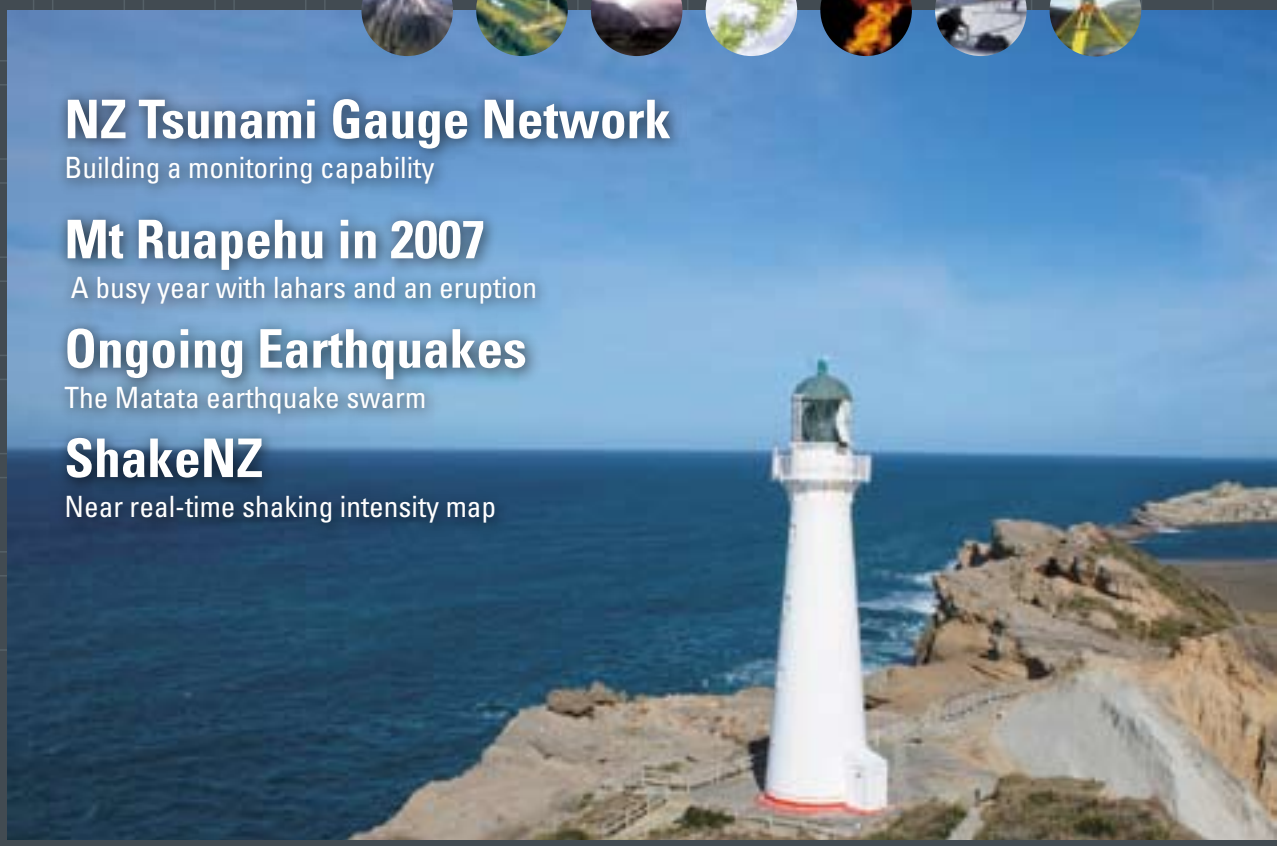
GEONET NEWS
EXPLORING THE GEONET PROJECT ISSUE NINE – JAN 2008

NZ Tsunami Gauge Network
Building a monitoring capability

Mt Ruapehu in 2007
A busy year with lahars and an eruption

Ongoing Earthquakes
The Matata earthquake swarm

ShakeNZ
Near real-time shaking intensity map



GeoNet

GNS SCIENCE TE PŪ AO

INSIDE

ISSUE NINE – JANUARY 2008

www.geonet.org.nz

GeoNet is a non-profit project operated by the Institute of Geological & Nuclear Sciences Limited (GNS Science) with core funding from the Earthquake Commission. It involves GNS Science building and operating a modern geological hazards monitoring system for New Zealand.

