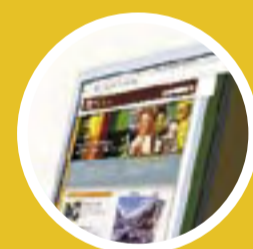




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# 19

SEPTEMBER 2005

The Institute of Geological & Nuclear Sciences Limited (GNS) is New Zealand's leading provider of earth and isotope scientific research and associated commercial services. GNS is an independent, government-owned company.

GNS publishes *Globe* to publicise the research and consultancy work of the company.

## GNS and the new frontier

*More than 90 percent of the New Zealand continent lies underwater, and exploring this vast area has become the new frontier. The marine area under New Zealand's jurisdiction may soon be 20 times larger than our land area when the outer limits of our continental shelf are defined under the United Nations Convention on the Law of the Sea. The challenge is to gain a thorough knowledge and understanding of this area so it can be prudently managed for future generations.*

New Zealand's offshore territory is a complex amalgam of plateaus, ridges, troughs, seamounts, volcanic arcs, and spreading centres. On a global scale, the New Zealand continent has a remarkable range of seafloor features. One of these is the Tonga-Kermadec arc – a 2500km-long chain of seafloor volcanoes from the Bay of Plenty to north of Tonga.

For the past decade the arc has been a focus for GNS, as knowledge of its geology, geochemistry and fauna is likely to have long-lasting implications for New Zealand. These may ultimately lead to new foods, new chemicals, advanced pharmaceuticals, minerals, and new sources of energy.

Below: Co-Chief Scientist on the 2005 Ring of Fire expedition, Alex Malahoff, with the Pisces IV submersible.

The deep-sea fauna along this arc may also give us clues about how life started on Earth. Because of its unique geological characteristics, this part of New Zealand enables us to attract international research partners. They, and their considerable resources, are a vital part of our research effort.

Since 1998, GNS and our international partners have systematically mapped the many submarine volcanoes and hydrothermal plumes along this 2500km stretch of seafloor. This has been done using the NIWA deepwater research ship *Tangaroa*, as well as ships of opportunity. To everyone's surprise, we have discovered that about 55 percent of the 90 volcanoes along this arc are discharging volcanic gases and hydrothermal plumes. The strike rate along the Kermadec portion of the arc is 70 percent. This is a much higher percentage of active seafloor volcanism than elsewhere in the world. It also means that the area is extremely fertile for scientific discovery.

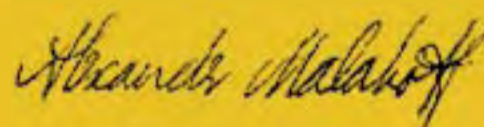
In October 2004, GNS began a bold new era of exploration and research with a manned submersible exploration of the Kermadec arc. With our partners from the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC), we made four dives into the crater of Brothers volcano, using the three-person submersible *Shinkai 6500*.

Up to 40 percent of the biological samples we recovered were new to science. The project, which used the mother ship *RV Yokuska*, was funded by the Japanese government.

This was followed in April-May 2005 by a seven-week Darwinian-style expedition, also to the Kermadec arc. Included in the project consortium were GNS and NIWA from New Zealand, and organisations from the United States and Germany. We dived 24 times on 10 active submarine volcanoes ranging in depth from 200m to 1900m. The expedition was based on the University of Hawaii's Hawaii Undersea Research Laboratory (HURL) deep submergence system. It comprises the mother ship, *RV Kaimikai-o-Kanaloa* with two submersibles, *Pisces IV* and *Pisces V*, on board.

The objective was to determine the relationship between active volcanism, the chemistry of the hydrothermal vents, the associated mineral deposits, and the biota populating the vents. The inclusion of geologists, geophysicists, chemists, oceanographers, microbiologists and macrobiologists on the expedition ensured a broad approach.

The research team collected hundreds of samples of hydrothermal water, gas, biota, minerals and rocks. They observed dozens of new marine species including giant barnacles and 30cm-long mussels. They also sampled black smokers with temperatures up to 300°C. The 30 scientists who participated are now analysing the samples and data. Scores of publications will result. The New Zealand-American Ring of Fire expedition of 2005 continues our model for meticulously planned, and multi-disciplinary expeditions that will be needed to definitively explore New Zealand's underwater territory. There is more information on this project on pages 4 and 5.



