1.24	2.73	5.17	4.14	0.46	0.00	0.39	0.00	0.00	100.00
M04-98	64.45	0.63	16.38	3.64	0.29	1.15	2.89	5.30	4.22	0.43	0.08	0.36	0.00	0.20	100.00
M04-98	61.86	0.88	17.22	4.75	0.25	1.40	3.67	5.20	3.85	0.43	0.01	0.29	0.00	0.23	100.00
M04-98	62.21	0.83	17.72	4.01	0.12	1.59	4.61	5.10	3.30	0.47	0.00	0.31	0.00	0.00	100.00
M04-100	64.96	0.76	16.72	3.06	0.14	1.02	2.78	5.43	4.15	0.31	0.00	0.38	0.07	0.22	100.00
M04-100	64.47	0.81	17.39	3.03	0.13	0.90	3.42	5.35	3.73	0.32	0.01	0.35	0.00	0.08	100.00
M04-100	64.63	0.68	16.62	3.27	0.19	1.04	3.07	5.40	4.22	0.36	0.07	0.36	0.10	0.00	100.00
M04-100	64.82	0.73	16.59	3.16	0.23	1.10	2.94	5.31	4.24	0.30	0.15	0.35	0.01	0.08	100.00
M04-100	64.68	0.78	16.80	2.92	0.19	1.13	3.03	5.41	4.17	0.34	0.00	0.26	0.00	0.34	100.00
M04-100	64.70	0.71	16.53	3.40	0.22	1.07	3.22	5.06	4.22	0.33	0.00	0.38	0.05	0.12	100.00
M04-100	64.90	0.64	16.80	3.21	0.21	0.99	2.90	5.22	4.32	0.48	0.00	0.37	0.00	0.01	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M04-100	64.98	0.67	16.94	3.15	0.20	1.06	3.03	5.29	4.15	0.20	0.08	0.36	0.00	0.00	100.00
M04-100	64.02	0.68	17.03	3.11	0.17	0.99	3.62	5.23	3.96	0.84	0.00	0.35	0.00	0.09	100.00
M04-59	64.34	0.70	13.92	3.51	0.37	2.90	5.29	4.10	4.26	0.12	0.10	0.35	0.01	0.04	100.00
M04-59	68.65	0.52	16.17	1.86	0.17	0.46	1.98	4.79	4.86	0.19	0.00	0.32	0.00	0.04	100.00
M04-59	69.51	0.39	15.41	1.73	0.08	0.52	1.50	5.01	5.15	0.08	0.07	0.48	0.07	0.01	100.00
M04-59	68.90	0.46	15.81	1.99	0.10	0.59	1.63	4.92	5.09	0.07	0.04	0.39	0.00	0.02	100.00
M04-59	68.86	0.50	15.71	2.00	0.11	0.49	1.77	4.83	5.07	0.06	0.04	0.47	0.00	0.09	100.00
M04-59	69.62	0.54	15.28	1.80	0.10	0.40	1.45	5.01	5.15	0.15	0.00	0.41	0.06	0.01	100.00
M04-59	67.54	0.70	15.32	2.43	0.10	1.27	2.78	4.74	4.68	0.00	0.05	0.35	0.00	0.03	100.00
M04-59	68.64	0.58	15.88	1.98	0.02	0.49	1.68	4.91	5.19	0.18	0.02	0.42	0.01	0.00	100.00
M04-59	68.07	0.55	15.92	2.08	0.00	0.59	1.84	5.16	4.99	0.23	0.00	0.38	0.18	0.00	100.00
M04-59	69.38	0.50	15.45	1.77	0.09	0.40	1.64	4.84	5.11	0.22	0.02	0.44	0.00	0.13	100.00
M04-59	67.21	0.41	17.15	1.77	0.09	0.44	2.71	5.24	4.53	0.04	0.02	0.33	0.05	0.00	100.00
M04-59	68.38	0.50	15.73	2.19	0.14	0.45	1.62	5.13	5.13	0.25	0.05	0.42	0.00	0.01	100.00
M04-59	68.52	0.54	15.60	2.19	0.22	0.54	1.67	5.06	5.09	0.02	0.04	0.39	0.00	0.12	100.00
M04-59	68.43	0.50	15.43	2.06	0.21	0.54	1.71	5.17	5.15	0.25	0.00	0.39	0.00	0.13	100.00
M04-156	58.46	0.71	19.17	5.30	0.16	1.65	6.03	5.02	2.79	0.58	0.00	0.11	0.02	0.00	100.00
M04-156	58.71	0.89	17.69	6.55	0.32	1.84	4.72	5.06	3.39	0.52	0.00	0.23	0.03	0.06	100.00
M04-156	59.56	0.98	16.63	5.58	0.16	2.44	4.94	5.10	3.48	0.52	0.00	0.28	0.03	0.29	100.00
M04-156	60.22	0.89	17.76	4.53	0.23	1.99	4.70	5.10	3.46	0.68	0.01	0.29	0.00	0.15	100.00
M04-156	59.23	0.67	19.53	4.17	0.11	1.21	5.90	5.40	2.92	0.44	0.06	0.25	0.11	0.00	100.00
M04-156	60.03	0.83	17.70	4.57	0.25	1.99	5.25	5.15	3.24	0.61	0.00	0.29	0.01	0.08	100.00
M04-156	58.77	1.03	17.58	6.59	0.17	1.81	4.76	4.83	3.38	0.73	0.00	0.24	0.04	0.04	100.00
M04-156	60.37	1.05	16.64	5.38	0.20	2.06	4.39	4.94	3.86	0.77	0.00	0.29	0.00	0.05	100.00
M04-156	58.51	0.79	18.75	4.85	0.24	2.43	6.26	4.88	2.66	0.38	0.00	0.17	0.10	0.00	100.00
M04-156	59.60	0.85	17.59	5.04	0.05	2.22	5.22	4.77	3.22	0.69	0.11	0.29	0.17	0.19	100.00
M04-156	59.02	0.75	17.92	4.94	0.26	2.39	5.80	4.93	3.08	0.65	0.00	0.19	0.00	0.08	100.00
M04-156	60.09	0.91	17.06	5.29	0.22	1.76	4.64	4.96	3.63	0.87	0.03	0.33	0.06	0.16	100.00
M04-156	57.75	0.77	15.76	6.76	0.17	5.72	4.42	4.35	3.24	0.69	0.00	0.19	0.17	0.00	100.00
M04-159	72.75	0.36	14.43	1.26	0.14	0.30	1.24	4.30	4.79	0.06	0.00	0.32	0.04	0.00	100.00
M04-159	72.68	0.32	14.14	1.57	0.04	0.15	1.30	4.40	4.85	0.10	0.00	0.40	0.00	0.03	100.00
M04-159	72.62	0.46	14.43	1.40	0.08	0.30	1.13	4.36	4.75	0.04	0.02	0.38	0.02	0.00	100.00
M04-159	72.22	0.34	14.23	1.42	0.27	0.22	1.27	4.58	4.89	0.00	0.12	0.37	0.00	0.08	100.00
M04-159	71.34	0.42	15.05	1.37	0.14	0.16	1.62	4.96	4.41	0.01	0.05	0.33	0.09	0.02	100.00
M04-159	72.40	0.48	14.31	1.15	0.14	0.24	1.30	4.57	4.87	0.09	0.00	0.33	0.00	0.10	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M04-159	72.33	0.40	14.18	1.54	0.22	0.17	1.20	4.56	4.85	0.16	0.00	0.39	0.00	0.00	100.00
M04-159	71.32	0.44	14.77	1.36	0.25	0.20	1.68	4.88	4.61	0.14	0.00	0.35	0.00	0.00	100.00
M04-159	72.58	0.48	14.03	1.28	0.19	0.19	1.35	4.47	4.78	0.14	0.00	0.39	0.12	0.00	100.00
M04-158	71.83	0.43	14.44	1.42	0.09	0.21	1.41	4.73	4.83	0.06	0.01	0.39	0.01	0.17	100.00
M04-158	72.38	0.33	14.49	1.28	0.04	0.27	1.43	4.47	4.76	0.00	0.00	0.40	0.00	0.15	100.00
M04-159	71.99	0.44	14.44	1.43	0.15	0.44	1.37	4.58	4.66	0.00	0.00	0.39	0.11	0.00	100.00
M04-176	67.66	0.61	15.78	2.45	0.18	0.78	2.00	5.03	4.64	0.19	0.12	0.41	0.04	0.08	100.00
M04-176	67.54	0.45	16.40	2.41	0.17	0.58	2.18	5.18	4.39	0.24	0.02	0.45	0.00	0.00	100.00
M04-176	67.60	0.64	16.01	2.36	0.13	0.78	2.15	5.24	4.55	0.05	0.09	0.35	0.06	0.00	100.00
M04-176	65.74	0.48	17.97	2.16	0.27	0.49	3.36	5.44	3.63	0.07	0.02	0.22	0.05	0.09	100.00
M04-176	67.52	0.57	16.37	2.27	0.13	0.59	2.00	5.26	4.61	0.16	0.00	0.38	0.01	0.13	100.00
M05-12hp	68.73	0.48	15.95	1.69	0.17	0.38	2.57	4.98	4.27	0.29	0.09	0.43	0.03	0.00	100.00
M05-12hp	69.88	0.55	15.44	1.65	0.04	0.35	2.05	5.09	4.65	0.12	0.00	0.35	0.00	0.00	100.00
M05-12hp	70.49	0.39	14.96	1.93	0.16	0.41	1.84	4.69	4.65	0.15	0.00	0.32	0.00	0.13	100.00
M05-12hp	70.53	0.45	14.63	1.74	0.21	0.35	1.74	4.78	4.86	0.14	0.01	0.38	0.00	0.21	100.00
M05-12hp	68.33	0.38	16.46	1.50	0.04	0.53	3.13	5.14	4.04	0.06	0.06	0.31	0.00	0.03	100.00
M05-12hp	68.42	0.47	16.44	1.57	0.05	0.44	2.90	5.29	3.89	0.15	0.00	0.32	0.01	0.05	100.00
M05-12hp	68.49	0.45	15.57	1.78	0.18	1.04	3.54	4.86	3.92	0.05	0.00	0.23	0.00	0.00	100.00
M05-13	69.97	0.56	15.41	1.85	0.12	0.41	1.85	4.97	4.41	0.00	0.00	0.41	0.00	0.17	100.00
M05-13	67.38	0.36	17.65	1.69	0.18	0.29	3.27	5.12	3.74	0.05	0.00	0.40	0.00	-0.10	100.00
M05-13	67.96	0.34	16.95	1.70	0.03	0.42	2.98	5.14	3.80	0.01	0.23	0.37	0.00	0.09	100.00
M05-13	69.61	0.34	15.33	2.07	0.26	0.29	1.92	5.09	4.49	0.00	0.01	0.47	0.01	0.09	100.00
M05-15	67.74	0.54	16.17	2.49	0.15	0.66	2.26	5.19	4.40	0.10	0.01	0.29	0.00	0.08	100.00
M05-15	68.19	0.51	16.12	2.28	0.18	0.65	2.15	5.13	4.37	0.00	0.05	0.37	0.00	0.07	100.00
M05-15	67.70	0.56	16.05	2.50	0.14	0.68	2.20	5.32	4.26	0.15	0.10	0.39	0.01	0.00	100.00
M05-15	67.34	0.65	16.19	2.48	0.25	0.76	2.35	5.17	4.42	0.05	0.00	0.39	0.00	0.04	100.00
M05-15	67.69	0.60	16.03	2.40	0.15	0.63	2.23	5.30	4.49	0.19	0.00	0.35	0.02	0.00	100.00
M05-15	67.73	0.62	16.01	2.50	0.17	0.57	2.27	5.20	4.44	0.23	0.00	0.32	0.00	0.00	100.00
M05-15	67.58	0.56	16.10	2.31	0.17	0.59	2.23	5.38	4.49	0.10	0.01	0.40	0.09	0.00	100.00
M05-15	67.65	0.60	15.95	2.33	0.11	0.66	2.16	5.48	4.47	0.00	0.00	0.35	0.11	0.17	100.00
M05-15	67.52	0.59	16.08	2.45	0.20	0.67	2.25	5.17	4.47	0.09	0.01	0.35	0.00	0.15	100.00
M05-15	67.63	0.70	16.04	2.31	0.14	0.61	2.32	5.18	4.44	0.25	0.04	0.30	0.03	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
M05-18	61.85	0.89	17.27	4.17	0.12	1.54	4.18	5.20	3.85	0.59	0.00	0.26	0.01	0.08	100.00
M05-18	62.41	0.82	17.02	4.18	0.20	1.80	3.73	4.93	4.02	0.50	0.11	0.25	0.00	0.07	100.00
M05-18	59.20	0.50	16.25	5.86	0.15	5.32	3.96	4.59	3.21	0.51	0.12	0.31	0.00	0.10	100.00
M05-18	60.25	0.62	16.75	5.35	0.22	3.66	4.26	4.72	3.39	0.48	0.00	0.28	0.01	0.08	100.00
M05-18	61.52	0.74	18.05	3.80	0.14	1.81	4.52	5.11	3.50	0.48	0.07	0.27	0.00	0.06	100.00
M04-111	66.67	0.95	15.59	2.91	0.14	0.63	1.69	5.10	5.49	0.51	0.00	0.18	0.00	0.20	100.00
M04-111	66.19	0.85	15.52	3.97	0.10	0.70	1.62	5.08	5.37	0.26	0.14	0.29	0.00	0.04	100.00
M04-111	67.46	0.82	15.30	2.89	0.12	0.68	1.52	5.11	5.54	0.28	0.00	0.25	0.05	0.04	100.00
M04-111	65.98	0.86	16.19	2.69	0.28	0.71	2.21	5.02	5.16	0.59	0.00	0.30	0.00	0.07	100.00
M04-111	66.36	0.80	16.44	2.59	0.09	0.59	2.18	5.41	4.92	0.30	0.10	0.22	0.05	0.00	100.00
M04-111	66.74	0.80	15.61	2.95	0.02	0.61	1.74	5.26	5.40	0.21	0.07	0.27	0.06	0.25	100.00
M04-111	65.81	0.63	17.05	2.66	0.02	0.64	2.60	5.38	4.78	0.32	0.00	0.24	0.00	0.00	100.00
M04-111	65.16	0.65	16.50	2.73	0.10	0.78	2.79	5.36	4.89	0.77	0.00	0.18	0.00	0.14	100.00
M04-111	67.08	0.81	15.63	2.87	0.23	0.63	1.88	5.20	5.41	0.24	0.00	0.28	0.00	0.00	100.00
M04-111	67.37	0.80	15.70	2.80	0.11	0.78	1.52	5.07	5.50	0.26	0.00	0.17	0.03	0.00	100.00
M04-111	66.83	0.76	15.63	3.06	0.09	0.70	1.45	5.12	5.58	0.25	0.05	0.29	0.02	0.17	100.00
E02-109	71.51	0.36	14.62	1.68	0.06	0.23	1.54	4.72	4.60	0.15	0.06	0.32	0.03	0.10	100.00
E02-109	71.32	0.35	14.91	1.63	0.12	0.33	1.56	4.52	4.64	0.00	0.13	0.42	0.00	0.07	100.00
E02-109	71.84	0.40	14.72	1.60	0.09	0.35	1.39	4.52	4.72	0.01	0.00	0.29	0.01	0.18	100.00
E02-109	71.57	0.45	14.74	1.44	0.14	0.38	1.44	4.58	4.71	0.15	0.00	0.38	0.05	0.00	100.00
E02-109	71.79	0.46	14.68	1.42	0.12	0.26	1.50	4.68	4.66	0.12	0.00	0.29	0.00	0.10	100.00
E02-109	71.45	0.43	14.73	1.65	0.12	0.41	1.46	4.74	4.65	0.13	0.00	0.30	0.04	0.00	100.00
E02-109	71.79	0.30	14.65	1.51	0.19	0.29	1.46	4.72	4.78	0.00	0.00	0.30	0.00	0.09	100.00
E02-109	71.70	0.40	14.69	1.61	0.11	0.29	1.55	4.73	4.57	0.00	0.07	0.35	0.00	0.00	100.00
E02-79	64.34	0.78	16.83	3.51	0.20	1.31	3.30	4.88	4.28	0.33	0.00	0.24	0.03	0.01	100.00
E02-79	61.95	0.74	17.30	4.45	0.22	1.73	4.31	4.82	3.74	0.40	0.06	0.19	0.07	0.02	100.00
E02-79	62.34	0.70	17.03	4.44	0.25	1.61	4.03	4.65	3.96	0.37	0.11	0.29	0.08	0.14	100.00
E02-79	61.35	0.68	18.48	3.97	0.10	1.49	5.07	4.89	3.35	0.44	0.00	0.20	0.00	0.00	100.00
E02-79	62.00	0.81	17.40	4.49	0.00	1.67	4.46	4.58	4.11	0.15	0.00	0.21	0.04	0.12	100.00
E02-79	61.58	0.69	17.16	4.65	0.08	1.82	4.66	4.67	3.84	0.39	0.13	0.21	0.00	0.13	100.00
E02-79	62.82	0.67	17.60	4.06	0.15	1.17	4.07	4.85	3.96	0.31	0.08	0.25	0.00	0.06	100.00
E02-79	61.93	0.80	17.14	4.49	0.22	2.13	4.72	4.41	3.55	0.28	0.00	0.21	0.03	0.10	100.00
E02-79	61.76	0.67	17.44	4.66	0.08	1.90	4.78	4.60	3.48	0.46	0.00	0.12	0.13	0.00	100.00
E02-79	62.42	0.74	17.06	4.66	0.10	1.77	4.03	4.48	4.14	0.44	0.09	0.19	0.00	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
E02-89	67.46	0.46	16.30	2.39	0.21	0.60	2.26	5.29	4.59	0.05	0.12	0.29	0.04	0.00	100.00
E02-89	67.86	0.49	16.32	2.17	0.12	0.61	2.19	5.36	4.58	0.06	0.08	0.31	0.00	0.00	100.00
E02-89	67.64	0.47	16.20	2.45	0.16	0.72	2.22	5.27	4.59	0.05	0.00	0.31	0.00	0.09	100.00
E02-89	67.69	0.51	16.19	2.30	0.08	0.65	2.35	5.21	4.57	0.21	0.00	0.32	0.04	0.00	100.00
E02-89	67.68	0.28	16.43	2.43	0.09	0.66	2.28	5.00	4.69	0.26	0.08	0.33	0.00	0.00	100.00
E02-89	67.80	0.41	16.44	2.35	0.25	0.72	2.26	5.02	4.51	0.00	0.00	0.26	0.03	0.04	100.00
E02-98	57.03	1.28	17.20	6.98	0.16	2.33	5.40	5.19	3.38	0.69	0.00	0.23	0.04	0.10	100.00
E02-98	57.47	1.11	17.47	6.46	0.13	2.76	5.83	4.29	3.53	0.77	0.03	0.22	0.00	0.00	100.00
E02-98	58.35	1.17	17.91	5.34	0.27	1.53	5.64	5.17	3.47	0.70	0.00	0.28	0.09	0.11	100.00
E02-98	58.50	1.10	17.34	6.04	0.05	1.92	5.54	5.03	3.64	0.75	0.00	0.22	0.05	0.00	100.00
E02-98	57.42	0.89	16.54	5.61	0.20	3.54	7.87	4.36	2.81	0.54	0.05	0.18	0.01	0.00	100.00
E02-98	58.40	0.88	17.56	5.72	0.15	1.89	5.71	5.13	3.45	0.67	0.00	0.24	0.01	0.25	100.00
E02-98	58.84	1.09	16.96	6.21	0.14	1.85	4.98	5.22	3.76	0.65	0.03	0.33	0.00	0.00	100.00
E02-98	57.87	1.06	17.82	5.87	0.16	1.73	5.70	5.15	3.66	0.72	0.05	0.16	0.00	0.07	100.00
E02-98	58.18	1.13	17.83	5.73	0.10	1.67	5.77	5.07	3.53	0.63	0.14	0.15	0.10	0.00	100.00
E02-95	57.73	1.14	16.04	7.43	0.16	3.21	5.63	4.49	3.26	0.72	0.00	0.31	0.00	0.00	100.00
E02-95	58.48	0.87	17.92	5.27	0.24	2.21	5.71	4.96	3.21	0.56	0.06	0.30	0.00	0.20	100.00
E02-95	58.43	0.92	18.45	5.53	0.16	2.00	5.91	4.74	3.10	0.53	0.00	0.24	0.00	0.00	100.00
E02-95	58.23	0.76	18.23	5.50	0.19	2.02	5.96	5.14	3.12	0.52	0.00	0.28	0.02	0.00	100.00
E02-95	58.32	0.78	17.80	6.16	0.23	2.27	5.45	4.92	3.07	0.65	0.06	0.16	0.13	0.00	100.00
E02-95	58.27	0.76	18.88	5.20	0.07	1.93	6.13	4.97	2.90	0.39	0.00	0.18	0.12	0.20	100.00
E02-95	59.30	1.08	16.74	6.37	0.19	2.25	4.35	4.80	3.77	0.61	0.00	0.38	0.05	0.10	100.00
E02-95	57.76	0.77	18.29	5.35	0.16	2.24	6.32	4.95	2.95	0.65	0.06	0.27	0.13	0.11	100.00
E02-95	57.71	0.98	18.19	5.66	0.21	2.46	6.34	4.80	2.90	0.51	0.00	0.23	0.00	0.01	100.00
E02-95	57.25	0.89	18.46	6.18	0.32	2.21	6.12	4.98	2.77	0.45	0.00	0.30	0.02	0.06	100.00
E02-95	58.33	0.88	17.73	5.76	0.13	2.13	5.64	5.02	3.32	0.62	0.05	0.26	0.05	0.08	100.00
E02-109	64.28	0.54	17.15	3.37	0.03	1.26	3.32	5.44	3.84	0.30	0.01	0.23	0.07	0.17	100.00
E02-109	64.94	0.72	16.62	3.32	0.33	0.99	2.72	5.37	4.26	0.19	0.12	0.44	0.00	0.00	100.00
E02-109	64.48	0.66	15.51	3.94	0.14	2.04	3.19	4.81	4.18	0.44	0.00	0.33	0.06	0.22	100.00
E02-109	65.20	0.79	16.72	3.36	0.13	0.94	2.77	5.34	4.10	0.31	0.00	0.30	0.05	0.00	100.00
E02-109	64.15	0.60	15.85	4.12	0.08	2.60	3.09	4.98	3.80	0.40	0.00	0.32	0.00	0.00	100.00
E02-109	65.45	0.62	16.28	3.64	0.03	1.00	2.41	5.23	4.44	0.44	0.12	0.31	0.04	0.00	100.00
E02-109	65.35	0.84	16.13	3.68	0.23	0.94	2.35	5.11	4.49	0.37	0.00	0.36	0.00	0.17	100.00
E02-109	64.66	0.86	16.60	3.40	0.10	1.01	3.19	5.44	4.03	0.32	0.00	0.30	0.09	0.00	100.00
E02-109	63.07	0.63	18.27	3.18	0.10	0.91	4.30	5.36	3.45	0.31	0.05	0.25	0.05	0.05	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
E02-109	64.57	0.82	17.11	3.31	0.06	1.12	3.04	5.44	3.94	0.22	0.00	0.30	0.05	0.00	100.00
E02-109	64.87	0.58	17.15	3.21	0.15	1.02	3.11	5.20	4.06	0.21	0.01	0.30	0.14	0.00	100.00
E02-109	65.43	0.79	16.22	3.57	0.13	1.09	2.41	5.21	4.48	0.25	0.02	0.37	0.00	0.00	100.00
Rua glass	63.56	1.13	13.95	6.66	0.09	2.92	4.60	3.74	2.73	0.44	0.00	0.14	0.02	0.00	100.00
Rua glass	64.02	1.05	14.88	6.07	0.05	2.01	4.45	4.05	2.86	0.29	0.04	0.20	0.04	0.00	100.00
Rua glass	64.15	1.01	14.78	6.17	0.12	1.94	4.73	4.03	2.76	0.10	0.00	0.21	0.00	0.00	100.00
Rua glass	62.43	1.07	15.31	6.31	0.08	2.41	5.38	3.77	2.53	0.31	0.16	0.20	0.02	0.03	100.00
Rua glass	62.51	0.96	15.60	6.46	0.10	1.91	5.44	4.11	2.41	0.30	0.00	0.14	0.07	0.00	100.00
Rua glass	63.63	1.10	14.92	6.17	0.16	1.91	4.65	4.04	2.62	0.49	0.00	0.27	0.01	0.03	100.00
Rua glass	63.60	1.26	14.96	5.96	0.03	2.06	4.48	4.05	2.74	0.50	0.07	0.21	0.00	0.09	100.00
Rua glass	62.21	1.02	15.78	6.05	0.23	2.37	5.46	4.13	2.38	0.15	0.04	0.12	0.05	0.00	100.00
Rua glass	62.66	1.08	15.10	6.07	0.14	2.66	5.12	3.90	2.46	0.31	0.10	0.17	0.04	0.17	100.00
Rua glass	64.44	1.11	14.68	6.01	0.05	2.35	4.10	4.10	2.71	0.24	0.00	0.22	0.01	0.00	100.00
EB-1B	63.62	1.09	15.45	5.74	0.12	1.78	5.01	4.23	2.59	0.12	0.00	0.24	0.01	0.00	100.00
EB-1B	62.36	0.97	15.45	6.31	0.14	2.44	5.33	4.07	2.46	0.27	0.00	0.20	0.00	0.00	100.00
EB-1B	64.47	0.57	17.18	3.41	0.03	1.07	3.53	5.19	3.92	0.24	0.04	0.31	0.03	0.02	100.00
EB-1B	62.35	0.84	17.03	5.15	0.17	1.20	3.43	4.92	3.95	0.24	0.00	0.38	0.15	0.19	100.00
EB-1B	63.46	0.59	17.72	3.03	0.12	1.14	3.92	5.21	3.91	0.37	0.12	0.39	0.00	0.00	100.00
EB-1B	63.51	1.00	14.78	6.22	0.18	2.29	4.61	3.86	2.78	0.39	0.08	0.19	0.00	0.08	100.00
EB-1B	62.76	1.03	15.13	6.33	0.11	2.30	4.97	4.15	2.61	0.20	0.00	0.22	0.08	0.09	100.00
Rk-22 light glass	57.93	1.04	17.92	5.65	0.20	2.37	5.41	5.22	3.24	0.71	0.04	0.26	0.00	0.04	100.00
Rk-22 light glass	58.30	0.95	17.70	5.83	0.23	2.27	5.13	5.37	3.30	0.53	0.00	0.42	0.09	0.00	100.00
Rk-22 light glass	58.15	0.96	18.05	5.65	0.18	2.24	5.34	5.34	3.20	0.46	0.00	0.27	0.08	0.16	100.00
Rk-22 light glass	56.78	0.99	18.02	6.24	0.26	2.92	5.86	4.97	3.02	0.57	0.10	0.32	0.00	0.01	100.00
Rk-22 light glass	57.84	1.05	17.82	5.98	0.22	2.44	5.29	5.09	3.44	0.39	0.00	0.40	0.06	0.03	100.00
Rk-22 light glass	57.81	0.85	18.54	5.69	0.19	2.28	5.83	5.26	2.99	0.42	0.00	0.31	0.00	0.00	100.00
Rk-22 light glass	58.32	0.96	17.33	6.26	0.25	2.37	5.12	4.98	3.43	0.54	0.05	0.33	0.00	0.03	100.00
Rk-22 light glass	58.03	0.88	17.95	6.04	0.10	2.34	5.36	5.21	3.09	0.60	0.00	0.30	0.00	0.12	100.00
Rk-22 light glass	56.61	0.98	15.97	6.59	0.13	3.93	7.07	4.63	2.92	0.65	0.01	0.26	0.11	0.15	100.00
Rk-22 light glass	56.61	1.12	16.10	7.57	0.19	4.75	4.40	5.01	3.43	0.64	0.00	0.19	0.01	0.00	100.00
Rk-14	63.83	0.67	16.64	3.93	0.09	1.31	3.29	4.95	4.60	0.19	0.09	0.41	0.08	0.00	100.00
Rk-14	67.62	0.50	16.24	2.52	0.16	0.64	2.32	5.13	4.62	0.00	0.00	0.34	0.00	0.04	100.00
Rk-14	68.54	0.59	15.44	2.28	0.13	0.65	1.79	5.01	4.95	0.22	0.00	0.45	0.00	0.04	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
Rk-13	62.13	0.83	16.69	4.84	0.19	1.86	3.94	4.59	4.29	0.35	0.01	0.37	0.00	0.00	100.00
Rk-13	63.01	0.83	16.78	4.01	0.02	1.45	3.46	5.04	4.23	0.49	0.00	0.36	0.07	0.27	100.00
Rk-13	61.73	0.85	16.85	4.70	0.06	1.80	4.17	4.81	4.09	0.36	0.00	0.41	0.06	0.08	100.00
Rk-13	64.28	0.67	16.54	3.86	0.12	1.27	3.07	5.05	4.49	0.19	0.04	0.43	0.00	0.00	100.00
Rk-13	61.44	0.82	16.87	4.59	0.26	1.89	4.27	5.02	3.94	0.33	0.17	0.42	0.03	0.00	100.00
Rk-12	68.46	0.62	16.19	1.64	0.12	0.30	1.45	4.88	5.90	0.00	0.00	0.30	0.00	0.23	100.00
Rk-12	65.10	0.78	16.64	3.26	0.11	1.14	2.73	5.19	4.49	0.15	0.02	0.33	0.01	0.03	100.00
Rk-12	65.11	0.61	16.74	3.35	0.19	1.09	2.81	5.20	4.56	0.27	0.00	0.32	0.00	0.00	100.00
Rk-12	66.56	0.81	14.69	5.17	0.07	1.35	4.05	4.61	2.17	0.15	0.14	0.27	0.05	0.00	100.00
Rk-12	66.15	0.76	14.57	5.35	0.05	1.50	4.44	4.32	2.05	0.38	0.00	0.27	0.00	0.17	100.00
Rk-20	66.57	0.56	16.42	2.57	0.19	0.97	2.56	4.67	4.60	0.44	0.07	0.32	0.00	0.02	100.00
Rk-20	65.51	0.54	16.99	2.95	0.16	0.99	3.18	4.84	4.28	0.41	0.00	0.36	0.00	0.00	100.00
Rk-20	68.09	0.39	16.14	2.22	0.07	0.71	2.17	5.11	4.45	0.13	0.02	0.37	0.00	0.17	100.00
Rk-20	67.45	0.46	16.06	2.92	0.17	0.63	2.25	5.09	4.58	0.12	0.09	0.31	0.00	0.00	100.00
Rk-20	67.82	0.47	16.24	2.29	0.22	0.57	2.13	5.13	4.65	0.01	0.17	0.40	0.00	0.00	100.00
Rk-20	66.96	0.46	16.16	2.91	0.02	0.83	2.26	5.13	4.66	0.11	0.00	0.39	0.01	0.14	100.00
Rk-18	66.84	0.51	16.43	2.70	0.13	0.81	2.52	5.10	4.42	0.17	0.11	0.28	0.00	0.03	100.00
Rk-18	61.80	0.79	17.89	5.12	0.14	1.09	4.00	5.16	3.52	0.17	0.00	0.27	0.04	0.01	100.00
Rk-17	64.83	0.43	17.48	2.81	0.17	1.15	3.61	5.17	4.02	0.19	0.00	0.23	0.07	0.00	100.00
Rk-17	64.00	0.55	18.53	2.47	0.04	0.82	3.88	5.31	4.00	0.16	0.00	0.26	0.00	0.11	100.00
Rk-17	63.27	0.50	19.03	2.47	0.20	0.59	4.58	5.13	3.79	0.04	0.01	0.27	0.00	0.16	100.00
Rk-17	66.13	0.77	15.44	3.62	0.19	1.51	2.25	4.65	4.90	0.10	0.07	0.31	0.04	0.00	100.00
Rk-17	65.13	0.58	17.43	2.51	0.13	0.97	3.17	5.54	4.13	0.14	0.01	0.32	0.00	0.00	100.00
Rk-17	61.81	0.63	18.71	3.05	0.10	1.46	5.29	5.08	3.27	0.19	0.22	0.24	0.00	0.00	100.00
Rk-17	63.33	0.41	19.14	2.19	0.11	0.49	4.51	5.62	3.58	0.11	0.00	0.37	0.00	0.21	100.00
Rk-17	64.51	0.50	18.14	2.63	0.09	0.81	3.74	5.27	3.80	0.30	0.00	0.24	0.00	0.03	100.00
Rk-17	63.12	0.53	15.86	4.09	0.22	2.78	4.58	4.40	3.89	0.34	0.00	0.20	0.10	0.00	100.00
Rk-16	63.83	0.62	15.95	4.10	0.22	1.96	3.80	4.55	4.35	0.45	0.01	0.24	0.00	0.00	100.00
Rk-16	64.62	0.64	17.15	3.32	0.15	1.21	3.35	4.83	4.20	0.32	0.00	0.28	0.00	0.00	100.00
Rk-16	64.37	0.66	16.77	3.70	0.16	1.24	3.21	5.17	4.13	0.29	0.00	0.32	0.06	0.00	100.00
Rk-16	64.08	0.64	17.81	3.11	0.12	0.93	3.73	5.22	3.98	0.32	0.00	0.26	0.00	0.00	100.00
Rk-16	60.01	1.05	17.70	6.94	0.22	0.90	3.73	5.07	3.57	0.42	0.07	0.26	0.00	0.04	100.00
Rk-16	63.66	0.61	16.32	3.91	0.12	2.16	3.87	4.78	3.98	0.29	0.00	0.29	0.00	0.12	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
Rk-16	64.14	0.80	16.64	4.40	0.17	1.24	2.96	4.85	4.36	0.30	0.00	0.37	0.00	0.00	100.00
Rk-16	64.08	0.53	17.68	3.31	0.05	1.06	3.79	5.05	4.00	0.23	0.00	0.20	0.05	0.00	100.00
Rk-16	62.80	0.60	18.28	3.10	0.20	0.92	4.39	5.40	3.72	0.34	0.00	0.32	0.00	0.00	100.00
Rk-16	63.42	0.54	15.95	4.42	0.09	2.50	3.39	4.73	3.98	0.49	0.00	0.22	0.03	0.25	100.00
Rk-16	65.14	0.70	16.33	3.21	0.27	0.91	3.00	5.00	4.62	0.42	0.06	0.38	0.00	0.00	100.00
Rk-21	61.93	0.64	19.78	2.60	0.16	0.66	5.55	5.08	3.03	0.26	0.00	0.28	0.03	0.01	100.00
Rk-21	56.65	1.07	17.92	6.42	0.13	2.03	6.89	4.56	3.27	0.69	0.02	0.29	0.05	0.00	100.00
Rk-21	55.99	0.71	20.19	4.85	0.27	1.81	8.17	4.83	2.37	0.52	0.00	0.21	0.07	0.03	100.00
Rk-21	55.98	0.59	22.43	3.63	0.14	1.20	8.74	4.61	2.15	0.32	0.05	0.17	0.00	0.00	100.00
Rk-21	55.99	0.61	18.16	6.30	0.26	3.40	7.18	4.58	2.73	0.53	0.07	0.23	0.00	0.00	100.00
Rk-21	54.71	0.45	20.79	6.05	0.14	3.05	8.18	4.29	2.12	0.19	0.00	0.15	0.00	0.00	100.00
Rk-21	56.07	0.74	21.53	3.97	0.16	1.46	8.59	4.56	2.36	0.34	0.00	0.20	0.09	0.00	100.00
Rk-21	50.75	0.46	21.25	6.37	0.27	6.85	8.77	3.42	1.32	0.19	0.00	0.16	0.07	0.17	100.00
Rk-21	56.99	1.03	16.13	5.99	0.12	3.30	8.03	4.23	3.22	0.53	0.00	0.30	0.04	0.07	100.00
ES-4	62.33	0.82	14.77	4.27	0.16	3.18	6.02	4.15	3.75	0.34	0.00	0.18	0.03	0.00	100.00
ES-4	63.72	0.72	13.92	3.99	0.10	3.36	5.28	4.17	3.86	0.40	0.17	0.30	0.01	0.00	100.00
ES-4	62.51	0.83	15.74	3.59	0.25	2.43	6.01	4.37	3.63	0.33	0.02	0.27	0.00	0.00	100.00
ES-4	64.14	0.50	18.62	2.29	0.18	0.68	4.26	4.96	3.82	0.18	0.00	0.26	0.10	0.00	100.00
ES-4	63.75	0.61	18.11	2.65	0.26	0.85	4.30	4.98	3.71	0.39	0.08	0.31	0.00	0.00	100.00
ES-5	69.76	0.49	15.10	1.90	0.18	0.51	1.53	4.95	4.87	0.28	0.00	0.42	0.00	0.00	100.00
ES-5	69.80	0.51	15.04	1.81	0.14	0.48	1.58	4.94	4.83	0.31	0.00	0.42	0.04	0.10	100.00
ES-5	70.02	0.41	15.53	1.69	0.21	0.49	1.44	4.75	4.84	0.23	0.00	0.31	0.07	0.01	100.00
ES-5	70.44	0.51	15.11	1.99	0.03	0.35	1.50	4.84	4.85	0.01	0.02	0.36	0.00	0.00	100.00
ES-5	69.50	0.40	15.07	1.86	0.22	0.43	1.68	5.16	4.81	0.23	0.00	0.37	0.08	0.18	100.00
ES-5	70.35	0.48	15.01	1.78	0.03	0.44	1.53	4.80	4.91	0.13	0.10	0.43	0.00	0.01	100.00
ES-5	68.45	0.55	16.91	1.67	0.05	0.27	2.46	4.91	4.32	0.06	0.00	0.31	0.00	0.00	100.00
ES-5	70.26	0.45	15.08	1.75	0.12	0.50	1.41	5.06	4.84	0.16	0.00	0.36	0.00	0.00	100.00
ES-5	70.19	0.58	15.27	1.84	0.17	0.39	1.47	4.77	4.75	0.15	0.00	0.36	0.00	0.06	100.00
ES-7	58.37	0.84	16.11	4.84	0.22	3.42	8.55	4.01	2.87	0.33	0.09	0.28	0.01	0.05	100.00
ES-7	68.10	0.65	15.81	2.31	0.11	0.53	1.78	4.98	5.20	0.21	0.00	0.35	0.00	0.00	100.00
ES-7	68.14	0.70	15.63	2.26	0.06	0.54	1.80	4.99	5.15	0.33	0.08	0.31	0.02	0.00	100.00
ES-7	68.34	0.68	15.74	2.25	0.18	0.62	1.76	4.73	5.09	0.13	0.06	0.29	0.04	0.09	100.00
ES-7	68.08	0.55	15.95	2.32	0.08	0.65	1.78	4.92	5.13	0.12	0.00	0.34	0.06	0.03	100.00
ES-7	68.84	0.61	15.76	2.20	0.18	0.66	1.80	4.20	5.09	0.14	0.00	0.33	0.00	0.19	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
ES-8	67.59	0.56	15.74	2.26	0.21	0.56	1.88	5.27	4.86	0.37	0.17	0.51	0.00	0.00	100.00
ES-10	67.87	0.63	15.52	2.53	0.19	0.75	2.01	4.90	4.86	0.21	0.12	0.41	0.00	0.00	100.00
ES-10	65.92	0.66	15.17	2.51	0.10	0.68	3.15	4.91	4.64	1.66	0.00	0.28	0.06	0.25	100.00
ES-10	67.92	0.57	15.58	2.63	0.18	0.68	2.03	5.05	4.85	0.25	0.00	0.23	0.03	0.00	100.00
ES-10	67.76	0.61	15.51	2.98	0.15	0.80	1.97	4.98	4.83	0.14	0.00	0.26	0.00	0.00	100.00
ES-10	63.90	0.88	15.64	3.97	0.14	1.82	3.88	4.54	4.16	0.44	0.06	0.36	0.08	0.11	100.00
ES-10	67.65	0.69	15.59	2.61	0.17	0.74	2.03	5.03	4.89	0.21	0.04	0.32	0.05	0.00	100.00
ES-10	68.33	0.58	15.45	2.79	0.01	0.61	2.09	4.61	4.81	0.30	0.00	0.39	0.03	0.00	100.00
U05-91	64.06	0.66	16.75	3.36	0.00	1.15	2.64	5.58	4.51	0.45	0.16	0.54	0.00	0.16	100.00
U05-91	64.28	0.59	16.80	3.37	0.15	1.17	2.63	5.54	4.45	0.28	0.02	0.49	0.21	0.01	100.00
U05-91	64.20	0.75	16.74	3.33	0.10	1.15	2.54	5.77	4.54	0.24	0.07	0.47	0.00	0.07	100.00
U05-91	64.30	0.84	16.68	3.24	0.13	1.11	2.69	5.57	4.49	0.37	0.00	0.54	0.00	0.02	100.00
U05-91	64.36	0.68	16.54	3.51	0.00	1.17	2.82	5.46	4.56	0.35	0.00	0.44	0.11	0.00	100.00
U05-91	64.46	0.79	16.93	3.32	0.14	1.03	2.57	5.45	4.40	0.35	0.11	0.43	0.00	0.00	100.00
U05-91	63.98	0.73	17.37	3.07	0.20	0.98	3.16	5.57	4.15	0.38	0.00	0.37	0.05	0.00	100.00
U05-91	64.21	0.72	16.45	3.49	0.19	1.16	2.63	5.50	4.50	0.56	0.06	0.50	0.00	0.00	100.00
U05-91	64.62	0.70	16.74	3.27	0.14	1.17	2.60	5.58	4.45	0.26	0.08	0.39	0.00	0.00	100.00
U05-91	64.12	0.68	16.91	3.44	0.21	1.12	2.66	5.19	4.51	0.32	0.13	0.49	0.00	0.23	100.00
U05-91	64.54	0.83	17.12	3.11	0.18	1.01	2.58	5.36	4.41	0.38	0.00	0.37	0.02	0.08	100.00
U05-7	65.03	0.59	17.69	2.46	0.11	0.72	3.29	5.02	4.33	0.38	0.00	0.20	0.05	0.14	100.00
U05-7	66.72	0.40	16.78	2.25	0.17	0.74	2.61	5.19	4.79	0.13	0.12	0.08	0.00	0.00	100.00
U05-7	65.08	0.59	17.15	2.99	0.08	0.88	3.01	5.28	4.11	0.35	0.07	0.31	0.07	0.03	100.00
U05-7	65.12	0.75	16.74	3.12	0.12	1.10	3.01	5.02	4.36	0.33	0.00	0.31	0.03	0.00	100.00
U05-7	65.50	0.57	16.68	2.97	0.00	1.00	2.94	5.13	4.43	0.25	0.00	0.35	0.08	0.08	100.00
U05-7	65.35	0.56	16.89	2.98	0.20	0.86	3.02	5.24	4.27	0.20	0.05	0.31	0.00	0.06	100.00
U05-7	63.65	0.54	18.75	2.66	0.08	0.77	4.39	5.08	3.54	0.11	0.00	0.28	0.14	0.01	100.00
U05-7	63.81	0.33	19.12	1.97	0.17	0.72	3.95	5.51	3.82	0.37	0.00	0.23	0.00	0.00	100.00
U05-8	55.51	1.03	19.67	5.55	0.02	2.19	7.81	4.68	2.85	0.50	0.00	0.20	0.00	0.00	100.00
U05-8	54.36	1.01	17.24	7.27	0.24	4.86	7.23	4.15	2.81	0.40	0.00	0.26	0.07	0.10	100.00
U05-20	70.73	0.28	16.12	1.01	0.18	0.25	1.38	4.77	4.79	0.00	0.07	0.24	0.00	0.20	100.00
U05-20	72.10	0.36	14.92	1.05	0.06	0.09	1.36	4.95	4.83	0.11	0.05	0.12	0.00	0.00	100.00
U05-20	70.80	0.20	16.02	0.96	0.16	0.27	1.68	5.13	4.45	0.06	0.00	0.21	0.05	0.00	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
U05-20	71.74	0.59	13.99	2.18	0.22	0.24	1.27	4.36	5.15	0.00	0.00	0.15	0.00	0.11	100.00
U05-20	71.76	0.50	14.71	1.17	0.07	0.24	1.00	4.84	5.38	0.20	0.00	0.11	0.00	0.00	100.00
U05-20	71.04	0.34	15.52	0.88	0.15	0.00	1.88	4.94	4.66	0.20	0.14	0.13	0.00	0.10	100.00
U05-20	70.38	0.29	16.02	1.12	0.21	0.13	1.92	5.29	4.24	0.16	0.01	0.14	0.07	0.02	100.00
U05-20	70.13	0.39	15.61	1.37	0.08	0.45	2.05	5.19	4.30	0.30	0.00	0.13	0.00	0.00	100.00
U05-20	72.82	0.35	13.98	1.29	0.18	0.13	0.97	4.26	5.44	0.16	0.03	0.10	0.00	0.27	100.00
U05-20	74.06	0.41	13.41	1.14	0.15	0.19	0.76	4.16	5.38	0.00	0.07	0.19	0.08	0.00	100.00
U05-32	67.01	0.40	17.25	1.87	0.14	0.35	3.31	5.31	3.77	0.17	0.00	0.35	0.06	0.00	100.00
U05-32	64.67	0.49	13.43	2.39	0.24	1.86	5.78	4.40	3.97	2.17	0.01	0.40	0.12	0.05	100.00
U05-33	67.35	0.57	16.07	2.75	0.09	0.66	2.29	5.24	4.38	0.04	0.16	0.37	0.00	0.00	100.00
U05-33	68.24	0.63	15.65	2.53	0.11	0.65	2.29	5.01	4.28	0.13	0.09	0.39	0.00	0.00	100.00
U05-33	67.35	0.67	16.22	2.29	0.23	0.58	2.21	5.01	4.89	0.08	0.08	0.38	0.00	0.01	100.00
U05-33	67.41	0.65	16.14	2.39	0.15	0.75	2.20	5.10	4.54	0.26	0.01	0.32	0.00	0.08	100.00
U05-33	66.95	0.64	16.11	2.62	0.08	0.82	2.46	5.10	4.48	0.15	0.04	0.42	0.01	0.11	100.00
U05-33	68.60	0.61	16.02	1.96	0.00	0.42	1.76	5.04	4.74	0.17	0.00	0.26	0.13	0.28	100.00
U05-33	67.64	0.57	15.83	2.51	0.11	0.78	2.27	5.14	4.39	0.27	0.12	0.38	0.00	0.00	100.00
U05-33	75.93	0.14	13.11	0.72	0.00	0.07	0.69	3.85	5.19	0.02	0.12	0.11	0.00	0.04	100.00
U05-36	71.41	0.69	14.07	1.62	0.02	0.53	1.05	4.45	5.82	0.08	0.09	0.07	0.01	0.06	100.00
U05-36	68.77	0.28	12.42	3.66	0.33	3.59	1.66	3.41	4.87	0.87	0.00	0.12	0.00	0.02	100.00
U05-36	70.07	0.37	15.71	1.31	0.10	0.30	1.52	4.80	5.41	0.00	0.06	0.25	0.00	0.09	100.00
U05-36	68.36	0.18	17.33	1.20	0.08	0.32	2.53	5.17	4.67	0.04	0.00	0.12	0.00	0.00	100.00
U05-36	70.02	0.35	15.86	1.09	0.02	0.44	1.10	4.94	5.84	0.15	0.05	0.09	0.00	0.04	100.00
U05-36	72.86	0.20	12.66	1.79	0.19	1.39	0.90	3.94	5.68	0.09	0.15	0.10	0.00	0.04	100.00
U05-36	71.40	0.28	15.10	1.07	0.08	0.33	1.01	4.60	5.99	0.07	0.00	0.05	0.01	0.00	100.00
U05-36	71.17	0.48	14.73	1.31	0.19	0.33	1.67	4.52	5.35	0.15	0.00	0.00	0.04	0.05	100.00
U05-36	70.51	0.43	15.86	1.02	0.00	0.07	1.68	4.68	5.56	0.00	0.00	0.13	0.00	0.05	100.00
U05-36	70.12	0.32	16.33	0.64	0.00	0.06	1.17	4.95	6.20	0.00	0.00	0.18	0.03	0.01	100.00
U05-36	70.63	0.52	14.83	1.61	0.12	0.28	1.25	4.74	5.52	0.23	0.00	0.24	0.00	0.03	100.00
U05-48	70.63	0.52	14.83	1.61	0.12	0.28	1.25	4.74	5.52	0.23	0.00	0.24	0.00	0.03	100.00
U05-48	68.55	0.49	16.75	1.22	0.10	0.22	2.50	5.12	4.64	0.02	0.10	0.17	0.00	0.10	100.00
U05-48	70.03	0.52	15.02	1.88	0.09	0.50	1.62	4.37	5.61	0.13	0.00	0.21	0.00	0.00	100.00
U05-48	70.27	0.43	15.17	1.63	0.00	0.32	1.55	4.84	5.40	0.07	0.00	0.19	0.00	0.12	100.00
U05-48	70.35	0.52	14.65	1.92	0.11	0.80	1.21	4.60	5.61	0.08	0.00	0.13	0.00	0.00	100.00
U05-48	69.30	0.47	15.54	1.37	0.07	0.08	2.11	4.89	5.23	0.46	0.00	0.20	0.09	0.19	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
U05-48	70.66	0.57	14.00	2.42	0.09	0.78	1.10	4.26	5.60	0.15	0.00	0.30	0.04	0.02	100.00
U05-56	64.13	0.68	16.03	3.85	0.13	1.67	3.62	4.84	4.19	0.36	0.00	0.36	0.00	0.13	100.00
U05-56	62.00	0.59	18.77	3.36	0.11	1.14	5.12	4.47	3.61	0.45	0.00	0.26	0.12	0.00	100.00
U05-56	69.80	0.89	13.77	2.80	0.03	2.09	1.33	3.90	4.78	0.30	0.09	0.19	0.00	0.03	100.00
U05-56	64.39	0.39	17.43	2.25	0.18	2.49	2.25	6.26	3.72	0.23	0.12	0.14	0.06	0.09	100.00
U05-56	61.59	0.62	17.91	3.12	0.19	1.95	6.71	4.60	2.77	0.29	0.00	0.18	0.00	0.04	100.00
U05-63	69.70	0.47	15.54	1.89	0.02	0.45	1.44	4.95	5.14	0.00	0.00	0.29	0.00	0.07	100.00
U05-63	70.28	0.55	14.82	1.78	0.10	0.41	1.30	4.68	5.33	0.31	0.02	0.28	0.01	0.11	100.00
U05-63	70.96	0.21	15.87	1.25	0.05	0.00	1.67	4.69	5.12	0.09	0.01	0.08	0.00	0.00	100.00
U05-63	69.50	0.22	17.63	0.31	0.06	0.00	1.39	6.25	4.41	0.00	0.06	0.01	0.00	0.17	100.00
U05-63	68.77	0.76	16.24	0.95	0.06	0.03	1.33	3.97	7.51	0.32	0.00	0.03	0.00	0.02	100.00
U05-69	70.36	0.68	14.96	1.65	0.11	0.51	1.31	4.70	5.23	0.00	0.00	0.44	0.00	0.03	100.00
U05-69	69.29	0.59	15.37	1.77	0.26	0.41	1.63	5.07	5.02	0.28	0.00	0.31	0.00	0.00	100.00
U05-69	68.55	0.73	16.28	1.60	0.08	0.37	1.97	5.12	4.78	0.17	0.00	0.29	0.04	0.00	100.00
U05-71	68.92	0.57	15.51	2.19	0.09	0.55	1.89	5.04	4.70	0.15	0.00	0.36	0.04	0.00	100.00
U05-71	68.65	0.48	15.47	2.54	0.13	0.68	1.78	5.11	4.57	0.19	0.00	0.36	0.00	0.03	100.00
U05-71	67.93	0.67	15.95	2.17	0.23	0.68	2.24	5.08	4.47	0.22	0.00	0.31	0.00	0.09	100.00
U05-71	68.57	0.52	16.15	2.21	0.23	0.53	2.25	4.67	4.46	0.00	0.00	0.33	0.00	0.06	100.00
U05-71	68.03	0.55	15.86	2.22	0.16	0.69	2.33	5.05	4.39	0.18	0.00	0.37	0.11	0.07	100.00
U05-71	68.49	0.57	15.53	2.54	0.19	0.63	1.93	4.91	4.69	0.08	0.00	0.36	0.06	0.00	100.00
U05-71	68.36	0.51	15.47	2.43	0.15	0.71	1.95	5.12	4.68	0.11	0.04	0.47	0.00	0.00	100.00
U05-71	67.86	0.45	16.46	2.11	0.19	0.64	2.41	4.74	4.41	0.27	0.11	0.34	0.00	0.00	100.00
U05-88	65.88	0.68	16.47	3.22	0.22	0.91	2.49	5.44	4.30	0.02	0.00	0.38	0.00	0.00	100.00
U05-88	62.17	0.43	19.99	2.50	0.06	0.72	5.02	5.75	2.76	0.21	0.00	0.30	0.10	0.00	100.00
U05-88	62.35	0.64	18.00	3.46	0.09	1.51	4.81	5.16	3.27	0.34	0.02	0.29	0.03	0.04	100.00
U05-88	64.15	0.72	16.47	3.44	0.05	1.25	3.58	5.27	4.08	0.64	0.00	0.35	0.00	0.00	100.00
U05-88	61.25	0.63	19.77	2.76	0.20	1.00	5.81	4.84	2.95	0.28	0.09	0.24	0.00	0.17	100.00
U05-88	61.05	0.49	20.16	2.81	0.05	1.01	5.75	5.31	2.73	0.19	0.04	0.30	0.00	0.11	100.00
U05-88	64.51	0.56	15.52	3.58	0.06	2.10	4.02	5.00	4.00	0.25	0.00	0.35	0.00	0.05	100.00
U05-88	65.20	0.71	16.63	3.24	0.08	1.11	2.62	5.30	4.36	0.30	0.11	0.33	0.01	0.00	100.00
U05-86	66.16	0.78	16.79	2.60	0.18	0.71	2.53	5.24	4.46	0.08	0.09	0.36	0.00	0.00	100.00
U05-86	66.17	0.55	16.44	3.04	0.15	0.93	2.39	5.18	4.44	0.29	0.00	0.34	0.00	0.08	100.00

