

Chapter 5

An integrated approach to Determining Volcanic Risk in Auckland, New Zealand: the multi-disciplinary DEVORA project

N.I. Deligne, J.M. Lindsay and E. Smid

5.1 Background

Auckland, New Zealand, is home to 1.4 million people, over a third of New Zealand's population, and accounts for ~35% of New Zealand's GDP (Statistics New Zealand, 2014). The city is built on top of the Auckland Volcanic Field (AVF), which covers 360 km², has over 50 eruptive centres (vents), and has erupted over 55 times in the past 250,000 years, producing a cumulative volume of ~2 km³ of tephra, lava and other volcanic deposits¹ (see Figure 5.1). The field is likely to erupt again: the most recent eruption, Rangitoto, was only 550 years ago. Most AVF vents are monogenetic, i.e. they only erupt once. This means that it is very likely that the next vent will erupt in a new location within the field. Despite considerable scientific efforts, no spatial (where) or temporal (when) patterns have been identified; indeed, the oldest (Pupuke volcano) and the youngest (Rangitoto) vents are located next to each other. As such, it is wholly unknown where or when the next eruption will be. The size of the next eruption is also difficult to address, as the last eruption, Rangitoto, accounts for nearly half of the erupted volume of the field, and it is unclear whether this eruption is an anomaly or signals a change in the eruptive behaviour of the field. These difficulties of assessing location, time and size of next eruption pose a considerable problem for emergency and risk managers. The main challenges facing Auckland and other populated areas coinciding with volcanic fields include:

- uncertainty of where and when the next eruption will take place;
- communicating to the public how an eruption of unknown location will impact them and how they can best prepare;
- planning for an event which hasn't occurred in historical time;
- foreseeing and appropriately planning for the range of possible impacts to the built environment, local, regional and national economy and psyche.

¹ Equivalent to volume of 800,000 Olympic size pools.

Deligne, N.I., Lindsay, J.M. & Smid, E. (2015) An integrated approach to Determining Volcanic Risk in Auckland, New Zealand: the multi-disciplinary DEVORA project. In: S.C. Loughlin, R.S.J. Sparks, S.K. Brown, S.F. Jenkins & C. Vye-Brown (eds) *Global Volcanic Hazards and Risk*, Cambridge: Cambridge University Press.