**Alex Malahoff**  
Chief Executive, and Co-Chief Scientist  
on the 2005 Ring of Fire expedition

### DIRECTORY

#### Chief Executive

Dr Alexander Malahoff

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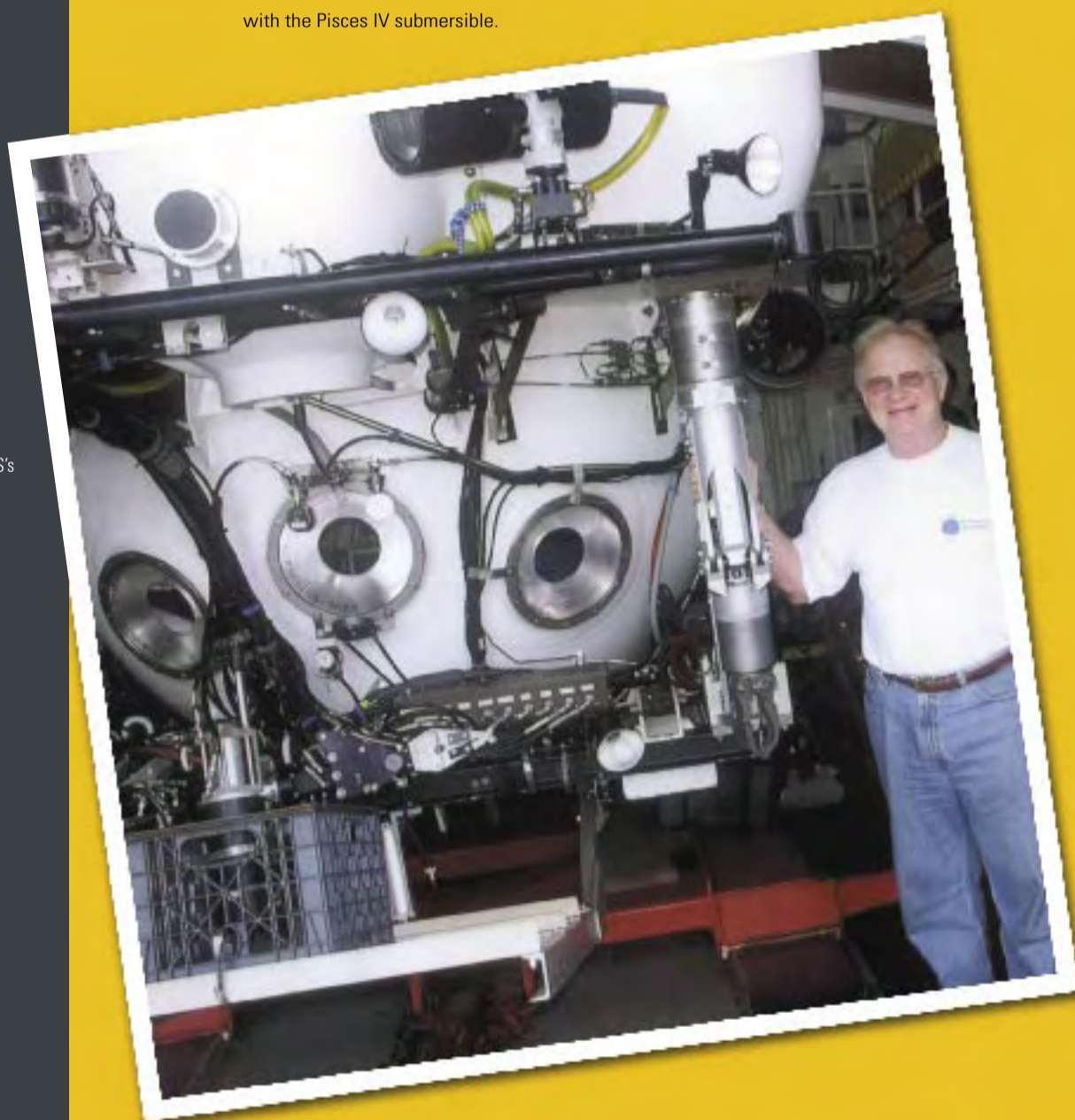
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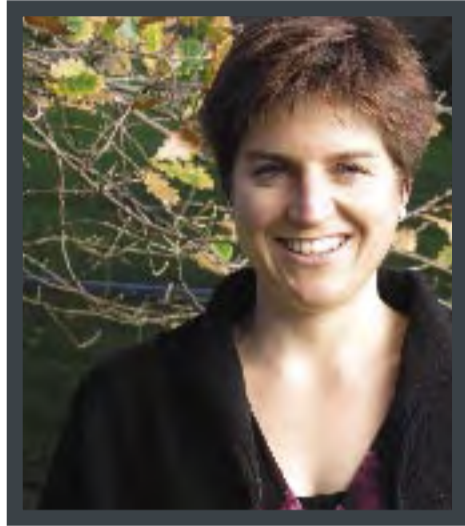
#### Coming soon...

This is the last issue of *Globe* to carry our existing logo. The next issue will appear under a new banner. It will be based on GNS's heritage, and will be part of a systematic refreshment of our identity to reflect our aspirations and the values of our clients.

**Cover image:** Five metre-tall metal-rich black smoker chimneys at Brothers Volcano, 450km northeast of Whakatane. The 1450m-deep chimneys are home to snow-like colonies of bacteria. See editorial and pages 4 and 5.



## Stronger end-user links for natural hazards



Hannah Brackley.

*Hannah Brackley has joined the Natural Hazards Group to provide stronger links between clients and GNS researchers. As Business Development Coordinator, she project manages the wide variety of commercial work that her group is involved in. As well as geological hazards work with many of New Zealand's territorial authorities, it includes ongoing and proposed projects in Turkey, Japan, Australia, Fiji, Tonga, Dubai, Indonesia, Vietnam, the Cook Islands, India, and Iran.*

Hannah works with Natural Hazards Marketing Manager Noel Trustrum in seeking commercial opportunities in areas where GNS has a competitive advantage, such as disaster risk reduction projects funded by international donor agencies. She also handles the contract proposals, and ensures contracts are completed to the satisfaction of the client. Before starting at GNS, Hannah spent five years as a researcher at Landcare Research in Palmerston North, where she undertook a funded PhD programme aimed at improving the knowledge of erosion-related organic carbon losses from the North Island's East Coast. Her role at GNS meets her desire to stay within the earth science field and have more involvement in making science work for end-users.

**To find out about the wide range of hazards-related services GNS offers, Hannah can be contacted at:**

**h.brackley@gns.cri.nz**

**or visit:** [www.gns.cri.nz/services/index](http://www.gns.cri.nz/services/index)

## Landmark tsunami study



A tsunami warning sign at Castle Point, Wairarapa.

