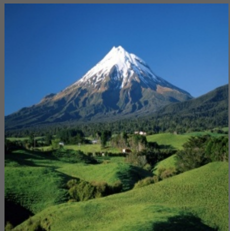
National Lifelines Forum: New Plymouth

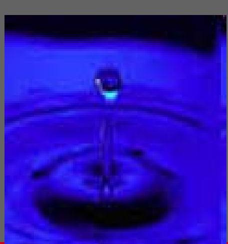
VISG
GeoNet (volcano)
Recent eruptions:Te Maari (Tongariro), White, Monowai, Havre

7 November 2012

Brad Scott (GNS Science)
For a huge team of people

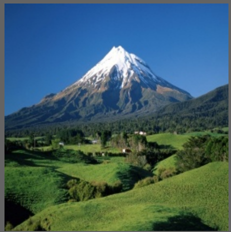


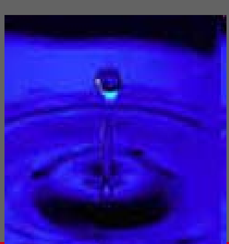




Volcanic Impacts Study Group (VISG)

- **Impacts of volcanic hazards on lifelines and mitigation measures**
  - **Facilitating uptake of knowledge**
  - **Supporting research**
- **National focal point for volcanic impacts research as it relates to infrastructure**
- **Part of AELG since 2003**

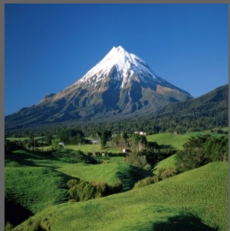




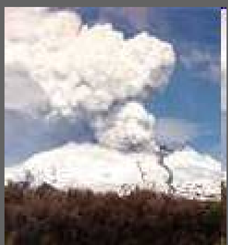
VISG Activities

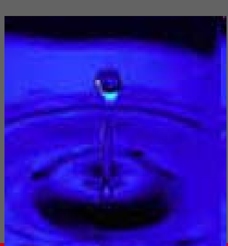
- Projects
- Annual Seminar
- Website www.aelg.org.nz

- Funding
  - AELG
  - Research grants (GNS, Massey, Auckland, Canterbury)
  - EQC

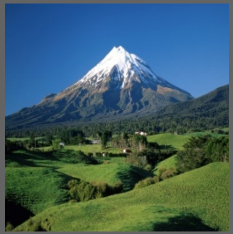
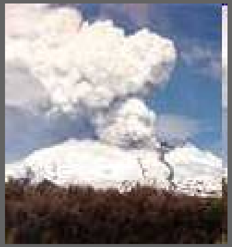


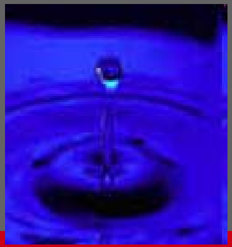
VISG Projects





- **Volcanic Ash Review – impacts on lifeline services and collection/disposal issues (2001)**
- **Volcanic Ash Impacts Reconnaissance Investigation (2002)**
- **Water Supply Vulnerability to Ash (2004)**
- **Health and Safety Ash Issues (2005)**
- **Volcanic Ash and Wastewater (2006)**
- **Impacts of Volcanic Ash on Electricity, Broadcasting, Radio Transmission and Communications (2008)**

VISG Poster Series

- Recommended Actions for Airports (2006)
- Recommended Actions for Roading Managers (2007)
- Advice for Water Supply Managers (2008)
- Advice for Electricity Network Managers (2009)
- Advice for Wastewater Managers (2010)

- Poster updates (2011-12)

VOLCANIC ERUPTION

Advice for Electricity Network Managers

Massey University · Auckland Engineering Lifelines · UC University of Canterbury · GNS Science

Ash Impacts on Electricity Distribution

Volcanic ash is: hard, highly abrasive, mildly corrosive and conductive.

Volcanic ashfalls can cause disruption to electricity supplies in the following ways:

- Ashfall buildup on insulators can lead to flashover (the unintended disruptive electric discharge over or around the insulator), causing disruption to distribution networks.
- Line breakages and damage to towers and poles due to ash loading, both directly onto the structures and by causing treefall onto lines, particularly in heavy, fine ashfall events. Snow and ice accumulation on lines and vegetation will exacerbate the risk
- Breakdown of substation and control equipment such as air conditioning/cooling systems due to ash penetration which can block air intakes and cause corrosion.
- Controlled outages during cleaning.

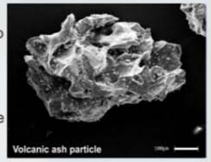
Of these, the main hazard is insulator flashover. Volcanic ashfall may also increase electrocution risks (by increasing touch potentials) to workers in substations.

Insulator Flashover

Factors contributing to risk of flashover include:

- Light wet weather conditions (dew, fog, drizzle or light rain) wets the ash and leads to a conductive layer forming on the surface which initiates leakage current and leads to arcing and flashover. Heavier rain will wash off contaminants.
- Ash grainsize (fine ash adheres to insulators more strongly).
- Presence of other contaminants e.g. sea salt, dust, agricultural sprays, smoke.
- Elapsed time since last maintenance.
- Insulator design and construction (ability to shed ash and resist acidic corrosion).

Ashfall covers a 33kV insulator following the May 2008 Chaiten eruption, Chile



ELECTROCUTION RISK

Resistivity of ground gravel cover may reduce following ashfall, reducing step potential and possibly increasing touch potentials.

Risk of Line and Substation Insulator Flashover

Risk factors		Probability of failure			
Line voltage	Ash moisture content	Ash thickness <5 mm		Ash thickness >5 mm	
		Fine ash	Coarse ash	Fine ash	Coarse ash
≤33 kV (domestic)	Wet	High	Low	High	Medium
	Dry	Low	Low	Low	Low
>33 kV (regional-national)	Wet	Medium	Low	High	Medium
	Dry	Low	Low	Low	Low

Risk Of Damage To Towers, Poles And Lines

	Weather conditions	Ash thickness <100 mm		Ash thickness >100 mm	
		Fine ash	Coarse ash	Fine ash	Coarse ash
Towers and poles	Wet	Low-medium	Low	Medium-high	Low
	Dry	Low	Low	Medium	Low
Lines	Wet	Low-medium	Low	High	Low-medium
	Dry	Low	Low	Medium	Low

Recommended Actions

Substations

- Prior to an ashfall, maintain insulators in a clean condition, especially in coastal areas
- During an ashfall, monitor buildup of ash on insulators. If conditions are wet, consider controlled outages to allow cleaning.
- Immediately after an ashfall, dispatch personnel to substations to dust, sweep and blow ash from electrical equipment, and clean roofs and gutters.
- Be aware of increased electrocution hazard if ashfall covers the ground. Isolate substations or electrical equipment before entering site.

Line insulators

- Maintain line insulators in a clean condition, especially in coastal areas.
- During an eruption, monitor buildup of ash on insulators.
- Make controlled cuts if necessary to clean insulators, or replace damaged insulators. Ensure all surfaces are cleaned, including underneath. Cost-benefit analysis will dictate whether cleaning or total replacement is appropriate.

Towers, poles and lines

- Maintain in a good state of repair; in particular ensure that lines are kept free of overhanging branches.
- During an eruption, continually monitor the network for ash accumulation on towers, lines, poles and overhanging branches.
- Replace or repair damaged components as appropriate.

General notes on cleanup of ash

- Remove dry ash from the most sensitive systems by blowing it off using air pressure of 30 psi or less, to avoid a sandblasting effect.
- Avoid rubbing or brushing equipment. Remove ash by vacuuming if possible.
- Regularly clean and/or replace vehicle and air-conditioning filters (stock spares)
- To avoid eye and respiratory irritation wear face masks and goggles
- Consider acquiring cleanup equipment (water blasters, air compressors)

The underside of a 33kV insulator coated in ash, which led to flashover, following ashfalls during the 2008 Chaiten eruption, Chile

Ash is cleaned from a 110 kV horizontal insulator string using pressurised water following the 1995 Ruapehu eruption, New Zealand (Transpower New Zealand)

The following resources provide further information on volcanic hazards:

http://www.geonet.org.nz
http://volcanoes.usgs.gov/ash/index.html
http://www.ivhhn.org
http://www.aelg.org

Drafted by Tom Wilson, Carol Stewart & David Johnston. 26 August 2009

VOLCANIC ERUPTION

Advice for Wastewater Managers

Massey University · Auckland Engineering Lifelines · UC University of Canterbury · GNS Science

Impacts on Waste Water Networks

Volcanic ash is: highly abrasive, mildly corrosive, conductive

Volcanic ashfall can cause damage and disruption to wastewater reticulation networks and treatment plants.

Systems with combined stormwater/sewer lines are most at risk. Ash will enter sewer lines where there is inflow or infiltration of stormwater (through illegal connections, cross connections, via gully traps, around manhole covers or through holes or cracks in sewer pipes).

System component	Impacts of volcanic ashfall
Sewerage reticulation networks	Volcanic ash may form unpumpable masses in catchpits and sewer lines, which may block lines, cause overflows and damage pumping equipment by overloading motors or causing abrasional damage and accelerated wear
Pre-treatment (comminutors, milliscreens)	Coarse ash is likely to block screens, cause abrasive damage to moving parts and overload mechanical equipment
Primary treatment (settling tanks)	Coarse ash will increase volume of raw sludge; fine ash may not settle. Low density pumice fragments will float.
Secondary treatment (biological reactors or oxidation ponds)	Ash deposited directly into open biological reactors, ponds and clarifiers may reduce or halt the oxidation process. Ash can also have a highly acidic surface coating that may affect bacterial processes (for example, nitrification). Trickling filter rock media can be stripped by coarse ash (if directly deposited)
Tertiary treatment (disinfection)	Any residual fine ash still present in effluent will reduce transmissivity which will reduce effectiveness of disinfection.
Sludge treatment	Acidic ash could negatively affect digester biological process and sludge dewatering equipment

It is time-consuming and expensive to remove ash from sewer lines and storm drains. In the event of an ashfall, the top priority should be preventing ash from entering stormwater drains and sewers.

In addition to entering treatment plants via sewer lines, ashfall may cause direct impacts on treatment plants:

Heavy ashfall (>150 mm) may collapse long span roofs

Airborne ash can clog air filtration systems, cause abrasional damage to moving parts of motors and cause arcing and flashover damage to electrical equipment

For uncovered waste stabilisation ponds, direct ashfall may interfere with biological treatment processes.

