

**Volcanoes**  
**2010 National Lifelines Forum**



Brad Scott  
Volcano Surveillance Coordinator



# 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.





# Volcanoes



active in the past  
300 years



active in the past  
10 000 years

# The Volcano Problem

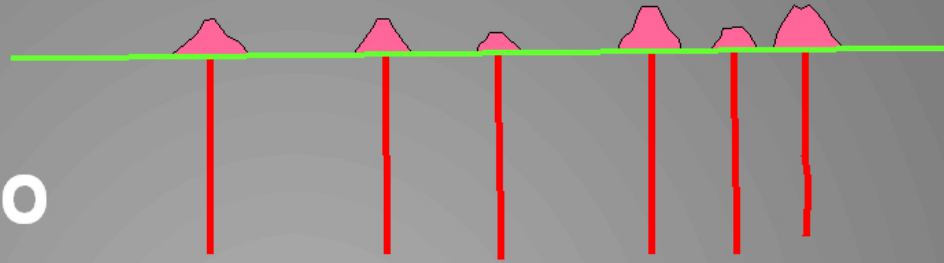
- Where are the volcanoes ?
- Are there various types ?
- What do we do when they are active?
- Past eruptions
  - How big have they been?
  - Where have they affected ?
  - How often have they occurred ?
- Future eruptions
  - How big ?
  - How often ?
  - When ?
  - What area would be affected ?



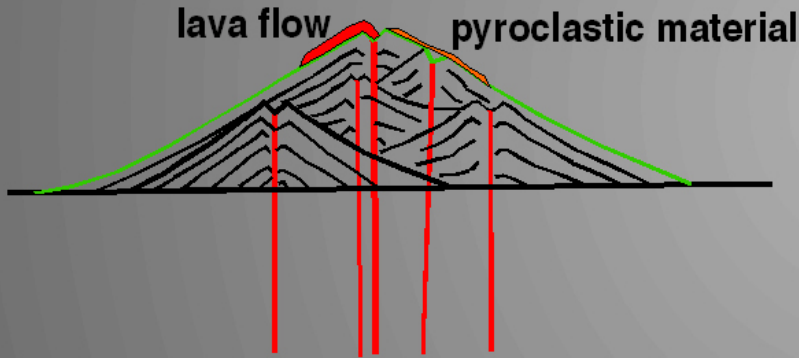


## Volcano Types

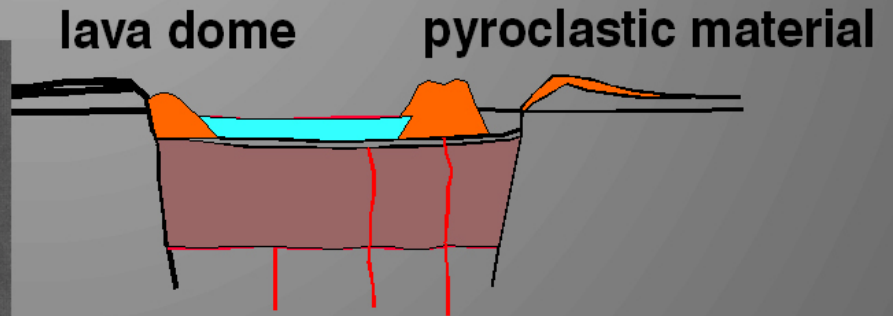
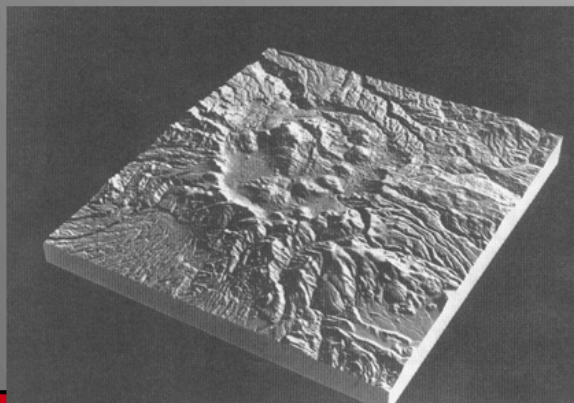
### Volcanic Field (Auckland)



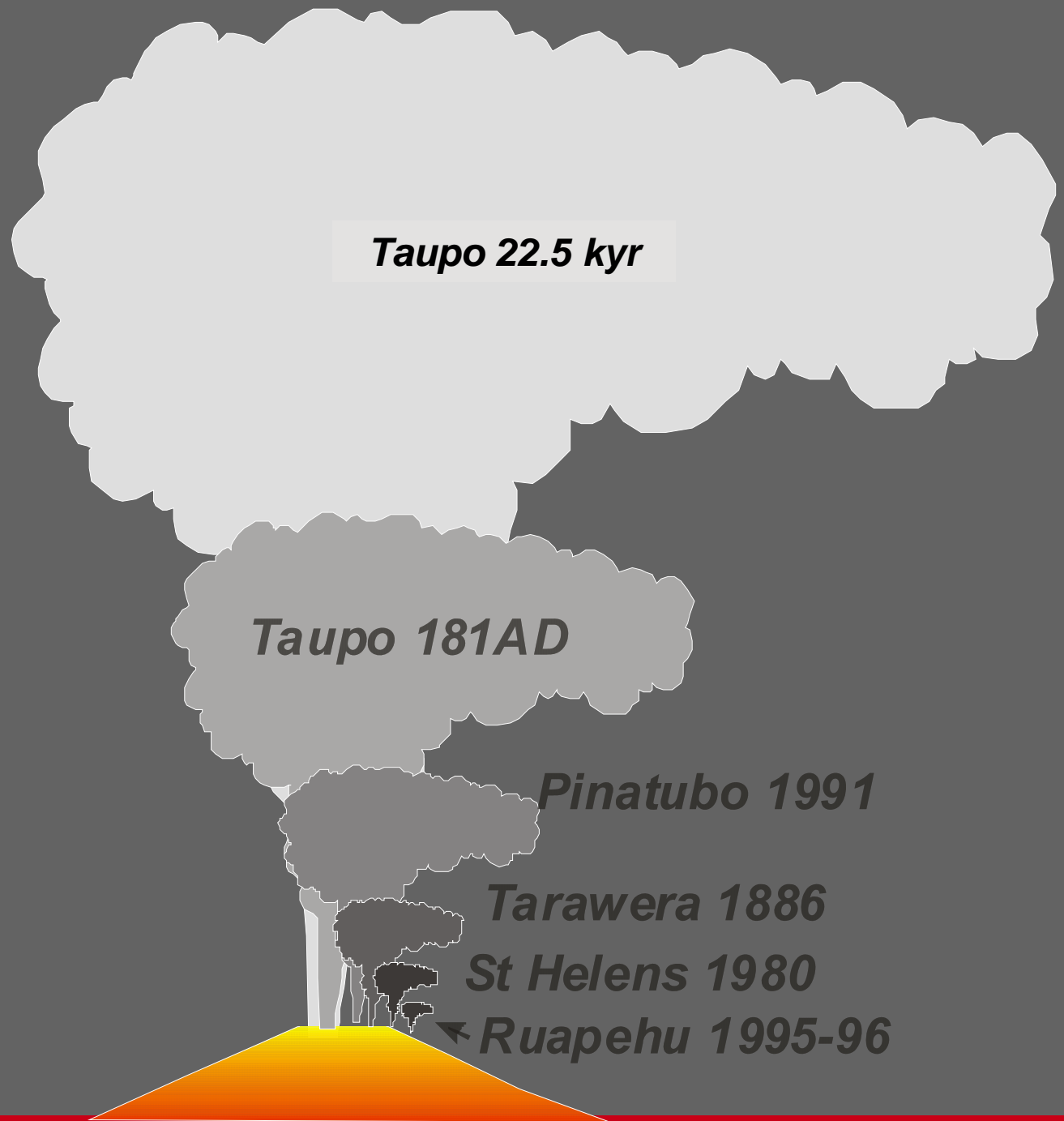
### Cone Volcano (Ruapehu, Egmont)



### Caldera Volcano (Taupo, Okataina, Raoul)



## Eruption Sizes



# A motivator in New Zealand Ruapehu Ash Impacts

Lessons:

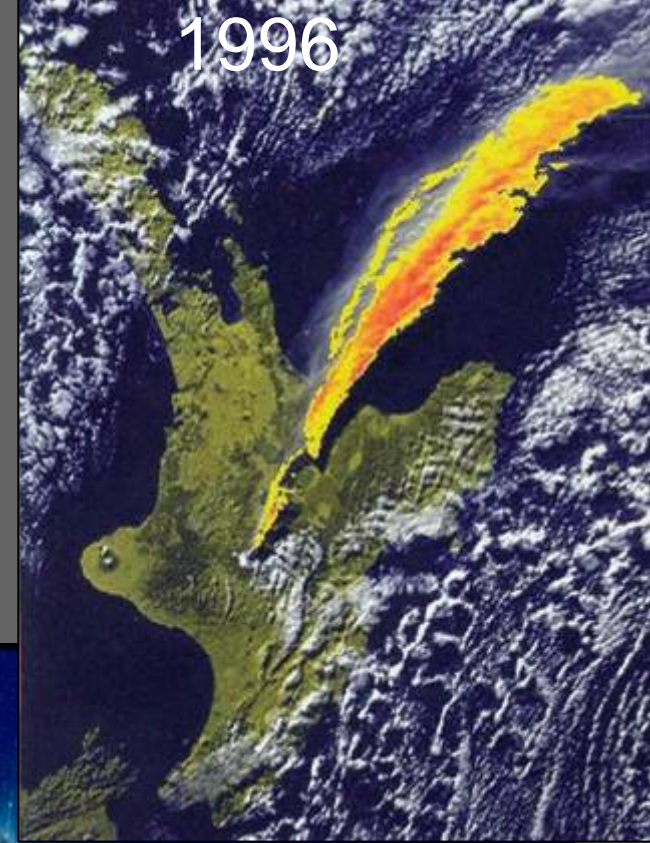
Air traffic

Ash cleanup

Electrical generation &  
transmission

Water and wastewater

Agriculture



23 September 1995





## Total Economic Impacts 1995-1996



|                | 1996    | 2010 value |
|----------------|---------|------------|
| tourism        | \$99.2M | \$133.2M   |
| electricity    | \$21.5M | \$28.9M    |
| central govt.  | \$ 5.7M | \$7.7M     |
| aviation       | \$ 2.4M | \$3.2M     |
| district govt. | \$ 0.6M | \$0.8M     |
| agriculture    | \$0.4M  | \$0.5M     |
| region. govt.  | \$0.2M  | \$0.3M     |

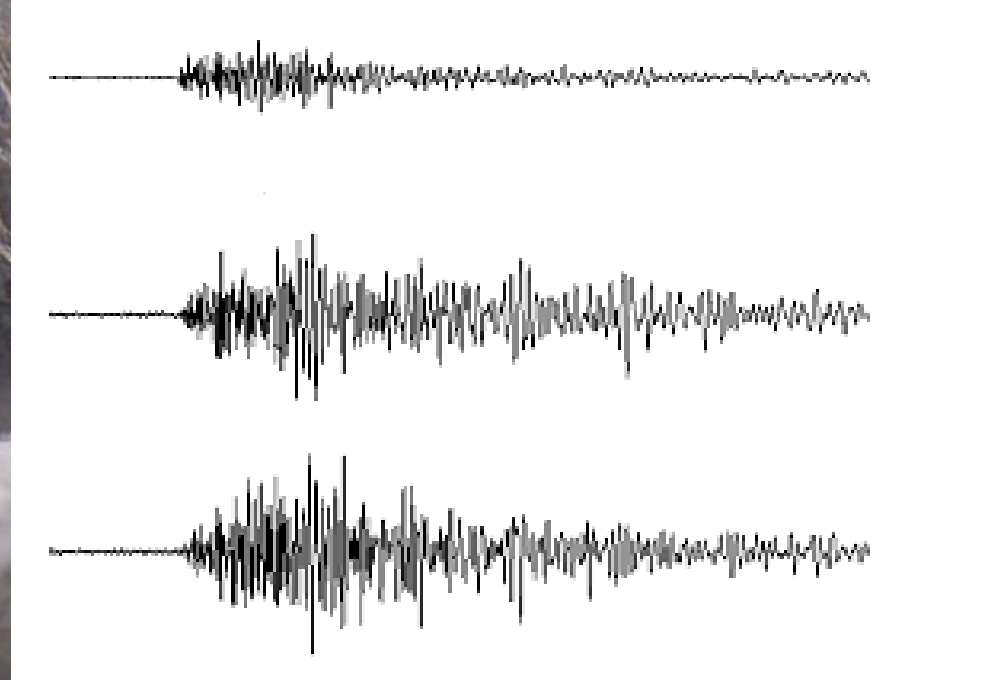
**TOTAL**      NZ\$130M **NZ\$175M**

|                  | 1945      | 1995 | 1996  |
|------------------|-----------|------|-------|
| Auckland         |           |      | ◆     |
| Hamilton         |           |      | ◆     |
| Whakatane        |           | ◆    | ◆     |
| Opotiki          |           | ◆ ◆  | ◆     |
| Gisborne         |           | ◆    | ◆ ◆   |
| Wairoa           |           | ◆ ◆  |       |
| Rotorua          |           | ◆ ◆  | ◆     |
| Taupo            | ◆ ◆ ◆ ◆   |      | ◆ ◆ ◆ |
| The Chateau      | ◆ ◆ ◆ ◆   | ◆    | ◆ ◆   |
| Iwikau           | no record | ◆    | ◆ ◆ ◆ |
| Taumarunui       |           |      | ◆ ◆   |
| Ohakune          | ◆ ◆ ◆ ◆   |      | ◆     |
| Waiouru          | ◆ ◆ ◆     | ◆    |       |
| Taihape          | ◆         | ◆    |       |
| Hawke's Bay      | ◆ ◆ ◆ ◆ ◆ | ◆ ◆  | ◆ ◆   |
| Wanganui         | ◆ ◆       |      |       |
| Palmerston North | ◆         |      |       |
| Wellington       | ◆         |      |       |

# Volcano Surveillance

GeoNet monitors all of New Zealand's active volcanos using:

- Water and gas chemistry
- Volcanic earthquakes and tremor
- Ground deformation
  
- Satellite based techniques
- Visual observations
- Photographs
- Lake, stream and spring temperatures



Continual monitoring of volcanos can provide early warnings of unrest or an impending eruption.