GeoNet is a 10 year project which started in 2001. It will provide real-time monitoring and data collection for rapid response to and research into earthquakes, volcanic eruptions and landslides. Data collected by GeoNet are available free of charge. Visit www.geonet.org.nz for more information.

GEONET: EDITORIAL

A FULL WORKOUT

KEN GLEDHILL
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In the early hours of the morning on October 16 2007 a magnitude 6.7 earthquake off the coast of Fiordland was felt by more than 1500 people and capped off a busy month for the GeoNet team. The period began with the 'week from hell' in late September, which exercised GeoNet systems and people, and our partners and collaborators, in all four geological perils: earthquake, tsunami, volcano and landslide.

Ruapehu stirred with a small hydrothermal eruption (page 6) on the evening of September 25, sending a lahar through a ski field and seriously injuring a climber at Dome Shelter. Various systems and people in GNS Science, the Department of Conservation (DoC) and local emergency management groups swung into action to respond, plan and evaluate the possible scenarios. While we were dealing with the aftermath of the Ruapehu eruption, the Matata earthquake swarm (page 7) in the Bay of Plenty came back to life with the largest earthquakes in the sequence so far (magnitudes 4.3, 4.7, 4.5).

On September 26 a helicopter pilot flying over Mount Aspiring National Park noticed a large landslide blocking the Young River. It had created a lake with a future threat of possibly damaging downstream consequences. Subsequent investigation showed the landslide was detected by the GeoNet seismograph network and occurred on August 29. The response to this event is ongoing and involves people and equipment from DoC, regional and district councils as well as the GeoNet team.

The following Sunday evening a magnitude 7.3 earthquake south-west of the South Island was felt in the lower part of New Zealand, and triggered a tsunami alert from the Pacific Tsunami Warning Center. Evaluation by the GeoNet and Ministry of Civil Defence and Emergency Management duty teams suggested little risk to New Zealand, and instruments subsequently confirmed this. The article on page 4 is a timely progress report on the tsunami gauge network being installed as part of GeoNet in partnership with Land Information New Zealand.

I have used a series of examples to answer questions posed by Hugh Cowan in the very first issue of GeoNet News, "What is GeoNet?" "Why is it so important?". Although we are continuing to enhance GeoNet, it is already providing fast and reliable information on geological hazard events. GeoNet collects data to facilitate research leading to an understanding and mitigation of these hazards, helping to create a more informed and resilient New Zealand community. The ShakeNZ map now featuring on the front page of the GeoNet web site (page 8) is an example of the way ahead!

Ken Gledhill, GeoNet Project Director, GNS Science

UP CLOSE

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"I like the variety and challenge from working in Fiordland one week and Raoul Island the next."

KAREN BRITTEN
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ANDREW COWIE
Senior Technician

Andrew Cowie is part of GeoNet's team of technicians based at Avalon who are continuing the roll-out and maintenance of GeoNet's geophysical networks.

After gaining a Bachelor of Science in geology at Otago University, Andrew worked as a radio technician for Works Infrastructure for seven years. There he worked on the Milford Road avalanche programme, designing, building and maintaining weather stations used for avalanche forecasting and maintaining a radio communications network.

After living in Dunedin for over 20 years, Andrew has now moved to the North Island and has been with the GeoNet team for just over a year.

With the recent focus on tsunami risk in New Zealand and GeoNet's involvement in a national tsunami gauge network, Andrew has become responsible for the construction of all the tsunami network sites in and around New Zealand.

Andrew enjoys the challenge and variety of his role and the opportunity to travel to exciting locations, especially the offshore islands such as Raoul, Chatham and Great Barrier.

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KAREN BRITTEN
Geochemistry Technician

Part of the GeoNet team based in Wairakei, Karen's main focus is volcano geochemistry where she investigates volcanic water and gas, and brings samples back to the lab for analysis. Her role also involves monthly flights over New Zealand's active volcanoes to monitor airborne gases.

Karen gained a Bachelor of Science in physiology and biochemistry, and a Postgraduate Diploma in Agricultural Science at Massey University.

Before joining GNS Science in 1994, Karen worked as a chemistry technician for the Taupo District Council where she sampled and analysed drinking and waste water.