Ashfall can also affect other critical infrastructure (electricity supply, water supply, telecommunications) which may in turn compromise the functioning of treatment plants.

City of Yakima, USA

On 18 May 1980, Mount St Helens volcano erupted. The city of Yakima (popn 50,000), 140 km to the east, received about 1 cm of volcanic ashfall.

By the next day, about 15 times the usual amount of solid matter was being removed from the pre-treatment processes at Yakima's wastewater treatment plant. This was despite Yakima having just five percent combined sewage and stormwater lines.

Ash was also observed in the raw sludge in the primary clarifiers.

Two days later, it was evident that the facility was suffering as vibrations were occurring in the grit classifier and the gear box of the mechanically-cleaned bar screen. Raw sewage lines became blocked.

On 21 May the City Manager announced a decision to bypass the treatment plant and discharge sewage directly to the Yakima River.

The total damage to the Yakima plant was estimated to be US$4 million.

Recommended Actions

For Wastewater Treatment Plants

Prior to an ashfall

Review stocks of essential items such as treatment chemicals and spare parts

Ensure access to backup power generation

In event of ashfall

Cover all external equipment with plastic

Shut down ventilation equipment where possible

Maintain a clean site to reduce contamination

Shut down all equipment not strictly required

Put all available pre-treatment equipment into operation at maximum removal rates

Put all primary clarifiers in operation and increase pumping rates

Shut down biofilters and cover (if open-air)

Monitor all processes for presence of ash, step up preventative maintenance

Monitor torque on all motor-driven equipment

Consider bypassing pumping stations and treatment plant as a protective measure to avoid plant damage/destruction

To Limit Entry of Ash into Sewerage Networks

Prior to an ashfall

Minimise stormwater entry to network, such as by enforcing regulations on illegal connections, remediating cross-connections and maintaining pipes in good repair

Ensure backup power generation for critical pump stations

In event of ashfall

Instruct public where to deposit ash cleared from property

Warn citizens against dumping ash into gully traps, stormwater drains, manholes and cesspits

If hosing ash from streets, place sandbags around or over drains, cesspits and manhole covers to reduce inflow of ash to sewers

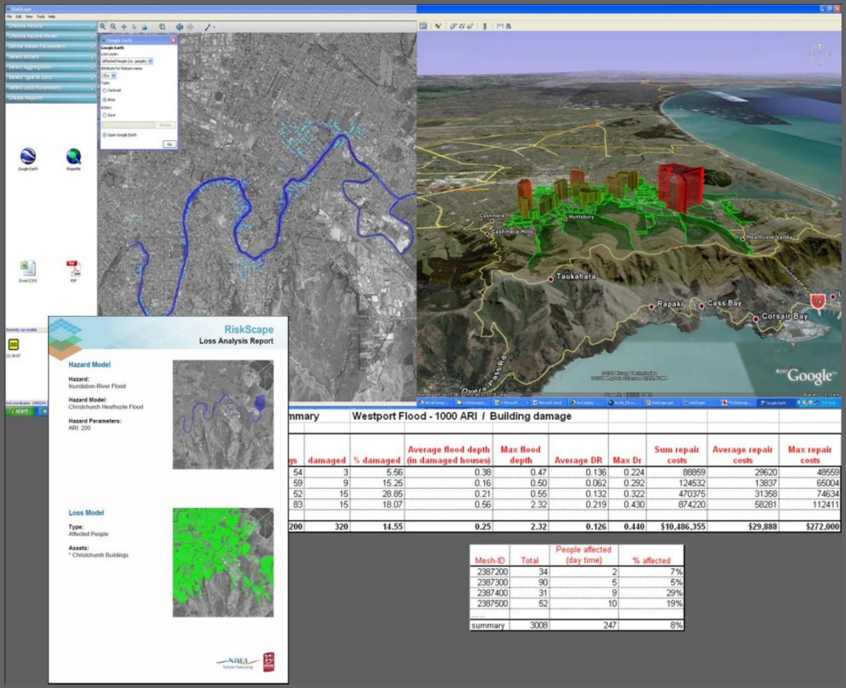
The following resources provide further information on volcanic hazards:

http://www.geonet.org.nz
http://www.gns.cri.nz
http://volcanoes.usgs.gov/ash/index.html
http://www.ivhhn.org

24 August 2010

Drafted by Carol Stewart, Tom Wilson, Scott Barnard and David Johnston

RiskScape



- Multi-hazard impact and risk assessment tool
- Multi-disciplinary, multi-agency research programme (2004)
- VISG outputs helping to develop ash fragility functions

NIWA
Taihoro Nukurangi

GNS SCIENCE
TE PŪ AO

What does GeoNet do?

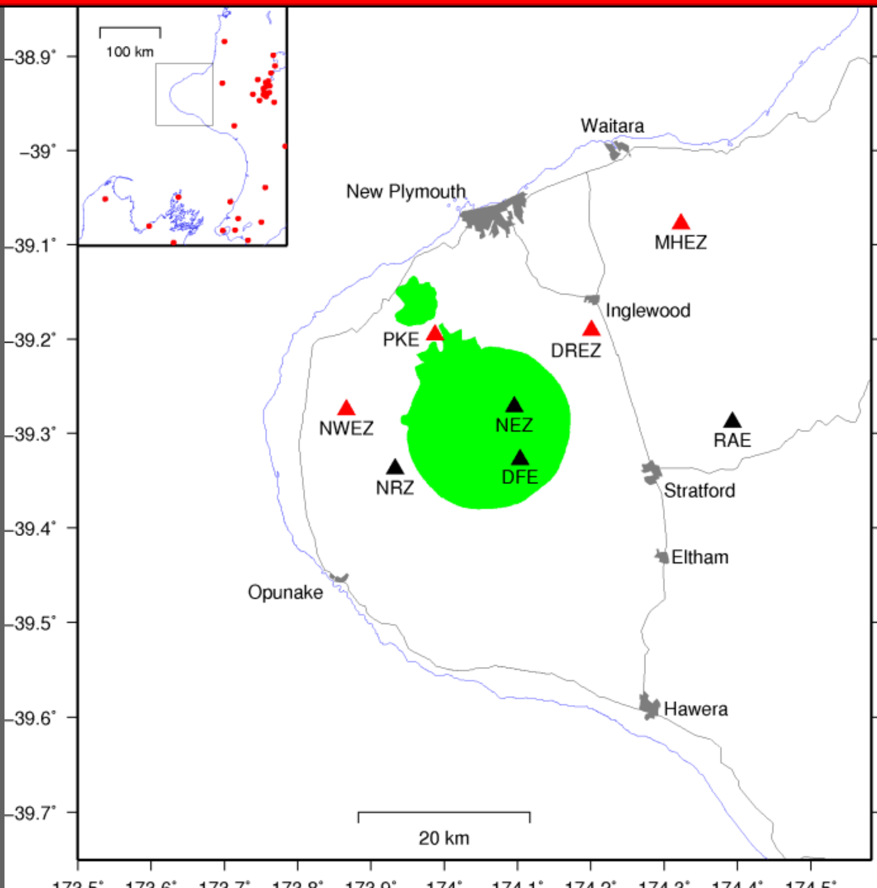
- Runs a national system to *monitor* and *collect data* for research of geological hazards in New Zealand

- It performs: - **Earthquake detection and analysis**
  - Volcano surveillance
  - Landslide response
  - Tsunami detection

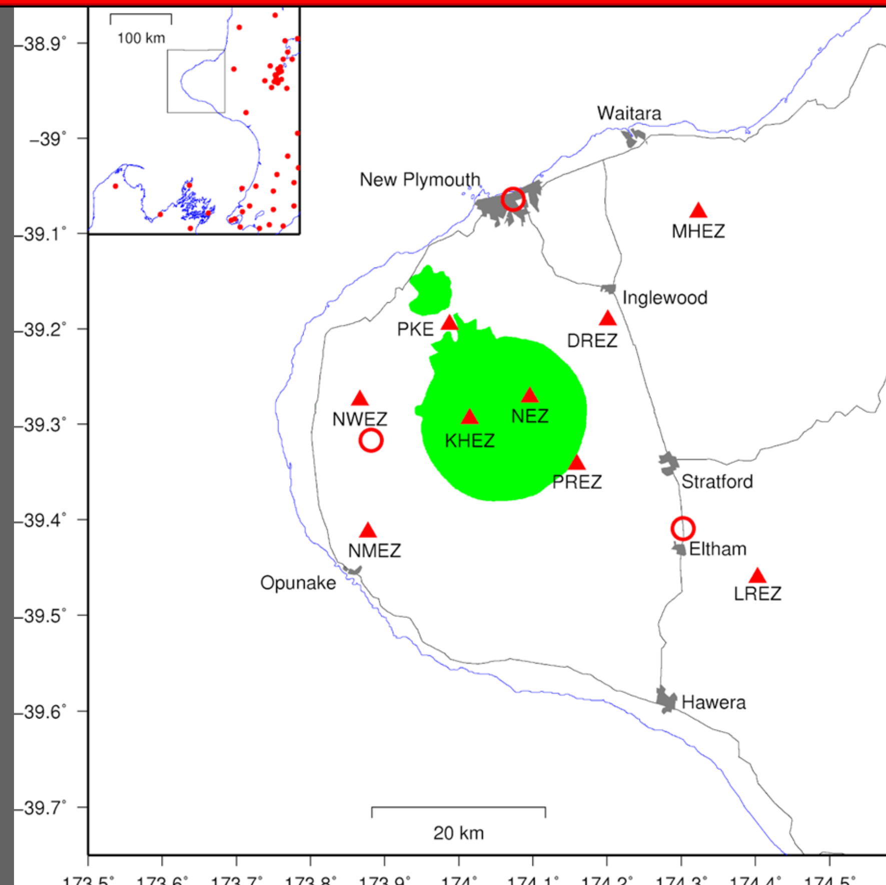
- Deliver information and data to monitoring staff, responding agencies, lifeline utilities, the research community and the general public.