*GNS is leading a major review of New Zealand's tsunami risk and preparedness. The 2004 Boxing Day earthquake and tsunami in the Indian Ocean prompted a systematic assessment of the risk of tsunami, the likely impacts, and our present state of preparedness. The study is being done under contract to the Ministry of Civil Defence and Emergency Management who will report the findings to the New Zealand Government. The project will give rise to two reports, on science and preparedness, which are scheduled to be finished by the end of this year.*

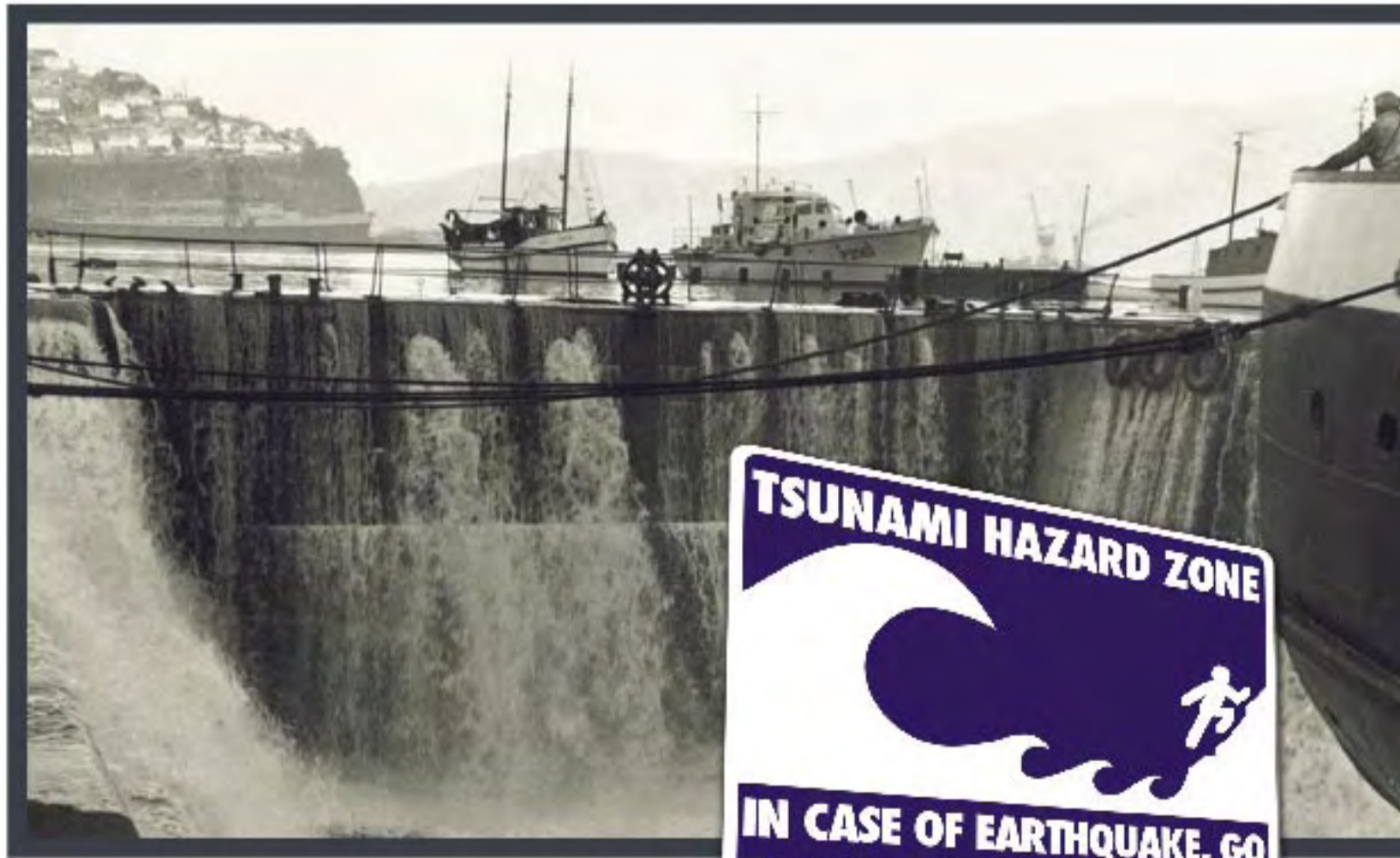
The reports will bring together knowledge which is currently scattered. In doing this, they will also identify areas where knowledge is lacking. The terms of reference require us to consult widely in New Zealand and internationally.

Focusing on 20 New Zealand cities, the first report will determine how often, on average, large tsunamis hit New Zealand's coast. This will be based on tsunamis generated by offshore earthquakes, undersea landslides, and erupting submarine volcanoes. Researchers will develop hazard estimates for each city by integrating local and trans-oceanic tsunami sources. They will also estimate casualties and impact on dwellings for a range of different tsunami scenarios.

The second report will review present warning and preparedness arrangements at regional and national level and recommend changes where appropriate. Thirty-three New Zealand researchers from eight organisations are involved in compiling the reports. More than half of the contributors are from GNS. Other contributing organisations include the National Institute of Water & Atmospheric Research (NIWA), the Ministry of Civil Defence and Emergency Management (MCDEM), territorial authorities, and New Zealand universities.

**Contact:** Kelvin Berryman

**Email:** [k.berryman@gns.cri.nz](mailto:k.berryman@gns.cri.nz)



A magnitude 9.3 earthquake in Chile in 1960 generated a tsunami that travelled across the Pacific. Here, the tsunami surge overtops the dry dock at Lyttelton. Photo courtesy of Port of Lyttelton.