# Volcanoes What are they up to



active in the past  
300 years



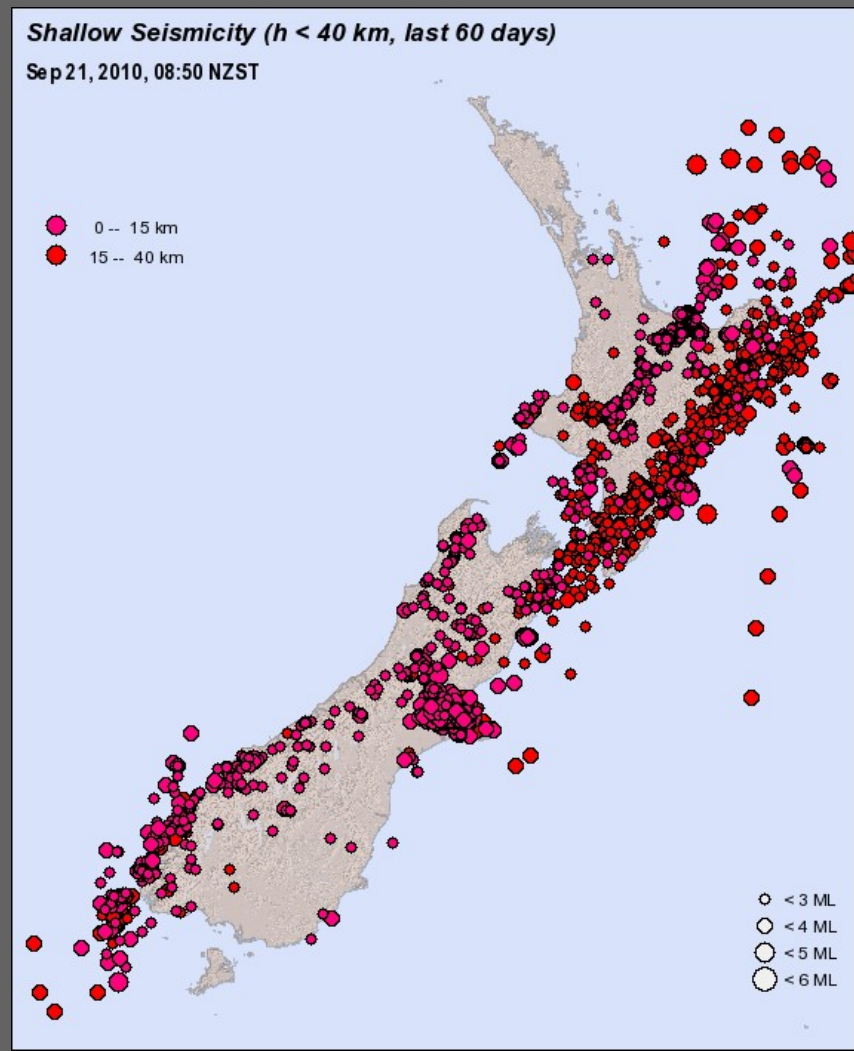
active in the past  
10 000 years



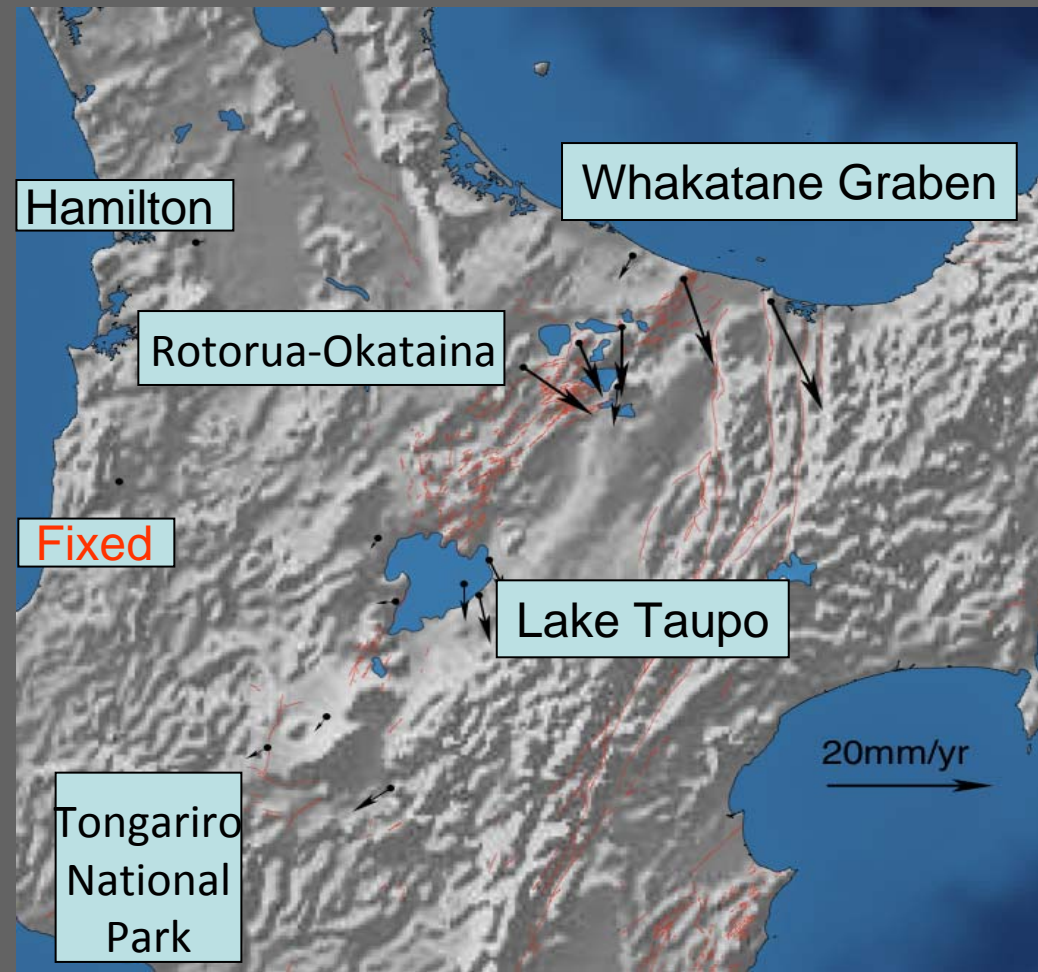


# Big Picture:

## recent Earthquakes (60 days)

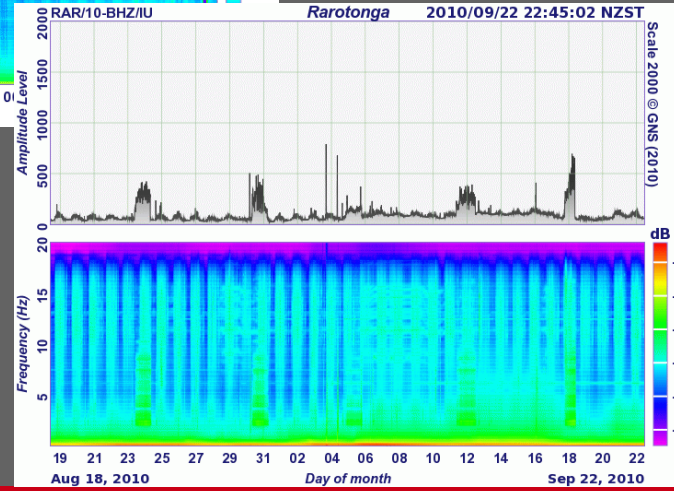
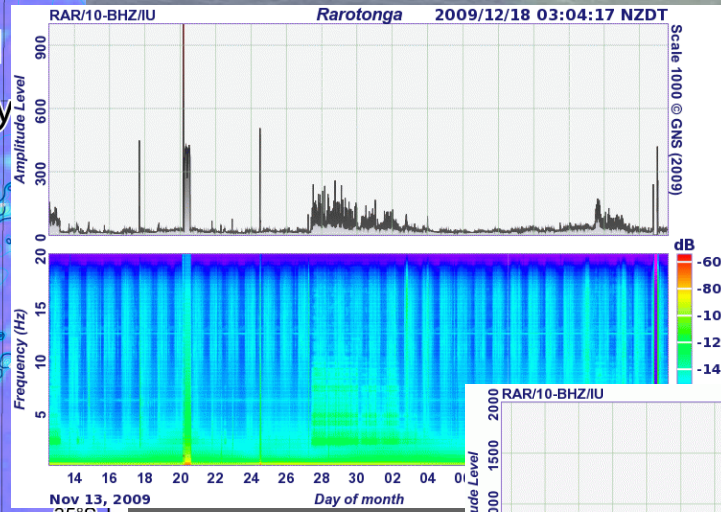
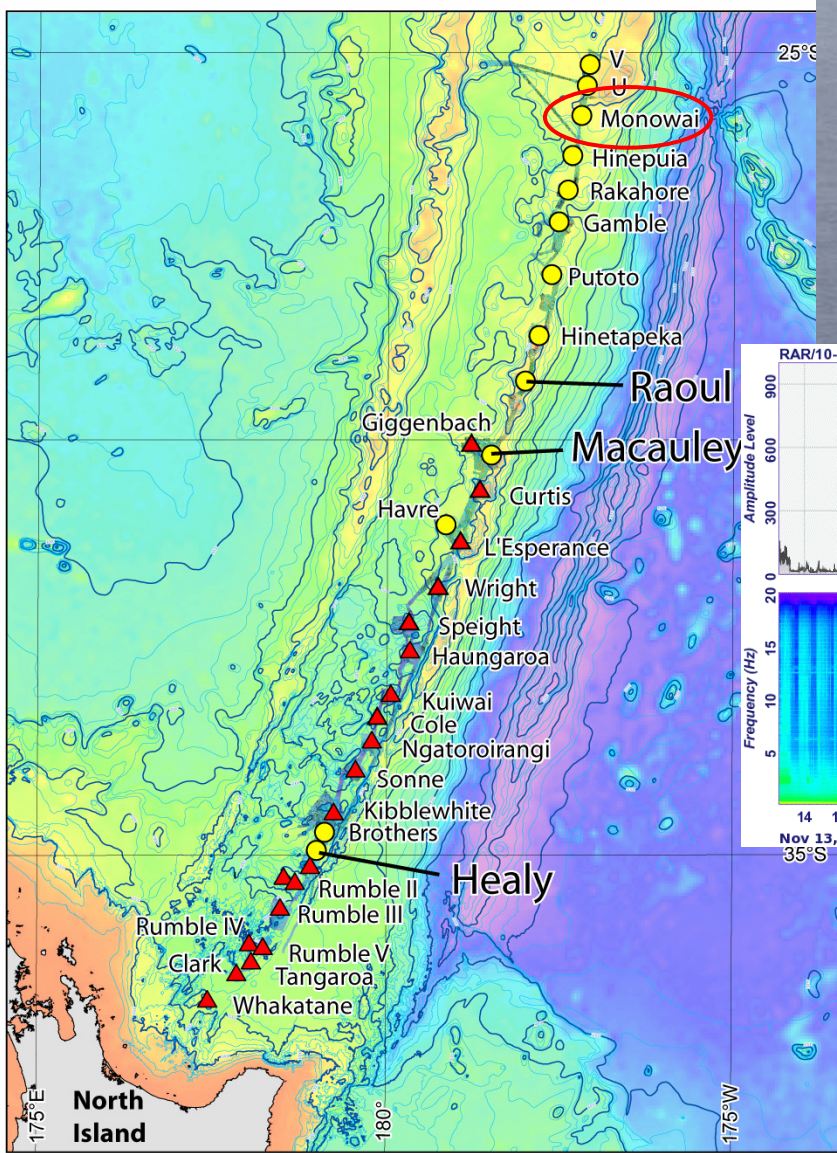
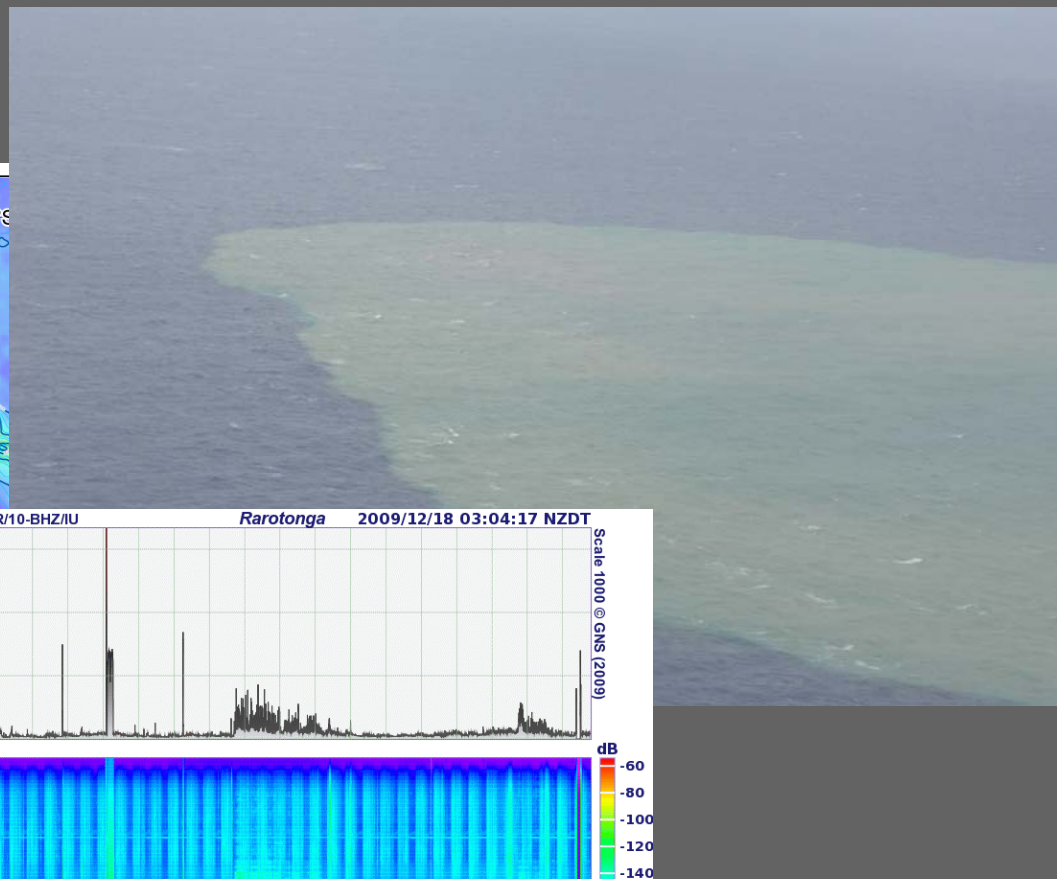


