# GLOBE

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Institute of Geological & Nuclear Sciences Newsletter




17

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

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**Cover image:** The edge of Champagne Pool at Waiotapu, near Rotorua. The hot pool fills a hydrothermal eruption crater that formed between 600 to 900 years ago. It is fed by a deep geothermal system that keeps the pool's temperature at 75degC. The vivid colours are caused by high concentrations of heavy metals in the native sulphur deposits that surround the pool. Extremophilic microorganisms are found in these deposits and in other geothermal areas throughout the North Island.
Story pages 4 & 5.

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# From the Chief Executive

*Since taking up the role of Chief Executive last year, I have been impressed by the quality of the people and the quality of the science in GNS. More importantly, I am impressed by the ability of GNS staff to use science to solve the problems of our clients in the real world.*

My personal passions in science are the exploration of the ocean floor, and the interaction of microbial life with rocks. In both these areas, in my previous position in Hawaii, I contributed to finding technical solutions to practical problems. Sometimes this was the deployment and safe retrieval of submersible craft. At other times, it was the design of high-pressure confinement vessels to bring microbes into the laboratory under the same conditions as they thrive in the ocean depths. This same ability within GNS to solve problems makes me proud to be Chief Executive.

In this issue of Globe, you will read about our plans to develop a bank of extremophile organisms obtained from New Zealand's geothermal environments. There is also coverage of our activities in the important field of nanotechnology. And a new ocean map covering the fourth largest EEZ in the world – page 8 – shows New Zealand as a continent, rather than the island nation we were brought up to think about.

My vision for GNS is to push forward with these and other challenging opportunities. We will explore our deep-sea regions to discover what resources lie within our EEZ. We will build the scientific capabilities we need to ensure New Zealand benefits from these resources. Foremost among these are energy resources, such as the North Sea-sized petroleum prospect we have identified in the Deepwater Taranaki Basin. We will also remind Government, as our predecessor organisations did, that we are providers of expert earth science advice and knowledge.

For example, in the mid-1980s the New Zealand Geological Survey expressed concern to the then government at serious inconsistencies in the assumed reserves of the Maui gas field. NZGS recommended independent modelling of the field's production to improve knowledge of its future potential. The then minister of energy acted on our recommendation and appointed a Canadian company to evaluate the field using our databases and reports held by the Ministry of Energy. Our involvement eventually resulted in a more informed and measured approach to the pricing of Maui gas contracts. Also, since that time we have stressed at a variety of public fora the need for significantly more exploration to find replacement gas fields before the Maui field depletes.

While pursuing our numerous challenges, it is imperative our traditional core does not become soft. By this, I mean not only the core of GNS, but also the core of New Zealand's earth and isotope science capability. For this reason, we are working with universities to establish a seamless partnership so that New Zealand students receive a truly excellent education in the earth sciences. We do not believe they do at present. This issue of Globe profiles the students we are currently supporting with post-graduate scholarships. We expect many to stay in New Zealand, or to return after an overseas sojourn, and strengthen the role of earth sciences, earth resources, and natural hazards in this country. When New Zealand can train and retain its own science professionals across all fields, we will know we have a knowledge economy.

Alexander Malahoff
Chief Executive

# Action hots up in geothermal

*GNS and Century Resources, a division of Downer EDI Ltd, have formed an alliance to offer services to the geothermal industry globally. The new relationship will give both organisations a stronger presence in geothermal markets such as Iran, Vietnam, India, Indonesia, and the Philippines.*

Century and GNS have worked together on geothermal projects in New Zealand and Australia for decades. The formal alliance will provide clients with a broad range of services, including geothermal exploration, geothermal development, environmental and hazard modelling, and geothermal resource management activities.

GNS has also recently secured a contract to run the secretariat for the geothermal section of the International Energy Agency (IEA). Geothermal scientist, Mike Mongillo, has been appointed as secretary at GNS's Wairakei Reseach Centre, near Taupo. GNS's standing in the international geothermal community was a major factor in the awarding of the secretariat.

Currently, eleven countries and one international organisation participate in the geothermal section of the IEA: Australia, Germany, Greece, Iceland, Italy, Japan, Mexico, New Zealand, Switzerland, the United Kingdom, the USA, and the Commission of European Communities. Invitations have been extended to other countries with geothermal resources to broaden the experience of the participants. Participating countries contribute to the cost of the secretariat.

The objectives of the geothermal section of the IEA include the sharing of information on geothermal energy and research, developing improved technologies for geothermal energy, enhancing our understanding of geothermal energy's benefits, and improving ways to avoid or lessen environmental drawbacks.

GNS's tenure of the secretariat will enable us to be better informed on geothermal activities throughout the world and increase our exposure in the international geothermal marketplace.