## The 2005 New Zealand-American Ring of Fire Expedition



### Pisces V specifications

**Length:** 6.1m  
**Width:** 3.2m  
**Height:** 3.35m  
**Weight:** 13.2 tonnes  
**Payload:** 270kg  
**Crew:** 1 pilot, 1 co-pilot, 1 observer  
**Maximum operating depth:** 2000m  
**Propulsion:** Two side-mounted reversible thrusters tiltable through 90 degrees  
**Power:** Two lead acid battery systems  
**Speed:** 2 knots  
**Normal dive duration:** 7 to 10 hours  
**Life support:** 140 hours for three people  
**Viewports:** Three forward-looking acrylic windows, 15cm internal diameter

## “It’s almost like observing another planet...”

*For GNS marine geologist Cornel de Ronde, a veteran of 10 dives in deepsea submersibles, each new dive is just as exciting as the first. “I’ve dived in several places around the world, but the Kermadec arc is special because we have been studying the volcanoes here from surface ships for several years. Also because a number of the vent sites are fairly shallow, so sometimes you get natural light penetrating the otherwise dark places we like to visit.*

“Mostly the ocean floor is like a desert with little to see other than sediments. But when you come across a hot spring, suddenly there’s an explosion of marine life and colour. It’s a remarkable contrast.

“The aim of the Ring of Fire project was to dive on different volcanoes at different depths. The Kermadec arc is really obliging in this regard with the volcano summits ranging from about 120 to 1800 metres below sea level.

“The three circular view-ports in the command capsule might look impossibly small, but with your nose up against the acrylic you have an excellent view. You can see features up to 20 or 30 metres away.

“It’s not a place for the claustrophobic. The discomfort factor is only minor considering there are three people in a small two metre sphere for eight hours. It gets cold in there as you go deeper – around four degrees Celsius at 1800 metres deep. So a couple of extra layers of clothing is recommended. Each person is responsible for their own food and water. Most take a sandwich, but there’s not a lot of time for eating. Eight hours goes by really quickly.

“Every turn you make and every ridge you crest, you come across something new. The volcanoes are absolutely spectacular. It’s almost like observing another planet. One of the most remarkable sights we saw was boiling water pouring out of lots of seafloor vents at around 160 metres deep at Giggenbach volcano. Even people who have done this for their whole career have not seen that.

“For the Ring of Fire project, we focused on the volcanoes that had high sulphur and metal contents in their plumes. Sulphur is one of the main energy sources for the micro-organisms that colonise the vents. They attract larger animals and so on up the food chain. The plumes with high metal contents, like iron and manganese, were good indicators of possible mineral deposits having formed on the seafloor nearby.

“In essence, we were looking for seafloor systems that were productive for animals and minerals.

“We were amazed at the abundance and diversity of the life forms at each volcano. It’s a very hostile environment – water temperatures of 300 degrees Celsius, enormous overlying pressures, strongly acidic vent fluids, and gases and trace metals at levels that would be toxic to other life forms.



“Not only do the microbes and animals cope in these environments, they thrive.

“New Zealand is one of the few places in the world where submarine volcanic arcs are being studied intensively. Increasingly, scientists believe that hydrothermal vents on the ocean floor is where life began.

“There’s also the question of life on other planets. The extreme conditions of the Kermadec arc vent sites might provide clues in that regard too.”

**Contact:** Cornel de Ronde

**Email:** [cornel.deronde@gns.cri.nz](mailto:cornel.deronde@gns.cri.nz)

**Far right:**

- 1 A large jellyfish at Monowai volcano
- 2 Cucumber-like sea urchins at Clark volcano
- 3 8m-tall sulphur-rich chimneys near the summit of Brothers volcano at a depth of 1200m
- 4 1m-long octopus at Monowai volcano
- 5 Limpet-encrusted pillow lava at Monowai volcano
- 6 Naturally-lit mussel bed covered in bacteria at Macauley volcano at a depth of 140m
- 7 Mass of longneck barnacles sway in the currents 1200m-deep at Brothers volcano
- 8 A coffin fish waits for a meal on the slopes of Giggenbach volcano at 1650m deep
- 9 A fairly typical beehive chimney venting 300°C hydrothermal fluids at Brothers volcano
- 10 Cross-section of copper-lined chimney from Brothers volcano. (Also shown in Figure 9).

## A milestone in deep-sea exploration

*The 2005 New Zealand-American Ring of Fire expedition was an intensive exploration of the volcanic ocean floor northeast of the North Island. The \$6.5 million project involved 30 scientists from three countries. Essential to the success of the seven-week project was the collaboration of multiple organisations into a formidable consortium.*

The team made 24 dives on 10 active submarine volcanoes ranging in depth from 200m to 1900m. Until this mission, knowledge of the geology, chemistry, and biology of the volcanoes of the Kermadec arc was scant. It was the first time that most of the volcanoes had been seen by humans. The expedition produced a massive amount of new information that will permeate through the international science community. A handful of the 30,000 deep-sea photographs taken during the expedition are shown here.

A major focus was the vibrant communities of hardy marine species that colonise the seafloor hydrothermal vents. When a vent becomes inactive, species must find another vent to colonise or die. One of the aims was to piece together the extraordinary cycle of life in these extreme conditions.