## cGPS displacements





# Kermadecs





# Raoul Island

*Recent eruptions: 1814,  
1870, 1964, 2006*



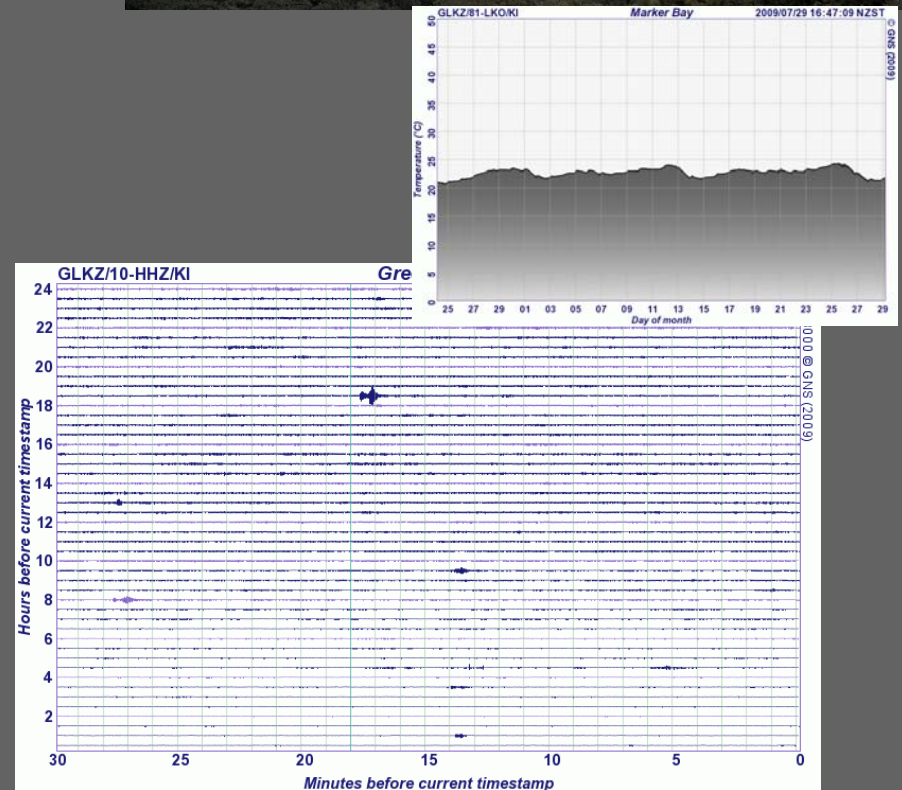
2009 Jul 29 02:45 pm NZST

RAOUL ISLAND

© Institute of Geological and Nuclear Sciences Ltd.

- Web cam
- Green Lake seismometer
- Green Lake temperature and water level
- Marker Bay Spring
- 2 tsunami gauges

CTBTO site (2004)





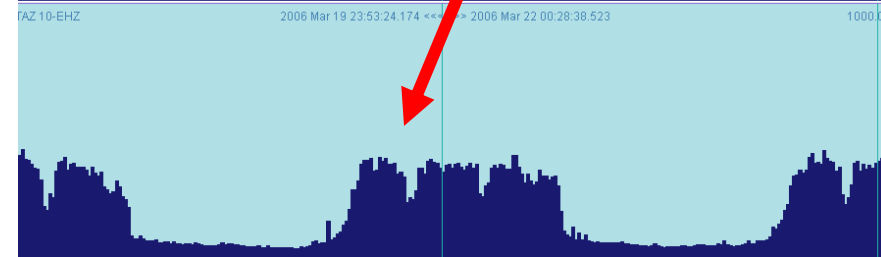
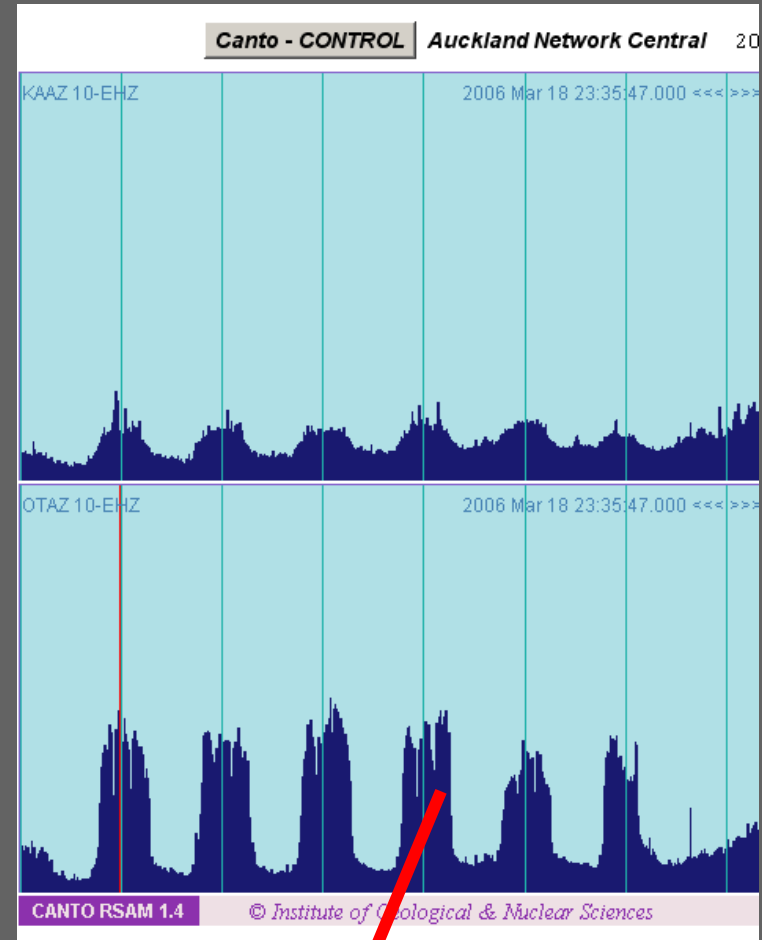
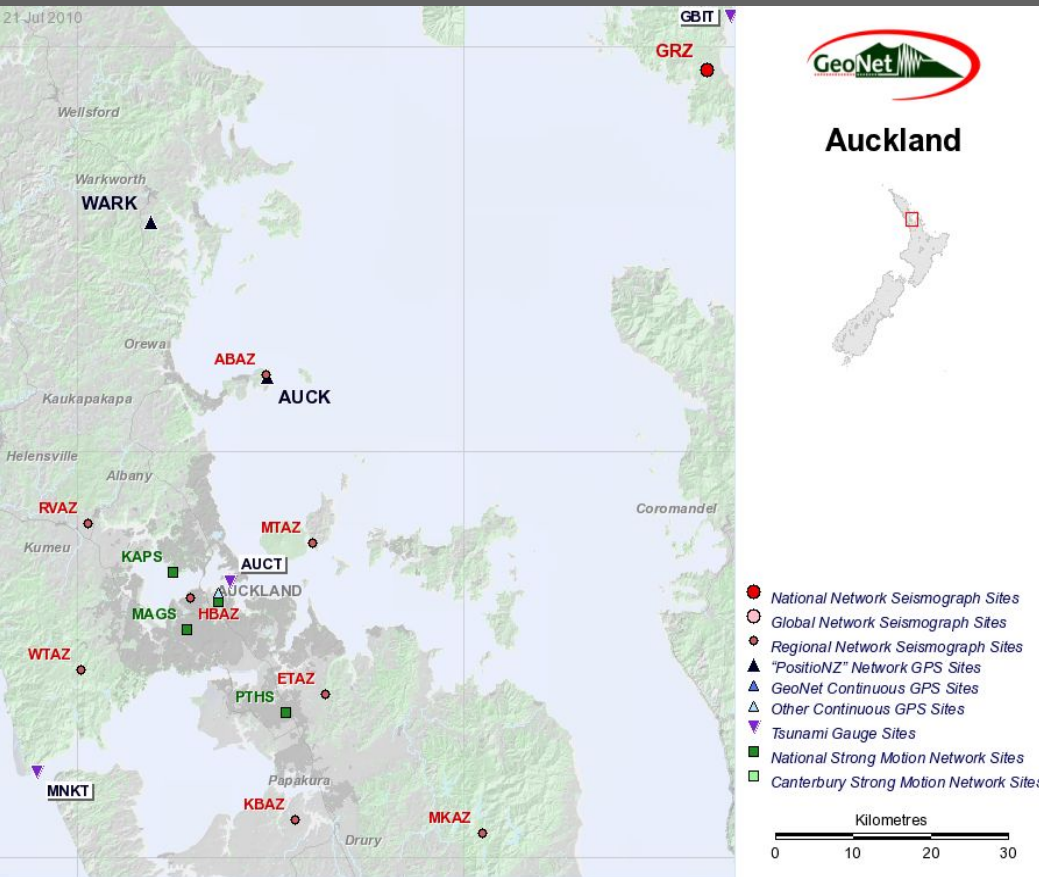






# Auckland Volcanic Field

- Seismic Network
  - upgraded by GeoNet (4 boreholes)
- Typically locates 1-2 earthquakes each year.
- cGPS
- Strong motion seismic





# White Island



- August 1998: 27 days at VAL 2
- Dec 1998 to February 1999: 61 days at VAL 2
- April to September 2000: 154 days at VAL 2

Last explosive eruption July 2000  
2001-2010 no eruptions

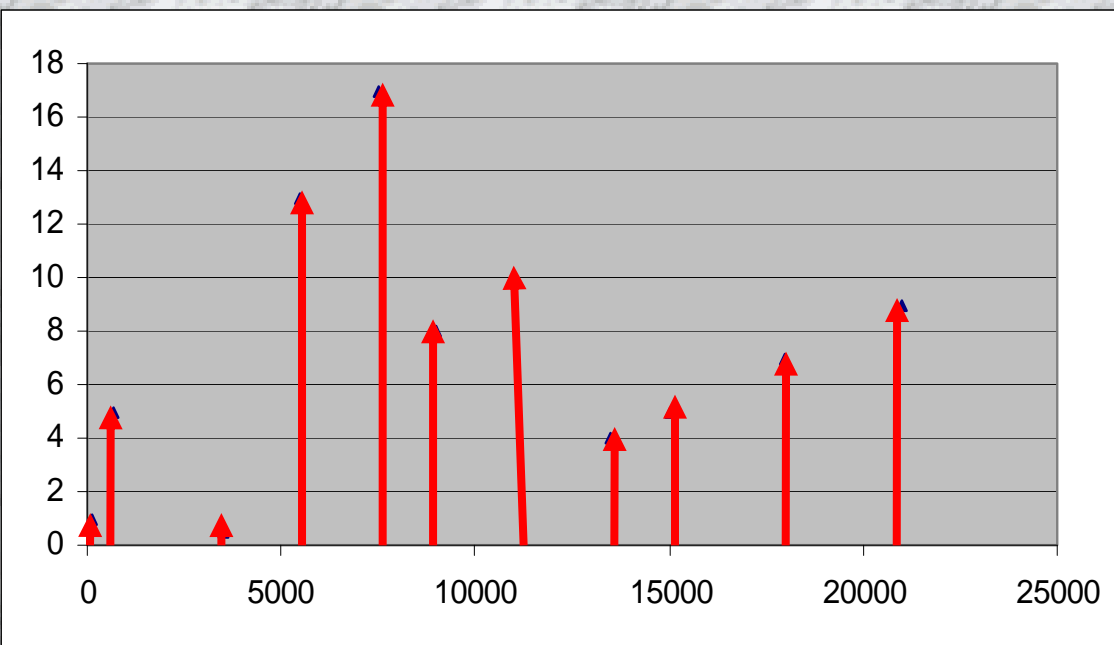
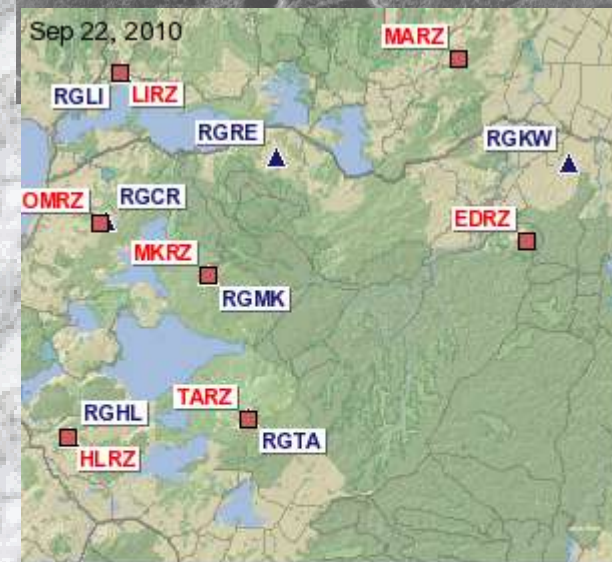
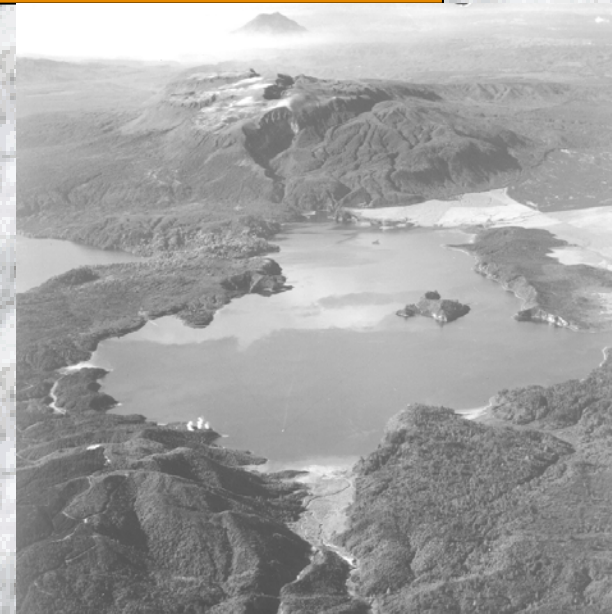
Crater lake is now established in the 1978/90  
crater