Sample	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Cr2O3	NiO	TOTAL
U05-86	66.07	0.76	16.30	2.94	0.23	0.80	2.47	5.20	4.52	0.28	0.00	0.39	0.04	0.01	100.00
U05-86	66.30	0.84	16.35	2.98	0.12	0.96	2.32	4.89	4.51	0.15	0.00	0.41	0.13	0.04	100.00
U05-86	65.90	0.59	16.20	3.05	0.02	0.87	2.26	5.43	4.57	0.33	0.18	0.47	0.07	0.04	100.00
M05-80	66.32	0.59	15.07	3.40	0.24	2.48	1.98	5.09	4.54	0.14	0.00	0.25	0.00	0.00	100.00
M05-80	67.65	0.69	15.89	2.46	0.13	0.79	1.96	4.90	4.98	0.27	0.06	0.31	0.00	0.00	100.00
M05-80	67.22	0.72	15.80	2.76	0.10	0.71	1.98	5.07	4.78	0.38	0.04	0.28	0.06	0.10	100.00
M05-80	66.93	0.72	15.81	2.63	0.12	0.87	2.02	5.15	4.90	0.40	0.13	0.27	0.00	0.15	100.00
M05-80	66.86	0.68	15.95	2.83	0.00	0.73	1.87	5.11	5.02	0.42	0.20	0.25	0.10	0.00	100.00
M05-80	66.98	0.59	15.74	2.69	0.20	0.81	2.00	5.23	4.96	0.43	0.09	0.34	0.00	0.00	100.00
M05-80	67.12	0.52	15.84	2.97	0.14	1.40	1.92	4.60	4.83	0.29	0.00	0.27	0.01	0.17	100.00
M05-80	67.03	0.74	15.54	2.95	0.16	0.81	2.03	5.09	5.19	0.18	0.00	0.29	0.03	0.00	100.00
M05-80 dk	66.81	0.79	15.73	2.93	0.16	0.74	1.98	5.04	4.88	0.29	0.15	0.34	0.06	0.09	100.00
M05-80 dk	66.31	0.77	15.65	3.17	0.16	1.25	2.52	4.81	4.80	0.37	0.06	0.31	0.00	0.00	100.00
M05-80 dk	67.29	0.65	15.91	2.52	0.04	0.74	2.09	5.18	5.02	0.15	0.00	0.30	0.07	0.05	100.00
M05-80 dk	66.77	0.55	15.59	2.85	0.23	1.11	2.09	4.91	4.94	0.30	0.05	0.34	0.08	0.19	100.00
M05-80 dk	66.75	0.86	15.98	2.70	0.03	0.84	2.05	5.07	4.95	0.45	0.00	0.29	0.00	0.18	100.00
M05-80 dk	66.83	0.61	15.77	3.02	0.19	0.82	2.07	5.25	4.93	0.25	0.00	0.29	0.11	0.00	100.00
M05-80 dk	65.11	0.58	17.98	2.38	0.03	0.67	3.44	5.50	4.07	0.08	0.01	0.17	0.00	0.02	100.00
M05-80 dk	67.09	0.71	15.80	2.71	0.22	0.80	2.03	5.23	5.09	0.24	0.00	0.33	0.00	0.00	100.00
M05-80 dk	66.46	0.78	15.94	2.91	0.15	0.85	2.13	5.30	4.97	0.45	0.00	0.26	0.00	0.00	100.00
M05-80 dk	66.83	0.77	15.75	2.72	0.14	0.87	2.07	5.09	4.80	0.33	0.18	0.34	0.14	0.00	100.00
M05-80 dk	67.33	0.60	15.60	3.02	0.20	0.76	2.06	4.89	5.00	0.39	0.00	0.27	0.00	0.00	100.00

Titanomagnetite:

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-79	0.16	9.49	3.44	34.60	48.63	0.65	3.38	0	0.05	0.06	0.04	0	0	0.51	0	0.21	101.22
E02-79	0	9.71	3.38	34.79	46.70	0.64	3.2	0	0	0	0.08	0	0.07	0.59	0	0	99.15
E02-79	0.07	9.75	3.55	35.13	47.85	0.65	3.31	0.03	0	0.07	0.12	0.08	0	0.53	0	0	101.13
E02-79	0.07	9.29	3.54	34.41	48.77	0.62	3.53	0	0.01	0	0	0	0	0.5	0	0.18	100.92
E02-79	0.16	9.59	3.61	35.59	48.52	0.6	3.17	0.06	0	0.08	0	0.01	0.08	0.55	0	0.04	102.06
E02-79	0.2	9.47	3.51	34.65	48.28	0.49	3.19	0.04	0.16	0	0	0	0	0.44	0	0.11	100.54
E02-79	0.15	6.5	5.27	32.36	51.59	0.4	3.42	0.05	0.01	0.04	0	0	0.05	0.57	0	0.12	100.53
E02-79	0.13	6.46	5.17	32.64	51.24	0.29	3.3	0.07	0	0	0.12	0	0.06	0.59	0	0	100.07
E02-79	0	9.33	3.53	35.00	48.49	0.5	3.19	0	0	0.03	0.11	0.08	0.06	0.51	0	0.03	100.86
E02-79	0.09	9.57	3.48	35.43	47.56	0.48	3.01	0.05	0	0	0.09	0.04	0	0.48	0	0.17	100.46
E02-79	0.05	9.28	3.48	34.07	49.16	0.49	3.27	0.1	0.14	0	0.11	0	0.02	0.44	0	0.27	100.88
E02-79	0.05	9.27	3.48	34.04	49.14	0.49	3.27	0.1	0.14	0	0.11	0	0.02	0.43	0	0.27	100.80
E02-79	0.04	6.44	5.17	32.63	52.02	0.33	3.2	0	0.01	0.02	0	0	0	0.53	0	0.19	100.58
E02-79	0.04	6.44	5.17	32.61	51.99	0.33	3.2	0	0.01	0.02	0	0	0	0.53	0	0.19	100.54
E02-79	0	6.54	5.27	32.01	51.96	0.34	3.43	0	0.11	0	0	0.06	0.01	0.6	0	0.04	100.37
E02-98	0.15	7.09	6.29	31.96	49.28	0.23	4.3	0.05	0	0.04	0	0.16	0	0.74	0	0	100.29
E02-98	0.11	7.21	6.17	31.58	50.91	0.34	4.4	0.1	0.14	0	0	0	0	0.47	0	0	101.44
E02-98	0.05	7.65	5.87	32.36	50.09	0.24	3.99	0.02	0.16	0.02	0	0	0	0.61	0	0.11	101.16
E02-98	0.13	7.5	5.75	32.69	50.02	0.39	4.16	0.04	0	0	0	0.1	0.05	0.4	0	0	101.24
E02-98	0.24	7.55	5.6	32.54	48.39	0.21	4.02	0.05	0	0	0	0	0.01	0.46	0	0.11	99.18
E02-98	0.08	7.2	6.36	32.29	49.68	0.15	4.26	0.03	0	0	0.04	0.09	0.02	0.58	0	0.19	100.97
E02-98	0.08	7.2	6.08	31.71	50.92	0.35	4.37	0.07	0.09	0.04	0	0.01	0	0.58	0	0	101.50
E02-98	0.12	7.26	5.71	32.12	50.25	0.24	4.34	0.04	0	0.02	0.05	0	0.04	0.51	0	0	100.70
E02-98	0	7.58	5.6	32.08	50.12	0.35	4.28	0	0	0.09	0.2	0.16	0	0.57	0	0	101.03
E02-98	0.16	7.41	5.9	31.98	49.70	0.55	4.28	0.01	0.05	0	0	0	0.01	0.52	0	0.01	100.58
E02-98	0.1	6.96	5.96	31.56	49.82	0.48	4.27	0.02	0	0	0	0	0	0.49	0.15	0	99.80
E02-95	0.04	7.12	5.3	32.66	50.01	0.47	3.51	0	0	0	0.09	0.01	0.01	0.56	0	0.01	99.79
E02-95	0	7.28	5.46	33.26	50.20	0.41	3.42	0.01	0	0	0	0	0	0.53	0	0	100.57
E02-95	0	7.28	5.46	33.26	50.20	0.41	3.42	0.01	0	0	0	0	0	0.53	0	0	100.57
E02-95	0.12	7.11	5.39	33.04	50.41	0.29	3.45	0	0	0.06	0.09	0	0.08	0.66	0	0.17	100.87
E02-95	0.02	6.84	5.44	32.11	50.84	0.33	3.61	0.14	0.06	0	0	0	0	0.72	0	0	100.11
E02-95	0.04	6.59	5	32.76	51.54	0.19	3.2	0.01	0.01	0.02	0	0.04	0	0.55	0	0.13	100.08
E02-95	0.14	7.14	5.42	32.96	50.25	0.48	3.39	0.06	0	0.03	0	0.15	0.04	0.43	0	0.14	100.62
E02-95	0.1	7.29	5.16	33.21	50.02	0.37	3.16	0.11	0.01	0.03	0	0	0.05	0.5	0	0.21	100.22
E02-95	0.13	6.98	5.36	33.23	50.33	0.39	3.27	0.11	0	0	0	0	0.05	0.55	0.16	0.03	100.59

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-95	0.12	7.09	5.17	33.32	50.47	0.25	3.23	0	0	0.03	0.01	0.01	0	0.43	0	0.16	100.28
E02-95	0.1	6.79	5.07	32.57	51.09	0.39	3.5	0.06	0	0	0.06	0	0	0.63	0	0.04	100.30
E02-95	0.22	7.74	1.72	33.95	52.79	1.65	1.94	0.06	0.05	0	0	0	0	0.32	0	0.12	100.56
E02-78p	0.06	9.47	3.49	34.14	48.55	0.63	3.5	0.02	0.11	0	0	0.04	0.08	0.41	0	0	100.50
E02-78p	0.04	9.07	3.95	33.94	48.75	0.54	3.84	0	0	0	0.05	0	0.05	0.42	0	0	100.65
E02-78p	0.05	8.97	4.08	33.58	48.93	0.52	4	0.06	0.01	0	0	0.15	0	0.51	0	0.02	100.87
E02-78p	0.14	9.05	4.31	32.70	49.00	0.44	4.2	0	0.22	0	0.09	0.15	0.08	0.52	0	0.04	100.93
E02-78p	0.01	8.79	3.97	32.02	50.80	0.59	4.35	0	0.23	0	0	0.02	0.05	0.45	0	0	101.29
E02-78p	0.04	9.08	3.93	33.36	48.66	0.62	3.89	0.06	0.01	0.02	0	0	0	0.41	0	0.16	100.24
E02-78p	0.07	8.98	4	33.24	49.42	0.47	3.9	0.06	0.11	0	0	0	0.1	0.6	0	0.29	101.25
E02-78p	0.06	8.64	4.23	33.11	49.31	0.49	4.01	0.07	0	0	0.06	0	0	0.43	0	0.22	100.64
E02-78p	0.07	8.96	4.02	33.46	48.89	0.56	4.03	0.05	0.01	0	0	0.04	0	0.45	0	0	100.53
E02-78p	0.02	8.85	3.93	32.73	49.96	0.52	4.24	0	0.09	0.03	0	0	0.01	0.48	0	0	100.86
E02-78p	0.17	9.1	2.97	35.42	48.95	0.74	2.79	0.01	0	0	0	0.03	0.06	0.58	0	0.02	100.83
E02-78p	0.14	9.12	2.99	34.98	48.73	0.66	2.63	0	0.07	0.07	0	0.02	0.04	0.5	0	0	99.95
E02-89	0	6.58	2.78	33.06	54.38	0.61	2.52	0.08	0	0.05	0	0.02	0.04	0.41	0	0	100.53
E02-89	0.05	6.53	2.72	33.09	53.85	0.74	2.34	0.04	0	0.04	0	0	0	0.43	0	0	99.83
E02-89	0.05	6.58	3.12	33.15	53.14	0.65	2.39	0	0	0.05	0	0.05	0	0.41	0	0	99.59
E02-89	0.1	6.59	2.88	33.60	54.10	0.66	2.48	0	0	0	0.09	0.02	0	0.46	0	0	100.98
E02-89	0.1	6.62	2.63	32.83	53.46	0.71	2.44	0.09	0.01	0.04	0.05	0	0	0.36	0	0	99.34
E02-89	0.12	6.62	2.84	33.52	54.03	0.74	2.37	0.04	0.01	0.02	0	0.05	0	0.36	0	0	100.72
E02-89	0	6.6	2.8	33.13	53.92	0.65	2.58	0	0	0	0	0	0.04	0.39	0.19	0	100.30
E02-89	0.07	6.48	2.93	32.84	54.17	0.74	2.65	0.01	0	0.03	0	0	0	0.38	0	0	100.30
E02-89	0.04	6.59	2.73	33.11	53.72	0.65	2.32	0.02	0.05	0	0.06	0	0.07	0.4	0	0.02	99.77
E02-89	0.07	6.53	2.88	33.00	53.73	0.67	2.52	0	0.01	0	0	0	0.03	0.51	0	0.14	100.09
E02-89	0.14	6.54	2.96	32.69	52.83	0.68	2.24	0.12	0.11	0	0	0	0	0.43	0	0	98.74
E02-99	0.12	7.39	1.6	35.29	53.85	1.25	1.42	0	0	0	0.08	0.02	0.04	0.3	0	0	101.36
E02-99	0.06	7.67	1.7	33.65	52.84	1.56	1.85	0	0	0.03	0	0	0.08	0.27	0	0.42	100.13
E02-99	0.01	7.48	1.63	33.13	53.31	1.71	1.69	0.04	0.14	0	0.02	0	0	0.25	0	0	99.41
E02-99	0.1	7.7	1.72	33.30	53.18	1.67	1.97	0	0.13	0	0	0.06	0	0.3	0	0.12	100.25
E02-99	0	7.17	1.65	33.81	54.59	1.56	1.67	0.03	0.07	0	0	0	0.04	0.4	0	0	100.99
E02-99	0	7.68	1.57	34.41	52.99	1.38	1.73	0	0	0	0	0	0.01	0.27	0	0	100.04
E02-99	0.13	7.77	1.85	34.35	52.53	1.51	1.68	0	0.07	0.03	0	0	0	0.34	0	0	100.26
E02-99	0	7.75	1.64	34.16	52.82	1.65	1.74	0	0	0	0	0.08	0	0.17	0	0.01	100.02
E02-99	0.1	7.75	1.71	34.29	53.32	1.28	1.81	0	0.11	0.02	0	0	0.08	0.37	0	0.03	100.87
E02-99	0.11	7.76	1.8	33.91	52.29	1.23	1.91	0.08	0.08	0	0	0.09	0.07	0.22	0	0	99.55
E02-100	0.18	7.64	1.98	34.99	52.21	1.03	1.57	0	0.01	0.05	0	0	0.06	0.27	0	0.11	100.10
E02-100	0.09	7.27	1.98	33.79	53.40	1.08	1.78	0	0.13	0.01	0	0.08	0.04	0.28	0	0	99.92

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-100	0.41	7.39	2.11	34.61	51.53	1.1	1.71	0.11	0	0	0	0	0.1	0.18	0	0.12	99.37
E02-100	0.15	7.72	1.93	34.55	52.31	1.26	1.68	0	0.07	0	0	0	0	0.37	0	0.1	100.14
E02-100	0.08	7.32	1.89	33.91	53.33	1.31	1.7	0	0.05	0.04	0.04	0	0	0.32	0	0.14	100.13
E02-100	0.08	7.51	2.33	34.36	53.03	1.17	1.96	0.04	0	0.05	0	0.12	0	0.39	0	0.11	101.16
E02-100	0.15	7.58	1.93	34.67	52.44	1.03	1.87	0.01	0	0	0	0	0	0.23	0	0	99.91
E02-100	0.14	7.53	1.87	34.57	52.32	1.07	1.54	0.14	0	0	0	0	0.01	0.17	0	0.25	99.61
E02-100	0.1	7.12	2.01	34.03	52.64	0.94	1.78	0.09	0	0	0	0.02	0	0.25	0	0	98.97
E02-100	0.02	7.48	1.94	34.19	52.15	1.11	1.67	0.01	0.01	0.02	0.13	0	0	0.28	0	0.03	99.05
M04-59	0.15	8.82	3.27	33.80	49.85	0.73	3.17	0.01	0.13	0	0	0.02	0	0.53	0.03	0.28	100.79
M04-59	0.15	8.1	3.05	33.79	49.49	0.71	2.83	0.02	0	0	0	0	0.03	0.41	0.08	0	98.66
M04-59	0.37	7.83	2.94	33.15	51.23	0.97	2.96	0	0.11	0.06	0.03	0.09	0	0.35	0.04	0	100.13
M04-59	0.04	6.74	3.05	33.27	52.87	0.54	2.52	0.02	0	0	0	0	0.05	0.32	0.06	0	99.49
M04-59	0.42	6.81	3.3	32.71	52.55	0.98	2.58	0.14	0.09	0.1	0.04	0	0.02	0.41	0.11	0.09	100.35
M04-59	0.17	9.15	3.25	33.32	50.75	0.72	3.3	0	0.33	0.06	0.16	0	0.02	0.5	0	0.16	101.89
M04-59	0.17	8.5	2.85	33.32	49.49	0.83	2.94	0.13	0.09	0.03	0.16	0.14	0.06	0.37	0.11	0	99.19
M04-59	0.13	7.98	2.55	33.50	52.42	1.03	2.8	0.09	0.07	0.03	0.01	0.02	0	0.45	0.04	0.12	101.23
M04-59	0.12	7.69	2.74	33.63	51.15	0.92	2.5	0.18	0	0	0.2	0.18	0	0.38	0	0	99.69
M04-59	0.12	6.86	3.86	33.42	52.65	0.7	2.84	0.01	0.01	0.01	0	0	0.03	0.52	0.04	0	101.07
M04-59	0.02	7.24	3.41	33.12	52.34	0.84	2.77	0.09	0	0.06	0	0.01	0.04	0.47	0	0	100.41
M04-59	0.1	7.77	1.97	34.47	52.04	0.87	2.13	0	0	0.01	0	0.02	0.06	0.5	0	0.07	100.01
M04-59	0.12	7.63	2.2	33.03	52.33	0.79	2.37	0.03	0.21	0	0.07	0	0	0.43	0	0	99.22
M04-61	0.17	7.22	3.66	33.78	50.48	0.8	2.43	0	0	0	0.14	0	0.01	0.51	0	0.01	99.21
M04-61	0.21	5.97	6.89	30.89	50.40	0.35	3.95	0.11	0.11	0	0	0	0	0.55	0.06	0	99.49
M04-61	0.14	7.06	2.99	33.49	51.83	0.9	2.05	0.01	0.07	0	0	0	0	0.42	0	0.2	99.16
M04-61	0.12	7.15	3.17	32.90	52.98	0.98	2.15	0.05	0.27	0	0	0	0	0.28	0	0	100.05
M04-61	0.08	6.12	7.59	31.88	50.03	0.29	3.97	0.04	0	0	0.01	0.07	0	0.68	0	0.08	100.84
M04-61	0.06	6.25	6.7	31.10	51.40	0.52	4.07	0.1	0.07	0	0	0	0.09	0.67	0	0.14	101.17
M04-61	0.25	6.53	5.12	32.20	51.01	0.69	3.45	0.03	0	0	0.1	0	0.02	0.58	0.03	0.11	100.12
M04-61	0.07	7.35	3.74	33.48	50.56	0.56	2.75	0	0	0	0.09	0	0	0.44	0.01	0.04	99.10
M04-61	0.19	6.35	6.65	32.68	50.12	0.45	3.51	0.02	0	0	0.02	0	0.01	0.63	0	0	100.63
M04-61	0.19	7.11	3.03	31.80	55.07	0.97	2.15	0.06	0.6	0.01	0	0	0	0.4	0	0.15	101.54
M04-61	0.14	7.06	3.52	32.17	52.74	0.62	2.85	0	0.21	0.06	0.13	0	0	0.48	0	0.16	100.13
M04-61	0.14	7.24	3.56	33.36	50.94	0.53	2.71	0.02	0.01	0	0	0.15	0.06	0.51	0	0.23	99.46
M04-71	0.12	6.64	3.43	32.90	53.70	0.61	3.13	0	0	0	0.1	0.14	0.07	0.6	0	0	101.44
M04-71	0.15	6.25	3.38	31.66	52.80	0.48	3.07	0.04	0	0.08	0	0	0	0.61	0.05	0.09	98.66
M04-71	0.13	6.74	3.47	33.56	53.10	0.56	2.71	0.06	0	0	0.01	0	0.04	0.54	0	0	100.92
M04-71	0.07	6.21	3.57	32.00	53.15	0.5	3.04	0.07	0	0	0.02	0	0	0.49	0.02	0	99.13

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-71	0.08	5.93	3.42	29.33	54.14	0.49	3.16	1.8	0	0.01	1.69	0	0.06	0.43	0.03	0.05	100.62
M04-71	0.01	6.67	3.35	32.42	52.75	0.54	2.92	0	0	0.04	0.01	0	0.03	0.44	0	0	99.19
M04-71	0.11	6.53	3.54	31.38	54.20	0.62	3.22	0.03	0.17	0.07	0	0	0.04	0.43	0.06	0.09	100.48
M04-71	0.07	7.37	2.04	33.93	52.55	1.17	1.44	0.04	0.16	0	0	0	0.08	0.31	0	0	99.16
M04-71	0.19	7.64	1.97	34.95	52.05	1.13	1.58	0	0	0	0.1	0	0.03	0.39	0	0.29	100.32
M04-71	0.17	6.66	3.59	32.19	52.86	0.47	3.26	0	0.01	0.06	0	0	0.02	0.37	0	0.12	99.77
M04-71	0.13	6.42	3.57	32.42	53.20	0.56	2.99	0	0	0.01	0	0	0.01	0.43	0	0.17	99.91
M04-71	0.26	6.61	3.73	30.68	52.04	0.6	3.6	0.08	0.08	0.13	0	0	0	0.44	0	0	98.24
M04-71	0.14	6.54	3.75	32.02	53.18	0.55	3.39	0.01	0	0.04	0.11	0.01	0.05	0.23	0	0	100.02
M04-71	0.13	6.77	3.56	32.06	52.97	0.49	3.2	0.05	0.12	0.01	0.02	0	0.05	0.48	0	0	99.91
M04-71	0.04	6.65	3.4	32.51	52.91	0.59	2.96	0.09	0	0	0	0	0.03	0.49	0.01	0	99.68
M04-71	0.04	6.71	3.45	31.59	53.14	0.64	2.85	0.08	0.2	0	0.08	0	0	0.41	0	0.13	99.32
M04-71	0.17	6.67	3.4	32.12	52.65	0.57	2.98	0.05	0.11	0.01	0.01	0.05	0.01	0.53	0	0	99.33
M04-71	2.27	6.33	3.55	32.17	50.80	0.65	3.81	0.68	0.29	0.05	0	0	0.07	0.4	0.06	0.03	101.17
M04-74	0	6.36	5.07	32.17	51.45	0.45	3.03	0.12	0	0.02	0	0	0.05	0.57	0.06	0.22	99.57
M04-74	1.01	6.21	5.53	32.25	50.44	0.43	3.56	0.57	0.11	0	0	0	0	0.46	0	0	100.57
M04-74	0.05	6.67	5	33.08	51.26	0.28	3.07	0.09	0	0	0	0	0	0.48	0.03	0	100.01
M04-74	0.11	6.5	2.06	33.27	54.30	1.43	1.76	0	0	0.04	0	0	0.05	0.36	0	0	99.88
M04-74	5.97	5.92	3.45	38.81	44.64	1.17	1.82	0.15	0.5	0.3	0.01	0	0	0.24	0	0.09	103.06
M04-74	0.17	7.62	2.07	34.57	51.72	1.1	1.75	0.08	0	0	0.04	0	0.03	0.16	0	0.01	99.32
M04-74	0.18	6.25	5.25	32.08	51.26	0.52	3.27	0	0.01	0	0.01	0	0.02	0.58	0	0.23	99.66
M04-74	0.25	5.87	5.05	31.73	51.84	0.32	3.21	0.08	0.06	0.01	0.03	0.06	0	0.51	0	0.02	99.04
M04-74	0.02	6.49	5.21	32.55	50.85	0.29	3.08	0.02	0	0.03	0.1	0	0	0.45	0.13	0.08	99.30
M04-74	0.17	6.66	5.13	32.27	51.37	0.51	3.22	0.06	0.12	0	0	0.11	0.01	0.6	0	0.11	100.34
M04-74	0.13	5.87	6.34	31.64	50.96	0.22	3.62	0.03	0.07	0	0	0	0.05	0.66	0.37	0	99.95
M04-74	0.13	6.24	5.2	32.12	51.23	0.3	3.19	0.04	0	0.07	0.07	0	0.03	0.49	0	0.06	99.17
M04-74	0.05	6.48	5.41	32.37	51.49	0.37	3.26	0	0.05	0	0.05	0.1	0.01	0.46	0.02	0.14	100.26
M04-74	0.16	6.5	5.32	32.75	51.08	0.43	3.17	0.04	0	0	0	0	0	0.46	0.04	0.16	100.11
M04-74	0.2	6.46	5.28	32.46	50.69	0.37	3.29	0.05	0.01	0	0.04	0	0	0.4	0	0	99.24
M04-76	0.22	6.82	5.8	32.53	50.16	0.39	3.68	0	0	0	0.13	0.05	0.06	0.49	0	0.21	100.53
M04-76	0.1	6.69	5.46	30.38	51.09	0.44	3.75	0.12	0.28	0	0	0	0	0.64	0	0.13	99.08
M04-76	0.15	7.16	5.75	33.36	49.33	0.26	3.32	0	0	0	0.01	0.01	0.04	0.49	0	0.18	100.06
M04-76	0.17	7.02	5.76	32.62	49.91	0.66	3.54	0.07	0	0.02	0	0	0.03	0.6	0	0.07	100.47
M04-76	0.28	6.75	5.59	31.30	51.01	0.35	3.97	0.06	0.17	0.03	0	0	0	0.52	0	0.04	100.08
M04-76	0.17	7.04	5.86	32.82	50.33	0.42	3.48	0.04	0.06	0	0.15	0	0.03	0.48	0	0.23	101.11
M04-76	0.08	6.84	5.76	32.40	50.22	0.42	3.64	0	0	0.03	0	0.06	0.07	0.58	0	0	100.11
M04-76	0.21	6.95	5.68	32.94	49.98	0.46	3.42	0.08	0	0	0.08	0	0	0.41	0	0.09	100.30
M04-76	0.1	7.2	5.7	32.07	50.77	0.41	3.58	0.07	0.22	0.01	0.05	0	0	0.52	0	0.03	100.73

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-76	0.09	6.67	5.58	31.24	51.81	0.4	3.79	0.1	0.15	0.07	0	0.07	0	0.4	0.04	0	100.41
M04-76	0.1	7.14	5.65	32.38	50.12	0.47	3.56	0.04	0.09	0.01	0.07	0.05	0	0.4	0	0	100.08
M04-76	0.21	7.07	5.63	32.35	50.62	0.48	3.44	0.08	0.21	0	0.16	0	0	0.67	0.01	0	100.93
M04-76	0.09	7.12	5.62	32.36	50.11	0.57	3.41	0	0.13	0	0	0.02	0.08	0.49	0	0	100.00
M04-76	0.13	7.21	5.07	32.86	50.34	0.55	3.46	0.03	0	0.02	0	0	0	0.52	0	0.05	100.24
M04-76	0.1	6.87	5.82	32.70	49.38	0.41	3.37	0.01	0	0	0	0	0.03	0.57	0.06	0.09	99.41
M04-80	0.17	7.37	2.01	33.13	53.45	1.33	2.02	0.04	0.16	0.06	0.03	0	0	0.33	0.01	0	100.11
M04-80	0.04	7.22	1.93	33.33	54.00	1.22	1.93	0	0.16	0	0	0.09	0.06	0.41	0	0	100.39
M04-80	0.15	7.32	2.14	33.98	52.50	1.23	1.91	0.01	0.01	0	0.11	0.02	0.06	0.1	0	0	99.55
M04-80	0.05	7.38	2.03	33.56	52.48	1.09	1.95	0	0.08	0	0.09	0	0.01	0.35	0	0	99.07
M04-80	0.17	7.38	2.19	33.57	52.66	1.25	1.99	0.04	0.11	0	0.07	0.06	0	0.31	0	0	99.80
M04-80	0.16	7.29	2.2	33.78	53.17	1.1	2.08	0.02	0.07	0	0	0	0.06	0.14	0	0	100.07
M04-80	0.09	7.54	2.13	32.96	53.69	1.17	1.89	0	0.36	0	0	0	0.02	0.34	0	0	100.19
M04-80	0.09	7	2.1	33.70	53.45	1.23	1.8	0.06	0	0.01	0.02	0	0	0.33	0.03	0.25	100.07
M04-80	0.23	7.01	2.12	32.44	54.15	1.29	1.93	0.03	0.27	0.07	0.12	0	0	0.31	0	0.11	100.09
M04-80	0.04	7.26	1.96	33.59	53.40	1.33	2	0	0	0.01	0.05	0.1	0.07	0.3	0	0.17	100.29
M04-80	0.24	7.39	2.06	34.30	53.28	1.34	1.95	0.08	0	0.04	0	0	0.02	0.2	0	0	100.90
M04-80	0.09	7.36	1.98	33.87	52.65	1.34	1.81	0.02	0.01	0.01	0	0.07	0.02	0.26	0	0.09	99.58
M04-80	0.13	7.59	2	34.11	53.28	1.18	1.9	0	0.13	0	0	0	0.02	0.18	0.04	0	100.56
M04-80	0.28	7.09	2.17	32.93	53.59	1.24	2.01	0.02	0.18	0.05	0	0	0	0.12	0.04	0.12	99.84
M04-80	0.08	7.34	2.12	34.03	53.05	1.35	1.79	0.09	0	0.04	0	0	0.02	0.21	0	0	100.13
M04-84	0.18	7.71	1.85	34.90	52.38	1.19	1.6	0	0.06	0	0.06	0.01	0	0.28	0	0	100.22
M04-84	0.14	7.32	2.04	33.96	52.54	1.41	1.76	0.07	0.01	0	0	0	0.08	0.36	0	0.08	99.77
M04-84	0	7.71	1.94	33.98	53.48	1.2	1.54	0.01	0.26	0	0	0	0.04	0.28	0.06	0	100.51
M04-84	0.04	7.63	1.96	34.75	52.18	1.2	1.59	0.01	0	0	0	0.09	0	0.38	0	0.05	99.88
M04-84	0.12	7.47	1.89	34.03	53.32	1.29	1.68	0	0.15	0	0.09	0	0	0.33	0	0	100.38
M04-84	0.04	7.49	1.87	34.06	52.85	1.26	1.69	0.08	0.07	0	0.02	0.02	0.02	0.42	0	0.01	99.90
M04-84	0.19	7.33	1.84	34.18	52.61	1.24	1.55	0.28	0	0.06	0	0	0	0.37	0	0	99.65
M04-84	0.16	7.26	1.85	33.27	53.58	1.4	1.85	0.05	0.12	0	0.08	0	0	0.12	0	0.17	99.91
M04-84	0.35	7.34	1.92	34.20	52.14	1.21	1.91	0.04	0	0.03	0	0	0.07	0.28	0.02	0	99.52
M04-84	0.14	7.7	2.01	34.53	52.05	1.44	1.63	0	0.01	0.01	0	0	0	0.25	0	0.16	99.93
M04-84	0.25	7.68	2.15	34.21	51.90	1.48	1.67	0.07	0.08	0.04	0.11	0	0	0.24	0	0	99.88
M04-84	0.14	7.69	1.96	34.45	51.89	1.15	1.67	0.13	0	0.06	0	0	0	0.29	0.03	0.07	99.53
M04-84	0.06	7.64	1.88	34.18	53.33	1.33	1.66	0.04	0.11	0.02	0	0.11	0	0.36	0	0.13	100.85
M04-84	0.12	7.71	1.88	34.67	52.38	1.3	1.59	0	0.06	0	0	0	0	0.26	0	0	99.97
M04-84	0	7.65	1.88	33.73	53.45	1.18	1.61	0	0.25	0	0.01	0.1	0	0.23	0	0	100.09
M04-84	0.04	7.65	1.87	33.37	53.51	1.34	1.47	0.04	0.33	0	0	0	0.04	0.28	0	0.08	100.02
M04-84	0.05	7.49	1.84	32.95	54.07	1.05	1.67	0.14	0.35	0.06	0.21	0	0.04	0.44	0	0	100.36

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-86	0.09	8.55	1.91	36.00	50.24	0.5	1.58	0.02	0.08	0	0	0.14	0.02	0.56	0	0	99.70
E02-86	0.01	6.67	2.37	34.63	54.11	0.57	1.44	0.04	0.06	0	0.02	0.05	0.05	0.55	0	0.13	100.70
E02-86	0.16	6.44	1.7	34.71	54.77	0.55	1.49	0.03	0	0.01	0	0	0.05	0.49	0	0.05	100.45
E02-86	0.1	7.39	1.52	35.41	53.23	0.37	1.52	0.14	0	0	0	0	0	0.44	0.17	0.18	100.47
E02-86	0.21	6.46	3.56	32.70	52.89	0.56	2.94	0	0	0	0	0.01	0	0.51	0	0.17	100.01
E02-86	0.08	6.64	3.56	32.70	53.48	0.54	3.07	0.03	0	0.04	0	0.03	0	0.42	0.2	0.1	100.89
E02-86	0.2	6.41	3.85	32.68	52.36	0.5	2.96	0.06	0.01	0	0.03	0	0	0.47	0.19	0	99.72
E02-86	0.09	6.61	3.36	34.05	53.54	0.56	1.91	0.06	0	0.15	0.16	0	0	0.5	0	0.14	101.13
E02-86	0.16	8.51	1.51	36.20	50.69	0.53	1.69	0	0	0	0	0	0.05	0.39	0	0	99.73
E02-86	0.1	6.65	3.62	32.35	53.64	0.52	3.26	0	0	0.06	0	0.04	0.07	0.42	0	0.18	100.91
E02-86	0	6.63	2.92	33.33	52.82	0.69	2.18	0	0.01	0	0	0.02	0	0.46	0	0	99.06
E02-86	0.07	6.61	3.65	32.30	53.24	0.53	3.27	0	0.01	0	0	0	0.06	0.38	0	0.04	100.17
E02-86	0.11	6.75	3.52	31.98	53.09	0.43	3.35	0	0.08	0.02	0.05	0	0	0.37	0	0.02	99.78
M04-69	0.15	6.62	2.78	32.38	52.61	0.77	2.2	0	0.13	0.08	0	0.08	0	0.5	0	0	98.30
M04-69	0	8.08	1.62	35.12	51.24	0.91	1.54	0.03	0	0.02	0.02	0	0.01	0.35	0	0	98.94
M04-69	0.06	6.67	2.79	33.31	53.55	0.82	2.4	0.01	0	0	0	0.06	0.08	0.49	0	0.01	100.25
M04-69	0.05	8.82	3.15	34.81	48.66	0.85	2.05	0.03	0.12	0.03	0	0	0.07	0.56	0	0.2	99.40
M04-69	0.07	6.68	2.87	34.31	53.11	0.71	1.72	0.08	0	0	0.15	0.05	0.04	0.4	0	0.1	100.28
M04-69	0.19	6.65	2.74	33.13	52.23	0.6	1.97	0.01	0.1	0	0	0	0.03	0.44	0	0.22	98.31
M04-69	0.12	6.68	2.87	33.30	53.71	0.72	2.54	0.08	0	0	0.04	0	0.01	0.42	0	0.03	100.52
M04-69	0.08	8.16	1.3	33.88	51.60	0.53	1.72	0	0.33	0	0	0	0	0.53	0.3	0	98.44
M04-69	0.09	6.85	2.79	33.40	52.52	0.71	2.29	0.04	0	0	0.14	0	0	0.36	0.18	0.15	99.52
M04-69	0	6.81	2.74	32.87	53.62	0.9	2.53	0	0	0.01	0	0.06	0.07	0.29	0	0.12	100.01
M04-150	0.21	9.03	4.12	34.04	48.57	0.52	4.01	0	0	0	0	0	0	0.45	0	0	100.95
M04-150	0.22	8.94	4.01	33.90	48.94	0.55	4.08	0.05	0	0	0	0	0	0.69	0.03	0	101.42
M04-150	0.11	8.34	4.19	33.19	49.35	0.42	3.94	0.05	0	0	0	0	0	0.58	0	0	100.17
M04-150	0.15	8.98	4.07	34.02	48.92	0.53	3.92	0.08	0	0	0	0	0	0.46	0.08	0	101.21
M04-150	0.16	9.26	4.13	34.26	48.40	0.72	3.93	0	0	0	0	0	0	0.56	0	0	101.41
M04-150	0.11	8.99	3.92	33.91	49.10	0.7	3.85	0.05	0	0	0	0	0	0.53	0	0	101.16
M04-150	0.01	8.56	4.27	33.10	49.69	0.64	4.01	0.12	0	0	0	0	0	0.55	0	0	100.95
M04-150	0.15	8.49	4.49	33.07	49.18	0.52	4.2	0.06	0	0	0	0	0	0.48	0.02	0	100.66
M04-150	0.16	8.41	4.28	33.08	49.12	0.61	4	0	0	0	0	0	0	0.43	0	0	100.09
M04-150	0.1	8.74	4.12	33.85	49.39	0.5	3.89	0	0	0	0	0	0	0.43	0	0	101.02
M04-150	0.13	9.08	3.85	33.99	48.40	0.51	3.85	0.04	0	0	0	0	0	0.57	0.03	0	100.45
M04-150	0.11	9.2	3.79	34.45	48.70	0.57	3.75	0	0	0	0	0	0	0.63	0.03	0	101.23
M04-150	0.17	9.22	3.82	34.56	48.32	0.41	3.76	0.04	0	0	0	0	0	0.64	0	0	100.94
M04-150	0.16	9.13	4.05	33.84	48.13	0.68	3.95	0	0	0	0	0	0	0.5	0.04	0	100.48
M04-150	0.15	8.81	4.1	33.90	49.18	0.46	3.96	0.04	0	0	0	0	0	0.54	0	0	101.14

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-150	0.21	9.14	4.14	34.45	48.48	0.47	3.94	0.01	0	0	0	0	0	0.55	0.06	0	101.46
M04-151	0.15	5.1	3.54	33.65	55.64	0.75	1.57	0.03	0	0	0	0	0	0.38	0.01	0	100.82
M04-151	0.12	6.9	3.2	33.45	53.30	0.66	2.77	0.09	0	0	0	0	0	0.41	0.09	0	101.00
M04-152	0.19	7.19	4.07	33.48	51.78	0.56	3.23	0.01	0	0	0	0	0	0.55	0	0	101.06
M04-152	0.12	6.87	3.76	32.34	52.06	0.64	3.31	0.02	0	0	0	0	0	0.41	0	0	99.53
M04-152	0.12	7.45	1.68	34.43	53.34	1.31	1.82	0	0	0	0	0	0	0.23	0.04	0	100.42
M04-152	0.15	1.66	5.6	27.59	60.97	0.87	3.59	0.06	0	0	0	0	0	0.47	0	0	100.96
M04-152	0.08	7.23	3.86	34.20	51.85	0.82	2.45	0.05	0	0	0	0	0	0.45	0	0	100.98
M04-152	0.03	7.19	3.98	34.11	51.08	0.46	2.49	0	0	0	0	0	0	0.47	0	0	99.81
M04-152	0.14	6.65	3.93	33.24	52.13	0.71	2.69	0	0	0	0	0	0	0.49	0	0	99.99
M04-152	0.09	7.11	3.42	34.40	52.15	0.61	2.23	0.07	0	0	0	0	0	0.43	0	0	100.51
M04-154	0.15	6.63	2.92	33.44	54.31	0.55	2.8	0.03	0	0	0	0	0	0.52	0	0	101.35
M04-154	0.05	6.72	3.62	32.74	53.31	0.73	3.09	0	0	0	0	0	0	0.51	0	0	100.77
M04-154	0.22	6.33	3.6	32.68	53.43	0.62	3.08	0	0	0	0	0	0	0.53	0.12	0	100.61
M04-154	0.21	6.41	3.93	32.61	53.68	0.5	3.39	0	0	0	0	0	0	0.44	0	0	101.17
M04-154	0.02	6.98	2.06	33.79	54.36	0.78	2.3	0	0	0	0	0	0	0.34	0	0	100.63
M04-154	0.03	6.74	1.9	33.53	54.48	0.67	2.23	0.07	0	0	0	0	0	0.47	0	0	100.12
M04-154	0.1	6.55	3.2	32.69	53.76	0.54	3.03	0.04	0	0	0	0	0	0.46	0	0	100.37
M04-154	0.11	6.54	3.54	32.68	54.10	0.62	3.22	0.02	0	0	0	0	0	0.44	0	0	101.27
M04-154	0.04	6.65	2.91	32.94	54.00	0.46	2.92	0	0	0	0	0	0	0.43	0	0	100.35
M04-154	0.24	6.71	3.1	33.52	53.27	0.56	2.78	0	0	0	0	0	0	0.49	0.03	0	100.71
M04-154	0.01	6.63	3.36	32.47	53.85	0.68	3.13	0	0	0	0	0	0	0.39	0	0	100.52
M04-154	0.06	7.66	2.22	33.58	52.24	0.92	2.65	0	0	0	0	0	0	0.51	0	0	99.84
M04-154	0.12	6.63	2.95	33.53	53.45	0.7	2.42	0	0	0	0	0	0	0.44	0	0	100.24
M04-155	0.23	6.44	6.03	32.79	50.59	0.45	3.49	0	0	0	0	0	0	0.66	0.01	0	100.69
M04-155	0.1	6.35	5.68	32.08	51.49	0.4	3.72	0	0	0	0	0	0	0.58	0.02	0	100.42
M04-155	0.05	6.13	5.42	31.53	52.50	0.49	3.7	0.16	0	0	0	0	0	0.5	0	0	100.48
M04-155	0.1	6.47	4.42	32.43	52.54	0.45	3.33	0.06	0	0	0	0	0	0.54	0.02	0	100.35
M04-155	0.24	7.15	3.53	33.64	51.90	0.58	2.96	0.04	0	0	0	0	0	0.58	0.01	0	100.63
M04-155	0.09	6.52	4.19	33.38	52.93	0.54	2.82	0.05	0	0	0	0	0	0.63	0	0	101.15
M04-155	0.07	6.66	5.79	31.90	51.36	0.45	4.09	0	0	0	0	0	0	0.64	0	0	100.96
M04-155	0.09	6.51	4.48	32.32	53.02	0.35	3.66	0	0	0	0	0	0	0.55	0	0	100.98
M04-155	0.05	5.98	6.29	30.83	51.32	0.51	4.05	0.06	0	0	0	0	0	0.51	0	0	99.60
M04-155	0.01	6.66	4.07	33.07	53.66	0.7	3.04	0.05	0	0	0	0	0	0.51	0	0	101.77
M04-155	0.09	6.67	3.99	32.71	52.78	0.67	3.12	0.03	0	0	0	0	0	0.46	0	0	100.52
M04-155	0.14	6.56	4.69	32.79	52.58	0.34	3.51	0	0	0	0	0	0	0.54	0.06	0	101.21
M04-155	0.1	6.9	5.15	32.66	51.25	0.47	3.65	0	0	0	0	0	0	0.54	0.1	0	100.83
M04-156	0.17	7.32	4.95	33.03	51.32	0.54	3.82	0.01	0	0	0	0	0	0.52	0	0	101.68

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-156	0.06	7	4.81	32.32	51.12	0.35	3.75	0	0	0	0	0	0	0.49	0	0	99.90
M04-156	0.22	7.04	5	32.21	51.18	0.39	4.06	0.07	0	0	0	0	0	0.4	0	0	100.58
M04-156	0.07	7.1	5.2	32.98	51.46	0.54	3.63	0	0	0	0	0	0	0.48	0.03	0	101.50
M04-156	0.05	6.94	4.94	32.40	52.02	0.57	3.74	0.06	0	0	0	0	0	0.48	0	0	101.20
M04-156	0.25	6.8	5.1	31.75	50.34	0.51	3.87	0.07	0	0	0	0	0	0.37	0.02	0	99.08
M04-156	0.23	7.1	4.95	32.42	50.48	0.46	3.82	0.09	0	0	0	0	0	0.57	0.03	0	100.15
M04-156	0.18	6.95	5.16	32.16	51.23	0.65	3.95	0.02	0	0	0	0	0	0.51	0.04	0	100.85
M04-156	0.22	7.04	4.83	32.15	50.94	0.57	3.94	0	0	0	0	0	0	0.47	0.02	0	100.18
M04-156	1.48	6.75	5.08	33.71	48.69	0.58	3.84	0.2	0	0	0	0	0	0.46	0.03	0	100.82
M04-156	0.14	7.04	5.11	32.51	51.35	0.49	3.82	0.08	0	0	0	0	0	0.45	0	0	100.98
M04-156	0.14	6.93	5.3	32.85	51.17	0.49	3.64	0.01	0	0	0	0	0	0.6	0	0	101.13
M04-156	0.2	7.07	5.13	33.34	50.98	0.48	3.47	0	0	0	0	0	0	0.5	0.06	0	101.23
M04-156	0.57	6.4	4.95	31.93	50.60	0.36	3.89	0.1	0	0	0	0	0	0.46	0.01	0	99.27
M04-156	0.1	6.85	4.95	32.07	51.68	0.58	3.84	0	0	0	0	0	0	0.4	0.01	0	100.48
M04-156	0.13	6.93	5.12	32.69	50.63	0.37	3.57	0	0	0	0	0	0	0.55	0	0	99.99
M04-158	0.02	7.55	1.86	34.70	53.11	1.16	1.7	0.02	0	0	0	0	0	0.19	0	0	100.31
M04-158	0.19	7.37	1.83	34.59	53.21	1.32	1.75	0.03	0	0	0	0	0	0.29	0	0	100.58
M04-158	0.1	7.38	2	33.97	52.91	1.4	1.95	0	0	0	0	0	0	0.28	0	0	100.00
M04-158	0.17	7.33	1.89	34.50	52.72	1.15	1.75	0.03	0	0	0	0	0	0.36	0.02	0	99.93
M04-158	0.18	7.57	1.98	34.57	52.21	1.4	1.72	0.04	0	0	0	0	0	0.36	0	0	100.02
M04-158	0.08	7.1	1.91	33.68	53.07	1.31	1.83	0.04	0	0	0	0	0	0.23	0.05	0	99.29
M04-158	0.06	7.13	1.92	33.81	53.39	1.35	1.81	0.08	0	0	0	0	0	0.34	0	0	99.89
M04-158	0.16	7.37	1.96	34.34	52.40	1.36	1.7	0	0	0	0	0	0	0.31	0	0	99.60
M04-158	0.07	7.47	1.88	34.44	52.69	1.38	1.66	0	0	0	0	0	0	0.31	0.02	0	99.92
M04-158	0.06	7.38	1.78	34.44	52.97	1.33	1.58	0	0	0	0	0	0	0.21	0	0	99.75
M04-158	0.08	7.35	1.86	34.31	54.05	1.28	1.92	0.11	0	0	0	0	0	0.26	0	0	101.22
M04-158	0.04	7.57	1.95	34.82	53.36	1.14	1.84	0	0	0	0	0	0	0.33	0	0	101.04
M04-158	0	7.55	1.9	34.22	52.86	1.25	1.92	0.01	0	0	0	0	0	0.46	0	0	100.17
M04-158	0.09	7.68	2.06	35.05	52.97	1.33	1.7	0.07	0	0	0	0	0	0.43	0	0	101.38
M04-158	0	7.64	1.93	34.39	52.44	1.16	1.82	0.02	0	0	0	0	0	0.29	0	0	99.69
M04-158	0.04	7.67	1.9	34.56	52.78	1.33	1.81	0	0	0	0	0	0	0.33	0	0	100.42
M04-158	0	7.48	2.05	34.13	53.54	1.52	1.94	0	0	0	0	0	0	0.29	0	0	100.95
M04-158	0	7.76	1.9	34.83	52.75	1.22	1.71	0.04	0	0	0	0	0	0.24	0.04	0	100.50
M04-158	0.1	7.61	2.01	34.43	52.34	1.28	1.83	0.01	0	0	0	0	0	0.23	0	0	99.84
M04-159	0.16	6.75	2.25	33.50	53.92	1.19	2.15	0	0	0	0	0	0	0.36	0	0	100.28
M04-159	0.1	7.33	1.98	33.92	53.27	1.3	2.06	0	0	0	0	0	0	0.23	0.02	0	100.21
M04-159	0.07	7.57	2	34.52	52.64	1.22	1.76	0.07	0	0	0	0	0	0.22	0	0	100.06
M04-159	0.05	7.36	2.14	34.45	53.04	1.11	1.86	0	0	0	0	0	0	0.33	0.01	0	100.35

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-159	0.3	7.55	1.99	34.33	52.44	1.43	2.04	0.01	0	0	0	0	0	0.28	0	0	100.37
M04-159	0.02	7.47	2.14	34.63	52.68	1.17	1.71	0	0	0	0	0	0	0.29	0.05	0	100.16
M04-159	0.14	7.54	2.14	34.56	52.12	1.25	1.78	0.01	0	0	0	0	0	0.31	0.01	0	99.86
M04-159	0.05	7.37	1.94	34.35	53.37	1.22	1.77	0.11	0	0	0	0	0	0.26	0	0	100.44
M04-159	0.15	7.17	2.1	34.17	53.06	1.26	1.79	0.03	0	0	0	0	0	0.14	0	0	99.87
M04-159	0.12	7.55	2.07	34.90	53.27	1.24	1.86	0	0	0	0	0	0	0.33	0.04	0	101.39
M04-159	0.08	7.46	2.26	34.58	52.53	1.2	1.79	0	0	0	0	0	0	0.31	0	0	100.21
M04-159	5.73	6.76	3.55	41.44	39.48	1.21	2.04	0.01	0	0	0	0	0	0.34	0.04	0	100.60
M04-164	0.04	7.79	2.33	35.04	52.19	1.02	1.9	0	0	0	0	0	0	0.48	0	0	100.80
M04-164	0.15	7.47	2.28	34.75	52.48	1.14	1.83	0.01	0	0	0	0	0	0.29	0.05	0	100.45
M04-164	0.15	7.43	2.17	34.35	52.44	1.21	1.94	0	0	0	0	0	0	0.39	0	0	100.08
M04-164	0.14	7.38	2.32	34.46	52.92	1.11	2.02	0.05	0	0	0	0	0	0.39	0.01	0	100.79
M04-164	0.09	7.59	2.17	34.94	52.47	0.87	1.9	0	0	0	0	0	0	0.43	0	0	100.46
M04-164	0.08	7.52	2.25	34.42	52.55	1.15	1.91	0.06	0	0	0	0	0	0.25	0	0	100.20
M04-164	0.09	7.5	2.22	34.30	52.50	1.14	2.01	0	0	0	0	0	0	0.3	0	0	100.05
M04-164	0	7.46	2.23	34.57	52.56	1.14	1.69	0.08	0	0	0	0	0	0.42	0	0	100.14
M04-164	0.14	7.22	2.15	34.11	53.12	1.07	2	0.03	0	0	0	0	0	0.12	0	0	99.96
M04-164	0.08	7.6	2.14	34.77	52.64	1.17	1.85	0	0	0	0	0	0	0.38	0.04	0	100.67
M04-164	0.12	8.08	2.29	35.06	51.80	1.22	2.03	0	0	0	0	0	0	0.33	0.04	0	100.97
M04-164	0.04	7.59	2.16	34.56	52.36	1.1	1.86	0.02	0	0	0	0	0	0.39	0	0	100.09
M04-166	0.18	8.32	2.76	33.70	52.55	1.11	2.62	0	0	0	0	0	0	0.41	0	0	101.65
M04-166	0.09	8.39	2.55	34.29	53.54	1.03	2.42	0.01	0	0	0	0	0	0.39	0	0	102.71
M04-166	0.05	8.34	2.62	33.92	53.93	0.89	2.73	0	0	0	0	0	0	0.32	0	0	102.81
M04-166	0.08	8.29	2.75	33.85	52.93	0.92	2.56	0.05	0	0	0	0	0	0.44	0.07	0	101.93
M04-166	0.22	7.98	2.81	33.30	53.35	0.91	2.81	0.1	0	0	0	0	0	0.33	0	0	101.81
M04-166	0.15	7.94	2.86	33.83	53.57	0.84	2.6	0	0	0	0	0	0	0.51	0	0	102.30
M04-166	0.27	8.01	2.74	33.92	53.61	0.96	2.54	0.09	0	0	0	0	0	0.27	0	0	102.41
M04-166	0	8.03	2.79	33.73	53.80	0.75	2.6	0	0	0	0	0	0	0.4	0.01	0	102.11
M04-166	0.2	8.12	2.92	33.70	52.66	0.87	2.67	0	0	0	0	0	0	0.41	0	0	101.55
M04-166	0.13	8.14	2.94	33.95	53.43	0.88	2.66	0.03	0	0	0	0	0	0.37	0.17	0	102.70
M04-166	0.2	8.02	2.55	33.82	53.31	1	2.42	0.01	0	0	0	0	0	0.34	0	0	101.67
M04-166	0.05	8.32	2.84	33.65	53.06	0.93	2.65	0.1	0	0	0	0	0	0.35	0	0	101.95
M04-166	0.14	8.04	2.68	33.73	53.67	1.03	2.54	0.02	0	0	0	0	0	0.37	0	0	102.21
M04-177	0.12	8.05	2.12	34.55	54.10	1.22	1.77	0.05	0	0	0	0	0	0.28	0	0	102.26
M04-177	0	7.84	2.01	33.91	54.44	1.22	1.82	0.1	0	0	0	0	0	0.41	0.01	0	101.76
M04-177	0.17	8.09	2.09	34.23	53.18	1.03	2.04	0	0	0	0	0	0	0.47	0.08	0	101.39
M04-177	0.14	7.8	2.12	33.88	53.69	1.23	1.86	0.06	0	0	0	0	0	0.34	0.07	0	101.19
M04-177	0.09	8.16	2.14	34.10	54.00	1.23	2.11	0.09	0	0	0	0	0	0.49	0	0	102.41

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-177	0.04	8.02	2.06	33.66	53.79	1.32	2.07	0	0	0	0	0	0	0.4	0	0	101.36
M04-177	0.1	8.09	2.08	33.91	53.86	1.14	2.18	0	0	0	0	0	0	0.31	0.02	0	101.69
M04-177	0.11	8.02	1.85	34.08	54.32	1.23	1.97	0.02	0	0	0	0	0	0.27	0	0	101.87
M04-177	0.05	7.8	2.06	33.77	54.55	1.28	2.02	0	0	0	0	0	0	0.43	0	0	101.96
M04-177	0.06	6.84	2.57	33.88	56.14	1.13	1.68	0	0	0	0	0	0	0.41	0	0	102.71
M04-177	0.21	7.8	2.25	34.59	53.73	0.95	1.81	0	0	0	0	0	0	0.38	0.06	0	101.78
M04-177	0.13	7.88	2.1	34.04	53.31	1.14	1.83	0.02	0	0	0	0	0	0.44	0.06	0	100.95
M04-177	0.04	8.1	2.01	34.32	53.60	1.13	1.8	0.04	0	0	0	0	0	0.49	0.02	0	101.55
M04-176	0.11	8.3	2.68	34.09	53.07	0.98	2.39	0.08	0	0	0	0	0	0.4	0	0	102.10
M04-176	0.08	8.22	2.73	33.37	53.12	1.05	2.73	0.04	0	0	0	0	0	0.44	0	0	101.78
M04-176	0	8.18	2.87	33.80	53.37	0.89	2.54	0.03	0	0	0	0	0	0.44	0	0	102.13
M04-176	0.24	8.25	2.81	33.77	52.15	0.94	2.59	0.05	0	0	0	0	0	0.49	0	0	101.29
M04-176	0.13	8.45	2.64	33.96	52.77	0.98	2.61	0	0	0	0	0	0	0.4	0	0	101.94
M04-176	0.19	8.28	2.78	33.94	53.12	1.1	2.61	0.04	0	0	0	0	0	0.52	0	0	102.59
M04-176	0.17	8.2	2.84	33.89	53.01	0.92	2.65	0	0	0	0	0	0	0.49	0	0	102.18
M04-176	0.06	8.23	2.44	33.85	53.65	0.92	2.51	0.03	0	0	0	0	0	0.38	0	0	102.08
M04-176	0	8.21	2.74	33.36	53.19	1.1	2.64	0	0	0	0	0	0	0.39	0.06	0	101.69
M04-176	0.08	8.19	2.72	33.57	53.02	0.89	2.66	0	0	0	0	0	0	0.4	0	0	101.53
M04-176	0.12	8.25	2.76	33.39	52.62	0.96	2.63	0.13	0	0	0	0	0	0.3	0	0	101.17
M04-176	0.07	8.29	2.82	34.06	53.20	0.84	2.57	0.04	0	0	0	0	0	0.41	0.09	0	102.38
M04-176	0.12	8.39	2.98	33.98	52.40	0.92	2.59	0.02	0	0	0	0	0	0.41	0	0	101.81
M04-176	0.18	8.31	2.89	33.68	52.23	1.05	2.61	0	0	0	0	0	0	0.35	0	0	101.30
M04-176	0.12	8.3	2.66	33.68	52.55	0.92	2.58	0.03	0	0	0	0	0	0.32	0.09	0	101.24
M04-174	0.07	8.05	3.04	33.35	52.49	0.77	2.71	0	0	0	0	0	0	0.46	0	0	100.94
M04-174	0.09	8.05	2.95	33.36	53.43	0.92	2.83	0	0	0	0	0	0	0.32	0.07	0	102.02
M04-174	0.39	7.66	3.32	33.17	52.39	0.84	2.91	0	0	0	0	0	0	0.51	0.01	0	101.20
M04-174	0.08	8.09	3.12	33.90	53.59	0.9	2.68	0	0	0	0	0	0	0.47	0	0	102.83
M04-174	0.11	7.57	3.26	32.82	54.74	0.88	3.11	0.09	0	0	0	0	0	0.36	0.07	0	103.01
M04-174	0.2	8.13	3.07	33.95	53.33	0.76	2.78	0.07	0	0	0	0	0	0.42	0	0	102.70
M04-174	0.04	7.96	2.97	33.46	53.54	0.89	2.7	0.01	0	0	0	0	0	0.56	0	0	102.13
M04-174	0.11	7.89	3.02	33.34	53.33	0.91	2.7	0.06	0	0	0	0	0	0.47	0.03	0	101.85
M04-174	0.15	7.97	2.89	33.55	53.60	1.01	2.68	0	0	0	0	0	0	0.32	0.05	0	102.22
M04-174	0.08	7.75	3.01	33.05	54.23	1	2.9	0.01	0	0	0	0	0	0.51	0	0	102.54
M04-174	0.17	8.02	3.04	33.39	53.34	0.82	2.87	0.1	0	0	0	0	0	0.33	0	0	102.08
M04-174	0.15	7.97	3.16	33.44	53.40	0.89	2.85	0.06	0	0	0	0	0	0.41	0.06	0	102.39
M04-174	0.18	7.96	2.88	33.34	53.07	1.03	2.71	0	0	0	0	0	0	0.43	0.03	0	101.63
M04-190	0.25	6.8	3.95	32.98	54.77	0.4	3.03	0.03	0	0	0	0	0	0.45	0	0	102.66
M04-190	0.09	7.62	2.34	33.59	54.69	0.96	2.34	0	0	0	0	0	0	0.45	0.05	0	102.13