Taranaki: Former Volcano Seismic Network

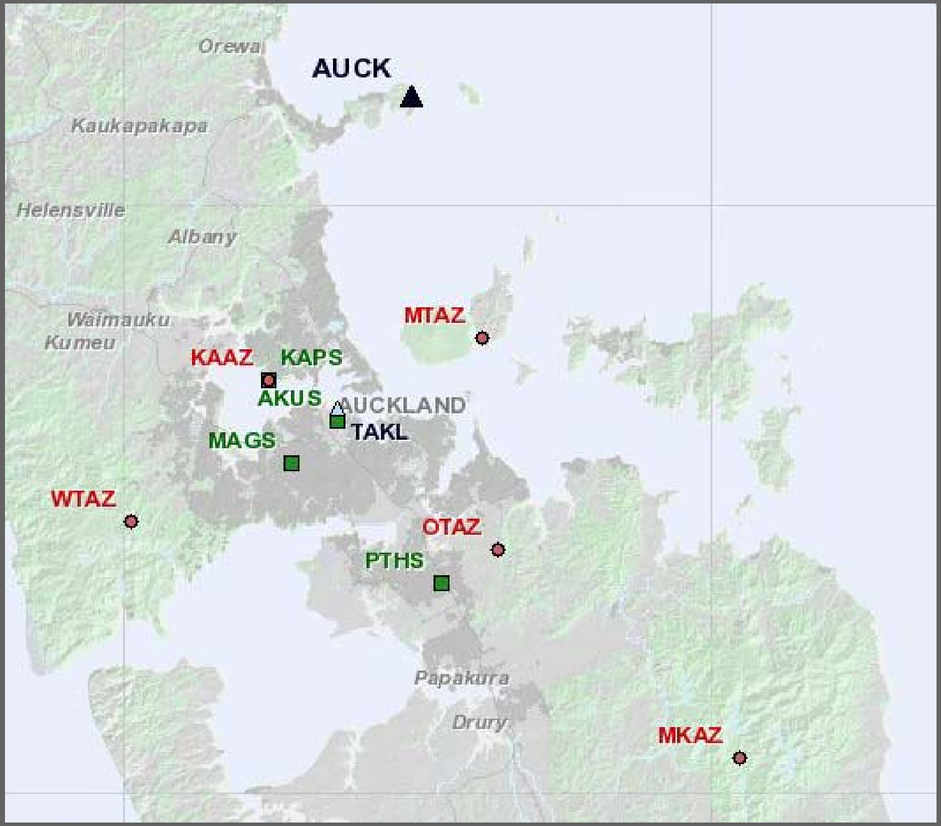


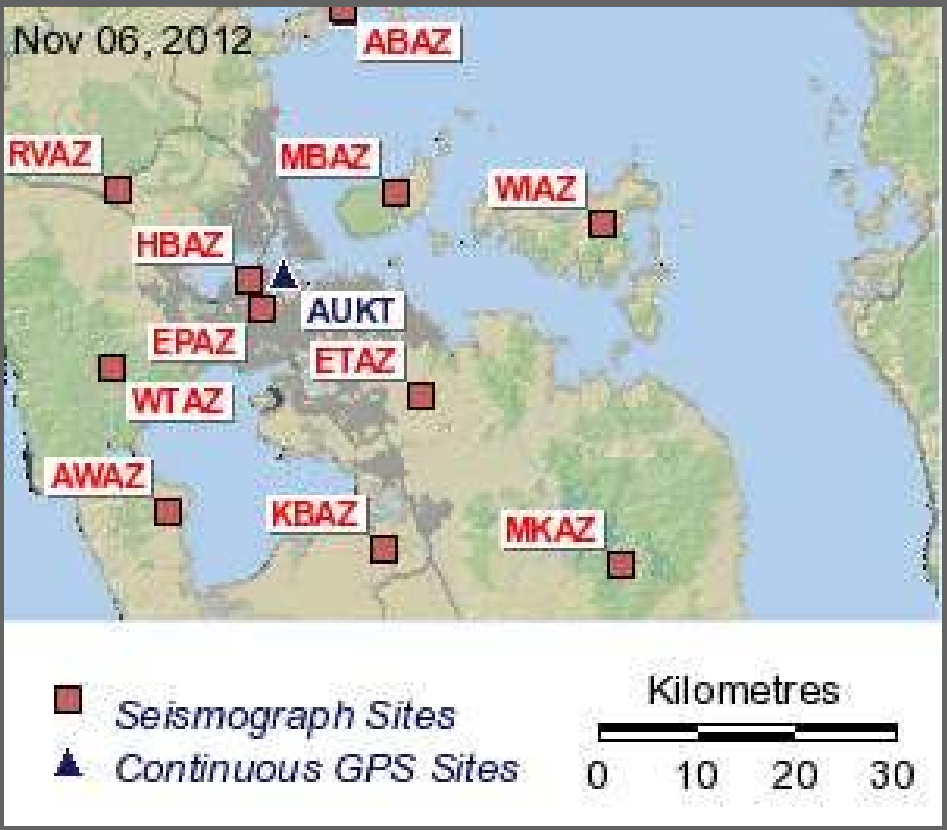
2008
4 three-component
4 vertical-component



2012
9 three-component
3 data hubs

Auckland: Former Volcano Seismic Network





2007

1 three-component
4 vertical-component
4 strong motion

2012

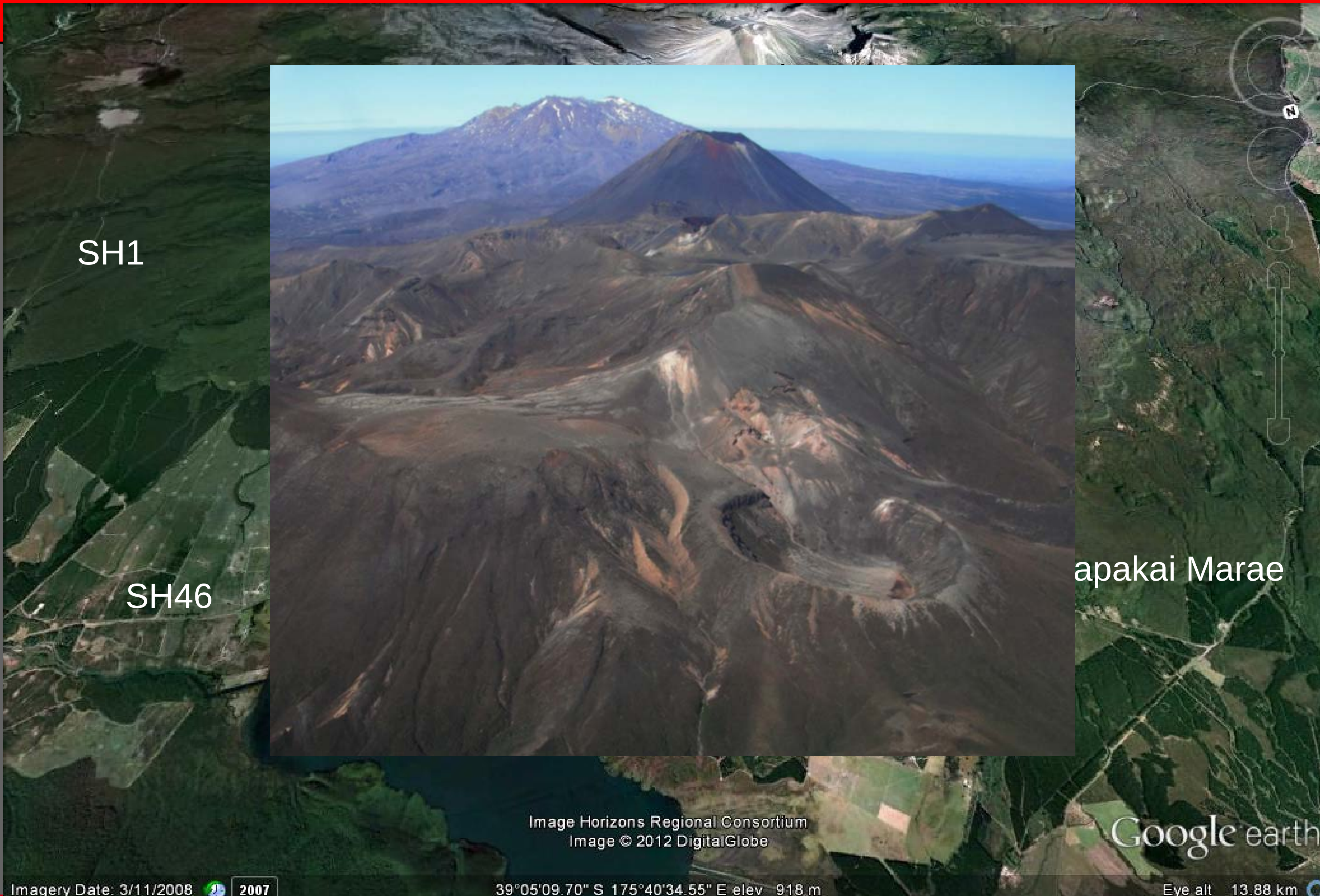
7 deep bore hole three-component
3 surface three component
1 single component borehole
4 strong motion

Tongariro Historical Eruptions

- Older reports are les certain
  - 1855: possibly Te Maari or Red Crater
  - 1869: possibly Tongariro or Ruapehu
  - 1886: ash erupted, uncertain vent
- 1892:
  - Flow had stripped vegetation from one river valley from Te Maari
  - Strong degassing
  - Ash/pumice between Te Maari and Blue Lake

- 1896-7:
  - Steam and ash eruptions
  - Incandescent rocks
  - 5 cm of ash on Desert Road

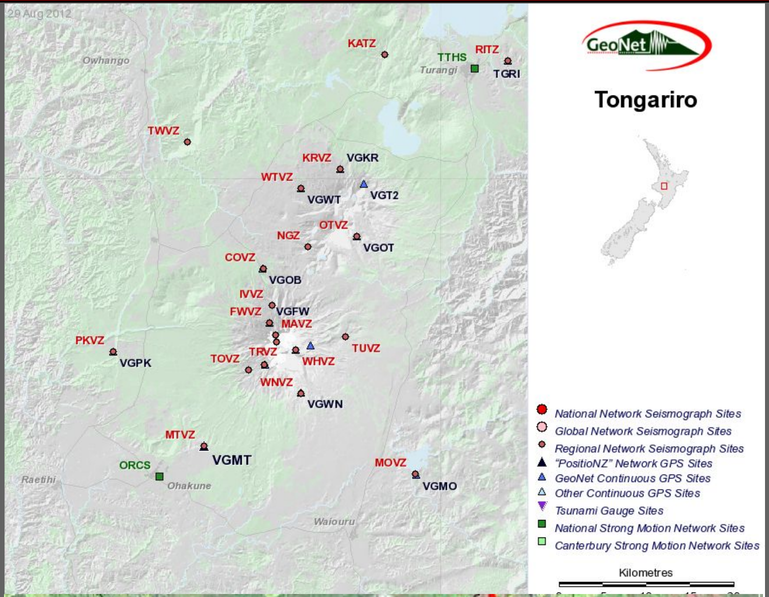
Te Maari (Tongariro)