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# New names added to the map

*Two former GNS scientists have had parts of Antarctica named after them in recognition of their work on the frozen continent.*

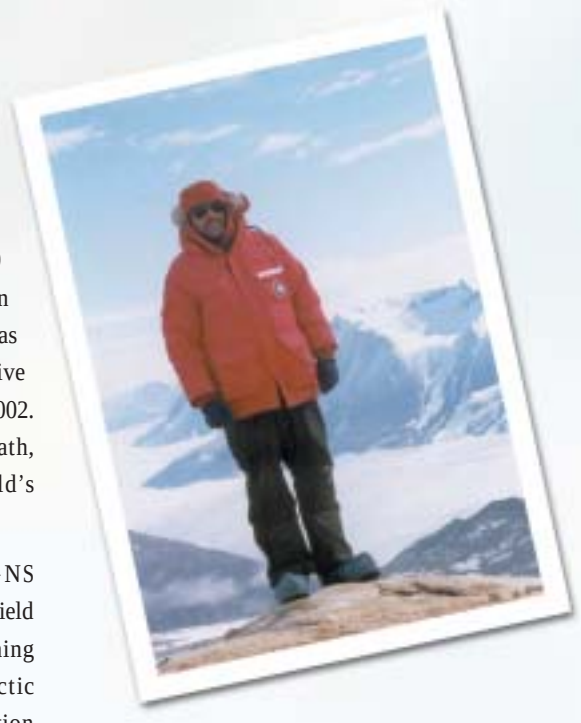
A mountain ridge on Ross Island now bares the name of Werner F Giggenbach, a leading gas geochemist who died in 1997 while working on Rabaul Volcano in Papua New Guinea. And Graeme Blick, a geodetic survey advisor with Land Information New Zealand, has a mountain named after him.

The US Geological Survey nominated Dr Giggenbach for his work during four field seasons in Antarctica in the 1970s. He was known for his pioneering work in geochemistry and for his energetic and fearless methods in collecting the best volcanic samples for analysis. On one occasion he rappelled into the inner crater of Mount Erebus to collect gas and lava samples, but colleagues had to pull him out hurriedly when an eruption showered him with volcanic bombs.

Giggenbach Ridge is to the northwest of Mt Terror on Ross Island. Dr Giggenbach has also had a submarine volcano named after him. Giggenbach volcano is 35km northwest of Macauley Island in the Kermadec group of islands northeast of New Zealand. It was discovered in April 2000 during a NIWA-led expedition on the research ship *Tangaroa*. It was found to be hydrothermally active during a GNS-led expedition in 2002. Between 1960 and his untimely death, Dr Giggenbach was one of the world's foremost gas geochemists.

Surveyor Graeme Blick, who worked for GNS between 1970 and 1994, spent a number of field seasons in Antarctica in the 1980s examining the potential uplift of the Trans-Antarctic Mountains and monitoring crustal deformation associated with volcanic activity around the summit of Mount Erebus on Ross Island. The naming in his honour was proposed by the United States Board on Geographical Names. Mount Blick rises to over 1400m and is to the north of the Carlstrom Foothills, Churchhill Mountains. Graeme has not seen his mountain yet, but says his next ambition is to go down and climb it.

The United States and New Zealand have a joint place naming arrangement for mapping and charting activities in the Ross Sea Region. This means the responsibility for assigning a name to unnamed features is shared collaboratively between the two countries. The honour is reserved for people, living or dead, who have made a direct and significant contribution to scientific research in Antarctica.



Left: Graeme Blick in Antarctica.
He would not only like to climb Mount Blick, but survey it as well.

Geochemist, Werner Giggenbach, rappelling into the Mt Erebus crater in December 1974 to collect volcanic gas samples. Shortly after this photo was taken, an eruption started and he was hauled out of the crater by colleagues.

# Extremophiles – benefiting from nature's super-survivors

*Over the next three years, GNS plans to collect several hundred viable extremophiles and house them in a specially built facility. It will be New Zealand's biggest collection of viable extremophiles, and it will enable GNS to work with industry and research partners to find new ways these microorganisms can be of use to humans.*

There are vast numbers of extremophile species living in New Zealand, and only a small percentage have been collected and identified. Even fewer have been stored as "viable" organisms because of the difficulties in keeping them alive once removed from their natural habitat. GNS uses special techniques to gradually chill the organisms to minus 70degC, at which point they become dormant yet remain viable.

It is intended the collection will represent a cross-section of species living in New Zealand's geothermal and volcanic areas, including undersea hydro-thermal vents. The long-term goal is to set up a New Zealand Centre for Extremophile Geomicrobiology. It will attract world-class partners and will be tied in with GNS's geothermal work at Wairakei.

Above and right: From hot springs on the ocean floor to the top of the highest volcano. Just a few of the hostile environments where extremophiles thrive in New Zealand.