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-190	0.15	7.64	2.23	33.62	54.28	0.95	2.28	0.06	0	0	0	0	0	0.59	0.05	0	101.84
M04-190	0.08	7.61	2.4	33.80	54.79	0.74	2.35	0.08	0	0	0	0	0	0.62	0.03	0	102.51
M04-190	0.22	7.69	2.63	33.49	53.53	1.01	2.42	0.02	0	0	0	0	0	0.49	0	0	101.50
M04-190	0.21	6.96	4.22	33.73	53.51	0.31	2.61	0.01	0	0	0	0	0	0.61	0.07	0	102.25
M04-190	0	8.56	3.34	35.51	55.94	0	2.92	0.96	0	0	0	0	0	1.67	0	0	108.90
M04-190	0.12	7.53	2.5	32.89	54.11	0.85	2.48	0.24	0	0	0	0	0	0.38	0	0	101.09
M04-190	0.02	7.75	2.21	33.32	54.26	1.01	2.3	0.07	0	0	0	0	0	0.49	0.01	0	101.44
M04-190	0.11	7.84	2.31	33.97	53.61	0.91	2.05	0.04	0	0	0	0	0	0.36	0.01	0	101.21
M04-190	0.17	7.68	2.35	33.82	54.23	0.93	2.24	0.08	0	0	0	0	0	0.56	0	0	102.06
M04-190	0.08	7.66	2.57	33.39	54.05	0.88	2.46	0.04	0	0	0	0	0	0.53	0.06	0	101.72
M04-190	0.16	6.96	3.92	33.03	53.99	0.67	2.68	0.05	0	0	0	0	0	0.51	0	0	101.97
M04-190	0.01	6.69	3.46	32.21	54.90	0.66	2.78	0.05	0	0	0	0	0	0.65	0	0	101.41
M04-190	0.19	7.57	2.51	33.51	54.20	0.95	2.41	0	0	0	0	0	0	0.44	0	0	101.78
M04-190	0.08	7.51	2.35	33.68	54.91	1.04	2.2	0	0	0	0	0	0	0.52	0.05	0	102.33
M04-190	0.21	7.79	2.42	33.87	53.30	0.9	2.23	0	0	0	0	0	0	0.45	0.06	0	101.23
M04-192	0.09	7.06	3.88	33.52	54.06	0.44	2.56	0	0	0	0	0	0	0.49	0	0	102.10
M04-192	0.14	8.03	2.28	34.13	53.81	0.9	2.26	0.02	0	0	0	0	0	0.43	0	0	102.00
M04-192	0.13	7.85	2.2	33.97	54.19	1.02	2.19	0.02	0	0	0	0	0	0.55	0.02	0	102.14
M04-192	0.09	7.64	2.24	33.25	54.51	0.98	2.43	0.06	0	0	0	0	0	0.46	0.07	0	101.73
M04-192	0.08	7.79	1.99	34.05	54.27	0.9	1.99	0.02	0	0	0	0	0	0.45	0	0	101.54
M04-192	0.1	7.64	2.34	33.94	54.88	1.02	2.17	0.03	0	0	0	0	0	0.53	0	0	102.65
M04-192	0.12	7.75	2.38	33.41	53.79	1.08	2.26	0.03	0	0	0	0	0	0.29	0	0	101.12
M04-192	0.06	7.77	2.39	33.96	54.03	0.9	2.15	0.01	0	0	0	0	0	0.57	0.06	0	101.90
M04-192	0.07	7.79	2.35	34.01	53.87	0.72	2.12	0.01	0	0	0	0	0	0.28	0.04	0	101.26
M04-192	0.18	6.83	4.09	33.05	53.32	0.58	2.55	0.03	0	0	0	0	0	0.59	0	0	101.22
M04-192	0.1	6.89	4.13	32.98	53.64	0.57	2.63	0	0	0	0	0	0	0.44	0.02	0	101.41
M04-192	0.13	7.91	2.45	33.78	54.48	1.07	2.46	0.04	0	0	0	0	0	0.45	0	0	102.77
M04-192	0.12	6.79	4.16	33.01	54.09	0.56	2.66	0.06	0	0	0	0	0	0.53	0.04	0	102.01
M04-192	0.07	6.63	4.18	32.81	54.48	0.7	2.63	0.01	0	0	0	0	0	0.64	0	0	102.15
U05-33	0	8.06	2.73	32.30	54.64	1.07	2.62	0	0.15	0	0	0	0	0	0.03	0	101.60
U05-33	0	8.22	2.87	32.21	54.40	0.84	2.51	0.05	0.27	0.01	0	0.04	0.04	0	0.02	0	101.48
U05-33	0.05	8.21	2.91	33.24	53.56	0.61	2.75	0.09	0	0	0.09	0	0	0	0	0	101.52
U05-33	0	8.13	3.01	32.31	54.74	0.9	2.5	0	0.27	0.02	0	0.06	0.06	0	0.08	0	102.08
U05-33	0.13	8.02	2.96	32.87	53.45	1.01	2.66	0.03	0	0.02	0.01	0.11	0	0	0.03	0	101.30
U05-33	0.08	8.05	2.84	32.54	54.28	0.83	2.61	0.03	0.14	0	0.06	0.04	0	0	0	0.1	101.60
U05-33	0.05	8.37	2.68	33.01	53.88	1.04	2.57	0.01	0.09	0	0	0.06	0.09	0	0.04	0	101.88
U05-33	0.06	8.21	2.73	31.88	53.80	0.79	2.41	0.01	0.29	0.07	0	0	0	0	0.03	0.05	100.32
U05-33	0	8.19	2.68	33.01	53.85	0.9	2.65	0	0	0.02	0	0.05	0.01	0	0.06	0.01	101.43

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-33	0	8.16	2.56	32.80	53.95	1.01	2.64	0.04	0.01	0	0	0	0.02	0	0.03	0	101.22
U05-33	0	8.27	2.76	32.58	53.99	0.88	2.56	0.02	0.15	0	0	0	0	0	0	0.07	101.27
U05-33	0.15	8.17	2.79	33.22	53.09	0.74	2.66	0.04	0	0	0	0	0.11	0	0.17	0.07	101.21
U05-69	0.06	7.64	2.1	33.05	54.70	1.1	2.04	0.03	0	0	0.06	0.08	0.01	0	0.03	0	100.90
U05-69	0.11	8.24	2.84	33.55	52.77	0.95	2.29	0	0	0.03	0	0.06	0.08	0	0.12	0	101.04
U05-69	0.09	8.07	2.68	32.84	54.25	0.94	2.51	0	0.07	0.01	0.06	0	0.04	0	0.09	0.23	101.88
U05-69	0.03	7.93	2.98	32.85	54.00	0.98	2.64	0.04	0	0	0.04	0.22	0.03	0	0	0	101.74
U05-69	0.16	8.12	2.71	33.04	52.07	0.88	2.35	0.01	0.01	0	0	0	0.01	0	0.03	0	99.39
U05-69	0	8.02	2.79	33.14	54.06	0.98	2.49	0.03	0	0	0	0	0.01	0	0.1	0	101.61
U05-69	0.09	8.1	2.81	33.02	52.87	0.74	2.51	0.06	0	0.03	0.05	0	0.04	0	0.05	0	100.37
U05-69	0.04	8.11	2.8	32.96	53.97	0.81	2.69	0.04	0.01	0.04	0.11	0	0.03	0	0.09	0	101.70
U05-69	0	7.89	2.8	32.01	55.14	0.86	2.69	0	0.21	0	0	0	0.04	0	0.01	0	101.65
U05-69	0	7.92	2.14	33.21	54.74	1.02	2.22	0.04	0	0	0	0	0	0	0.1	0.02	101.41
U05-69	0	8.43	3.04	33.45	52.86	0.84	2.6	0.02	0	0	0.01	0	0.03	0	0.09	0	101.37
U05-69	0.07	8.23	2.11	33.63	53.40	0.95	2	0	0	0.01	0	0	0.06	0	0	0.1	100.56
U05-69	0.09	8.23	2.79	32.94	53.27	1.02	2.65	0.03	0	0.02	0	0.09	0	0	0.06	0.03	101.22
U05-4	0.15	8.51	4.12	31.50	51.63	0.53	4.23	0.04	0	0	0	0	0.02	0	0.01	0.14	100.88
U05-4	0.19	8.24	4.15	31.11	51.08	0.5	4.16	0.05	0	0	0.1	0	0	0	0.05	0.09	99.72
U05-4	0	8.58	4.11	31.20	51.34	0.56	4.11	0.08	0	0.03	0	0	0.05	0	0	0.1	100.16
U05-4	0.11	8.47	4.27	31.06	51.85	0.57	4.21	0.06	0	0.08	0	0	0.07	0	0	0.31	101.06
U05-4	0.14	8.56	3.43	33.06	51.15	0.83	2.77	0.04	0	0.04	0	0	0.01	0	0.06	0	100.09
U05-4	0	8.31	4.1	30.45	52.51	0.69	4.02	0.05	0.2	0	0.08	0.03	0.03	0	0.12	0	100.59
U05-4	0	8.21	4.06	30.99	52.54	0.6	4.32	0	0	0	0	0	0.06	0	0.09	0	100.87
U05-4	0.08	7.61	3.93	31.33	53.12	0.66	3.64	0	0	0.02	0.05	0	0.1	0	0.11	0	100.66
U05-4	0.09	8.73	4.31	31.47	50.69	0.54	4.07	0.09	0	0.06	0	0	0	0	0.02	0.11	100.18
U05-4	0	8.56	3.85	31.17	51.46	0.67	4.16	0.02	0	0	0	0.03	0.02	0	0.12	0	100.06
U05-4	0	8.57	4.33	31.29	50.96	0.56	4.21	0	0	0.02	0	0.09	0	0	0.16	0	100.19
U05-4	0.2	8.3	4.34	30.83	51.58	0.62	4.41	0.11	0	0.06	0.05	0	0.04	0	0.03	0	100.57
U05-4	0.11	7.93	4.03	30.29	52.23	0.36	3.69	0.02	0.21	0.06	0	0	0.08	0	0	0.2	99.21
U05-4	0.01	8.37	4	30.85	51.42	0.63	4.16	0.11	0	0	0	0	0.04	0	0.03	0	99.62
U05-8	0.04	8.72	4.27	31.88	51.01	0.52	3.85	0	0.06	0.01	0.02	0.03	0.03	0	0	0.01	100.45
U05-8	0.08	7.19	3.58	31.26	54.82	0.66	3.53	0	0	0.03	0.02	0.05	0	0	0.11	0	101.33
U05-8	0.15	13.1	1.42	38.85	44.09	0.6	1.47	0	0	0.05	0	0	0.03	0	0.06	0	99.82
U05-8	0.03	6.38	6.68	29.04	52.34	0.35	4.6	0.05	0	0.03	0.01	0.04	0.04	0	0.15	0.23	99.97
U05-8	0.14	7.27	6.14	30.51	51.72	0.33	4.5	0.06	0	0.01	0.03	0	0.04	0	0.05	0.07	100.87
U05-8	0.16	7.94	6.67	29.38	50.83	0.28	4.82	0.03	0.34	0	0.09	0	0	0	0.12	0.12	100.78
U05-8	0.32	4	8.07	25.70	56.71	0.39	5.78	0.02	0.18	0.02	0.01	0	0	0	0.35	0.12	101.67
U05-8	0.1	6.8	3.2	31.70	56.42	0.86	2.12	0	0.24	0.08	0.02	0	0	0	0.11	0.06	101.71

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-8	0.01	6.59	4.46	31.93	54.64	0.46	2.81	0	0	0	0	0	0.03	0	0	0.13	101.06
U05-8	0.24	6.93	3.37	32.12	54.80	0.78	2.69	0	0.01	0.06	0	0.02	0	0	0.01	0	101.03
U05-8	0.15	7.84	2.01	33.24	54.26	0.54	1.81	0.1	0.18	0	0.13	0	0.08	0	0.19	0.04	100.56
U05-9	0.19	6.31	5.56	31.06	53.97	0.48	3.14	0.01	0.07	0.07	0	0	0.03	0	0	0.17	101.06
U05-9	0.09	8.42	2.52	32.21	53.64	0.82	2.71	0	0.22	0.03	0	0	0	0	0.18	0	100.85
U05-9	0.47	1.68	6.28	26.40	61.54	1.15	3.89	0	0	0	0	0.05	0	0	0	0.05	101.50
U05-9	0.07	9.47	3.26	34.52	49.50	0.56	2.5	0	0	0	0	0	0.07	0	0.03	0	99.98
U05-9	0.11	6.31	1.67	32.30	57.91	1.19	1.23	0.05	0.17	0.02	0.04	0	0.04	0	0.15	0	101.19
U05-9	0.23	7.71	6.07	32.36	51.09	0.58	3.54	0	0	0.09	0.04	0.08	0	0	0.05	0	101.84
U05-9	0.02	7.31	4.31	31.84	53.56	0.78	2.66	0.02	0.15	0.01	0.2	0.08	0.01	0	0.08	0	101.03
U05-9	0.05	6.16	6.41	30.04	54.11	0.5	3.73	0	0.07	0.05	0.02	0.05	0.05	0	0.11	0.38	101.73
U05-9	0.17	6.01	7.42	30.33	52.63	0.3	4.1	0.05	0	0	0	0	0.05	0	0.1	0.2	101.36
U05-9	0.04	7.11	6.8	28.92	53.48	0.34	4.46	0.02	0.43	0.02	0	0.11	0.06	0	0.2	0.15	102.14
U05-9	0.15	7.21	3.66	31.97	53.36	0.78	2.88	0	0	0.01	0	0	0	0	0.2	0	100.23
U05-9	0.09	6.33	6.35	31.46	52.80	0.25	3.45	0	0	0	0	0.01	0	0	0.16	0	100.90
U05-9	0.07	6	6.35	30.99	52.88	0.41	3.24	0.05	0.01	0	0	0	0.03	0	0.18	0	100.21
U05-9	0.2	6.07	6.44	31.42	53.19	0.33	3.38	0	0.01	0	0	0	0.06	0	0.04	0.01	101.15
U05-9	0.06	6.24	7.69	30.55	51.68	0.14	4.1	0.06	0.01	0	0.02	0.07	0.01	0	0.17	0	100.80
U05-0	0.07	6.29	2.83	33.17	55.67	0.7	2.47	0.05	0	0.02	0	0.01	0.01	0	0.07	0.14	101.51
U05-0	0.05	5.58	3.27	32.04	56.91	0.84	2.5	0	0.1	0.04	0	0.01	0.05	0	0.02	0	101.41
U05-0	0.23	6.37	2.62	32.84	56.47	0.81	2.52	0.09	0.14	0.02	0	0	0.02	0	0	0.11	102.24
U05-0	0.19	6.39	2.74	33.59	55.62	0.88	2.42	0.05	0	0.03	0	0	0	0	0.14	0	102.04
U05-0	0.37	6.47	2.6	34.04	55.31	0.75	2.42	0.02	0	0.04	0.04	0	0.05	0	0.1	0	102.21
U05-0	0.1	6.87	2.44	33.77	54.39	0.86	1.9	0	0.14	0	0	0	0.09	0	0.11	0	100.67
U05-0	0.22	6.28	2.85	33.19	55.79	0.65	2.59	0	0	0.08	0.15	0.01	0	0	0.03	0.18	102.02
U05-0	0.12	6.43	2.87	33.22	55.84	0.74	2.26	0	0.18	0	0	0.07	0.06	0	0.08	0	101.87
U05-0	0.21	6.55	2.56	32.98	56.63	0.8	2.34	0	0.29	0	0	0	0	0	0.16	0	102.52
U05-0	0.1	6.39	2.43	33.20	56.25	1.11	2.14	0.03	0.1	0	0	0	0	0	0	0	101.74
U05-1	0.29	7.14	3.78	35.50	53.11	0.55	1.77	0.04	0.14	0.02	0	0	0.05	0	0.13	0	102.52
U05-1	0.06	8.61	1.52	35.90	52.25	0.77	1.87	0.03	0	0.03	0	0	0.02	0	0	0.05	101.10
U05-1	0.12	9.38	1.46	36.09	51.81	0.67	1.76	0	0.2	0.06	0.02	0.08	0.15	0	0	0.21	102.01
U05-1	0.01	8.08	2.21	34.35	52.84	0.84	2.26	0.03	0.1	0	0	0.02	0.06	0	0	0.05	100.85
U05-1	0	9.54	1.29	35.99	50.58	0.82	2.06	0.08	0	0.06	0	0	0.04	0	0	0	100.46
U05-1	0.13	8.48	2.05	36.05	51.89	0.82	1.88	0.08	0	0	0.02	0	0	0	0.05	0.05	101.50
U05-1	0.31	7.14	3.22	33.87	52.50	0.7	2.52	0.07	0	0.1	0.04	0.05	0.04	0	0.13	0	100.69
U05-1	0.16	8.89	2.22	37.43	51.82	0.81	1.61	0	0.01	0.02	0	0	0.1	0	0	0	103.08
U05-7	0.1	6.99	2.62	33.93	54.39	0.47	2.57	0.02	0	0	0	0	0	0	0.12	0.18	101.39
U05-7	0.07	6.85	3.28	32.52	54.13	0.63	2.98	0.03	0.1	0	0	0.05	0.04	0	0.08	0.11	100.87

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-7	0.11	6.92	3.05	33.74	54.78	0.59	2.88	0	0	0.02	0	0	0	0	0.09	0	102.18
U05-7	0.06	6.89	3.39	32.58	53.76	0.8	3.12	0.08	0.01	0.01	0	0	0.1	0	0.07	0	100.87
U05-7	0.04	7.07	3.39	31.46	54.86	0.65	3.12	0.13	0.26	0.07	0.06	0	0.12	0	0.01	0.28	101.52
U05-7	0.17	6.52	2.52	33.20	56.15	0.85	2.44	0.03	0.11	0.04	0.01	0.08	0.06	0	0.13	0	102.31
U05-7	0.1	7.1	3.14	32.85	54.46	0.72	2.76	0.07	0.16	0.06	0	0	0.05	0	0.03	0	101.50
U05-7	0.1	7.03	3.3	32.77	54.87	0.86	3.3	0.05	0.06	0	0	0	0.03	0	0.08	0	102.45
U05-7	0.1	5.93	0.76	34.16	57.78	0.89	1.26	0.08	0	0	0.02	0	0.09	0	0.01	0.04	101.12
U05-7	0.06	6.84	3.21	33.66	54.51	0.69	2.73	0.01	0	0	0	0.01	0	0	0.08	0.04	101.84
U05-7	0.09	6.23	0.98	34.35	58.25	0.92	1.56	0.07	0	0.05	0	0	0	0	0.05	0	102.54
U05-7	0.09	6.45	2.87	32.60	56.65	0.81	2.45	0	0.26	0.02	0.07	0	0.02	0	0.09	0	102.38
U05-8	0.18	7.28	3.68	32.55	53.99	0.84	2.81	0.01	0.33	0.02	0	0	0.1	0	0	0	101.79
U05-8	0.09	9.88	3.99	34.21	46.86	0.38	3.56	0.01	0.17	0	0	0	0.07	0	0.11	0	99.33
U05-8	0.12	8.15	3.78	34.08	51.29	0.61	2.91	0.23	0	0.09	0.14	0.04	0.06	0	0	0.17	101.67
U05-8	0	7.26	4.88	33.32	52.02	0.52	3.08	0	0.1	0.01	0	0	0.05	0	0.11	0	101.35
U05-8	0.2	6.85	5.24	32.52	52.32	0.36	3.94	0.01	0	0.03	0	0	0.05	0	0.04	0.02	101.58
U05-8	0.11	7.13	4.94	32.92	52.03	0.69	3.41	0.04	0.01	0	0	0	0	0	0.11	0.23	101.62
U05-8	0.03	6.96	5.43	31.90	52.21	0.27	4.35	0.01	0	0	0	0	0.09	0	0.06	0	101.31
U05-8	0.11	7.2	4.99	34.14	51.78	0.65	2.8	0	0	0.06	0.08	0.03	0.11	0	0.04	0.03	102.02
U05-8	0.12	6.48	3.39	32.52	56.57	0.74	2.45	0.06	0.34	0.03	0.02	0.01	0	0	0.03	0	102.76
U05-8	0.1	7.14	4.89	33.80	51.95	0.54	3.11	0	0	0.02	0	0.05	0	0	0.13	0	101.73
U05-8	0	6.72	3.52	33.15	54.10	0.58	2.76	0	0.01	0	0	0.02	0.05	0	0.07	0.24	101.21
U05-8	0.08	6.93	3.32	33.34	54.06	0.8	2.89	0.09	0	0	0	0	0.06	0	0.21	0	101.79
U05-14	0.03	7.28	1.58	34.58	54.61	1.56	1.43	0.11	0	0	0.06	0.16	0	0	0	0	101.41
U05-14	0.02	8.51	2.67	35.68	51.69	0.74	1.83	0	0.12	0.04	0	0	0	0	0.1	0	101.40
U05-14	0.13	7.47	1.29	35.37	55.23	1.05	1.62	0.03	0	0.04	0.05	0	0.02	0	0	0	102.30
U05-14	0.1	7.8	1.26	35.75	54.67	1.41	1.31	0	0.01	0	0.01	0	0.07	0	0	0.19	102.58
U05-14	0.09	7.8	1.61	35.45	53.81	1.34	1.33	0.05	0	0.08	0	0	0.03	0	0.03	0.06	101.68
U05-14	0.13	7.11	1.65	34.28	55.37	1.54	1.77	0	0.01	0.02	0.06	0	0.07	0	0	0.05	102.06
U05-14	0.21	7.17	1.97	34.06	55.21	1.21	1.83	0.04	0.12	0.04	0.06	0.11	0.07	0	0	0.19	102.30
U05-14	0.18	7.84	1.66	35.03	53.28	1.15	1.64	0	0.11	0	0	0	0	0	0.16	0	101.05
U05-14	0.2	9.03	1.3	35.41	51.74	1.26	1.97	0.15	0.09	0	0	0	0.07	0	0	0	101.22
U05-14	0.01	7.67	1.8	35.00	54.07	1.13	1.49	0.02	0.08	0	0	0	0.06	0	0.1	0.18	101.61
U05-19	0.13	7.64	1.83	33.42	55.48	1.12	1.4	0.01	0.51	0.05	0	0	0.04	0	0.01	0.1	101.74
U05-19	0.11	7.18	2.11	35.00	54.30	0.94	1.74	0.04	0	0.01	0	0	0.03	0	0.12	0.01	101.59
U05-19	0.09	7.53	1.98	34.59	53.75	1.22	1.73	0	0	0.05	0	0	0.08	0	0.13	0.31	101.46
U05-19	0.09	6.33	0.73	34.72	57.76	1.18	0.88	0.02	0.11	0	0	0	0	0	0.09	0	101.91
U05-19	0.15	8.09	1.21	36.00	53.31	0.83	1.64	0	0	0	0.15	0.03	0.05	0	0.04	0	101.50
U05-19	0.08	7.54	1.8	33.68	55.33	1.26	1.74	0.07	0.28	0.01	0	0.07	0.05	0	0	0.11	102.02

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-19	0.11	8.96	1.21	36.28	51.20	0.79	1.79	0	0	0	0.02	0.02	0.05	0	0	0	100.43
U05-19	0.11	7.32	2.2	34.07	54.20	1.24	1.78	0	0.14	0.02	0	0	0.06	0	0.04	0	101.18
U05-19	0.08	7.55	2.01	33.65	54.50	1.2	1.84	0.02	0.22	0.07	0	0.06	0.11	0	0	0	101.31
U05-19	0.01	7.46	1.94	34.38	53.16	1.13	1.8	0	0	0	0.06	0	0.01	0	0	0	99.95
U05-19	0.21	7.98	1.91	35.78	53.59	1.09	1.3	0	0.19	0	0	0	0.02	0	0.01	0.02	102.09
U05-24	0.14	7.74	2.28	35.74	53.70	1.09	1.65	0.14	0.01	0	0	0	0	0	0	0	102.49
U05-24	0.04	7.62	1.97	35.54	53.14	1.08	1.39	0.01	0	0	0	0	0.04	0	0.05	0	100.89
U05-24	0.08	7.3	2.45	34.26	55.27	0.98	1.63	0.02	0.3	0	0	0.07	0.1	0	0.08	0.04	102.58
U05-24	0.11	7.08	2.31	34.10	55.79	0.92	1.53	0	0.32	0.02	0	0	0.08	0	0	0.04	102.30
U05-24	0.14	7.1	2.29	33.62	55.26	0.91	1.63	0.08	0.34	0	0	0.03	0.06	0	0	0.07	101.53
U05-24	0.13	7.1	2.39	33.83	55.85	1.03	1.5	0.01	0.36	0.09	0.03	0.06	0.03	0	0.19	0	102.60
U05-24	0.14	7.66	2.2	34.31	55.15	1.11	1.98	0	0.21	0.08	0	0	0.02	0	0.02	0	102.89
U05-24	0.26	7.75	2.23	35.64	53.23	1.06	1.72	0.03	0	0.07	0.01	0	0.06	0	0	0	102.06
U05-24	0.22	7.86	2.17	34.24	54.49	1.04	1.85	0	0.36	0.01	0.12	0.01	0.05	0	0.14	0.07	102.63
U05-24	0.31	7.21	2.27	35.44	54.18	0.98	1.44	0	0.13	0	0	0	0.12	0	0.14	0	102.22
U05-24	0.18	7.1	2.45	33.55	55.58	1.07	1.68	0.15	0.34	0	0.04	0	0	0	0.15	0.22	102.52
U05-32	0.14	7.92	2.7	34.77	53.03	0.7	2.73	0	0	0	0.05	0	0	0	0.01	0	102.06
U05-32	0	8.14	2.74	34.23	53.43	0.91	2.58	0.03	0.15	0	0	0.06	0	0	0.09	0	102.36
U05-32	0.14	7.74	2.2	34.80	54.10	1.17	1.93	0.01	0.11	0.01	0	0.12	0.05	0	0	0.04	102.42
U05-32	0.12	7.61	2.17	35.09	53.28	1.12	1.69	0.09	0	0.04	0	0	0.08	0	0.06	0	101.35
U05-32	0.06	7.37	2.42	35.39	53.84	0.92	1.65	0.04	0	0.02	0.03	0.01	-0.01	0	0.14	0	101.88
U05-32	0.08	7.97	2.83	34.06	52.10	0.92	2.52	0.05	0	0.11	0	0	0.03	0	0.01	0	100.68
U05-32	0.16	7.92	2.83	34.47	52.10	0.8	2.51	0	0	0.07	0	0.04	0.1	0	0.07	0.08	101.15
U05-32	0.19	8.05	2.69	34.48	52.49	0.98	2.47	0.01	0.09	0.01	0	0	0.02	0	0	0	101.48
U05-32	0.08	7.98	2.61	32.89	53.03	0.88	2.54	0	0.32	0.02	0	0	0.09	0	0	0	100.44
U05-32	0	7.55	3.6	32.98	53.02	0.64	2.73	0	0.22	0.02	0	0	0	0	0.11	0.18	101.05
U05-36	0.13	8.94	1.66	36.95	52.62	0.91	1.82	0.02	0	0	0	0	0.04	0	0	0.1	103.19
U05-36	0.18	9.87	1.29	37.08	51.76	1.12	1.63	0.07	0.18	0.05	0	0	0.01	0	0.13	0	103.37
U05-36	0.13	9.66	2.76	35.80	51.07	0.88	2.87	0.04	0.09	0	0	0	0.02	0	0	0.24	103.56
U05-36	0.29	8.11	1.95	35.84	54.10	1.08	2.05	0	0	0.11	0	0	0.04	0	0.02	0	103.59
U05-36	0.1	8.87	1.76	36.99	52.89	1.03	1.54	0.03	0.08	0	0	0	0	0	0.09	0	103.38
U05-36	0.14	8.41	2.1	34.78	53.57	0.99	1.7	0.79	0.21	0	0.4	0	0	0	0	0	103.10
U05-36	0	8.58	2.18	35.67	53.06	1.08	1.96	0	0.05	0.08	0.05	0.08	0.01	0	0.02	0	102.82
U05-36	0.32	8.35	2.23	36.27	52.73	0.89	2.19	0	0	0.01	0	0	0.03	0	0.06	0	103.08
U05-36	0.11	8.46	2.47	35.57	52.86	0.86	2.36	0	0	0.05	0	0	0.05	0	0.05	0.2	103.04
U05-36	0.09	9.42	1.27	38.10	51.67	0.99	1.02	0.04	0.05	0.01	0	0	0.05	0	0	0	102.72
U05-36	0.36	7.97	1.81	35.83	53.17	1	1.87	0.12	0	0	0	0.15	0.09	0	0.04	0.09	102.50
U05-44	0.02	8.27	2.54	35.09	52.98	0.9	2.49	0.08	0	0	0	0	0	0	0.07	0.04	102.48

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-44	0.09	8.15	2.84	34.82	53.48	0.7	2.72	0	0.1	0	0.05	0	0	0	0.03	0	102.98
U05-44	0.1	8.08	2.37	33.51	53.83	1.02	2.67	0	0.21	0.05	0.09	0.12	0.07	0	0.1	0	102.22
U05-44	0.29	8.26	2.62	35.01	52.25	0.97	2.73	0	0	0.02	0	0.04	0	0	0.05	0	102.23
U05-44	0.23	9.2	3.96	35.25	49.73	0.58	3.56	0.06	0	0	0.03	0.04	0.03	0	0	0	102.67
U05-44	0.08	8.38	2.57	35.20	53.12	1.03	2.66	0.04	0	0	0	0	0	0	0.12	0	103.19
U05-44	0.07	8.26	2.73	33.88	53.65	1.26	2.73	0.06	0.15	0.05	0.01	0	0.04	0	0.15	0	103.04
U05-44	0.15	8.21	2.84	35.05	52.93	1.16	2.61	0.04	0	0.01	0	0.02	0.03	0	0.06	0	103.11
U05-44	0.18	8.12	2.65	35.22	53.17	0.83	2.58	0.03	0	0	0	0.07	0.05	0	0.06	0.16	103.12
U05-44	0.02	7.99	2.44	35.21	53.93	1.05	2.26	0.01	0	0.04	0	0	0.07	0	0.13	0	103.15
U05-51	0.17	8.12	2.72	34.47	53.95	0.96	2.52	0.04	0.18	0.06	0.04	0.05	0.07	0	0.11	0	103.46
U05-51	0.08	9.62	1.72	36.96	51.46	0.74	1.76	0.09	0.16	0	0	0	0	0	0.05	0	102.63
U05-51	0.01	8.17	2.68	35.37	53.23	0.88	2.41	0	0	0	0	0	0	0	0	0	102.75
U05-51	0.21	8.07	2.67	34.81	53.26	1.09	2.49	0	0	0.06	0	0	0	0	0	0.29	102.95
U05-51	0.05	9.69	2.47	38.10	50.67	0.88	1.74	0	0	0	0	0.01	0.05	0	0.04	0.02	103.72
U05-51	0.05	8.29	2.61	35.42	52.64	0.85	2.38	0	0	0	0	0	0.08	0	0.04	0.05	102.41
U05-51	0.01	8.15	2.6	35.05	53.35	0.72	2.61	0	0	0.03	0	0	0	0	0.05	0	102.57
U05-51	0.11	9.83	2.8	35.92	50.28	0.79	3.05	0	0	0.1	0	0.02	0	0	0	0	102.90
U05-51	0.15	8.3	2.83	35.45	53.11	0.85	2.7	0	0.01	0	0.06	0.01	0.05	0	0.01	0	103.53
U05-56	0.09	7.14	5.19	34.21	51.79	0.38	3.04	0.01	0	0	0	0	0	0	0.03	0	101.88
U05-56	0.37	9.61	2.83	35.75	49.92	0.91	3.02	0.11	0.09	0	0.01	0.09	0.02	0	0.18	0	102.91
U05-56	0.01	9.85	2.73	35.82	51.14	0.8	3.15	0.04	0	0.09	0	0.02	0	0	0.08	0.08	103.81
U05-56	0.05	9.18	3	35.35	50.85	0.89	2.87	0	0.01	0.06	0	0	0.02	0	0.06	0	102.34
U05-56	0.1	8.46	2.77	35.86	51.54	0.79	2.18	0.08	0	0	0	0.01	0.05	0	0.11	0	101.95
U05-56	0.1	7.04	4.72	32.94	53.96	0.53	3.05	0.12	0.23	0.03	0	0.01	0.07	0	0.01	0	102.81
U05-56	0.2	9.69	2.69	36.00	49.95	0.89	2.92	0.05	0	0.02	0.04	0	0.01	0	0.08	0.07	102.61
U05-56	0.07	9.79	2.75	35.62	50.72	0.85	2.99	0.03	0.1	0	0.05	0.05	0.08	0	0	0.11	103.22
U05-56	0.19	9.86	2.7	36.33	49.90	0.72	2.72	0	0.12	0	0.01	0.06	0.07	0	0.12	0	102.79
U05-56	0.25	9.28	2.96	35.36	51.03	1.08	3.05	0.08	0	0.08	0	0.06	0.06	0	0.13	0.1	103.52
U05-56	0.13	9.88	2.53	36.37	49.84	0.73	2.91	0.02	0	0	0.06	0.01	0.01	0	0.06	0	102.55
U05-56	0.13	10.02	2.53	36.52	49.79	0.82	2.82	0.01	0	0	0.1	0	0	0	0.03	0.15	102.92
U05-60	0.21	9.82	2.79	36.23	48.77	0.78	2.65	0.04	0	0.06	0	0	0.03	0	0.03	0.07	101.48
U05-60	0.25	9.72	1.96	36.94	48.94	0.87	2.02	0	0	0.01	0.01	0.07	0.04	0	0.1	0.07	101.00
U05-60	0.08	9.34	1.81	36.23	50.07	0.91	1.73	0.09	0.06	0.03	0	0	0.1	0	0.16	0.06	100.67
U05-60	0.23	9.98	0.99	38.05	49.72	1.1	1.36	0	0	0	0.11	0	0.03	0	0.04	0	101.61
U05-60	0.17	9.48	1.48	35.73	50.31	0.87	2.07	0.1	0.11	0.03	0	0.02	0	0	0.1	0	100.47
U05-60	0.17	7.98	2.88	34.96	53.01	0.92	2.64	0.03	0	0	0.01	0	0.04	0	0	0	102.64
U05-60	0.14	8.23	2.74	35.28	53.65	1.01	2.54	0.04	0.01	0.04	0	0	0.01	0	0	0.12	103.81
U05-60	0.16	8.31	3.02	35.06	52.95	1.02	2.83	0	0	0.05	0	0	0.04	0	0.1	0	103.55

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-60	0	8.14	2.79	34.26	54.68	0.97	2.79	0	0.13	0.07	0	0	0.04	0	0.05	0	103.92
U05-60	0.18	8.3	2.76	35.61	52.90	0.87	2.51	0.12	0	0	0	0.08	0.01	0	0.04	0.01	103.39
U05-60	0.08	8.14	2.25	34.90	53.45	0.91	1.99	0	0.2	0	0	0.04	0.09	0	0.13	0	102.18
U05-60	0.14	8.27	2.8	35.53	53.56	1.1	2.5	0	0	0.05	0.01	0.05	0.01	0	0.01	0	104.03
U05-60	0.28	8.54	2.92	34.75	53.27	0.95	2.53	0.07	0.23	0.09	0.01	0	0	0	0.07	0.11	103.82
U05-60	0	8	2.64	34.49	53.32	1.03	2.67	0	0	0	0	0.08	0	0	0.11	0	102.34
U05-60	0.21	7.84	2.11	35.53	54.32	1	1.95	0.04	0.07	0	0	0.03	0.05	0	0.01	0.06	103.22
U05-71	0.15	8.59	2.86	34.65	53.36	0.86	3.01	0.01	0.15	0.04	0	0	0.05	0	0.19	0	103.92
U05-71	0.22	8.26	2.71	34.75	53.53	0.95	2.7	0.04	0.14	0	0.02	0	0.08	0	0.03	0	103.43
U05-71	0.04	8.29	2.88	33.23	54.21	0.81	3	0	0.36	0	0	0	0.03	0	0.11	0	102.96
U05-71	0.09	8.27	2.73	33.82	52.22	1	2.83	0.44	0	0	0.12	0.04	0	0	0	0.07	101.63
U05-71	0.14	8.25	2.85	34.50	52.53	1.02	2.84	0.01	0	0.01	0	0	0.04	0	0	0.18	102.36
U05-71	0.13	8.37	2.75	34.54	52.10	0.99	2.77	0.05	0	0.04	0	0.06	0.03	0	0	0.05	101.88
U05-71	0.17	8.38	2.68	34.83	51.83	1	2.74	0	0	0	0	0.03	0.01	0	0.08	0	101.74
U05-71	0.1	8.24	2.78	33.38	53.33	0.81	2.87	0.05	0.27	0.01	0	0	0.1	0	0.11	0.09	102.14
U05-71	0.07	8.08	2.78	33.92	53.21	0.86	2.54	0.02	0.2	0.01	0	0.11	0	0	0	0.06	101.86
U05-71	0.12	8.27	2.61	34.26	53.46	0.74	2.93	0.01	0.13	0.02	0.05	0	0.02	0	0.03	0	102.65
U05-74	0.06	7.24	2.77	33.79	54.00	0.73	2.73	0.02	0	0	0	0.03	0.03	0	0.01	0	101.41
U05-74	0.05	7.3	3.04	33.52	54.04	0.78	3.06	0	0	0	0	0.02	0.07	0	0.11	0	101.99
U05-74	0.04	7.61	2.88	34.14	53.91	0.76	2.47	0	0.13	0	0	0	0.02	0	0	0	101.96
U05-74	0.06	7.37	2.79	34.04	54.39	0.88	2.23	0	0.16	0	0	0.07	0.02	0	0	0	102.01
U05-74	0.22	7.36	2.94	33.19	54.20	0.59	2.47	0.29	0.28	0.02	0.05	0.01	0.08	0	0.09	0	101.79
U05-74	0.18	7.26	2.77	33.76	52.51	0.86	2.33	0.01	0	0.04	0	0	0	0	0.08	0.16	99.96
U05-74	0.18	7.35	2.81	34.29	53.43	0.61	2.65	0.04	0	0	0	0.06	0.09	0	0.13	0.05	101.69
U05-74	0.1	7.51	2.89	33.96	52.95	0.8	2.67	0.03	0.01	0	0.13	0.06	0.05	0	0.04	0	101.20
U05-74	0	7.41	2.92	33.85	54.14	0.8	2.74	0.06	0	0.04	0	0	0	0	0.09	0.01	102.06
U05-74	0.1	7.79	3.01	34.43	52.95	0.83	2.57	0	0.06	0	0	0	0	0	0	0	101.74
U05-74	0.05	7.83	2.87	33.95	55.14	0.98	2.78	0.01	0.15	0.07	0.02	0	0.08	0	0.02	0	103.95
U05-78	0	10.57	1.81	37.20	48.46	0.98	2.04	0	0	0.04	0	0	0.11	0	0.01	0.12	101.34
U05-78	0.1	9.92	2.46	36.72	47.91	1	1.84	0.06	0	0.09	0	0	0.03	0	0.12	0	100.24
U05-78	0.4	10.72	2.02	37.68	47.15	0.97	1.64	0.02	0.23	0	0	0	0.04	0	0.15	0	101.02
U05-78	0.12	10.65	2.49	37.97	47.66	0.97	2.02	0	0	0.01	0.06	0	0.04	0	0.06	0.08	102.13
U05-78	0.18	10.12	2.3	36.77	50.02	0.71	2.29	0.11	0.14	0.04	0	0.14	0.01	0	0.05	0.11	102.99
U05-78	0.19	9.92	2.43	37.02	49.47	1	2.03	0.09	0	0.12	0	0	0.05	0	0	0.05	102.37
U05-78	0.16	4.69	2.23	31.30	60.64	1.19	2.03	0	0.23	0.04	0	0	0	0	0	0.07	102.58
U05-78	0.2	10.51	2.02	37.91	48.58	0.9	1.7	0	0.15	0	0	0	0	0	0.12	0	102.08
U05-78	0.26	9.41	2.84	36.26	49.00	0.86	2.34	0.11	0	0.06	0.04	0.09	0.02	0	0.16	0	101.45
U05-78	0.21	9.95	1.95	38.68	48.94	1.06	1.05	0.03	0	0	0.02	0.02	0.04	0	0.04	0.16	102.15

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-81	0.17	10.19	2.01	37.14	48.99	1.06	1.71	0.11	0.1	0.06	0	0.02	0.01	0	0.03	0	101.60
U05-81	0.19	14.97	1.64	41.23	39.45	0.97	2.2	0.06	0	0.02	0	0	0.04	0	0.07	0.04	100.88
U05-81	0.17	10.33	1.94	36.82	49.55	0.85	1.97	0.13	0.23	0	0	0	0.06	0	0.09	0	102.13
U05-81	0.05	10.55	0.97	37.72	50.11	1.03	1.26	0.07	0.16	0.08	0	0	0.05	0	0	0	102.05
U05-81	0.14	7.75	0.98	37.02	54.83	0.64	0.62	0	0.13	0.01	0	0	0.1	0	0	0.08	102.30
U05-81	0.06	9.96	1.79	37.25	50.26	1.13	1.69	0	0.09	0	0	0.1	0	0	0	0	102.33
U05-81	0.23	10.62	1.78	37.13	48.90	1.05	1.99	0.1	0.18	0	0.03	0.03	0	0	0	0	102.04
U05-81	0.07	11.03	1.62	37.62	48.68	0.96	1.94	0.03	0.08	0.13	0	0.2	0.05	0	0	0	102.41
U05-81	0.21	10.63	1.55	36.92	49.21	1.1	1.67	0	0.32	0.01	0.02	0.09	0.01	0	0.09	0	101.82
U05-91	0.13	9.67	3.2	34.26	50.46	0.82	3.37	0	0.28	0	0.12	0.17	0.02	0	0.11	0	102.61
U05-91	0.07	9.51	3.32	34.24	49.74	0.67	3.29	0	0.19	0.03	0	0.03	0.06	0	0	0	101.15
U05-91	0.18	9.66	3.28	35.18	49.25	0.59	3.45	0	0.06	0	0.02	0.08	0.06	0	0	0	101.82
U05-91	0.15	9.57	3.55	34.64	50.44	0.85	3.41	0.07	0.15	0.06	0.09	0.04	0	0	0	0	103.02
U05-91	0.13	9.41	3.38	34.46	49.34	0.87	3.64	0	0	0	0	0.14	0.02	0	0.03	0	101.42
U05-91	0.14	9.66	3.35	35.22	48.93	0.64	3.48	0	0.01	0	0	0.07	0.05	0	0.08	0	101.62
U05-91	0	9.58	3.32	34.53	49.63	0.71	3.61	0.06	0	0.02	0	0.19	0.07	0	0	0.07	101.78
U05-91	0.14	9.63	3.23	35.19	48.93	0.66	3.43	0	0	0	0.17	0	0	0	0.05	0	101.42
U05-91	0.2	9.38	3.2	34.94	49.56	0.64	3.44	0	0	0.05	0.07	0.09	0	0	0.04	0.01	101.63
U05-91	0.08	9.65	3.06	35.00	49.73	0.66	3.41	0.04	0	0.08	0	0.1	0.05	0	0.05	0	101.91
U05-91	0.24	9.91	3.15	34.90	49.94	0.8	3.48	0	0.12	0.12	0	0	0.01	0	0.03	0.04	102.73
U05-86	0.08	9.69	3.17	34.77	49.36	0.81	3.2	0	0.08	0.08	0	0.03	0	0	0.14	0.07	101.48
U05-86	0.15	9.88	3.27	33.70	50.11	0.82	3.07	0.03	0.39	0.11	0	0	0	0	0	0.27	101.80
U05-86	0.15	9.78	3.16	35.83	49.18	0.84	3.16	0.02	0	0	0	0	0.02	0	0.06	0	102.20
U05-86	0.25	9.75	2.98	35.95	48.76	0.77	2.97	0.03	0	0.03	0	0	0.01	0	0.06	0.03	101.59
U05-86	0.05	9.8	3.17	35.53	49.17	0.61	3.14	0.07	0	0.07	0	0	0.02	0	0	0	101.64
U05-86	0.17	9.62	3.23	35.18	49.23	0.91	3.06	0	0	0.15	0	0.11	0.05	0	0.02	0.02	101.75
U05-86	0.32	9.92	3.04	36.16	48.61	0.59	3.09	0.16	0	0.04	0	0	0	0	0	0	101.93
U05-86	0.17	9.79	3.06	35.67	49.14	0.91	2.9	0.06	0.07	0	0	0	0.08	0	0.02	0.05	101.93
U05-86	0.14	9.84	3.05	35.72	48.71	0.74	3.07	0.05	0	0.03	0	0	0	0	0.04	0	101.39
U05-86	0.25	8.81	3.34	34.91	51.25	0.83	3.1	0.02	0.06	0.04	0.12	0.01	0.04	0	0	0.06	102.84
U05-86	0.15	9.77	3.06	35.79	49.20	0.85	3.09	0.03	0	0	0	0	0.02	0	0	0.03	101.99
U05-88	0.17	8.87	3.57	34.55	50.34	0.76	3.39	0.02	0	0	0	0	0.03	0	0.01	0.15	101.87
U05-88	0.26	9.47	3.37	35.59	49.33	0.73	3.33	0	0	0	0	0	0.05	0	0.08	0	102.21
U05-88	0.12	9.6	3.2	34.66	50.36	0.79	3.14	0.09	0.22	0	0	0	0.06	0	0	0.02	102.26
U05-88	0.24	9.23	3.03	35.45	49.37	0.6	2.87	0.12	0	0.06	0	0	0	0	0.07	0	101.04
U05-88	0.22	9.1	3.59	34.96	50.34	0.7	3.41	0.08	0	0	0	0	0	0	0.03	0.25	102.68
U05-88	0.2	9.42	3.14	35.44	49.12	0.77	2.86	0.18	0	0.06	0.12	0.14	0.07	0	0.09	0	101.61
U05-88	0.13	9.34	3.25	35.02	49.79	0.9	3.24	0.01	0.01	0	0	0	0.06	0	0.03	0.04	101.82

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-88	0.18	9.16	3.1	33.22	50.80	0.72	3.27	0.12	0.33	0	0	0	0.02	0	0.06	0.14	101.12
U05-88	0.22	9.38	3.23	34.92	50.37	0.68	3.14	0	0.13	0.09	0.06	0	0.03	0	0.07	0.07	102.39
U05-88	0.23	9.44	3.35	34.45	49.71	0.78	3.22	0	0.22	0	0.07	0.09	0.02	0	0.07	0.03	101.68
U05-95	0.15	7.76	3.12	33.91	52.85	0.58	2.92	0	0.08	0	0	0	0.06	0	0.04	0.15	101.62
U05-95	0.12	7.69	3.58	33.72	52.83	0.5	3.26	0	0	0.1	0.17	0.02	0.05	0	0.06	0.02	102.13
U05-95	0.14	7.34	3.08	34.49	54.10	0.76	2.69	0.01	0	0.02	0	0	0	0	0.2	0	102.84
U05-95	0	7.85	2.96	34.32	52.93	0.79	2.69	0.05	0	0	0	0	0	0	0.04	0.06	101.69
U05-95	0.2	7.45	2.41	35.10	54.14	1.04	2.07	0.09	0	0	0.08	0	0.03	0	0.04	0	102.65
U05-95	0.26	7.67	2.95	35.03	53.03	0.82	2.19	0.07	0.09	0	0.17	0	0.05	0	0.03	0	102.36
U05-95	0.17	7.81	3.02	34.62	52.36	0.6	2.67	0	0	0.04	0	0	0.05	0	0	0	101.34
U05-95	0.35	7.42	3.06	33.05	54.93	0.9	2.75	0.03	0.36	0	0	0	0.14	0	0.03	0.08	103.10
U05-95	0.2	7.59	2.94	33.92	53.05	0.95	2.85	0	0	0.03	0	0	0.1	0	0.01	0	101.64
U05-95	0.16	7.52	3.05	34.74	51.77	0.52	2.26	0	0	0.02	0	0	0	0	0.05	0	100.10
U05-95	0.21	7.87	3.06	34.71	52.78	0.82	2.74	0	0.01	0.02	0	0	0.07	0	0	0	102.29
M04-100	0.05	8.99	3.13	34.18	50.03	0.78	3.05	0.08	0.11	0.03	0	0	0.1	0.33	0.21	0	101.07
M04-100	0.09	8.93	3.11	34.46	49.42	0.71	3.1	0.11	0	0	0	0	0.1	0.29	0	0	100.32
M04-100	0.09	9	3.03	33.31	49.44	0.83	3.24	0	0.12	0.04	0.05	0	0.08	0.42	0	0.22	99.87
M04-100	0.17	8.6	3.34	34.08	49.49	0.77	3.17	0	0	0.04	0	0.01	0	0.35	0	0	100.02
M04-100	0.19	8.83	3.3	34.42	49.73	0.81	3.11	0.13	0	0.04	0	0.05	0	0.48	0	0.17	101.26
M04-100	0.1	8.71	3.25	34.40	49.40	0.6	2.98	0	0	0.04	0	0	0.06	0.41	0	0.15	100.10
M04-100	0	8.79	3.21	34.00	48.92	0.62	3.01	0.18	0	0.01	0	0.08	0.02	0.4	0	0.01	99.26
M04-100	0.04	8.59	3.2	33.77	49.34	0.71	3.15	0	0	0	0.03	0	0.01	0.52	0	0.15	99.51
M04-100	0.14	8.62	3.14	34.13	50.33	0.62	3.21	0	0.01	0.05	0	0.11	0.01	0.45	0	0.19	101.01
M04-100	0.07	8.84	3.38	34.31	50.26	0.79	3.25	0	0	0.11	0.06	0.08	0.02	0.29	0.26	0	101.73
M04-99	0.03	10.34	1.68	35.69	47.44	0.68	2.31	0.05	0.05	0.05	0	0	0.06	0.54	0	0.43	99.35
M04-99	0.06	9.93	2.22	35.42	47.20	0.85	2.59	0.07	0	0	0	0.1	0.06	0.37	0	0	98.87
M04-99	0.06	9.92	2.25	35.96	48.02	0.83	2.51	0.11	0	0	0	0.02	0	0.5	0	0	100.18
M04-99	0.01	10.1	2.13	35.80	48.52	0.85	2.63	0	0	0	0.05	0.05	0	0.25	0	0.3	100.69
M04-99	0.06	10.25	2.3	36.47	48.08	0.87	2.6	0	0.01	0	0.15	0.11	0.02	0.43	0	0	101.34
M04-99	0.05	9.74	2.12	35.56	48.08	0.83	2.52	0.06	0	0.03	0	0	0	0.67	0	0	99.67
M04-99	0.06	10.13	2.21	36.11	48.02	0.89	2.52	0.11	0	0.01	0	0.15	0.06	0.32	0	0	100.59
M04-99	0.09	10.04	2.24	36.07	47.85	0.74	2.45	0.01	0.05	0	0	0.14	0	0.22	0	0	99.89
M04-99	0.19	10.03	2.25	36.18	47.63	0.68	2.48	0	0.07	0	0	0	0	0.47	0	0.05	100.03
M04-99	0	10.09	2.32	35.95	47.26	0.66	2.54	0.05	0	0	0	0.12	0.02	0.33	0	0	99.34
M04-99	0.06	9.67	2.41	35.20	48.71	0.87	2.86	0.05	0	0	0	0.03	0.01	0.43	0	0.12	100.42
M04-98	0.12	6.8	5.51	33.67	49.88	0.39	2.82	0	0	0.02	0	0.07	0.04	0.67	0	0	99.99
M04-98	0.08	6.7	5.47	32.76	51.29	0.41	3.07	0.03	0.08	0.06	0.13	0.12	0.04	0.48	0	0.03	100.75
M04-98	0.04	9.82	3.61	34.67	48.05	0.69	3.63	0.07	0	0.06	0	0	0.07	0.5	0	0	101.21