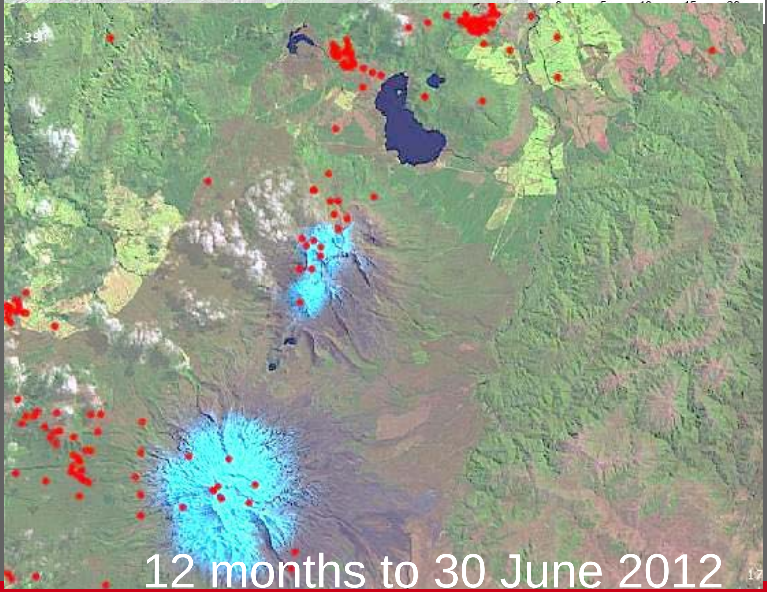


GNS Science

Routine monitoring at Tongariro

- **Seismic monitoring**
  - "Tornillos" since 2001
  - Few other tectonic eqs
- **Annual sampling of fumaroles**
  - No significant changes over several years
- **cGPS network**
  - No significant changes over several years



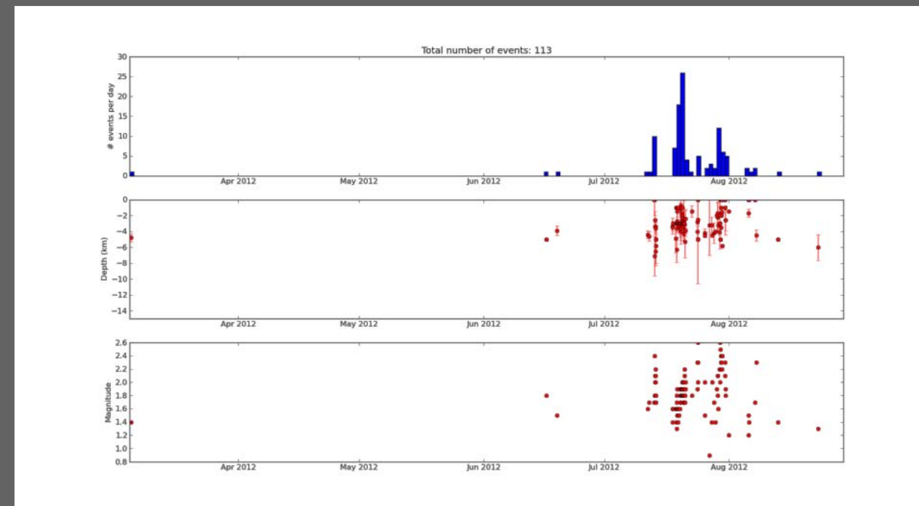


12 months to 30 June 2012

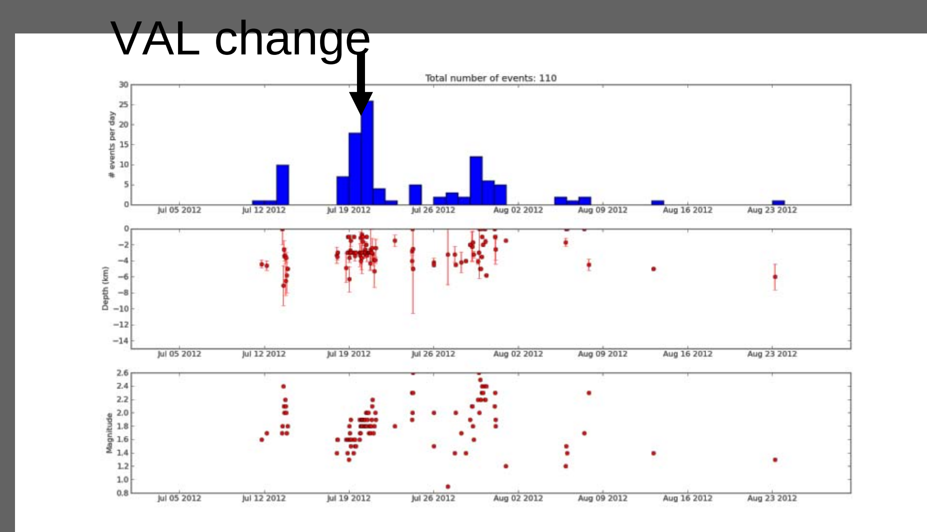
Unrest timeline

Seismicity

- **First earthquakes: 11-13 July – "hybrids"**
- **Main swarm: 18-22 July**

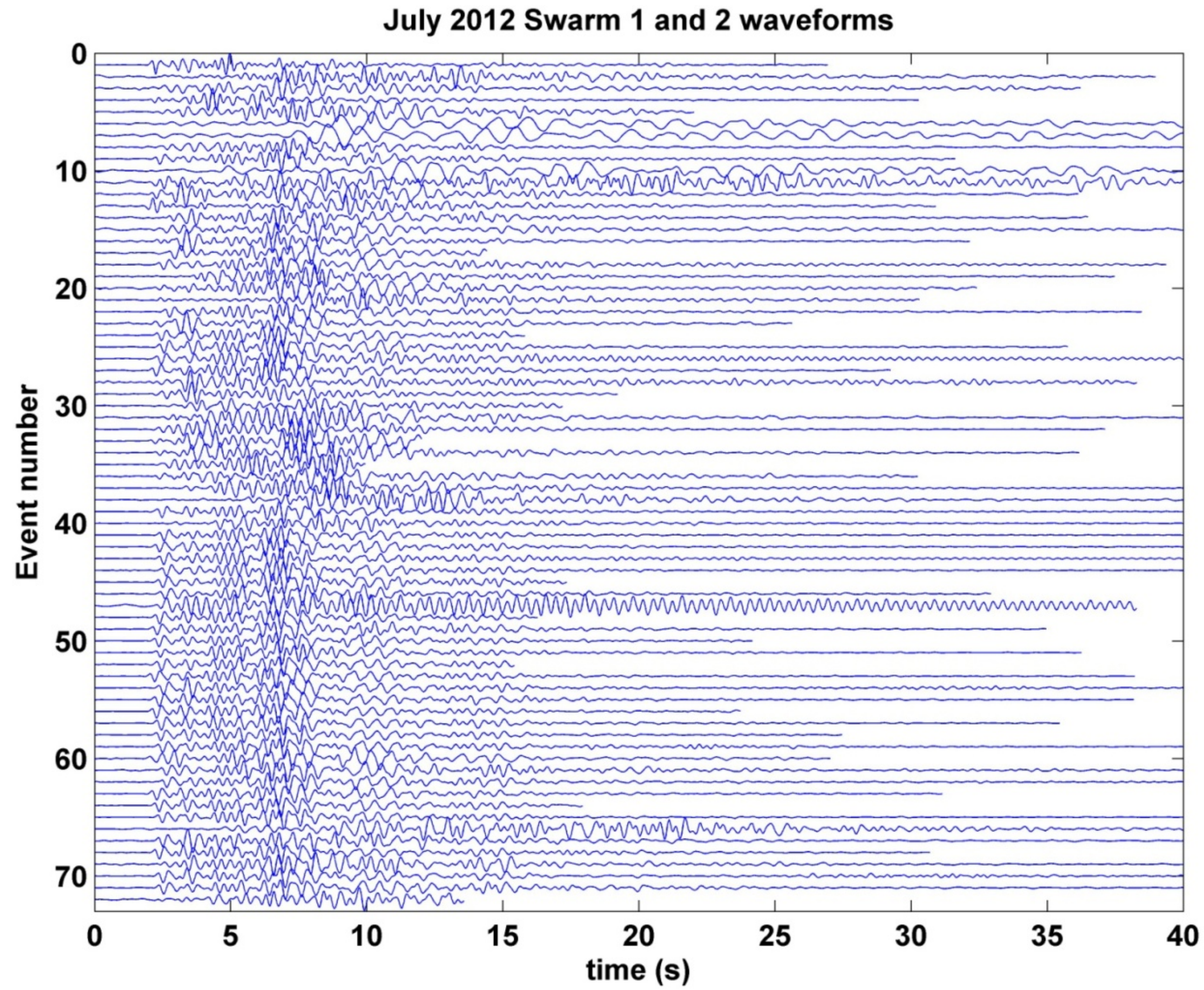


➢ **Increased volcanic alert level to 1 (signs of unrest) on 20 July; aviation colour code to yellow**



- **Minor swarm: 26-31 July**

Similar earthquakes with a few very dissimilar ones



Unrest timeline: 20/21 July

- **20 July: VAL = 1**
- **Response actions**
  - **Informed MCDEM, DOC, MetService, CPVAG chair, SFG members**
  - **Contacted iwi**
- **Field work: 21 July**
  - **Additional seismic stations installed inc. one at Te Maari**
  - **Additional fumarole sampling (Te Maari and Oturere) undertaken**

Unrest timeline – 23 July

- **Put out seismic stations = stop the earthquakes!**
- **Geochemistry data = magmatic signature**