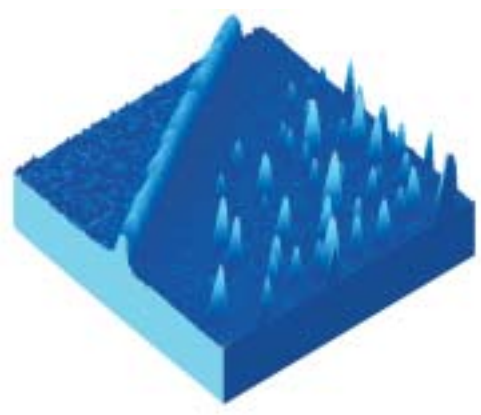
**What are extremophiles?**

**They are microorganisms, many of which are bacteria, that grow and reproduce in extreme conditions on and under the ground. This includes water at temperatures as high as 110degC, and high acidity, high pressures, and high salt concentrations. Some are equally at home in extremely low temperatures and high concentrations of normally toxic substances such as sulphur, arsenic and mercury. Some live in rocks 4km below the Earth's surface. They also thrive in combinations of the above conditions. Their extreme needs fascinate scientists who marvel at their biochemistry, which has potentially huge implications for biotechnology and many other sectors.**

# Nanotechnology – the biggest thing since the iron age

*Nanotechnology is fast becoming one of the most highly energised branches of science. Advocates believe it will change human lives even more profoundly than the Industrial Revolution. It will allow us to manipulate and position individual atoms and molecules, leading to an unprecedented range of new products and materials. It will spawn lighter, stronger, more precise, more energy efficient, and less expensive materials than today's most advanced technologies.*

Right: A photo of nanowhiskers taken through an atomic force microscope. This prototype structure has potential applications in the electronics industry.



Nanotechnology will allow us to make supercomputers that are almost invisible to the naked eye. It will usher in low-cost solar cells and batteries that could replace fossil and nuclear fuels with clean, abundant solar power. And nanomedical devices will travel through our blood vessels eliminating infections and cancer, and monitoring bodily functions.

All this is a long way from the present state of this nascent field. But, given the pace of change to date, it is only a matter of time before these things materialise.

The intense interest worldwide in nano-structures stems from the fact that they appear to have vastly superior electrical, mechanical, chemical and optical properties to conventional materials. Because the field is so new, the definition of what constitutes nanotechnology is vague, even among nano-trailblazers. Nanotechnology hovers on the border between individual atoms and molecules. It works on the scale of a nano-metre – one billionth of a metre – or about one half-millionth the size of a full stop.

There are varied approaches to making nanostructures. GNS nanotechnology team leader, Andreas Markwitz, is possibly the only person in the world at present successfully using a combination of a linear accelerator, an ion implanter and electron beam annealing to make nanostructures. With collaborators in New Zealand and overseas, GNS is working towards commercial production of nanostructures for use in the electronics and manufacturing industries.

"We've started to form alliances with organisations in Japan, Australia and Britain to enable our prototype structures – nanowhiskers and nanoboulders – to be developed commercially," says Andreas.

Nanowhiskers, which appear like bristles or whiskers under an atomic force microscope, are made of pure silicon atoms attached to a pure silicon wafer. They are typically about 100 atoms long and 20 atoms wide.

Nanoboulders are somewhat larger and possibly made of carbon atoms sitting on a flat silicon wafer.

GNS has filed three provisional patents covering the fabrication technique pioneered by Andreas. In short, this method involves firing silicon ions at a silicon wafer which is heated to 1000degC for several minutes. The force behind the ions is 5000 volts. All this happens in a vacuum chamber.

"Our prognosis is that the electronics industry will start using new nanoelectronic devices within the next 12 years. Within 25 years, nanotechnology will form a significant part of the electronics industry. The uptake in other industries will probably be similar."

As the GNS nanotechnology programme gathers momentum, new staff and equipment will be required. In 2004, a new ion implanter will be brought to GNS's National Isotope Centre in Lower Hutt, enabling the implantation side of the fabrication process to take place in New Zealand.

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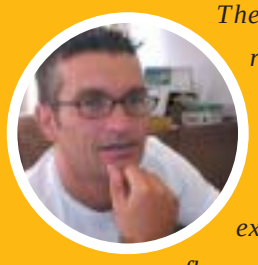
# GNS's extremophile initiative is being led by scientists Chris Daughney and Bruce Mountain

## The limits of life



*The questions in extremophile research are numerous. One of the areas biogeochemist Bruce Mountain is investigating is how extremophiles are able to influence the types and structures of minerals that form in hydrothermal environments. His research includes investigations into the temperature limit of life through the study of the stability of amino acids at high temperatures.*

Bruce is also investigating the role of bacteria in the cycling of heavy metals around deep-sea hydrothermal vents, hot springs, and silica sinter deposits. Understanding these processes is crucial to the understanding of the ecological, mineralogical and chemical evolution of these environments.

Bruce says the meeting of biosphere and geosphere has been propelled partly by the realisation that microbial activity has a major impact on the way the natural world works. Only 10 years ago, biogeochemistry was merely a footnote at most geochemical conferences. Now there are entire conferences devoted to it.

Extremophiles have helped shape the planet over the past 3.5 billion years. They break down rock, build mineral deposits, consume toxic substances, and form by-products ranging from methane gas to native sulphur (sulphur occuring in a free state).

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## Where metal and bacteria meet

*Geomicrobiologist Chris Daughney's work involves examining how different conditions influence the metal adsorption capabilities of extremophiles. His project is believed to be the first-ever systematic investigation of metal adsorption by extremophiles.*

The main objectives are:

- To quantify and understand the extent of metal adsorption by extremophiles under a variety of biological, chemical, and physical conditions
- To precisely identify mechanisms involved in metal-extremophile adsorption
- To isolate and culture novel extremophiles from New Zealand's hot springs and hydrothermal vents, and characterise their growth requirements, particularly their interactions with dissolved metals.