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-98	0.12	9.56	3.51	34.40	48.41	0.75	3.5	0	0.06	0.02	0.07	0.01	0.07	0.41	0	0.12	101.00
M04-98	0.18	9.47	3.44	34.53	47.28	0.64	3.31	0.08	0	0.02	0.09	0.04	0.05	0.43	0	0.11	99.67
M04-98	0.12	9.49	3.58	35.07	47.96	0.52	3.38	0	0	0.02	0	0	0	0.5	0	0	100.65
M04-98	0.18	9.51	3.51	34.95	47.70	0.46	3.52	0	0	0	0.07	0.04	0.02	0.45	0	0	100.41
M04-98	0	8.96	3.54	32.67	49.39	0.64	3.51	0.04	0.16	0.03	0	0.06	0	0.3	0	0.32	99.62
M04-98	0.14	9.38	3.48	34.43	47.83	0.62	3.54	0	0	0	0.1	0.03	0	0.4	0	0	99.95
M04-98	0.1	9.69	3.47	34.97	47.14	0.61	3.31	0.03	0	0	0	0	0	0.47	0	0.03	99.82
M04-98	0.09	9.54	3.3	34.48	48.13	0.61	3.42	0.1	0	0	0	0.08	0.02	0.39	0	0.23	100.39
M04-98	0	9.69	3.43	34.17	47.66	0.6	3.47	0.02	0.06	0	0	0.1	0.11	0.44	0	0.17	99.92
M04-96	0.13	9.86	3.22	35.13	47.51	0.67	3.26	0.11	0	0	0	0.09	0.1	0.55	0	0.21	100.84
M04-96	0.07	9.96	3.41	34.85	46.81	0.67	3.38	0.1	0	0	0	0	0.06	0.53	0	0.13	99.97
M04-96	0	10.01	3.19	35.14	47.30	0.66	3.31	0	0.01	0	0	0.04	0	0.54	0	0.03	100.23
M04-96	0.2	10.03	3.38	34.68	46.80	0.58	3.43	0.03	0.14	0	0	0	0.06	0.57	0	0	99.89
M04-96	0.14	9.81	3.5	34.43	47.48	0.69	3.49	0	0.12	0	0	0.04	0	0.49	0	0	100.19
M04-96	0.19	10.26	3.35	35.52	45.80	0.55	3.28	0.02	0	0.01	0	0.01	0.07	0.51	0	0.14	99.71
M04-96	0.19	10.26	3.35	35.52	45.80	0.55	3.28	0.02	0	0.01	0	0.01	0.07	0.51	0	0.14	99.71
M04-96	0.08	9.89	3.26	34.95	46.56	0.68	3.25	0	0	0	0	0.06	0.08	0.42	0	0	99.22
M04-96	0.06	9.99	3.26	34.80	46.61	0.66	3.3	0.1	0	0	0	0	0	0.53	0	0.16	99.47
M04-96	0.07	10.15	3.24	35.74	46.88	0.63	3.05	0.03	0	0.05	0.04	0	0.08	0.6	0	0.05	100.61
M04-96	0	10.48	2.86	35.26	46.95	0.62	2.99	0.06	0.15	0	0	0.17	0	0.4	0	0.02	99.96
M04-96	0.22	10.15	3.26	35.63	46.72	0.63	3.24	0.04	0	0.07	0.01	0.01	0.05	0.54	0	0	100.57
M04-93	0.09	7.96	2.01	34.48	52.23	1.07	2.01	0.08	0	0.1	0	0.01	0	0.46	0	0.04	100.54
M04-93	0.05	7.95	2.03	34.78	50.95	1.01	1.73	0.03	0	0	0	0	0.04	0.32	0	0	98.89
M04-93	0.16	7.63	2.31	33.88	52.69	1.16	2.16	0	0.11	0	0.11	0	0.04	0.21	0	0	100.46
M04-93	0.08	7.98	1.93	34.71	50.99	0.82	1.92	0.12	0	0	0	0	0.07	0.4	0.16	0	99.18
M04-93	0.06	7.89	2.12	34.71	52.44	1.03	1.95	0	0.05	0	0	0	0.04	0.31	0	0.05	100.65
M04-93	0.07	8.22	2.12	34.81	51.42	1.07	1.95	0	0	0.04	0	0	0	0.15	0	0.14	99.98
M04-93	0.05	7.81	1.96	34.00	52.60	1.12	1.83	0.01	0.12	0.03	0.05	0	0.06	0.33	0	0.16	100.13
M04-93	0.1	8.3	2.06	34.95	51.34	1	1.89	0.1	0.07	0	0.09	0	0	0.3	0	0	100.20
M04-93	0.01	6.83	3.38	33.68	52.43	0.85	2.05	0.02	0	0.06	0	0.04	0	0.66	0	0.15	100.17
M04-93	0	30.53	0.45	55.45	7.80	0.24	1.8	0	0	0	0	0.17	0	0.33	0	0	96.77
M04-93	0.05	30.72	0.56	55.49	7.91	0.35	1.84	0	0.01	0.08	0	0.01	0	0.32	0	0	97.34
M04-93	0.03	8.14	2.15	34.57	52.21	1.15	2.13	0.05	0	0.07	0.06	0.05	0.01	0.3	0	0	100.93
M04-92	0.12	7.87	2.56	34.68	52.12	1.05	2.24	0	0	0.04	0	0.01	0.06	0.48	0	0.04	101.27
M04-92	0.1	7.8	2.57	34.37	51.74	0.93	2.23	0	0.05	0.02	0	0.03	0.04	0.44	0.16	0	100.48
M04-92	0.11	7.96	2.38	34.03	51.92	0.97	2.39	0.08	0	0.07	0	0	0	0.46	0	0.21	100.58
M04-92	0.15	8	2.51	34.91	50.83	0.63	2.25	0	0	0	0	0	0.05	0.35	0	0	99.68
M04-92	0.2	8.04	2.37	35.10	51.34	0.79	2.12	0	0	0	0	0.11	0.11	0.23	0	0.15	100.56

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-92	0.05	7.8	2.44	33.49	52.38	1.06	2.36	0	0.13	0	0	0.1	0	0.44	0	0.13	100.37
M04-92	0.05	7.8	2.44	33.50	52.41	1.06	2.36	0	0.13	0	0	0.1	0	0.44	0	0.13	100.42
M04-92	0.16	7.66	2.43	34.22	52.37	0.89	2.45	0.06	0	0	0.1	0.04	0.07	0.27	0	0	100.73
M04-92	0.12	7.98	2.39	34.13	50.85	0.93	2.22	0.04	0	0.01	0	0	0.07	0.29	0	0.23	99.26
M04-92	0.13	7.91	2.43	34.33	53.05	0.97	2.35	0	0.14	0	0	0	0	0.4	0	0	101.71
M04-92	0.14	7.94	2.49	33.82	51.82	0.93	2.26	0.12	0.11	0.06	0	0	0.05	0.26	0	0	100.00
M04-92	0.01	7.68	2.37	34.18	52.29	0.88	2.33	0.04	0	0	0.07	0.06	0	0.51	0	0	100.42
M04-91	0.13	7.96	2.21	34.21	52.46	0.98	2.17	0.04	0.14	0	0	0	0.01	0.3	0	0	100.62
M04-91	0.13	7.81	1.96	34.52	51.58	1.12	1.89	0	0	0.03	0	0.09	0	0.39	0	0	99.52
M04-91	0.1	8.96	2.17	35.58	49.18	1.02	1.9	0	0	0.02	0.1	0	0.07	0.43	0	0.15	99.68
M04-91	0	7.9	2.05	34.45	52.40	1.17	2.04	0.03	0	0	0	0.05	0.12	0.38	0	0.11	100.70
M04-91	0.24	9.13	2.12	35.91	47.71	0.95	1.83	0	0	0	0.04	0	0	0.38	0	0	98.31
M04-91	0.1	7.8	2.1	34.63	52.53	1.01	1.9	0.01	0.07	0	0.1	0	0	0.36	0	0.11	100.72
M04-91	0.05	7.75	2.05	34.05	51.97	1.11	2.13	0.01	0.01	0	0	0	0.01	0.37	0	0.02	99.53
M04-91	0.1	7.75	2.13	34.51	52.62	1.17	2.02	0.06	0	0.03	0.07	0.03	0.12	0.38	0	0.05	101.04
M04-91	0.13	7.73	2.05	34.51	52.62	1.04	1.89	0.04	0.08	0	0	0	0	0.24	0	0	100.34
M04-91	0.18	7.69	2.12	33.43	51.67	0.91	2.28	0	0.14	0	0	0	0.04	0.46	0	0	98.92
M04-91	0.12	7.6	2.09	34.01	51.97	1.03	2.02	0	0.06	0	0	0	0.01	0.39	0	0	99.30
M04-91	0.02	7.78	2.09	34.28	51.94	1.14	1.94	0	0	0.03	0	0.04	0.04	0.25	0	0	99.55
M04-102	0.14	9.12	3.12	34.96	48.91	0.88	2.99	0	0	0	0	0	0.02	0.56	0	0.03	100.73
M04-102	0.09	9.27	2.85	33.24	50.71	0.83	2.9	0.02	0.41	0.06	0	0	0	0.36	0	0	100.74
M04-102	0.08	9.11	3.01	34.59	49.84	0.83	3.04	0.02	0.08	0	0	0.14	0.07	0.44	0	0	101.25
M04-102	0.09	9.33	2.72	35.23	48.76	0.63	2.89	0.05	0	0	0	0.04	0	0.49	0	0	100.23
M04-102	0.12	9.31	2.79	34.94	48.61	0.83	2.87	0.01	0	0.05	0.07	0	0.02	0.47	0	0	100.08
M04-102	0.22	9.1	2.79	34.22	49.71	0.59	3.09	0.04	0.11	0.11	0	0	0	0.43	0	0	100.40
M04-102	0.13	9	3.15	34.70	48.98	0.77	3.01	0.09	0	0	0	0.02	0.07	0.42	0	0	100.33
M04-102	0.13	9.18	2.96	34.92	48.68	0.78	2.92	0.01	0	0	0	0.07	0	0.54	0	0.15	100.33
M04-102	0.09	9.4	2.77	35.47	48.80	0.69	2.82	0.03	0	0	0.02	0.02	0	0.46	0	0.02	100.59
M04-102	0	9.08	2.89	34.02	50.24	0.78	3	0.01	0.11	0.05	0.19	0	0	0.37	0	0.16	100.91
M04-102	0.04	9.42	2.83	34.91	48.63	0.7	2.99	0.02	0	0.04	0	0.04	0.06	0.44	0	0	100.12
E02-79	0.16	9.49	3.44	34.60	48.63	0.65	3.38	0	0.05	0.06	0.04	0	0	0.51	0	0.21	101.22
E02-79	0	9.71	3.38	34.79	46.70	0.64	3.2	0	0	0	0.08	0	0.07	0.59	0	0	99.15
E02-79	0.07	9.75	3.55	35.13	47.85	0.65	3.31	0.03	0	0.07	0.12	0.08	0	0.53	0	0	101.13
E02-79	0.07	9.29	3.54	34.41	48.77	0.62	3.53	0	0.01	0	0	0	0	0.5	0	0.18	100.92
E02-79	0.16	9.59	3.61	35.59	48.52	0.6	3.17	0.06	0	0.08	0	0.01	0.08	0.55	0	0.04	102.06
E02-79	0.2	9.47	3.51	34.65	48.28	0.49	3.19	0.04	0.16	0	0	0	0	0.44	0	0.11	100.54
E02-79	0.15	6.5	5.27	32.36	51.59	0.4	3.42	0.05	0.01	0.04	0	0	0.05	0.57	0	0.12	100.53
E02-79	0.13	6.46	5.17	32.64	51.24	0.29	3.3	0.07	0	0	0.12	0	0.06	0.59	0	0	100.07

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-79	0	9.33	3.53	35.00	48.49	0.5	3.19	0	0	0.03	0.11	0.08	0.06	0.51	0	0.03	100.86
E02-79	0.09	9.57	3.48	35.43	47.56	0.48	3.01	0.05	0	0	0.09	0.04	0	0.48	0	0.17	100.46
E02-79	0.05	9.28	3.48	34.07	49.16	0.49	3.27	0.1	0.14	0	0.11	0	0.02	0.44	0	0.27	100.88
E02-79	0.05	9.27	3.48	34.04	49.14	0.49	3.27	0.1	0.14	0	0.11	0	0.02	0.43	0	0.27	100.80
E02-79	0.04	6.44	5.17	32.63	52.02	0.33	3.2	0	0.01	0.02	0	0	0	0.53	0	0.19	100.58
E02-79	0.04	6.44	5.17	32.61	51.99	0.33	3.2	0	0.01	0.02	0	0	0	0.53	0	0.19	100.54
E02-79	0	6.54	5.27	32.01	51.96	0.34	3.43	0	0.11	0	0	0.06	0.01	0.6	0	0.04	100.37
E02-98	0.15	7.09	6.29	31.96	49.28	0.23	4.3	0.05	0	0.04	0	0.16	0	0.74	0	0	100.29
E02-98	0.11	7.21	6.17	31.58	50.91	0.34	4.4	0.1	0.14	0	0	0	0	0.47	0	0	101.44
E02-98	0.05	7.65	5.87	32.36	50.09	0.24	3.99	0.02	0.16	0.02	0	0	0	0.61	0	0.11	101.16
E02-98	0.13	7.5	5.75	32.69	50.02	0.39	4.16	0.04	0	0	0	0.1	0.05	0.4	0	0	101.24
E02-98	0.24	7.55	5.6	32.54	48.39	0.21	4.02	0.05	0	0	0	0	0.01	0.46	0	0.11	99.18
E02-98	0.08	7.2	6.36	32.29	49.68	0.15	4.26	0.03	0	0	0.04	0.09	0.02	0.58	0	0.19	100.97
E02-98	0.08	7.2	6.08	31.71	50.92	0.35	4.37	0.07	0.09	0.04	0	0.01	0	0.58	0	0	101.50
E02-98	0.12	7.26	5.71	32.12	50.25	0.24	4.34	0.04	0	0.02	0.05	0	0.04	0.51	0	0	100.70
E02-98	0	7.58	5.6	32.08	50.12	0.35	4.28	0	0	0.09	0.2	0.16	0	0.57	0	0	101.03
E02-98	0.16	7.41	5.9	31.98	49.70	0.55	4.28	0.01	0.05	0	0	0	0.01	0.52	0	0.01	100.58
E02-98	0.1	6.96	5.96	31.56	49.82	0.48	4.27	0.02	0	0	0	0	0	0.49	0.15	0	99.80
E02-95	0.04	7.12	5.3	32.66	50.01	0.47	3.51	0	0	0	0.09	0.01	0.01	0.56	0	0.01	99.79
E02-95	0	7.28	5.46	33.26	50.20	0.41	3.42	0.01	0	0	0	0	0	0.53	0	0	100.57
E02-95	0	7.28	5.46	33.26	50.20	0.41	3.42	0.01	0	0	0	0	0	0.53	0	0	100.57
E02-95	0.12	7.11	5.39	33.04	50.41	0.29	3.45	0	0	0.06	0.09	0	0.08	0.66	0	0.17	100.87
E02-95	0.02	6.84	5.44	32.11	50.84	0.33	3.61	0.14	0.06	0	0	0	0	0.72	0	0	100.11
E02-95	0.04	6.59	5	32.76	51.54	0.19	3.2	0.01	0.01	0.02	0	0.04	0	0.55	0	0.13	100.08
E02-95	0.14	7.14	5.42	32.96	50.25	0.48	3.39	0.06	0	0.03	0	0.15	0.04	0.43	0	0.14	100.62
E02-95	0.1	7.29	5.16	33.21	50.02	0.37	3.16	0.11	0.01	0.03	0	0	0.05	0.5	0	0.21	100.22
E02-95	0.13	6.98	5.36	33.23	50.33	0.39	3.27	0.11	0	0	0	0	0.05	0.55	0.16	0.03	100.59
E02-95	0.12	7.09	5.17	33.32	50.47	0.25	3.23	0	0	0.03	0.01	0.01	0	0.43	0	0.16	100.28
E02-95	0.1	6.79	5.07	32.57	51.09	0.39	3.5	0.06	0	0	0.06	0	0	0.63	0	0.04	100.30
E02-95	0.22	7.74	1.72	33.95	52.79	1.65	1.94	0.06	0.05	0	0	0	0	0.32	0	0.12	100.56
E02-100	0.18	7.64	1.98	34.99	52.21	1.03	1.57	0	0.01	0.05	0	0	0.06	0.27	0	0.11	100.10
E02-100	0.09	7.27	1.98	33.79	53.40	1.08	1.78	0	0.13	0.01	0	0.08	0.04	0.28	0	0	99.92
E02-100	0.41	7.39	2.11	34.61	51.53	1.1	1.71	0.11	0	0	0	0	0.1	0.18	0	0.12	99.37
E02-100	0.15	7.72	1.93	34.55	52.31	1.26	1.68	0	0.07	0	0	0	0	0.37	0	0.1	100.14
E02-100	0.08	7.32	1.89	33.91	53.33	1.31	1.7	0	0.05	0.04	0.04	0	0	0.32	0	0.14	100.13
E02-100	0.16	6.89	2.8	34.55	53.29	0.87	1.88	0	0	0.05	0	0	0	0.52	0	0	101.01
E02-100	0.08	7.51	2.33	34.36	53.03	1.17	1.96	0.04	0	0.05	0	0.12	0	0.39	0	0.11	101.16
E02-100	0.15	7.58	1.93	34.67	52.44	1.03	1.87	0.01	0	0	0	0	0	0.23	0	0	99.91

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-100	0.14	7.53	1.87	34.57	52.32	1.07	1.54	0.14	0	0	0	0	0.01	0.17	0	0.25	99.61
E02-100	0.1	7.12	2.01	34.03	52.64	0.94	1.78	0.09	0	0	0	0.02	0	0.25	0	0	98.97
E02-100	0.02	7.48	1.94	34.19	52.15	1.11	1.67	0.01	0.01	0.02	0.13	0	0	0.28	0	0.03	99.05
E02-100	0.14	7.54	1.87	34.51	52.67	1.32	1.79	0.05	0	0	0.06	0.01	0	0.39	0	0	100.35
E02-106	0.07	9.83	0.98	35.81	49.13	1.3	1.79	0	0	0.07	0	0	0	0.31	0	0.22	99.51
E02-106	0.11	7.51	1.8	35.10	52.07	1.13	1.25	0.05	0.01	0.01	0	0.05	0.05	0.34	0	0	99.47
E02-106	0	7.31	2.01	34.13	52.83	1.11	1.83	0	0	0	0	0.01	0	0.43	0	0.03	99.69
E02-106	0.15	8.73	1.5	36.78	49.97	1.11	1.02	0.02	0	0	0	0	0	0.3	0	0	99.58
E02-106	0.21	6.82	2.45	33.90	54.01	1.12	1.18	0.05	0.26	0.07	0	0.06	0	0.37	0	0	100.50
E02-106	0.14	6.66	2.25	34.80	53.85	1.18	1.06	0.05	0	0.04	0	0.01	0.06	0.23	0	0.14	100.47
E02-106	0.19	7.28	2.18	34.84	52.17	0.94	1.41	0.02	0.06	0	0	0.07	0	0.26	0	0	99.42
E02-106	0.19	7.62	1.94	35.28	52.05	1.32	1.31	0.07	0.01	0	0	0	0.01	0.36	0	0.02	100.18
E02-106	0.19	7.62	1.94	35.28	52.05	1.32	1.31	0.07	0.01	0	0	0	0.01	0.36	0	0.02	100.18
E02-106	0.11	8.41	1.15	35.51	51.66	0.94	1.65	0.11	0	0	0	0	0	0.28	0	0.04	99.85
E02-106	0.14	7.83	2.09	34.62	52.76	0.92	1.07	0	0.4	0	0	0.08	0	0.31	0	0	100.22
E02-86	0.09	8.55	1.91	36.00	50.24	0.5	1.58	0.02	0.08	0	0	0.14	0.02	0.56	0	0	99.70
E02-86	0.01	6.67	2.37	34.63	54.11	0.57	1.44	0.04	0.06	0	0.02	0.05	0.05	0.55	0	0.13	100.70
E02-86	0.16	6.44	1.7	34.71	54.77	0.55	1.49	0.03	0	0.01	0	0	0.05	0.49	0	0.05	100.45
E02-86	0.1	7.39	1.52	35.41	53.23	0.37	1.52	0.14	0	0	0	0	0	0.44	0.17	0.18	100.47
E02-86	0.21	6.46	3.56	32.70	52.89	0.56	2.94	0	0	0	0	0.01	0	0.51	0	0.17	100.01
E02-86	0.08	6.64	3.56	32.70	53.48	0.54	3.07	0.03	0	0.04	0	0.03	0	0.42	0.2	0.1	100.89
E02-86	0.2	6.41	3.85	32.68	52.36	0.5	2.96	0.06	0.01	0	0.03	0	0	0.47	0.19	0	99.72
E02-86	0.09	6.61	3.36	34.05	53.54	0.56	1.91	0.06	0	0.15	0.16	0	0	0.5	0	0.14	101.13
E02-86	0.16	8.51	1.51	36.20	50.69	0.53	1.69	0	0	0	0	0	0.05	0.39	0	0	99.73
E02-86	0.1	6.65	3.62	32.35	53.64	0.52	3.26	0	0	0.06	0	0.04	0.07	0.42	0	0.18	100.91
E02-86	0	6.63	2.92	33.33	52.82	0.69	2.18	0	0.01	0	0	0.02	0	0.46	0	0	99.06
E02-86	0.07	6.61	3.65	32.30	53.24	0.53	3.27	0	0.01	0	0	0	0.06	0.38	0	0.04	100.17
E02-86	0.11	6.75	3.52	31.98	53.09	0.43	3.35	0	0.08	0.02	0.05	0	0	0.37	0	0.02	99.78
E02-101	0.14	7.62	1.94	35.18	52.93	1.28	1.61	0	0	0	0	0.06	0	0.26	0	0	101.03
E02-101	0	7.59	2.06	34.13	52.83	1.23	1.84	0.1	0	0.02	0	0.01	0.01	0.23	0	0.13	100.18
E02-101	0.1	7.54	1.96	34.31	52.79	1.39	1.81	0.05	0	0	0	0.13	0.04	0.16	0	0	100.28
E02-101	0.01	7.59	1.82	34.61	53.42	1.18	1.6	0.01	0.09	0	0.03	0.05	0.07	0.43	0	0.01	100.92
E02-101	0.07	7.69	1.83	34.41	52.17	1.36	1.71	0	0	0	0.02	0	0.08	0.16	0	0	99.51
E02-101	0.05	7.45	1.86	33.99	52.60	1.2	1.94	0.03	0	0	0.07	0	0	0.43	0	0	99.63
E02-101	0.27	7.58	1.95	34.56	52.33	1.2	1.83	0	0	0.04	0.01	0.13	0	0.29	0	0.15	100.34
E02-101	0.12	7.7	1.9	34.74	52.63	1.18	1.71	0.06	0	0	0.12	0.04	0.06	0.29	0	0.24	100.80
E02-101	0.08	7.54	1.93	34.11	52.20	1.27	1.85	0	0	0	0	0	0.02	0.19	0	0	99.19
E02-101	0.05	7.4	1.84	33.79	52.82	1.34	1.83	0.03	0	0.04	0	0	0.08	0.23	0	0	99.45

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
E02-101	0.05	7.5	1.79	33.98	53.05	1.42	1.75	0	0	0.07	0	0	0	0.2	0	0.03	99.85
E02-101	0.09	7.55	2.02	34.40	52.07	1.15	1.79	0.06	0	0	0.14	0	0	0.39	0	0	99.66
E02-104	0.08	7.52	1.73	34.25	52.45	1.22	1.67	0	0	0	0	0	0.14	0.23	0	0.19	99.48
E02-104	0.1	7.48	1.61	33.81	53.39	1.31	1.68	0	0.13	0	0.03	0	0.07	0.35	0	0.14	100.09
E02-104	0	7.3	1.84	34.01	53.88	1.26	1.9	0.06	0	0.02	0	0	0.01	0.32	0	0	100.59
E02-104	0.15	7.17	1.8	34.52	53.33	1.03	1.68	0.07	0	0	0	0.02	0.08	0.27	0	0	100.12
E02-104	0.06	7.28	1.83	34.29	53.24	1.07	1.7	0	0	0.02	0	0	0.06	0.27	0	0.14	99.96
E02-104	0.08	7.27	1.88	33.87	52.43	1.04	1.7	0.01	0	0.02	0	0	0.04	0.26	0	0.27	98.87
E02-104	0.06	7.16	1.87	33.40	52.63	1.17	1.77	0.24	0.01	0	0	0.07	0	0.17	0	0	98.54
E02-104	0.05	7.2	1.69	34.25	53.57	1.03	1.63	0	0	0.02	0	0	0	0.13	0	0.16	99.73
E02-104	0.01	7.14	1.83	33.55	53.56	1.34	1.72	0	0.01	0.04	0.15	0.08	0.02	0.22	0	0.18	99.85
E02-104	0.13	7.22	2.03	34.00	53.20	1.16	1.87	0.07	0	0.07	0	0	0	0.42	0	0	100.16
E02-107	0.12	0	0.49	29.47	66.12	0	0	0.07	0.07	0.05	0.04	0	0	0	0.12	0	96.15
E02-107	0.03	0.85	3.02	26.23	65.66	1.68	2.42	0.01	0.19	0.01	0.11	0.07	0.06	0.29	0	0.3	101.33
E02-109	0.11	7.51	2.03	34.59	52.43	1.14	1.81	0	0	0	0.24	0	0.06	0.38	0	0	100.31
E02-109	0.06	7.37	1.82	34.15	52.87	1.1	1.7	0	0	0.08	0.16	0.06	0.1	0.26	0	0	99.73
E02-109	0.12	7.31	1.96	33.47	52.80	1.16	1.99	0	0.01	0.05	0	0	0	0.29	0	0.28	99.44
E02-109	0.02	7.39	2.06	33.57	52.55	1.15	1.83	0.01	0	0.05	0	0	0.06	0.37	0	0.43	99.49
E02-109	0	7.32	1.86	33.44	54.24	1.21	1.85	0.11	0.14	0.04	0	0	0	0.38	0	0	100.59
E02-109	0	7.53	1.89	34.21	53.11	1.05	1.78	0.01	0.01	0.1	0.08	0	0	0.27	0	0	100.04
E02-109	0.11	7.2	1.96	33.91	53.35	1.16	2.01	0.06	0	0	0.04	0	0	0.3	0	0	100.10
E02-109	0.19	7.4	2	34.41	52.72	1.17	1.84	0.06	0	0.02	0	0.02	0.09	0.28	0	0	100.20
E02-109	0.13	7.43	2.1	34.48	52.58	0.99	1.81	0.07	0	0	0.03	0	0.08	0.16	0	0.1	99.96
E02-109	0.04	7.02	2.07	33.84	53.98	1.21	1.82	0.04	0	0.08	0	0.15	0.01	0.4	0	0	100.66
E02-109	0.14	7.21	2.02	34.15	53.96	1.08	1.89	0	0.07	0.04	0.14	0	0	0.35	0	0	101.05
E02-112	0.07	7.74	2.06	34.19	52.13	1.36	1.91	0	0	0.06	0	0	0	0.46	0	0.02	100.00
E02-112	0.1	7.87	2.31	34.19	52.13	1.13	2.11	0	0.07	0.04	0	0	0.06	0.4	0	0.02	100.42
E02-112	0.07	8.24	0.98	35.26	51.83	0.87	1.61	0.04	0	0	0	0	0.09	0.46	0	0.16	99.61
E02-112	0.1	7.93	2.25	33.75	52.50	1.03	2.3	0	0.15	0.04	0	0	0.01	0.43	0	0	100.50
E02-112	0.18	7.68	2.15	34.80	51.97	1.15	1.74	0	0	0.03	0.03	0	0	0.34	0	0.13	100.20
E02-112	0.01	7.53	2.13	33.44	53.35	1.24	2.3	0	0	0.13	0	0	0.1	0.46	0	0	100.69
E02-112	0	7.98	2.29	34.64	51.80	1.23	1.94	0	0	0.03	0	0	0.06	0.39	0	0	100.37
E02-112	0.08	7.98	2.17	34.80	51.78	0.96	1.89	0.07	0.01	0.03	0	0	0	0.32	0	0.13	100.22
E02-112	0.09	7.76	2.06	34.53	52.29	1.02	2.03	0.03	0	0	0	0	0	0.4	0	0.13	100.33
E02-112	0.1	7.06	2.51	33.77	52.60	1.03	1.98	0.07	0.01	0	0.12	0.15	0	0.24	0	0	99.64
E02-112	0.11	7.59	2.26	33.65	52.67	1.08	2.18	0.05	0.06	0.03	0.27	0	0	0.3	0	0.2	100.46
E02-112	0.08	8.18	0.66	34.13	53.86	0.79	1	0.06	0.47	0.02	0	0	0.08	0.4	0	0.21	99.94
M04-60	0.01	8.35	3.78	31.83	49.83	0.45	3.9	0.07	0.14	0.07	0	0	0	0.58	0	0	99.00

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-60	0.2	8.66	4	32.64	49.52	0.57	3.79	0.1	0.17	0	0.11	0.12	0	0.39	0	0.27	100.54
M04-60	0.11	7.7	4.81	31.97	49.97	0.51	4.11	0	0.01	0.09	0	0.06	0	0.48	0	0	99.82
M04-60	0.11	8.95	4.03	32.55	49.34	0.48	4.01	0.08	0.21	0.03	0	0.18	0.07	0.45	0	0	100.48
M04-60	0	8.67	4.11	33.53	49.18	0.45	3.68	0	0	0.09	0	0	0.07	0.56	0	0	100.34
M04-60	0	9.11	3.9	32.97	47.77	0.54	4.07	0.03	0	0.02	0	0.08	0	0.53	0	0	99.01
M04-60	0.13	7.69	1.81	34.52	53.15	1.28	1.58	0	0.13	0.02	0	0.05	0	0.28	0	0	100.65
M04-60	0.15	8.99	3.65	33.85	48.17	0.61	3.54	0.05	0	0	0.03	0	0	0.39	0	0.12	99.55
M04-60	0.07	8.59	3.93	33.33	49.44	0.46	3.55	0.03	0.09	0.05	0.08	0	0.01	0.53	0	0.01	100.17
M04-64	0.12	8.84	3.67	33.72	48.36	0.5	3.64	0.02	0	0	0	0	0	0.44	0	0	99.31
M04-64	0.12	9.16	3.56	34.85	47.26	0.58	2.96	0	0	0.02	0	0	0.06	0.52	0	0	99.09
M04-64	0.12	8.26	3.71	32.20	49.38	0.55	3.81	0.13	0.07	0	0	0.02	0	0.55	0	0.13	98.93
M04-64	0.13	8.08	4.01	31.94	49.68	0.61	4.01	0.1	0	0.08	0.11	0	0	0.56	0	0.16	99.47
M04-64	0.09	8.58	3.9	32.57	49.17	0.58	4.08	0.05	0	0.02	0	0	0	0.46	0	0.18	99.67
M04-64	0	8.98	3.72	33.14	48.72	0.56	3.73	0	0.09	0	0	0.04	0.02	0.59	0	0.1	99.69
M04-64	0	8.64	3.64	32.97	49.32	0.59	3.68	0	0.08	0	0	0	0.1	0.62	0	0	99.64
M04-64	0.01	10.2	2.68	35.09	46.94	0.72	3.21	0.05	0	0	0.09	0	0.02	0.47	0	0	99.49
M04-64	0.11	12.08	1.8	37.34	44.45	0.85	2.7	0.04	0	0.09	0.1	0	0	0.6	0	0.15	100.31
M04-64	0.06	11.73	2.18	36.76	43.83	0.72	2.77	0.06	0	0.07	0	0	0	0.55	0	0	98.73
M04-64	0.07	8.08	3.53	33.52	49.91	0.64	3.09	0.03	0	0.04	0.16	0.09	0	0.46	0	0	99.62
M04-64	0.08	10.9	2.46	37.66	46.07	0.8	1.94	0.01	0.1	0	0	0	0.02	0.55	0	0	100.59
M04-66	0.09	8.97	3.6	33.55	49.10	0.53	3.88	0	0	0.05	0	0.23	0	0.44	0	0	100.43
M04-66	0.07	8.85	2.93	34.78	50.08	0.87	2.58	0	0.12	0	0.07	0.03	0.06	0.56	0	0	101.00
M04-66	0.05	9.25	3.07	34.85	48.68	0.71	2.65	0.03	0.12	0.02	0	0	0	0.59	0	0	100.02
M04-66	0.05	9.44	4.4	36.49	46.52	0.59	1.99	0	0.1	0	0	0	0	0.44	0	0.13	100.16
M04-66	0.08	8.69	3.69	32.89	49.35	0.52	3.94	0	0	0.13	0	0	0	0.65	0	0	99.95
M04-66	0.1	9.16	3.6	33.74	47.61	0.43	3.24	0.03	0.09	0.09	0	0	0	0.38	0	0	98.47
M04-67	0	6.15	2.72	32.62	54.69	0.69	2.48	0	0	0.03	0	0	0.14	0.37	0.2	0	100.09
M04-67	0	8.14	2.94	33.87	51.18	0.58	2.71	0.01	0.13	0	0.18	0.01	0	0.65	0	0	100.40
M04-67	0.01	7.28	3.96	32.85	51.78	0.58	3.17	0.02	0.05	0	0.03	0.01	0.01	0.41	0	0	100.17
M04-67	0.08	6.87	3.26	32.47	53.47	0.74	2.84	0	0.09	0.05	0	0	0.06	0.41	0	0.11	100.45
M04-67	0.05	7.1	4.2	34.01	51.02	0.4	2.54	0	0	0	0.1	0	0.04	0.29	0	0	99.76
M04-67	0	7.23	4.24	34.15	51.03	0.57	2.44	0	0	0.03	0	0.01	0.08	0.49	0	0	100.27
M04-67	0.06	7.36	4.26	34.22	50.84	0.67	2.54	0	0	0	0.13	0.02	0	0.41	0	0.03	100.54
M04-67	0.13	7.45	4.07	33.21	50.61	0.62	3.26	0	0	0	0.09	0.12	0	0.61	0	0	100.17
M04-67	0.1	7.12	4.31	33.70	51.24	0.57	2.8	0.02	0	0.01	0	0	0.1	0.4	0	0	100.37
M04-67	0.09	8.21	4.37	34.85	48.87	0.61	2.64	0	0	0	0.07	0.11	0	0.31	0	0.03	100.16
M04-67	0.15	7.21	3.9	32.55	51.88	0.55	3.18	0	0.13	0	0.1	0	0	0.51	0	0.14	100.30
M04-69	0.15	6.62	2.78	32.38	52.61	0.77	2.2	0	0.13	0.08	0	0.08	0	0.5	0	0	98.30

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-69	0	8.08	1.62	35.12	51.24	0.91	1.54	0.03	0	0.02	0.02	0	0.01	0.35	0	0	98.94
M04-69	0.06	6.67	2.79	33.31	53.55	0.82	2.4	0.01	0	0	0	0.06	0.08	0.49	0	0.01	100.25
M04-69	0.05	8.82	3.15	34.81	48.66	0.85	2.05	0.03	0.12	0.03	0	0	0.07	0.56	0	0.2	99.40
M04-69	0.07	6.68	2.87	34.31	53.11	0.71	1.72	0.08	0	0	0.15	0.05	0.04	0.4	0	0.1	100.28
M04-69	0.19	6.65	2.74	33.13	52.23	0.6	1.97	0.01	0.1	0	0	0	0.03	0.44	0	0.22	98.31
M04-69	0.12	6.68	2.87	33.30	53.71	0.72	2.54	0.08	0	0	0.04	0	0.01	0.42	0	0.03	100.52
M04-69	0.08	8.16	1.3	33.88	51.60	0.53	1.72	0	0.33	0	0	0	0	0.53	0.3	0	98.44
M04-69	0.09	6.85	2.79	33.40	52.52	0.71	2.29	0.04	0	0	0.14	0	0	0.36	0.18	0.15	99.52
M04-69	0	6.81	2.74	32.87	53.62	0.9	2.53	0	0	0.01	0	0.06	0.07	0.29	0	0.12	100.01
M04-72	0.21	6.91	2.88	33.84	53.23	0.46	2.51	0.11	0.01	0	0	0.01	0	0.29	0.14	0.14	100.74
M04-72	0.11	7.13	3.31	34.72	51.76	0.53	1.87	0.06	0	0	0	0	0.05	0.47	0	0.28	100.28
M04-72	0.16	8.82	1.05	36.03	51.36	1.02	1.62	0	0	0.04	0	0.07	0.01	0.3	0	0.14	100.62
M04-72	0.13	6.66	2.83	33.81	54.01	0.71	2.3	0	0	0.04	0.09	0	0.09	0.4	0	0	101.06
M04-72	0.17	6.56	3.53	33.56	52.72	0.49	2.24	0.02	0.06	0	0.1	0	0	0.41	0	0.2	100.06
M04-72	0.09	7.19	2.83	34.60	53.04	0.77	2	0.05	0	0	0.07	0	0	0.42	0	0.21	101.26
M04-72	0	6.83	3.25	34.47	52.04	0.55	1.73	0	0	0.03	0	0.02	0	0.48	0	0	99.40
M04-72	0.02	7.79	1.89	35.22	51.66	0.88	1.1	0.03	0.11	0	0	0	0	0.23	0	0	98.93
M04-73	0.1	6.94	3.32	32.82	52.76	0.67	2.7	0	0.09	0	0	0.04	0.05	0.44	0	0.19	100.12
M04-73	0.03	6.66	2.12	34.09	54.48	0.42	1.66	0.05	0.12	0	0.09	0.21	0.05	0.38	0	0	100.36
M04-73	0	6.45	2.94	32.39	54.77	0.69	2.69	0.51	0	0	0.36	0	0.07	0.46	0	0	101.33
M04-73	0.05	8.27	1.36	35.77	51.42	1.26	0.85	0	0.08	0	0	0.05	0.07	0.26	0	0.2	99.64
M04-73	0.21	8.03	2.5	35.03	51.23	0.83	2.19	0.01	0	0.03	0.05	0.07	0	0.3	0	0	100.48
M04-73	0	6.72	3.15	32.61	53.76	0.63	2.39	0.06	0.15	0.05	0.05	0	0	0.65	0	0.17	100.39
M04-73	0.07	7.23	5.67	32.84	49.52	0.41	3.47	0.06	0	0	0.23	0	0	0.6	0	0.23	100.33
M04-73	0	6.8	2.83	33.46	53.25	0.67	2.37	0	0	0	0	0.08	0.09	0.4	0	0.01	99.96
RK-48	0.02	9.21	1.15	36.32	51.03	1.37	1.46	0	0	0.02	0	0	0.05	0	0	0	100.63
RK-48	0	7.44	0.96	35.82	53.94	0.7	0.8	0	0	0.05	0	0	0.03	0	0.06	0.22	100.01
RK-48	0.09	10.27	2.12	36.74	48.06	0.89	2.28	0.01	0	0	0	0	0.03	0	0	0.09	100.58
Rk-49	0.16	10.43	3.92	35.16	45.41	0.65	3.62	0.01	0	0	0.13	0.1	0	0	0.08	0.1	99.77
Rk-49	0.12	9.42	2.77	34.70	48.90	0.92	3.04	0.04	0	0	0.07	0.15	0.03	0	0.01	0.09	100.27
Rk-49	0.07	9.44	2.83	34.76	48.91	0.85	3	0	0	0	0.06	0	0	0	0	0.19	100.11
Rk-49	0	9.64	3.3	34.26	49.29	0.7	3.31	0	0.17	0	0	0	0	0	0.06	0.02	100.74
Rk-49	0	8.08	3.19	33.18	51.56	0.93	3.14	0.01	0	0.03	0.11	0.21	0.06	0	0.03	0.15	100.68
Rk-49	0.05	9.09	2.74	34.24	49.58	1.01	3.04	0.06	0	0	0.2	0.01	0.11	0	0.1	0	100.23
Rk-49	0.01	9.1	5.29	32.73	47.02	0.59	4.41	0.04	0	0.01	0	0.08	0	0	0	0	99.28
Rk-49	0.25	11.58	3.43	38.76	42.27	0.52	2.05	0	0	0	0.07	0	0	0	0.17	0	99.10
Rk-49	0.13	9.55	3.47	34.30	47.68	0.88	3.47	0	0	0	0	0	0	0	0.13	0.08	99.69
Rk-49	0.01	9.69	2.63	34.96	48.52	1.02	2.81	0.01	0	0.02	0.11	0.06	0	0	0	0.05	99.90

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-50	0.13	9.78	2.79	34.87	49.04	0.88	3.02	0.03	0.1	0.02	0	0	0.01	0	0.01	0.1	100.78
Rk-50	0.16	9.76	2.21	36.36	48.40	1.01	2.2	0	0	0	0	0.02	0	0	0.12	0.03	100.27
Rk-50	0.2	9.57	3.01	35.31	48.97	0.81	3.12	0.12	0	0	0.04	0.01	0	0	0.05	0.02	101.23
Rk-50	0.17	9.45	2.95	34.90	48.38	0.82	2.99	0.02	0	0.03	0.15	0.04	0	0	0.03	0.07	99.99
Rk-50	0.06	9.14	1.36	36.18	50.69	0.92	1.84	0	0	0	0.08	0	0	0	0.09	0	100.36
Rk-50	0.11	9.27	2.78	34.65	49.32	0.91	3	0.06	0	0	0	0	0	0	0	0.09	100.19
Rk-50	0	9.36	2.82	33.79	49.89	0.78	3.08	0	0.2	0	0.04	0.02	0.03	0	0.02	0.05	100.09
Rk-50	0.04	9.52	2.82	34.79	49.75	0.84	3.07	0.08	0.07	0.01	0.09	0.04	0.09	0	0.14	0	101.35
Rk-50	0.08	9.42	2.95	34.58	48.22	0.78	3.08	0	0	0	0.01	0	0.04	0	0	0.05	99.22
Rk-50	0.15	9.32	2.9	34.51	48.66	0.81	3.01	0.15	0	0.05	0	0	0.04	0	0.07	0.02	99.68
U05-3	0.22	9.1	3.78	34.80	48.71	0.52	3.3	0	0	0.04	0.18	0	0	0	0.1	0.17	100.91
U05-3	0.12	8.83	3.74	33.96	48.88	0.53	3.44	0.05	0	0.04	0.09	0	0	0	0.09	0	99.77
U05-3	0.19	9.17	4.09	34.07	47.85	0.51	3.77	0.01	0	0	0.25	0.11	0	0	0.01	0.05	100.08
U05-3	0.16	8.95	4.19	33.48	48.47	0.61	4	0	0	0	0.18	0.02	0.02	0	0.2	0.11	100.39
M06-62	0.07	8.95	2.85	34.14	50.50	0.95	3.01	0.01	0.08	0.01	0.02	0	0.01	0	0.08	0.05	100.73
M06-62	0.03	9.78	2.64	31.50	46.71	0.63	2.58	2.86	0.01	0.03	2.72	0.04	0.05	0	0.1	0.02	99.70
M06-62	0.04	8.61	2.94	34.25	50.37	0.8	2.94	0.03	0	0	0	0	0	0	0.04	0	100.01
M06-62	0	8.82	2.95	34.32	50.43	0.7	2.97	0	0	0.05	0	0	0	0	0.02	0.13	100.39
M06-62	0.01	8.8	2.87	34.15	49.55	0.72	2.93	0.08	0	0	0.03	0	0.08	0	0.08	0	99.31
M06-62	0.12	8.82	3	34.12	49.66	0.93	3.07	0.03	0	0.01	0	0	0	0	0	0	99.76
M06-62	0.1	8.66	3.05	34.16	49.81	0.78	2.96	0.03	0	0.02	0.08	0.16	0	0	0.14	0.11	100.06
M06-62	0.15	8.82	3.01	34.37	50.20	0.73	2.98	0	0.1	0	0.13	0.01	0.01	0	0.14	0	100.65
M06-62	0.11	9	2.79	34.49	49.70	0.74	2.99	0.01	0	0.03	0	0	0	0	0	0.09	99.95
M06-62	0.05	8.85	2.88	33.98	50.24	0.78	3.16	0	0	0.04	0.1	0.09	0.06	0	0.04	0.14	100.41
M06-62	0.06	8.51	3.17	32.57	50.91	0.88	3.12	0.04	0.21	0.03	0	0	0	0	0.05	0.22	99.77
M06-62	0.07	8.84	2.98	34.40	49.99	0.74	3.02	0.1	0	0	0	0	0.08	0	0	0	100.22
M06-64	0.02	7.8	2.75	33.81	51.92	0.88	2.57	0.03	0.01	0	0	0	0	0	0	0	99.79
M06-64	0.1	7.63	2.99	33.52	52.28	0.88	2.88	0.04	0	0	0	0.04	0	0	0	0	100.36
M06-64	0	7.68	2.84	32.83	52.40	0.75	2.55	0.07	0.16	0.06	0.01	0	0	0	0	0.01	99.36
M06-64	0.14	8.12	2.98	33.68	51.64	0.92	2.82	0.01	0.06	0	0.03	0	0.06	0	0.04	0.31	100.80
M06-64	0.08	7.52	2.94	33.65	51.86	0.73	2.7	0	0	0	0	0	0	0	0.17	0	99.65
M06-64	0.04	7.78	2.98	33.68	51.54	0.93	2.63	0.09	0	0	0	0.06	0	0	0.09	0	99.81
M06-64	0	7.73	2.97	33.18	53.26	0.91	2.67	0	0.16	0.01	0	0	0.01	0	0	0.14	101.04
M06-64	0.12	7.46	3.08	32.86	52.96	0.84	2.87	0.04	0.12	0.04	0.08	0.09	0.06	0	0.04	0	100.65
M06-64	0	7.84	2.87	32.54	52.52	0.86	2.71	0	0.24	0	0	0	0	0	0.04	0.15	99.76
M06-64	0.22	7.93	3.12	34.29	51.16	0.8	2.77	0	0	0	0.02	0	0.05	0	0.06	0	100.42
M06-64	0.04	7.57	2.99	33.52	52.42	0.91	2.75	0.04	0	0.01	0	0	0	0	0.05	0	100.30
M06-66	0.1	7.15	4.15	33.36	52.05	0.65	3.05	0	0	0	0.12	0.07	0	0	0.03	0	100.74

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M06-66	0.07	10.78	2.4	35.94	46.37	0.78	2.95	0.02	0	0.02	0.02	0	0	0	0	0.03	99.38
M06-66	0.15	9.66	2.9	35.65	48.69	0.81	2.89	0.05	0	0	0.08	0	0.02	0	0.1	0.05	101.04
M06-66	0.12	10.13	2.57	35.39	48.14	0.92	3.12	0.03	0	0.02	0.05	0	0.04	0	0.1	0.03	100.67
M06-66	0.06	9.84	2.73	35.47	48.65	0.77	2.91	0.17	0	0	0.11	0	0	0	0	0	100.71
M06-66	0.04	7.5	3.54	32.99	51.77	0.93	2.96	0.04	0	0.03	0.13	0	0	0	0	0	99.92
M06-66	0.04	9.77	2.87	35.00	48.77	0.85	3.09	0.12	0	0	0	0.25	0	0	0	0.12	100.88
M06-66	0.01	10.62	2.26	34.88	47.65	0.95	3.06	0.04	0.14	0	0	0.03	0.03	0	0.31	0.15	100.13
M06-66	0.09	7.47	3.99	33.38	51.79	0.72	2.97	0.01	0.06	0	0	0	0	0	0	0	100.49
M06-66	0.1	10.14	2.9	35.39	48.24	0.95	3.17	0.04	0	0.03	0.13	0	0	0	0.08	0.1	101.27
M06-66	0.16	7.27	3.91	33.49	51.63	0.57	2.99	0	0	0	0.05	0	0	0	0.03	0.07	100.17
M06-69	0.02	9.15	3.53	33.92	48.56	0.58	3.44	0.02	0.01	0	0	0.01	0	0	0.01	0.13	99.37
M06-69	0.03	9.14	3.49	34.13	48.67	0.73	3.31	0.03	0.01	0	0.17	0	0.02	0	0.08	0.04	99.85
M06-69	0.08	9	3.53	33.86	49.08	0.77	3.33	0.03	0	0.05	0	0.07	0	0	0.02	0.16	99.99
M06-69	0.07	8.81	3.43	33.86	48.81	0.68	3.29	0	0	0	0.16	0	0	0	0.08	0.02	99.20
M06-69	0.11	8.91	3.53	33.61	49.34	0.66	3.46	0.03	0.1	0	0.01	0	0	0	0.2	0.01	99.97
M06-69	0.17	9.23	3.54	34.43	49.28	0.6	3.57	0.06	0.01	0.02	0	0	0	0	0.1	0.11	101.12
M06-69	0.11	9.15	3.57	34.48	49.08	0.71	3.41	0	0	0	0	0	0	0	0.09	0.09	100.69
M06-69	0.06	9.17	3.52	34.25	48.97	0.6	3.42	0	0	0.05	0	0	0.03	0	0.05	0.03	100.15
M06-69	0.03	9.02	3.58	33.84	49.10	0.76	3.32	0	0	0.08	0	0	0	0	0.06	0.11	99.91
M06-69	0.01	8.88	3.69	33.65	49.32	0.78	3.55	0.02	0.01	0	0	0.1	0.1	0	0.13	0	100.24
M06-69	0.12	8.97	3.65	34.16	48.82	0.65	3.31	0.03	0.01	0.01	0.05	0	0	0	0.13	0.17	100.08
M06-69	0.09	8.91	3.59	34.08	49.38	0.83	3.38	0.03	0	0	0.06	0	0	0	0.09	0.05	100.48
Rk-21	0.08	0.85	15.53	19.30	52.50	0.78	9.03	0	0	0	0	0	0.04	0	0.06	0.13	98.30
Rk-21	0.17	13.56	1.28	39.58	37.12	0.07	1.44	0.11	0	0.01	0.04	0	0.01	0	0.04	0.02	93.45
Rk-21	0.21	7.79	7.71	32.63	46.30	0.5	4.33	0	0	0	0.07	0.01	0.07	0	0.5	0.17	100.29
Rk-21	0.16	9.37	3.09	33.92	47.01	0.59	2.87	0	0.14	0	0.03	0	0	0	0	0.12	97.30
Rk-21	0.23	3.64	7.11	30.10	53.51	0.39	3.49	0.01	0.01	0	0	0	0.01	0	1.27	0	99.76
Rk-21	0.08	5.91	7.35	29.97	50.56	0.24	4.81	0	0	0	0.05	0	0.1	0	0.32	0.12	99.50
Rk-21	0.22	5.69	8.34	30.85	50.78	0.41	4.52	0.07	0	0	0.07	0	0.02	0	0.33	0.24	101.54
Rk-29	0.06	7.76	2.32	33.20	52.28	1.14	2.29	0.06	0.13	0	0.02	0	0.02	0	0.02	0	99.30
Rk-29	0.13	8.19	2.24	34.49	52.42	1.22	1.8	0.05	0.19	0.02	0.02	0	0	0	0	0.03	100.80
Rk-29	0.09	7.98	2.33	34.48	51.72	1.31	2.07	0	0	0.01	0	0	0.01	0	0.12	0	100.12
Rk-29	0.15	7.6	2.58	34.08	52.59	1.05	1.77	0	0.16	0.05	0.02	0.05	0.06	0	0.14	0.16	100.46
Rk-29	0.01	8.04	2.36	34.31	51.40	1.1	2.13	0	0.01	0	0	0	0.02	0	0	0	99.38
Rk-29	0.09	7.9	2.27	33.89	52.31	1.13	2.41	0	0.01	0	0.02	0	0.02	0	0.01	0.19	100.25
Rk-29	0.14	8.2	1.95	34.43	51.41	1.27	2.13	0.04	0	0	0.07	0.01	0.01	0	0.06	0.05	99.77
Rk-29	0	7.83	2.24	33.15	52.37	1.01	2.39	0.04	0.11	0.02	0	0	0	0	0.02	0.04	99.22
Rk-29	0.17	8	2.35	34.29	51.02	1.14	2.2	0.05	0	0.01	0.11	0.01	0	0	0.12	0	99.47

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-29	0.14	8.02	2.33	34.59	51.30	1.16	2.08	0.01	0	0	0.06	0.01	0.03	0	0	0	99.73
Rk-27	0.11	7.51	2.04	34.28	52.94	1.23	1.91	0.02	0	0	0.14	0.03	0.01	0	0.01	0.08	100.31
Rk-27	0.19	7.38	2.12	33.28	54.03	1.29	1.97	0.08	0.23	0	0.05	0	0	0	0	0	100.62
Rk-27	0.12	7.66	2.05	34.39	52.35	1.28	1.87	0	0.01	0	0	0	0	0	0.03	0	99.76
Rk-27	0.23	7.5	2.02	33.89	53.10	1.39	1.88	0.1	0.01	0.08	0.11	0.04	0	0	0.02	0.23	100.60
Rk-27	0.19	7.65	1.97	34.04	52.95	1.4	1.89	0.02	0.1	0	0.08	0	0	0	0.01	0	100.31
Rk-27	0.01	7.52	1.99	33.80	53.19	1.32	1.91	0.05	0	0.06	0.04	0	0.06	0	0	0.05	100.00
Rk-27	0.14	7.51	1.93	33.92	52.94	1.33	1.92	0	0	0.04	0	0	0	0	0	0.19	99.92
Rk-27	0.04	10.59	1.15	36.14	47.99	0.74	2	0	0.1	0.06	0.01	0.1	0.12	0	0	0.3	99.34
Rk-27	0.07	7.59	2.04	33.94	53.16	1.25	1.97	0.1	0	0.04	0.01	0.09	0.09	0	0	0.19	100.54
Rk-27	0.05	8.61	1.25	35.83	50.68	0.99	1.29	0.02	0	0	0.07	0	0.03	0	0	0.14	98.96
Rk-27	0.11	7.65	2.07	34.14	53.10	1.03	2.23	0.02	0.01	0.04	0	0	0	0	0.04	0	100.43
Rk-26	0	8.02	1.97	33.90	52.76	1.14	1.84	0.05	0.21	0	0	0	0.04	0	0.18	0.03	100.14
Rk-26	0.13	7.53	2.03	33.85	52.32	1.12	1.85	0.07	0.08	0	0	0	0	0	0.02	0	99.00
Rk-26	0.06	7.62	2.11	33.68	52.31	1.3	2.01	0	0	0.04	0.1	0	0	0	0.04	0.16	99.43
Rk-26	0.1	7.23	2.03	33.92	53.21	1.27	1.89	0	0	0	0.02	0	0.01	0	0.04	0.06	99.78
Rk-26	0	7.64	0.65	34.63	54.32	1.44	0.44	0.06	0.26	0	0.01	0	0.03	0	0	0.19	99.68
Rk-26	0.1	7.48	2.16	34.17	53.27	1.41	1.84	0.02	0	0.05	0	0.05	0.02	0	0	0.09	100.67
Rk-26	0.09	7.66	2.02	34.53	52.52	1.26	1.77	0.04	0	0.01	0.14	0.02	0.02	0	0.01	0	100.09
Rk-26	0.14	7.49	1.91	33.93	52.74	1.4	1.92	0.06	0	0.01	0	0.02	0.07	0	0	0	99.69
Rk-26	0.1	6.8	1.68	31.25	47.71	1.24	1.4	0	0.01	0	0.05	0	0	0	0.03	0.08	90.34
Rk-26	0.11	6.91	1.36	33.28	55.00	1.33	1.79	0	0.1	0	0.01	0	0	0	0	0	99.89
Rk-26	0.08	7.52	2.07	33.15	53.01	1.26	1.76	0	0.24	0	0.02	0	0	0	0.08	0.12	99.30
Rk-25	0.04	7.46	1.91	33.99	52.53	1.24	1.67	0.02	0	0	0	0	0	0	0.01	0.26	99.13
Rk-25	0	7.58	1.87	33.12	53.45	1.52	1.69	0.07	0.18	0.02	0	0	0.03	0	0.01	0.13	99.68
Rk-25	0.1	7.52	1.92	34.11	51.92	1.28	1.55	0.01	0.01	0.02	0	0	0.04	0	0	0.17	98.66
Rk-25	0.08	7.78	1.92	34.81	52.16	1.3	1.59	0.06	0	0	0	0.01	0	0	0.07	0	99.79
Rk-25	0.17	7.64	2.02	33.82	52.13	1.29	1.76	0	0.13	0	0.17	0	0	0	0.07	0.04	99.24
Rk-25	0.13	7.6	1.99	33.69	52.59	1.31	1.69	0	0.16	0	0	0	0.03	0	0	0.09	99.29
Rk-25	0.05	7.61	1.97	33.26	51.98	1.3	1.67	0	0.17	0	0.15	0	0.01	0	0.15	0.12	98.43
Rk-25	0.05	7.42	1.99	33.06	52.30	1.15	1.76	0.04	0.17	0	0.05	0	0	0	0	0	97.99
Rk-25	0.01	7.71	1.96	33.87	51.91	1.5	1.53	0	0.05	0.05	0	0	0	0	0	0.04	98.63
Rk-25	0	7.58	1.9	33.73	52.91	1.3	1.74	0.07	0.07	0	0.01	0	0	0	0.1	0.19	99.60
Rk-24	0	0	0.16	27.95	69.60	0.46	1.63	0.08	0	0	0.05	0.17	0	0	0	0	100.11
Rk-24	0.06	7.07	3.3	33.54	52.49	0.92	2.31	0	0	0	0	0	0.01	0	0.08	0.26	100.04
Rk-24	0.12	9.24	4.18	32.92	47.31	0.57	3.84	0	0.14	0	0.01	0	0	0	0.03	0	98.36
Rk-23	0.11	7.12	5.6	32.89	50.19	0.64	3.39	0.04	0	0	0	0.07	0	0	0.06	0	100.11
Rk-23	0.09	5.84	7.94	30.78	50.37	0.28	4.44	0.04	0	0.01	0.06	0.05	0	0	0.19	0	100.09