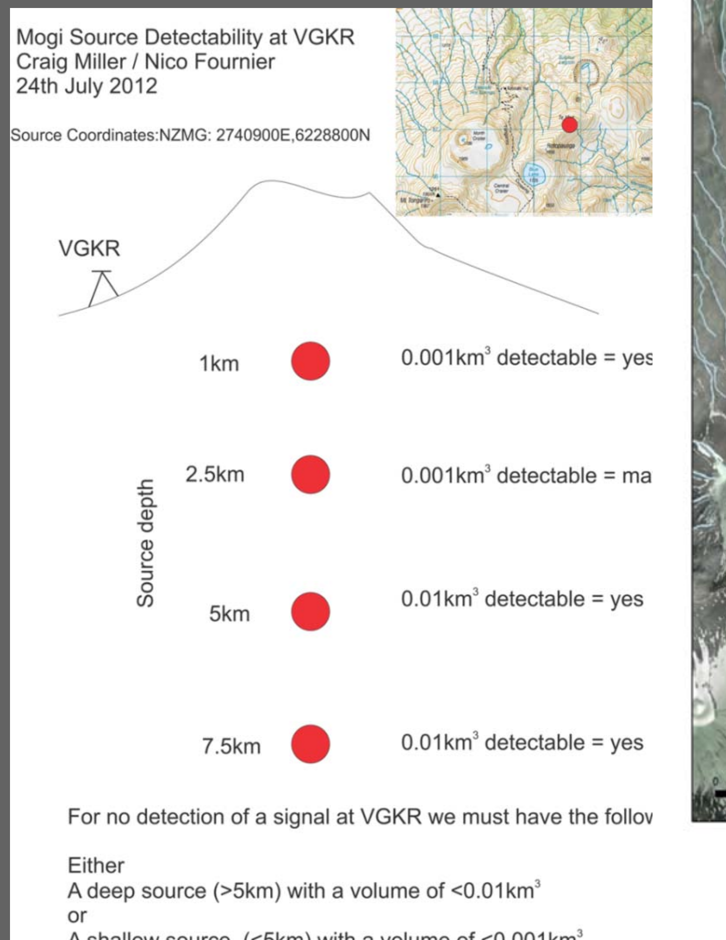
Site	N_2/Ar	H_2/Ar	CO_2/CH_4	CH_4/CO
Te Maari - 2001	95	0.1	14800	na
Te Maari-May 2012	92	0.1	5400	13.6
Te Maari-July 2012	**1251**	**65**	**91000**	**8.9**

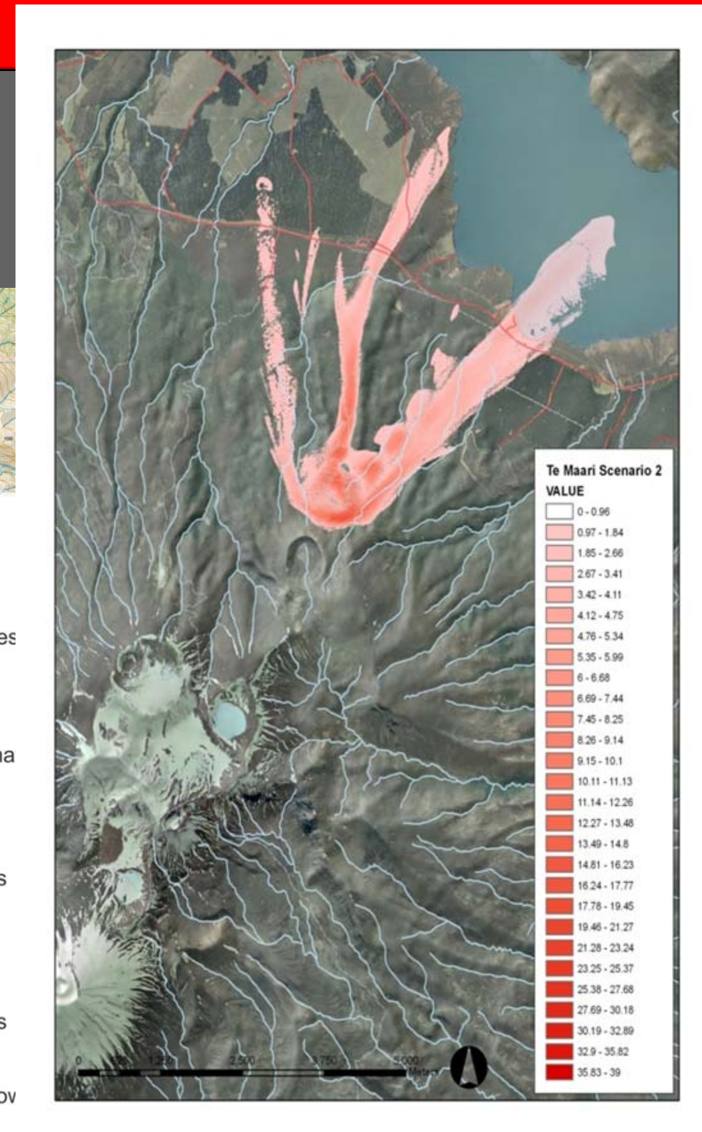
An easy volcano to deal with?

- Limited infrastructure impacted?
  - Major Transpower lines
  - Intake to Genesis hydropower
  - SH1, 46
- Low population density?
  - Up to 400 people over summer months at Rotoaira
  - Tongariro Alpine Crossing
  - Cultural sensitivity
- Low hazard?
  - Ashfall and ballistics
  - Lahars
  - Pyroclastic density currents

Developing models and scenarios

- **Understanding historic activity (GNS, Massey, Waikato)**
- **Geodetic models**
- **Flow models (Massey)**





Engagement with community

- Liaison through DOC with iwi for sampling and site installs
- Papakai Marae hui facilitated by DOC on 31 July

Photo: Harry Keys

Papakai Marae hui – 31 July

- Presented latest data and possible scenarios
- Extensive discussion about local response plans
- Criticisms (of DOC, GNS, Taupo DC):
  - Hadn’t informed community earlier
  - Maunga is tapu: wouldn’t allow anyone on the mountain again
  - Incorrect pronunciation
- We listened
  - Continued to engage
  - Te Ariki apologised

Future scenarios (31 July version)

- Most likely: the unrest will decrease to background

- Next most likely: escalation of unrest to minor eruption – possibly like 1892 or 1896/7

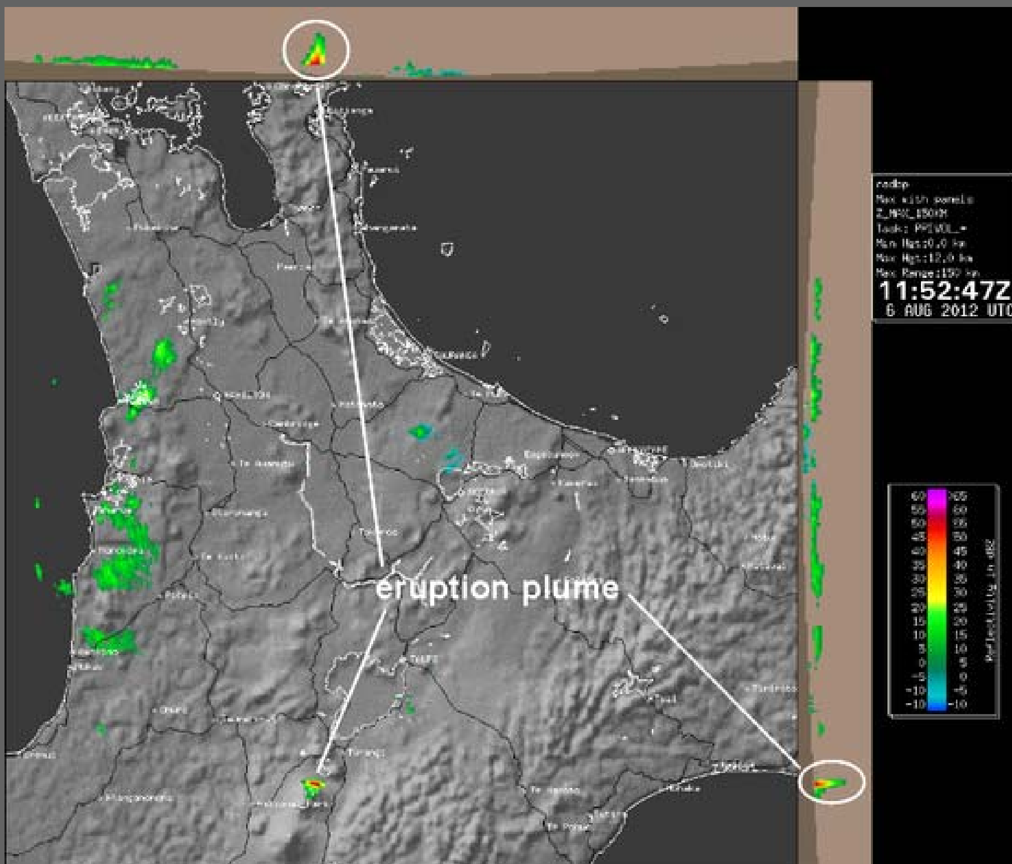
- Least likely: eruption develops into a large event – like the three large eruptions between 10,000 and 15,000 years ago

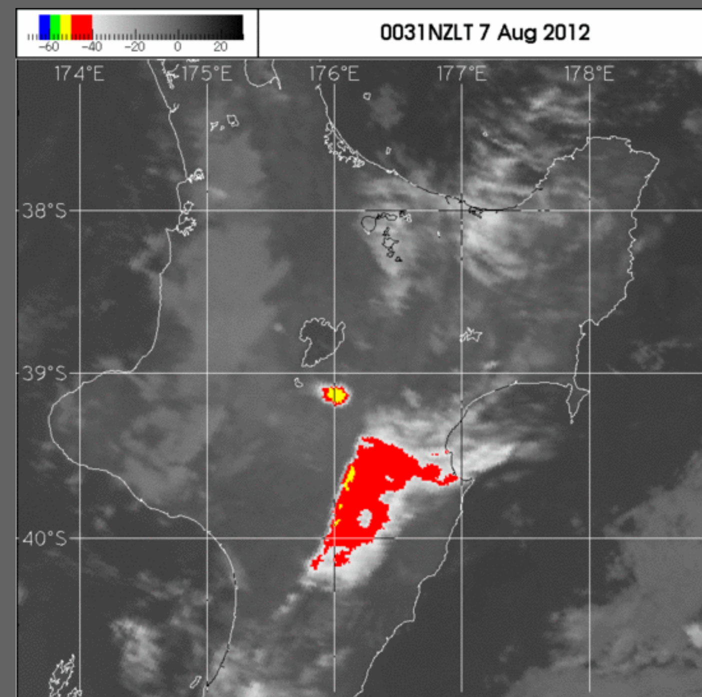
Next Minute …….