An understanding of the way extremophiles remove metals from solutions will open up biotechnology applications in many areas, including remediation of metal-contaminated environments, treatment of waste water, recovery of valuable metals from geothermal waste streams, reduction of scale precipitation in high-temperature industrial processes, and the development of biosensors.

These applications have a potential global market worth billions of dollars every year. Because of the diversity of New Zealand's geothermal environments, and the experience of GNS staff and their collaborators, New Zealand is well placed to become a world leader in extremophile geomicrobiology.

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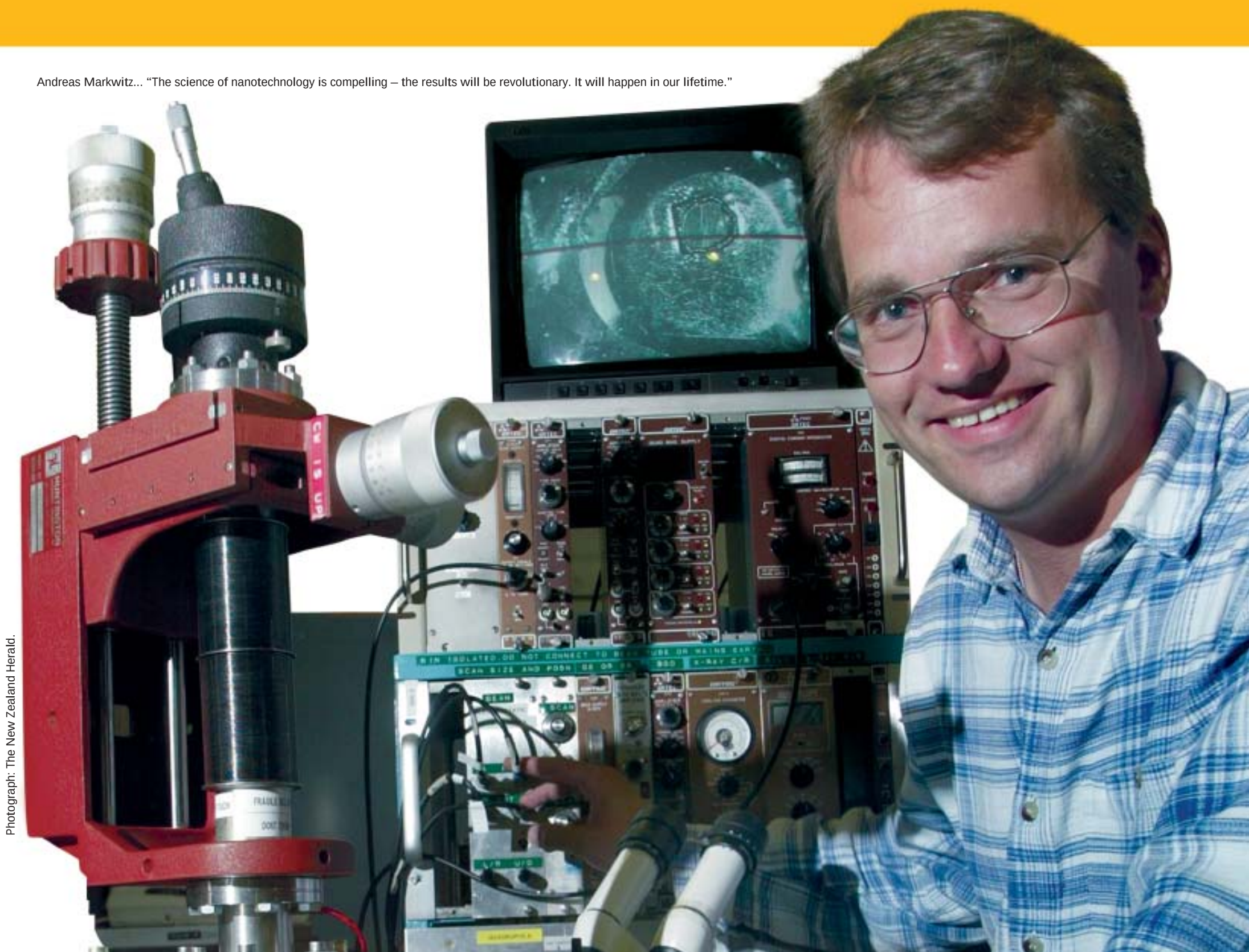
Andreas Markwitz... "The science of nanotechnology is compelling – the results will be revolutionary. It will happen in our lifetime."



Photograph: The New Zealand Herald.

Geochemist, Kevin Faure... his laser ablation laboratory has been so successful that he was hired by a US university to build a similar facility in Nevada last year.

# Minerals bare all under a laser beam

*Minerals, some as old as 3.5 billion years, yield fascinating secrets about the Earth's past when they are vaporised by carbon dioxide laser beam.*

GNS's laser ablation facility, the only one of its type in the Southern Hemisphere, attracts business from all over the world. The facility, which determines the origin of oxygen-bearing minerals, is located at GNS's National Isotope Centre in Lower Hutt.