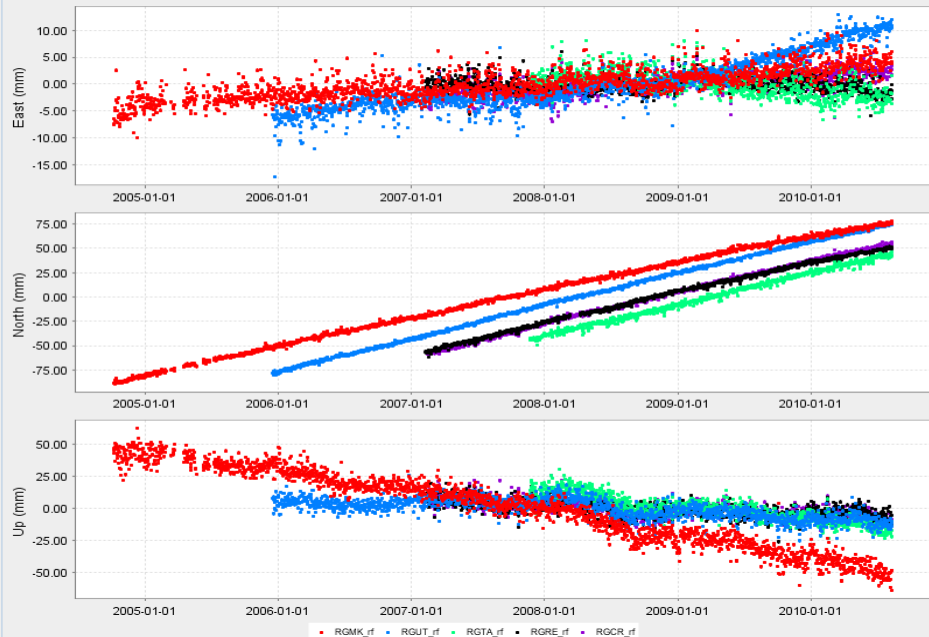
# Okataina Volcanic Centre

Tarawera 1886

- medium-large eruptions
- aligned vents
- long repose intervals

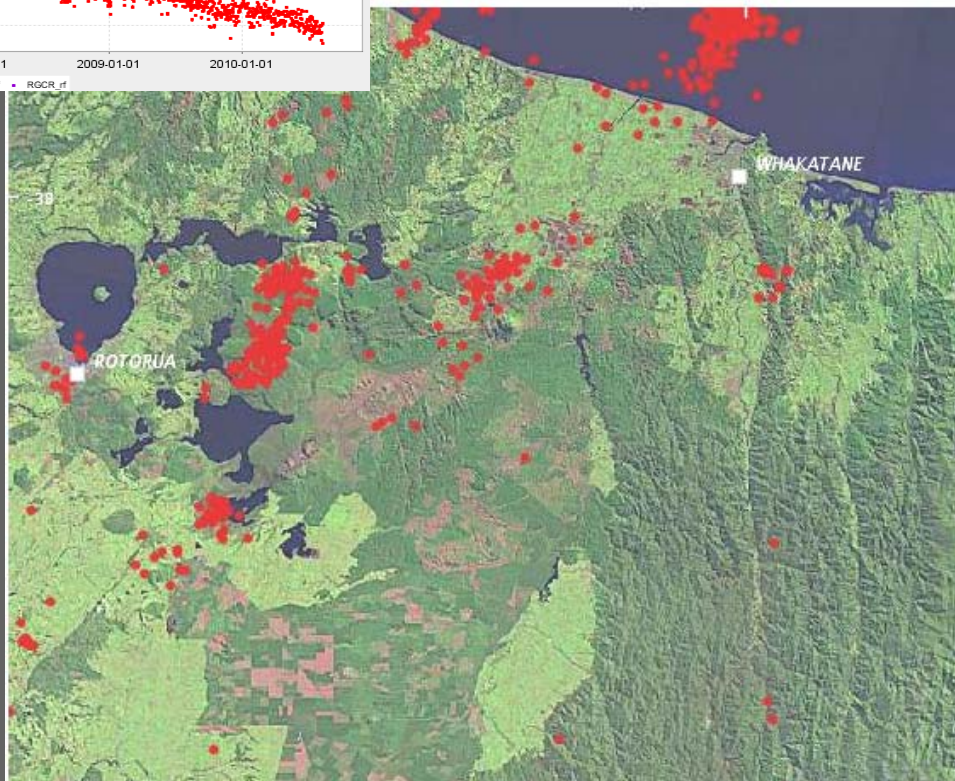


### GPS Time Series



# Deformation 2005-2010

# Earthquakes 2010



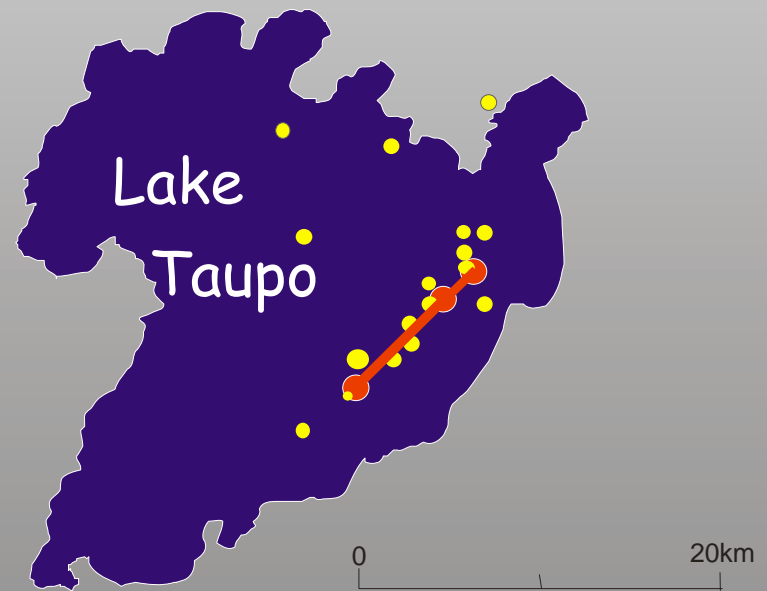
- Legend**
- Depth less than 40 km
  - Depth between 40 km and 69 km
  - Depth between 70 km and 99 km
  - Depth between 100 km and 149 km
  - Depth between 150 km and 199 km
  - Depth between 200 km and 299 km
  - Depth greater than 300 km
- Magnitude less than 3.9
  - Magnitude between 4 and 4.9
  - Magnitude between 5 and 5.9
  - Magnitude between 6 and 6.9
  - Magnitude greater than 7





# Taupo Volcanic Centre

- post 22ka vent
- suggested 1.8 ka vent
- 1.8ka vent lineation

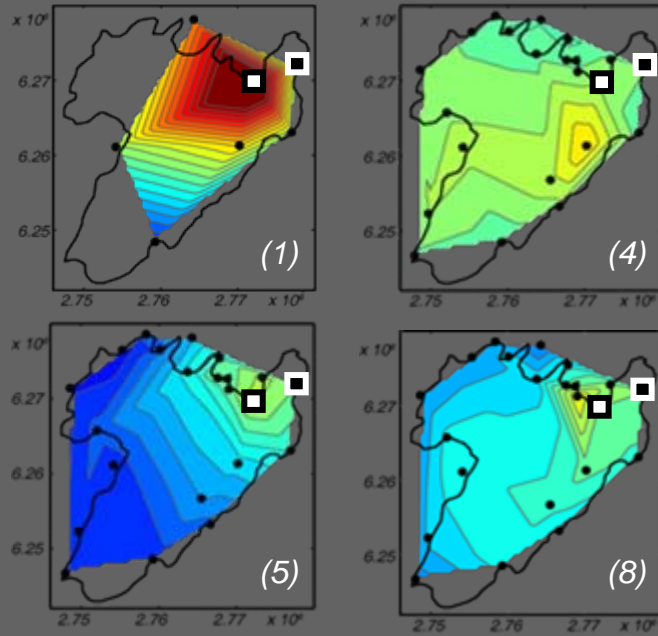


■ Seismograph Sites  
▲ Continuous GPS Sites

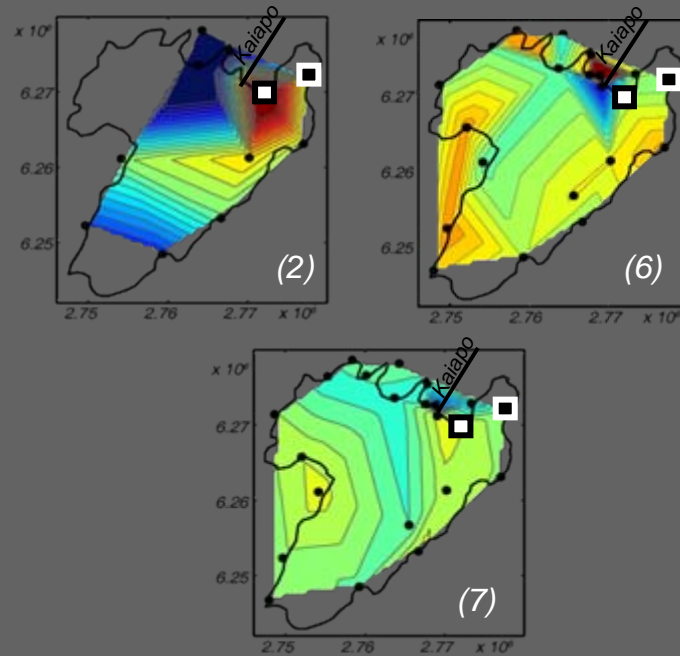
Kilometres  
0 10 20

# Deformation results - lake levelling

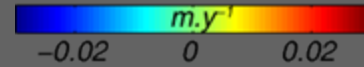
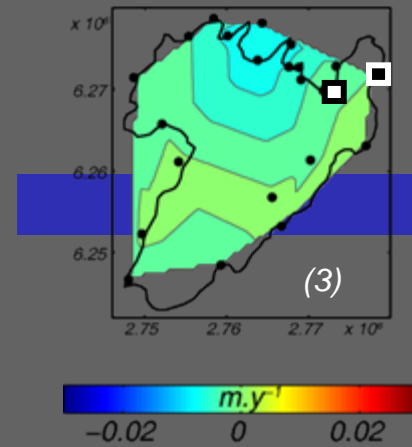
## Inflation



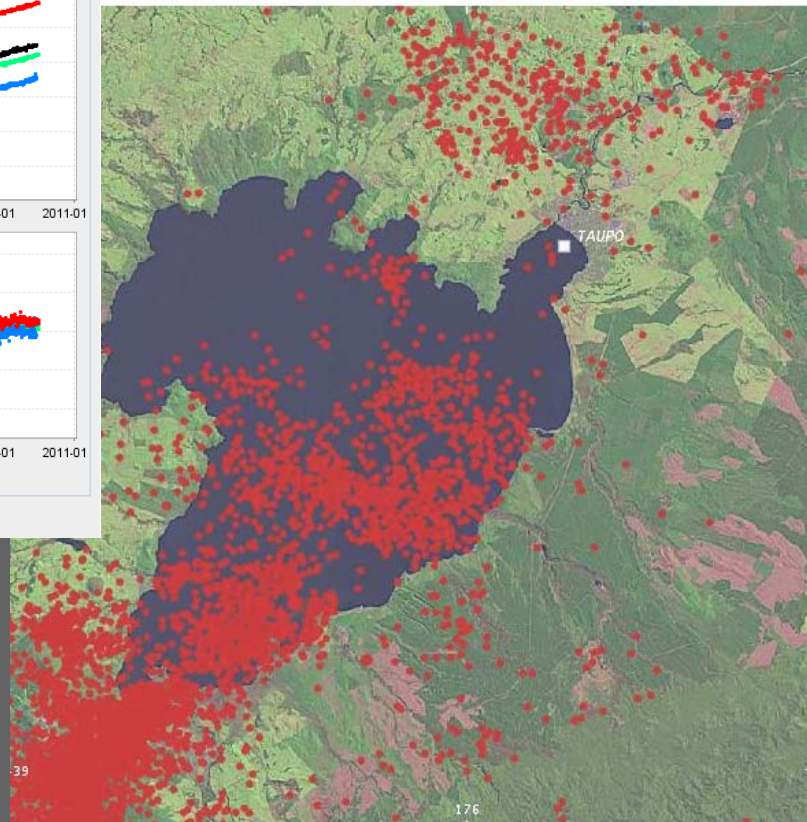
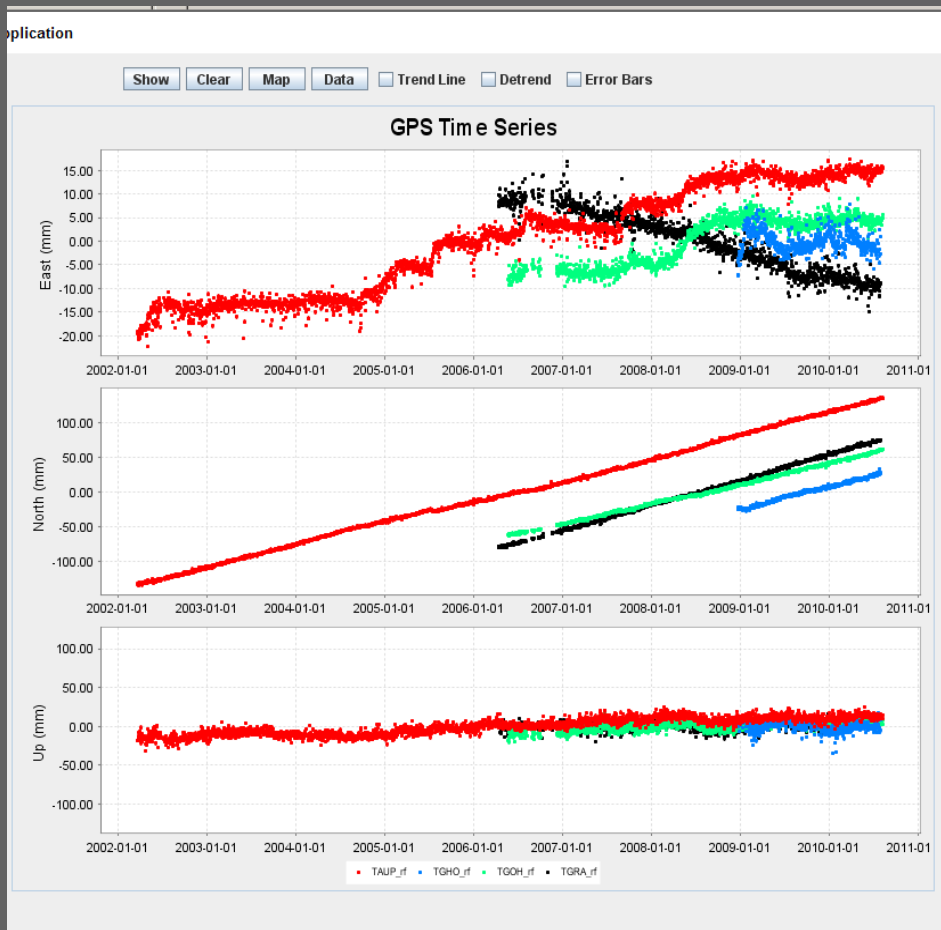
## Fault Motion



