ORIGIN OF SELECTED SOIL PARENT MATERIALS AND SEDIMENTS IN NORTH ISLAND, NEW ZEALAND

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ABSTRACT

In this thesis the origin of soil parent materials in the North Island of New Zealand was investigated. The parent materials varied from basaltic, andesitic and rhyolitic volcanics to quartzose beach sands and quartzofeldspathic sedimentary rocks. Oxygen isotope and grain size analysis show that quartz from global aerosolic dust (represented by the 5 - 2 μm size fraction), interregional loess (represented by the 63 - 20 μm size fraction) and intraregional sand (represented by the > 63 μm size fractions) can be identified in soils formed from these materials. In addition, high temperature quartz from Central North Island rhyolitic tephras is identified in basaltic soils in Northland.

The presence of locally derived quartz in the aerosolic dust fraction is demonstrated in the basaltic Kiripaka soil from Northland. In this soil a low temperature quartz component with a $\delta^{18}O$ value of <u>circa</u> 26 $^{o}/oo$ (in contrast to the aerosolic quartz $\delta^{18}O$ value of 12 - 13 $^{o}/oo$) was derived from nearby Tertiary marine shales by erosion and wind transport.

In all of the soils examined, no evidence of pedogenic α-quartz was obtained. In particular, quartz from the highly siliceous albic horizon of a Wharekohe soil, a "kauri podzol", is of detrital rather than authigenic origin.

Aerosolic quartz accumulation in soils developed on a series of surfaces of known age in southern North Island shows a correlation between age and the amount of quartz accumulated. Thus within a region, relative ages of surfaces can be estimated from quartz accumulation.

In an Egmont soil from Taranaki, an increased rate of quartz accumulation is noted in the lower part of the soil profile. This is

correlated with a late glacial climate prior to the circa 11,000 year B.P. post-glacial rise in sea-level. During this time tephric loess with a substantial (30%) detrital quartzofeldspathic component accumulated. After the sea-level rise cut off the source of the tephric loess, only tephra accumulated to form the upper part of the soil profile, in which the detrital quartzofeldspathic component is small.

The chronosequence concept could not be directly applied to a development sequence of basaltic soils in Northland. Only one soil, the Kiripaka, accumulated fast enough for the glacial/post-glacial change in quartz accumulation to be detected. The remaining basaltic soils, Whatitiri, Waiotu, Kerikeri, Ruatangata and Okaihau, accumulated slowly on old surfaces and in some cases were subject to erosion.

In a mineralogical examination of the sand and silt fractions of the basaltic soils, four distinct components are recognised:

1. Basaltic component - comprising minerals inherited from primary basalt tephra or lava. These include calcic plagioclase, magnetite, augite and, rarely, olivine.
2. Secondary component - glaebules of gibbsite, goethite and lesser amounts of clay minerals and hematite.
3. Rhyolitic component - abundant in the surface horizons of all six soils and comprising rhyolitic glass shards and pumice, sodic plagioclase, hypersthene, hornblende, augite, biotite, titanomagnetite, quartz, zircon and rare sanidine.
4. Detrital component - comprising predominantly quartz < 125 μm in size and largely derived as loess and aeroslic dust. Other minerals occurring are muscovite, plagioclase and rarely microcline and tourmaline.

Through the soil development sequence the basaltic component rapidly becomes unimportant while the secondary component increases in significance to a level where the soil grain size characteristics are largely controlled by the distribution of gibbsite and goethite glaebules.

In a further study of quartz accumulation with time, a core of marine sediment from off the east coast of the southern North Island is examined. Core P69 contains five tephras, Whakatane Ash, Rotoma Ash, Waiohau Ash, Rerewhakaaitu Ash and Kawakawa Tephra, which have been radiocarbon dated from terrestrial sequences. Interpolation and extrapolation of sedimentation rates in core P69 allowed estimates of the ages of four further rhyolitic tephras from the Central North Island, for which no reliable radiocarbon dates are available:

Okareka Ash	17,100 years B.P.
Te Rere Ash	19,100 years B.P.
Poihipi Tephra	20,300 years B.P.
Okaia Tephra	21,200 years B.P.

Quartz accumulation decreases abruptly from a high Otiran (glacial) to a low Aranuian (post-glacial) rate at *circa* 14,700 years B.P. This is matched by a similar abrupt change in both biogenic silica and carbonate accumulation. The changes are interpreted as reflecting a southward shift of a strong westerly wind system at the end of the Otiran. The decreased wind intensity, coupled with forest expansion led to a reduction in erosion and reduced transport of quartz. The biological components also decreased at this time, probably due to changes in ocean currents and upwelling of cold, nutrient-rich water, as a result of the decreased wind intensity.

Compared with aerosolic dust accumulation in the southern North Island chronosequence, far greater amounts of aerosolic quartz accumulated in core P69 over a similar time period. This indicates that local contributions to the 5 - 2 µm size fraction can cause much larger variations in quartz accumulation than those caused by rainfall variations reported in the literature.

The following late Otiran - Aranuian chronology is suggested, based on the evidence in core P69:

23,000 - 19,200	cold, glacial
19,200 - 18,500	glacial, slight amelioration
18,500 - 16,200	glacial, maximum cold
16,200 - 14,700	climatic amelioration, maximum aeolian transport and erosion, little forest cover
14,700 - 14,400	southward migrating circumpolar currents and westerly wind systems leave area of core P69, rapid expansion of forest cover
14,400 - 9,500	ameliorating climate, early post-glacial
9,500 - present	post-glacial.

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TABLE OF CONTENTS

Page

Page

Page

LIST OF FIGURES

Figure Page

LIST OF TABLES

LIST OF PLATES

List of Symbols Not Defined in the Text

B.P.	before present (1950)
^{o}C	temperature, degrees celsius
^{14}C	carbon isotope, atomic number 14
g	gram
mg	milligram
μg	microgram
K/Ar	Potassium/Argon
km	kilometre
l	litre
M	Molar
m	metre
mm	millimetre
μm	micron
my	million years
U/Th	Uranium/Thorium
>	greater than
<	less than
$\phi = -\log_2 mm$	arithmetic grain size measure
Folk and Ward Grain Size Parameters	
M_z	Graphic Mean
σ_I	Inclusive Graphic Standard Deviation
Sk_I	Inclusive Graphic Skewness
K_G	Graphic Kurtosis