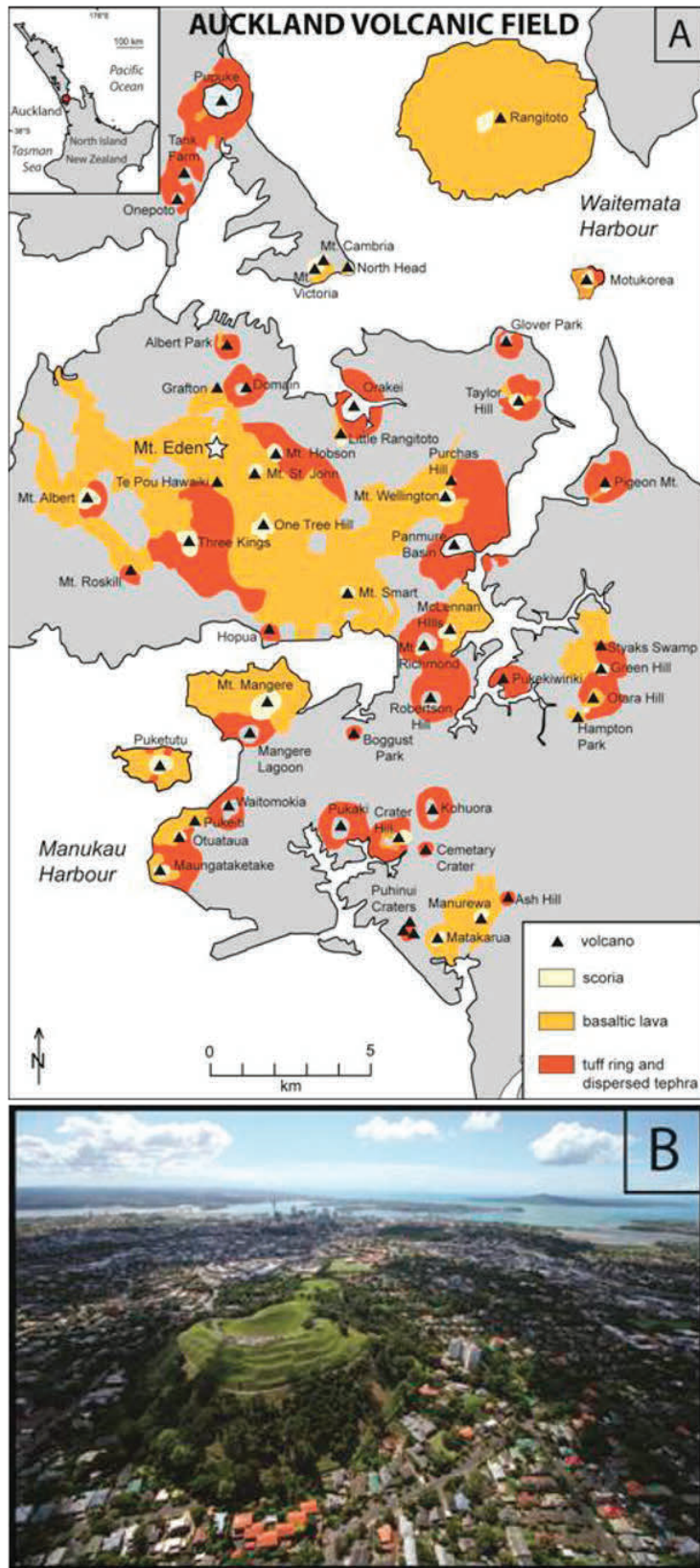


Figure 5.1 a) Map of Auckland Volcanic Field; star indicates location of Mt Eden. b) View of Mt Eden looking to the north highlighting the complete overlap of AVF and city (© Auckland Council).

5.2 DEVORA

The DETERMINING Volcanic Risk in Auckland (DEVORA) programme is a 7-year multi-agency research programme launched in November 2008. DEVORA was established following Exercise Ruauumoko, a 2007-2008 national Cabinet-lead Civil Defence exercise simulating an AVF eruption, in part to address knowledge gaps revealed by the exercise (Ministry of Civil Defence and Emergency Management, 2008). It is co-led by GNS Science (New Zealand's geologic survey) and the University of Auckland, with associated researchers at Massey University, the University of Canterbury and Victoria University of Wellington. It is funded by these organisations, the Earthquake Commission (national government), and Auckland Council (local/regional government). The DEVORA programme has a mandate to investigate the geological context of the AVF, volcanic hazards, and risk posed by the AVF, as reflected by the three themes organising the programme (Figure 5.2), listed below along with key questions:

- 1) Theme 1: Geological Model
 - Where is AVF magma coming from?
 - Why does it leave its source?
 - What controls the path of magma in the crust?
 - Where will the magma reach the surface?
 - What is the crust underlying the AVF made of?
 - Why is the most recent eruption the largest?
 - How fast will magma travel to the surface?
 - When will we detect the ascending magma?
- 2) Theme 2: Probabilistic Volcanic Hazard Model
 - What is the distribution in time of past eruptions affecting Auckland?
 - What is the likelihood and size of future eruptions affecting Auckland?
 - What are likely styles and hazards of future eruptions?
 - Where are we in the lifespan of the AVF?
 - How do we usefully calculate probabilistic volcanic hazard for Auckland?
 - What is the probabilistic volcanic hazard?
 - How intensive should the monitoring be to provide adequate warning of an AVF eruption?
- 3) Theme 3: Risk and Social Model for Auckland
 - Who and what are exposed to volcanic hazards in Auckland?
 - How will each hazard affect people and infrastructure?
 - How will people and organisations cope in an eruption?
 - What are the flow-on effects nation-wide from an eruption affecting Auckland?
 - How can we calculate risk to people and infrastructure?
 - What are the risks to people and infrastructure?
 - How can these risks be reduced?