The Ring of Fire consortium consisted of GNS, the National Institute of Water & Atmospheric Research (NIWA), the National Oceanic and Atmospheric Administration (NOAA), the University of Hawaii, the University of Washington, Oregon State University, Kiel University of Germany, and the University of Mississippi.

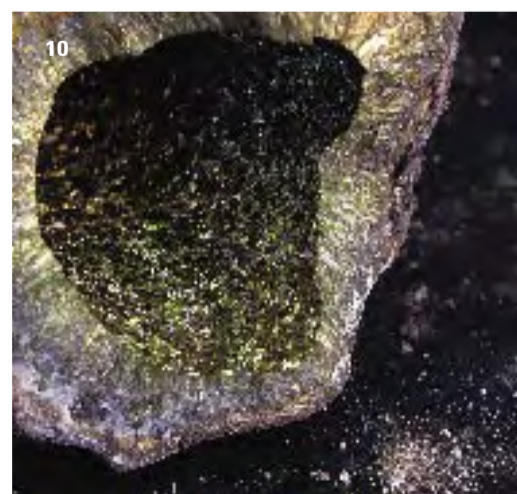
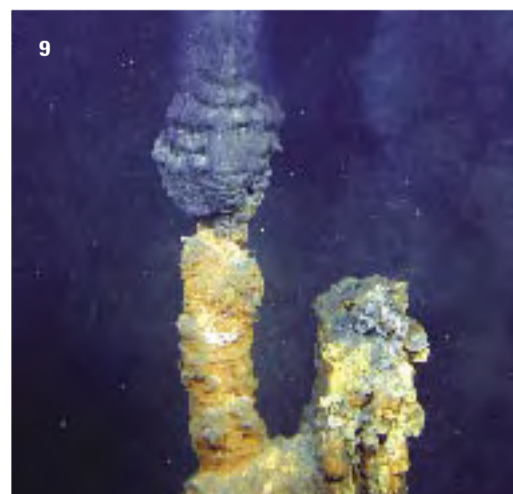
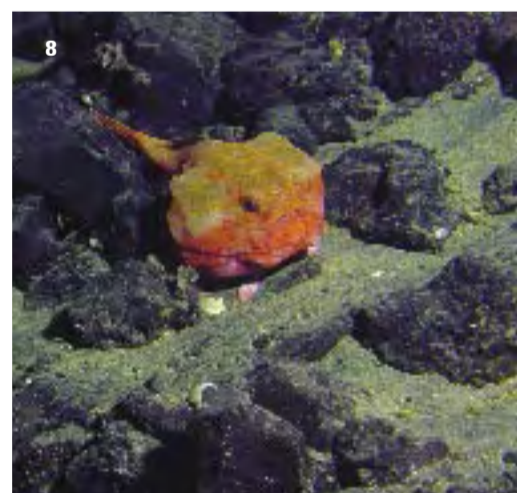
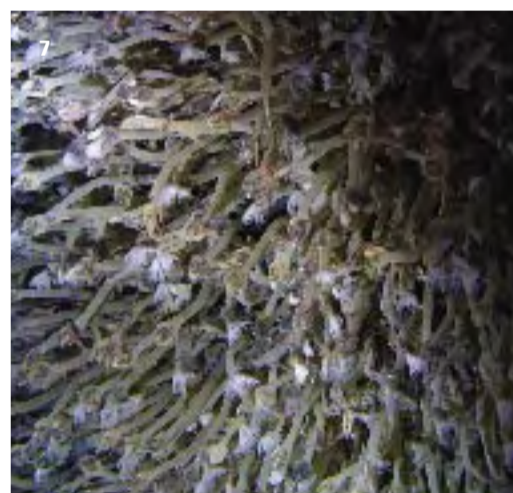
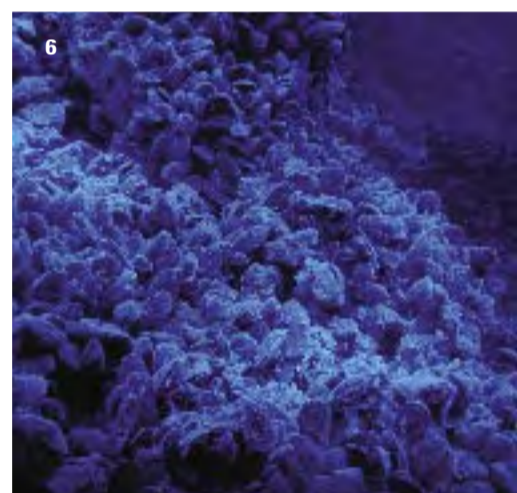
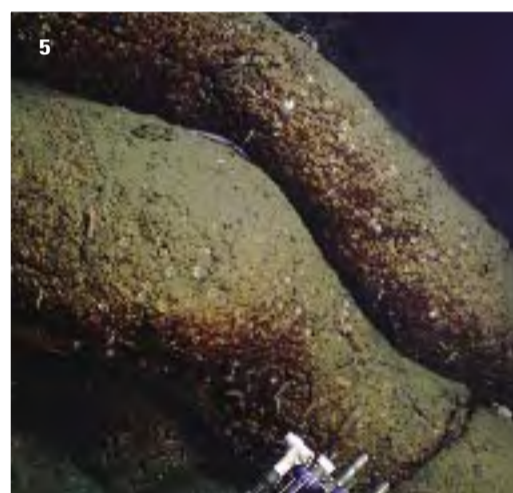
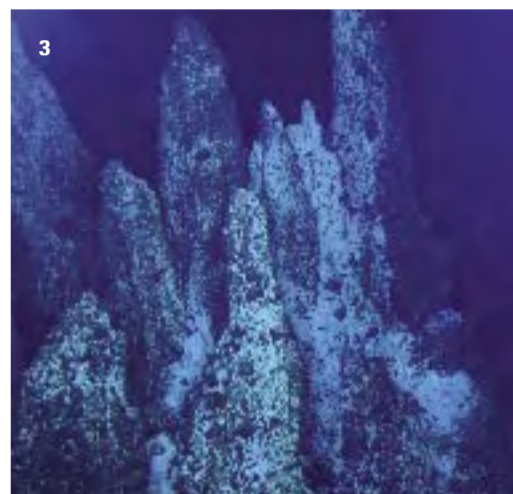
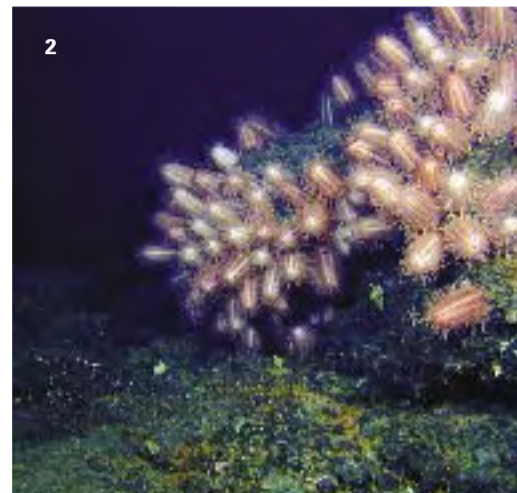