6 August 2012: the eruption

- The eruption started at 23:52 and lasted a few minutes
- Initial rumbling noise
- Three jets: to west, to east and straight up
- Lightning in ash clouds
- Ballistics up to 2 km from vents
- Eruption column rose to about 6-7 km and ash fell to beyond the east coast between Gisborne and Hawke's Bay
- Produced several new craters, focussed on the 1896 craters (Upper Te Maari)
- Debris flow/lahar down Mangatipua stream

Eruption images (remote sensing)





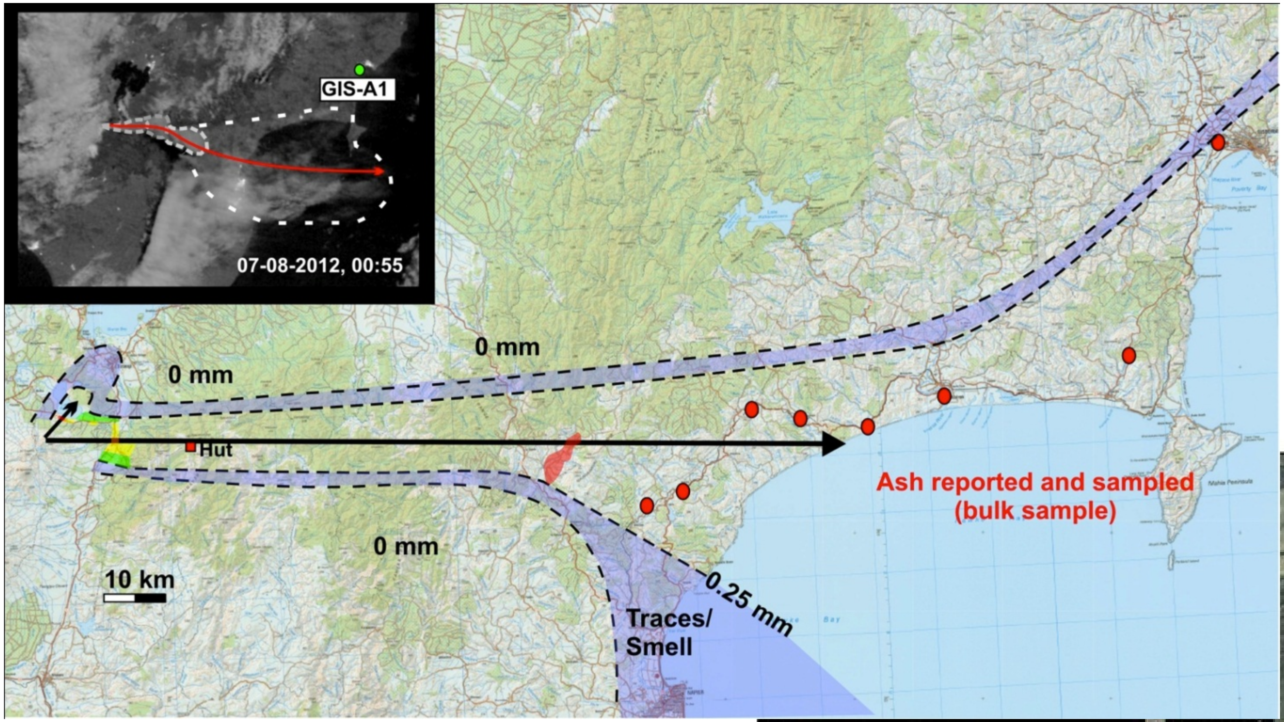
Images: MetService and NIWA

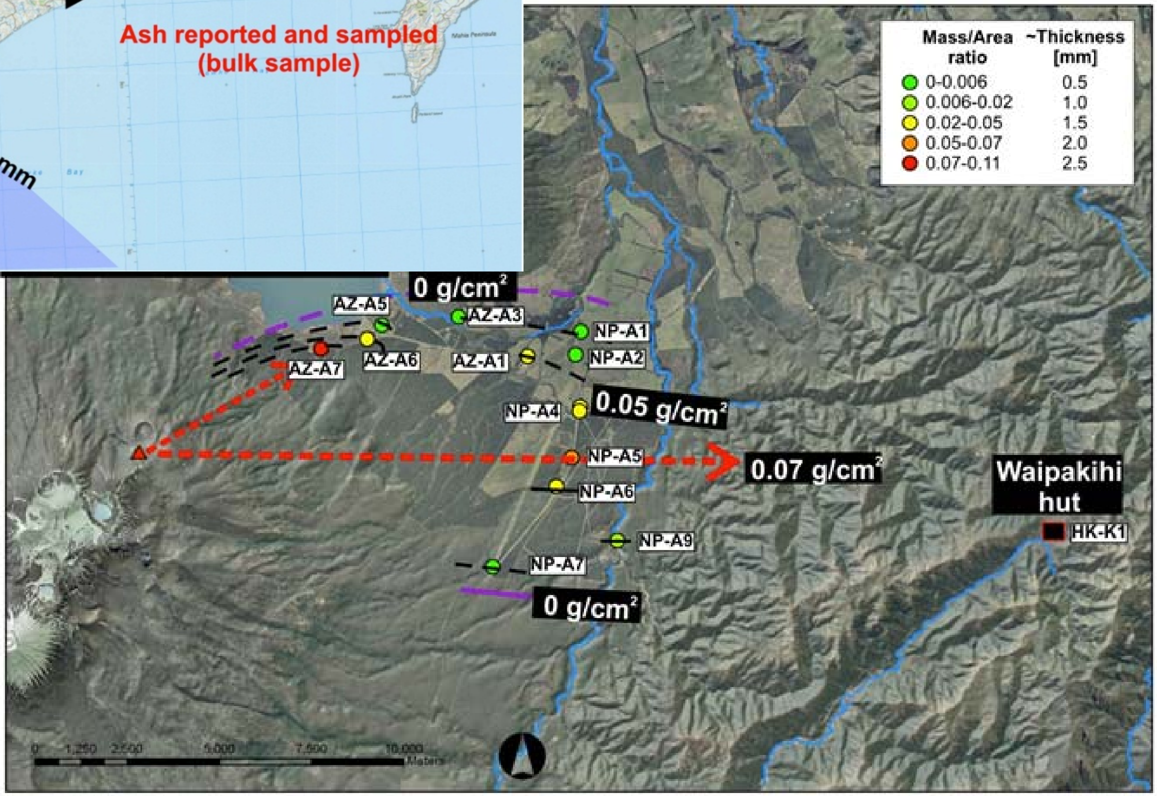
The new landscape

Ashfall and ballistic blocks

Impacts

Tongariro – Distal ash fall distribution





Chemical/health concerns of future ash falls

- Fluoride concentrations 20-70 ppm (moderately high)
- Sulphur concentrations 1500-3225 ppm (very high)

- Acidic
- Very fine grained

- *Health implications for future ash falls* – drinking water from rainfall systems – taste and appearance will be unpleasant before harmful concentrations of F or other elements are reached.
- Acid rains could start if the gas plume is persistently overhead
- Fine ash can cause asthma, eye and lung irritation

- *Agriculture implications for future ash falls* – if ash is covering pasture, supply supplementary feed.
- Replace stock water if troughs are discoloured or stock not drinking
- Longer term positive/fertiliser effect

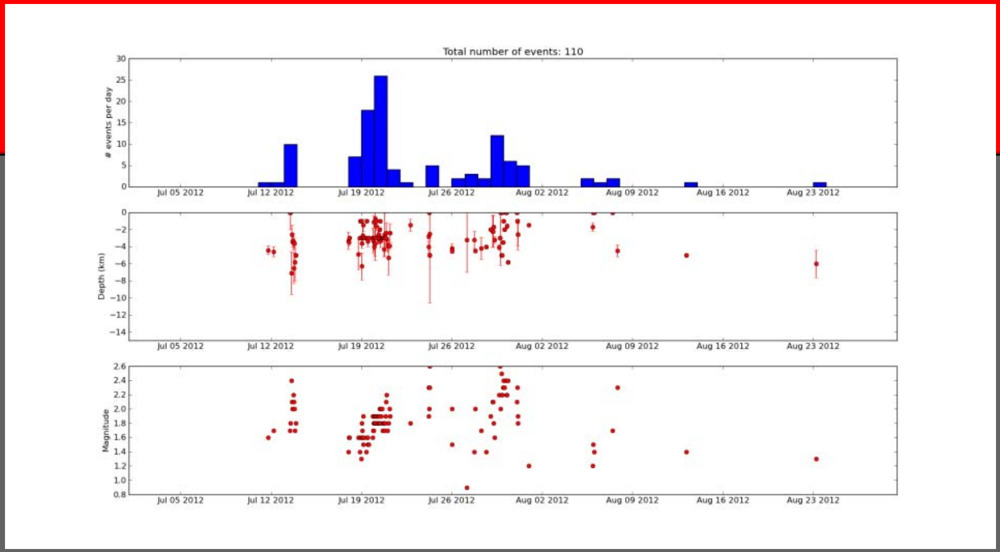
Debris avalanche/lahar

- Travelled ca. 2 km
- Caused by probable collapse of crater wall
- Several phases of flow?