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-23	0.13	5.94	7.55	30.58	50.31	0.28	4.48	0	0	0	0.1	0	0.01	0	0.24	0.22	99.85
Rk-23	0.19	5.92	5.48	31.57	52.01	0.34	3.21	0	0.15	0	0.19	0.11	0.04	0	0.52	0.11	99.85
Rk-23	0.08	7.36	5.5	32.29	50.01	0.59	3.63	0	0.05	0.02	0	0	0	0	0.13	0.15	99.81
Rk-23	0.06	7.07	5.68	33.16	49.01	0.42	2.95	0.02	0	0.02	0	0.01	0.02	0	0.07	0	98.49
Rk-23	0.04	5.68	7.32	29.68	50.68	0.2	4.7	0.02	0.01	0	0	0	0	0	0.42	0.13	98.88
Rk-23	0.14	5.77	8.1	30.71	49.97	0.28	4.31	0.05	0	0.08	0	0.05	0	0	0.32	0.01	99.79
Rk-23	0.2	6.26	6.87	30.87	50.24	0.31	4.46	0	0	0	0.09	0.07	0	0	0.18	0.14	99.69
Rk-23	0.08	7.28	5.36	32.23	49.64	0.54	3.77	0.02	0	0	0.08	0.04	0	0	0.26	0	99.30
Rk-23	0.13	6.3	4.8	31.74	51.75	0.42	3.32	0.05	0.01	0	0.02	0	0	0	0.09	0.15	98.79
Rk-23	0.09	8.3	5.41	31.97	48.13	0.44	4.48	0.02	0	0.02	0.02	0	0.01	0	0.36	0.29	99.54
Rk-30	0.16	4.02	2.76	32.00	57.94	1.2	1.34	0.02	0	0	0	0.04	0.06	0	0	0	99.54
Rk-30	0.11	2.76	0.66	32.18	62.18	0.64	0.39	0	0.01	0.03	0.07	0	0	0	0.06	0	99.10
Rk-30	0.05	7.8	2.25	33.59	51.47	1.24	2.24	0.05	0	0	0.15	0	0	0	0.02	0	98.86
Rk-30	0.11	8.46	1.61	34.84	50.34	1.13	1.82	0	0.01	0	0	0	0	0	0.05	0	98.37
Rk-30	0.13	8.35	2.14	35.10	50.32	1.2	1.62	0.08	0	0	0.18	0	0.03	0	0	0.18	99.33
Rk-30	0.08	8.05	2.2	34.03	50.41	1.15	1.96	0	0	0.06	0.05	0.02	0	0	0.04	0	98.06
Rk-30	0.13	9.12	1.77	36.26	50.08	1.02	1.65	0.02	0	0.01	0.07	0.01	0.01	0	0.02	0.21	100.38
Rk-30	0.08	8	2.37	34.66	50.65	0.92	1.77	0.04	0.05	0	0	0	0	0	0.09	0	98.63
Rk-30	0.01	12.24	2.24	37.33	41.48	0.9	2.22	0.08	0	0	0.05	0.12	0.03	0	0.03	0	96.73
Rk-30	0.08	6.82	2.22	33.06	53.55	1.11	2.2	0.02	0.01	0	0.23	0	0	0	0.16	0	99.47
Rk-31	0.19	8.14	2.93	32.46	50.54	1.09	3.44	0	0.01	0.04	0	0	0.02	0	0.02	0	98.88
Rk-31	0.04	8.1	2.7	33.96	50.86	0.99	2.53	0	0	0	0.01	0	0	0	0.05	0	99.25
Rk-31	0.01	7.8	2.73	32.91	52.27	0.9	2.55	0.05	0.17	0	0	0.01	0.04	0	0.08	0.12	99.64
Rk-31	0.1	8.08	2.85	34.62	50.77	0.73	2.43	0	0	0	0.05	0.04	0.02	0	0.13	0	99.82
Rk-31	0.07	12.82	2.67	37.93	41.14	0.88	2.66	0.01	0	0.01	0.27	0.06	0.01	0	0	0	98.53
Rk-31	0.04	3.67	3.17	32.04	57.79	0.48	1.32	0.01	0	0	0	0	0	0	0.08	0.08	98.68
Rk-31	0.06	8.98	2.9	34.08	49.48	1.03	2.91	0.03	0	0.07	0.11	0.09	0	0	0.02	0	99.76
Rk-31	0.01	8.04	3.46	34.42	50.38	0.73	2.2	0.03	0.06	0.04	0	0	0.08	0	0.13	0.04	99.62
Rk-31	0.12	7.97	2.16	34.40	51.06	1.02	1.94	0	0	0.03	0.05	0	0	0	0.02	0.13	98.90
Rk-31	0.15	8.05	2.71	34.96	50.59	0.78	2.1	0	0	0	0.14	0	0.06	0	0	0.02	99.57
Rk-31	0.01	7.94	3.41	34.54	50.55	0.66	2.32	0.1	0	0	0	0.03	0	0	0.03	0	99.59
Rk-31	0.01	8.16	2.68	34.91	50.86	0.88	1.86	0.01	0.06	0	0.06	0.02	0	0	0	0	99.51
Rk-31	0.06	9.21	2.19	35.96	48.80	0.86	1.69	0.03	0	0.09	0	0	0	0	0.04	0	98.93
Rk-31	0.08	4.76	2.6	34.45	56.55	0.27	0.7	0.04	0	0	0	0	0	0	0.07	0.04	99.56
Rk-31	0.08	7.69	2.39	33.97	52.88	1.1	2.06	0.02	0.12	0.01	0	0.04	0.05	0	0.04	0	100.46
Rk-31	0	5.39	3.25	31.42	55.89	1	2.66	0.02	0	0	0.03	0.1	0.03	0	0.15	0	99.94
Rk-31	0	7.9	2.74	34.81	51.40	0.92	1.96	0.03	0	0	0.17	0	0.07	0	0.01	0	100.01
Rk-31	0.08	7.72	2.31	34.04	52.15	1.14	1.95	0.08	0.07	0	0	0	0.01	0	0.11	0.04	99.70

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-31	0	7.6	2.21	33.76	52.06	1.2	2.04	0.06	0	0	0.06	0	0.04	0	0.08	0	99.11
Rk-31	0.18	7.1	2.28	31.23	48.57	1.18	1.83	0	0.17	0	0	0.01	0.04	0	0.02	0	92.60
Rk-32	0.12	5.61	7.86	29.38	49.57	0.29	4.38	0.04	0.11	0.02	0.08	0.01	0	0	0.4	0.17	98.03
Rk-32	0.08	7.56	2.01	33.82	51.79	1.34	1.73	0.06	0	0	0.14	0	0	0	0	0.18	98.70
Rk-32	0.1	5.79	7.49	29.81	49.50	0.36	4.19	0.06	0.1	0	0	0	0.03	0	0.29	0.04	97.77
Rk-32	0.01	7.3	1.93	33.29	52.48	1.34	1.92	0	0.01	0	0	0	0.03	0	0	0	98.32
Rk-32	0.09	7.6	2.15	33.86	51.58	1.04	2.06	0.02	0	0	0.13	0.02	0.07	0	0	0	98.62
Rk-32	0.23	5.63	7.24	29.62	49.49	0.36	4.55	0.03	0	0	0.08	0	0	0	0.73	0.27	98.23
Rk-32	0.11	7.73	1.82	35.53	51.30	0.89	0.71	0	0.14	0.02	0.04	0	0	0	0.12	0	98.41
Rk-32	0.11	7.24	1.95	33.07	51.99	1.39	1.88	0.08	0	0.03	0.16	0.04	0.04	0	0	0.01	97.99
Rk-32	0.12	7.85	2.48	33.82	49.70	1.05	2.08	0.05	0	0	0.07	0	0	0	0.28	0	97.50
Rk-32	0.12	7.45	2.07	33.05	51.41	1.36	1.84	0.08	0.09	0	0.04	0	0.03	0	0.12	0	97.66
Rk-32	0	5.68	7.82	30.24	49.88	0.28	4.28	0	0.01	0.01	0.05	0.02	0.05	0	0.17	0	98.49
Rk-32	0.08	6.59	6.97	29.70	49.33	0.36	5.06	0.06	0	0	0.07	0	0	0	0.02	0	98.24
Rk-34	0.04	8.15	2.5	34.09	51.40	0.98	2.36	0.08	0	0.07	0.12	0	0	0	0.03	0	99.81
Rk-34	0.05	9.06	2.7	36.47	48.51	0.56	1.72	0.03	0	0	0	0	0	0	0.15	0.08	99.33
Rk-34	0	9.69	1.84	34.85	48.79	1.01	2.62	0.01	0	0.04	0	0	0.01	0	0.05	0	98.91
Rk-34	0.05	8.09	2.63	34.87	51.32	1.04	2	0.04	0.01	0	0.17	0.1	0	0	0.03	0.04	100.39
Rk-34	0	8.38	2.68	33.95	50.29	0.86	2.64	0.05	0	0	0	0	0	0	0	0	98.85
Rk-34	0.15	8	2.56	35.19	50.98	1.01	1.85	0	0	0	0.13	0.06	0.09	0	0.04	0	100.07
Rk-34	0.13	9.49	1.76	35.52	49.99	0.97	2.49	0.06	0	0.02	0	0	0	0	0	0.02	100.44
Rk-34	0.01	12.85	1.43	36.32	43.75	1.94	2.3	0.06	0.22	0.01	0.04	0	0	0	0.09	0.1	99.13
Rk-34	0.09	7.91	1.78	34.68	51.60	1.18	1.69	0	0	0	0.08	0	0	0	0	0.03	99.04
Rk-34	0.06	9.83	2.11	37.05	47.55	0.71	1.55	0	0	0.02	0	0.12	0.05	0	0	0.1	99.16
Rk-35	0.03	8.41	3.06	34.12	51.15	1.03	2.53	0.02	0.09	0	0	0.02	0.02	0	0.06	0.18	100.72
Rk-35	0.01	7.78	3.6	33.92	51.22	0.76	2.47	0.07	0.08	0	0	0.02	0.03	0	0.09	0	100.05
Rk-35	0.06	7.81	2.25	34.50	52.39	0.97	2.14	0.04	0	0.01	0	0.02	0	0	0.07	0	100.26
Rk-35	0	8.45	2.85	34.62	50.15	0.79	2.47	0	0	0.01	0	0	0	0	0.19	0	99.53
Rk-35	0.11	8.14	2.65	35.47	50.88	0.81	1.86	0.03	0	0	0	0	0.02	0	0	0.02	99.99
Rk-35	0.1	8.17	2.84	34.26	51.24	0.91	2.49	0.02	0.05	0	0.01	0	0	0	0.03	0.07	100.19
Rk-35	0.01	6.82	4.33	32.89	52.16	0.43	2.77	0.05	0.06	0.05	0.01	0.09	0	0	0.11	0	99.78
Rk-35	0.07	8.27	2.86	33.36	51.17	1.04	2.54	0.02	0.18	0.02	0	0	0.02	0	0	0	99.55
Rk-35	0	8.19	2.71	33.95	50.64	0.92	2.49	0.02	0.01	0	0.1	0	0.03	0	0.09	0.07	99.22
Rk-35	0.22	8.2	2.88	33.67	50.48	0.84	2.7	0	0.1	0	0.01	0.06	0.01	0	0.02	0.12	99.31
Rk-35	0.02	6.28	4.69	32.80	52.77	0.53	2.62	0.09	0.05	0	0.17	0	0	0	0.05	0	100.07
Rk-35	0.07	8.1	2.77	33.81	50.77	0.97	2.64	0.03	0	0	0.06	0	0	0	0.02	0	99.24
Rk-36	0.07	8.26	2.69	34.32	51.01	1.05	2.43	0.04	0	0	0	0	0	0	0.01	0.12	100.00
Rk-36	0.08	8.23	2.62	34.06	50.96	0.92	2.62	0.06	0.01	0	0	0	0	0	0.05	0	99.61

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-36	0.1	8.15	2.68	33.93	51.25	0.94	2.7	0.07	0	0	0	0	0.05	0	0	0.06	99.93
Rk-36	0.12	8.29	2.66	34.35	50.73	0.87	2.51	0.05	0	0	0	0	0	0	0.04	0.15	99.77
Rk-36	0.08	8.15	2.7	34.22	51.77	0.94	2.42	0	0.06	0.04	0.08	0	0.04	0	0	0.07	100.57
Rk-36	0.05	8.25	2.8	34.28	51.14	0.76	2.66	0.02	0	0	0.13	0.04	0.04	0	0	0.13	100.31
Rk-36	0.18	8.32	2.69	34.24	50.52	0.97	2.42	0.05	0	0.05	0.05	0	0	0	0	0.24	99.73
Rk-36	0	7.64	2.77	33.60	52.08	0.87	2.57	0.01	0	0	0	0.01	0.01	0	0.11	0.11	99.78
Rk-36	0.01	8.41	2.79	34.27	50.74	0.86	2.66	0.05	0	0	0	0	0.02	0	0	0	99.81
Rk-36	0	9.48	1.18	37.27	49.78	0.8	1.02	0	0.08	0	0	0	0.03	0	0.17	0	99.82
Rk-36	0.11	7.95	2.85	33.62	52.12	1.03	2.69	0.06	0.06	0	0.07	0	0.07	0	0.05	0.17	100.85
Rk-36	0.01	8.45	2.67	34.65	50.61	0.72	2.52	0.01	0	0	0	0	0.04	0	0.01	0	99.69
Rk-37	0.11	8.42	2.68	34.37	50.67	0.96	2.54	0.11	0	0	0	0.05	0	0	0	0.09	99.99
Rk-37	0.01	8.26	2.66	33.66	51.78	0.88	2.75	0.02	0.1	0	0	0.01	0	0	0.04	0.01	100.18
Rk-37	0.13	8.61	2.25	34.89	50.71	0.65	2.35	0	0.05	0	0.1	0	0	0	0.07	0.21	100.02
Rk-37	0.07	8.28	2.71	33.63	51.37	0.95	2.65	0.04	0.11	0.02	0.09	0	0.07	0	0	0	99.99
Rk-37	0.09	8.31	2.75	34.25	50.72	0.84	2.63	0.08	0	0	0.02	0	0	0	0	0.03	99.72
Rk-37	0.13	9.32	1.71	36.48	50.35	1.15	1.78	0.06	0	0.01	0.1	0	0.01	0	0	0	101.11
Rk-37	0.02	8.7	1.18	36.14	50.31	1.03	1	0	0	0.02	0.02	0	0	0	0.03	0.14	98.60
Rk-37	0	8.35	2.69	33.87	50.30	1.03	2.51	0.06	0	0.01	0	0	0.04	0	0.11	0.1	99.07
Rk-37	0	8.16	2.79	33.57	51.68	0.96	2.86	0	0.05	0	0	0	0	0	0.07	0	100.14
Rk-37	0.19	8.4	2.67	34.50	50.48	0.88	2.65	0.03	0	0	0.32	0	0.03	0	0	0	100.15
Rk-37	0.19	8.37	2.66	34.39	50.33	0.88	2.64	0.03	0	0	0.31	0	0.03	0	0	0	99.83
Rk-37	0.07	8.13	2.65	33.88	50.62	0.85	2.46	0.04	0.01	0.04	0.02	0	0.04	0	0	0.05	98.86
Rk-37	0.04	8.5	2.58	34.58	50.06	0.99	2.28	0.05	0	0.01	0	0.01	0	0	0.04	0	99.13
M06-20	0.13	7.94	5.8	33.34	48.81	0.57	3.7	0.03	0	0	0	0.06	0	0	0.03	0.11	100.52
M06-20	0.16	7.75	5.88	33.12	49.30	0.59	3.85	0	0.01	0	0.11	0	0	0	0.09	0.06	100.92
M06-20	0.16	7.66	5.92	33.10	49.28	0.4	3.96	0	0	0	0	0.08	0	0	0.12	0	100.67
M06-20	0.1	7.81	5.86	32.55	49.65	0.56	3.67	0	0.16	0	0.05	0.05	0.01	0	0.07	0.21	100.76
M06-20	0	6.59	6.61	31.53	50.75	0.45	4.1	0.01	0	0	0	0	0	0	0.13	0.11	100.28
M06-20	0.16	7.72	5.95	32.63	48.61	0.48	4.02	0	0	0.01	0.02	0	0	0	0	0.01	99.62
M06-20	0.21	7.85	5.84	33.21	48.39	0.53	3.74	0	0	0.01	0.02	0.06	0	0	0	0.06	99.92
M06-20	0.14	7.71	6	33.26	48.91	0.45	3.74	0.04	0	0	0	0.1	0	0	0.1	0.05	100.50
M06-20	0.12	7.86	6.4	31.95	47.55	0.67	4.2	0.06	0.11	0.02	0	0	0	0	1.67	0.22	100.83
M06-20	0.02	8.16	5.66	33.61	48.58	0.6	3.48	0	0	0.01	0	0	0.04	0	0	0.12	100.27
M06-20	0.07	7.72	5.8	31.98	49.46	0.44	3.81	0	0.19	0.02	0.13	0	0	0	0	0	99.62
M06-20	0	7.64	5.93	32.31	49.80	0.51	3.9	0.04	0.07	0	0.02	0.1	0	0	0.04	0.11	100.47
M06-30	0.12	8.2	2.88	34.20	50.84	0.88	2.63	0	0	0.04	0	0	0.01	0	0	0.01	99.81
M06-30	0	8.18	2.64	34.17	51.39	0.88	2.55	0	0	0.03	0	0.03	0	0	0.06	0	99.93
M06-30	0.09	8.12	2.93	34.15	50.76	0.72	2.62	0.01	0.01	0	0	0	0.02	0	0.02	0.12	99.57

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M06-30	0.11	8.16	2.73	33.12	51.74	1.06	2.53	0.04	0.23	0	0.1	0	0	0	0.05	0.08	99.95
M06-30	0.12	8.08	2.76	34.30	50.63	0.73	2.53	0.01	0	0	0	0.09	0	0	0.04	0	99.30
M06-30	0	8.23	2.67	33.29	51.73	1.19	2.65	0.01	0.13	0	0	0	0	0	0.06	0	99.97
M06-30	0.14	8.22	3	34.02	51.02	0.97	2.6	0	0.07	0.01	0.04	0	0	0	0	0.12	100.21
M06-30	0	8.1	2.87	33.87	51.42	0.91	2.62	0.01	0.01	0	0.05	0	0	0	0.05	0.23	100.14
M06-30	0.01	8.12	2.68	33.62	51.96	0.83	2.71	0.01	0.11	0	0.23	0	0.01	0	0.1	0	100.39
M06-30	0.13	8.39	3.06	34.90	50.15	0.79	2.4	0	0	0.02	0.1	0	0.11	0	0.05	0.09	100.19
M06-33	0.08	8.54	2.91	33.57	50.60	0.9	3.11	0	0.06	0	0.11	0	0	0	0	0	99.88
M06-33	0.14	8.6	3.16	34.10	50.00	0.88	3.12	0	0	0	0.08	0.02	0	0	0.06	0	100.16
M06-33	0.06	8.48	2.98	34.06	50.44	0.69	3.02	0.01	0	0	0	0.01	0.1	0	0.07	0.08	100.00
M06-33	0.13	8.72	3.04	34.28	49.11	0.78	2.85	0	0	0.04	0.08	0.07	0.12	0	0.15	0	99.38
M06-33	0.13	8.52	2.99	33.20	50.60	0.73	3.19	0	0.08	0.09	0	0	0	0	0.13	0.14	99.80
M06-33	0.01	8.52	3.02	33.58	50.58	0.87	3.17	0.05	0.01	0	0	0	0.01	0	0	0	99.82
M06-33	0.06	8.83	2.92	34.10	50.13	0.81	2.98	0.01	0.07	0	0.15	0	0	0	0.02	0	100.07
M06-33	0.12	8.91	3	34.39	49.63	0.7	3.15	0.05	0	0	0	0	0.02	0	0.05	0	100.02
M06-33	0.01	8.62	3.06	33.59	49.78	0.83	2.95	0.2	0.01	0.02	0.22	0	0.01	0	0	0	99.30
M06-33	0	8.6	2.96	33.55	50.49	0.83	2.98	0.02	0	0.09	0	0	0	0	0	0.21	99.74
M06-33	0.04	8.64	2.99	34.03	50.12	0.84	3.06	0	0	0	0	0.11	0.03	0	0.08	0	99.94
M06-33	0.08	8.69	2.97	34.11	50.10	0.98	2.9	0.05	0	0.03	0	0.06	0	0	0	0	99.97
M06-52	0.12	14.92	2.02	40.41	37.56	1.07	2.19	0	0	0.02	0	0	0	0	0.06	0	98.38
M06-52	0.05	7.97	2.21	33.92	51.69	1.26	2.18	0.05	0.01	0.02	0.11	0	0.04	0	0.02	0	99.53
M06-52	0	8.33	2.81	33.08	48.83	1.04	2.46	0	0	0.08	0.04	0	0.08	0	0.12	0.18	97.05
M06-52	0.14	9.17	1.7	36.95	48.85	0.96	1.07	0.05	0	0	0	0	0.01	0	0	0.12	99.02
M06-54	0.16	7.95	2.66	33.34	51.48	0.9	2.67	0.49	0	0	0.57	0	0.04	0	0.03	0.1	100.39
M06-54	0.16	7.91	2.64	33.20	51.27	0.9	2.65	0.49	0	0	0.57	0	0.04	0	0.03	0.1	99.96
M06-54	0.01	8.37	2.46	33.27	51.22	1.04	2.7	0	0.12	0	0.05	0.14	0.04	0	0.08	0.07	99.57
M06-54	0.2	8.04	2.53	33.23	51.40	0.82	2.69	0.61	0	0	0.62	0	0.08	0	0	0.22	100.45
M06-54	0.19	8.11	2.7	34.19	51.49	1.01	2.65	0.04	0	0.01	0	0	0	0	0	0.09	100.49
M06-54	0.01	7.99	2.62	33.29	51.88	1.02	2.66	0	0.09	0	0	0	0	0	0	0	99.56
M06-54	0.04	8.26	2.38	33.91	51.02	0.91	2.58	0	0.01	0.02	0.12	0	0.02	0	0	0.02	99.30
M06-54	0.1	8.21	2.68	33.61	51.20	0.97	2.85	0.08	0	0	0.19	0	0.01	0	0	0.17	100.07
M06-54	0.07	8.04	2.61	33.74	51.24	0.78	2.74	0.01	0	0	0.17	0	0	0	0.13	0.16	99.69
M06-54	0	8.27	2.66	33.52	51.14	0.95	2.67	0.03	0.08	0	0.1	0	0	0	0.16	0.1	99.68
M06-54	0.17	8.18	2.57	34.17	50.91	0.98	2.58	0	0	0.01	0.17	0	0	0	0.13	0.1	99.98
M06-54	0.05	8.09	2.5	33.21	51.33	1.14	2.66	0	0.07	0	0.07	0	0.02	0	0.07	0.05	99.27
M06-55	0.05	9.71	2.79	34.88	48.50	0.86	3.03	0.06	0	0.04	0	0	0	0	0.01	0	99.93
M06-55	0.08	9.39	2.82	34.31	48.70	1.09	2.82	0.05	0.07	0.02	0.02	0	0	0	0.02	0	99.39
M06-55	0.23	9.58	2.82	34.95	48.25	0.9	2.87	0	0.07	0.04	0.22	0	0.01	0	0.11	0	100.05

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M06-55	0.06	9.25	2.69	32.80	48.74	0.83	2.85	1.42	0.01	0.02	1.57	0	0.01	0	0.14	0	100.40
M06-55	0.06	9.29	2.82	34.29	48.80	1.02	2.97	0.02	0	0.02	0.01	0.02	0	0	0	0.08	99.40
M06-55	0.04	9.57	2.84	34.68	48.84	1.04	3.04	0.05	0	0.01	0.26	0	0.03	0	0	0.03	100.43
M06-55	0.04	9.31	2.71	34.04	49.44	1.04	3.04	0.06	0.07	0	0.03	0	0.07	0	0	0	99.85
M06-55	0	9.46	2.8	34.30	48.51	0.8	3.03	0.09	0	0.05	0	0.02	0	0	0.01	0	99.07
M06-55	0.06	9.2	2.79	34.10	49.26	0.72	3.18	0.04	0	0	0.1	0	0	0	0.01	0.29	99.75
M06-55	0.09	9.53	2.73	33.69	49.61	1	3.1	0	0.2	0.05	0	0.02	0	0	0	0.02	100.04
M06-55	0.2	9.37	2.85	34.36	48.57	0.97	3.09	0	0.07	0	0.04	0	0.02	0	0.13	0	99.68
M06-55	0	9.23	2.66	34.25	48.58	0.8	2.96	0	0	0	0	0	0	0	0	0	98.48
M06-56	0.08	7.56	1.9	33.80	52.53	1.3	1.95	0.03	0	0	0	0	0	0	0.04	0.16	99.35
M06-56	0.17	7.34	2.08	34.12	53.38	1.47	1.85	0	0	0	0	0	0.01	0	0.05	0.22	100.69
M06-56	0.08	7.38	2.11	33.87	53.07	1.29	1.92	0.08	0	0	0.09	0	0	0	0	0.14	100.03
M06-56	0.09	7.37	1.78	33.76	53.38	1.47	1.87	0	0	0.03	0.06	0	0.03	0	0	0.05	99.89
M06-56	0.07	7.28	1.87	33.71	53.59	1.27	1.91	0.06	0	0	0	0.06	0	0	0	0.22	100.04
M06-56	0.07	7.23	1.84	33.34	52.95	1.64	1.8	0.03	0	0	0	0	0.01	0	0.06	0.08	99.05
M06-56	0.04	7.2	1.75	32.79	54.51	1.47	1.94	0.06	0.15	0.02	0	0.07	0	0	0	0.05	100.05
M06-56	0	7.3	1.92	33.26	53.36	1.46	1.85	0	0.07	0	0	0	0.01	0	0.04	0.07	99.35
M06-56	0.04	7.34	1.99	33.80	53.62	1.49	1.9	0.06	0	0	0	0	0	0	0.05	0.08	100.37
M06-56	0.18	7.32	1.91	33.57	53.51	1.43	2.1	0	0	0	0.15	0.08	0	0	0	0.27	100.51
M06-56	0.02	7.45	2.05	33.09	53.56	1.37	2.05	0.12	0.09	0	0	0	0	0	0	0.19	100.00
M06-56	0	7.28	1.91	33.21	53.18	1.42	2.03	0.06	0	0.01	0.1	0	0	0	0.02	0	99.22
M06-57	0.12	8.53	2.35	34.83	50.99	1.13	2.34	0.03	0	0.02	0	0	0	0	0.07	0	100.41
M06-57	0.07	8.56	2.55	34.62	50.34	1.09	2.24	0.06	0	0.03	0.08	0	0	0	0.01	0.11	99.76
M06-57	0.04	8.86	2.43	35.12	49.51	0.99	2.17	0.07	0	0	0.04	0.01	0.02	0	0.13	0	99.39
M06-57	0	8.65	2.33	34.77	50.85	1	2.27	0.05	0.01	0.01	0	0	0.03	0	0.06	0.12	100.15
M06-57	0.14	8.65	2.46	34.90	49.87	0.99	2.19	0.03	0	0.02	0	0.07	0	0	0.12	0.21	99.65
M06-57	0.1	8.4	2.87	33.56	51.13	0.89	2.48	0	0.25	0	0.13	0	0.01	0	0	0.05	99.87
M06-57	0.13	8.61	2.38	34.79	50.50	1.1	2.35	0.08	0	0	0	0.02	0.03	0	0	0	99.99
M06-57	0.08	8.62	2.38	33.85	51.17	1	2.24	0	0.22	0	0	0	0	0	0	0.28	99.84
M06-57	0.05	8.42	2.32	34.59	50.93	1.22	2.25	0.03	0	0	0.02	0	0.01	0	0.13	0	99.97
M06-57	0.05	8.05	3.17	34.07	50.78	0.98	2.59	0	0	0	0	0	0	0	0	0	99.69
M06-57	0	8.23	2.67	34.75	51.63	1.07	2.29	0	0	0	0	0	0	0	0	0	100.64
M06-57	0.17	8.31	2.56	34.41	51.11	1.12	2.39	0	0	0.05	0.01	0.13	0.04	0	0.14	0.23	100.68
M06-58	0.09	9.8	2.8	35.04	47.92	0.78	3.11	0	0	0	0	0	0.01	0	0	0	99.55
M06-58	0	9.16	2.93	35.08	49.05	0.92	2.57	0.02	0	0	0	0.05	0	0	0.02	0	99.81
M06-58	0.1	9.39	2.56	34.64	49.08	0.82	2.96	0.09	0	0.02	0.07	0	0	0	0.08	0.12	99.93
M06-58	0.01	9.85	2.71	35.35	48.65	0.76	3.03	0	0	0.01	0.14	0	0	0	0.04	0	100.55
M06-58	0.14	9.46	2.7	34.76	48.82	0.78	2.72	0.02	0.1	0	0.04	0	0	0	0.05	0.25	99.84

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M06-58	0.06	9.95	2.86	34.84	47.33	0.89	3.02	0	0	0.07	0	0	0	0	0.07	0	99.09
M06-58	0.11	9.83	2.74	35.13	47.28	0.94	2.83	0.03	0	0	0	0.01	0.03	0	0.04	0	98.98
M06-58	0.14	9.55	2.7	34.52	48.91	0.98	3.06	0.01	0.06	0	0.07	0.06	0	0	0	0.1	100.16
M06-58	0.06	9.96	2.62	35.14	47.71	0.9	2.91	0.05	0	0.03	0	0.09	0	0	0.09	0	99.56
M06-58	0.15	9.97	2.73	35.37	47.80	1.02	2.95	0	0.01	0	0.1	0.13	0	0	0	0	100.23
M06-58	0.04	9.96	2.66	34.98	48.42	0.98	2.96	0.02	0.06	0	0.06	0	0	0	0.11	0.11	100.36
M06-58	0.01	9.78	2.84	34.36	48.18	0.96	3.05	0.02	0.01	0.04	0	0	0	0	0.07	0.34	99.66
M06-60	0.08	8.04	2.76	33.27	51.87	1.13	2.77	0	0.11	0	0	0	0.07	0	0.11	0	100.21
M06-60	0.14	8.14	2.95	34.37	49.86	0.77	2.38	0.09	0	0	0	0	0.06	0	0.09	0.03	98.88
M06-60	0.05	7.84	2.95	33.41	51.19	0.77	2.82	0	0	0.03	0	0	0.08	0	0	0	99.15
M06-60	0.01	8.18	2.7	33.83	51.20	1.04	2.68	0.01	0	0	0	0	0.03	0	0.01	0.01	99.69
M06-60	0	8.17	2.57	33.15	52.38	1.05	2.67	0	0.18	0	0.08	0	0	0	0	0.06	100.31
M06-60	0.07	8.2	2.44	33.83	50.51	0.82	2.61	0.04	0	0	0.15	0	0.04	0	0	0	98.71
M06-60	0.11	8.03	2.91	33.59	51.59	0.79	2.64	0.02	0.12	0.04	0	0.07	0	0	0	0	99.91
M06-60	0.08	8.31	2.98	34.04	50.34	0.91	2.74	0	0	0.02	0	0	0	0	0.06	0	99.48
M06-60	0.11	8.17	2.68	34.25	51.59	0.85	2.53	0.03	0.07	0	0.12	0	0	0	0.02	0	100.42
M06-60	0.1	8.15	2.47	33.26	50.79	0.77	2.3	0.99	0	0.03	1.18	0.03	0.01	0	0.11	0.02	100.22
U05-36	0.12	8.52	1.56	35.35	50.67	0.96	1.64	0	0	0.04	0	0.02	0.08	0	0	0.12	99.08
U05-36	0.1	8.88	1.61	36.05	51.08	0.88	1.66	0	0.06	0	0.04	0	0	0	0.03	0.1	100.49
U05-36	0.18	8.94	1.24	35.42	51.22	1.05	1.7	0.06	0.09	0.07	0	0	0.03	0	0	0.05	100.05
U05-36	0.04	9.22	1.53	37.02	50.43	0.86	1.39	0.01	0	0	0.01	0.15	0	0	0	0.07	100.73
U05-36	0.07	8.21	1.94	34.94	51.64	1.06	1.82	0.14	0	0.01	0	0	0	0	0.04	0.09	99.96
U05-36	0.08	8.04	2	35.10	51.99	0.98	1.77	0.01	0	0.05	0.04	0	0.01	0	0	0	100.07
U05-36	0.09	9.28	1.23	36.47	50.21	0.95	1.54	0.03	0.01	0	0.11	0	0.02	0	0.01	0.1	100.04
U05-36	0.17	8.47	2.03	35.19	51.15	1.01	1.64	0.26	0.09	0	0.36	0	0	0	0.07	0.13	100.57
U05-36	0.16	8.46	2.69	35.36	51.50	0.97	2.4	0	0	0	0.01	0	0.04	0	0	0.05	101.64
U05-36	0	9.29	1.28	37.19	50.65	0.8	1.05	0	0.01	0.08	0.07	0.09	0.02	0	0.04	0.19	100.77
U05-44	0.08	8.26	2.65	33.81	51.27	1.21	2.65	0	0.01	0.01	0	0	0.01	0	0	0.14	100.10
U05-44	0.1	7.94	2.7	34.05	51.61	0.57	2.76	0.02	0	0	0	0	0	0	0	0.08	99.82
U05-44	0.08	8.46	2.68	35.06	50.66	0.96	2.28	0.01	0	0	0	0.01	0.04	0	0.04	0	100.29
U05-44	0.09	7.83	2.96	33.66	50.91	0.95	2.47	0.08	0	0.03	0	0	0.08	0	0	0.05	99.11
U05-44	0.09	8.33	2.83	33.30	51.01	0.98	2.77	0.02	0.12	0.04	0	0	0	0	0	0.04	99.53
U05-44	0.11	8.01	2.81	34.40	51.57	0.98	2.52	0	0	0	0	0	0	0	0.06	0	100.47
U05-44	0.09	8.39	2.29	34.08	51.79	1.03	2.46	0.06	0.11	0	0	0	0	0	0.01	0	100.31
U05-44	0.23	8.36	2.64	34.68	50.86	0.72	2.63	0.02	0	0.04	0	0	0.06	0	0	0.06	100.30
U05-44	0.23	8.03	2.66	34.64	51.98	0.89	2.3	0	0.09	0.03	0	0.07	0.03	0	0.05	0	101.00
U05-44	0.08	7.94	3	33.81	51.64	0.81	2.59	0.06	0.06	0	0	0.05	0.04	0	0.12	0.22	100.42
U05-56	0.15	10.07	2.75	36.08	48.45	0.78	2.93	0.06	0	0.01	0	0.1	0	0	0	0	101.38

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-56	0.11	9.39	2.48	35.57	49.41	0.86	2.43	0.05	0	0.06	0	0	0	0	0	0.07	100.42
U05-56	0	6.98	5.09	32.89	52.31	0.42	3.04	0.1	0.15	0	0	0.01	0.09	0	0.12	0	101.20
U05-56	0.04	9.48	3.2	34.81	48.60	0.87	3.16	0	0	0	0	0	0.02	0	0.1	0	100.28
U05-69	0	8.37	2.81	34.60	52.04	0.87	2.65	0.05	0	0	0.15	0.18	0	0	0.08	0.23	102.03
U05-69	0	8.07	2.77	34.65	52.36	0.79	2.58	0	0	0	0.24	0	0	0	0.05	0	101.50
U05-69	0.09	8.32	2.36	35.29	51.74	1.07	2.06	0.06	0	0	0.04	0	0	0	0	0	101.03
U05-69	0	6.88	0.97	34.72	56.19	0.74	0.84	0.04	0.21	0.01	0	0.09	0	0	0.04	0.09	100.82
U05-69	0.1	8.42	2.89	34.47	51.35	1.1	2.73	0	0	0	0.1	0.05	0.04	0	0.07	0.11	101.43
U05-69	0.14	8.47	2.79	34.62	52.36	0.91	2.38	0	0.18	0.07	0.12	0	0	0	0	0	102.04
U05-69	0.06	8.07	3	34.19	52.03	0.99	2.63	0.03	0	0.07	0.13	0.03	0	0	0	0	101.23
U05-69	0	6.76	4.61	33.63	52.75	0.48	2.69	0.09	0	0.03	0.08	0	0.01	0	0	0	101.14
U05-69	0.06	8.44	2.83	34.69	51.37	0.91	2.62	0.08	0	0	0	0.15	0	0	0.02	0.06	101.23
U05-69	0.05	8.3	2.78	34.45	51.69	0.82	2.51	0.1	0.01	0.04	0	0	0	0	0	0.18	100.92
U05-69	0.01	8.28	2.78	34.56	51.68	0.8	2.59	0.03	0	0.03	0	0	0	0	0.02	0	100.78
U05-69	0.02	8.12	2.2	34.46	52.44	0.92	2.06	0.04	0.12	0	0.01	0	0	0	0.02	0	100.41
Rk-40	0.13	8.01	2.68	34.37	52.78	0.92	2.61	0.04	0.05	0.02	0.01	0	0	0	0.08	0.02	101.72
Rk-40	0.1	8.08	2.54	34.29	51.42	0.87	2.42	0.03	0	0.05	0.07	0	0.01	0	0.03	0	99.91
Rk-40	0.01	8.03	2.64	34.16	52.57	0.86	2.42	0	0.06	0.06	0.12	0.02	0.03	0	0	0.06	101.04
Rk-40	0	8.04	3.45	34.35	50.86	0.79	2.41	0.03	0	0	0	0	0	0	0.01	0.31	100.24
Rk-40	0.03	8.11	2.71	34.39	52.12	0.82	2.66	0	0	0.02	0	0.02	0.08	0	0.03	0	100.99
Rk-40	0.04	7.97	3.44	34.31	50.81	0.6	2.37	0	0.1	0	0	0.04	0.02	0	0.01	0	99.72
Rk-40	0.1	8.09	2.63	33.90	51.59	0.9	2.38	0.06	0.07	0.06	0.15	0.14	0	0	0.08	0.13	100.29
Rk-40	0.05	8.25	2.54	34.53	51.77	0.97	2.56	0	0	0	0.19	0	0	0	0.06	0	100.92
Rk-40	0.26	8.21	2.69	34.67	51.03	0.95	2.42	0.03	0	0.06	0.25	0.08	0.06	0	0.07	0.07	100.85
Rk-40	0.1	7.66	3.58	34.01	51.31	0.67	2.68	0.12	0	0.01	0	0	0	0	0.06	0	100.19
Rk-40	0.02	7.97	2.43	34.70	52.05	0.71	2.3	0	0	0	0.1	0	0.03	0	0	0	100.30
Rk-40	0.18	8.13	2.51	35.08	51.35	0.81	2.28	0.04	0	0	0.19	0.03	0.03	0	0.18	0	100.80
Rk-40	0.09	8.1	2.51	34.59	52.21	0.81	2.12	0.01	0.12	0.03	0.04	0.01	0.02	0	0	0.03	100.69
Rk-44	0.17	7.47	3.03	34.36	51.85	0.8	2.33	0	0	0	0.11	0	0.04	0	0.13	0.05	100.33
Rk-44	0.01	8.51	3.12	34.75	50.31	0.78	2.63	0	0	0	0.11	0.04	0.02	0	0.14	0	100.42
Rk-44	0.14	7.75	3.38	34.56	51.55	0.66	2.4	0.07	0	0.08	0	0	0.02	0	0.11	0	100.72
Rk-44	0.02	8.24	2.99	34.37	50.72	0.67	2.45	0.1	0	0.04	0.06	0	0.02	0	0.1	0.15	99.94
Rk-44	0.08	6.79	3	32.22	53.90	1.04	2.79	0.13	0.05	0	0	0	0.05	0	0	0.07	100.12
Rk-44	0.13	10.09	2.97	35.67	46.89	1.15	2.64	0.03	0	0.02	0	0	0	0	0	0	99.59
Rk-44	0.15	8.3	1.03	34.42	52.14	1	1.17	1.14	0.08	0	1.37	0	0.05	0	0.12	0.09	101.07
Rk-44	0.09	9.23	2.68	37.17	48.29	0.86	1.1	0.04	0	0.1	0.1	0	0	0	0	0	99.66
Rk-44	0.08	6.94	0.98	34.59	55.22	1.14	1.32	0	0.01	0.03	0	0.06	0	0	0.13	0	100.50
Rk-44	0.13	8.45	2.79	34.36	50.25	0.9	2.32	0.04	0.01	0.13	0	0	0.05	0	0.06	0.1	99.59

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-44	0.03	8.9	2.07	35.41	49.42	0.55	2.13	0.04	0	0	0.11	0	0.02	0	0.09	0	98.77
Rk-44	0.07	5.73	3.41	32.15	55.88	1.07	2.63	0.08	0	0	0.05	0	0.05	0	0	0	101.12
Rk-46	0.14	8.29	2.59	34.66	50.45	0.68	2.47	0.01	0	0	0	0	0	0	0	0	99.29
Rk-46	0.08	8.14	2.79	34.17	50.56	0.83	2.47	0	0	0	0	0.09	0	0	0	0.14	99.26
Rk-46	0	8.46	2.33	34.45	52.27	0.94	2.77	0.03	0	0	0	0	0.03	0	0	0	101.27
Rk-46	0	8.07	2.66	34.34	51.95	0.96	2.11	0.04	0.09	0	0	0	0	0	0.06	0.15	100.44
Rk-46	0.08	8.52	2.67	34.64	50.47	0.92	2.49	0.06	0	0	0	0	0	0	0	0.02	99.87
Rk-46	0.09	8.11	2.85	35.28	51.89	0.96	2.19	0	0	0	0.02	0	0.02	0	0	0	101.41
Rk-46	0.06	8.15	2.72	34.27	51.88	0.77	2.84	0	0	0	0	0.14	0.04	0	0.1	0	100.96
Rk-46	0.15	7.92	2.76	33.72	51.82	0.98	2.18	0	0.19	0	0.01	0.17	0	0	0.11	0.22	100.23
Rk-46	0.2	8.16	2.55	34.48	51.66	0.94	2.56	0	0	0.03	0.16	0.09	0.07	0	0.02	0.1	101.02
Rk-13	0.01	9.3	3.66	34.49	48.46	0.56	3.46	0	0	0	0.03	0	0.03	0	0.19	0	100.20
Rk-13	0.08	6.81	5	32.55	50.77	0.52	3.05	0.02	0	0	0	0.09	0.05	0	0.1	0.33	99.36
Rk-13	0.2	6.54	5.65	32.49	51.72	0.27	3.65	0.01	0.01	0	0	0	0	0	0.02	0.17	100.72
Rk-13	0.13	7.24	4.46	32.72	51.41	0.37	2.93	0	0.22	0	0	0.02	0	0	0.1	0.06	99.66
Rk-13	0.14	9.46	3.23	34.14	48.56	0.6	3.38	0	0.05	0.02	0.01	0	0	0	0.04	0.37	100.01
Rk-13	0.11	9.63	3.67	34.86	47.75	0.47	3.53	0	0	0	0.09	0	0.04	0	0.12	0.09	100.35
Rk-13	0.13	9.22	3.54	34.20	48.47	0.69	3.51	0	0	0	0	0	0	0	0.09	0.09	99.95
Rk-13	0.02	9.56	3.68	33.53	49.18	0.59	3.81	0.06	0.13	0.07	0	0.01	0	0	0.11	0	100.76
Rk-13	0.04	9.54	3.54	34.37	48.28	0.46	3.73	0.02	0	0	0.13	0	0.02	0	0.07	0	100.20
Rk-13	0	7.56	4.46	33.93	51.42	0.54	2.96	0	0	0.03	0	0	0	0	0.12	0.07	101.09
Rk-14	0.1	9.82	3.73	35.42	47.90	0.77	3.28	0.04	0	0	0	0	0.02	0	0.04	0	101.12
Rk-14	0.05	9.76	3.41	35.02	47.73	0.65	3.18	0	0	0.03	0	0.01	0.07	0	0.05	0.12	100.08
Rk-14	0.12	9.45	3.46	34.84	47.67	0.45	3.28	0	0.01	0	0	0	0.04	0	0.16	0.05	99.53
Rk-15	0.04	4.76	1.97	31.44	59.16	0.83	1.57	0.01	0.28	0	0	0	0	0	0.1	0	100.16
Rk-15	0.21	6.38	4.55	32.08	52.27	0.75	3.21	0	0.01	0.02	0.14	0	0.05	0	0.08	0.05	99.80
Rk-15	0.18	5.09	2.29	32.96	57.28	1.27	1.41	0	0	0.02	0.09	0	0.04	0	0.02	0.15	100.81
Rk-15	0.12	6.9	1.47	34.14	53.55	0.8	1.57	0	0	0.02	0	0	0.03	0	0	0	98.60
Rk-15	0.13	7.89	4.91	34.18	48.22	0.63	2.67	0	0	0	0.11	0	0.04	0	0	0.08	98.86
Rk-15	0.07	5.29	4.55	30.75	54.99	0.68	2.82	0.03	0.2	0	0.03	0	0.06	0	0.33	0.13	99.92
Rk-15	0.21	6.98	3.99	32.28	52.44	0.57	3.33	0.06	0.11	0	0.22	0.02	0	0	0.09	0	100.30
Rk-15	0.1	5.23	4.6	31.25	54.26	0.71	2.97	0.04	0	0	0.01	0.01	0.08	0	0.33	0.15	99.74
Rk-16	0.09	7.05	3.9	32.36	52.21	0.58	3.31	0.05	0	0.04	0	0	0.01	0	0.08	0.11	99.80
Rk-16	0.06	7.2	3.54	32.45	52.58	0.79	3.2	0.03	0.01	0	0	0	0.07	0	0.05	0.23	100.21
Rk-16	0.12	7.21	3.79	33.38	51.53	0.51	2.73	0.01	0	0.09	0	0	0.02	0	0.01	0	99.39
Rk-16	0.02	6.87	3.97	32.02	52.33	0.52	3.47	0.04	0	0.01	0	0.14	0	0	0.15	0	99.54
Rk-16	0.14	6.89	4.01	33.97	51.76	0.7	2.37	0	0	0	0.02	0	0	0	0.12	0	99.98
Rk-16	0	7.76	1.53	34.10	53.61	0.78	2.31	0.12	0	0	0	0	0.06	0	0.13	0.06	100.45

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-16	0.08	6.18	1.62	33.05	57.60	0.69	1.76	0.09	0.21	0	0	0	0	0	0.06	0.18	101.52
Rk-16	0.08	7.36	3.97	33.04	50.89	0.48	3.1	0.06	0	0	0.07	0.06	0.1	0	0.01	0	99.22
Rk-16	0.12	7.08	4.23	33.09	51.67	0.43	3.17	0.1	0	0	0	0.07	0.05	0	0.11	0	100.12
Rk-16	0.13	7.17	4.09	33.62	52.03	0.73	2.52	0.01	0.06	0.06	0.15	0.04	0	0	0.06	0.09	100.77
Rk-17	0.12	7.02	3.32	32.71	52.85	0.67	2.9	0	0.07	0.02	0.06	0	0.02	0	0	0	99.76
Rk-17	0.16	6.63	3.3	33.82	52.86	0.6	2.27	0	0	0	0.11	0.05	0	0	0.17	0.03	100.00
Rk-17	0.17	7.27	4.03	33.13	51.90	0.6	3.28	0.05	0	0.01	0.16	0	0.03	0	0.13	0.05	100.82
Rk-17	0.08	7	3.38	33.09	53.41	0.78	2.8	0.05	0.01	0.03	0.04	0	0	0	0.13	0.15	100.95
Rk-17	0.14	7.1	3.37	33.11	52.38	0.6	2.87	0	0	0.06	0.01	0	0	0	0.02	0	99.66
Rk-17	0.07	7.13	3.11	33.60	52.68	0.72	2.41	0.09	0	0	0	0	0.03	0	0.05	0.18	100.06
Rk-17	0.09	7.08	3.32	32.35	53.16	0.67	2.74	0.02	0.14	0.12	0.08	0.02	0.05	0	0	0	99.84
Rk-17	0.12	6.73	3.03	32.97	53.66	0.69	2.69	0.04	0	0	0.01	0	0	0	0	0.16	100.10
Rk-17	0.11	7.01	3.35	33.07	52.77	0.8	2.79	0	0	0.04	0	0	0	0	0.06	0	100.00
Rk-17	0.02	9.41	3.55	34.23	48.63	0.69	3.62	0	0	0	0	0	0	0	0.06	0	100.21
Rk-17	0.02	6.25	2.76	32.83	54.58	0.73	2.24	0.1	0.01	0	0	0	0.01	0	0.21	0.15	99.88
Rk-18	0.09	7.07	3.18	33.14	52.98	0.72	2.82	0.05	0.01	0	0.07	0	0.02	0	0.02	0	100.18
Rk-18	0.17	7.12	3.28	33.23	52.60	0.75	2.53	0.12	0.09	0	0.1	0	0	0	0.07	0.05	100.11
Rk-18	0.17	6.21	3.05	32.32	53.99	0.62	2.44	0	0.13	0	0	0.01	0	0	0.06	0	99.00
Rk-18	0.1	7.05	3.17	33.06	52.34	0.66	2.74	0	0	0.03	0.01	0.09	0	0	0.06	0	99.31
Rk-18	0.09	7.05	3.15	33.06	52.55	0.6	2.79	0	0	0.04	0.02	0	0	0	0.07	0	99.42
Rk-18	0.28	6.95	3.32	32.79	52.84	0.51	2.69	0	0.2	0	0.13	0	0.05	0	0.06	0.06	99.88
Rk-18	0.16	7.07	3.13	33.23	52.76	0.81	2.75	0	0.01	0	0.16	0	0	0	0.05	0.06	100.19
Rk-18	0.16	6.87	3.28	33.15	52.35	0.53	2.77	0.03	0	0	0	0.05	0	0	0.13	0	99.32
Rk-18	0.09	6.73	2.6	33.57	53.59	0.72	1.74	0	0.11	0.01	0.08	0	0.05	0	0.02	0.2	99.51
Rk-18	0.01	7.03	3.3	33.12	52.91	0.57	2.51	0	0.11	0	0	0	0.01	0	0.01	0	99.58
Rk-18	0.12	7.07	3.22	33.04	52.71	0.76	2.91	0.02	0	0	0	0	0.04	0	0.07	0	99.95
Rk-19	0.14	6.61	2.86	32.75	54.20	0.8	2.3	0	0.1	0	0.2	0.05	0.03	0	0	0.4	100.44
Rk-19	0.11	6.91	3.34	33.52	51.99	0.83	2.11	0	0	0.06	0	0.1	0.04	0	0	0.09	99.11
Rk-19	0.12	6.81	1.47	34.03	54.40	0.7	1.66	0	0.01	0.03	0	0.09	0.02	0	0.08	0.22	99.64
Rk-20	0.21	8.96	2.94	34.98	49.85	0.89	2.46	0.03	0.14	0.01	0.02	0	0.05	0	0.24	0.08	100.86
Rk-20	0.11	6.72	2.72	33.37	54.39	0.84	2.45	0	0	0	0.08	0.13	0.07	0	0.02	0.17	101.06
Rk-20	0.25	7.76	1.86	35.40	52.78	1.24	1.25	0.03	0.1	0.03	0.14	0.12	0.02	0	0	0	100.98
Rk-20	0.09	6.81	2.76	32.98	54.11	0.89	2.32	0	0.09	0.03	0	0	0	0	0.09	0.15	100.33
Rk-20	0.04	9.94	0.9	37.25	48.75	1.31	1.06	0.02	0	0	0	0	0	0	0	0.05	99.33
Rk-20	0.18	6.43	2.88	32.88	53.19	0.97	2.21	0	0	0.04	0	0.04	0.07	0	0.07	0.04	99.00
Rk-20	0.05	8.56	1.02	36.31	51.24	1.1	0.96	0	0	0	0	0.03	0	0	0.07	0.19	99.53
Rk-20	0.19	6.73	2.97	33.06	53.83	0.86	2.33	0.07	0.12	0	0	0	0	0	0	0	100.16
Rk-20	0.04	7.46	0.97	33.42	54.71	1.3	1.71	0.05	0.17	0	0	0	0	0	0.05	0	99.88