Karen enjoys the excitement of her role which has taken her as far as Raoul Island, where she obtained fumarole, spring, soil and gas samples after the 2006 eruption.

Karen has also worked with the GNS Science Ocean Exploration section who study undersea volcanoes. She has accompanied them on their research cruises, assisting with the mapping of the Kermadec volcanic arc and with the study of the geochemistry of volcanic plumes.

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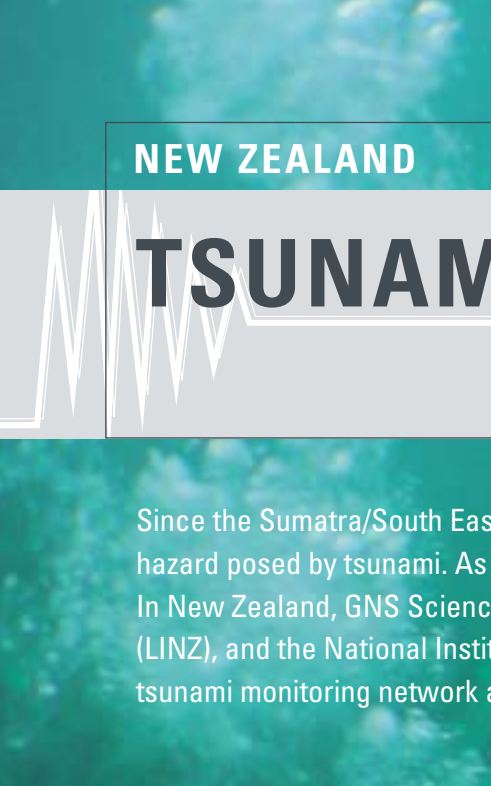
"Life is full of adventure, if you choose to look around the next corner!"

TSUNAMI GAUGE NETWORK

Since the Sumatra/South East Asia Tsunami of December 2004 there has been an increased awareness of the hazard posed by tsunami. As a result, the number of tsunami monitoring stations around the world is increasing. In New Zealand, GNS Science (through the GeoNet Project), in partnership with Land Information New Zealand (LINZ), and the National Institute of Water and Atmospheric Research (NIWA), is establishing a real-time tsunami monitoring network around the coast and on offshore islands.



Although the risk of a tsunami hitting New Zealand has not increased, the 2004 tsunami provided a timely reminder that a reliable warning system is required in New Zealand. Once the gauges are in place, real-time sea level readings will be sent to GNS Science who will analyse the information and alert the Ministry of Civil Defence and Emergency Management (MCDEM) of any tsunami threat. MCDEM is then responsible for issuing civil defence warnings and organising the appropriate response.

The real-time tsunami monitoring network will consist of 20 stations and is scheduled to be completed by 2010. Five stations will be located on offshore islands, including Australian sites at Norfolk Island and Macquarie Island; these stations will monitor incoming regional and distant events. Eight stations will be positioned along at-risk coasts and will detect the first landfall of tsunami waves on the main islands. A further seven stations will be installed at centres of population that are vulnerable to tsunami and will be used to issue an 'all clear' after an event.

At each tsunami monitoring station, relative sea level will be measured by two pressure sensors submerged in the ocean. The pressure sensors will either be attached to a wharf, jetty or near-vertical rock surface (the vertical attachment method), or else be bolted to the sea floor (the ocean bottom attachment method). The sensors will be connected to data logging equipment that will record relative sea level, sampling ten times per second. An equipment cabinet will house the data logger, communications gear and batteries. A small GPS antenna, which will provide accurate time, will be mounted near the cabinet. Solar panels and telemetry equipment may also be mounted near the equipment cabinet as required.

Two pilot sites are being built in Wellington to test the two installation styles. The vertical attachment pilot site was installed at Queens Wharf in Wellington Harbour in early 2007. Data from this site provided a very good record of the Solomon Island tsunami on April 2 2007, including a verification of resonance in the harbour. The ocean bottom pilot site will be installed off the south coast of Wellington near the airport during the summer of 2007-2008. This location was chosen to test the strength and integrity of the ocean bottom attachment design under exposure to large swells. For permanent tsunami monitoring stations, locations with minimal swell exposure will be chosen.