- Remobilisation of debris flow or sudden release of dammed water could threaten c 1 km of Tongariro Alpine Crossing, SH46 culvert 14.14 and areas downstream

- Assesed/monitored by DoC, Massey Uni and TDC

Since the eruption



- Seismicity: quiet
- Observations
  - Deposits
  - Ballistics
  - Debris flows
- Collected more gas

Date	SO_2	H_2S	CO_2
9 August	2091	364	3900
22 August	380	-	-
29 August	150	30	420
Ruapehu (24 August)	24	0.2	790

Frequent reports of gas smell in lower North Island

Photo: Brent Alloway

Current understanding

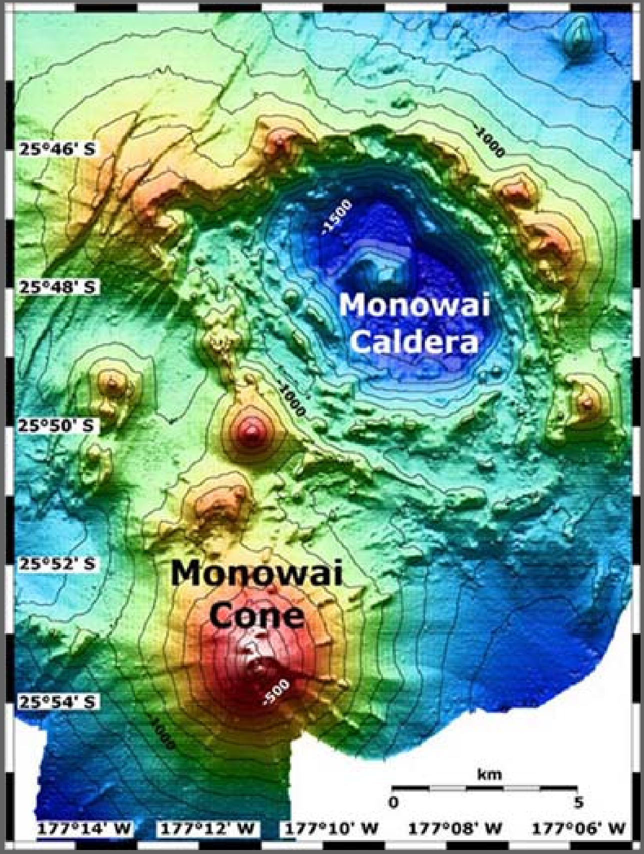
- The eruption was driven by gas with little or no new magma
- Probably initiated by a landslide from west side of Te Maari: triggered by or caused earthquakes?
- Magma is somewhere under the volcano, but from our data we can’t tell exactly where or how much
- Magma could be involved in future eruptions

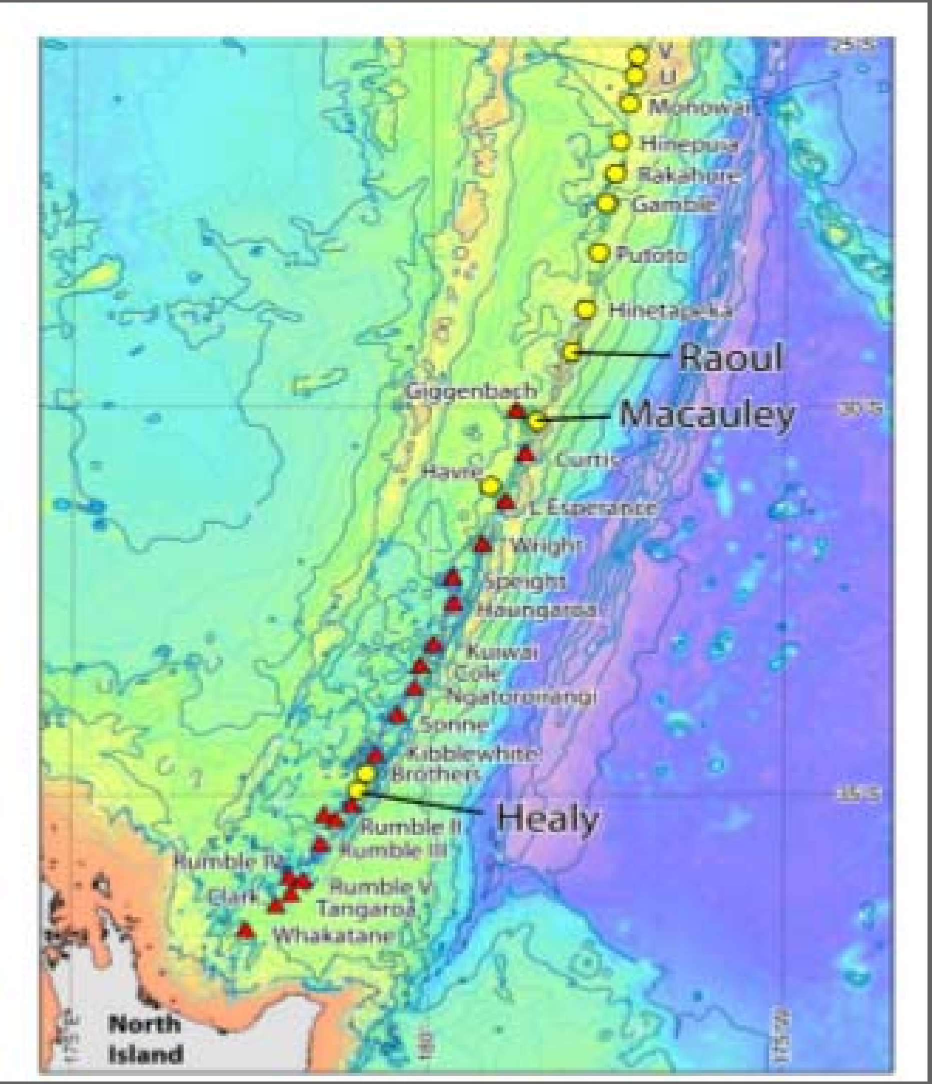
White Island

- Gas flux changes
- Deformation, crater floor uplift
- Rapid lake level changes (5-7 m overnight)
- Volcanic tremor and volcanic earthquakes