About 70 percent of samples come from overseas, particularly Australia and North America. Main clients are universities and mineral exploration companies.

The process consists of extracting oxygen from oxide and silicate minerals by heating with a carbon dioxide laser. The advantage of this method is that the laser beam delivers a very high temperature (up to 1000degC) within seconds. This helps to break down strong chemical bonds and release the oxygen in minerals.

The released oxygen is analysed in a mass spectrometer to determine the ratio of oxygen isotopes – oxygen 18 and oxygen 16. The ratio tells geologists about the environment in which the mineral was formed, such as its temperature and the source of fluids from which it precipitated. It also shows whether alteration has occurred to the mineral since it formed.

Oxide and silicate minerals are robust and retain their composition even when subjected to severe conditions for prolonged periods. Analysis of these minerals for their oxygen isotope ratios provides chemical "snapshots" of the Earth's crust and oceans at various stages during its development.

The oldest minerals to pass through the laboratory, from Australia and South Africa, were about 3.5 billion years old.

The lab can handle up to 21 samples a day, with sample sizes as small as 1 to 2 milligrams. The facility has been so successful that geochemist, Kevin Faure, who built and operates it, was flown to the United States in 2002 to build a similar facility at the University of Nevada at Reno.

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The GNS valuation report will enable horizons.mw to develop a robust water allocation policy for the region.

# Valuation report an asset to water management

*GNS recently estimated the economic value of water resources in the Manawatu-Wanganui region at $2.4 billion. The 112-page report, commissioned by regional council horizons.mw, covers streams, rivers, dams, lakes, and aquifers, and will assist in developing future water allocation policy.*

"We have been aware of the competing demands for water in some parts of the region for some time. We commissioned this report to help us understand the resource in an economic context. Water is a critical resource for both economic and environmental prosperity. The information in the report will help us manage the critical balance between the need to protect the environment and the water needed to sustain the region's economic growth," said horizons.mw Resources Group Manager, Michael McCartney.

The report, produced by Paul White of GNS's Groundwater Group, evaluated the relative economic importance of water sources (rivers, streams and underground aquifers), sectors (productive and recreation uses) and the specific demand verses the supply available in the different areas in the Manawatu-Wanganui region. To do this, Paul divided the diverse Manawatu-Wanganui region into 16 sub-regions. Values for productive and recreational uses were given in each sub-region.

The total value of productive uses is $2.4 billion and *in situ* or recreational values total $283 million. Industry usage tops the productive list at $1231 million, followed by hydro power generation at $473 million, human water supplies $303 million, community waste disposal schemes $261 million, and agriculture $145 million. The economic values of *in situ* uses are fishing $28 million, hunting $53 million, boating $53 million, and recreation $12 million.

horizons.mw intends to use the report to develop water allocation policy. Of particular interest is the value placed on water in the sub-regions, and the potential to use this information to determine how much money should be devoted to managing water resources within the whole region or particular sub-regions. Another potential use of the report is to investigate the use of trade-offs between productive sector uses, or between productive sector uses and *in situ* uses.

The report is publicly available and can be downloaded from the regional council's website: www.horizonsmw.govt.nz

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# GNS hazards work sets international benchmark

*Earthquake hazards consultancy work done by GNS at a nuclear research reactor site in Australia looks set to become a benchmark for hazard assessment and seismic safety for these facilities internationally.*

The work programme, managed by GNS at the reactor construction site at Lucas Heights, near Sydney, has been endorsed by the International Atomic Energy Agency (IAEA). The GNS report was instrumental in the Australian Nuclear Science and Technology Organisation (ANSTO) gaining approval from Australia's independent nuclear regulator, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) to go ahead with building a replacement research reactor at Lucas Heights.

Geological hazard assessment work done by an international team, managed by GNS, played a significant role in the decision to proceed.

ANSTO's replacement reactor site is adjacent to the existing reactor, and will be used for research and the production of radioisotopes for medical and industrial purposes. Production from the Lucas Heights facility is widely used by organisations throughout Asia and the Southwest Pacific.

During excavation of 200 million year-old bedrock at the site, two fault strands crossing the main reactor area were observed. The lack of younger rock or soil horizons at the replacement reactor site to record the age of the most recent fault movement presented a significant technical challenge. This challenge was met with a multi-faceted approach, including a thorough review of earth strain and earthquake occurrence in southeast Australia, paleomagnetic measurement of mineralised zones formed along the faults, and development of a model of the recurrence of surface fault movement in the region.

The studies concluded that the last movement on the faults was at least five million years ago. In its report, GNS concluded that the faulting observed at the site was old and did not present a hazard according to international guidelines set by the IAEA for siting of nuclear facilities.

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Earthquake hazard assessment work done by GNS at Lucas Heights in Australia looks set to become a new benchmark for seismic safety at nuclear research reactor sites worldwide.

# Budget super-computer for quake research

*Seismologists at GNS have linked together 33 PCs in a budget version of a super-computer to work on complex earthquake research. The "cluster computer" has sped up research projects considerably. A three-dimensional modelling task that used to take up to nine months to complete using GNS's most powerful computer, can now be done in two weeks.*

Seismologists Rafael Benites and Russell Robinson work in three-dimensional earthquake modelling, which requires high-end computing power. Computer clusters are particularly useful for problems that can be broken into discrete units, with the results combined at the end.

