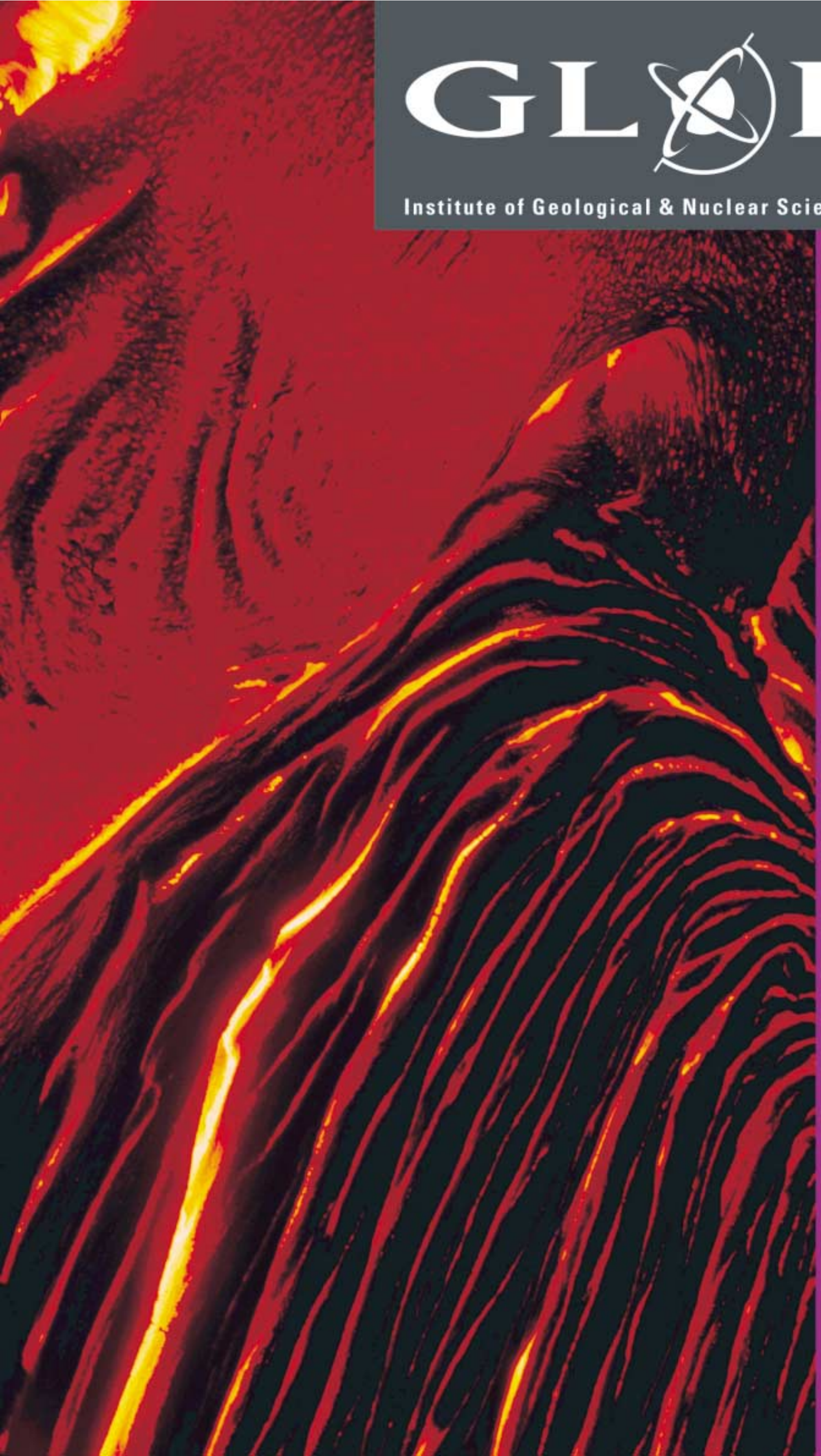

GLOBE

Institute of Geological & Nuclear Sciences Newsletter

15
MAY 2001

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 Crown Research Institute.

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Cover image: Pahoehoe lava – a fluid basaltic lava, typically between 900 and 1200ºC. Speeds as high as 40kmh have been recorded on steep slopes. Pahoehoe lava has been produced during eruptions within the Auckland Volcanic Field. Outcrops can be seen on the Manukau Harbour foreshore.

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Major upgrade for New Zealand's hazard monitoring network

Earthquakes, volcanoes, landslides, geothermal activity and tsunamis will be under increased surveillance with a major upgrade planned for New Zealand's hazard monitoring network.

The Earthquake Commission (EQC)* will contribute $50 million towards modernising New Zealand's surveillance equipment. The upgraded system, called GeoNet, will be designed, installed and operated by GNS.

The EQC commitment – $5 million a year for the next 10 years – is the culmination of several years detailed planning, including extensive reviews by international technical experts and independent financial audits.