Right: The GeoNet team measuring water depth at South Bay Marina, Kaikoura.

Far right: Staff conducting a site investigation at Castlepoint.

Background photograph: A diver from NZ Diving and Salvage investigating the submarine bedrock at Murimoto Island, North Cape.

Right inset: Proposed stations for the Tsunami Gauge Network.

Two additional monitoring stations were installed during 2007. The Port of Napier station was built in September. The Chatham Island station, which is located at the Owenga Wharf on the eastern side of the island, was established in December.

Relative sea level data will be transmitted in real time from the tsunami monitoring stations to the GeoNet Data Management Centre in Lower Hutt. Data from higher priority stations on offshore islands and at-risk areas will be transmitted via satellite. Data from lower priority stations designed to provide confirmation of tsunami waves will be transmitted via radio or terrestrial communication systems.

Under our current system, initial warnings are sent from overseas centres such as the Pacific Tsunami Warning Center in Hawaii. Once the system is upgraded, warnings will continue to be provided from these centres, but the local gauges will enable GNS Science to issue local alerts and track the progress of tsunami at a local level.

The tsunami monitoring network will contribute to an international collaboration to collect and share real-time tsunami data in the Pacific. All data will be available to the public via the GeoNet website, and to the international tsunami community via the Global Telecommunication System (GTS).

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MOUNT RUAPEHU IN 2007

On March 18 2007 the fragile dam of rock and ash holding back Ruapehu's summit Crater Lake gave way and sent a lahar streaming down the Whangaehu River. Later in the year, the mountain again produced lahars, although on a much smaller scale, following a hydrothermal eruption.

Above, top to bottom: Survey equipment on the Mount Ruapehu Crater Lake tephra dam before the March lahar; image from the 'dam-cam' taken 37 minutes after failure of the main part of the tephra dam in March 2007; lahar from the September eruption flowing down the Whakapapa ski field; staff conducting a GPS survey on one of the September lahars.

The March lahar was one of the most anticipated geological events of the past decade and one GNS Science, Massey University, and the Department of Conservation had been monitoring since the 1996 Ruapehu eruption. A comprehensive science programme developed by GNS Science and Massey University captured arguably the world's most complete dataset on a single lahar event, and attracted considerable attention from overseas researchers.

A GNS Science time-lapse camera overlooking the outlet area captured the moment of failure as 1.3 million cubic metres of warm acidic water gushed out. A sensor array installed and operated by GNS Science and Massey University measured its peak depth at over 8 metres and the ground-shaking associated with the flow. Additional sensors and observation teams at multiple locations downstream were able to track the evolution of the lahar from its initiation, at the summit crater, to the coast 155 km away, 16 hours later.

Because the possibility of a break-out lahar was predicted a decade in advance, a state-of-the-art warning system ERLAWS (Eastern Ruapehu Lahar And Warning System) had been developed by the Department of Conservation and a consortium of local government bodies, emergency services and infrastructure agencies. The flawless functioning of the warning system along with preventative engineering measures and the actions of responding agencies on the day resulted in no casualties and minimal property damage. This was in direct contrast to the 1953 Tangiwai disaster when, in an identical situation, a volcanic dam blocking the outlet as a result of eruptions in 1945 failed without warning. A lahar was generated that critically damaged a railway bridge minutes before the arrival of the Wellington-Auckland express train resulting in New Zealand's worst volcanic tragedy with the loss of 151 lives.

On the evening of September 25, Ruapehu came back to life with a hydrothermal eruption through the Crater Lake. The explosive eruption occurred at 8:26pm and was accompanied by an earthquake that lasted for eight minutes. Lahars were triggered in two catchments by water thrown out of the lake basin landing on the snow-clad summit of the mountain and running down its flanks. A small snow slurry lahar travelled about 1 km down the Whakapapa ski field near the Far West T-bar, while several larger flows occurred in the Whangaehu valley. These flows were radically different from the March lahar, consisting of 80% or more snow with the balance being Crater Lake water and rock debris, and did not travel anywhere near as far.

Visual observations of the lake level after the eruption indicated that approximately 500,000 cubic metres of water, the equivalent of 200 Olympic-sized swimming pools, were ejected from the lake during the eruption.