The cluster cost about $60,000. It performs the same function as a very expensive computer, at a fraction of the price. The pair estimate the cluster has increased their productivity by at least 100 percent. Off-the-shelf software, called MPI software, is needed to make the computers work together.

Rafael Benites, who focuses on the way seismic waves are transmitted through the ground, sets each computer a separate task. He benefits from the processing speed of the cluster. At present he is focusing on the repercussions of a rupture on the Wellington Fault.

"It's a matter of breaking the problem into a number of units of similar size and complexity. Once a task is set, I pretty much leave the cluster alone and check it every day or two and ask for regular status reports until the job is finished."

Russell Robinson's specialty is synthetic seismicity, and he benefits from the cluster's large memory. One of his projects is investigating the Marlborough Fault system, where there are 15 large faults covering the top third of the South Island.

Using the cluster, he can simulate an earthquake on the Alpine Fault to see how it affects the other 14 large faults in the region. The cluster will help identify if a large earthquake on the Alpine Fault will accelerate or retard earthquakes on other major faults in the top third of the South Island.

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# New maps released

GNS has just published two more geological maps in the new 1:250,000 scale series.

The Greymouth and Wairarapa maps are available from GNS at $25 each in hard copy or on CD-ROM. The Greymouth sheet covers the central part of the West Coast from Ross to Granity, and includes major coalfields and gold mining areas. The Wairarapa sheet includes an area of complex Cretaceous and Tertiary geology of interest because of its petroleum potential.

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# Post-graduate GNS scholarships

**GNS funds nine post-graduate scholarships and GNS staff supervise, or co-supervise, 45 post-graduate students at New Zealand universities. The scholarships are valued at up to $30,000-a-year to the holder. Three scholarships are currently vacant. Below are details of the six current scholarship-holders.**

## Andrea Todd and Tim Popham

*GNS, in conjuction with the Te Rananga o Ngai Tahu, has offered post-graduate scholarships to two students to aid the assessment of pounamu (greenstone or jade) in New Zealand. The aim of the research is to quantify the national stock of pounamu and to determine the sensitivity of the resource to geological and human-induced change. The knowledge gained from this project will enable informed management of the resource for future generations.*

Tim Popham and Andrea Todd are the successful applicants for the GNS Maori Development Scholarships. Tim has a BSc in geology and zoology from Otago University and Andrea has a BSc in computer science plus a diploma in geology, also from Otago University. Both Tim and Andrea are of Ngai Tahu descent and will do their post-graduate research at Otago University.

The research will involve desktop studies and fieldwork. The latter will include the study of landslides, glaciers and rivers, and the transport of sediment in remote regions of New Zealand. Tim and Andrea are being supervised by Simon Cox of GNS and Professor Alan Cooper of Otago University's Geology Department.

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Photograph above: Andrea Todd, pounamu expert Russell Beck and Tim Popham discuss the distribution of pounamu (greenstone or jade) in the South Island.

## Michelle Salmon

Michelle Salmon is the recipient of a joint GNS-Victoria University Scholarship. She is examining the crustal structure of the central North Island using earthquake, seismic, and magnetotelluric data. A major focus of her work is the attenuation rate of seismic waves under the central North Island. Her work will help define several major crustal features and will lead to improved earthquake hazard assessment for the North Island. Michelle is working with Stephen Bannister and Hugh Bibby at GNS, and with Martha Savage and Tim Stern at Victoria University. She has a BSc (Hons) in geophysics from Victoria University of Wellington and a Bachelor of Engineering (Civil) from the University of Canterbury.

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## Beatrice Maré-Jones

Beatrice Maré-Jones is the winner of the GNS-Victoria University PhD Scholarship. Her project involves developing methodologies to estimate undiscovered reserves of oil and gas in the Taranaki Basin. Working with GNS's basin modelling team in Lower Hutt, Beatrice will use a wide range of research and exploration data. She will also determine the economic implications of her findings. Her final report, due in 2006, is expected to be of use to a variety of sectors. Beatrice has a BSc (Hons) in geology from Victoria University of Wellington, and has studied energy law and economics. She was previously an advisor with Crown Minerals, the government group responsible for managing New Zealand's petroleum estate. Her work is supervised by Peter King and Rob Funnell of GNS's Hydrocarbons Section.

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## Anna Chappell

Anna Chappell has been awarded a PhD scholarship within the GNS Marsden Fund project "Retreat From the Pole: Cenozoic decline and migration of Antarctic flora". Led by GNS palynologist, Ian Raine, the project will investigate the idea that "Antarctic" elements in the modern flora of New Zealand could be descendants of the cold-adapted plants which evolved in Antarctica during an extended period of cooling and glaciation over the past 40 million years. Working with Professor Phil Garnock-Jones at Victoria University of Wellington, Anna will use molecular biology techniques to decipher the ancestral relationships of austral-alpine plants which may be "ghosts" of the former Antarctic flora. Anna has a BSc (Hons) in Biochemistry and Molecular Biology from the Australian National University, Canberra, and has recently been a research assistant at the Auckland Cancer Society Research Centre.