**Above centre:** Surfacing after an eight-hour dive in *Pisces V* are chief pilot Terry Kerby (headband), Cornel de Ronde of GNS (top), and co-pilot Steve Price.

**Far left:** Launching the submersible *Pisces V*.

**More information:**

- <http://starbulletin.com/2005/08/10/news/index2.html>
- <http://www.noaanews.noaa.gov/stories2005/s2487.htm>
- <http://www.gns.cri.nz/research/marine/kermadec/expeditions>
- <http://oceanexplorer.noaa.gov/explorations/05fire/welcome.html>



## Coming up...

### The 1855 Wairarapa Earthquake Sesquicentennial Symposium

**When:** 8 - 10 September 2005

**Where:** Te Papa, Wellington

**What:** 150 years of thinking about magnitude 8-plus earthquakes and seismic hazard in New Zealand. Includes field trip and public seminar.

**Website:** [www.eqc.govt.nz](http://www.eqc.govt.nz) (under Quicklinks on the right)

**Contact:** Ursula Cochran ([u.cochran@gns.cri.nz](mailto:u.cochran@gns.cri.nz))

### The 47th NZ Water and Wastes Association Annual Conference and Expo

**When:** 28 - 30 September 2005

**Where:** The Aotea Centre, Auckland

**What:** The main event on the water and wastes annual calendar

**Website:** [www.nzwwa.org.nz/annualconf](http://www.nzwwa.org.nz/annualconf)

**Contact:** Melissa Climo ([m.climo@gns.cri.nz](mailto:m.climo@gns.cri.nz))

### The Mt Ruapehu Eruptions – 10 Years On

**When:** 14 - 16 October 2005

**Where:** Whakapapa Village, Mt Ruapehu

**What:** What did we learn and what are we doing differently now?

**Website:** [www.cav.volcano.info/ruapehu](http://www.cav.volcano.info/ruapehu)

**Contact:** Graham Leonard ([g.leonard@gns.cri.nz](mailto:g.leonard@gns.cri.nz))

### Basics of Geothermal Technology

**When:** 26 October 2005

**Where:** Park Heritage Hotel, Rotorua

**What:** A one-day seminar for those interested in geothermal technology but who have limited background in science and engineering.

**Website:** [www.auckland.ac.nz/gei/shortcourse](http://www.auckland.ac.nz/gei/shortcourse)

**Contact:** Stuart Simmons ([sf.simmons@auckland.ac.nz](mailto:sf.simmons@auckland.ac.nz))

### Planning for a Volcanic Crisis

**When:** 9 - 11 November 2005

**Where:** Mercure Hotel, Auckland

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

Includes field trip to Rangitoto Island.

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

**Contact:** Daryl Barton ([d.barton@gns.cri.nz](mailto:d.barton@gns.cri.nz))

### 2005 New Zealand Minerals Conference

**When:** 13 - 16 November 2005

**Where:** Carlton Hotel, Auckland

**What:** Realising New Zealand's mineral potential

**Website:** [www.crownminerals.govt.nz/minerals/conference](http://www.crownminerals.govt.nz/minerals/conference)

**Contact:** Melissa Climo ([m.climo@gns.cri.nz](mailto:m.climo@gns.cri.nz))

## New website...

### Preventing damage from volcanic ash

Falling volcanic ash can turn daylight into darkness and can cause a heap of unpleasant problems.

A new website provides information and guidance for homeowners, business, and communities on the best action to take before, during and after ash fall.

The Ash-Impacts Website is a collaboration involving the US Geological Survey, GNS, the University of Hawaii, and Canterbury University.

<http://volcanoes.usgs.gov/ash>



Above: Scientists John West (left), Chris Kroger, and Murray Bartle with the Eagle FA scanner which has been installed in meat processing plants in five countries.