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-20	0.1	6.78	2.76	32.92	53.92	0.84	2.32	0.08	0.07	0.06	0	0	0.04	0	0.1	0.05	100.04
Rk-20	0.08	6.53	2.48	32.72	54.49	0.76	2.5	0.09	0	0	0	0	0.04	0	0	0.15	99.84
Rk-20	0	6.72	2.98	32.83	54.52	0.8	2.62	0	0.07	0	0	0	0	0	0	0	100.55
Rk-20	0.06	6.46	2.7	33.08	54.64	0.75	2.3	0.03	0	0.03	0	0.03	0	0	0.05	0.19	100.31
Rk-20	0.19	6.83	2.93	33.07	53.95	0.8	2.34	0.01	0.18	0	0.13	0	0	0	0.17	0.05	100.65
Rk-20	0.06	7.49	1.96	34.98	53.13	0.98	1.35	0	0.09	0.01	0.05	0	0	0	0.08	0	100.19
Rk-20	0	6.57	2.95	33.21	54.30	0.68	2.36	0	0.01	0	0.1	0	0	0	0	0.17	100.35
U05-75	0.21	8.81	3.06	34.82	49.92	0.72	3	0.07	0	0	0	0	0	0	0.04	0	100.64
U05-75	0.12	8.46	2.95	34.46	50.16	0.64	2.79	0.02	0	0.03	0	0	0.04	0	0.15	0	99.82
U05-75	0.09	9.93	3.05	35.59	48.26	0.57	2.71	0.05	0.11	0.04	0	0	0.04	0	0.02	0.1	100.57
U05-75	0	9.62	1.41	36.10	49.68	0.84	1.85	0	0.07	0	0	0	0	0	0.01	0	99.57
U05-75	0.03	8.26	3.1	33.93	50.63	0.78	2.8	0.04	0	0	0	0.12	0	0	0	0.14	99.82
U05-75	0.13	8.31	2.9	34.08	51.02	0.8	2.53	0.07	0.14	0	0.06	0.2	0.09	0	0.15	0.03	100.50
U05-75	0.18	8.4	2.96	34.07	51.24	0.72	2.86	0	0.15	0	0.08	0	0.01	0	0.18	0	100.86
U05-75	0.03	8.31	2.8	33.63	50.89	0.7	2.74	0	0.07	0.04	0	0	0.07	0	0.06	0.14	99.48
U05-75	0.23	10.15	1.02	37.29	48.95	0.86	1.03	0.03	0.17	0.09	0.21	0.19	0.01	0	0.08	0.23	100.55
U05-75	0.24	10.19	2.94	35.88	46.64	0.91	2.68	0.1	0	0.06	0.14	0	0.01	0	0.01	0.03	99.83
U05-76	0.28	10.2	2.44	36.48	48.01	0.93	2.27	0.04	0.12	0	0.12	0.01	0.01	0	0.07	0.16	101.14
U05-76	0.31	9.67	3.32	34.96	47.96	0.64	3.54	0.01	0.01	0	0	0	0.01	0	0	0.07	100.50
U05-76	0.31	9.57	3.52	35.13	47.41	0.62	3.38	0	0	0	0	0	0.05	0	0.04	0	100.03
U05-76	0.22	9.97	3.41	35.05	47.15	0.67	3.54	0.13	0	0.01	0.14	0	0	0	0.37	0.01	100.67
U05-76	0.22	10.1	3.24	34.11	48.24	0.8	3.26	0	0.29	0	0.07	0.02	0.05	0	0.14	0.35	100.89
U05-82	0.29	9.49	2.71	35.21	48.94	0.93	2.94	0.01	0	0.08	0	0	0.03	0	0.03	0	100.65
U05-82	0.15	10.24	1.99	36.32	46.81	0.85	2.14	0.11	0	0	0.11	0.02	0.08	0	0	0.11	98.93
U05-83	0.18	10.19	3.06	35.60	46.99	0.74	3.2	0	0	0	0.16	0.12	0.12	0	0	0	100.36
U05-83	0.14	10.31	2.92	37.86	45.74	0.67	1.59	0	0	0.04	0	0.02	0	0	0.02	0	99.31
U05-83	0.14	9.96	2.71	35.41	47.64	0.85	2.85	0.03	0	0.06	0	0	0.01	0	0.05	0	99.71
U05-83	0.1	10.25	2.75	34.39	47.33	0.77	2.99	0.05	0.15	0.06	0.07	0.02	0.05	0	0.08	0.3	99.35
U05-83	0.21	12.3	1.93	40.51	43.00	0.66	1.08	0	0	0.06	0	0	0.05	0	0	0	99.80
U05-83	0.3	12.02	1.48	38.81	44.21	0.66	1.73	0	0.11	0	0.1	0	0.01	0	0.04	0.1	99.57
U05-83	0.11	9.98	3.17	35.46	47.40	0.63	3.1	0	0.01	0.01	0	0.08	0.02	0	0	0.06	100.03
U05-83	0.19	13.91	1.33	41.79	39.98	0.69	1.05	0.04	0.01	0	0.09	0	0	0	0.14	0	99.22
U05-83	0.14	9.73	2.91	34.02	47.85	0.7	3.37	0	0.09	0.03	0	0.09	0.05	0	0	0.04	99.02
U05-83	0.15	10.14	2.97	35.54	47.28	0.86	3.12	0	0	0	0	0	0.04	0	0.02	0	100.13
U05-83	0.22	10.07	3.05	35.61	47.01	0.83	3	0	0	0.04	0	0	0.03	0	0.02	0	99.88
U05-83	0.14	10.26	2.64	35.87	47.46	0.98	2.87	0.03	0	0	0	0	0.01	0	0.02	0	100.28
U05-84	0.29	9.87	2.43	36.09	44.95	0.85	1.94	0	0	0.01	0	0	0.03	0	0.13	0	96.59
U05-84	0.15	8.88	3.05	33.94	49.33	0.84	3.3	0.03	0	0.01	0	0	0	0	0.15	0	99.67

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-84	0.16	9.68	3.06	35.46	47.41	0.61	2.83	0	0	0.05	0.09	0.05	0.03	0	0.07	0	99.50
U05-85	0.22	9.73	3.32	34.54	47.84	0.85	3.44	0.05	0.05	0	0	0	0.08	0	0	0	100.12
U05-85	0.1	11.22	2.29	36.63	46.09	0.85	2.8	0.1	0	0.05	0	0	0.09	0	0.1	0.02	100.34
U05-85	0.27	9.73	3.29	35.39	47.26	0.65	3.13	0	0	0	0.09	0	0.01	0	0	0.11	99.93
U05-85	0.24	14.91	1.08	42.03	39.01	0.8	0.9	0.02	0.18	0.02	0.02	0.04	0.01	0	0.04	0.14	99.45
U05-85	0.26	9.65	3.4	34.68	47.69	0.81	3.25	0.09	0.06	0.03	0	0	0.07	0	0.07	0	100.06
U05-85	0.23	9.92	3.02	34.78	47.60	0.74	3.14	0	0.11	0.05	0	0	0	0	0.04	0	99.63
U05-85	0.14	9.72	3.3	34.66	46.92	0.76	3.15	0.04	0	0.04	0.01	0	0.03	0	0.06	0.03	98.86
U05-85	0.3	10.07	3.33	35.86	46.95	0.61	3.26	0.02	0	0.02	0.04	0	0	0	0.18	0	100.64
U05-85	0.16	9.33	3.38	34.26	48.88	0.75	3.28	0.06	0.07	0.05	0	0	0	0	0	0	100.21
U05-85	0.24	9.57	3.49	34.91	47.91	0.73	3.36	0.01	0	0.06	0	0.02	0.02	0	0.15	0	100.47
U05-85	0.28	9.78	3.29	35.09	47.97	0.71	3.27	0.08	0.05	0	0.15	0.15	0.08	0	0.06	0.17	101.12
U05-85	0.31	9.9	3.37	35.68	47.60	0.9	3.22	0	0	0	0.13	0	0	0	0.16	0.09	101.36
U05-85	0.1	9.73	3.08	35.14	47.12	0.66	2.98	0	0	0	0	0	0.01	0	0.01	0	98.83
U05-85	0.27	9.57	3.53	34.64	48.57	0.68	3.2	0.09	0.12	0.04	0.03	0	0.02	0	0.08	0.25	101.10
U05-89	0.21	7.99	4.06	32.47	47.53	0.57	3.09	0.04	0.05	0	0	0	0.01	0	0.13	0.29	96.44
U05-89	0.17	9.8	3.25	34.28	46.93	0.82	3.52	0	0.01	0	0.21	0	0.05	0	0	0	99.03
U05-89	0.17	9.9	3.5	34.53	47.27	0.69	3.48	0.06	0.08	0	0.06	0.01	0	0	0.05	0	99.80
U05-89	0.13	9.94	2.9	34.87	47.83	0.68	3.45	0.07	0	0	0.11	0	0.04	0	0.14	0.02	100.19
U05-89	0.1	9.65	3.58	33.76	48.69	0.85	3.45	0.14	0.14	0	0.03	0	0.06	0	0.07	0.31	100.84
U05-89	0.14	9.9	3.41	35.24	47.22	0.64	3.25	0	0	0.02	0	0	0.01	0	0	0.04	99.87
U05-89	0.11	9.77	3.6	35.30	47.85	0.62	3.3	0	0	0.04	0.09	0	0.03	0	0.13	0	100.84
U05-89	0.09	9	3.96	33.73	48.74	0.61	3.33	0.02	0.1	0.06	0.04	0.16	0.09	0	0.08	0.05	100.05
U05-89	0.12	10.2	3.73	35.28	46.37	0.72	3.42	0	0	0.02	0	0.16	0.03	0	0.12	0	100.17
U05-89	0.12	9.66	3.37	34.35	47.62	0.68	3.39	0	0.06	0	0.16	0	0.01	0	0.14	0.1	99.66
U05-89	0.01	10.59	3.3	35.86	48.18	0.68	3.1	0	0.16	0	0	0.01	0.04	0	0.05	0.1	102.08
U05-89	0.13	10.09	3.38	35.39	47.21	0.69	3.35	0	0.01	0	0	0	0	0	0.08	0	100.33
U05-89	0.13	9.97	3.89	35.11	47.53	0.72	3.5	0	0.05	0	0.01	0	0.03	0	0	0	100.94
U05-89	0.16	8.69	4.09	33.42	50.12	0.8	3.49	0.05	0.16	0	0.08	0	0.06	0	0	0	101.12
U05-93	0.19	9.36	3.63	34.53	48.60	0.69	3.42	0.08	0	0	0.05	0.01	0.05	0	0	0.3	100.91
U05-93	0.17	8.93	3.71	34.24	49.23	0.56	3.51	0	0.01	0.03	0.03	0.13	0.03	0	0.13	0.06	100.77
U05-93	0.07	9.18	3.9	33.90	48.18	0.68	3.54	0	0	0.02	0	0	0.03	0	0.1	0.18	99.78
U05-93	0.04	9.02	3.7	32.90	49.53	0.77	3.68	0.05	0.13	0.04	0.05	0.06	0.02	0	0	0	100.00
U05-93	0.09	9.45	3.56	34.42	48.23	0.65	3.08	0.03	0.13	0	0.04	0	0.07	0	0.01	0.07	99.83
U05-93	0.16	10.86	2.12	36.56	46.70	0.85	2.74	0	0	0.02	0.02	0	0.06	0	0.09	0.09	100.27
U05-93	0.17	9.12	3.59	34.17	49.11	0.69	3.62	0	0	0.02	0	0	0.07	0	0	0.04	100.60
U05-93	0.22	8.8	3.61	34.08	49.28	0.72	3.5	0.02	0	0	0	0	0	0	0	0	100.23
U05-93	0.14	7.92	1.23	33.37	53.11	0.98	2.51	0	0.08	0	0.06	0	0.04	0	0.04	0.06	99.54

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-93	0.08	8.97	3.67	33.34	49.20	0.72	3.63	0	0.1	0	0	0.04	0.04	0	0.14	0	99.93
U05-93	0.14	9.78	1.93	36.43	48.52	0.66	2.17	0	0	0.01	0	0.07	0.04	0	0.07	0.15	99.98
U05-93	0.08	8.49	2.85	34.85	50.87	0.72	2.47	0.09	0.05	0	0	0	0.04	0	0.05	0	100.56
U05-93	0.12	9.07	3.56	34.39	48.77	0.68	3.27	0.06	0.01	0.01	0.02	0.14	0.04	0	0.1	0.02	100.25
U05-93	0.06	7.81	3.63	32.73	51.62	0.69	3.43	0.01	0.08	0	0	0	0.1	0	0.09	0	100.25
U05-93	0.06	9.18	3.82	34.21	49.04	0.65	3.33	0	0.07	0.02	0	0	0.07	0	0	0.13	100.59
E02-97	0.17	6.92	4.82	31.28	52.12	0.41	3.95	0.04	0.16	0	0.14	0	0.07	0	0.03	0	100.12
E02-97	0.19	5.91	7.66	29.37	50.92	0.32	5.06	0.01	0.11	0.01	0.11	0	0.09	0	0.02	0	99.78
E02-97	0.28	7.11	5.62	31.34	49.64	0.38	4.39	0.02	0	0	0	0.1	0.07	0	0.09	0.23	99.28
E02-97	0.16	6.1	7.95	30.17	49.24	0.2	4.97	0	0	0	0	0.05	0.1	0	0.25	0	99.19
E02-97	0.16	6.53	5.28	31.22	52.19	0.48	3.61	0.02	0.16	0.02	0.02	0	0.11	0	0	0.17	99.96
E02-97	0.22	6.72	7.11	30.51	50.11	0.43	4.61	0	0.18	0.01	0.01	0	0.08	0	0.15	0	100.13
E02-97	0.42	7.49	6.33	32.64	49.06	0.38	4.41	0.12	0	0	0	0	0.06	0	0.05	0	100.96
E02-97	0.19	6.14	7.22	29.92	50.75	0.44	4.97	0.02	0	0.06	0.05	0.05	0.07	0	0.21	0.04	100.13
E02-97	0.19	7.11	5.47	32.34	50.55	0.28	4.02	0.02	0	0.02	0	0.03	0.03	0	0.17	0.03	100.26
E02-97	0.18	6.11	3.94	30.64	54.43	0.34	3.73	0.04	0.16	0	0.08	0	0.02	0	0.07	0.11	99.85
E02-97	0.17	8.02	4.89	32.42	49.53	0.59	3.73	0	0.13	0	0	0	0	0	-0.1	0.1	99.48
E02-97	0.15	6.26	6.62	31.46	51.25	0.24	4.23	0.01	0	0	0.07	0.06	0.06	0	0.13	0.15	100.69
E02-97	0.18	7.11	4.79	32.43	50.63	0.43	3.6	0.04	0	0.02	0.03	0.01	0	0	0.08	0	99.35
E02-97	0.25	6.36	6.28	30.65	50.97	0.24	4.3	0.12	0.1	0.01	0.06	0	0.03	0	0.2	0.17	99.74
E02-97	0.17	8.41	4.32	32.67	49.22	0.74	4.01	0.07	0	0.01	0	0	0.03	0	0	0.03	99.68
E02-97	0.19	6.78	5.12	31.33	52.53	0.37	4.13	0.09	0.09	0	0	0	0.04	0	0.07	0.23	100.97
E02-98	0.18	7.82	5.6	31.78	49.48	0.45	4.45	0	0.08	0.02	0.06	0.01	0.06	0	0.04	0.02	100.05
E02-98	0.16	7.16	6.5	31.96	49.40	0.54	4.25	0.01	0	0	0	0	0.05	0	0.06	0	100.09
E02-98	0.28	7.56	5.42	32.15	49.59	0.55	4.19	0.08	0	0	0.02	0.05	0.07	0	0	0.13	100.09
E02-98	0.35	7.37	6.08	31.73	48.69	0.45	4.16	0.06	0.1	0	0	0	0.02	0	0.12	0.09	99.22
E02-98	0.19	7.2	6.27	31.30	50.44	0.51	4.09	0.03	0.17	0.04	0.05	0.09	0.08	0	0.1	0.29	100.85
E02-98	0.13	7.5	6.2	32.43	48.95	0.54	3.98	0	0.01	0	0	0	0.02	0	0.08	0.11	99.95
E02-98	0.15	7.54	5.88	31.65	49.11	0.5	4.29	0.03	0.05	0.03	0.04	0	0	0	0.18	0	99.45
E02-98	0.1	7.46	5.61	31.62	50.00	0.48	4.13	0	0.1	0.01	0	0.02	0.03	0	0.11	0.08	99.75
E02-98	0.19	7.3	6.19	31.80	49.65	0.3	4.51	0.05	0	0	0.12	0.06	0.05	0	0.04	0.1	100.36
E02-98	0.21	7.73	5.73	32.01	49.86	0.29	4.47	0.06	0.08	0	0	0.04	0.07	0	0.06	0.1	100.70
E02-98	0.2	7.63	5.37	32.03	48.94	0.44	4.19	0.02	0	0.01	0.04	0	0.03	0	0.04	0.02	98.96
E02-98	0.13	7.53	5.25	31.49	50.06	0.54	4.32	0.04	0.06	0	0	0	0.05	0	0.11	0	99.58
E02-98	0.17	7.42	5.87	31.37	49.93	0.54	4.43	0.04	0.08	0	0.1	0	0.06	0	0.11	0.08	100.21
Rk-12	0.06	6.75	3.2	31.32	52.28	0.91	2.85	0.16	0.06	0.05	0.02	0.01	0	0	0	0	97.67
Rk-12	0.04	8.85	3.77	34.80	47.96	0.32	2.63	0.02	0.06	0	0	0	0.02	0	0.47	0.3	99.24
Rk-12	0.39	8.71	4	35.20	47.29	0.25	2.93	0.05	0	0	0.08	0	0.01	0	0.3	0.1	99.31

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-12	0.22	6.64	4.17	32.51	51.16	0.35	2.74	0.15	0.06	0.03	0	0	0.01	0	0.16	0.1	98.31
Rk-12	0.17	8.67	2.51	34.88	49.79	0.81	1.87	0	0.2	0	0.24	0	0	0	0.14	0.05	99.33
Rk-15	0.19	9.44	3.08	36.11	46.74	0.34	2.23	0.05	0	0.04	0	0.01	0.04	0	0.03	0	98.30
Rk-15	0.25	9.4	3.29	35.88	46.94	0.34	2.23	0.01	0.1	0.04	0.14	0.01	0.05	0	0.21	0.1	99.00
Rk-15	0.08	10.17	2.19	35.72	47.08	0.53	2.5	0.03	0.08	0	0.09	0.08	0.03	0	0	0	98.58
Rk-15	0.16	10.18	2.08	35.88	46.46	0.74	2.31	0.03	0	0.03	0	0	0.01	0	0.1	0.22	98.20
Rk-15	0.12	9.39	3.3	34.92	47.60	0.7	2.97	0	0	0	0.12	0	0.07	0	0	0	99.19
Rk-15	0.24	9.36	3.9	35.04	46.50	0.72	2.17	0.05	0.23	0.03	0.1	0	0.14	0	0.15	0	98.64
Rk-21	0.24	6.1	7.49	30.16	50.05	0.26	4.23	0.07	0.18	0.01	0.03	0	0.02	0	0	0.21	99.05
Rk-21	0.21	5.96	7.7	30.62	50.51	0.22	4.38	0	0.09	0	0.18	0	0.03	0	0.12	0.27	100.28
Rk-21	0.21	8.03	4.59	33.20	50.05	0.65	3.68	0.06	0	0.02	0.02	0.06	0.04	0	0.13	0.2	100.94
Rk-21	0.15	6.43	6.57	31.14	50.42	0.6	4.04	0	0	0.04	0.13	0.05	0.02	0	0	0.14	99.73
Rk-39	0.11	6.98	3.25	32.12	52.96	0.67	2.65	0	0.23	0	0.06	0.06	0.06	0	0	0.08	99.23
Rk-39	0.1	8.95	1.19	34.90	50.33	0.92	1.7	0	0.15	0	0.14	0	0	0	0.12	0.15	98.65
Rk-41	0.12	9.69	3.92	33.73	47.24	0.5	3.76	0	0.14	0	0.12	0.13	0	0	0.04	0	99.39
Rk-41	0.22	7.19	3.8	33.49	51.36	0.66	2.78	0.02	0	0.01	0	0	0.05	0	0	0.07	99.65
Rk-41	0.12	8.36	2.37	33.72	51.35	1	2.36	0	0.2	0	0	0	0	0	0	0	99.49
Rk-41	0.19	8.9	2.97	33.87	50.36	0.7	2.75	0.03	0.26	0.05	0.01	0	0	0	0	0	100.09
Rk-41	0.08	9.19	2.76	34.23	49.49	0.91	2.63	0	0.19	0	0.09	0	0	0	0	0	99.57
Rk-43	0.11	8.42	2.35	34.14	50.38	0.92	2.27	0.11	0.09	0	0	0	0.06	0	0.09	0	98.94
Rk-43	0.15	8.3	2.58	33.26	50.90	0.95	2.71	0	0.17	0	0	0	0.06	0	0.06	0	99.14
Rk-43	0.11	8.24	2.17	33.82	50.73	0.97	1.98	0.72	0	0.05	1.01	0.08	0	0	0.01	0	99.88
Rk-43	0.22	8.24	2.41	34.45	50.28	1.06	2.29	0.04	0	0	0.14	0.07	0.05	0	0	0.01	99.27
Rk-43	0.26	8.15	2.29	33.96	51.08	1	2.29	0.08	0.09	0.03	0.1	0	0.09	0	0	0.09	99.51
Rk-43	0.11	8.19	2.38	34.11	49.97	0.77	2.21	0.04	0	0.02	0.07	0	0.03	0	0	0.21	98.11
Rk-43	0.17	8.25	2.2	34.24	50.58	0.98	2	0.01	0.13	0	0.09	0.07	0.12	0	0.03	0	98.87
Rk-43	0.06	8.37	2.27	34.76	50.09	1	2	0.01	0	0	0	0.1	0.01	0	0.04	0	98.71
Rk-43	0.1	8.45	2.2	34.52	50.57	0.95	2.14	0	0.08	0	0.06	0	0.04	0	0.05	0	99.16
Rk-43	0.21	9.18	2.94	35.78	47.59	0.69	2.24	0.03	0	0	0	0	0.07	0	0.03	0	98.76
Rk-43	0.19	8.15	2.28	34.43	49.94	0.93	2.09	0.06	0.01	0	0	0	0.05	0	0.1	0	98.23
Rk-43	0.16	8.34	2.13	34.45	50.12	0.92	2.16	0.08	0	0.01	0.01	0	0	0	0	0.07	98.44
Rk-46	0.17	6.79	4.37	33.15	51.26	0.65	2.4	0	0.1	0	0	0	0.05	0	0	0.1	99.04
Rk-46	0.05	8.42	2.51	33.98	50.34	0.88	2.45	0.01	0.01	0.02	0.01	0	0	0	0	0.31	98.99
Rk-46	0.21	12.05	1.37	39.18	40.25	0.34	0.92	0	0	0	0	0	0.03	0	0	0.09	94.45
U05-6	0.11	5.88	2.94	32.02	54.87	0.69	2.28	0.11	0.11	0	0	0	0	0	0.11	0.1	99.22
U05-6	0.11	7.04	3.99	32.68	52.04	0.72	3.13	0	0.01	0.02	0	0	0.03	0	0.02	0.04	99.84
U05-6	0.22	7.02	3.35	33.61	52.14	0.63	2.67	0.01	0	0	0.01	0.18	0.08	0	0.11	0	100.03
U05-6	0.15	6.94	3.99	33.29	51.48	0.47	2.73	0	0	0	0	0	0.02	0	0.06	0.22	99.36

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-6	0.17	7.47	2.37	34.15	52.88	0.83	2.08	0.05	0.11	0	0.01	0.02	0.03	0	0.2	0	100.37
U05-6	0.2	6.31	2.72	33.53	53.54	0.87	1.94	0	0	0	0	0.04	0.06	0	0.07	0	99.28
U05-6	0.21	7.69	4.11	32.93	50.70	0.53	3.64	0.09	0	0	0.06	0	0.04	0	0.07	0	100.07
U05-6	0.16	6.14	6.85	31.14	50.64	0.16	4.06	0.03	0.09	0	0	0	0.04	0	0.36	0.12	99.79
U05-6	0.12	7.35	3.56	33.84	51.80	0.62	2.66	0	0	0	0	0	0.02	0	0.03	0.13	100.13
U05-6	0.23	7.83	4.33	32.64	49.67	0.7	3.69	0.07	0	0	0	0.09	0.05	0	0.08	0.06	99.44
U05-6	0.17	7.8	4.2	32.24	51.53	0.51	3.52	0.09	0.21	0	0	0	0.03	0	0.03	0.24	100.57
U05-6	0.19	7.43	4.14	32.48	50.46	0.55	3.56	0.01	0	0.03	0	0	0.01	0	0.14	0	98.99
U05-6	0.27	7.62	2.44	35.11	51.64	0.99	1.37	0.02	0.09	0.02	0.04	0	0.03	0	0.11	0.19	99.93
U05-6	0.1	7.24	3.57	34.01	50.66	0.57	2.28	0	0	0	0.02	0	0	0	0.18	0	98.63
U05-10	0.19	6.07	6.44	31.63	50.37	0.26	3.57	0.05	0.06	0	0.04	0	0.05	0	0.19	0	98.92
U05-10	0.22	6.86	5.2	31.55	50.69	0.33	3.43	0.03	0.18	0	0.07	0.02	0.03	0	0	0.27	98.88
U05-10	0.2	6.58	3.95	32.79	51.31	0.56	2.59	0	0	0.02	0.12	0	0	0	0.01	0.14	98.28
U05-10	0.04	6.81	4.33	31.05	50.95	0.51	3.53	0.04	0.07	0	0	0	0.09	0	0	0	97.42
U05-10	0.15	6.89	4.95	31.99	50.00	0.58	3.42	0.05	0	0	0	0	0	0	0	0	98.03
U05-10	0.01	7.37	2.31	34.49	52.97	0.93	1.47	0.01	0.12	0.01	0	0	0.02	0	0.13	0	99.84
U05-10	0.18	6.48	4.9	31.24	52.40	0.29	3.49	0.04	0.21	0	0.14	0	0.04	0	0.16	0.17	99.75
U05-10	0.13	6	6.08	30.80	49.84	0.25	3.76	0.02	0	0	0.08	0.08	0.04	0	0	0.03	97.12
U05-16	0.09	7.47	1.72	33.29	53.32	1.32	1.56	0.09	0.19	0.06	0	0	0	0	0	0	99.12
U05-16	0.22	7.45	1.89	34.09	51.93	1.36	1.68	0.04	0	0.03	0	0	0.04	0	0	0	98.72
U05-16	0.36	8.44	1.32	35.30	51.43	1.25	1.26	0.01	0.23	0	0.05	0.03	0.06	0	0.09	0	99.83
U05-16	0.3	9.12	1.11	38.27	48.88	0.31	0.27	0.01	0.1	0.05	0.17	0	0.03	0	0	0.05	98.67
U05-22	0.09	7.39	1.98	33.01	52.33	1.08	2	0.06	0.11	0.02	0	0.02	0.05	0	0.03	0	98.18
U05-25	0.26	9.44	2.08	35.48	45.85	0.73	1.75	0	0	0.08	0	0	0.02	0	0	0.05	95.74
U05-25	0.16	16.36	0.91	42.12	32.87	0.78	0.9	0.05	0.1	0	0.05	0	0.07	0	0	0.09	94.46
U05-27	0.17	6.87	1.15	33.29	53.85	1.27	1.74	0	0	0	0	0	0	0	0.06	0.16	98.55
U05-27	0.06	8.23	1.82	33.78	51.46	1.33	2.18	0.07	0	0.02	0	0.06	0	0	0	0.22	99.23
U05-27	0.28	9.18	2.3	36.00	47.05	0.59	1.91	0	0	0	0	0.02	0.01	0	0.07	0	97.42
U05-27	0.22	8.04	1.75	34.39	51.51	1.22	1.51	0	0.16	0.05	0.14	0.11	0.01	0	0.07	0	99.18
U05-27	0.09	6.05	0.81	32.79	55.68	0.68	1.25	0.03	0.1	0.07	0	0.04	0.08	0	0.05	0.16	97.88
U05-40	0.24	8.3	3.24	34.41	48.87	0.6	2.63	0	0	0	0	0	0	0	0.05	0.09	98.43
U05-40	0.02	8.39	2.89	34.83	49.59	0.73	2	0	0.05	0	0	0	0.02	0	0.02	0.08	98.62
U05-40	0.22	10.23	2.39	34.69	47.96	0.81	3.24	0	0.14	0	0.06	0	0.04	0	0.01	0.1	99.89
U05-40	0.05	8	2.86	33.17	50.80	0.77	2.29	0.06	0.19	0.02	0	0	0	0	0.03	0.11	98.35
U05-40	0.13	8.13	2.7	33.59	51.22	0.79	2.64	0.11	0.08	0.02	0	0	0.03	0	0.1	0.16	99.69
U05-40	0.23	7.71	3.54	34.03	50.45	0.55	2.68	0	0.01	0	0.02	0	0.04	0	0	0.2	99.46
U05-40	0.11	8.5	3.1	34.39	49.05	0.76	2.54	0.03	0	0	0	0	0	0	0	0.08	98.57
U05-40	0.21	8.38	2.87	34.54	49.78	0.85	2.03	0.74	0	0.02	0.91	0.03	0	0	0.09	0	100.45

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-40	0.11	8.29	3.04	33.58	50.78	0.81	2.68	0.03	0.12	0	0	0	0	0	0	0.27	99.71
U05-40	0.13	8.54	2.84	34.52	49.58	0.84	2.57	0.03	0	0	0.05	0.04	0	0	0.01	0	99.15
U05-40	0.24	8.48	1.82	35.52	50.39	0.97	1.85	0	0	0	0.04	0	0.04	0	0.05	0	99.40
U05-40	0.45	7.71	3.22	33.80	49.64	0.92	2.7	0.03	0	0	0.08	0	0.01	0	0.07	0	98.63
U05-41	0.14	8.17	2.72	33.37	50.16	0.91	2.79	0.09	0	0	0	0	0.01	0	0.08	0.18	98.62
U05-41	0.16	8.19	2.94	34.22	50.80	0.81	2.41	0.01	0.11	0.01	0	0	0.04	0	0.09	0.06	99.86
U05-41	0.26	8.06	2.7	34.07	49.86	0.8	2.59	0	0	0	0.18	0	0.01	0	0.08	0	98.61
U05-41	0.26	8.38	2.62	34.48	50.24	0.85	2.68	0.07	0	0	0.21	0.08	0.03	0	0.13	0	100.03
U05-41	0.15	8.07	2.64	34.19	50.19	0.88	2.41	0	0	0	0.12	0	0.07	0	0.13	0	98.85
U05-41	0.18	8.32	3.05	34.02	50.44	0.74	2.64	0	0.11	0.02	0	0.09	0.07	0	0	0.05	99.73
U05-41	0.12	8.08	3.04	33.49	50.39	0.75	3.03	0	0	0.02	0	0.12	0.06	0	0.2	0	99.31
U05-41	0.08	8.21	2.21	34.24	51.72	1.04	1.87	0	0.2	0	0	0	0.01	0	0.01	0	99.59
U05-41	0.14	8.25	2.78	34.20	50.12	0.78	2.52	0	0	0	0.02	0.07	0.05	0	0	0.21	99.14
U05-41	0.19	8.51	2.89	34.86	49.45	0.65	2.37	0.07	0	0.06	0.06	0	0.04	0	0.03	0	99.18
U05-43	0.43	7.99	2.81	35.09	48.60	0.7	1.94	0	0	0	0.15	0.06	0.03	0	0.01	0	97.81
U05-43	0.36	8.57	3.04	34.28	48.90	0.8	2.79	0.02	0.05	0.01	0	0	0.03	0	0.14	0.07	99.07
U05-43	0.34	8.64	3.06	34.43	49.62	0.95	2.87	0.05	0	0.07	0	0	0.07	0	0	0	100.10
U05-57	0.05	10.36	2	36.21	47.92	0.81	2.59	0.09	0	0	0	0	0	0	0.1	0.01	100.15
U05-57	0.04	9.92	2.95	35.36	47.96	0.7	3.11	0.01	0	0	0.01	0	0	0	0.06	0	100.11
U05-57	0.07	9.7	2.86	34.98	48.43	0.81	3.09	0	0	0	0	0	0.08	0	0.02	0.13	100.17
U05-57	0.15	10.98	1.98	36.74	45.51	0.85	2.4	0	0	0.03	0	0.03	0.12	0	0.02	0	98.80
U05-57	0.06	9.6	2.59	34.47	48.38	0.72	2.95	0	0.07	0	0	0	0.02	0	0.11	0.2	99.17
U05-57	0.19	9.52	2.98	35.45	47.88	0.67	2.84	0	0	0.03	0.14	0.02	0.06	0	0.17	0	99.95
U05-59	0.09	8.28	2.7	33.27	50.75	0.86	2.6	0.08	0.17	0	0.05	0.02	0.02	0	0.04	0	98.93
U05-59	0.06	8.22	2.58	32.75	51.32	0.92	2.63	0.04	0.22	0	0.07	0	0.06	0	0.04	0.17	99.08
U05-59	0	8.45	2.49	34.33	51.39	1.02	2.6	0	0	0.02	0	0	0	0	0	0	100.30
U05-59	0.11	8.25	2.48	33.18	50.21	0.99	2.69	0.08	0	0.03	0	0	0.08	0	0	0.26	98.35
U05-59	0	8.35	2.44	33.38	50.52	0.87	2.61	0.15	0.01	0.05	0	0	0	0	0	0.12	98.49
U05-59	0.12	8.38	2.67	34.17	50.61	0.84	2.73	0.05	0.01	0	0.14	0	0.04	0	0	0	99.76
U05-59	0.1	8.13	2.95	33.80	50.62	0.91	2.77	0.05	0	0.01	0.06	0.16	0.1	0	0.1	0	99.77
U05-59	0.13	8.92	2.35	36.42	49.21	0.6	1	0.07	0.22	0	0	0	0	0	0.04	0	98.95
U05-59	0.12	8.65	2.78	34.92	49.52	0.79	2.33	0	0	0.03	0.04	0.12	0.02	0	0	0.1	99.42
U05-59	0.01	8.34	1.31	33.85	53.12	0.94	1.6	0.09	0.36	0	0	0	0.01	0	0.01	0	99.64
U05-59	0.16	8.28	2.52	33.60	50.87	1	2.91	0	0	0	0	0	0.02	0	0	0.15	99.50
U05-59	0.04	8.55	2.57	34.46	50.09	0.99	2.36	0	0	0.04	0.12	0	0.03	0	0.06	0.03	99.34
U05-61	0.14	8.7	2.23	34.09	49.21	1.13	2.45	0.07	0	0	0.08	0	0	0	0	0	98.10
U05-61	0.07	11.43	1.38	37.55	44.45	0.93	0.95	0	0.23	0	0	0	0	0	0.15	0.26	97.40
U05-61	0.1	8.97	1.3	36.14	49.98	1.13	1.37	0.03	0.01	0	0.15	0	0.05	0	0.1	0	99.34

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-61	0.16	8.63	2.2	34.04	49.15	1.16	1.71	0	0.17	0.03	0.12	0	0.07	0	0	0.22	97.65
U05-61	0.06	8.47	2.2	33.95	50.34	1.02	2.53	0	0	0.03	0	0	0	0	0.07	0	98.67
U05-61	0.09	9.35	2.1	36.29	48.26	1.2	1.46	0.06	0.01	0.01	0.04	0.01	0.01	0	0.11	0	99.00
U05-63	0.09	9.57	2.53	35.22	48.92	0.88	2.76	0.04	0	0	0	0	0.04	0	0.02	0.15	100.22
U05-63	0	9.61	2.27	35.02	48.69	0.83	2.74	0.03	0	0	0	0	0.1	0	0	0.01	99.30
U05-63	0.07	9.61	2.46	35.20	49.15	0.91	2.82	0.08	0	0.03	0.09	0	0.04	0	0.13	0	100.58
U05-63	0.13	10.48	2.59	35.97	47.62	0.84	3.03	0	0.01	0	0.18	0.06	0.08	0	0.02	0.15	101.15
U05-63	0.1	9.61	2.46	34.79	49.10	0.86	2.75	0	0.13	0.02	0.03	0	0.02	0	0.11	0.01	99.99
U05-63	0.12	9.54	2.33	35.73	49.69	0.9	2.69	0	0.01	0	0.06	0.05	0.01	0	0.09	0	101.22
U05-63	0.16	9.77	2.54	35.16	49.08	0.76	2.83	0.02	0.14	0.01	0.14	0.06	0.05	0	0.05	0	100.77
U05-63	0.08	9.92	2.3	35.55	48.34	0.85	2.8	0	0	0	0.11	0.02	0.03	0	0	0	100.01
U05-63	0.15	7.07	4.29	33.66	52.44	0.67	2.88	0.08	0	0.01	0.09	0	0.02	0	0.15	0.16	101.67
U05-63	0.08	7.11	4.45	32.89	51.96	0.48	2.8	0.05	0.2	0	0	0	0.04	0	0.2	0	100.26
U05-63	0.04	10.11	2.64	35.73	48.62	0.7	3.03	0	0	0.05	0.01	0	0.05	0	0.02	0	101.00
U05-63	0.01	9.61	2.42	34.82	48.30	0.86	2.86	0	0	0	0	0	0.03	0	0.08	0	98.99
U05-63	0.06	9.91	2.33	35.80	48.59	0.83	2.66	0.03	0	0.04	0.03	0	0	0	0.22	0	100.50
U05-63	0.18	9.89	2.42	35.01	49.26	0.91	2.83	0	0.17	0.03	0.21	0	0.02	0	0.1	0.06	101.09
U05-64	0.18	9.38	1.69	36.66	48.76	0.89	1.42	0	0.01	0.05	0.07	0	0.01	0	0.02	0.1	99.24
U05-64	0.09	9.58	2.3	35.25	49.24	0.87	2.58	0.15	0	0.08	0.07	0	0.07	0	0	0	100.28
U05-64	0.17	8.97	2.93	33.51	47.51	0.74	2.39	0	0.21	0.01	0.01	0.04	0.01	0	0	0.22	96.72
U05-66	0.06	6.32	2.37	32.92	55.19	0.99	1.59	0.04	0.15	0.04	0	0	0.03	0	0.06	0.22	99.98
U05-66	0.07	6.28	2.15	32.43	54.50	1.04	1.8	0.07	0.07	0.04	0	0	0	0	0	0.17	98.62
U05-68	0.11	8.1	2.52	34.45	51.46	0.87	2.48	0	0	0.01	0.06	0	0.08	0	0.06	0	100.20
U05-68	0.01	7.95	2.49	33.37	51.60	1.03	2.53	0.14	0	0.06	0.01	0	0	0	0.08	0	99.27
U05-68	0.1	8.13	2.6	34.28	50.73	0.82	2.34	0.09	0	0	0	0.03	0.05	0	0.04	0.15	99.35
U05-68	0.13	7.61	3.11	33.64	51.46	0.82	2.57	0.07	0	0	0	0	0.01	0	0.08	0.25	99.76
U05-68	0.17	7.83	2.32	35.06	50.76	1.32	1.33	0.12	0	0	0	0	0.07	0	0.08	0.08	99.14
U05-68	0.03	7.91	2.53	33.44	50.98	0.99	2.13	0.18	0.1	0	0.02	0	0.02	0	0.06	0	98.39
U05-10	0.1	7.87	2.52	33.84	51.50	1.27	1.94	0.01	0.09	0.03	0.06	0	0	0	0	0.12	99.35
U05-10	0.13	7.95	2.82	33.82	51.15	0.83	2.64	0.04	0	0.04	0.24	0.03	0.05	0	0.04	0.06	99.84
U05-10	0.11	7.52	2.79	33.46	52.65	0.81	2.58	0.02	0.08	0.01	0	0	0	0	0	0.04	100.06
U05-10	0.06	6.18	6.41	31.80	50.06	0.34	3.35	0.02	0	0.02	0.15	0	0.02	0	0.13	0.15	98.69
U05-10	0.05	6.58	4.38	32.41	52.58	0.47	3.18	0.13	0	0	0.15	0.04	0	0	0.05	0	100.02
U05-10	0.03	6.17	6.65	32.06	50.73	0.2	3.51	0.04	0	0	0.06	0	0.1	0	0.16	0.19	99.91
U05-10	0.2	6.22	6.46	32.26	50.39	0.35	3.5	0	0	0.04	0.07	0.01	0.07	0	0.25	0.01	99.83
U05-10	0.11	7.41	3.51	33.63	51.51	0.59	2.7	0	0.01	0.02	0.08	0.04	0	0	0.14	0.14	99.88
U05-10	0.05	7.23	3.38	33.57	52.48	0.64	2.69	0	0	0	0.07	0	0.01	0	0.08	0.15	100.36
U05-23	0.06	7.27	2.1	33.91	52.28	1.3	1.6	0	0.01	0.03	0	0	0.02	0	0.11	0.02	98.71

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-23	0	7.55	2	33.65	53.49	1.36	1.8	0	0.09	0.06	0	0.01	0.06	0	0	0.07	100.14
U05-23	0.07	7.99	2.22	34.39	51.56	1.3	1.93	0	0	0.04	0.17	0	0	0	0	0	99.67
U05-23	0.11	2.62	4.48	24.81	60.74	3.42	3.41	0	0.19	0	0	0	0.01	0	0.05	0.03	99.88
U05-23	0	7.61	2.05	33.31	52.72	1.43	1.98	0.06	0	0.03	0.04	0	0.02	0	0	0.39	99.64
U05-23	0.21	7.7	1.82	34.87	51.97	1.39	1.52	0.03	0	0	0	0	0	0	0.03	0	99.54
U05-23	0.11	7.62	1.89	34.24	51.81	1.25	1.49	0.13	0	0.04	0	0	0.04	0	0.07	0.17	98.86
U05-23	0.11	7.66	2.02	33.86	51.84	1.36	1.64	0.04	0.1	0.01	0	0	0	0	0.07	0	98.71
U05-23	0.04	7.96	2.35	33.87	51.96	0.98	1.88	0.04	0.17	0.02	0	0	0.03	0	0.03	0.14	99.48
U05-23	0.09	7.82	2.11	34.80	51.90	1.15	1.75	0.04	0	0.02	0.02	0	0.04	0	0.2	0	99.94
U05-29	0.11	7.89	2.51	32.96	52.05	1.15	2.31	0.08	0.18	0.03	0	0	0.01	0	0	0.15	99.43
U05-29	0.07	8.01	2.23	34.64	50.94	1.24	1.78	0	0	0	0.04	0	0	0	0	0	98.95
U05-29	0.04	8.02	2.39	33.82	52.21	1.25	2.08	0	0.16	0	0	0.01	0.02	0	0.04	0	100.04
U05-29	0.06	7.95	2.25	33.73	51.37	1.22	1.85	0.08	0.09	0.01	0.03	0	0.01	0	0.08	0.27	99.00
U05-29	0.08	8.05	2.42	33.98	51.21	1.1	2.08	0	0.11	0.01	0	0	0.05	0	0.12	0	99.21
U05-45	0.21	9.32	1.68	36.13	48.67	0.89	1.86	0	0	0	0.05	0	0.02	0	0	0	98.83
U05-45	0.12	10.94	1.21	37.74	46.07	1.18	1.46	0	0	0.01	0.16	0	0	0	0.07	0	98.96
U05-45	0.26	10.52	1.16	37.31	46.98	1.01	1.76	0.06	0	0	0.11	0	0	0	0.1	0	99.27
U05-45	0.15	8	2.93	33.63	50.76	0.9	2.62	0	0.05	0	0	0	0	0	0	0.16	99.20
U05-46	0.16	8.35	2.71	34.53	50.22	0.81	2.51	0.04	0	0.01	0.14	0	0	0	0.02	0	99.50
U05-46	0.09	8	2.71	33.43	51.82	1.02	2.6	0.12	0.08	0.03	0	0	0.03	0	0	0	99.93
U05-48	0.08	10.97	1.73	36.87	46.41	0.84	2.31	0.09	0	0	0	0	0.06	0	0.1	0.12	99.58
U05-48	0.19	11.99	1.41	38.26	41.62	0.83	1.1	0	0.12	0	0.02	0	0	0	0.04	0	95.58
U05-48	0.09	8.49	2.1	34.86	51.52	0.98	1.8	0.08	0.17	0	0	0	0	0	0.01	0	100.10
U05-53	0.14	9.54	2.02	35.98	47.20	0.91	1.73	0.03	0	0	0	0	0	0	0.12	0.2	97.87
U05-9	0.25	6.62	5.64	31.95	51.28	0.55	3.9	0.06	0	0	0.19	0.11	0	0	0	0.02	100.57
U05-9	0.23	7.48	6.04	33.11	48.90	0.32	3.76	0	0	0.01	0	0	0	0	0.1	0.14	100.09
U05-9	0.09	6.6	5.54	32.38	51.63	0.36	3.48	0.07	0	0	0	0	0	0	0	0.19	100.34
U05-9	0.18	6.65	7.36	30.90	49.55	0.21	4.85	0.07	0	0	0	0	0	0	0.25	0.15	100.16
U05-9	0	6.85	4.61	32.27	51.51	0.25	3.38	0.01	0	0.03	0	0	0.01	0	0.14	0.14	99.20
U05-9	0.15	6.55	7.3	30.46	51.66	0.28	4.71	0	0.22	0.01	0	0	0	0	0.01	0.08	101.43
U05-9	0.02	6.84	4.91	32.66	51.86	0.25	3.43	0	0	0	0.08	0.05	0.04	0	0.08	0.16	100.38
U05-9	0.11	6.6	4.44	32.33	52.03	0.56	3.27	0	0	0	0.08	0	0	0	0.1	0	99.52
U05-9	0.17	6.75	7.19	30.27	49.24	0.2	5.22	0.01	0	0	0.1	0	0.06	0	0.04	0	99.24
U05-9	0.07	5.96	7.61	30.30	51.04	0.33	4.17	0.06	0.2	0	0.01	0.1	0.06	0	0.18	0	100.08
U05-9	0.23	7.09	4.64	34.15	50.49	0.41	2.54	0.07	0	0	0.05	0.02	0	0	0.16	0.19	100.04
U05-9	0.04	6.51	7.39	30.66	50.13	0.21	4.83	0	0	0	0	0	0.01	0	0.14	0.16	100.07
U05-9	0.09	6.76	7.32	30.97	49.21	0.23	4.69	0.03	0	0	0	0	0	0	0.19	0.17	99.66
U05-9	0.07	6.84	5.2	31.85	50.89	0.39	3.73	0.04	0	0	0.05	0	0.02	0	0	0.09	99.17

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-14	0.07	7.51	1.76	34.07	52.92	1.6	1.67	0	0	0.02	0	0	0	0	0.04	0	99.67
U05-14	0.04	7.49	1.77	32.18	53.99	1.75	1.86	0	0.32	0	0	0	0	0	0.03	0	99.44
U05-14	0.21	7.79	1.67	33.87	52.15	1.74	1.7	0.07	0.07	0	0.01	0	0.04	0	0	0	99.32
U05-14	0	7.31	1.66	32.99	53.93	1.53	1.72	0.05	0.08	0.07	0.09	0	0	0	0.05	0.21	99.69
U05-69	0.13	8.12	2.77	33.45	50.63	0.84	2.77	0.09	0	0.05	0	0	0	0	0.01	0.11	98.97
U05-69	0.13	8.2	2.76	34.19	50.74	0.91	2.51	0	0.01	0.02	0	0	0.02	0	0.04	0.14	99.67
U05-69	0.06	8.4	2.71	33.35	50.98	0.8	2.93	0.07	0.08	0.01	0.01	0.02	0	0	0	0.13	99.56
U05-69	0	7.01	2	34.64	53.59	0.94	1.31	0.1	0	0.02	0	0.12	0	0	0	0	99.72
U05-69	0.1	7.97	2.74	33.68	50.91	1.01	2.51	0.03	0	0.05	0.02	0	0.01	0	0	0	99.03
E02-99	0.1	7.78	1.82	32.84	54.12	1.49	1.82	0.06	0.36	0	0.01	0	0	0	0	0.11	100.51
E02-99	0.04	7.25	1.68	33.48	54.67	1.4	1.58	0.07	0.11	0.07	0	0	0.01	0	0.01	0.22	100.60
E02-99	0	8.33	1.68	34.22	52.73	1.69	1.83	0.04	0.12	0	0	0.03	0	0	0.1	0	100.77
E02-99	0	7.42	1.29	29.69	52.90	1.63	1.38	2.57	0.14	0.04	2.92	0.28	0.12	0	0	0	100.38
E02-99	0	6.96	2.21	33.38	54.84	1.63	1.91	0.06	0	0.05	0.01	0	0	0	0.07	0.08	101.21
E02-99	0.14	7.27	1.75	33.17	54.50	1.55	1.81	0.09	0.15	0	0	0	0	0	0.13	0.29	100.85
E02-99	0.01	7.72	1.74	33.44	52.34	1.5	1.7	0	0.1	0.04	0.04	0	0	0	0.08	0	98.71
E02-99	0.06	8.19	1.77	34.51	51.73	1.57	1.78	0.1	0	0	0.03	0.07	0.02	0	0	0	99.83
E02-99	0.07	7.72	1.75	32.97	53.62	1.66	1.99	0.02	0.21	0	-0.1	0	0.03	0	0.05	0	99.99
E02-99	0	7.87	1.6	34.41	52.73	1.74	1.59	0	0	0	0.09	0	0	0	0	0	100.04
E02-99	0	7.86	1.59	34.37	52.68	1.74	1.59	0	0	0	0.09	0	0	0	0	0	99.92
E02-99	0.07	7.6	1.66	33.75	53.93	1.67	1.56	0.01	0.17	0	0.18	0	0.01	0	0.14	0.12	100.87
E02-99	0.04	7.36	1.58	34.29	54.20	1.49	1.67	0	0.01	0	0.11	0	0.01	0	0	0	100.77
E02-100	0.04	7.56	1.93	33.39	53.02	1.51	1.83	0.03	0.1	0	0	0.07	0.08	0	0.13	0.18	99.87
E02-100	0.18	7.55	2.1	34.01	52.68	1.25	1.91	0	0.07	0	0	0.01	0	0	0.01	0.11	99.88
E02-100	0	7.59	2.09	33.60	53.46	1.14	1.78	0	0.22	0	0	0.13	0	0	0.05	0	100.06
E02-100	0.15	7.58	2.03	34.48	51.82	1.09	1.72	0.04	0	0.01	0.01	0	0.01	0	0	0	98.94
E02-100	0.06	7.75	2.03	33.99	52.98	1.4	1.89	0.03	0.09	0	0.13	0	0.08	0	0	0.01	100.44
E02-100	0.05	7.3	2.23	34.14	52.74	0.93	1.81	0.01	0	0.02	0.01	0	0	0	0	0.16	99.40
E02-100	0.14	7.86	1.97	34.43	52.71	1.27	1.7	0	0.13	0.02	0.04	0	0.01	0	0	0	100.28
E02-100	0.1	7.8	1.99	33.23	53.01	1.23	1.9	0.03	0.25	0.05	0	0	0	0	0.03	0	99.61
E02-100	0.06	7.78	2.02	34.61	52.98	1.34	1.79	0.07	0	0.04	0.07	0.03	0.03	0	0	0	100.82
E02-100	0.1	7.78	2.04	34.35	53.25	1.33	1.66	0.08	0.1	0	0.09	0.09	0	0	0	0.3	101.18
E02-100	0.02	7.69	1.89	34.25	52.86	1.36	1.81	0.02	0	0.03	0.05	0	0.05	0	0	0	100.04
E02-100	0	7.24	1.75	33.32	53.68	1.21	1.73	0.05	0.1	0.02	0.13	0	0.03	0	0.05	0.09	99.40
Rk-22	0.18	7.56	5.85	32.91	48.84	0.54	3.68	0	0	0.01	0.02	0.08	0.06	0	0	0.08	99.81
Rk-22	0.13	7.77	5.6	32.64	48.71	0.35	3.96	0.09	0	0	0	0.01	0.02	0	0.03	0	99.31
Rk-22	0.15	7.36	6.07	32.58	48.56	0.52	3.65	0	0	0.03	0.1	0	0.05	0	0	0	99.07
Rk-22	0.01	7.58	5.04	31.70	49.65	0.48	4.17	0	0	0.01	0.14	0	0.04	0	0.23	0	99.05

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-22	0.12	7.47	5.8	32.47	49.77	0.49	4.04	0	0.01	0	0.04	0	0.06	0	0.06	0	100.33
Rk-22	0.14	7.59	5.73	32.15	49.74	0.41	3.79	0	0.16	0.02	0	0	0	0	0.06	0.11	99.90
Rk-22	0.2	7.77	5.86	33.34	48.89	0.67	3.69	0	0	0	0	0	0	0	0.08	0.03	100.53
Rk-22	0	8.65	4.87	32.96	48.76	0.6	4.12	0.02	0	0.02	0	0	0	0	0.18	0	100.18
Rk-22	0.02	7.6	5.94	32.25	49.05	0.53	3.76	0.03	0.06	0.01	0	0	0	0	0.06	0.09	99.40
Rk-22	0.07	7.53	5.86	32.81	49.09	0.47	3.71	0	0	0	0.09	0.09	0.07	0	0.07	0.06	99.92
Rk-22	0.13	9.68	7.51	34.37	42.28	0.82	3.69	0.01	0	0	0	0	0	0	0.06	0.29	98.83
Rk-22	0	9.83	3.07	35.21	46.26	0.76	2.68	0.02	0	0	0	0	0	0	0.5	0.12	98.44
Rk-22	0.06	7.59	5.97	32.57	49.33	0.43	3.98	0.01	0	0.02	0	0	0.03	0	0	0.01	99.99
Rk-33	0.21	7.88	4.94	32.29	50.07	0.63	4.03	0.02	0.07	0	0.07	0.02	0	0	0.11	0.2	100.55
Rk-33	0.13	7.14	3.33	32.81	52.01	0.76	2.99	0	0	0	0.16	0.05	0.02	0	0.08	0.03	99.51
Rk-33	0.14	10.26	2.6	35.71	46.75	0.84	2.69	0.06	0	0.02	0.01	0	0	0	0.05	0.18	99.31
Rk-33	0.06	6.38	1.22	32.72	55.49	0.84	2.07	0.11	0.01	0	0.01	0.04	0.05	0	0.02	0	99.02
Rk-33	0.09	8.9	4.12	33.62	47.87	0.51	3.64	0.03	0	0	0.06	0	0	0	0	0	98.85
Rk-33	0.15	14.12	1.67	41.42	40.14	0.71	0.88	0.66	0.06	0.02	0.79	0	0.04	0	0.16	0.1	100.92
Rk-33	0.01	7.71	2.23	33.18	52.66	1.21	1.8	0.07	0.18	0.04	0	0.02	0	0	0	0.27	99.38
Rk-33	0	7.71	3.06	34.16	51.91	0.71	2.45	0.04	0	0	0.01	0	0	0	0.04	0.1	100.19
Rk-33	0.13	6.92	5.09	32.43	50.91	0.51	3.17	0	0.06	0	0.07	0	0.05	0	0.07	0.35	99.76
Rk-46	0.06	8.1	0.94	35.54	51.35	0.67	1.1	0.19	0	0	0.08	0	0	0	0	0.06	98.09
Rk-46	0.04	8.35	2.63	33.86	50.96	0.98	2.19	0.12	0.13	0.01	0.19	0	0.06	0	0.07	0.24	99.83
Rk-46	0.15	8.29	2.64	33.53	51.10	1.01	2.81	0	0.08	0.01	0.13	0.02	0	0	0	0.06	99.83
Rk-46	0.04	8.82	4.03	32.86	48.11	0.52	3.94	0.01	0	0.01	0.04	0	0.02	0	0.03	0	98.43
Rk-46	0.07	8.52	2.51	34.44	50.45	0.87	2.45	0.01	0	0	0	0.02	0.1	0	0.03	0.28	99.75
Rk-46	0.07	7.14	3.16	33.42	52.40	0.78	2.55	0.08	0	0	0.11	0	0	0	0.1	0	99.82
Rk-46	0.06	6.95	3.27	33.20	53.18	0.65	2.77	0	0.01	0	0.05	0	0	0	0	0.02	100.17
Rk-46	0.08	7.17	0.94	34.27	55.38	0.63	1.07	0.03	0.31	0.02	0.05	0.09	0	0	0.11	0	100.15
Rk-46	0.1	8.53	2.76	34.46	50.54	0.9	2.65	0.03	0	0	0	0	0	0	0.06	0.17	100.19
Rk-46	0.08	6.91	3.21	32.91	52.85	0.63	2.73	0.1	0	0	0	0	0	0	0.01	0.13	99.56
Rk-46	0	6.77	4.13	33.36	51.38	0.43	2.41	0	0	0	0	0	0.02	0	0	0.12	98.61
Rk-47	0.05	9.14	1.24	35.96	50.77	0.89	1.88	0.02	0	0.02	0.07	0	0.01	0	0.08	0	100.13
Rk-47	0.18	8.72	1.85	35.40	49.66	1.06	1.64	0.06	0.05	0	0.09	0	0.03	0	0	0	98.74
Rk-47	0.07	8.67	1.83	35.25	49.86	1.03	1.51	0	0.09	0	0	0	0	0	0.04	0	98.34
Rk-47	0.1	8.44	2.21	35.75	50.51	0.96	1.66	0	0	0.02	0	0.09	0.01	0	0.21	0.05	100.01
Rk-47	0.11	9.02	1.51	35.67	49.72	0.94	1.48	0	0.1	0	0.04	0.11	0.05	0	0.05	0.09	98.88
Rk-47	0.11	7.88	2.77	34.68	50.62	0.96	2.01	0	0	0	0	0.08	0.05	0	0.15	0	99.30
Rk-47	0.05	7.47	1.38	35.99	53.55	0.77	0.91	0	0	0	0.05	0.02	0	0	0.08	0.28	100.55
Rk-47	0	8.93	1.4	35.51	51.29	0.92	2.05	0	0	0.01	0.11	0.09	0	0	0.01	0	100.31
Rk-47	0.09	10.11	2.53	35.20	47.87	0.7	2.81	0	0.11	0.05	0	0	0.02	0	0.17	0.06	99.71