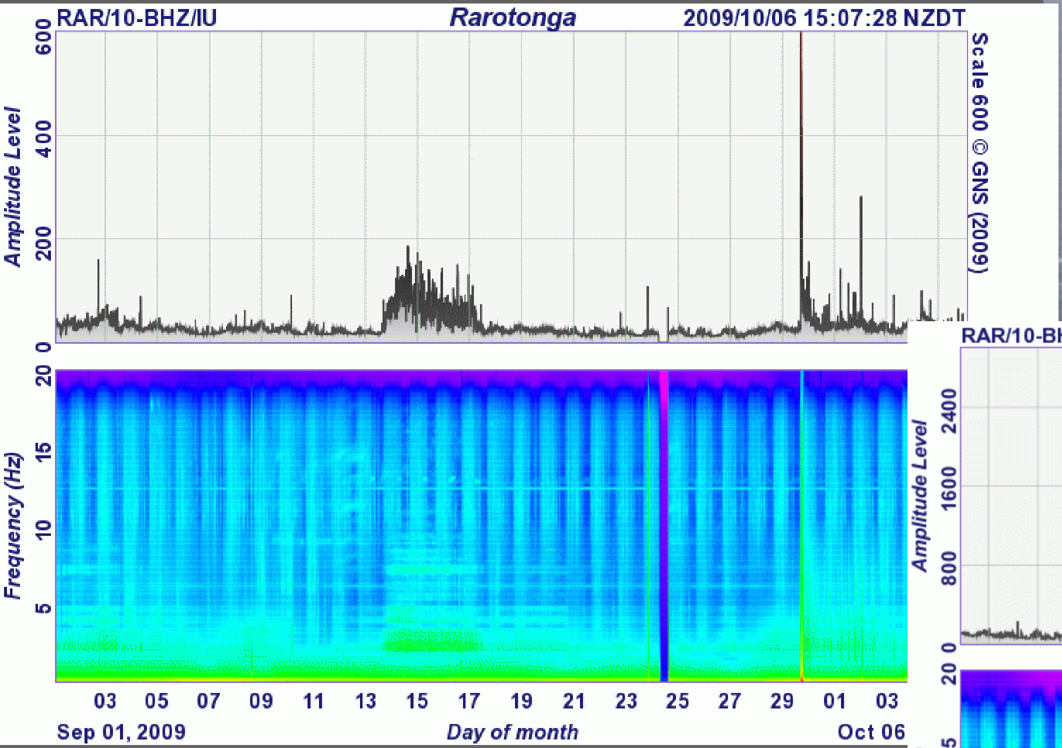


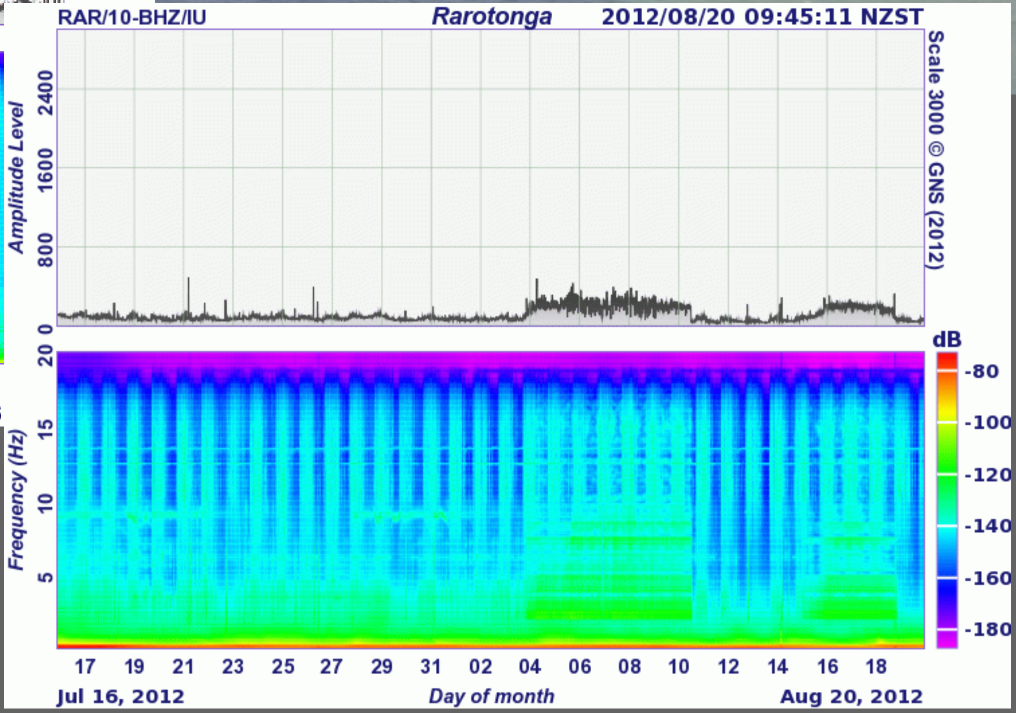
Kermadec's: submarine volcanoes



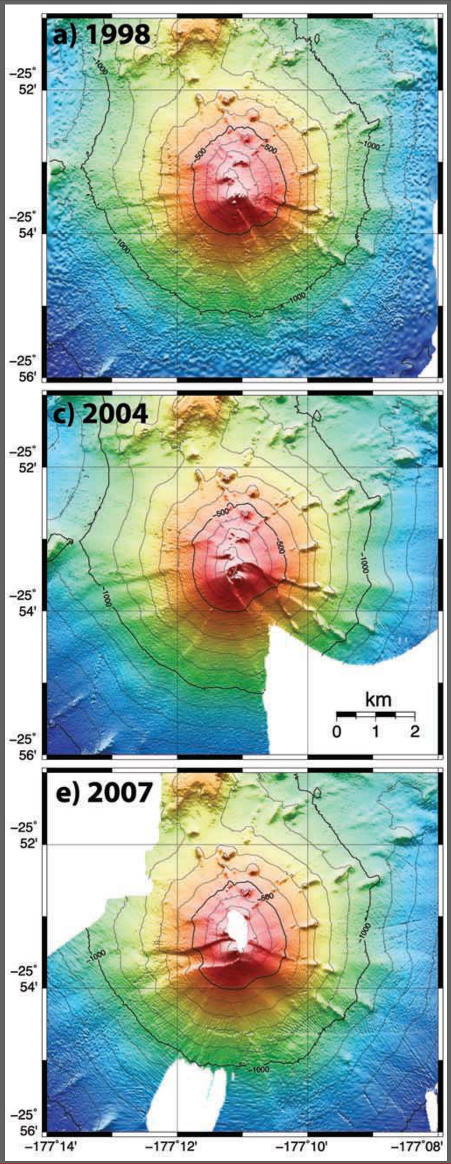


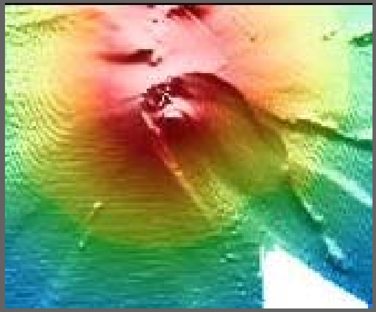
Typical Monowai eruptions

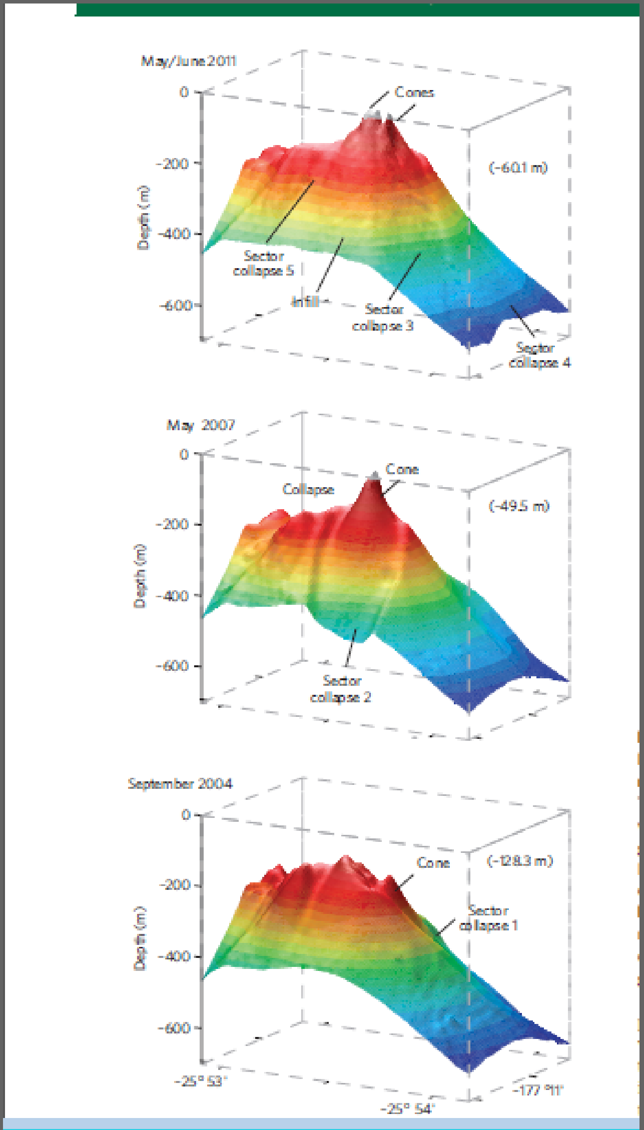




Changes at Monowai



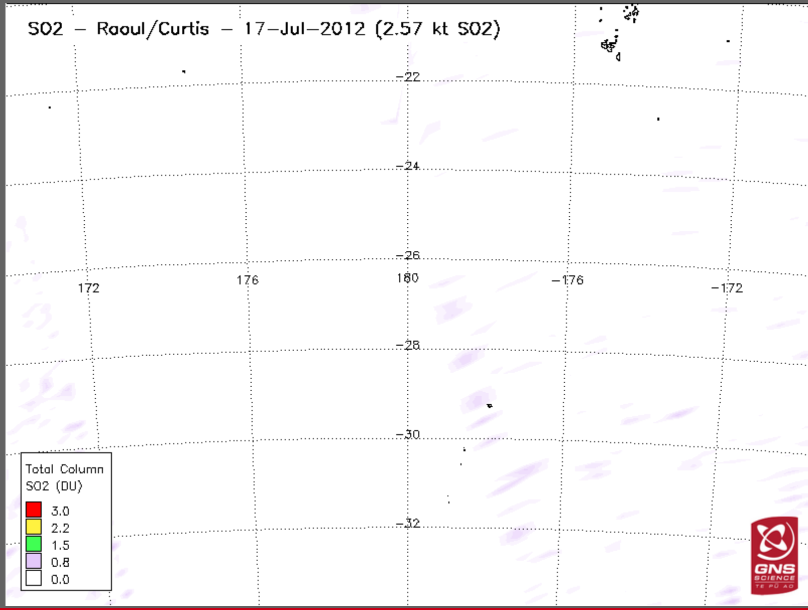




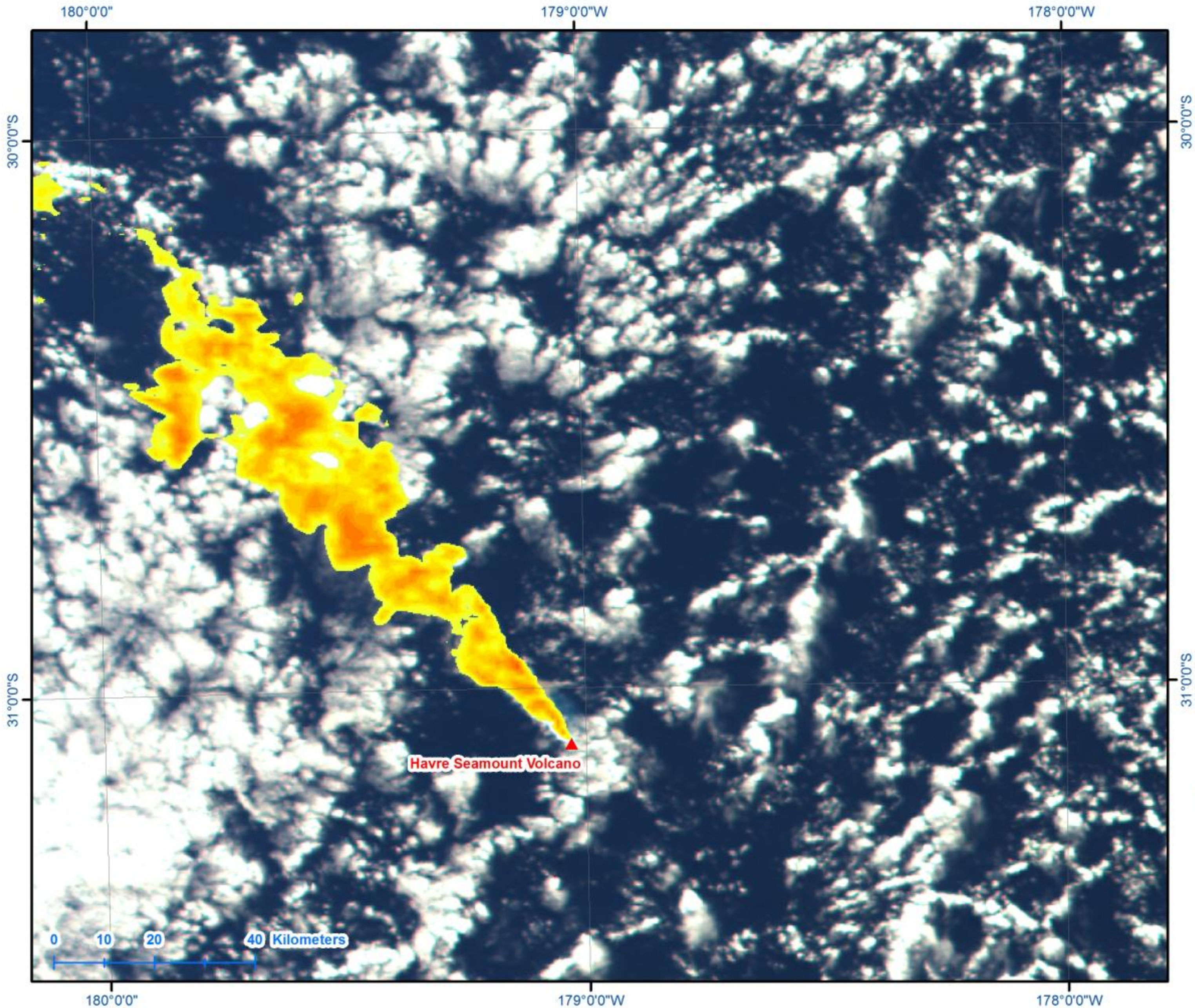
Havre submarine eruption

- **Pumice raft reported by aircraft**
  - **RNZAF mapped it**
- **Remote sensing teams (French/USA)**
  - **Back traced plume to Harve**

- **Eruption started about July 17**
  - **No gas plume (OMI)**



Havre Seamount pumice raft, Kermadec Islands



Legend

Cloud Temp. (band 20)

High : 34°C

Low : 21°C

MODIS, Terra
(bands 1, 4, 3, 250 m res.)
2012/07/18 - 21:50 (UTC)

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