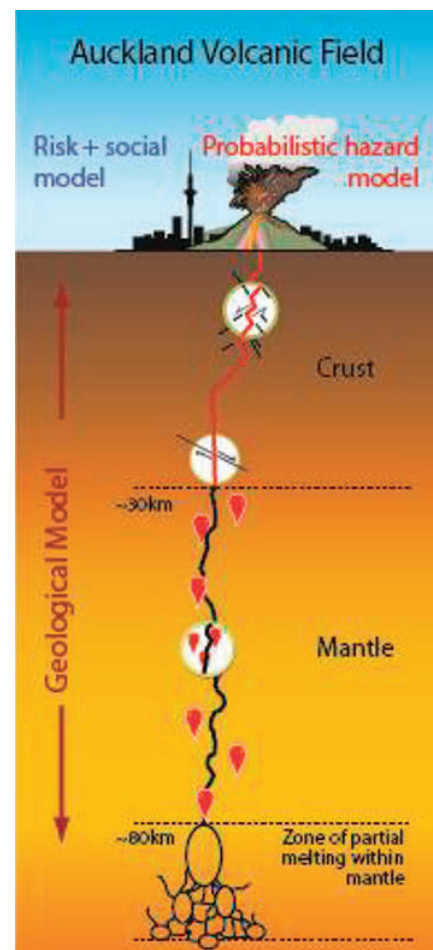


Figure 5.2 Scope of DEVORA themes.

To ensure that DEVORA outputs are useful not just scientifically but practically, government representatives sit on the DEVORA steering committee, which charts and directs DEVORA efforts. Furthermore, there is an annual research forum open to Auckland Council and Civil Defence staff and representatives from critical infrastructure and utility organisations. Here, recent findings and ongoing research are presented. This strengthens communication between scientists and decision makers, and enables policy to be informed by the most recent scientific findings. Indeed, the Auckland Volcanic Field Contingency Plan, the policy document which details response arrangements should an AVF eruption occur, has been recently reviewed and updated in close consultation with DEVORA scientists. Additionally, through DEVORA, University of Auckland students and the Auckland Civil Defence team participate in an annual informal mock eruption exercise. A longitudinal study is planned to compare public risk perception in 2008 and now, and will evaluate effectiveness of the DEVORA and associated programmes in improving public understanding of AVF hazards and risk.

As of the first quarter of 2014, seven Masters and 11 PhD projects have been at least partially supported by DEVORA, over 180 presentations have been given at scientific conferences, and over 80 papers have been accepted or published in a range of peer-reviewed scientific journals. Sample titles of published papers include:

- Asthenospheric control of melting processes in a monogenetic basaltic system: a case study of the Auckland Volcanic Field, New Zealand (McGee et al., 2013);
- Age, distance, and geochemical evolution within a monogenetic volcanic field: Analysing patterns in the Auckland Volcanic Field eruption sequence (Le Corvec et al., 2013);
- Longevity of a small shield volcano revealed by crypto-tephra studies (Rangitoto volcano, New Zealand): change in eruptive behaviour of a basaltic field (Shane et al., 2013);
- Amplified hazard of small-volume monogenetic eruptions due to environmental controls, Orakei Basin, Auckland Volcanic Field, New Zealand (Németh et al., 2012);
- LiDAR-based quantification of lava flow susceptibility in the City of Auckland (New Zealand) (Kereszturi et al., 2012);
- Some challenges of monitoring a potentially active volcanic field in a large urban area: Auckland Volcanic Field, New Zealand (Ashenden et al., 2011);
- The communication of uncertain scientific advice during natural hazard events (Doyle et al., 2011);
- Evacuation planning in the Auckland Volcanic Field, New Zealand: a spatio-temporal approach for emergency management and transportation network decisions (Tomsen et al., 2014).

5.3 Discussion

The breadth and scope of the DEVORA programme has produced not only invaluable scientific outputs that advance scientific understanding of volcanic fields, but also important and applicable information for government policy makers and risk and emergency managers. As such, DEVORA is a model for the production of scientific research for science and society, resulting in strengthened ties between scientists and practitioners. Although the location, timing, and size of the next eruption is unknown, and an AVF eruption will be unwelcomed due to its highly disruptive nature, Auckland and New Zealand will be as best prepared as possible given the high uncertainty of such an event.

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