## Subsidence



# Deformation and earthquakes 2002-2010 (cGPS)



- Legend
- Depth less than 40 km
  - Depth between 40 km and 69 km
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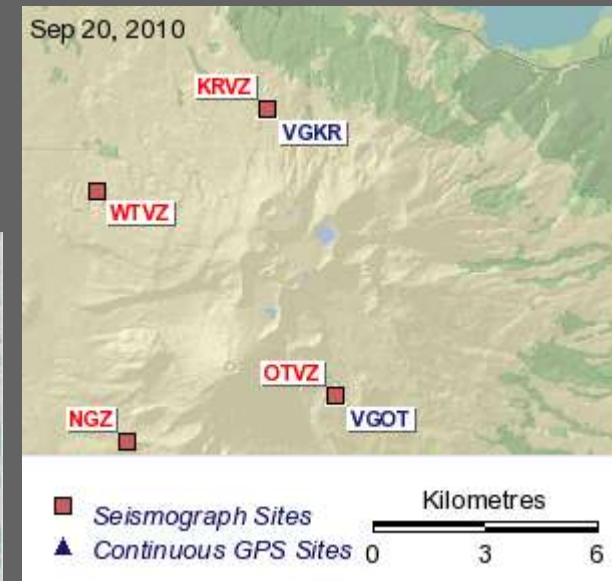
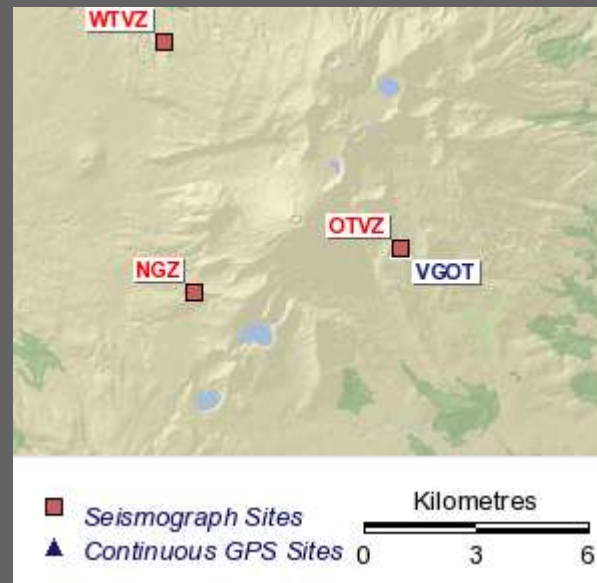
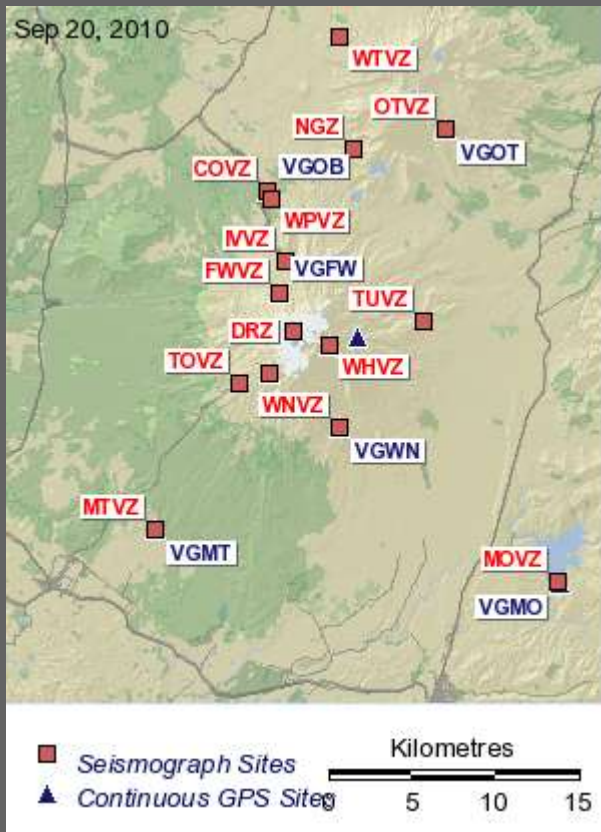


# Tongariro National Park (monitoring)



- Tongariro
  - Water and gas sampling
  - Seismic Network
  - cGPS
- Ngauruhoe
  - Gas sampling
  - Seismic Network
  - Airborne gas monitoring
  - cGPS
  - Volcano cam
- Ruapehu
  - Crater Lake chemistry/temperature
  - Seismic network (1 downhole)
  - Bore hole Tiltmeter
  - cGPS
  - Airborne gas monitoring
  - Volcano cam
- DoC
  - Eruption Detection System (Whakapapa\_Turoa ski field) and Whangaehu River

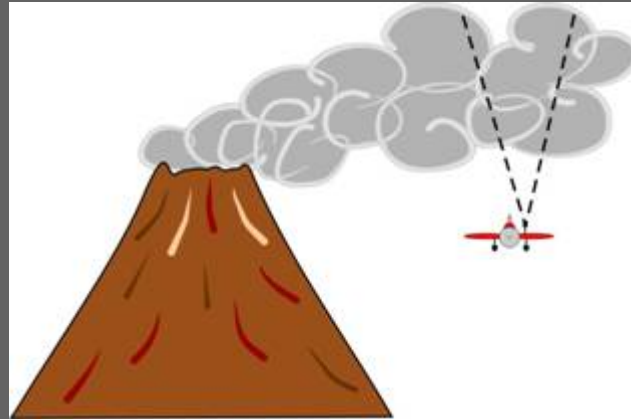
# Seismic and cGPS networks



## New/upgraded:

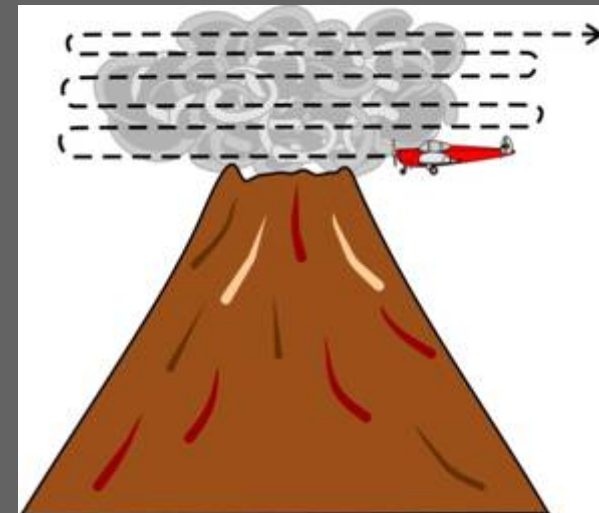
- WNVZ Borehole, seismic
- COVZ: Borehole, seismic and tilt
- EDS airwave detectors (3)
- WHVZ seismic

Some telemetry rerouted via Taupo



## Gas work based on airborne/ground measurements

$\text{CO}_2$ ,  $\text{H}_2\text{S}$  and  $\text{SO}_2$



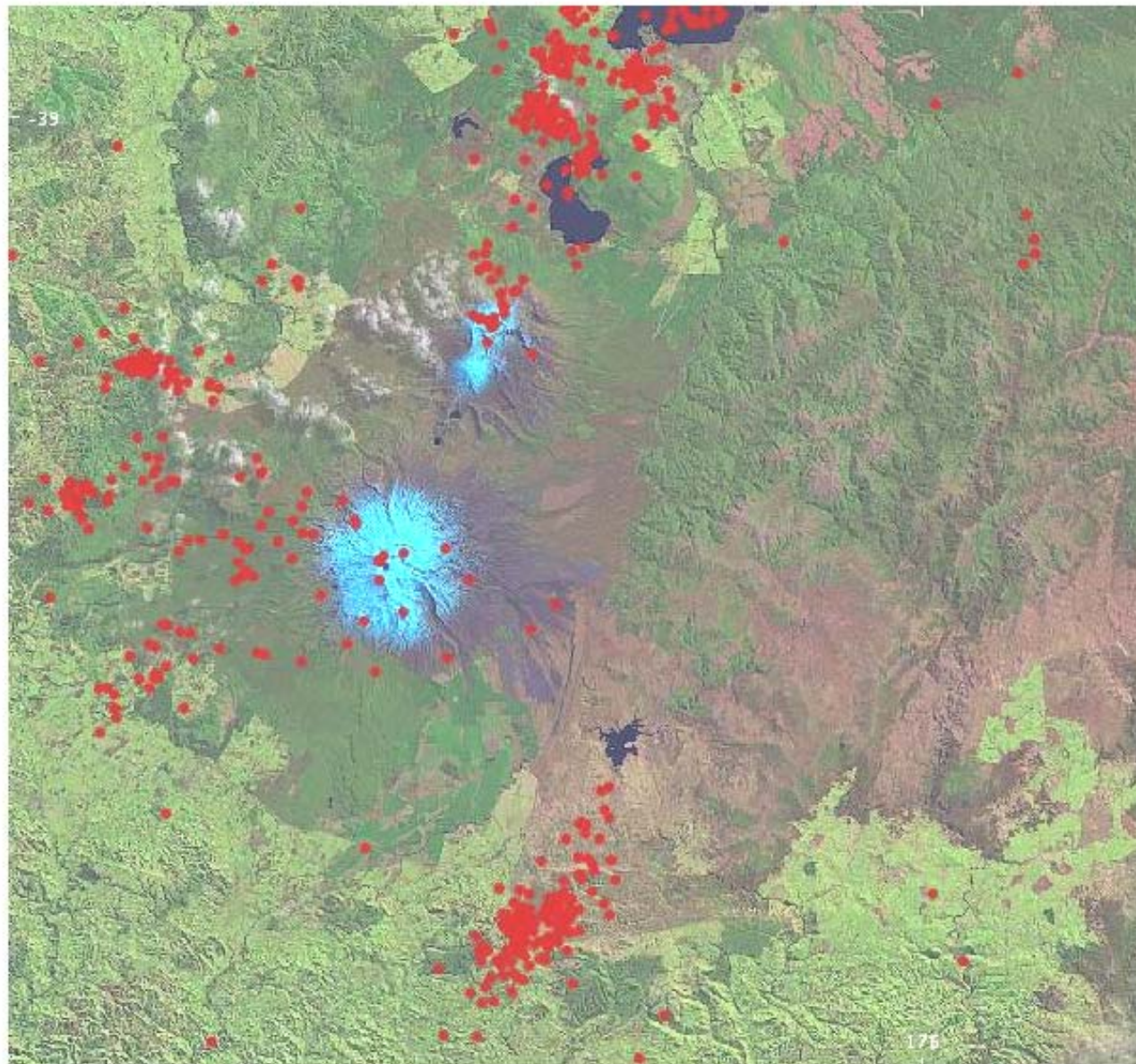


# Chemistry of lakes, fumaroles and springs





# January to September 2010, earthquakes



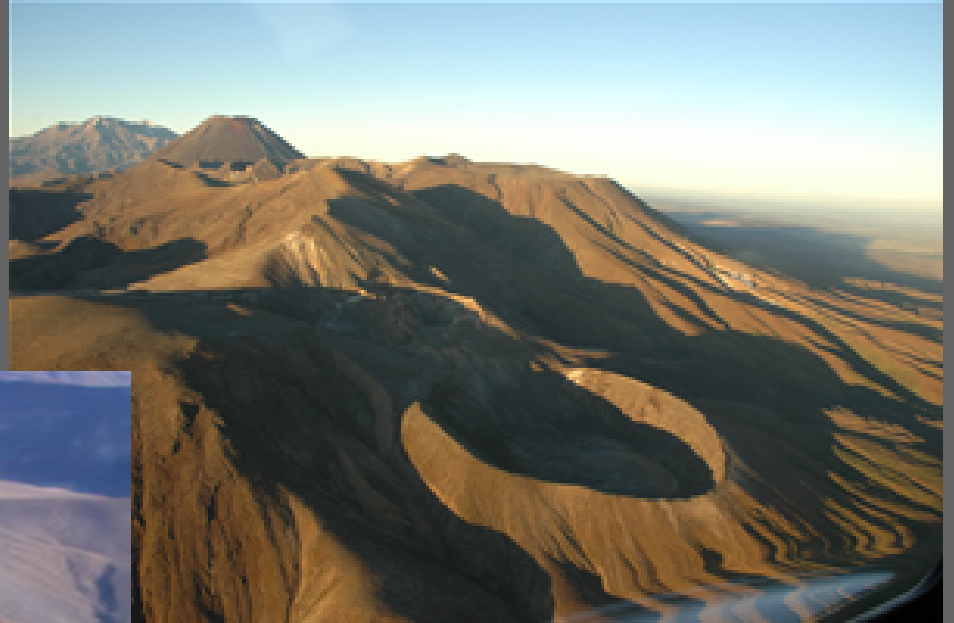
## Legend

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[www.geonet.org.nz](http://www.geonet.org.nz)