## Award for x-ray scanner team

*A team of GNS scientists and engineers who develop x-ray-based scanning and measuring equipment recently won a business award. GNS IsoScan won the Discovering Gold category at the 2005 Wellington Region Gold Awards. This category recognises successful commercialisation of innovative technology.*

The IsoScan entry was the Eagle FA meat scanner developed in partnership with ANZCO Foods and US-based scanner manufacturer Smiths Detection. The scanner, which is helping to revolutionise quality control in the meat export industry, has been installed in meat processing plants in New Zealand, Australia, and North and South America.

Using technology that is similar but more advanced than airport baggage scanners, it gives an instant reading of fat content of boxes of meat destined for export markets.

These measurements are likely to eliminate the need to pay penalties for meat consignments that exceed agreed fat margins.

The scanner is able to handle up to 20 export meat boxes a minute on the production line. It enables operators to make on-the-spot adjustments so the product meets agreed specifications. The GNS IsoScan team have more scanning applications in development, particularly for the food and wool processing industries.

The award is fitting recognition for the pioneering work of senior GNS scientist Murray Bartle, who has worked tirelessly to perfect dual energy x-ray technology for the food industry.

Dr Bartle and his team can justifiably be proud of what they have achieved with the scanner. The award is an example of the wide recognition of GNS's National Isotope Centre. The facility has an excellent record of developing business opportunities for New Zealand, based on innovative isotope technologies.

**Contact:** Joe Manning

**Email:** [j.manning@gns.cri.nz](mailto:j.manning@gns.cri.nz)

## Seismic software meets King Kong

One of the most powerful computers in the Southern Hemisphere is taking GNS's seismic processing capability into a new realm. GNS has teamed up with the New Zealand Supercomputing Centre (NZSC) to boost the speed and versatility of the GNS-developed GLOBE Claritas seismic processing software.

Wellington-based NZSC is made up of 1008 Intel 2.8 Gigahertz Xenon processors on 504 IBM dual Blade servers. Each of the processors is equivalent to a modern desktop computer, and they can be tasked to work together in groups on a single computational problem.

Trials with the GNS software using a group of 28 computers at NZSC have produced encouraging results. A processing job that took four hours on a GNS desktop computer was completed in 10 minutes – 24 times faster than normal.

Early indications are that the facility will enable GNS to extend its services to processing three-dimensional seismic data and large complex assignments previously not possible.

"We're still testing the scalability of Claritas software to find the optimum computing power to work with," says Seismic Processing Manager Guy Maslen.

"The power of the NZSC facility, combined with the ability to add user-defined modules to GLOBE Claritas, will allow us to pursue exciting new business models."

These are likely to include offering "computing on demand" services to boost the resources available to existing Claritas clients, as well as much faster turnaround on projects.

NZSC is a joint venture involving special effects company Weta Digital and Telecom New Zealand and it is operated by Gen-i. NZSC hosts commercial users on its unused capacity. It was used to do the digital special effects in the *Lord of the Rings* trilogy and in the soon-to-be-released remake of *King Kong*.

**Contact:** Guy Maslen  
**Email:** g.maslen@gns.cri.nz



Seismic Processing Manager, Guy Maslen...  
"the huge increase in computing power opens up a range of exciting possibilities for our seismic processing services."

## Hazard service bridges the gap

The flood of new legislation facing territorial authorities is forcing them to hire external specialists. An example of this is Manukau City Council (MCC) which is working with joint venture company, PropertyInsight, to link natural hazard information with its many planning and operational functions.



**Andrew Thakurdas, Manager – Business and Service Value, Manukau City Council – comments:**  
**"Manukau City Council have found a treasure in PropertyInsight manager, Pim Willemstein, who has been very patient in helping us work through a number of issues which otherwise would have stalled our progress. It is great that extraordinary people like Pim are helping the 'ordinary people' in the workplace make more use of experts in New Zealand. They are making a significant and positive difference to the way that things are being done today and into tomorrow in a local government environment."**

MCC decided that contracting a natural hazards specialist was more economical than hiring staff and developing a new capability. There was also the realisation that geological hazards are not just the responsibility of civil defence, but impact on a wide range of Council staff. Liability is another reason MCC decided to engage PropertyInsight.

PropertyInsight is a joint venture involving GNS, Valuation New Zealand, and Niu Pacific. Through its website, it provides natural hazard information for more than 1,000,000 urban properties in New Zealand. Its purpose is to provide a national portal where people can find property-related geological hazard information. The main users of the PropertyInsight website are the public, territorial authorities, property lawyers, and insurance companies.

MCC and PropertyInsight are working together to ensure that hazard information is included on external documents such as PIMs and LIMs. PropertyInsight is also managing the integration of national, regional, and local natural hazard databases relevant to MCC and potentially other parts of Auckland.

For the pilot with MCC, PropertyInsight is including factors such as salt spray, and wind and noise zones, with existing earthquake and landslide information. Working with PropertyInsight allows Council staff and ratepayers to independently assess up-to-date hazard information easily. The information is instantly available via the internet and provided in a customised format which is standardised throughout New Zealand. This later feature will make it economical for all territorial authorities to use.

One of the long-term objectives of this initiative is to get people to use the information to make their property less vulnerable to hazards, according to PropertyInsight general manager Pim Willemstein.

"Everyone wins with this system. Territorial authorities can reduce their exposure to risk and meet compliance expectations, and property owners and buyers have easy access to comprehensive hazard information on individual properties."

**Contact:** Pim Willemstein  
**Email:** info@propertyinsight.co.nz  
**Web:** www.propertyinsight.co.nz

## What's your disaster story?

GNS and Te Ara, the encyclopedia of New Zealand, are on the lookout for personal accounts of natural disasters in New Zealand. We are interested in first-hand accounts of earthquakes, floods, volcanic eruptions, tsunamis, or landslides.