Ballistic (rock fall) eruption deposits extended north from the lake, and actually exceeded the ash fallout zone. Typically ash travels further; however, in this case the ballistic rocks were ejected with sufficient force to out-travel the lighter ash material.

Research on all of these events is ongoing, and is already shedding new light on lahar processes and hazards at Ruapehu, New Zealand's most active onshore volcano.

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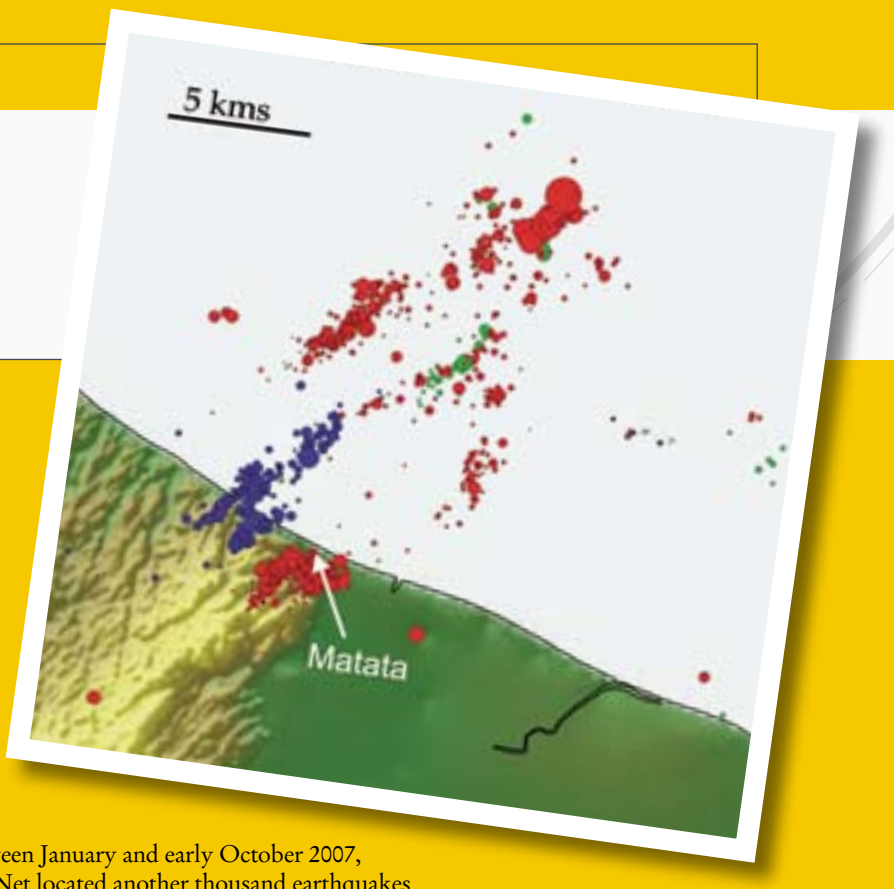
MATATA

EARTHQUAKE SWARM

The central North Island is well known for its active volcanoes, but it also experiences lots of relatively small, very shallow earthquakes. Many of these earthquakes occur in swarms, sequences of many tens or even hundreds of events in a small area without a clear largest event.



Above:
The complex, changing pattern of where the Matata earthquakes have actually occurred. 2005 earthquakes are shown in blue, 2006 in green, and red circles show the 2007 activity. The burst of large earthquakes in late September 2007 is shown by the largest red circles. The lineations suggest that the earthquakes are occurring on active fault lines.

What distinguishes earthquakes in the central North Island is that they are very shallow, usually less than 10 km deep. This means that even relatively small earthquakes can be felt quite strongly close to their source.

In January 2005 an earthquake swarm started just a few kilometres west of the small Bay of Plenty coastal settlement of Matata. At first GNS Science seismologists thought it would follow the pattern of most swarms, quite intense activity for a few days after which it would die way. However the swarm steadily grew and peaked in April when GeoNet located more than 10 earthquakes a day in the area with the largest earthquake being magnitude 4.1. In August the swarm started to settle down and by December the earthquakes had almost stopped. By the end of 2005, GeoNet had located more than a thousand earthquakes in the Matata area.