# Red Crater; Tongariro



Minor local earthquakes  
Tornillo earthquakes (very rare)



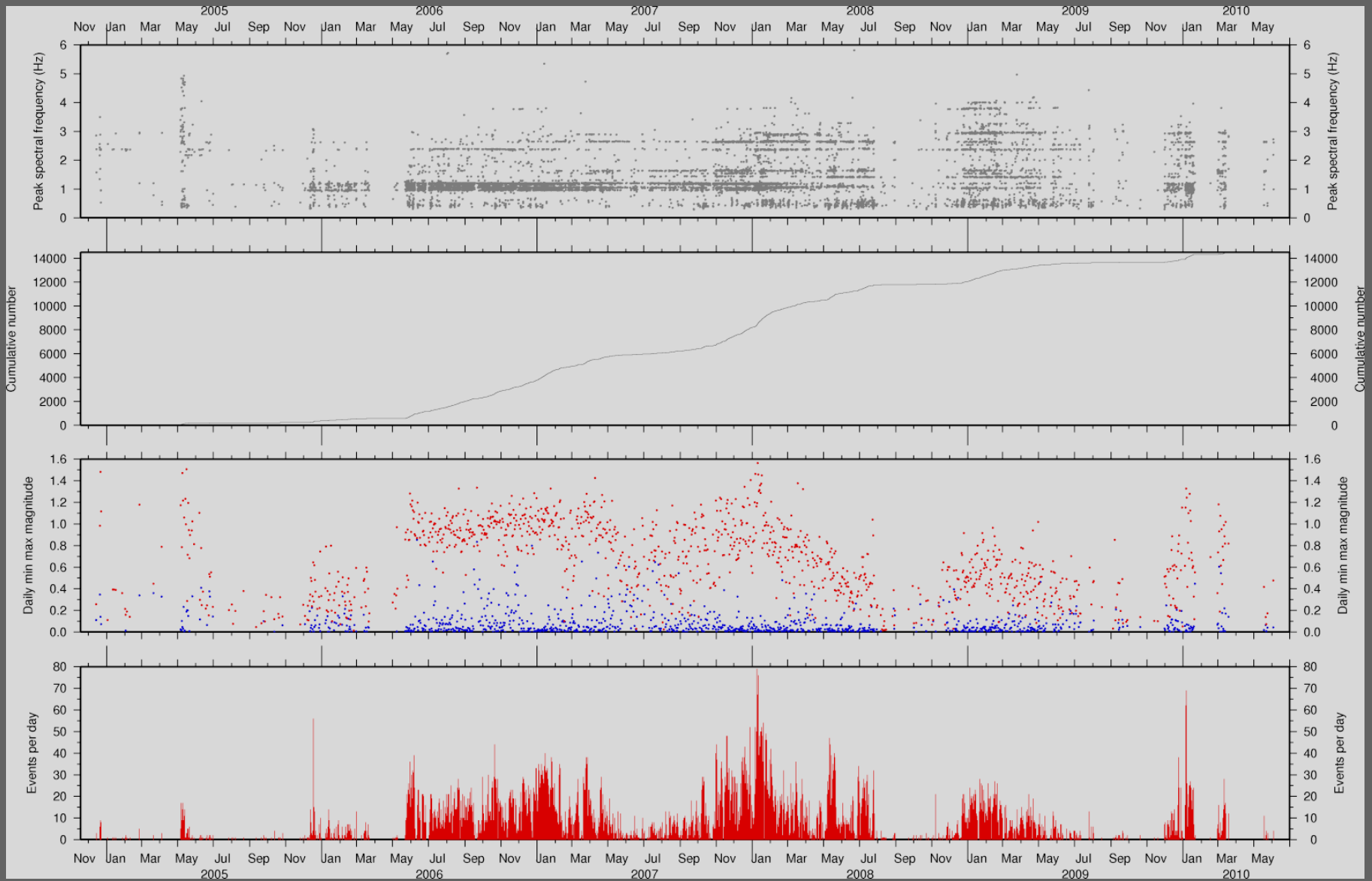
# Ngauruhoe

Young Cone about 4000 yrs old

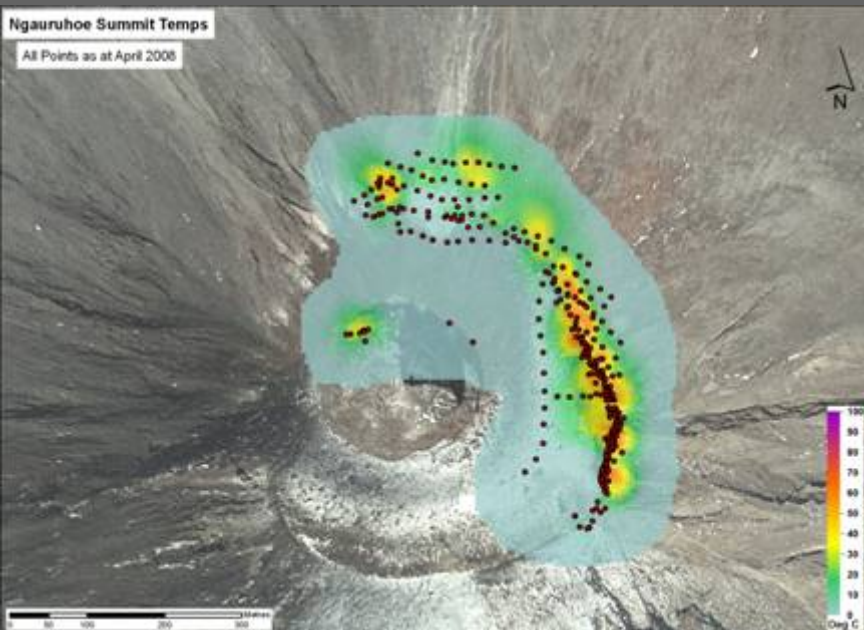
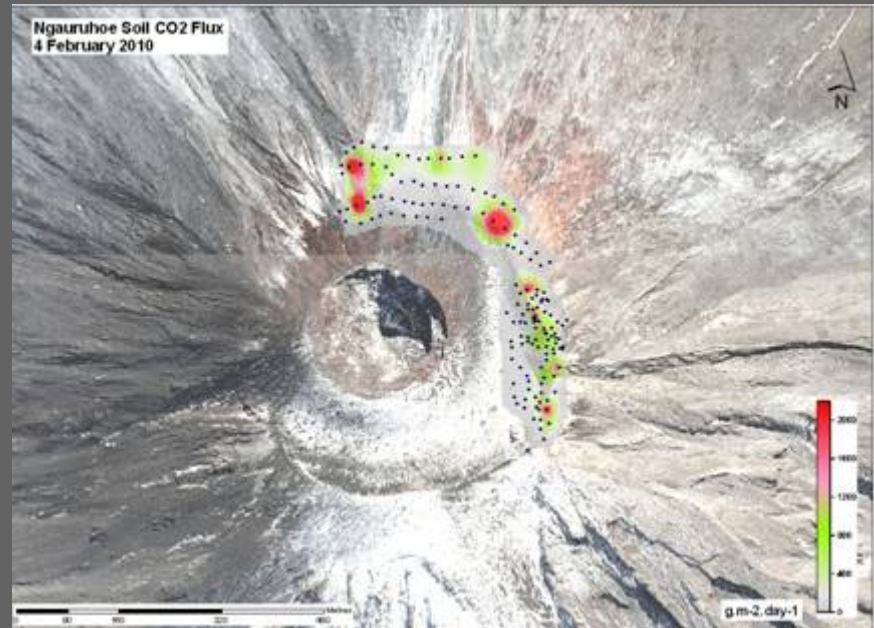
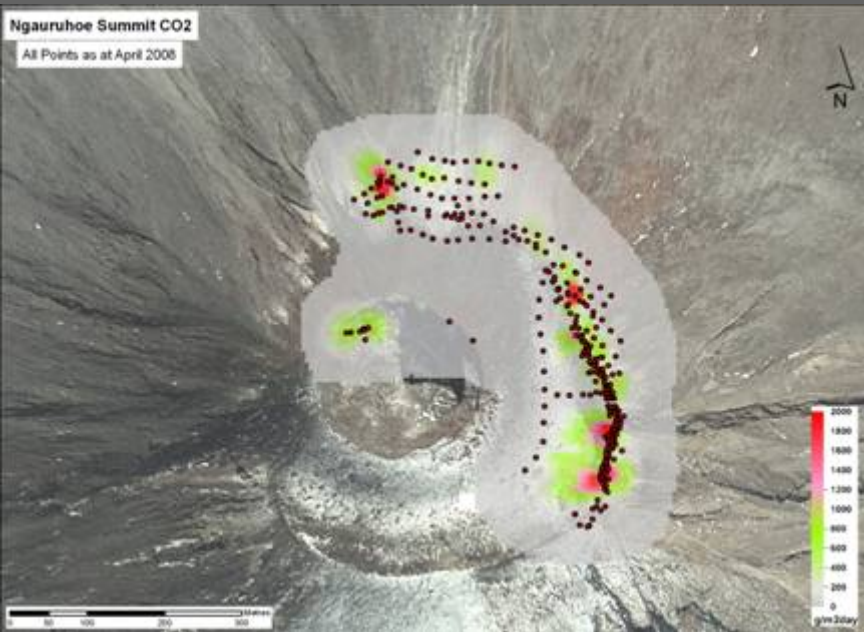
Typically produces ash eruptions, pyroclastic and lava flows



- In May 2006 earthquake activity at Ngauruhoe increased significantly
- The sequence is still continuing, becoming more dominated by quiet periods



# Ngauruhoe summit gas



**Flux** 23.6 t/day (46,600 m<sub>2</sub>) 2010  
20.2 t/day (45,150 m<sub>2</sub>) 2008



An aerial photograph of a snow-covered volcano. The central feature is a large, dark, circular crater lake. The surrounding slopes are covered in thick white snow, with some rocky outcrops visible. The sky is clear and blue. The text 'Ruapehu' is written in green on the left side, and a list of characteristics is on the right. A red bar at the bottom contains the text 'GNS Science'.

