Approaches to forecast volcanic hazard in the Auckland Volcanic Field, New Zealand

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VOLCANIC RISK SOLUTIONS

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No Telling Where Next

But Signs Expected

When any of the 50 volcanic centres in Auckland next erupts, there is likely to be some warning to allow evacuation.

"Unlike with earthquakes, it is possible to see something coming," the senior lecturer in geology at the University of Auckland, Dr Ian Smith, told a civil defence seminar yesterday.

The next eruption could occur anywhere in metropolitan Auckland, but is was likely to be of short duration.

The last eruption to affect people in New Zealand was Tarawera, 100 years ago.

Dr Smith said yesterday: "What we need in this country is a good eruption to remind people about the effects it can have."

Auckland University has established a seismometer on Motutapu Island and the Auckland Regional Authority is siting others at dams in the Hunua and Waitakere ranges.

Dr Smith said these would give between 24 hours and a week's warning of coming volcanic activity.

The threat to life would not be great but destruction of property could be considerable.

The last local eruption was on Rangitoto about 800 years ago.

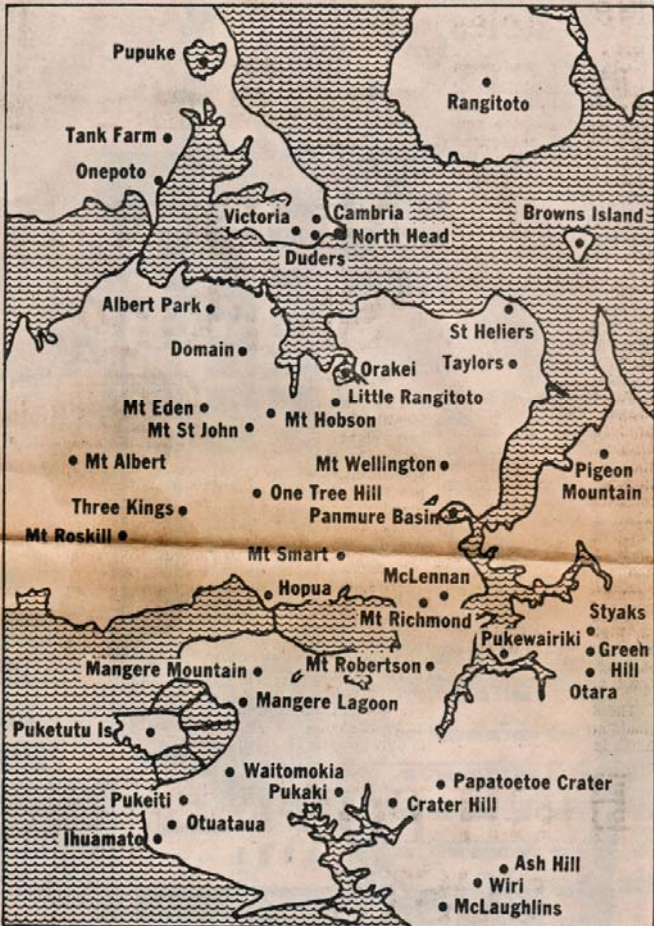
Explosive outbursts could be expected from areas like the Orakei or Panmure basins, Lake Pupuke or the Onepoto basin.

The blasts would cause destruction up to three kilometres away with damage extending several kilometres. Such eruptions had produced 160 km/h surges, removing trees for up to a kilometre.

In addition, wet ash would clog drains, affect water supplies and disrupt traffic. The weight of it could cause buildings to collapse.

The more visible cones such as Mt Eden, Mt Wellington or Mangere could throw up lava, producing heat damage up to a kilometre away.

Dr Smith said that there was no way of predicting where a future eruption would be.



The main volcanic areas in Auckland.

New Zealand Herald, 25th July 1985

Abstract

Monogenetic basaltic volcanism is characterised by a complex array of behaviours in the spatial distribution of magma output and also temporal variability in magma flux and eruptive frequency. For understanding monogenetic volcanoes different topographic and remote sensing-based information can be used, such as Digital Surface Models (DSMs). These data are most appropriately analysed in a Geographic Information System (GIS). In this study a systematic dataset of the Auckland Volcanic Field (AVF), New Zealand, was collected and pre-processed to extract quantitative parameters, such as eruptive volumes, sedimentary unit thicknesses, areas affected, spatial locations, and topographic positions. The topographic datasets available for the AVF were Shuttle Radar Topography Mission (SRTM), Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), contour-based Digital Elevation Models, and Light Detection And Range (LiDAR) datasets. These were validated by comparing their elevations to high accuracy ground control reference data from multiple Real-Time-Kinematic (RTK) Global Positioning System and Terrestrial Laser Scanning surveys. The attribute extraction was carried out on the LiDAR DSM, which had the best vertical accuracy of ≤0.3 m. The parameterisation of monogenetic volcanoes and their eruptive products included the extraction of eruptive volumes, areas covered by deposits, identification of eruptive styles based on their sedimentary characteristics and landform geomorphology. A new conceptual model for components of a monogenetic volcanic field was developed for standardising eruptive volume calculations and tested at the AVF. In this model, a monogenetic volcano is categorised in six parts, including diatremes beneath phreatomagmatic volcanoes, or crater infills, scoria/spatter cones, tephras rings and lava flows. The most conservative estimate of the total Dense Rock Equivalent eruptive volume for the AVF is 1.704 km^3. The temporal-volumetric evolution of the AVF is characterised by a higher magma flux over the last 40 ky, which may have been triggered by plate tectonic processes (e.g. increased asthenospheric shearing and back-arc spreading underneath the Auckland region). The eruptive volumes were correlated with the sequences of eruption styles preserved in the pyroclastic record, and environmental influencing factors, such as distribution and thickness of water-saturated post-Waitemata sediments, topographic position, distance from the sea and known fault lines. The past eruptive sequences are characterised by a large scatter without any initially obvious trend in relation to any of the four influencing factors. The influencing factors, however, showed distinct differences between sub-domains of the field, i.e. North Shore, Central Auckland and Manukau Lowlands. Based on the spatial variability of these environmental factors, a susceptibility conceptual model was provided for the AVF. Based on the comparison of area affected by eruption styles and eruptive volume, lava flow inundation is the most widespread hazard of the field. To account for this, a topographically adaptive numerical method was developed to model the susceptibility for lava flow inundation in the AVF. This approach distinguished two different hazard profiles for the valley-dominated Central Auckland and North Shore regions, and the flat Manukau Lowlands. A numerical lava flow simulation code, MAGFLOW, was applied to understand the eruption and rheological properties of the past AVF lava flow in the Central Auckland area. Based on the

simulation of past lava flows, three eruptive volume-based effusive eruption scenarios were developed that best characterise the range of hazards expected.

To synthesise, susceptibility mapping was carried out to reveal the patterns in expected future eruption styles of the AVF, based on the eruptive volumes and environmental factors. Based on the susceptibility map, the AVF was classified as highly susceptible to phreatomagmatic vent-opening eruptions caused by external environmental factors. This susceptibility map was further combined with eruptive volumes of past phreatomagmatic phases in order to provide an eruption sequence forecasting technique for monogenetic volcanic fields. Combining numerical methods with conceptual models is a new potential direction for producing the next generation of volcanic hazard and susceptibility maps in monogenetic volcanic fields. These maps could improve and standardise hazard assessment of monogenetic volcanic fields, raising the preparedness for future volcanic unrest.

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