The personal stories will be added to Te Ara's section on 'Earth, Sea and Sky' which explores the shaping forces of New Zealand's natural environment. Te Ara will put the best of the contributions online, and all contributions will be forwarded to GNS where they will be compiled into a science report which will be available to the public.

Accounts of disaster experiences should be around 500 words and supporting photographs would be useful. Te Ara needs to receive contributions by 16 September 2005. GNS Hazards Management Scientist David Johnston says disaster stories are a valuable resource as they help scientists to improve their understanding of the impact of natural hazards.

Te Ara is the world's first national online encyclopedia and it is being published progressively in themes over the next seven years. Details on how to submit your disaster story can be found on the Te Ara News section at [www.teara.govt.nz](http://www.teara.govt.nz)

**Contact:** David Johnston  
**Email:** d.johnston@gns.cri.nz



## Physics celebrated in short videos

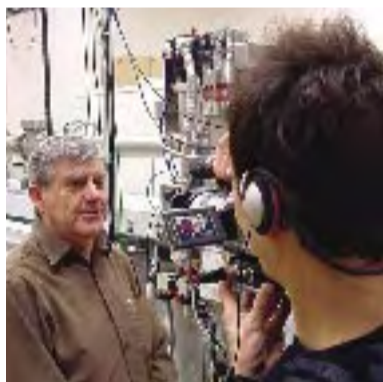
Videos about the ways physics is applied in today's world can be seen on the *E=mc<sup>2</sup>* website. Several of the short videos were filmed at GNS's National Isotope Centre in Lower Hutt. They explain radiocarbon dating, x-ray scanning and measuring, and radiometric dating of rocks. More GNS videos are planned.

The six-minute videos are aimed at teenagers to show the huge variety of applications that physics-based technologies have. They can be accessed through the *E=mc<sup>2</sup>* website, which is part of New Zealand's celebrations for the International Year of Physics. The website pays tribute to the major insights into the workings of the universe as published by Albert Einstein in 1905.

The clever and varied ways in which physics is applied in everyday life will be a surprise even to some scientists.

For more information visit:

[www.eequalsmcsquared.auckland.ac.nz](http://www.eequalsmcsquared.auckland.ac.nz) (under What's New)



Rodger Sparks (top) and Hamish Campbell explain radiocarbon dating and radiometric dating of rocks respectively.

## Recent publications

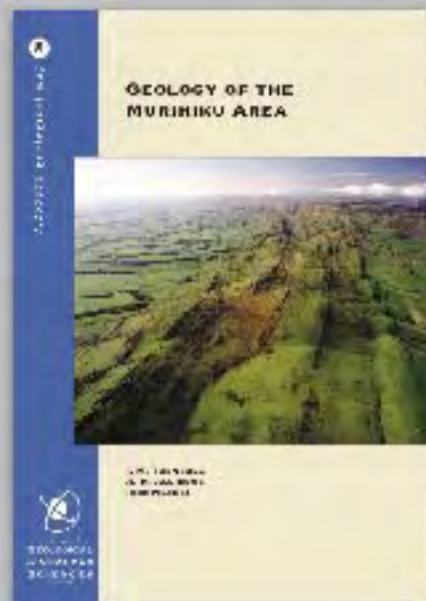


### Revised geological timescale for New Zealand

New Zealand has the best geological timescale in the world thanks to a new GNS publication. The new timescale revises the definitions of all 69 geological stages in New Zealand, spanning 542 million years. The 284-page publication has been hailed internationally as clear, systematic and data-rich. It is expected to remain a benchmark reference for all branches of earth science for many years. Scientists use a geological timescale as a time framework for all studies of the history of the Earth and its life. As well as assigning a geological age to rocks, fossils and economic minerals, a timescale calibrates the rates of geological processes such as fault rupture, plate movement, submergence, uplift, erosion, and volcanic activity. Rates of climate change, sea-level change, and biodiversity change are also measured in terms of a geological timescale. The book and wall chart are available from GNS for \$40. The wall chart only is \$10.

### New Zealand geology in poster form

The jigsaw of New Zealand's many rock types is shown in a new wall poster available from GNS. Our rocks range from soft mudstone to hard gneiss with ages ranging from 500 million years old to volcanic rock erupted in the past 50 years. The oldest rocks were part of the ancient continent of Gondwanaland. More recent rocks were formed after the New Zealand continent drifted away from its parent. The 590mm x 910mm poster is available from GNS for \$20.



### Southland's geology exposed

A new geological map of the southern part of New Zealand shows the region in more detail than ever before. Geology of the Murihiku Area covers 18,000 square kilometres of South Otago and Southland, including Foveaux Strait and Stewart Island. It replaces outdated geological maps of the area and combines a vast amount of published and unpublished material, plus new research, to produce a valuable resource about Southland geology. The large full-colour 1:250,000-scale geological map is tucked into a sleeve in the back cover of a well-illustrated 74-page companion book. It is available from GNS for \$30.



### Waikato bares all

The geology of the prosperous western North Island is revealed in this new 68-page book and geological map that covers 11,000 square kilometres of the Waikato, King Country, and northern Taranaki. The offshore area, with its significant oil and gas potential, has been only lightly explored and more discoveries are expected. The book also describes onshore resources including extensive ironsand and coal deposits, as well as aggregate, sand, and limestone resources. A folded full-colour 1:250,000-scale geological map is tucked into a sleeve in the back cover of this publication which is available from GNS for \$30.