Multiple cone

Active over 270,000 years

Collapse events

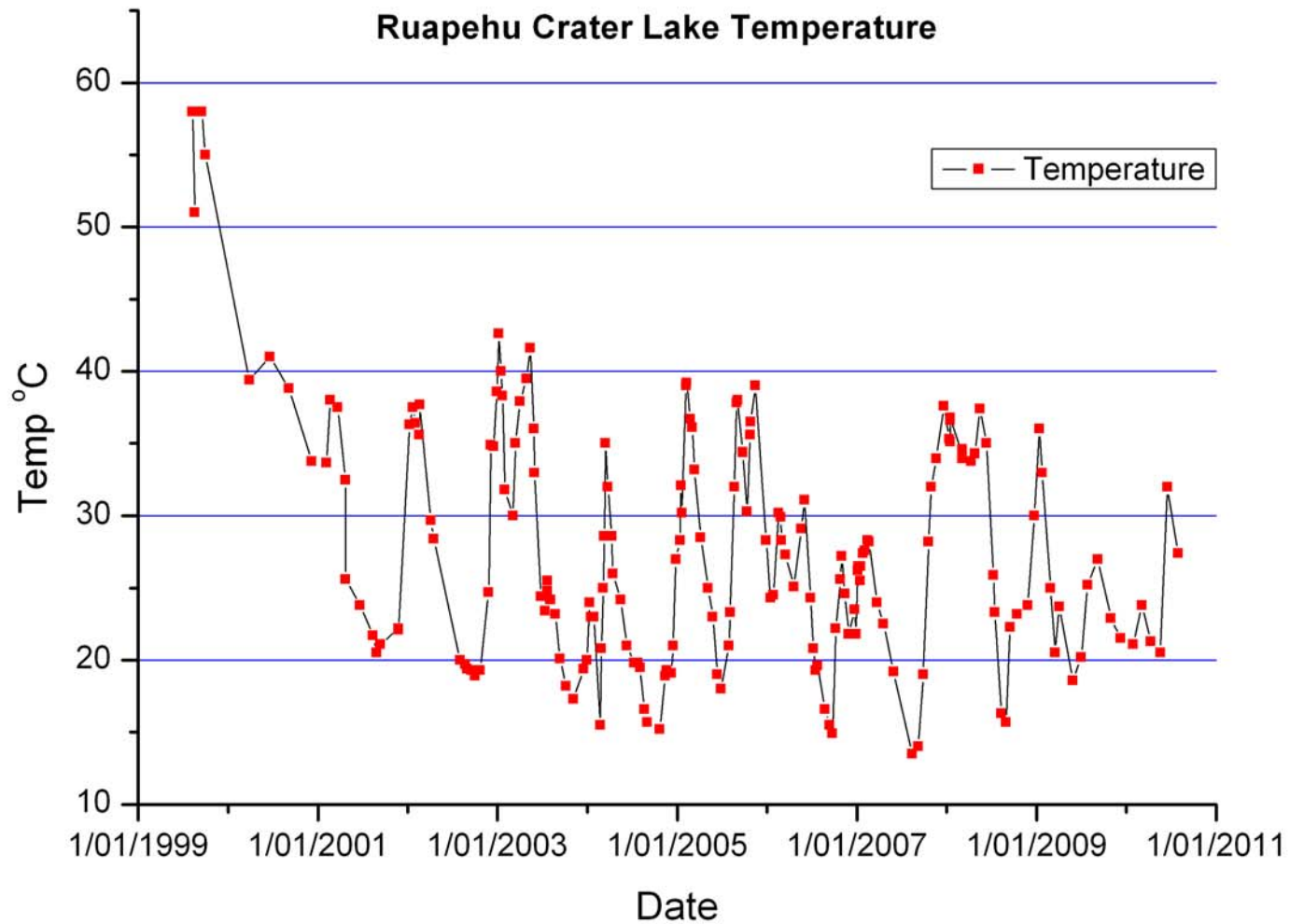
Summit Crater lake

Ruapehu

# Last Eruption 25 Sept 2007



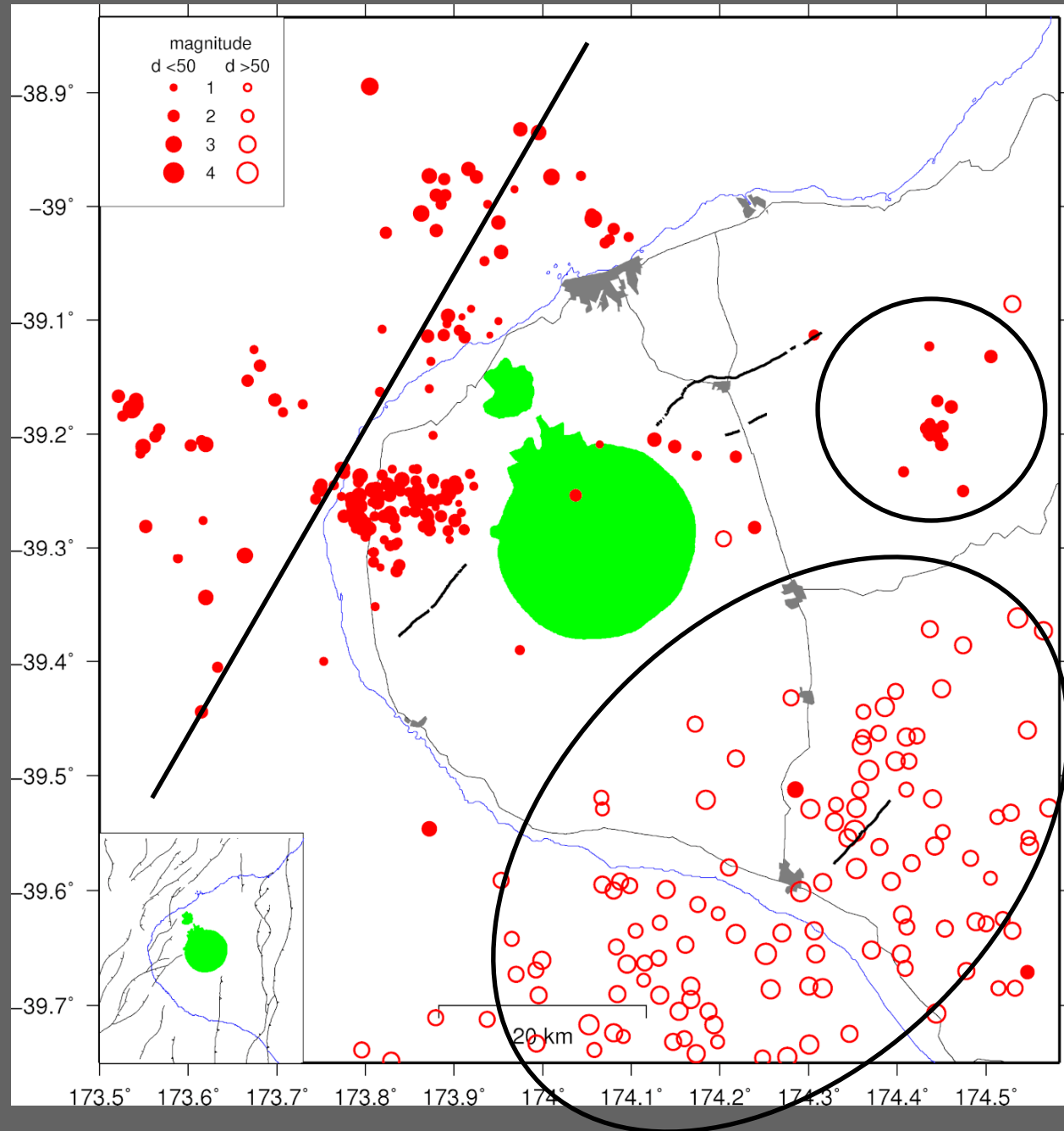
# Current Situation: Crater Lake temperature





# Taranaki

- 309 events (12mths)
- 5 felt
  - all shallow and offshore
- typical distribution
- typical number of earthquakes



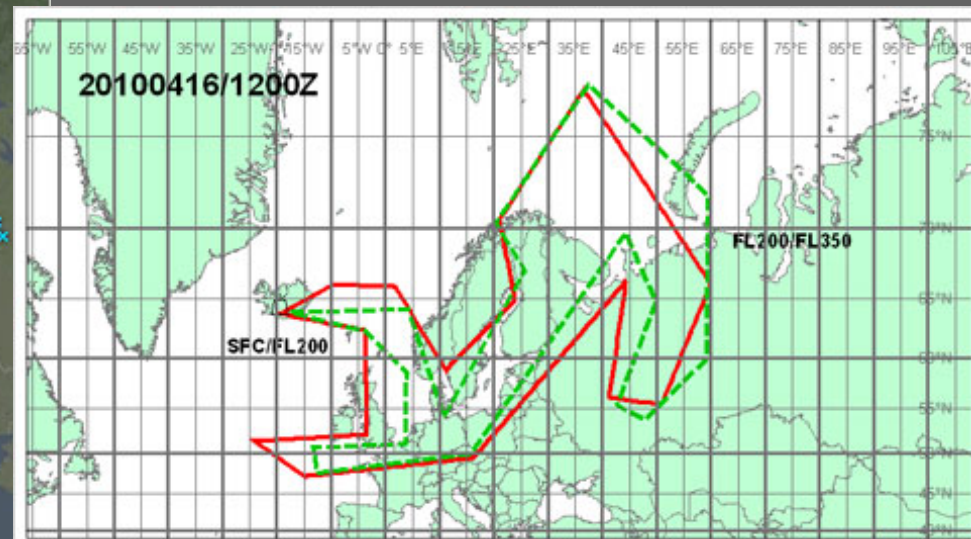
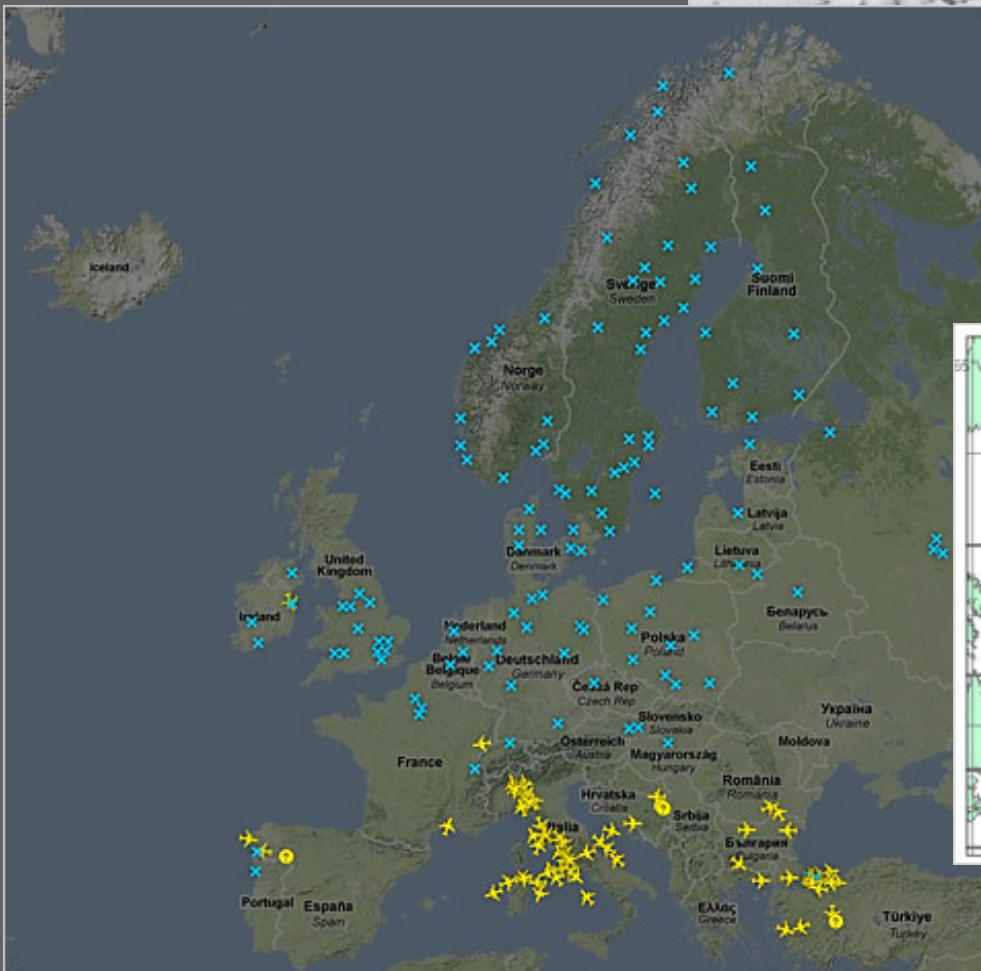
# Iceland - Trigger of renewed interest on the disruptive effects of Volcanic events on Aviation



A EUMETSAT natural-color satellite image shows lava fountains, lava flows, a volcanic plume, and steam from vaporized snow



# Iceland (closed large amounts of airspace)





# Volcanoes and Aviation

## Airframes and Motors

Deposition of material on hot-section components.  
Erosion of compressor blades and rotor-path components.  
Blockage of fuel nozzles and cooling passages.  
Contamination of the oil system and bleed-air supply.  
Opacity of windscreen and landing lights.  
Contamination of electronics.  
Erosion of antenna surfaces.  
Plugging of the pitot-static system which indicates the airspeed of the aircraft.



## Airports

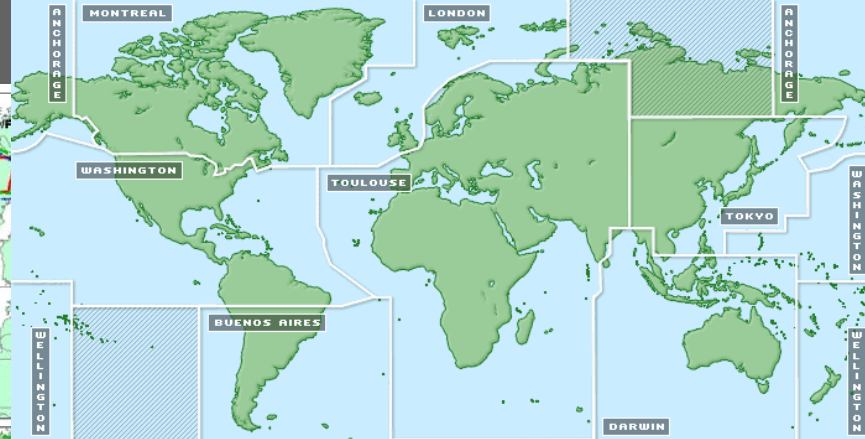
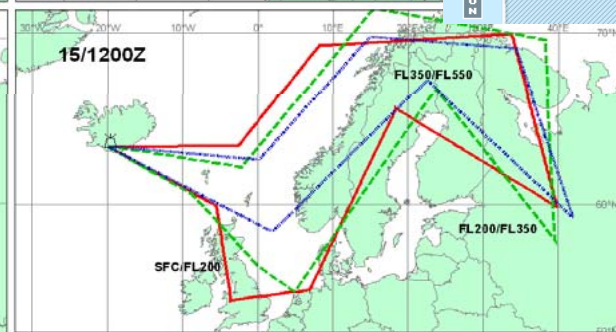
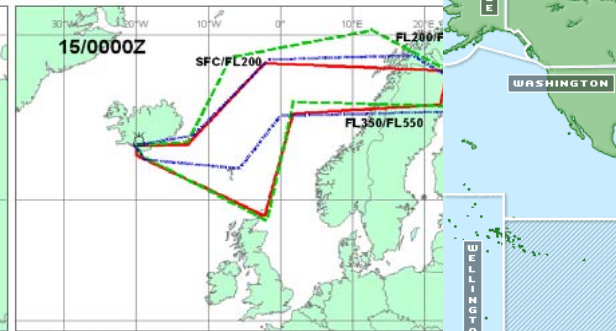
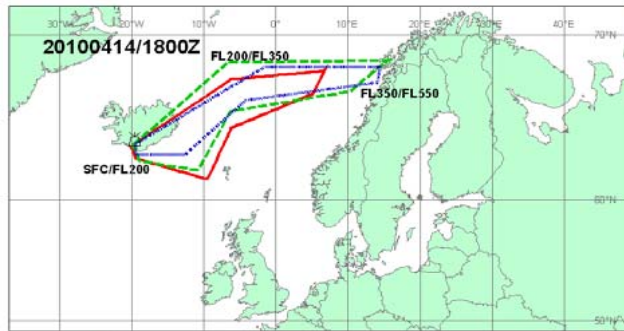
Loss of runways  
Loss of support services  
Aircraft on the ground