Through most of 2006 Matata was quiet, but in December the earthquakes started again. This time about half were near Matata and the rest beneath the sea about 10 km to the north. The number of earthquakes peaked in April and May, the largest being magnitude 4.2 on April 3. The earthquakes then followed the same pattern as 2005 and started to slowly die away. Seismologists were surprised when the swarm suddenly picked up again in September with four earthquakes above magnitude 4, including two shakes of magnitude 4.7 and 4.5 early on the morning of September 30. The largest of these was felt along the Bay of Plenty coast from Waihi to Opotiki and as far south as Rotorua. GeoNet received more than 400 felt reports via its web-based felt reporting system. The magnitude 4.7 earthquake was felt most strongly in Matata and Edgecumbe where some reported it strong enough to do minor damage.

Between January and early October 2007, GeoNet located another thousand earthquakes in the Matata area, with two new permanent sites close to Matata helping collect additional data on the swarm.

By using the detailed recordings of the earthquake waves recorded by nearby GeoNet seismographs, Stephen Bannister from GNS Science has been able to show that the earthquakes are occurring in several distinct groups, both close to Matata and out to sea in a north-easterly direction. The area around Matata has many distinct north-easterly trending active fault lines, so it is likely that the earthquakes are produced by movement on some of these faults. Fellow GNS scientist Tony Hurst has shown that the style of faulting that caused the 2005 earthquakes is consistent with these north-easterly trending active fault lines and possibly a result of crustal extension in a northwest-southeast direction. For these reasons seismologists think it is unlikely that some kind of volcanic activity is going on beneath the Bay of Plenty.

One of the great difficulties in dealing with earthquake swarms is the fact that they often don't follow the mainshock-aftershock pattern. For this reason seismologists don't know how long a swarm will continue and the size of the largest earthquake that might be expected. Victoria University seismologist Euan Smith and international collaborators are now planning to use the GeoNet earthquake database to look for patterns in other central North Island earthquake swarms and try to answer some of these questions.

In the meantime the GeoNet seismographs continue to keep a close watch on the Matata area and you can follow the bigger shakes on the GeoNet website.

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GEONET WEBSITE

NEAR REAL-TIME SHAKING MAP

When an earthquake is felt, the GeoNet website – **www.geonet.org.nz** – is the first port of call for all the vital details. But web traffic has shown that many people visit our website before this information is available. With the latest addition to our website, ShakeNZ, we can display information about shaking intensity across the entire country in a matter of minutes.

For a number of years the GeoNet project has been bringing you details about the earthquakes you feel: the time, the location and the magnitude. However, it takes our Duty Officer at least 15 minutes to establish these and get them onto the website.

Now we can make that wait a bit more interesting with ShakeNZ, our near real-time shaking intensity map of New Zealand. It can't tell you exactly where the earthquake was, but it can tell you how widely and to what extent it has affected the country. And that is important information in the first few minutes after any large, damaging earthquake.

The map uses data-streams from over 100 continuously recording seismographs around New Zealand. If the ground is also subject to strong shaking, we can add extra data from another 200 strong motion instruments.

The shaking intensity data is mapped to expected values on the Modified Mercalli Intensity (MMI) scale and plotted as size and colour-coded icons on a map of New Zealand. It is also available in a text-only format for additional detail and use by the visually impaired.

Data on the map are updated every minute, and represent the strongest shaking intensity recorded at each site within the last hour. A handy feature of ShakeNZ is the ability to 'turn the clock back' over the previous hour to see when and where significant shaking first appeared. On occasions when two or more earthquakes occur within an hour, use of this function will help unscramble the shaking intensity patterns.

This is the latest addition to our redesigned website, released earlier this year, and another way GeoNet is making the impact of earthquakes easier to understand.

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Lead organisation in the GeoNet project

COMING UP...

UNDERSTANDING AND MANAGING EARTHQUAKE HAZARDS
When: 15-16 May 2008
Where: GNS Science, Wellington
Contact: Julia Becker
Email: j.becker@gns.cri.nz

2ND AUSTRALASIAN NATURAL HAZARDS MANAGEMENT CONFERENCE
When: 29-30 July 2008
Where: Te Papa, Wellington
Contact: www.hazards-education.org/ahmc/2008
Email: ahmc@hazards-education.org

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