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## Kate Wilson

Kate Wilson, holder of the Sarah Beanland Memorial Scholarship, is studying the earthquake risk between Wellington and East Cape. For her PhD project, Kate will use a number of disciplines, including radiocarbon dating, paleontology, geomorphology, and stratigraphy to test a theory that the level of coupling between the Pacific and Australian tectonic plates to the east of the North Island decreases along a line from Wellington to East Cape. If her study is able to show the level of coupling decreases to the north, then the hazard from deep earthquakes will also decrease to the north. However, if the results do not support the concept of variable coupling, then the earthquake hazard on the east coast is likely to be higher than presently believed. Kate's work is supervised by Kelvin Berryman at GNS and Tim Little at Victoria University of Wellington. Kate has an MSc (Hons) in earth science from Massey University.

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# Glacier science lesson for students

*GNS researchers recently took secondary school students to the top of the Tasman Glacier to measure ice depth. The six-day field trip was part of a long-term project to use glacier ice to better understand past weather patterns and climate in New Zealand.*

Glaciers hold detailed and systematic records of past climatic and environmental changes. In particular, they contain records of climate forcing agents such as $CO_2$, $CH_4$, dust, aerosols, and solar irradiance, plus climate responses such as rainfall, temperature, and wind strength.

Ice cores extending back several hundred years, covering the pre-industrial and industrial period, are crucial in distinguishing between human-induced and natural climate variations.

GNS climate researcher, Uwe Morgenstern, plans to collect deep ice cores from several locations on New Zealand glaciers within the next few years. It will be the first time deep ice core recovery has been attempted on a New Zealand glacier. The technically challenging operation will require drilling equipment and expertise from overseas.

Three senior students and their teacher, Julian Thomson, from the Rudolf Steiner School in Lower Hutt, accompanied Dr Morgenstern, geophysicist Matt Watson (Auckland University) and glaciologist Dr Andrew Mackintosh (Victoria University of Wellington) on a field trip to the upper Tasman Glacier to search for the best sites to drill for ice cores. The students, all volunteers, helped by carrying the heavy ground-penetrating radar equipment used to measure ice depth. The students underwent several months of preparation, learning climbing techniques and snow survival skills before the trip.

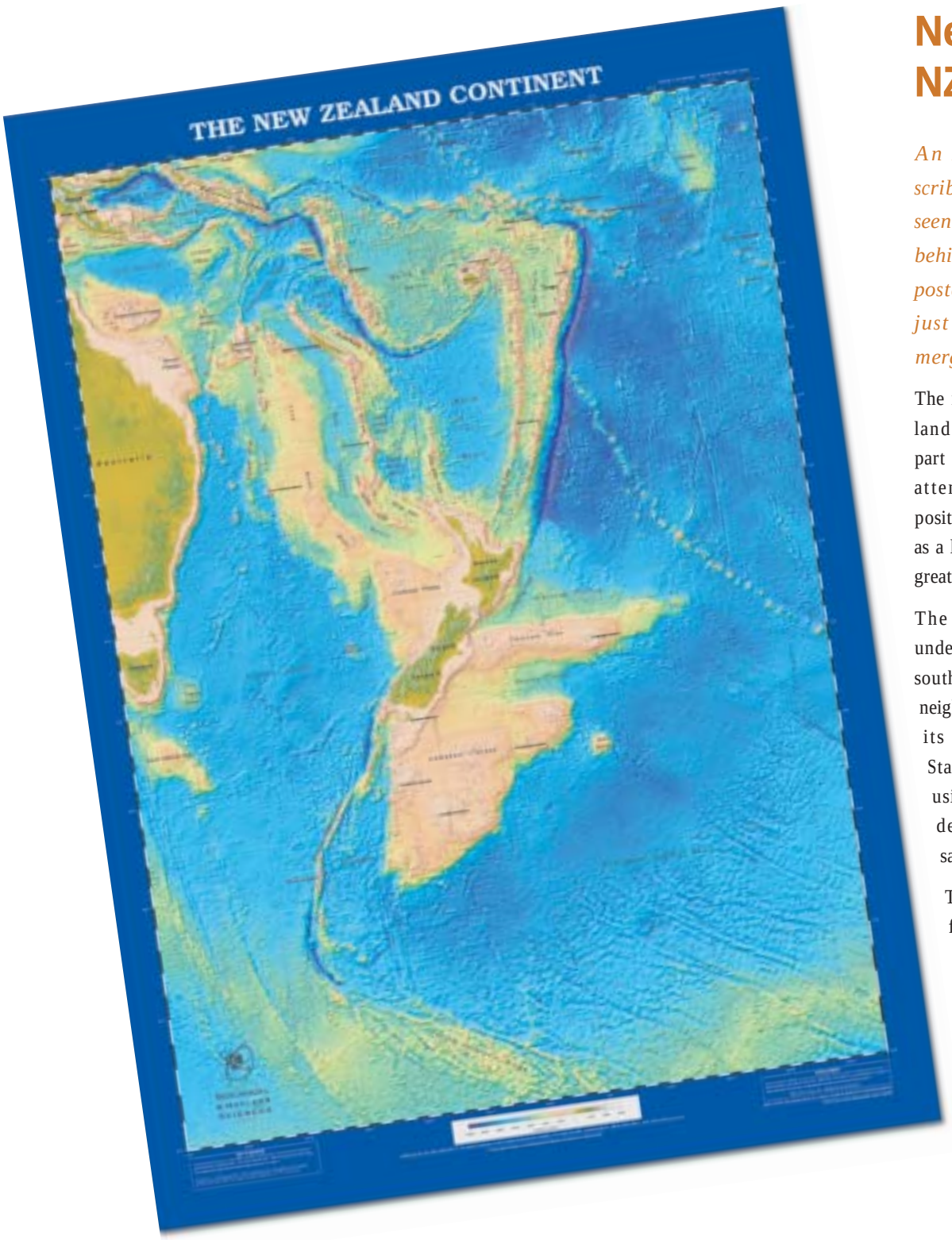
The Franz Josef and Fox glaciers on the West Coast are comparatively young, and their ice records only go back between 40 and 50 years. So for the past two years, Dr Morgenstern has concentrated his research on the 30km-long Tasman Glacier, which contains ice on the surface up to 90 years old, and is expected to contain ice at its base spanning several hundred years.