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
Rk-47	0.17	10.77	1.31	37.50	46.48	1.14	1.6	0	0.01	0	0.01	0	0	0	0.14	0.12	99.25
Rk-47	0.12	8.07	2.72	35.22	51.20	0.82	2.05	0	0	0	0.09	0	0.04	0	0.02	0.06	100.41
Rk-48	0.19	9.83	2.09	35.55	45.30	1.15	1.74	0	0	0	0.01	0	0	0	0.03	0.2	96.08
Rk-48	0.08	7.83	2.95	32.77	48.17	0.76	2.48	0.06	0	0	0	0	0	0	0.03	0	95.13
Rk-48	0.08	8.05	2.96	34.46	50.33	0.75	2.3	0.07	0	0.02	0	0	0	0	0.18	0	99.21
Rk-48	0	8.07	2.6	33.86	51.28	0.8	2.5	0	0	0.02	0	0.06	0.03	0	0	0.22	99.44
Rk-48	0.01	8.89	2.46	35.14	49.88	0.98	2.12	0	0	0.01	0.05	0	0	0	0	0.25	99.79
Rk-48	0.12	8.23	2.9	35.02	50.68	0.95	2.16	0.09	0	0	0	0	0.04	0	0.02	0	100.21
Rk-48	0.13	8.09	2.62	34.98	50.78	1.01	1.94	0.05	0.01	0	0.02	0	0.04	0	0.05	0	99.72
Rk-48	0.09	9.13	2.88	34.66	48.18	0.78	2.65	0.02	0	0	0.02	0	0	0	0.02	0.16	98.60
Rk-48	0.08	8.21	2.68	34.18	51.38	0.88	2.39	0	0.11	0	0.01	0.05	0.08	0	0	0	100.05
Rk-48	0.04	7	2.32	33.27	53.47	1.23	2.16	0	0	0	0.05	0.05	0	0	0	0.01	99.60
Rk-48	0.11	8.09	2.81	34.78	51.31	0.7	2.34	0	0	0.03	0.08	0	0	0	0.02	0.12	100.38
Rk-48	0.13	8.13	2.71	34.68	50.73	0.73	2.29	0.02	0	0.03	0.01	0	0	0	0.03	0.04	99.53
Rk-48	0.01	8.74	2.58	34.95	50.10	0.89	2.36	0.03	0	0	0	0	0.05	0	0.06	0.04	99.80
U05-72	0.09	8.6	2.75	33.77	50.96	0.99	2.85	0	0.12	0	0.09	0	0.01	0	0	0	100.23
U05-72	0.09	8.6	2.75	33.77	50.96	0.99	2.85	0	0.12	0	0.09	0	0.01	0	0	0	100.23
U05-72	0.05	8.63	2.72	33.58	50.69	0.93	2.85	0	0.01	0.13	0	0	0	0	0.08	0.26	99.93
U05-72	0.08	8.5	2.9	33.52	50.02	0.94	2.85	0.09	0.07	0	0.12	0.03	0	0	0.08	0	99.20
M05-12sp	0.13	6.86	2.46	34.56	53.48	1.01	1.28	0	0.09	0	0	0	0.01	0	0	0.06	99.94
M05-12sp	0	7.65	2.38	34.20	52.80	0.94	1.6	0.07	0.15	0.03	0	0.02	0.02	0	0	0.12	99.98
M05-12sp	0.07	7.94	2.24	34.62	51.47	1.13	1.84	0	0	0.04	0	0	0.02	0	0.02	0	99.39
M05-12sp	0	7.65	2.25	34.77	52.08	0.98	1.58	0.08	0	0	0	0	0.02	0	0.09	0.14	99.64
M05-12sp	0.02	6.6	3.99	33.61	52.12	0.59	2.06	0	0.01	0.06	0	0	0	0	0.05	0.04	99.15
M05-12sp	0.08	7.39	2.53	34.51	52.60	0.9	1.5	0.02	0.13	0	0.02	0.01	0	0	0.06	0.09	99.84
M05-12sp	0.05	6.67	4.03	33.98	52.09	0.53	2.06	0.02	0	0.04	0.12	0	0.04	0	0.08	0.07	99.78
M05-12sp	0.08	7.65	2.5	34.67	51.72	1.01	1.79	0	0	0.02	0.13	0	0.01	0	0	0.03	99.61
M05-12sp	0.01	7.89	2.34	33.97	51.47	1.05	1.66	0	0.18	0	0.19	0.01	0.01	0	0.02	0	98.79
M05-12sp	0.05	7.49	2.52	34.15	52.28	0.92	1.57	0.72	0.01	0	0.51	0	0.06	0	0	0.03	100.31
M05-12sp	0.06	7.45	2.53	34.33	52.60	0.92	1.63	0.08	0.12	0	0.02	0	0.04	0	0.17	0.11	100.06
M05-12sp	0.15	7.19	2.52	33.86	52.84	1.18	1.68	0	0.13	0.01	0.14	0.01	0.01	0	0.03	0.02	99.77
M05-12sp	0	7.58	2.48	34.28	52.92	0.95	1.55	0	0.19	0	0.08	0	0	0	0.08	0.13	100.24
M05-12sp	0.09	7.23	2.47	34.80	52.57	0.89	1.52	0.09	0	0	0.06	0.02	0.02	0	0.03	0.1	99.89
M05-13	0	7.29	2.29	34.30	53.47	1.07	1.54	0	0.11	0.02	0.09	0	0.02	0	0.12	0	100.31
M05-13	0.02	7.88	2.06	34.13	52.13	1.07	1.81	0	0.05	0.05	0.07	0.03	0	0	0	0.21	99.51
M05-13	0	7.96	2.04	34.10	52.67	0.89	1.94	0.01	0.15	0.02	0.06	0	0.02	0	0	0.04	99.89
M05-13	0.02	7.91	2.26	33.30	52.76	1	1.99	0	0.24	0	0.04	0	0.01	0	0.05	0.39	99.97
M05-13	0.13	8.13	2.13	34.54	51.53	1.18	1.84	0	0.1	0	0.1	0	0	0	0	0.03	99.70

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M05-13	0.13	7.92	2.17	34.33	51.74	1.16	1.95	0.14	0	0.01	0.06	0	0	0	0.03	0.19	99.84
M05-13	0.04	8.02	2.07	34.80	51.61	1.17	1.73	0.05	0.01	0	0	0	0.03	0	0	0.01	99.55
M05-13	0	7.96	2.12	34.33	51.82	1.09	2	0.04	0	0.02	0	0	0	0	0	0	99.38
M05-13	0	8.02	2.19	34.68	51.81	1.15	1.86	0	0	0	0.07	0.08	0	0	0.01	0.13	100.00
M05-13	0.18	7.14	2.3	33.72	53.53	1.23	1.6	0.07	0.18	0.01	0.06	0	0.03	0	0.01	0	100.06
M05-13	0.02	7.45	2.56	34.80	52.27	0.91	1.7	0	0.01	0	0	0	0	0	0.13	0.03	99.88
M05-13	0.09	7.6	2.23	34.55	51.76	0.99	1.66	0.08	0	0.01	0.02	0.07	0	0	0.12	0.16	99.34
M05-15	0	8.44	2.78	34.16	51.16	0.76	2.42	0	0.16	0	0	0	0	0	0.03	0	99.92
M05-15	0.22	7.99	2.84	34.26	51.03	0.94	2.58	0	0	0	0.18	0.06	0	0	0.13	0.11	100.34
M05-15	0	8.07	2.78	32.83	52.89	0.83	2.67	0.09	0.27	0	0	0	0	0	0.04	0.19	100.66
M05-15	0	8.34	2.7	33.69	51.30	0.91	2.57	0.04	0.14	0	0.01	0.02	0	0	0.15	0	99.87
M05-15	0.1	7.94	2.86	34.16	51.03	0.82	2.53	0	0	0	0.16	0.05	0.02	0	0.01	0	99.68
M05-15	0.06	8.25	2.96	34.64	51.38	0.81	2.64	0.02	0	0	0.26	0.08	0.03	0	0	0	101.13
M05-15	0.14	8.12	2.83	34.03	50.73	0.97	2.62	0.02	0	0	0	0.15	0	0	0.17	0.14	99.92
M05-15	0.17	8.34	2.76	33.35	51.61	0.94	2.58	0.08	0.25	0.05	0.09	0	0	0	0.15	0	100.38
M05-15	0.17	8.37	2.78	34.71	50.94	0.95	2.53	0	0	0	0.06	0	0.01	0	0	0.16	100.68
M05-15	0.03	8.28	2.83	33.98	51.45	0.84	2.62	0	0.08	0.04	0.04	0	0	0	0.01	0	100.20
M05-15	0.01	8.22	2.72	34.38	50.70	0.83	2.4	0.01	0.01	0	0.08	0.09	0	0	0.06	0	99.50
M05-15	0	8.35	2.76	33.89	50.76	0.91	2.65	0	0	0	0	0	0.02	0	0.13	0.34	99.81
M05-18	0	8.04	2.96	32.96	52.23	0.71	2.84	0.03	0.2	0	0.08	0	0	0	0.01	0.12	100.17
M05-18	0.09	8.08	3.08	33.85	50.78	0.79	2.87	0.02	0	0	0.11	0	0.02	0	0.05	0	99.74
M05-18	0	8.19	2.54	33.28	52.05	0.91	2.77	0.04	0.13	0	0.05	0	0.06	0	0	0	100.02
M05-18	0.13	8.05	3.12	33.88	51.32	0.8	2.95	0.04	0.01	0	0	0	0	0	0.04	0.04	100.38
M05-18	0.24	7.93	2.78	33.75	51.20	0.85	2.62	0.11	0.05	0.03	0.16	0.04	0.01	0	0	0.01	99.77
M05-18	0	8.36	2.68	33.72	50.71	0.84	2.75	0.09	0	0.01	0	0	0	0	0.02	0.13	99.31
M05-18	0.11	8.23	2.69	34.20	51.29	0.99	2.68	0.01	0	0.01	0.09	0	0	0	0	0.01	100.31
M05-18	0.07	8.3	2.91	33.58	51.35	0.85	2.92	0	0.09	0.03	0	0	0	0	0.07	0	100.17
M05-18	0.05	8.11	3.01	33.72	50.90	0.86	2.9	0	0	0.02	0	0	0	0	0.23	0	99.80
M05-18	0.12	8.35	2.98	34.09	50.98	0.89	2.91	0.04	0	0.01	0.08	0	0	0	0.07	0.11	100.63
M05-18	0.1	7.05	4.64	31.72	51.17	0.42	3.77	0.02	0.05	0	0.08	0	0	0	0.02	0.04	99.08
M05-8	0.14	7.66	4.34	32.62	50.65	0.41	3.8	0	0	0.03	0	0	0	0	0.07	0.08	99.80
M05-8	0.12	7.52	4.44	31.83	51.26	0.55	4.02	0	0.01	0.02	0.04	0	0.01	0	0.09	0.37	100.28
M05-8	0.07	7.52	4.42	31.50	52.39	0.66	3.97	0.03	0.15	0.04	0.16	0	0.08	0	0	0.08	101.07
M05-8	0.01	7.38	4.42	31.87	51.68	0.34	4.08	0.06	0	0	0	0	0	0	0.12	0.17	100.13
M05-8	0.07	7.36	4.7	32.04	51.64	0.6	4	0.06	0	0.03	0	0.01	0	0	0.04	0	100.55
M05-8	0.15	7.04	4.68	31.57	50.94	0.47	3.85	0	0	0	0.02	0	0	0	0	0.34	99.07
M05-8	0.03	7.73	4.14	31.71	50.98	0.45	3.93	0.01	0.11	0.01	0.07	0	0	0	0.06	0	99.23
M05-8	0.1	7.55	4.4	32.13	50.50	0.47	3.7	0.1	0	0.02	0.13	0.01	0.05	0	0.12	0.3	99.58

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M05-8	0.24	7.79	4.29	32.95	50.99	0.37	3.77	0.05	0.08	0	0.11	0.14	0.03	0	0.04	0	100.84
M04-109	0.15	9.69	3.5	34.75	47.46	0.82	3.36	0.05	0	0	0.09	0.05	0.07	0	0.05	0	100.04
M04-109	0.15	9.64	3.43	35.14	47.62	0.6	3.25	0	0	0.01	0.17	0	0	0	0.07	0	100.08
M04-109	0.01	9.78	3.56	34.79	47.37	0.75	3.27	0.08	0	0	0	0	0.03	0	0.09	0	99.73
M04-109	0.08	9.86	3.41	34.56	46.80	0.79	3.27	0.12	0	0.02	0	0.01	0.05	0	0.07	0	99.04
M04-109	0.08	10.12	3.37	35.06	47.02	0.72	3.39	0.04	0	0.01	0.01	0	0.04	0	0	0	99.86
M04-109	0.04	9.69	3.41	34.88	47.73	0.62	3.29	0.02	0	0	0.06	0	0	0	0.04	0.02	99.80
M04-109	0.12	9.79	3.47	34.42	48.02	0.74	3.44	0.05	0.07	0	0	0	0.02	0	0.06	0.21	100.41
M04-109	0.09	9.72	3.48	35.09	47.97	0.79	3.2	0.01	0	0	0	0	0	0	0.07	0.17	100.59
M04-109	0.07	9.8	3.49	34.77	47.74	0.85	3.38	0	0.01	0	0.02	0	0	0	0.04	0.04	100.21
M04-109	0.09	10.03	3.5	34.91	46.71	0.8	3.29	0.07	0	0	0.1	0	0.02	0	0	0.07	99.59
M04-111	0.19	9.73	3.64	34.58	48.15	0.88	3.53	0	0.06	0.02	0	0	0.04	0	0.01	0	100.83
M04-111	0.08	9.86	3.74	35.35	47.52	0.62	3.33	0.04	0	0	0.12	0.02	0.05	0	0.05	0	100.78
M04-111	0.14	9.67	3.82	34.48	47.48	0.76	3.51	0.04	0	0	0.02	0	0	0	0.02	0.24	100.18
M04-111	0.1	10.1	3.65	34.82	46.73	0.87	3.39	0.03	0	0.03	0.1	0.07	0	0	0.11	0.17	100.17
M04-111	0.1	10.64	3.35	35.37	45.54	0.72	3.44	0	0	0	0	0	0	0	0	0	99.16
M04-111	0.1	9.86	3.72	34.93	47.37	0.63	3.52	0.05	0	0	0.02	0.03	0	0	0	0	100.23
M04-111	0.04	9.98	3.61	35.09	47.40	0.54	3.54	0.02	0	0	0.04	0	0.01	0	0.15	0.02	100.43
M04-111	0.18	9.83	3.94	34.73	47.63	0.74	3.27	0.01	0.15	0.02	0.14	0	0	0	0.06	0.08	100.78
M04-111	0.29	9.98	3.75	35.03	46.29	0.62	3.6	0	0	0.01	0	0.02	0	0	0.01	0.01	99.61
M04-111	0	9.93	3.77	34.17	46.72	0.63	3.73	0	0	0	0	0	0	0	0.08	0.13	99.16
M04-111	0	11.1	2.94	35.82	45.51	0.81	3.32	0	0	0	0	0	0.02	0	0.09	0	99.61
U05-72	0.08	8.47	2.78	34.07	50.15	0.74	2.85	0.03	0	0	0.08	0	0	0	0.15	0.09	99.49
U05-72	0.04	8.32	3.01	33.95	50.69	0.87	2.93	0	0	0	0.09	0	0	0	0.14	0	100.04
U05-72	0.09	8.51	2.98	33.86	50.65	0.88	2.85	0.02	0.1	0	0.08	0	0	0	0.05	0	100.07
U05-72	0.17	8.23	2.72	34.06	51.37	0.88	2.75	0.02	0	0.05	0.02	0	0	0	0	0.18	100.45
U05-72	0.13	8.77	2.85	34.09	50.26	0.79	2.84	0	0.13	0	0.07	0	0	0	0.04	0.02	99.99
U05-72	0.05	8.67	2.81	34.50	50.59	0.95	2.83	0	0	0	0.02	0.01	0.02	0	0.1	0	100.55
U05-72	0.17	8.31	2.75	34.14	50.29	0.77	2.66	0.05	0	0.01	0.08	0	0	0	0.06	0.19	99.49
U05-72	0.14	8.34	2.83	34.07	50.28	0.9	2.72	0	0	0	0	0	0.03	0	0.01	0.13	99.45
U05-72	0.21	8.61	2.84	34.12	49.72	0.92	2.91	0.02	0	0	0	0	0	0	0	0.1	99.44
U05-73	0.13	9.15	3.8	33.93	47.75	0.56	3.61	0.06	0	0	0	0	0	0	0.16	0	99.14
U05-73	0.11	10.7	2.98	37.59	43.54	0.74	1.51	0.15	0	0	0	0	0.01	0	0.05	0	97.39
U05-73	0.09	8.74	2.9	33.52	48.73	0.73	3.01	0.08	0	0	0	0	0	0	0	0.18	97.98
U05-73	0	10.5	1.66	36.56	47.20	1.06	2.03	0	0	0.02	0.09	0.11	0.08	0	0.07	0	99.38
U05-73	0.12	11.57	1.49	38.35	44.84	0.86	1.44	0.06	0.06	0.01	0.05	0	0.04	0	0.03	0.09	99.01
U05-73	0.08	9.83	1.68	35.85	48.05	1.09	2.01	0.13	0	0	0	0.01	0	0	0.06	0	98.80
U05-73	0.2	8.41	3.02	34.66	49.50	0.92	2.26	0	0	0.09	0	0.02	0	0	0	0.04	99.12

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
U05-73	0.24	8.08	3.29	34.08	49.18	0.66	2.66	0	0	0	0.13	0.01	0.03	0	0.07	0.1	98.53
U05-73	0.05	10.7	1.27	37.96	46.94	1.05	1.24	0	0	0.05	0.08	0.1	0.02	0	0.1	0	99.56
U05-73	0.11	11.2	1.33	38.28	46.17	0.88	1.55	0	0	0.06	0.02	0	0.03	0	0.16	0.03	99.82
U05-73	0.08	8.96	2.79	34.34	49.04	0.69	2.76	0	0	0.03	0.03	0	0	0	0.05	0.3	99.07
M04-28	0.01	6.92	3.27	33.01	52.51	0.66	2.66	0	0	0	0.13	0	0	0	0.04	0	99.22
M04-28	0.16	7.08	3.24	33.45	52.20	0.77	2.52	0	0	0.02	0.16	0	0.01	0	0.11	0.15	99.86
M04-28	0.05	6.97	3.31	32.69	51.84	0.74	2.68	0	0	0	0	0	0.01	0	0.16	0.18	98.63
M04-28	0.05	6.99	3.32	32.79	52.01	0.74	2.69	0	0	0	0	0	0.01	0	0.16	0.18	98.95
M04-28	0.11	6.85	3.12	32.67	53.06	0.84	2.46	0	0.1	0.03	0	0	0.03	0	0.05	0.08	99.41
M04-28	0.01	6.75	2.97	33.04	53.01	0.68	2.24	0.05	0	0	0.12	0	0	0	0.1	0.39	99.36
M04-28	0.09	6.77	3.4	32.35	53.00	0.63	2.44	0.09	0.18	0	0.05	0.01	0.07	0	0.06	0.17	99.32
M04-28	0.27	6.81	3.13	32.68	53.03	0.8	2.5	0.04	0.15	0	0.11	0	0	0	0	0.1	99.61
M04-28	0.04	7.22	2.4	33.72	52.81	0.97	2.01	0.08	0	0.04	0	0	0	0	0.02	0.01	99.32
M04-28	0.06	6.88	3.29	32.51	52.37	0.77	2.79	0	0.01	0	0	0	0	0	0.04	0.1	98.82
M04-28	0.09	6.97	3.4	33.21	52.36	0.7	2.69	0	0	0	0.21	0.14	0.02	0	0.13	0.06	99.97
M04-28	0.09	6.98	3.24	32.38	53.01	0.84	2.67	0.04	0.09	0.06	0.22	0.07	0.02	0	0.03	0.13	99.87
M05-12 hp	0.1	6.76	2.38	34.15	53.59	1.07	0.99	0.01	0.19	0.02	0.07	0	0	0	0	0	99.32
M05-12 hp	0.06	7.87	2.33	34.87	51.70	1.04	1.8	0.01	0	0	0.04	0	0	0	0.04	0.08	99.84
M05-12 hp	0.07	6.84	2.49	34.70	52.89	1.01	1.05	0.03	0	0.06	0	0	0.01	0	0	0.17	99.32
M05-12 hp	0.06	7.72	2.3	34.55	51.91	1.07	1.58	0.11	0	0.08	0	0.05	0	0	0	0.12	99.55
M05-12 hp	0.01	7.97	2.11	34.96	51.21	0.99	1.62	0.03	0	0	0	0	0.02	0	0	0	98.92
M05-12 hp	0.04	7.24	2.12	34.08	52.36	1	1.62	0.07	0	0	0.25	0.1	0.06	0	0	0.1	99.04
M05-12 hp	0.15	7.33	2.32	34.46	53.29	1.07	1.69	0.02	0.1	0	0.07	0	0.03	0	0.02	0	100.56
M05-12 hp	0.04	8.08	2.23	34.47	52.43	1.11	1.64	0.09	0.18	0.03	0	0	0.08	0	0.08	0.04	100.50
M05-12 hp	0.05	7.93	2.28	34.93	52.11	1.2	1.75	0	0	0	0.09	0	0	0	0.02	0.19	100.55
M05-12 hp	0.16	7.35	2.61	34.42	52.24	0.99	1.87	0	0	0.02	0.07	0.05	0.06	0	0.02	0.13	99.99
M05-12 hp	0.04	7.24	2.41	34.18	53.00	0.93	1.66	0	0.08	0	0	0	0.01	0	0.08	0.16	99.79
M05-12 hp	0.13	7.05	2.32	34.11	53.50	1.13	1.07	0.02	0.26	0	0	0	0	0	0	0	99.59
M05-12 hp	0.13	7.05	2.32	34.11	53.50	1.13	1.07	0.02	0.26	0	0	0	0	0	0	0	99.59
M05-78 dk pumice	0.14	8.34	2.78	33.26	48.04	0.76	2.71	0.04	0	0	0.02	0	0.03	0	0	0	96.12
M05-78 dk pumice	0.09	5.97	4.64	31.71	50.92	0.51	2.75	0	0	0.02	0.12	0	0.04	0	0.14	0	96.91
M05-78 dk pumice	0.14	8.29	2.65	33.04	48.69	0.89	2.54	0	0.05	0.04	0	0.01	0.03	0	0	0.11	96.48
M05-78 dk pumice	0.18	7.81	2.9	33.24	48.94	0.7	2.48	0	0	0	0.05	0.02	0.03	0	0.09	0.22	96.66
M05-78 dk pumice	0.01	7.62	3.03	33.03	49.53	0.89	2.34	0.03	0	0	0	0	0.06	0	0	0.01	96.55
M05-78 dk pumice	0.01	8.28	2.8	34.62	50.38	0.82	2.24	0.09	0	0	0	0	0.02	0	0	0	99.26
M05-78 dk pumice	0.08	7.83	3.08	32.97	50.03	0.58	2.8	0.02	0.05	0.03	0	0.01	0	0	0.04	0	97.52
M05-78 dk pumice	0	8.39	2.73	33.22	49.25	1	2.47	0	0.07	0	0	0	0	0	0	0.14	97.28
M05-78 dk pumice	0.11	5.96	4.72	31.92	51.42	0.59	2.73	0.06	0	0	0.06	0	0	0	0.03	0	97.60

M05-78 dk pumice	0.07	8.41	2.7	34.10	48.33	0.76	2.28	0	0	0	0	0.01	0	0	0	0.01	96.68
M05-78 dk pumice	0.15	8.23	3.01	34.03	49.39	0.7	2.61	0	0	0.03	0	0	0.01	0	0	0	98.16
M05-78 dk pumice	0.16	6.77	3.71	33.02	51.18	0.43	2.34	0.08	0.07	0	0.06	0	0	0	0.02	0.08	97.92
M05-74	0.04	8.86	2.82	34.23	48.73	0.78	2.73	0.02	0	0.02	0	0	0	0	0.08	0	98.31
M05-74	0.13	9.33	2.74	34.49	49.01	0.9	2.81	0.05	0.09	0.01	0.08	0.08	0	0	0	0.04	99.77
M05-74	0.18	9.12	2.77	34.04	47.57	0.85	2.66	0.04	0.09	0	0.01	0.02	0.01	0	0.06	0	97.42
M05-74	0.08	9.14	2.64	34.03	47.67	0.78	2.78	0.1	0	0	0.04	0	0.01	0	0.08	0.08	97.44
M05-74	0.18	9.03	2.84	34.02	47.80	0.92	2.91	0.07	0	0	0.15	0	0.07	0	0.11	0	98.10
M05-74	0.02	9.07	2.78	34.17	48.52	0.8	2.82	0.01	0.01	0.01	0.07	0.1	0.05	0	0.01	0.04	98.48
M05-74	0.05	9.04	2.66	34.50	48.93	0.78	2.64	0	0	0.07	0	0	0.03	0	0	0.01	98.70
M05-74	0.08	8.93	2.65	34.25	49.07	0.83	2.8	0	0	0	0.02	0	0	0	0.01	0.13	98.77
M05-74	0.06	9.14	2.71	34.35	48.52	0.81	2.83	0	0	0.04	0.05	0	0.08	0	0.08	0	98.67
M05-74	0.11	8.94	2.78	33.74	48.78	0.9	2.83	0	0.06	0.04	0	0	0	0	0.07	0.09	98.34
M05-74	0.1	8.88	2.87	34.36	48.73	0.84	2.69	0.07	0	0	0.02	0	0	0	0.01	0.07	98.65
M05-67	0.1	8.09	2.26	34.69	52.10	1.22	2.03	0.02	0.05	0	0	0	0	0	0.08	0.01	100.65
M05-67	0.1	7.56	2.19	34.01	52.24	1.25	2.01	0.03	0	0	0.1	0.03	0	0	0.02	0	99.54
M05-67	0.06	7.85	2.05	34.47	52.48	1.07	1.91	0	0	0.09	0.05	0	0	0	0.13	0.08	100.25
M05-67	0.1	8.08	2.11	34.76	51.22	0.93	1.98	0.05	0.01	0	0.08	0	0.03	0	0.12	0.01	99.49
M05-67	0.07	7.79	2.15	34.49	51.95	1.1	1.91	0	0	0.01	0.1	0	0	0	0.04	0.04	99.66
M05-67	0.02	7.8	2.13	34.18	52.54	1.02	1.75	0	0.16	0	0	0	0	0	0.08	0	99.68
M05-67	0.07	8.13	2.15	33.59	52.56	1.04	2.13	0	0.24	0.01	0.05	0	0	0	0	0.09	100.06
M05-67	0.12	8.02	2.09	34.88	51.47	0.97	1.95	0.01	0	0.01	0	0	0	0	0.1	0	99.63
M05-67	0.13	4.58	3.23	33.43	57.02	0.4	1.48	0	0	0.01	0	0	0.02	0	0.07	0	100.37
M05-67	0	7.86	2.12	34.51	51.71	1.11	1.83	0	0	0	0.01	0	0	0	0	0	99.15
M05-67	0.19	7.89	2.26	33.86	53.61	1.21	2.11	0.04	0.21	0.01	0.02	0.09	0	0	0.04	0.24	101.78
M05-67	0	7.98	1.96	34.64	52.80	1.05	1.96	0	0	0.04	0.05	0	0	0	0.1	0.19	100.77
M05-61	0.16	7.33	1.83	33.64	53.82	1.4	1.88	0.04	0.06	0	0.11	0.03	0	0	0	0.28	100.58
M05-61	0	7.3	1.92	33.78	53.46	1.22	1.93	0.03	0	0	0.02	0	0	0	0.08	0.08	99.82
M05-61	0.1	7.35	1.8	33.70	53.61	1.37	1.82	0.02	0	0.07	0.03	0	0.03	0	0	0.23	100.13
M05-61	0.01	7.8	1.81	34.42	52.96	1.26	1.83	0.04	0.01	0.01	0	0	0	0	0	0.05	100.20
M05-61	0.04	7.1	2	33.49	54.70	1.25	1.86	0	0.13	0.03	0	0.05	0.08	0	0.1	0	100.83
M05-61	0.07	7.37	1.95	34.03	54.34	1.41	1.73	0.04	0.1	0.02	0.1	0.12	0	0	0.01	0	101.30
M05-61	0.02	7.59	1.85	33.90	53.71	1.26	1.82	0	0.08	0	0.07	0.01	0	0	0.09	0.34	100.74
M05-61	0	7.64	2.02	34.48	53.33	1.33	1.81	0.02	0	0	0.01	0	0.02	0	0.06	0.12	100.84
M05-61	0.09	7.49	1.91	34.02	53.62	1.33	1.84	0	0.05	0.03	0.02	0	0.02	0	0.03	0.13	100.58
M05-61	0.01	7.25	1.96	34.59	53.51	1.22	1.51	0	0	0	0.05	0.01	0.02	0	0	0	100.13
M05-61	0.1	6.93	2.39	34.22	53.94	0.99	1.84	0	0	0	0.17	0	0	0	0	0.16	100.74
M05-61	0.08	7.35	1.99	34.03	53.53	1.41	1.81	0	0.01	0.02	0.1	0	0.05	0	0	0.08	100.47
M05-80	0.09	10.01	2.85	35.28	48.28	0.7	2.98	0	0.08	0.05	0.07	0	0	0	0	0	100.39

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M05-80	0.07	10.08	2.97	35.85	48.22	0.72	3	0.02	0	0.05	0	0	0.02	0	0.11	0	101.11
M05-80	0.1	10.03	2.8	34.83	48.74	0.84	3.14	0.1	0.14	0	0.07	0	0	0	0.07	0	100.85
M05-80	0.08	9.94	2.87	35.28	48.36	0.8	3.08	0	0	0.08	0	0	0.01	0	0.09	0.01	100.60
M05-80	0.06	9.95	2.82	34.68	48.52	0.76	2.89	0	0.18	0.02	0	0	0.04	0	0	0.14	100.06
M05-80	0.04	10.08	2.73	35.61	47.66	0.76	2.84	0.02	0	0	0	0	0.03	0	0.04	0.15	99.97
M05-80	0.05	10.03	2.79	35.40	47.72	0.7	3.09	0.03	0	0	0.01	0.05	0	0	0.13	0	100.00
M05-80	0.09	10.21	2.84	35.64	47.89	0.64	3.17	0.05	0	0	0.05	0.02	0.01	0	0	0.13	100.74
M05-80	0.1	9.79	2.76	34.77	48.36	0.82	3.06	0.07	0.07	0	0.03	0	0	0	0	0	99.84
M05-80	0.06	10.13	2.82	35.36	48.07	0.81	3.12	0.05	0	0.01	0	0	0	0	0	0.14	100.57
M05-80	0.1	10.03	2.8	35.70	47.46	0.71	2.78	0	0	0.04	0	0.06	0	0	0.02	0.1	99.80
M05-80 dk	0.06	10.28	2.93	35.85	47.56	0.7	2.9	0.02	0.06	0	0.12	0.19	0.03	0	0	0	100.69
M05-80 dk	0.1	9.8	2.95	35.29	48.45	0.75	3.07	0.04	0	0.03	0.02	0	0	0	0.12	0.12	100.75
M05-80 dk	0.22	9.89	2.75	35.86	47.54	0.61	2.84	0.05	0	0.01	0.13	0.07	0.03	0	0	0	100.00
M05-80 dk	0.1	10.01	2.79	35.41	48.15	0.64	3.09	0.11	0	0.04	0.04	0.08	0	0	0	0.02	100.48
M05-80 dk	0.09	10.22	2.93	35.62	47.67	0.7	3.02	0.04	0.01	0.03	0.11	0	0	0	0	0.18	100.63
M05-80 dk	0.08	9.86	2.88	35.14	48.22	0.87	3.06	0.02	0	0.04	0.01	0	0	0	0	0	100.18
M05-80 dk	0.01	9.96	2.99	35.55	47.57	0.69	2.9	0.04	0	0	0	0	0.01	0	0.04	0	99.76
M05-80 dk	0.2	10.02	2.88	35.58	47.47	0.64	2.99	0	0.05	0	0.02	0	0.04	0	0.05	0.07	100.01
M05-80 dk	0.19	9.82	3.02	35.52	47.79	0.65	2.95	0	0.01	0	0	0	0	0	0.03	0.28	100.26
M05-80 dk	0.07	10.06	2.87	35.31	47.66	0.81	2.99	0	0	0.06	0.02	0	0.09	0	0.15	0.12	100.21
M05-78	0.17	8.41	2.75	35.02	51.04	0.69	2.57	0.05	0	0.02	0.06	0	0	0	0.01	0	100.79
M05-78	0.11	8.68	2.62	34.84	50.57	0.9	2.47	0	0.05	0	0.09	0	0.01	0	0.01	0.04	100.39
M05-78	0.15	8.39	2.9	34.07	50.89	0.82	2.65	0.06	0.12	0	0.05	0.16	0.04	0	0	0	100.30
M05-78	0.12	8.48	2.67	34.25	50.46	0.74	2.39	0	0.15	0	0.06	0	0	0	0.09	0.04	99.46
M05-78	0.06	8.45	3.01	34.54	50.38	0.78	2.63	0	0	0.03	0.13	0	0.03	0	0	0	100.04
M05-78	0.02	8.35	2.68	34.12	50.66	0.86	2.57	0.11	0	0	0	0.02	0	0	0.03	0.06	99.48
M05-78	0.02	8.19	2.69	33.48	51.19	0.61	2.72	0.13	0.11	0	0.08	0	0.03	0	0.09	0	99.33
M05-78	0.07	8.55	2.72	34.55	49.39	0.8	2.38	0.05	0	0.01	0.04	0.07	0.04	0	0.15	0.05	98.88
M05-78	0.05	8.39	2.74	33.93	50.05	0.84	2.6	0.03	0	0.01	0.08	0	0.02	0	0	0.18	98.92
M05-78	0	8.44	2.65	34.01	50.14	0.89	2.62	0	0	0	0.09	0	0	0	0.06	0.06	98.96
M07-1 dk	0.09	7.93	2.86	32.93	50.89	0.85	3.13	0.02	0	0	0	0	0	0	0	0	98.70
M07-1 dk	0.08	8.03	5.23	31.31	50.28	0.61	4.47	0.03	0.18	0	0	0.07	0	0	0.06	0	100.35
M07-1 dk	0.21	7.6	2.2	33.50	53.44	1.19	1.84	0	0.3	0	0.02	0	0	0	0.08	0.09	100.47
M07-1 dk	0.13	4.63	6.82	28.14	53.54	0.43	4.99	0	0	0.03	0	0	0	0	0.28	0.09	99.08
M07-1 dk	0.2	6.6	3.19	33.47	52.00	0.6	2.1	0.03	0	0	0	0	0.03	0	0	0.14	98.36
M07-1	0.01	6.2	2.74	33.52	54.70	0.86	1.82	0	0	0.04	0.06	0.04	0.01	0	0.15	0	100.15
M07-1	0.18	6.05	2.32	32.82	54.00	0.74	1.9	0	0.01	0.02	0.17	0.01	0	0	0.17	0.24	98.63
M07-1	0.01	8.14	1.29	35.45	53.18	0.81	1.28	0.03	0.15	0.02	0.11	0	0.04	0	0.07	0	100.58

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M07-1	0.15	9.15	3.76	34.58	47.01	0.7	3.01	0	0	0	0	0	0	0	0.08	0	98.44
M07-1	0.11	7.89	2.91	34.19	51.09	1	2.4	0	0	0.02	0	0	0	0	0.13	0	99.74
M07-1	0.05	6.97	4.16	31.67	51.93	0.46	3.64	0	0.01	0.09	0.06	0	0	0	0.16	0.01	99.21
M07-1	0	8.13	2.62	33.80	51.89	0.76	2.43	0.1	0.1	0.01	0.06	0	0.01	0	0.02	0.19	100.11
M07-1	0.02	6.94	4.28	31.96	52.01	0.58	3.58	0.02	0	0	0	0.09	0.01	0	0.01	0	99.51
M07-1	0.05	8.7	1.65	35.48	50.01	1.33	1.37	0.06	0	0	0	0.04	0	0	0.16	0.17	99.01
M07-2	0.12	6.32	3.46	32.80	53.12	0.74	2.51	0	0	0	0.11	0	0	0	0.07	0	99.25
M07-2	0	6.16	3.64	31.99	54.04	0.85	2.6	0.04	0	0.05	0	0	0	0	0.08	0.28	99.74
M07-2	0.11	7.19	3.46	32.89	52.67	0.74	2.67	0.07	0.12	0.01	0.06	0.05	0	0	0.03	0.13	100.20
M07-2	0.09	6.55	3.51	32.57	53.11	0.56	2.9	0.01	0	0.03	0.01	0.04	0	0	0.13	0	99.51
M07-2	0.11	7.27	3.4	33.14	51.82	0.87	2.75	0	0	0	0	0	0.01	0	0.06	0.16	99.59
M07-2	0.07	7.74	2.92	34.21	51.03	0.87	2.11	0.11	0	0.03	0	0.1	0.05	0	0	0	99.24
M07-2	0.11	7.12	3.23	32.85	52.01	0.73	2.76	0	0	0.06	0	0.01	0	0	0.03	0.02	98.93
M07-2	0.11	7.17	2.67	32.88	52.24	0.82	2.21	0.05	0.11	0.01	0.04	0	0	0	0.14	0.23	98.68
M07-2	0.04	7.01	3.37	33.25	52.63	0.65	2.69	0	0.01	0.01	0.1	0	0	0	0.08	0	99.84
M07-2	0.04	6.8	3.34	32.78	53.06	0.73	2.82	0	0	0	0	0	0.02	0	0.08	0.05	99.71
M07-2	0	7.16	3.4	33.30	52.11	0.8	2.43	0.06	0	0.01	0	0	0	0	0.15	0.25	99.67
M07-2	0.08	7	3.34	33.53	52.85	0.85	2.31	0.03	0	0.02	0.11	0.09	0	0	0.07	0.34	100.62
M07-3	0.01	6.94	4.15	32.45	51.41	0.53	2.65	0	0.11	0	0	0.04	0.03	0	0.07	0.26	98.65
M07-3	0.12	8.71	3.56	34.28	48.86	0.87	2.91	0	0	0	0.18	0.15	0	0	0.01	0.11	99.76
M07-3	0.09	7.06	4.12	33.59	51.50	0.57	2.69	0.01	0	0.01	0.11	0	0	0	0.07	0.01	99.84
M07-3	0.12	7.01	4.16	32.78	50.70	0.71	2.71	0.05	0	0.03	0	0.18	0	0	0.06	0.17	98.67
M07-3	0.06	7.27	3.96	32.92	50.81	0.72	2.93	0.02	0	0	0	0.1	0.04	0	0.06	0	98.89
M07-3	0.04	6.94	4.22	33.00	50.75	0.52	2.73	0	0	0	0.01	0	0	0	0.01	0	98.21
M07-3	0.21	6.83	4.15	33.50	52.06	0.67	2.76	0.02	0	0	0	0	0	0	0.09	0.06	100.35
M07-3	0	7.49	3.86	32.94	50.94	0.72	3.03	0.05	0	0	0.08	0.11	0.02	0	0.05	0	99.29
M07-3	0.1	7.18	4.17	33.47	50.90	0.58	2.67	0	0	0.05	0	0	0	0	0.13	0.05	99.30
M07-3	0.02	7.12	4.25	33.41	51.80	0.69	2.65	0	0	0	0	0	0	0	0.1	0.39	100.43
M07-3	0.07	7.51	5.59	33.32	49.20	0.55	3.27	0.06	0	0	0	0.07	0.02	0	0.08	0.01	99.74
M07-3	0.08	6.96	4.26	33.45	51.58	0.74	2.68	0	0	0	0.06	0	0	0	0.13	0	99.94
M07-4	0.08	6.98	3.16	33.02	52.72	0.72	2.8	0	0	0	0.03	0.01	0	0	0.1	0	99.61
M07-4	0.1	6.74	3.27	33.45	53.43	0.72	2.49	0.05	0	0	0	0	0	0	0	0.02	100.27
M07-4	0.14	6.34	2.63	33.77	53.66	0.8	1.7	0.03	0	0	0.04	0	0.04	0	0.01	0.09	99.25
M07-4	0.05	7.01	3.08	32.92	52.49	0.72	2.71	0.02	0	0	0	0	0	0	0.1	0.06	99.16
M07-4	0.07	6.22	2.4	34.00	54.66	0.81	1.55	0.07	0	0	0.06	0	0.04	0	0.07	0	99.95
M07-4	0.01	6.17	2.27	32.58	55.67	0.9	1.61	0.16	0.2	0.03	0.25	0.09	0	0	0.15	0	100.08
M07-4	0.05	7.01	2.81	33.75	52.69	0.77	2.2	0	0	0	0.11	0	0	0	0.07	0	99.46
M07-4	0.03	6.35	2.34	33.61	54.60	0.98	1.64	0.01	0	0.03	0	0.11	0.01	0	0.04	0.08	99.82

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M07-4	0.04	6.21	2.73	33.21	54.37	0.94	1.96	0.06	0	0	0	0	0	0	0.22	0.03	99.77
M07-4	0.16	6.84	2.29	34.57	53.65	1.01	1.54	0.07	0	0	0.09	0	0	0	0.02	0.02	100.26
M07-5	0.09	7.64	5.54	32.15	49.68	0.5	3.99	0	0	0.08	0	0.01	0	0	0.01	0.15	99.84
M07-5	0.1	7.83	5.12	32.36	50.47	0.69	3.82	0	0.14	0	0	0	0	0	0.08	0	100.61
M07-5	0.15	7.88	5.36	33.11	48.65	0.41	3.77	0	0	0	0	0.07	0	0	0.11	0	99.51
M07-5	0.15	7.73	5.08	32.83	50.24	0.44	3.88	0	0.05	0	0.05	0	0	0	0.06	0	100.51
M07-5	0.09	7.91	5.69	32.80	48.92	0.47	4.01	0.05	0	0	0	0	0.01	0	0.05	0	100.00
M07-5	0.14	7.9	4.99	32.71	49.00	0.55	3.85	0.01	0	0	0.07	0	0.03	0	0.11	0.02	99.38
M07-5	0.16	7.71	5.14	32.21	49.02	0.59	3.96	0.06	0	0	0.05	0	0	0	0.02	0	98.92
M07-5	0.06	7.9	5.05	32.33	49.20	0.44	4.04	0.08	0	0	0	0	0	0	0.07	0	99.17
M07-5	0.07	7.86	5.18	32.94	49.28	0.52	3.69	0.02	0	0.02	0.01	0.07	0	0	0.03	0	99.68
M07-5	0.15	7.81	5.49	32.94	48.83	0.53	3.74	0	0	0.03	0.07	0.08	0.07	0	0.03	0	99.77
M04-111	0.07	10.91	2.79	34.65	46.30	0.74	3.29	0.01	0.19	0.02	0.07	0	0	0	0.05	0.17	99.26
M04-111	0.16	10.34	3.26	35.43	45.97	0.68	3.28	0	0	0.01	0.15	0	0.1	0	0.08	0	99.45
M04-111	0.08	10.86	2.75	35.83	45.64	0.76	3.1	0.06	0	0	0	0	0	0	0.02	0	99.10
M04-111	0.14	11.31	2.84	36.11	44.44	0.8	3.17	0.05	0	0	0	0	0	0	0	0.04	98.90
M04-111	0.04	10.35	2.87	34.31	44.98	0.78	3.06	0.13	0.05	0	0.03	0	0.01	0	0.12	0.02	96.76
M04-111	0.16	11.04	2.77	35.82	45.43	0.82	3.19	0.05	0.01	0.01	0	0.02	0	0	0	0.14	99.46
M04-111	0.1	11.39	2.59	35.26	46.12	0.94	3.2	0.01	0.22	0	0.01	0	0	0	0	0.11	99.95
M04-111	0.12	10.31	2.93	34.96	47.30	0.87	3.34	0.08	0.06	0	0.11	0.02	0.02	0	0.14	0	100.26
M04-111	0.17	11.05	2.79	35.36	46.24	0.99	3.13	0.03	0.17	0	0.06	0	0.03	0	0.05	0.11	100.18
M04-111	0.11	7.86	3.32	32.83	51.17	0.84	3.23	0.06	0	0.07	0	0	0	0	0.04	0	99.54
M04-107	0.01	7.99	3.44	33.59	50.78	0.64	3.01	0.1	0	0	0	0	0.02	0	0.14	0	99.72
M04-107	0.04	7.86	3.32	33.03	51.65	0.58	3.37	0.02	0	0.01	0.04	0.01	0	0	0	0.13	100.06
M04-107	0	7.92	3.24	32.86	51.00	0.69	3.24	0.11	0	0	0	0.05	0	0	0	0	99.11
M04-107	0.05	7.64	3.38	32.99	51.72	0.77	3.24	0.01	0	0	0.17	0	0	0	0.08	0	100.05
M04-107	0.14	7.97	3.2	33.37	50.56	0.74	3.11	0.02	0	0	0	0.02	0	0	0.04	0	99.17
M04-107	0.13	7.84	3.47	33.26	50.88	0.71	3.23	0.01	0	0	0.1	0.04	0.05	0	0	0	99.73
M04-107	0.08	8.03	3.53	32.92	50.42	0.9	3.22	0.06	0	0	0.17	0.08	0.07	0	0.12	0.23	99.83
M04-107	0.14	7.87	3.42	32.29	52.19	0.58	3.3	0.04	0.27	0.01	0	0.05	0.01	0	0.07	0	100.24
M04-107	0.05	7.61	3.62	32.73	51.34	0.76	3.28	0	0	0.03	0.03	0	0	0	0	0	99.45
M04-107	0	7.83	3.2	32.55	51.46	0.62	3.24	0.07	0.09	0	0	0	0	0	0.21	0.03	99.30
M04-108	0.01	7.75	3.41	33.28	51.29	0.59	3.07	0	0	0	0.04	0	0	0	0	0.1	99.54
M04-108	0.02	7.92	3.33	32.77	51.23	0.71	3.27	0	0.06	0.02	0.03	0.01	0.02	0	0.12	0	99.51
M04-108	0	7.98	3.2	33.17	51.29	0.77	3.21	0.02	0	0	0	0	0.03	0	0.02	0	99.69
M04-108	0.06	7.86	3.48	32.85	52.16	0.66	3.19	0.01	0.15	0.03	0.07	0.04	0.02	0	0	0	100.58
M04-108	0.02	7.77	3.26	32.17	52.31	0.65	3.31	0	0.2	0	0	0	0.01	0	0.05	0	99.75
M04-108	0	9.56	3.13	33.87	47.34	0.51	2.73	0.95	0	0.05	0.91	0	0.07	0	0.06	0.07	99.25

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-108	0.01	7.96	3.26	32.20	53.15	0.68	3.39	0	0.28	0	0	0.17	0.05	0	0	0	101.15
M04-108	0.15	7.88	3.24	33.28	51.45	0.78	3.17	0	0	0.05	0.01	0.01	0	0	0	0.06	100.07
M04-108	0.05	7.89	3.3	33.41	51.53	0.61	3.25	0	0	0	0	0	0	0	0	0	100.04
M04-108	0.03	7.8	3.27	33.05	51.64	0.66	3.13	0.01	0	0.02	0	0.02	0	0	0.15	0.34	100.11
M05-75	0.09	8.67	2.48	34.71	50.47	1.16	2.44	0	0	0.02	0	0.02	0.03	0	0.09	0	100.17
M05-75	0	8.46	2.46	34.17	50.75	0.95	2.55	0.01	0	0.02	0	0	0.06	0	0.06	0.05	99.54
M05-75	0.08	8.77	2.41	34.77	50.29	0.94	2.48	0.04	0	0.04	0.12	0.05	0.01	0	0.12	0	100.12
M05-75	0.13	8.31	2.34	33.93	50.53	1	2.55	0.03	0	0	0	0.09	0	0	0.09	0.16	99.16
M05-75	0.02	8.37	2.17	34.10	50.95	0.95	2.51	0	0	0	0	0	0	0	0.05	0.05	99.17
M05-75	0.08	8.57	2.39	34.21	50.97	0.8	2.44	0.09	0.09	0	0	0.02	0.02	0	0	0.23	99.90
M05-75	0.1	8.13	2.16	30.17	51.62	0.8	2.22	3.41	0	0.04	3.36	0	0.09	0	0	0.16	102.26
M05-75	0.18	8.66	2.45	34.47	50.26	1.07	2.63	0.01	0.01	0.01	0.06	0	0	0	0	0	99.80
M05-75	0.15	8.73	2.43	33.71	50.75	1.08	2.5	0.05	0.19	0	0.15	0.02	0.02	0	0.11	0.24	100.13
M05-75	0.1	8.34	2.65	33.57	50.76	0.74	2.96	0.11	0	0.02	0	0.01	0	0	0	0.14	99.40
M05-70	0.16	7.9	2.66	33.76	50.69	0.79	2.59	0.01	0	0	0.1	0	0	0	0.04	0.11	98.81
M05-70	0.09	8.02	2.81	32.70	52.20	1.02	2.66	0.07	0.25	0.03	0	0	0	0	0.03	0	99.88
M05-70	0.05	8.15	2.62	33.97	51.49	0.93	2.79	0	0	0	0	0.12	0	0	0.19	0	100.31
M05-70	0.13	8.22	2.7	33.69	51.04	0.84	2.56	0.06	0.09	0	0.01	0.08	0	0	0.03	0.28	99.73
M05-70	0.17	7.94	2.73	32.93	51.13	0.99	2.83	0	0.06	0.07	0	0.05	0	0	0	0.03	98.93
M05-70	0.15	8.16	2.66	33.87	51.72	0.98	2.96	0	0	0.02	0.13	0	0	0	0.07	0	100.72
M05-70	0.05	8.11	2.9	33.82	51.20	0.85	2.82	0.02	0	0	0.12	0	0.04	0	0.04	0.08	100.05
M05-70	0.13	7.9	2.52	31.64	51.97	0.82	2.28	2.32	0	0.04	2.05	0.07	0.07	0	0.09	0.07	101.96
M05-70	0.11	8.24	2.7	34.60	51.24	1	2.44	0.06	0	0.01	0	0.11	0.03	0	0.07	0	100.60
M05-69	0.06	8.98	2.71	31.09	48.10	0.78	2.86	2.08	0	0	2.69	0.05	0.07	0	0	0.21	99.69
M05-69	0.04	7.95	2.33	33.14	50.30	0.86	2.28	0.11	0.05	0.02	0.08	0.07	0.01	0	0	0.09	97.33
M05-69	0	8.21	2.67	33.80	51.93	0.94	2.44	0	0.14	0	0	0	0	0	0	0.1	100.23
M05-69	0.06	8.6	2.83	34.90	50.09	0.72	2.44	0	0	0	0	0	0	0	0	0.17	99.81
M05-69	0	8.01	2.68	33.71	51.12	0.84	2.49	0.04	0	0.07	0	0	0	0	0.04	0	99.00
M05-69	0.11	8.33	2.81	33.73	48.47	0.77	2.52	0	0	0.01	0	0	0	0	0.06	0.02	96.83
M05-69	0.1	6.52	4.84	32.70	51.00	0.34	2.86	0.01	0	0.05	0	0	0	0	0.05	0	98.48
M05-69	0.04	8.29	3	33.01	49.02	0.73	2.63	0.04	0.12	0	0	0	0.01	0	0.02	0	96.91
M05-69	0.11	7.93	2.54	33.65	50.55	0.86	2.51	0.05	0	0	0	0	0	0	0	0	98.20
M05-69	0.09	8.06	2.64	34.46	51.05	0.91	2.31	0	0	0	0	0.18	0	0	0	0.04	99.74
M05-69	0.18	8.14	2.59	34.56	50.69	0.69	2.5	0	0	0	0	0	0.03	0	0.01	0	99.39
M05-69	0	7	4.72	32.98	51.03	0.31	3.06	0.12	0	0	0	0.12	0.02	0	0.05	0	99.41
M05-69	0.02	7.94	2.67	34.50	51.75	0.76	2.36	0.02	0.01	0	0	0	0	0	0.14	0	100.17
M04-115	0.09	7.77	2.42	33.30	51.50	1.09	2.31	0.05	0.09	0	0	0	0.01	0	0.09	0	98.72
M04-115	0	9.63	3.82	33.77	47.50	0.59	3.89	0	0	0.01	0.02	0	0.02	0	0	0.05	99.30