## Airspace (VAAC's)

Closed



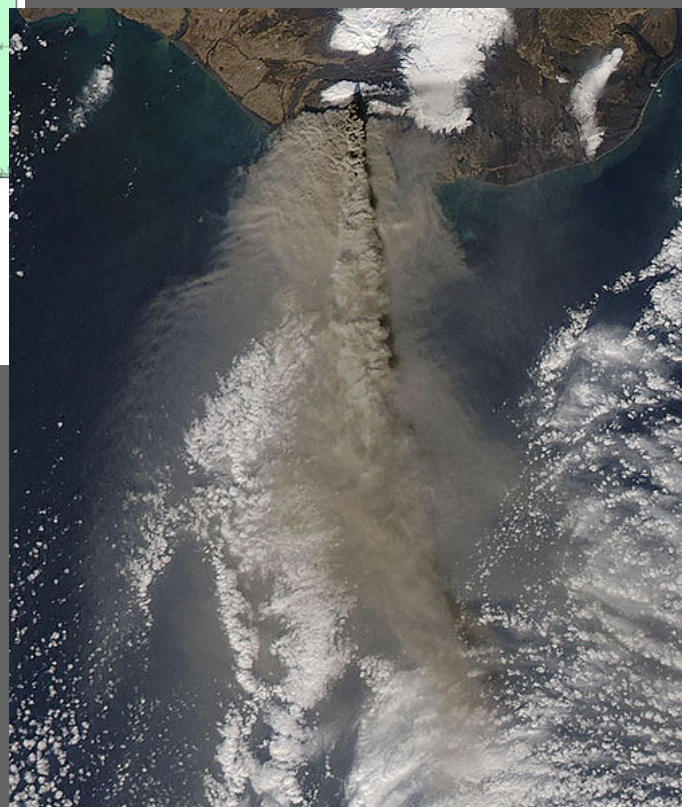
# Airspace closures are controlled by VAAC's



VA ADVISORY  
 DTG: 20100414/1800Z  
 VAAC: LONDON  
 VOLCANO:  
 EYJAFJALLAJOKULL  
 PSN: N6338 W01937  
 AREA: ICELAND

SUMMIT ELEV: 1666M  
 ADVISORY NR: 2010/003  
 INFO SOURCE: ICELAND MET OFFICE  
 AVIATION COLOUR CODE: UNKNOWN  
 ERUPTION DETAILS: PLUME FROM VOLCANO  
 REPORTED TO BE UP TO 11KM HEIGHT

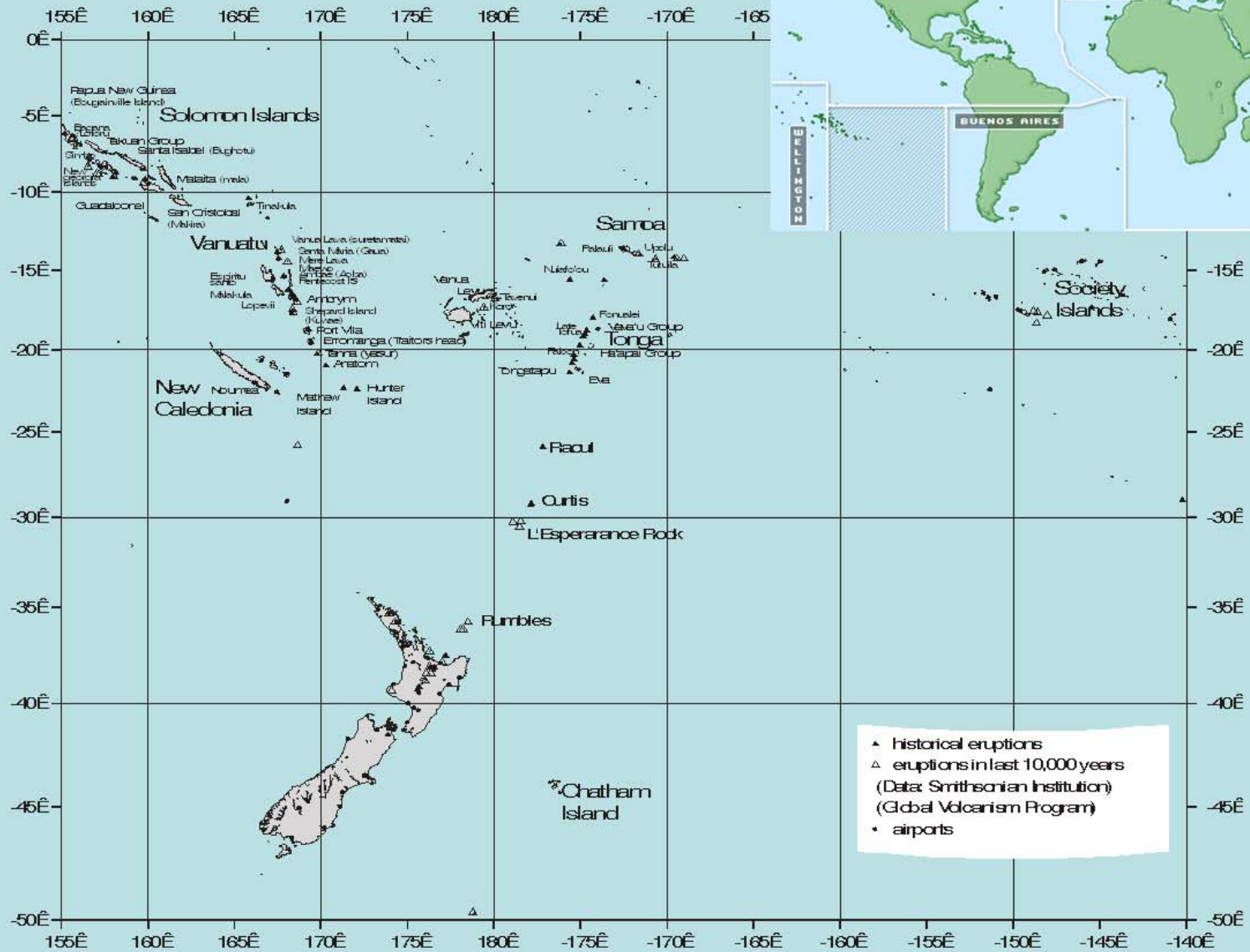
RMK: SCIENTISTS ARE ON ROUTE TO INVESTIGATE FURTHER  
 NXT ADVISORY: 20080415/0000Z



The VAACs were established in September 1995 in Darwin, Australia, at a meeting of the [International Civil Aviation Organization \(ICAO\)](#). At this meeting it was decided that to ensure that volcanic cloud hazards were addressed there must be an interface between volcano observatories, meteorological agencies and air traffic control centers



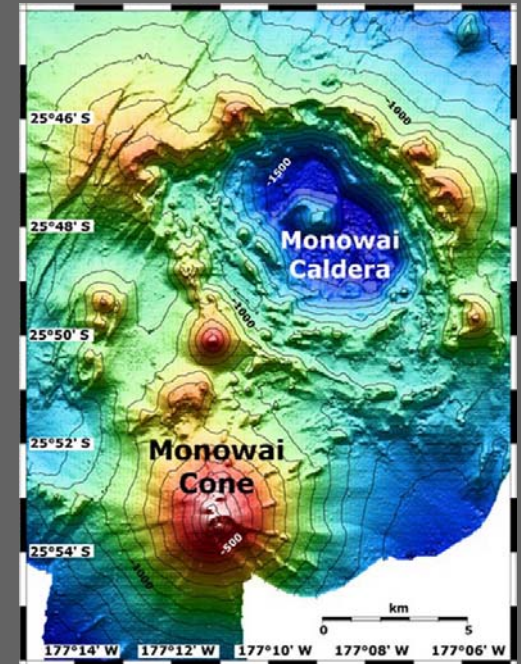
# Wellington VAAC volcano





# Eruptions-Activity in VAAC area 2009-2010

- West Matua (Tonga) May 2009
- Rumble III July 2009 (submarine)
- Gaua (Van.), ash eruptions Sept '09 -
- Tinakula (Solomons), October 2009
- Ambrym (Van.), lava lakes Nov '09 -
- Yasur (Van.) explosions, ash Mar '10 -
- Monowai-acoustic events
- PNG/Indonesia activity .....





# Infrastructure Ash Management Posters

## Volcano Hazard Posters

### VOLCANIC ERUPTION

#### ADVICE FOR ELECTRICITY NETWORK MANAGERS

**ASH IMPACTS ON ELECTRICITY DISTRIBUTION**

Recent ashfall on New Zealand's power network has shown that ash can have a significant impact on electricity distribution. This poster provides advice on how to manage ash impacts on electricity distribution.

**INSULATOR FLASHOVER**

Insulators can become contaminated by ash, which can lead to insulator flashover. This poster provides advice on how to manage ash impacts on insulators.

**RECOMMENDED ACTIONS**

Monitor ashfall levels and report to the relevant authority. Inspect insulators and conduct tests. Clean insulators and conduct tests. Report any ashfall to the relevant authority.

### VOLCANIC ERUPTION

#### RECOMMENDED ACTIONS FOR ROADING MANAGERS

**VOLCANIC ASH**

Ash requires a different approach to preventing road closures. This poster provides advice on how to manage ash impacts on roads.

**REDUCTION**

Reduce ashfall on roads by using sand and gravel. This poster provides advice on how to manage ash impacts on roads.

**READINESS**

Prepare for an eruption by having a plan in place. This poster provides advice on how to manage ash impacts on roads.

**RESPONSE**

Respond to an eruption by following the plan. This poster provides advice on how to manage ash impacts on roads.

### GUIDELINES ON PREPAREDNESS BEFORE, DURING AND AFTER AN ASHFALL

This poster provides advice on how to prepare for, respond to, and recover from an ashfall.

**BEFORE:** Prepare a plan, check your car, and have a kit.

**DURING:** Stay indoors, avoid driving, and wear a mask.

**AFTER:** Clean your car, avoid driving, and wear a mask.

Logos: VVHNN, Cities and Volcanoes Commission, USGS, IAVCEI, GNS Science.

### VOLCANIC HAZARDS AT WHAKAPAPA

#### MT RUAPEHU

This poster shows the hazards at Whakapapa and Mt Ruapehu. It includes a map of the area and a list of hazards.

**HAZARDS:** Lahars, ashfall, gas, and debris.

**WHAT TO DO!:** If there is an eruption, move out of the valleys, especially those that lahars are likely to follow.

Logos: VVHNN, Cities and Volcanoes Commission, USGS, IAVCEI, GNS Science.

### VOLCANIC ERUPTION

#### ADVICE FOR WATER SUPPLY MANAGERS

**IMPACTS ON WATER SUPPLIES**

Volcanic ash can impact water supplies in several ways. This poster provides advice on how to manage ash impacts on water supplies.

**WATER DEMAND**

High demand for water typically occurs after an eruption. This poster provides advice on how to manage ash impacts on water supplies.

**EFFECTS ON EQUIPMENT**

Ash can damage water supply equipment. This poster provides advice on how to manage ash impacts on water supplies.

**RECOMMENDED ACTIONS**

Monitor ashfall levels and report to the relevant authority. Inspect equipment and conduct tests. Clean equipment and conduct tests. Report any ashfall to the relevant authority.

### VOLCANIC ERUPTION

#### RECOMMENDED ACTIONS FOR AIRPORTS

**REDUCTION**

Develop a Volcano-Related Management Plan. This poster provides advice on how to manage ash impacts on airports.

**READINESS**

Prepare for an eruption by having a plan in place. This poster provides advice on how to manage ash impacts on airports.

**RESPONSE**

Respond to an eruption by following the plan. This poster provides advice on how to manage ash impacts on airports.

**RECOVERY**

Recover from an eruption by following the plan. This poster provides advice on how to manage ash impacts on airports.

Logos: VVHNN, Cities and Volcanoes Commission, USGS, IAVCEI, GNS Science.

### THE HEALTH HAZARDS OF VOLCANIC ASH

#### A guide for the public

This poster provides advice on the health hazards of volcanic ash.

**HEALTH HAZARDS:** Respiratory issues, eye irritation, and skin irritation.

**WHAT TO DO!:** Avoid breathing ash, wear a mask, and avoid driving.

Logos: VVHNN, Cities and Volcanoes Commission, USGS, IAVCEI, GNS Science.

### VOLCANIC HAZARDS AT TONGARIRO

This poster shows the hazards at Tongariro. It includes a map of the area and a list of hazards.

**HAZARDS:** Lahars, ashfall, gas, and debris.


**WHAT TO DO!:** If there are any signs of an eruption, move as quickly as possible down the mountain away from the Summit Hazard Zone.

Logos: VVHNN, Cities and Volcanoes Commission, USGS, IAVCEI, GNS Science.

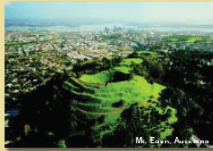
# Coming activities:

VISG Seminar: Hosted in Taranaki 28 Oct 2010  
Volcano Short Course Taupo Nov 8-9

NATURAL HAZARDS CENTRE



Mount Ngauruhoe, 1974




Mount Egmont, Auckland

## PLANNING FOR A VOLCANIC CRISIS

Suncourt Hotel, Taupo  
8-9 November 2010

Taupo Volcano Field Trip (optional)  
10 November 2010




Lake Taupo

**How well will your organisation cope with a future volcanic crisis?**


This two day course will present a state-of-the-art assessment of volcanic hazards in New Zealand, and will help you better understand how your organisation can better prepare for, and mitigate against, a future volcanic crisis.

Volcanologists, psychologists, social scientists and emergency managers form part of the multi-disciplinary team that explores relationships between the physical and social aspects of natural hazards and their management.

The course is designed for those involved in all aspects of natural hazard management: planners, educators, engineers, local and central government policy makers, insurance managers, emergency managers and business, utility and property owners.



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[www.naturalhazards.net.nz/courses](http://www.naturalhazards.net.nz/courses)



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