Dr Morgenstern, who has two children at the Rudolf Steiner School in Lower Hutt, says the school helpers were invaluable and he will be hoping for similar support on future glacier trips.

**Contact:** Uwe Morgenstern

**Email:** u.morgenstern@gns.cri.nz

Students and researchers with ground-penetrating radar equipment on the Tasman Glacier.




# New poster puts NZ in its place

*An American geologist recently described it as the best map he had ever seen of this part of the world. The idea behind the GNS New Zealand Continent poster is to show that New Zealand is just the emergent part of a vast submerged continent.*

The map highlights that New Zealand, with a land area of 250,000 square kilometres, is part of a much larger undersea area. It focuses attention on New Zealand's precarious position, and indeed the reason for its existence as a landmass, along the collision zone of two great tectonic plates.

The map identifies major land areas, underwater features and island nations of the southwest Pacific, including our Pacific island neighbours. The seafloor is coloured to show its texture. GNS geoscientist, Vaughan Stagpoole, compiled the 1:10,000,000 map using publicly available bathymetry data derived from ship measurements and satellite gravity information.

This 990mm x 685mm poster is available from GNS. The $20 price includes packing and postage. To order a copy, email us at: sales@gns.cri.nz

**Contact:** Vaughan Stagpoole

**Email:** v.stagpoole@gns.cri.nz

## Coming up...

### The 18th NZ Geochemical Group Conference

**When:** 6-9 July 2003
**Where:** Edward Percival Research Station and Teaching Lab, Kaikoura, New Zealand
**What:** The two-yearly gathering of researchers and students interested in all aspects of geochemistry, mostly applied to New Zealand.
**Contact:** Ed Mroczek (e.mroczek@gns.cri.nz)

### Cities On Volcanoes 3

**When:** 13-19 July 2003
**Where:** Hilo, Hawaii
**What:** Broad spectrum gathering to discuss the latest developments in volcanic crisis-management and preparedness for communities living on or near active volcanoes.
**Contact:** David Johnston (d.johnston@gns.cri.nz)

### The 18th International Radiocarbon Conference

**When:** 1-5 September 2003
**Where:** Te Papa, Wellington, New Zealand
**What:** The four-yearly gathering of the world's leading specialists in radiocarbon dating.
**Contact:** Nancy Beavan (n.beavan@gns.cri.nz)

### NZ Water & Wastes Association Annual Conference

**When:** 17-19 September 2003
**Where:** Aotea Centre, Auckland
**What:** The biggest event in the New Zealand water and wastes industry, attended by hundreds of water sector professionals.
**Contact:** Paul White (p.white@gns.cri.nz)

### Coasts & Ports Conference

**When:** 9-12 September 2003
**Where:** Hyatt Regency, Auckland
**What:** Coastal development – a quest for excellence.
**Contact:** Phil Glassey (p.glassey@gns.cri.nz)

### International Tsunami Workshop

**When:** 25-26 September 2003
**Where:** Wellington Convention Centre, New Zealand
**What:** Tsunamis in the South Pacific – research towards preparedness and mitigation.
**Contact:** Gaye Downes (g.downes@gns.cri.nz)

### NZ Hydrological Society 2003 Symposium

**When:** 18-21 November 2003
**Where:** The Great Lake Centre, Taupo, New Zealand
**What:** Hydrology and the community – bridging the gap between hydrologists and resource management planners.
**Contact:** Paul White (p.white@gns.cri.nz)

### Geological Society of NZ Annual Conference

**When:** 1-4 December 2003
**Where:** Otago University, Dunedin, New Zealand
**What:** The premier annual gathering of New Zealand geologists.
**Contact:** Simon Nathan or Phil Glassey (s.nathan@gns.cri.nz **or** p.glassey@gns.cri.nz)