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-115	0.02	9.68	3.75	34.28	47.92	0.73	3.69	0	0.01	0	0	0.1	0.02	0	0.01	0.01	100.22
M04-115	0.09	9.81	3.9	34.15	46.79	0.69	3.81	0	0	0	0	0	0.06	0	0	0.02	99.32
M04-115	0.09	9.7	3.78	34.02	47.41	0.6	3.93	0.02	0	0	0	0	0	0	0.13	0.06	99.74
M04-115	0.09	7.85	3.77	32.72	51.07	0.63	3.48	0.05	0.06	0	0.03	0	0.02	0	0	0	99.76
M04-115	0.1	9.5	4	33.50	48.07	0.7	3.92	0	0.1	0	0.04	0.04	0	0	0.01	0	99.98
M04-115	0.12	9.85	3.65	34.45	47.57	0.67	3.86	0	0	0	0	0.11	0.07	0	0.07	0	100.42
M04-115	0.04	7.25	2.32	33.71	52.96	1.15	2.11	0	0	0	0	0.16	0	0	0.07	0	99.77
M04-115	0.1	7.88	2.34	33.86	51.04	1.01	2.28	0	0	0	0	0	0	0	0.05	0.11	98.66
M04-116	0.07	10.08	1.98	35.87	48.81	1	2.54	0.05	0.01	0	0	0	0	0	0.07	0.16	100.65
M04-116	0.11	9.95	1.89	35.80	48.49	0.9	2.49	0.06	0	0	0	0	0.08	0	0.09	0.13	100.00
M04-116	0.06	9.76	1.9	35.44	48.81	0.95	2.54	0.06	0	0	0.12	0	0.01	0	0.01	0	99.66
M04-116	0.1	10.05	1.87	35.45	48.42	0.92	2.57	0	0.06	0	0	0	0	0	0.13	0.18	99.75
M04-116	0.19	9.87	1.94	35.75	48.44	0.98	2.61	0	0	0	0	0	0	0	0.06	0	99.84
M04-116	0	9.97	1.82	35.61	48.71	0.86	2.42	0.04	0.05	0	0.15	0	0	0	0.01	0	99.64
M04-116	0.04	9.84	1.94	35.71	48.39	0.77	2.42	0.03	0	0	0	0	0	0	0.02	0.11	99.27
M04-116	0.08	9.81	1.83	35.60	48.20	0.9	2.38	0	0.01	0	0.15	0.09	0.03	0	0	0	99.09
M04-116	0.06	10	1.84	35.98	48.47	0.91	2.34	0.01	0	0.04	0	0	0	0	0	0	99.64
M04-24	0.21	6.53	5.23	32.76	50.26	0.3	2.96	0.02	0	0.05	0	0	0	0	0.03	0	98.35
M04-24	0.04	9.64	3.64	33.89	49.34	0.55	3.39	0	0.29	0	0	0	0	0	0.09	0.08	100.95
M04-24	0	6.85	5	32.47	52.26	0.42	3.03	0.03	0.19	0	0	0	0.01	0	0.16	0	100.42
M04-24	0.05	9.22	3.58	34.56	48.29	0.65	3.19	0	0	0	0	0	0.03	0	0.13	0.12	99.82
M04-24	0.01	9.55	3.61	34.88	48.34	0.66	3.32	0.01	0	0	0	0	0	0	0	0.02	100.40
M04-24	0.11	9.43	3.57	34.44	48.47	0.67	3.39	0	0.01	0.06	0.1	0	0.02	0	0.1	0.15	100.52
M04-24	0.08	9.31	3.66	34.50	50.18	0.86	3.4	0	0.12	0	0	0.14	0	0	0.07	0	102.33
M04-24	0.15	6.45	5.69	32.48	51.86	0.37	3.56	0.02	0	0	0.03	0	0.03	0	0.11	0.13	100.88
M04-24	0.13	9.19	3.66	34.19	48.85	0.77	3.44	0.05	0.01	0.03	0.05	0.03	0	0	0.05	0.09	100.54
M04-24	0.02	9.4	3.6	34.94	47.92	0.5	3.16	0	0	0	0.08	0.06	0	0	0.1	0.03	99.81
M04-28	0.07	7.03	3.3	33.34	52.81	0.79	2.66	0.01	0	0	0.06	0	0	0	0.13	0.07	100.27
M04-28	0	6.82	3.24	32.71	53.91	0.8	2.94	0	0	0.01	0	0	0.01	0	0.06	0.04	100.54
M04-28	0.09	6.37	2.75	32.91	54.88	0.59	2.37	0.02	0.07	0.04	0.02	0.02	0	0	0.03	0	100.17
M04-28	0.09	6.86	3.36	32.43	53.54	0.85	2.75	0.03	0.12	0.03	0.04	0	0.03	0	0.12	0.03	100.28
M04-28	0.11	6.83	3.4	33.04	54.15	0.76	2.65	0	0.14	0	0	0	0	0	0.08	0	101.16
M04-28	0	6.69	3.44	32.99	52.76	0.66	2.52	0.05	0	0.01	0	0	0	0	0.12	0	99.24
M04-28	0	6.89	3.42	32.99	52.93	0.65	2.82	0.02	0	0	0	0.05	0	0	0.18	0	99.95
M04-28	0.09	6.96	3.37	33.28	52.91	0.81	2.75	0	0	0	0.11	0.05	0	0	0.17	0	100.50
M04-28	0	6.85	3.69	33.50	53.65	0.76	2.67	0	0	0	0	0	0.04	0	0.09	0.08	101.33
M04-28	0.01	6.92	3.31	32.90	53.50	0.58	2.73	0	0.06	0.05	0	0	0	0	0.04	0	100.11
M04-31	0	7.28	4.36	33.77	51.20	0.45	2.72	0.07	0	0	0	0	0	0	0.06	0.07	99.99

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-31	0.19	6.83	4.41	33.10	51.95	0.71	2.85	0.09	0	0.06	0	0	0.01	0	0.04	0	100.24
M04-31	0.22	7.16	4.43	34.11	50.97	0.44	2.8	0	0	0	0.02	0.07	0	0	0.19	0	100.41
M04-31	0.12	7.06	4.33	33.72	52.01	0.54	2.63	0	0.05	0.02	0	0	0	0	0.04	0.14	100.66
M04-31	0.09	7.49	3.91	33.11	51.57	0.66	3.15	0	0	0.03	0	0	0	0	0.09	0.19	100.28
M04-31	0	6.45	2.68	33.32	55.21	0.8	2.36	0	0	0	0	0	0	0	0.08	0.04	100.94
M04-31	0.21	6.86	4.57	33.57	51.60	0.67	2.73	0.04	0	0	0.15	0	0	0	0.05	0.14	100.60
M04-31	0.07	7.26	4.45	34.03	51.12	0.54	2.62	0.1	0	0	0.04	0	0	0	0.02	0	100.25
M04-31	0.08	7.05	4.44	33.45	51.59	0.63	2.8	0.04	0	0	0.02	0	0	0	0.09	0.13	100.32
M04-31	0	6.96	4.22	33.38	51.51	0.62	2.58	0	0	0.02	0	0.01	0.03	0	0.03	0	99.36
M04-36	0.05	7.35	2.02	33.77	54.12	1.36	1.74	0.02	0.15	0	0	0	0	0	0.07	0	100.65
M04-36	0.12	7.75	1.96	34.45	53.49	1.22	1.7	0.02	0.14	0	0.11	0.09	0	0	0	0.13	101.18
M04-36	0	7.37	1.99	34.68	53.20	1.12	1.49	0	0	0	0.11	0	0.01	0	0.07	0.17	100.21
M04-36	0.2	7.79	1.98	34.87	52.31	1.18	1.82	0	0	0.03	0.18	0.12	0	0	0.07	0.03	100.58
M04-36	0	7.82	1.92	35.06	52.82	1.07	1.52	0.04	0.01	0.03	0	0	0	0	0.06	0.14	100.49
M04-36	0.05	7.17	1.92	33.39	54.79	1.22	1.66	0.02	0.22	0	0.02	0	0	0	0	0.14	100.60
M04-36	0.05	7.74	2.07	34.82	52.69	1.18	1.77	0.03	0	0	0	0.08	0.03	0	0	0	100.46
M04-36	0.15	7.65	2.04	34.31	52.75	1.29	1.56	0.05	0.13	0	0.01	0.04	0	0	0	0.08	100.05
M04-36	0.01	7.53	2.02	34.20	53.25	1.27	1.9	0	0	0.02	0	0.01	0	0	0	0	100.21
M04-36	0	7.65	2.06	34.11	53.17	1.27	1.64	0.02	0.13	0.01	0	0.18	0.01	0	0	0	100.24
M04-39	0	7.73	2.39	34.21	52.10	0.94	2.07	0.01	0	0	0	0.04	0	0	0	0.17	99.67
M04-39	0.11	6.59	2.94	33.52	53.77	0.97	2.14	0.02	0	0.01	0	0.03	0.07	0	0	0	100.16
M04-39	0.14	7.76	2.12	34.26	51.98	1.16	2.09	0	0	0	0.06	0	0.02	0	0.03	0.03	99.65
M04-39	0.18	7.82	2.38	34.69	51.77	1.1	2.05	0.05	0	0	0.11	0	0	0	0.12	0	100.28
M04-39	0.18	7.81	2.29	34.82	51.88	1.04	1.87	0	0	0.01	0.22	0.17	0	0	0.06	0.23	100.58
M04-39	0.1	7.53	2.24	34.06	52.59	1.07	2.12	0	0.01	0.02	0.06	0	0	0	0.06	0	99.86
M04-39	0.1	7.87	2.29	34.63	52.13	1.12	1.95	0	0	0	0.13	0	0	0	0.09	0.28	100.59
M04-39	0.02	7.96	2.32	34.57	51.68	1.26	1.91	0	0	0	-0.1	0	0.05	0	0	0	99.68
M04-39	0.04	7.5	2.26	34.04	52.48	1.18	1.92	0.05	0	0.01	0.12	0.04	0	0	0.03	0.05	99.72
M04-39	0.07	7.29	2.38	34.03	53.24	1	1.89	0	0.1	0	0.01	0	0.03	0	0.17	0	100.21
M05-34	0.02	7.58	2.76	33.38	51.63	0.89	2.53	0	0	0.02	0.17	0	0.02	0	0.16	0.07	99.23
M05-34	0.11	7.75	2.39	33.04	51.30	0.89	2.38	0.1	0.06	0.07	0.14	0	0	0	0.05	0.07	98.35
M05-34	0.03	7.62	2.39	32.96	53.88	1.07	2.32	0.02	0.26	0	0	0	0	0	0.01	0	100.56
M05-34	0.11	6.74	4.4	33.64	52.95	0.58	2.48	0.01	0.11	0	0.06	0	0.01	0	0.05	0.04	101.17
M05-34	0.05	6.77	4.2	33.41	52.27	0.58	2.5	0.03	0	0.06	0.12	0.05	0	0	0.05	0.08	100.18
M05-34	0.12	7.08	1.66	34.35	53.86	1.13	1.57	0.06	0.01	0	0.09	0.12	0	0	0	0	100.05
M05-34	0.1	7.97	3.34	33.81	50.36	0.58	2.67	0	0	0.06	0.07	0	0.06	0	0	0.21	99.22
M05-34	0.05	7.27	2.99	33.91	53.02	0.81	2.46	0	0	0	0.07	0	0.02	0	0.09	0.09	100.78
M05-34	0.01	7.75	2.38	34.27	52.82	1.03	2.3	0.01	0	0	0.12	0	0	0	0.03	0	100.72

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M05-34	0.1	5.7	2.61	33.21	55.83	0.96	1.79	0.06	0	0	0.12	0	0	0	0	0	100.38
M05-34	0.07	7.64	2.52	34.09	52.06	0.88	2.27	0.05	0	0	0.17	0.12	0.05	0	0.1	0.07	100.09
M05-34	0.09	7.01	4.26	33.94	51.74	0.39	2.65	0.04	0	0	0	0	0	0	0	0	100.12
M05-34	0.15	7.88	2.36	35.07	52.41	0.89	2.15	0.02	0	0	0.1	0	0	0	0.11	0	101.14
M05-34	0.13	7.96	2.45	34.59	51.54	1.02	2.2	0	0	0	0	0	0	0	0	0	99.89
M05-34	0	7.8	2.49	33.52	53.04	0.79	2.36	0.08	0.13	0	0.09	0	0	0	0	0.28	100.57
M05-37	0.13	6.44	2.97	31.57	54.62	0.55	3.35	0.09	0.05	0	0	0.07	0	0	0.11	0.11	100.06
M05-37	0.04	6.56	3.11	31.43	53.57	0.6	3.33	0	0	0.04	0	0.07	0	0	0.02	0.08	98.85
M05-37	0.16	6.82	4.26	32.35	52.78	0.63	3.55	0	0.01	0.03	0.07	0	0	0	0.18	0	100.84
M05-37	0	6.47	2.77	32.98	55.02	0.73	2.51	0.02	0	0	0	0	0.02	0	0.05	0.16	100.73
M05-37	0.11	6.53	3.1	32.18	54.22	0.69	3.14	0.03	0	0	0.08	0	0	0	0.08	0.11	100.27
M05-37	0.12	6.69	2.99	32.07	53.95	0.58	3.08	0.1	0.07	0	0.01	0	0.05	0	0.07	0.05	99.83
M05-37	0.01	6.67	2.87	32.61	54.04	0.66	2.63	0.05	0	0.06	0.02	0.08	0	0	0.01	0.11	99.82
M05-37	0.13	6.7	3.25	32.55	54.25	0.63	3.32	0	0	0	0	0.01	0.04	0	0.09	0	100.97
M05-37	0	6.37	3.28	32.52	55.03	0.8	2.83	0	0	0.03	0.01	0	0.06	0	0.05	0.06	101.04
M05-33	0.12	6.39	5.72	32.32	52.39	0.47	3.14	0.08	0.14	0	0	0.01	0	0	0.09	0.13	101.00
M05-33	0.59	6.27	7.07	32.62	50.65	0.24	4.29	0	0	0	0	0.04	0.06	0	0.11	0	101.94
M05-33	0.01	6.62	5.43	32.86	51.54	0.42	3.18	0.05	0	0	0.01	0.06	0.04	0	0.16	0	100.38
M05-33	0.08	6.52	5.47	32.78	52.18	0.59	3.25	0	0	0.06	0.07	0	0.04	0	0.32	0	101.37
M05-33	0.14	6.5	5.46	32.41	51.08	0.51	3.14	0.08	0	0.03	0	0	0	0	0.04	0.14	99.53
M05-33	0.14	6.44	5.33	32.79	51.61	0.36	3.19	0.02	0	0	0.07	0	0.06	0	0.13	0.1	100.24
M05-33	0.15	6.85	5.23	32.94	50.95	0.45	3.3	0.02	0	0	0.12	0	0.04	0	0.18	0.07	100.30
M05-33	0.07	6.51	5.42	32.91	52.24	0.33	3.29	0	0	0.03	0.07	0.01	0	0	0.14	0.05	101.07
M05-39	0.14	7.49	1.82	34.53	53.39	1.45	1.69	0.05	0	0.01	0	0.06	0	0	0	0	100.63
M05-39	0.07	7.52	2.07	34.25	53.09	1.3	1.86	0	0	0	0	0.09	0.03	0	0.06	0.19	100.53
M05-39	0.14	7.72	2.05	34.10	53.60	1.21	1.83	0.07	0.18	0	0.01	0.07	0.04	0	0	0.06	101.08
M05-39	0.04	7.75	2.06	34.52	52.89	1.27	1.89	0.04	0	0.02	0.09	0	0.01	0	0.03	0	100.61
M05-39	0.26	7.91	2.1	34.15	53.70	1.27	1.8	0	0.26	0.01	0.23	0.11	0.04	0	0.04	0.33	102.21
M05-39	0	7.47	1.91	33.35	54.87	1.23	1.72	0.04	0.24	0.06	0.05	0	0	0	0	0.14	101.09
M05-39	0.06	7.91	2.11	34.29	53.59	1.23	1.67	0.06	0.19	0.05	0.05	0.15	0	0	0.04	0.11	101.51
M05-39	0.02	7.6	2.06	34.50	53.31	1.41	1.75	0.04	0	0.02	0	0.11	0.01	0	0.04	0	100.87
M05-40	0.11	7.42	2.09	33.93	53.15	1.27	2.09	0.04	0	0	0	0	0	0	0	0	100.10
M05-40	0.11	7.39	2.11	34.07	53.60	1.25	1.97	0.06	0	0.04	0.09	0	0	0	0.01	0.09	100.79
M05-40	0.14	6.91	2.06	33.24	53.80	1.13	1.76	0	0.11	0.07	0.28	0.12	0.08	0	0	0	99.70
M05-40	0.08	7.57	2.07	34.30	53.33	1.15	1.97	0	0	0.01	0	0	0	0	0	0.25	100.73
M05-40	0	7.48	2.04	33.34	54.18	1.3	1.97	0	0.19	0	0.02	0	0	0	0	0	100.53
M05-40	0.14	7.35	2.24	34.42	53.37	1.25	1.94	0	0	0	0	0.04	0.03	0	0	0	100.79
M05-40	0.03	7.47	2.01	33.06	53.88	1.37	1.86	0	0.23	0.02	0.04	0.04	0.03	0	0.01	0	100.05

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M05-40	0	7.38	2.19	33.91	53.30	1.4	1.91	0.05	0	0	0	0	0	0	0	0	100.15
M05-43	0.16	7.06	2.3	33.83	54.03	1.01	2.17	0	0.01	0.06	0	0	0.02	0	0	0	100.65
M05-43	0.07	7.88	2.35	34.70	52.55	1.13	2.11	0.03	0	0	0.04	0	0	0	0	0	100.86
M05-43	0.02	7.69	2.19	33.89	51.65	0.94	2.12	0.01	0	0.01	0	0.08	0	0	0.03	0	98.63
M05-43	0.01	7.71	2.19	34.16	53.02	1.08	2.12	0.03	0	0.04	0.15	0.01	0	0	0.09	0.11	100.72
M05-43	0.02	7.74	2.17	34.29	52.41	0.97	2.14	0	0	0	0	0	0.02	0	0.02	0	99.78
M05-43	0.05	6.57	5.49	32.63	51.74	0.36	3.29	0.13	0	0.05	0	0	0.03	0	0.29	0	100.63
M05-43	0.12	6.47	5.4	32.06	52.37	0.4	3.42	0	0.11	0	0	0	0	0	0.07	0.13	100.56
M05-43	0.13	6.5	5.36	32.92	51.75	0.42	3.22	0	0	0	0.07	0	0.01	0	0.04	0	100.41
M05-43	0.07	6.64	5.11	32.41	52.32	0.47	3.22	0.03	0.1	0	0.02	0	0	0	0.09	0.06	100.54
M05-43	0.11	6.17	4.82	32.79	53.26	0.42	3.09	0.05	0	0.01	0	0	0	0	0.23	0	100.95
M05-43	0.02	6.48	5.36	32.61	51.88	0.41	3.16	0.01	0	0.04	0	0	0	0	0	0	99.98
M05-43	0.07	6.5	5.34	32.68	51.60	0.39	3.15	0.09	0	0.01	0.06	0	0.02	0	0	0	99.91
M04-52	0.15	6.01	3.93	32.71	53.66	0.41	2.82	0	0	0	0.11	0	0	0	0.15	0	99.95
M04-52	0	5.97	3.98	32.22	54.17	0.55	2.89	0	0	0	0.11	0.07	0.01	0	0.11	0.04	100.13
M04-52	0.04	5.04	2.62	31.58	57.23	1.33	2.12	0.05	0	0	0	0.06	0.01	0	0.04	0	100.12
M04-52	0.1	6.33	3.4	32.65	54.40	0.67	2.82	0.11	0	0	0	0	0.03	0	0	0	100.51
M04-52	0.06	6.21	3.51	32.35	54.01	0.63	2.72	0.07	0.01	0.03	0	0	0.03	0	0.07	0.02	99.72
M04-52	0.09	6.32	3.68	32.26	53.49	0.6	2.81	0.08	0	0.05	0	0	0	0	0	0.08	99.46
M04-52	0.06	6.39	3.9	32.70	52.91	0.54	2.69	0	0	0	0	0.04	0	0	0.04	0.17	99.44
M04-52	0.07	6.15	3.55	32.60	53.59	0.52	2.62	0.08	0	0	0.11	0.08	0	0	0.12	0	99.50
M04-52	0.05	5.82	4.29	32.12	53.73	0.58	2.66	0.08	0.01	0.02	0	0	0	0	0.02	0.12	99.50
M04-52	0.11	6.52	3.24	32.46	54.10	0.69	2.91	0.06	0	0.05	0.01	0.03	0.01	0	0	0	100.20
M04-51	0.11	7.21	2.03	33.84	52.91	1.2	1.62	0.16	0.01	0.06	0	0.05	0.12	0	0	0.04	99.36
M04-51	0.16	6.92	1.96	33.31	53.10	1.04	2.01	0	0	0.02	0.04	0	0.09	0	0	0.09	98.74
M04-51	0.06	8.25	2.08	34.32	49.94	1.12	1.78	0.14	0	0.03	0.03	0	0	0	0	0	97.75
M04-51	0.01	10.1	0.9	36.87	48.27	1.45	1.22	0.05	0	0	0.01	0	0.01	0	0.07	0	98.95
M04-51	0.16	7.55	2.08	34.06	52.20	1.4	1.86	0.09	0	0	0.12	0	0	0	0.01	0.01	99.55
M04-51	0.04	7.44	2	33.29	53.54	1.22	1.84	0	0.15	0.04	0.01	0	0	0	0	0.16	99.73
M04-51	0.05	7.64	2.06	34.16	52.36	1.27	1.82	0.07	0.01	0	0	0.07	0.03	0	0	0.04	99.57
M04-51	0.08	8.27	0.83	35.66	52.11	1.14	1.02	0	0.07	0	0.09	0	0.01	0	0	0.06	99.34
M04-51	0	8.48	0.96	35.52	51.77	1.29	1.26	0	0	0.04	0	0	0	0	0	0	99.31
M04-51	0	4.6	0.97	32.14	59.97	1	0.77	0	0.22	0.02	0.12	0.04	0.09	0	0.01	0.07	100.03
M04-53	0.09	6.43	3.43	32.60	54.51	0.58	2.54	0.06	0.16	0	0.08	0	0	0	0	0.01	100.49
M04-53	0.09	8.92	2.37	36.04	49.90	0.93	1.91	0	0	0	0.01	0.03	0	0	0.02	0.01	100.23
M04-53	0	6.86	2.63	32.61	55.02	0.8	2.45	0	0.16	0.05	0.07	0	0	0	0	0.04	100.69
M04-53	0.04	6.46	3.03	33.40	53.12	0.55	2.11	0	0	0	0.04	0	0	0	0.12	0.09	98.96
M04-53	0.15	6.49	2.77	33.50	54.29	0.69	2.38	0	0	0	0	0	0.03	0	0.07	0	100.38

Sample	SiO2	TiO2	Al2O3	FeO	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	V2O3	Cr2O3	NiO	TOTAL
M04-53	0.06	7.87	2.68	34.15	50.30	0.46	2.31	0.01	0	0	0.03	0	0	0	0.01	0.08	97.96
M04-53	0.06	6.95	2.74	32.71	53.36	0.85	2.3	0	0.13	0.05	0.01	0	0.03	0	0.08	0.01	99.27
M04-53	0.09	7.24	2.71	34.57	52.31	0.57	1.98	0.03	0	0	0.02	0	0.03	0	0.06	0	99.61
M04-53	0.1	6.41	2.97	33.65	53.36	0.58	1.91	0.05	0.01	0	0	0	0	0	0	0.11	99.15
M04-53	0.09	6.78	2.81	32.58	54.47	0.89	2.27	0.01	0.15	0.04	0.08	0	0.02	0	0	0.35	100.54
M04-54	0.12	6.84	1.8	34.29	54.00	0.99	1.59	0.02	0	0	0	0	0.06	0	0	0	99.71
M04-54	0.09	5.73	2.95	32.34	55.15	0.79	2.4	0.01	0	0	0.05	0	0	0	0.04	0	99.55
M04-54	0.18	6.25	3.02	33.71	54.19	0.8	1.93	0.02	0	0.03	0.08	0	0.05	0	0	0.09	100.35
M04-54	0.09	6.4	2.56	33.19	54.75	0.72	2.36	0.05	0	0	0	0	0.02	0	0.12	0.03	100.29
M04-54	0.09	6.71	1.88	33.33	55.02	0.79	2.19	0.02	0	0	0.04	0	0	0	0.03	0.33	100.43
M04-54	0.14	6.65	2.58	34.23	53.88	0.74	1.67	0.09	0.05	0	0	0	0	0	0	0	100.03
M04-54	0.09	6.58	1.86	33.57	55.10	1.01	1.69	0.07	0.05	0	0.02	0	0.03	0	0	0.17	100.24
M04-54	0.16	7.87	3.74	36.10	49.37	0.33	1.64	0	0	0	0	0	0.06	0	0.14	0.1	99.50
M04-54	0.07	6.79	2.37	33.89	54.19	0.69	2.07	0	0	0	0	0	0.03	0	0.01	0.17	100.28
M04-54	0	5.42	2.74	33.08	56.14	0.66	1.72	0.02	0	0.02	0.08	0	0	0	0.11	0.08	100.06
M04-56	0.07	7.97	2.3	35.69	52.50	0.62	1.81	0.02	0	0.03	0	0.08	0	0	0.01	0.07	101.17
M04-56	0.05	8.78	4.01	33.15	48.41	0.68	3.77	0	0	0	0	0	0	0	0.09	0	98.94
M04-56	0.01	8.2	2.4	35.87	51.90	0.71	1.85	0	0	0	0	0	0.07	0	0.15	0	101.16
M04-56	0.16	6.92	2.72	34.03	53.10	0.84	2.08	0	0	0	0.08	0	0	0	0.02	0.06	100.02
M04-56	0.12	9.88	2.03	36.59	48.37	1.07	1.98	0.01	0	0	0.05	0	0	0	0	0.04	100.13
M04-56	0.14	7.6	2.65	34.69	52.46	0.79	2.2	0.06	0	0	0.15	0.01	0.04	0	0.02	0	100.81
M04-56	0	6.69	2.45	33.62	53.85	0.74	1.86	0	0	0.03	0	0	0.05	0	0.04	0.22	99.54
M04-56	0.07	8.07	2.63	35.39	51.52	0.58	2.08	0	0	0.01	0.11	0	0.01	0	0	0	100.47
M04-56	0.14	6.54	2.64	32.98	55.10	0.74	2.24	0.16	0.13	0.02	0	0	0.08	0	0.02	0	100.80
M04-56	0.15	3.7	3.14	30.74	59.15	0.91	1.83	0.1	0.13	0	0	0	0	0	0.03	0.05	99.93
M04-57	0.09	6.59	4.16	32.93	52.82	0.52	2.95	0.05	0	0	0.02	0	0.05	0	0.04	0	100.22
M04-57	0.13	7.61	2.26	34.19	52.25	0.84	2.29	0	0	0	0.04	0	0	0	0.06	0.01	99.67
M04-57	0.17	8.26	2.2	34.80	52.05	0.89	2.26	0	0.09	0	0.1	0	0.04	0	0.04	0	100.90
M04-57	0	7.69	1.92	34.26	53.30	0.96	2.17	0	0	0	0	0	0	0	0	0.07	100.37
M04-57	0.09	7.66	2.08	33.94	52.60	0.85	2.4	0	0	0	0	0.05	0.02	0	0.09	0.1	99.88
M04-57	0.12	6.6	4.06	32.79	53.29	0.6	3.13	0	0	0	0	0.05	0.04	0	0	0.02	100.71
M04-57	0.09	7.76	2.56	34.26	52.70	0.98	2.4	0.02	0.01	0	0	0	0	0	0	0.08	100.86
M04-57	0.15	6.87	4.22	33.44	52.41	0.56	2.9	0.07	0	0	0.02	0	0	0	0	0	100.64
M04-57	0.08	7.5	2.27	35.38	53.11	0.82	1.61	0.05	0	0	0.02	0	0	0	0.1	0.08	101.02
M04-57	0.12	7.73	2.57	33.68	52.73	0.88	2.81	0.04	0	0	0.04	0	0	0	0	0.1	100.70

Appendix 6: Whole-rock geochemistry:

XRF

Rock samples were prepared for analysis in a uniform manner to ensure internal consistency. Clean rock fragments were soaked in distilled water, rinsed and dried. These clean fragments were crushed between tungsten carbide plates and a 100g aliquot of each sample ground to <200 mesh in a tungsten carbide ring grinder. Samples were prepared for XRF analysis as fused glass discs. The flux used was La-free 1220 flux from Spectrochem. Major and trace element concentrations were determined by X-ray fluorescence using standard techniques using a SRS3000 spectrometer. Matrix correction procedures for major elements followed Norrish and Hutton (1969). A suite of 36 international standards were used for calibration. Data reduction used Siemens SPECTRA 3000 software; the Compton scatter of X-ray tube line Rh K β_1 was used to correct for mass attenuation and appropriate corrections were used for those elements analysed at energies below the Fe absorption edge. Precision is better than 1% for Sr and Zr, 1-3% for V, Cr, Zn and Y, 3-5% for Ba, 5-10% for Rb and Nb, 10-20% for Pb and more than 20% for La and Th. Detection limits are <2ppm for Rb, Sr, Y, Zr and Nb, 2-5ppm for V, Cr, Zn, La, Pb, and Th, 5-10ppm for Ba.

Laser Ablation ICP-MS

Trace elements of representative samples from each unit were analysed by (LA-ICP-MS; Australian National University) using a 54 μm laser spot on polished XRF fused glass discs. The system used was an 'EXCIMER laser systems', operating deep in the ultra-violet spectrum at a wavelength of 193nm and capable of ablating silicate, oxide and sulphide phases. It was used in tandem with the ICP-MS instruments for precision microsampling and analysis.

During analyses of over 300 samples (from volcanoes of the Tonga-Kermadec Arc, Smith I.E.M pers. comm. 2005); after every 10 analyses a standard of NIST 612 was run and to minimise 'machine drift' a linear interpolation of the counts between two standards that bracket the set of unknowns of interest was employed (Pearce et al. 1997). ^{29}Si concentrations obtained by the XRF method was chosen to act as the internal standard for the LA-ICP-MS analyses to account for any variation in ablation yield between samples and calibration standards and the 'matrix effect' of variations between counts per second and ppm of different elements (Perkins and Pearce, 1995). During the course of the analyses period, BCR – 2 glass standard was also analysed (every 20 analyses) to provide an independent calibration

An initial La anomaly within the XRF fused glass disks was later found to be the result of La contamination in the Spectrochem flux supplied. The La contamination was homogeneous throughout the flux therefore a correction factor of 19.6 was used.

Sample notes:

There are additional samples within the 'whole-rock data – calibration sheets' excel file that are samples taken from lava-flow fields. The enclosed text files contain the location details of each of these samples: M05 – 1 to 6; and E03 – xx.

Please note, however, that these analyses have not been included within the discussion of the thesis (i.e. tephra – whole rock excel file). In addition, samples EB and E02-173 are samples of the ‘Curtis Ridge lithic lapilli eruption episode’ (see Chapter 5).

Cited references:

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USGS recommended BCR2 Values:

http://minerals.cr.usgs.gov/geo_chem_stand/basaltbcr2.html

Sample no.	E02-79	E02-80	E02-82	M04-141	M04-52	M04-57	M04-147	M04-71	M04-59	M04-67	M04-69
Approximate Age	1400	1600	1600?	<1400	300	500-800	1400	1700	800	1500	1500-1600
Batch no.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO2	55.17	54.23	53.22	55.39	55.30	55.51	57.26	53.76	56.69	54.15	55.47
TiO2	0.89	0.91	0.89	0.81	0.77	0.81	0.75	0.83	0.78	0.89	0.78
Al2O3	17.03	17.38	17.25	18.64	17.14	18.04	17.53	16.93	17.56	17.27	17.63
Fe2O3	8.11	8.24	8.51	7.52	7.21	6.91	6.21	8.47	6.57	8.47	7.36
MnO	0.17	0.16	0.17	0.16	0.15	0.15	0.15	0.17	0.15	0.17	0.17
MgO	3.42	3.41	3.69	2.69	3.56	2.40	2.21	4.39	2.39	3.53	2.94
CaO	7.55	7.58	8.28	8.15	7.85	6.68	6.34	9.06	6.66	8.27	7.86
Na2O	3.71	3.64	3.51	3.74	3.62	3.91	4.00	3.46	3.94	3.62	3.85
K2O	2.47	2.35	2.15	2.13	2.63	2.74	2.98	1.89	2.89	2.24	2.24
P2O5	0.27	0.29	0.26	0.29	0.27	0.33	0.28	0.23	0.30	0.26	0.26
H2O	0.06	0.25	0.21	0.20	0.17	0.45	0.56	0.20	0.15	0.05	0.05
LOI	0.47	0.99	1.02	-0.13	0.71	1.64	0.96	0.31	1.20	0.34	0.31
Total	99.30	99.43	99.17	99.59	99.37	99.58	99.20	99.70	99.26	99.25	98.94
Sc	20.00	21.00	19.00	12.80	20.00	15.00	12.00	23.00	12.00	18.00	16.00
V	224.00	235.00	232.00	202.30	202.00	185.00	169.80	226.00	175.00	228.00	186.00
Cr	8.00	7.00	20.00	8.30	41.00	4.00	7.80	64.00	0.00	14.00	9.00
Ni	3.00	3.00	1.00	4.00	10.00	0.00	3.60	16.00	0.00	4.00	1.00
Cu	92.00	99.00	71.00	35.50	92.00	84.00	60.60	83.00	71.00	84.00	45.00
Zn	88.00	89.00	85.00	70.10	81.00	83.00	70.90	84.00	80.00	87.00	85.00
Ga	18.00	19.00	19.00	21.80	23.00	24.00	20.70	22.00	19.00	18.00	19.00
Rb	64.00	60.00	54.00	50.70	67.00	70.00	73.90	45.00	76.00	56.00	56.00
Sr	576.00	591.00	594.00	702.90	583.00	692.00	645.80	598.00	677.00	601.00	648.00
Y	23.00	24.00	23.00	23.80	22.00	24.00	24.20	21.00	25.00	24.00	24.00
Zr	132.00	133.00	117.00	113.10	134.00	153.00	156.30	105.00	153.00	117.00	123.00
Nb	5.03	5.06	4.35	4.13	5.16	6.18	5.84	4.14	5.60	4.30	4.41
Cs	3.41	3.01	2.69	1.85	3.92	3.74	4.05	2.64	3.72	2.82	3.03
Ba	840.64	801.84	761.39	763.43	972.32	1037.04	1020.78	704.28	945.10	765.98	764.37
La	13.50	18.00	16.99	25.01	20.51	22.79	23.91	15.45	20.17	15.16	15.91
Ce	35.49	34.55	30.73	30.05	38.72	43.98	42.67	30.63	40.91	31.59	32.75
Pr	4.50	4.41	3.96	3.84	4.84	5.46	5.23	3.99	5.05	4.03	4.21
Nd	19.74	19.57	17.87	17.24	20.28	23.30	22.43	17.47	21.39	17.91	18.42
Sm	4.49	4.37	4.12	4.08	4.62	5.16	4.73	4.10	4.82	4.12	4.26
Eu	1.30	1.26	1.20	1.26	1.27	1.34	1.34	1.20	1.28	1.22	1.24
Gd	4.49	4.28	4.06	4.15	4.12	4.79	4.40	4.13	4.33	4.02	4.23
Tb	0.72	0.70	0.68	0.67	0.69	0.73	0.71	0.68	0.70	0.67	0.67
Dy	3.86	3.88	3.77	3.79	3.95	4.11	3.83	3.71	3.75	3.69	3.78
Ho	0.79	0.82	0.76	0.78	0.78	0.81	0.83	0.78	0.75	0.76	0.79
Er	2.27	2.25	2.19	2.17	2.23	2.28	2.22	2.17	2.23	2.22	2.26
Tm	0.33	0.31	0.29	0.29	0.30	0.31	0.29	0.31	0.30	0.31	0.31
Yb	2.16	2.05	1.97	2.08	2.16	2.26	2.21	2.07	2.03	2.02	2.07
Lu	0.33	0.32	0.30	0.31	0.33	0.36	0.33	0.34	0.32	0.29	0.32
Hf	3.58	3.62	3.22	3.28	4.22	4.60	4.43	3.19	4.10	3.05	3.12
Ta	0.50	0.40	0.48	0.35	0.73	0.79	0.50	0.75	0.48	0.40	0.37
Pb	12.10	11.71	9.84	7.02	13.46	13.87	14.19	9.56	12.16	9.45	9.59
Th	6.92	6.69	5.59	5.83	8.57	9.06	8.71	5.57	7.95	5.61	5.90
U	1.57	1.49	1.29	1.40	2.04	1.97	2.03	1.29	1.82	1.29	1.36

Sample no.	E02-84	E02-84L	E02-85	E02-173	E02-173L	M04-72	M04-73	E03-48	M04-73c	M04-159	M04-162
Approximate Age	1900	1900	2100	1800	1800	2500-2600	2500-2600	>1700?	2500-2600	3100	3600
Batch no.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1?	2.00	2.00
SiO2	53.34	55.46	56.27	53.56	54.58	56.00	54.53	54.76	58.43	57.72	57.14
TiO2	0.84	0.80	0.75	0.86	0.81	0.77	0.82	0.91	0.65	0.61	0.66
Al2O3	17.69	17.65	17.46	17.35	17.15	17.41	17.05	17.37	17.82	18.06	18.00
Fe2O3	8.21	7.59	7.04	8.18	8.00	7.38	8.15	8.34	5.98	5.82	6.06
MnO	0.17	0.17	0.17	0.17	0.18	0.17	0.17	0.17	0.16	0.17	0.16
MgO	3.40	3.06	2.78	3.71	3.83	3.10	3.66	3.52	1.98	1.75	1.98
CaO	8.18	7.83	7.52	8.55	8.57	7.90	8.46	8.05	6.91	6.73	7.05
Na2O	3.59	3.85	3.93	3.61	3.59	3.86	3.66	3.68	4.13	4.07	4.16
K2O	2.02	2.23	2.34	2.09	2.16	2.25	2.10	2.34	2.45	2.32	2.24
P2O5	0.28	0.26	0.26	0.27	0.26	0.25	0.24	0.28	0.27	0.30	0.28
H2O	0.44	0.12	0.00	0.21	0.09	-0.06	0.02	0.05	-0.02	0.55	0.51
LOI	1.26	0.47	0.65	0.78	0.14	0.24	0.17	0.00	0.36	1.22	0.92
Total	99.41	99.49	99.18	99.35	99.37	99.26	99.03	99.45	99.11	99.30	99.15
Sc	15.00	14.00	14.00	22.00	19.00	15.00	20.00	19.00	7.00	3.80	10.20
V	210.00	194.00	168.00	219.00	207.00	185.00	217.00	232.00	124.00	105.70	135.40
Cr	23.00	12.00	22.00	37.00	46.00	19.00	20.00	7.00	12.00	8.70	19.40
Ni	4.00	4.00	3.00	4.00	8.00	4.00	9.00	3.00	0.00	2.60	6.00
Cu	66.00	41.00	46.00	83.00	33.00	60.00	72.00	72.00	31.00	15.00	26.60
Zn	87.00	86.00	84.00	88.00	86.00	85.00	84.00	87.00	81.00	74.80	75.00
Ga	19.00	19.00	17.00	19.00	18.00	17.00	18.00	18.00	18.00	21.40	21.10
Rb	51.00	56.00	61.00	52.00	50.00	58.00	53.00	58.00	65.00	58.40	58.60
Sr	628.00	636.00	626.00	630.00	618.00	635.00	622.00	611.00	652.00	667.50	655.30
Y	23.00	23.00	25.00	23.00	24.00	24.00	23.00	24.00	24.00	24.20	24.30
Zr	127.00	122.00	133.00	118.00	115.00	125.00	116.00	124.00	143.00	140.10	143.80
Nb	4.65	4.48	5.03	4.46	4.24	4.61	4.16	4.66	4.54	4.99	5.35
Cs	2.75	2.44	3.27	2.75	2.87	3.04	2.83	3.06	3.19	3.55	3.44
Ba	720.25	780.44	808.69	753.13	750.02	761.02	702.73	791.51	744.49	883.08	796.50
La	15.21	15.00	16.26	17.57	15.70	16.40	14.93	16.64	#REF!	22.47	19.75
Ce	31.17	32.50	34.71	32.12	30.97	33.31	30.76	33.37	33.17	40.43	39.18
Pr	4.00	4.07	4.41	4.18	3.96	4.22	3.95	4.29	4.07	5.00	4.83
Nd	18.13	18.20	19.16	18.61	17.53	18.37	17.61	19.24	17.56	22.18	21.10
Sm	4.12	4.29	4.39	4.33	4.11	4.14	4.04	4.44	3.90	4.72	4.78
Eu	1.22	1.26	1.25	1.27	1.22	1.24	1.20	1.30	1.11	1.32	1.29
Gd	4.12	4.16	4.11	4.39	4.21	4.08	3.83	4.33	3.77	4.55	4.37
Tb	0.67	0.69	0.69	0.71	0.68	0.66	0.64	0.68	0.59	0.69	0.71
Dy	3.75	3.79	3.65	3.78	3.72	3.60	3.69	3.94	3.32	3.93	4.00
Ho	0.78	0.79	0.75	0.81	0.74	0.76	0.76	0.79	0.71	0.82	0.82
Er	2.19	2.22	2.23	2.31	2.14	2.19	2.07	2.27	2.06	2.41	2.43
Tm	0.28	0.30	0.31	0.31	0.29	0.30	0.30	0.32	0.28	0.31	0.31
Yb	2.01	2.06	2.19	2.11	1.97	2.06	2.03	2.07	1.89	2.49	2.35
Lu	0.30	0.31	0.31	0.32	0.29	0.31	0.29	0.32	0.30	0.37	0.35
Hf	3.44	3.30	3.51	3.24	2.96	3.28	3.03	3.44	3.30	3.98	4.05
Ta	0.38	0.38	0.42	0.40	0.39	0.37	0.32	0.34	0.42	0.44	0.43
Pb	10.87	9.57	10.71	10.17	9.54	9.84	9.11	10.13	11.06	13.67	12.36
Th	6.27	5.90	6.70	5.87	5.81	6.19	5.56	6.23	6.49	8.02	7.06
U	1.33	1.32	1.55	1.30	1.31	1.43	1.30	1.43	1.55	1.83	1.62

Sample no.	M04-189	M04-189L	M04-80	M04-90	M04-91	M04-160L	M05-61	M05-61L	M05-66	M04-166L
Approximate Age	3600	3600	3600	3600	3680	3400	3600	3600	3800	4600
Batch no.	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00
SiO2	54.84	55.49	56.96	57.95	56.30	55.92	58.30	57.74	54.89	55.14
TiO2	0.86	0.86	0.60	0.60	0.68	0.83	0.62	0.61	0.83	0.82
Al2O3	17.42	17.60	18.55	18.13	18.36	18.32	18.93	17.01	19.87	18.04
Fe2O3	8.12	8.22	5.74	5.73	6.21	7.50	5.79	6.00	7.46	7.49
MnO	0.20	0.19	0.17	0.17	0.17	0.17	0.17	0.19	0.17	0.16
MgO	3.89	3.93	1.67	1.70	1.94	2.63	1.63	1.92	2.37	2.77
CaO	5.63	5.68	6.69	6.67	7.27	7.84	6.72	6.64	7.87	8.04
Na2O	3.99	3.99	3.99	4.10	3.95	3.92	4.06	4.06	3.78	3.80
K2O	2.46	2.45	2.21	2.32	2.10	2.23	2.29	2.41	1.92	2.19
P2O5	0.32	0.32	0.29	0.29	0.29	0.29	0.29	0.26	0.32	0.29
H2O	0.65	0.28	0.78	0.51	0.71	0.11	0.24	0.54	0.16	0.37
LOI	1.16	0.15	1.63	1.16	1.41	-0.10	0.41	1.96	0.01	0.13
Total	99.53	99.18	99.28	99.32	99.38	99.66	99.45	99.33	99.64	99.24
Sc	10.80	17.20	5.70	5.30	7.80	12.00	8.00	11.00	12.00	10.00
V	179.10	230.50	105.90	108.60	135.70	178.00	101.00	115.00	174.00	203.50
Cr	6.80	11.80	16.40	8.40	14.20	6.00	0.00	5.00	1.00	23.00
Ni	3.20	7.70	3.20	0.00	3.50	3.00	0.00	0.00	0.00	6.70
Cu	67.80	43.80	23.10	59.40	30.30	32.00	29.00	170.00	47.00	18.70
Zn	75.10	64.60	76.80	99.20	75.00	94.00	92.00	217.00	89.00	80.20
Ga	20.20	20.90	21.20	19.00	20.80	24.00	24.00	23.00	24.00	21.20
Rb	71.80	61.00	56.00	55.80	53.10	57.00	59.00	61.00	49.00	59.60
Sr	655.30	634.90	673.20	647.00	666.70	663.00	693.00	651.00	671.00	662.00
Y	23.60	22.50	24.00	24.50	24.50	24.00	25.00	24.00	25.00	24.30
Zr	154.60	142.20	143.40	139.90	138.10	132.00	145.00	131.00	149.00	134.20
Nb	5.68	5.28	5.11	5.05	5.22	4.59	5.39	5.01	5.39	4.62
Cs	3.82	3.21	3.56	3.77	3.33	3.26	3.57	1.91	2.99	2.96
Ba	977.43	904.59	899.44	911.76	777.70	836.88	878.75	824.24	674.95	777.15
La	22.45	16.12	21.75	21.53	20.22	15.92	21.48	19.16	17.41	16.56
Ce	41.23	32.05	42.69	42.04	39.73	33.04	42.93	38.08	35.98	33.71
Pr	5.11	4.20	5.25	5.33	4.95	4.33	5.41	4.82	4.82	4.36
Nd	21.51	18.47	22.29	22.70	21.28	19.28	23.18	20.81	21.17	19.62
Sm	4.76	4.24	4.91	4.87	4.88	4.36	5.01	4.32	4.65	4.49
Eu	1.31	1.39	1.25	1.35	1.27	1.33	1.32	1.27	1.29	1.35
Gd	4.30	4.10	4.45	4.53	4.51	4.37	4.65	4.14	4.70	4.30
Tb	0.70	0.64	0.71	0.72	0.70	0.71	0.74	0.70	0.77	0.69
Dy	3.86	3.58	4.04	4.14	4.15	3.92	4.21	3.91	4.27	3.93
Ho	0.79	0.74	0.83	0.86	0.87	0.84	0.89	0.83	0.90	0.87
Er	2.22	2.17	2.54	2.49	2.46	2.31	2.58	2.29	2.51	2.40
Tm	0.28	0.28	0.33	0.32	0.32	0.29	0.35	0.30	0.34	0.28
Yb	2.09	2.22	2.42	2.36	2.23	2.29	2.47	2.24	2.41	2.17
Lu	0.34	0.34	0.36	0.37	0.35	0.35	0.39	0.34	0.40	0.38
Hf	4.27	4.16	3.97	4.04	3.87	3.80	4.27	3.90	4.39	3.86
Ta	0.51	0.40	0.40	0.45	0.42	0.37	0.86	0.90	0.78	0.39
Pb	12.94	9.66	14.87	14.63	12.53	9.85	14.45	19.83	12.77	10.68
Th	8.47	7.65	8.74	8.32	7.09	6.44	8.36	7.34	6.97	6.45
U	1.95	1.79	2.00	1.92	1.58	1.53	1.92	1.73	1.53	1.47

Sample no.	M04-176L	M05-69L	M05-70	M05-70L	M05-74	M05-74L1	M05-74L2	M05-75	M06-62L	M05-78
Approximate Age	4800	4600	5112	5112	7068	7068	7068	7700	7700	7939
Batch no.	3.00	3.00	3.00	3.00	4.00	4.00	4.00	4.00		5.00
SiO2	54.42	54.43	53.02	55.53	54.54	55.97	55.95	55.55	56.18	53.75
TiO2	0.83	0.81	0.93	0.79	0.89	0.79	0.87	0.83	0.75	0.75
Al2O3	18.11	17.65	19.92	17.73	18.96	17.99	18.11	19.22	18.01	19.07
Fe2O3	7.59	7.20	8.11	6.43	7.79	6.48	7.56	7.19	7.52	7.42
MnO	0.16	0.16	0.17	0.16	0.17	0.16	0.17	0.17	0.17	0.17
MgO	2.62	2.48	2.74	2.37	2.60	2.39	2.61	2.48	2.66	2.47
CaO	7.71	6.94	8.27	6.93	7.87	6.99	7.75	7.65	7.55	7.59
Na2O	3.67	3.84	3.66	3.93	3.65	3.94	3.85	3.74	3.84	3.59
K2O	2.14	2.37	1.96	2.50	2.09	2.52	2.28	2.10	2.24	1.95
P2O5	0.29	0.28	0.35	0.26	0.33	0.26	0.29	0.31	0.28	0.32
H2O	0.49	1.00	0.18	0.69	0.25	0.57	0.17	0.00	0.03	0.56
LOI	0.55	2.65	0.19	2.09	0.30	1.58	0.05	0.28	-0.02	1.91
Total	98.58	99.80	99.49	99.40	99.44	99.64	99.66	99.52	99.22	99.54
Sc	11.50	10.00	14.00	9.00	12.00	10.00	10.00	14.00	11.00	9.00
V	204.90	183.00	197.00	170.00	190.00	167.00	187.00	164.00	169.00	161.00
Cr	12.50	2.00	8.00	4.00	0.00	3.00	3.00	22.00	4.00	3.00
Ni	6.60	1.00	4.00	1.00	0.00	1.00	0.00	7.00	1.00	2.00
Cu	82.30	36.00	57.00	33.00	50.00	33.00	30.00	40.00	25.00	55.00
Zn	96.40	93.00	91.00	98.00	94.00	98.00	96.00	96.00	87.00	86.00
Ga	21.40	24.00	25.00	24.00	25.00	25.00	22.00	25.00	17.00	25.00
Rb	58.60	64.00	49.00	68.00	52.00	68.00	57.00	53.00	57.00	48.00
Sr	647.20	649.00	697.00	657.00	634.00	666.00	631.00	671.00	659.00	686.00
Y	24.80	25.00	25.00	24.00	26.00	25.00	25.00	27.00	23.00	23.00
Zr	135.10	151.00	160.00	152.00	140.00	158.00	135.00	148.00	124.00	127.00
Nb	4.55	5.00	5.53	5.49	5.17	5.22	5.14	5.64	4.81	5.27
Cs	3.51	2.96	3.06	3.48	3.02	3.48	3.22	3.22	2.69	3.00
Ba	770.43	848.03	762.02	898.76	760.74	843.60	821.85	778.43	767.00	763.47
La	20.04	16.29	18.19	20.82	18.37	23.93	17.81	18.76	14.80	19.51
Ce	35.89	32.12	34.64	36.31	36.45	40.40	35.59	38.35	30.00	34.29
Pr	4.70	4.26	4.91	4.74	5.06	5.37	4.73	5.22	3.84	4.36
Nd	20.72	18.31	21.92	20.25	22.18	23.52	21.13	22.77	16.72	19.36
Sm	4.54	4.32	5.14	4.55	4.95	5.32	4.83	5.15	3.92	4.37
Eu	1.40	1.23	1.48	1.34	1.46	1.46	1.43	1.45	1.20	1.31
Gd	4.58	4.23	4.83	4.41	5.25	5.16	4.85	4.92	3.59	4.14
Tb	0.76	0.70	0.78	0.71	0.83	0.82	0.78	0.82	0.59	0.68
Dy	4.32	3.98	4.42	4.00	4.50	4.70	4.41	4.56	3.33	3.88
Ho	0.89	0.78	0.92	0.82	0.97	0.95	0.91	0.98	0.71	0.78
Er	2.48	2.29	2.53	2.32	2.68	2.79	2.63	2.76	2.02	2.28
Tm	0.32	0.30	0.32	0.30	0.34	0.37	0.34	0.36	0.26	0.31
Yb	2.33	2.28	2.31	2.29	2.51	2.56	2.46	2.45	1.93	2.18
Lu	0.37	0.34	0.36	0.35	0.38	0.37	0.38	0.37	0.29	0.34
Hf	3.90	4.21	4.65	4.60	4.35	4.33	4.01	4.37	3.32	3.72
Ta	0.38	0.73	0.92	0.88	0.55	0.38	0.43	0.39	0.38	0.50
Pb	11.23	11.87	13.12	17.72	12.47	12.60	11.41	13.35	11.43	13.63
Th	6.24	7.50	8.36	8.05	7.01	6.99	6.56	7.34	5.92	6.77
U	1.43	1.71	1.58	1.80	1.48	1.58	1.49	1.54	1.45	1.59

Sample no.	M04-99	M04-100	M04-102	M04-111	M04-112	E03-61	M04-71L	M04-73b	M04-74	EB-4b
Approximate Age	8900	8917	9347	9300	9900	1700	2400	2500-2600	2660	1700
Batch no.	6.00	6.00	6.00	6.00	6.00	Fantha ms	Fantha ms	Fantha ms	Fantha ms	Fanath ms
SiO2	52.26	54.20	54.68	53.10	55.53	50.93	53.32	50.88	50.91	51.08
TiO2	0.90	0.88	0.89	0.98	0.85	1.06	0.81	1.03	1.03	1.01
Al2O3	19.00	18.54	18.34	18.06	18.30	17.75	16.77	17.02	17.03	17.36
Fe2O3	7.89	7.75	7.60	8.51	7.47	9.90	8.37	9.84	9.85	9.63
MnO	0.20	0.17	0.16	0.17	0.17	0.18	0.17	0.17	0.17	0.17
MgO	2.65	2.64	2.70	3.28	2.57	4.27	4.34	4.64	4.68	4.56
CaO	8.27	8.28	8.16	8.35	8.14	9.74	8.91	10.13	10.22	9.44
Na2O	3.61	3.94	3.89	3.66	3.80	3.43	3.37	3.18	3.16	3.37
K2O	1.79	2.04	2.17	2.08	2.21	1.84	1.86	1.76	1.72	1.84
P2O5	0.32	0.31	0.30	0.27	0.31	0.28	0.23	0.27	0.26	0.27
H2O	0.94	0.31	0.27	0.40	0.18	0.06	0.33	-0.06	0.08	0.05
LOI	1.66	0.66	0.58	0.60	0.07	-0.04	0.50	0.48	0.37	0.52
Total	99.50	99.73	99.74	99.43	99.57	99.39	98.98	99.34	99.49	99.32
Sc	11.20	10.00	12.20	18.80	11.00	22.00	24.10	25.00	27.00	25.00
V	202.1	197.4	203.4	254.4	174.6	297.00	251.40	291.00	292.00	277.00
Cr	8.60	11.60	10.10	12.40	7.80	20.00	76.60	52.00	53.00	41.00
Ni	4.20	3.10	4.10	5.70	4.90	8.00	18.90	11.00	11.00	12.00
Cu	84.70	75.00	73.00	88.60	45.40	113.00	77.80	74.00	80.00	100.00
Zn	87.30	82.40	74.00	83.80	72.90	89.00	84.90	88.00	88.00	84.00
Ga	22.10	22.20	21.90	21.60	21.60	19.00	20.00	18.00	19.00	19.00
Rb	43.80	50.50	51.70	47.90	55.80	44.00	46.40	42.00	42.00	43.00
Sr	703.9	722.9	710.4	634.0	651.7	620.00	597.60	592.00	591.00	597.00
Y	26.30	25.00	24.70	24.30	27.00	23.00	22.30	24.00	23.00	21.00
Zr	134.7	132.3	127.4	120.0	133.4	106.00	107.80	99.00	98.00	105.00
Nb	5.04	4.94	4.49	4.44	4.95	3.87	4.11	4.16	3.66	3.90
Cs	2.59	2.92	2.97	2.58	2.95	2.25	2.63	2.41	2.07	2.23
Ba	672.6	735.0	756.4	775.2	794.7	666.37	690.97	694.47	636.64	671.87
La	8	8	1	5	5	13.46	15.98	17.05	14.39	15.42
Ce	18.92	19.60	17.64	17.39	18.54	28.83	30.33	30.08	27.26	27.45
Pr	42.49	37.95	35.50	34.70	38.09	3.79	3.97	4.01	3.62	3.67
Nd	5.17	4.95	4.68	4.55	5.00	17.42	17.67	18.80	17.03	16.96
Sm	22.71	21.90	21.04	20.10	22.28	4.48	4.28	4.68	4.10	4.08
Eu	5.21	5.13	4.90	4.60	4.96	1.30	1.24	1.41	1.26	1.27
Gd	1.38	1.43	1.41	1.38	1.44	4.11	4.17	4.52	4.38	4.14
Tb	4.84	4.93	4.88	4.59	4.96	0.70	0.68	0.77	0.70	0.66
Dy	0.79	0.79	0.75	0.78	0.81	3.81	3.91	4.19	3.81	3.69
Ho	4.54	4.16	4.14	4.25	4.36	0.78	0.81	0.87	0.82	0.74
Er	0.91	0.87	0.86	0.92	0.97	2.21	2.20	2.51	2.24	2.14
Tm	2.55	2.44	2.37	2.44	2.66	0.29	0.29	0.34	0.32	0.29
Yb	0.34	0.32	0.31	0.31	0.33	1.95	2.16	2.18	1.94	1.96
Lu	2.26	2.26	2.26	2.29	2.55	0.28	0.32	0.34	0.31	0.28
Hf	0.36	0.34	0.35	0.34	0.41	2.93	3.14	3.04	2.72	2.83
Ta	3.89	3.77	3.60	3.66	4.07	0.27	0.40	0.41	0.36	0.33
Pb	0.38	0.37	0.36	0.39	0.35	4.66	9.70	8.70	8.08	4.97
Th	12.47	11.54	11.67	10.82	10.05	4.45	5.61	4.90	4.54	4.53
U	6.17	6.06	5.79	5.79	6.40	1.06	1.26	1.14	1.05	1.08
U	1.34	1.35	1.35	1.29	1.47					