"The EQC contribution represents about 60 percent of the funding needed to get a robust surveillance network underway," says GNS Hazards Group Manager Robin Falconer. "It will modernise the core national network over the next few years and means we can sustain operations after that."

Other national and regional organisations will be invited to contribute according to their operational needs for hazard information, so the project should be approaching target levels of funding for an expanded, "fit-for-purpose" system after the first few years of the rollout. The first task will be to upgrade the existing network, which is old, sparse and increasingly difficult to maintain.

When fully implemented, GeoNet will greatly improve geological hazard monitoring and strengthen disaster management response, including EQC's ability to process claims more efficiently.

"More and higher quality data from GeoNet will mean new geophysical research opportunities and the knowledge gained should help the community to become more resilient to the impacts of geological hazards," says Robin Falconer.

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The Earthquake Commission (EQC)* will contribute $50 million towards modernising New Zealand's surveillance equipment. The upgraded system, called GeoNet, will be designed, installed and operated by GNS.

Earth deformation specialist John Beavan (left) and GeoNet Project Manager Hugh Cowan with part of a new earth deformation installation north of Wellington. Up to 100 such installations are planned around New Zealand as part of GeoNet. *Photo The Evening Post*

(Below) Robin Falconer, Hazards Group Manager GNS (left), David Middleton General Manager EQC, and Hugh Cowan, GeoNet Project Manager. GeoNet is the culmination of five years of technical review, project development, and equipment trials by GNS staff.

* EQC is a Crown entity, owned by the New Zealand Government and controlled by a board of commissioners. It administers the Natural Disaster Fund, comprising capital and reserves. The Government guarantees that this fund will meet all its obligations.

EQC's role is to help New Zealanders recover from the effects of earthquakes, volcanic eruptions, landslips, hydrothermal activity, and tsunamis, or fire caused by these; and in the case of residential land, storm or flood damage.

Residential property owners with fire insurance are covered by EQC against the cost of these disasters. EQC helps organise repair and replacement after an event.

See www.eqc.govt.nz

What the EQC funding will buy:

- SEISMOGRAPHS to measure accurately the magnitude and location of earthquakes
- GLOBAL POSITIONING SYSTEM (GPS) equipment to pin-point earth deformation so that scientists can see where strain is building up or being released in the earth's crust
- SEISMIC, chemical, and GPS equipment for early detection of volcanic unrest
- SEISMIC RECORDERS for buildings, bridges, dams and other structures to give engineers information on how those structures perform in an earthquake.

Much of the information will be available in near real time as the equipment will be linked by satellite and radio to data centres in Wairakei and Wellington.

A fully operational GeoNet will improve responses to:

- EARTHQUAKE EMERGENCIES: Accurate details within minutes on the size and location of an earthquake, and the severity of ground shaking in different locations.
- VOLCANIC ERUPTIONS: Improved ability to detect early signs of volcanic unrest and impending eruptions.
- SEISMIC HAZARD ASSESSMENT: Better intelligence on the severity of ground shaking throughout New Zealand. This enables smarter decisions on the siting of roads, bridges, water, oil, and gas pipelines, and other community lifelines and services.
- SCIENTIFIC RESEARCH: Will enable scientists to pursue new avenues of research that, internationally, are leading to a better knowledge of geological hazards.
- TSUNAMI WARNINGS: This requires regional co-operation. The upgrade will enable New Zealand to make a valuable contribution to tsunami warning in the South Pacific.
- EARTHQUAKE ENGINEERING: Will provide improved intelligence of how structures perform during earthquakes. This will enable engineers to improve design and construction techniques.

More information on GeoNet is available at: www.gns.cri.nz/news/release/geonet.htm

Marine geosciences

Seabed charts boost efficiency of fishing

GNS has been contracted by a Nelson-based mapping company to develop technology that enables the production of charts and animated three-dimensional images of the ocean floor for the fishing industry. Used as part of visual navigation systems on fishing vessels, the charts and 3D images improve operating efficiency and help reduce damage to benthic ecosystems.

Many of New Zealand's most valuable commercial fishing grounds are in deep water – 500-800m – and fish are often concentrated near the bottom. Catching fish in these depths without snagging the trawl on the bottom requires considerable skill and knowledge of the shape of the seafloor. The digital charts and 3D animated images allow the operators to 'fly through' seamounts, valleys and canyons and to better identify trawling sites.

This research project is jointly funded by Seabed Mapping International Ltd (SMI) and Technology New Zealand. The new products are particularly helpful in new territories where quick identification of likely spots is important. Traditionally, a skipper can spend some time running the boat over new features to visualise their shape. The charts and animated images enable just one or two passes to confirm the shape on the chart before fishing can begin.

The new products are lifelike in their contouring and gridding.

The quality of the outputs is directly related to the amount and quality of the input data, which has resulted in the development and installation of a dedicated bathymetry recording system on fishing vessels.

The new process enables raw digital bathymetry data to be merged with a range of other data, including those collected by the client, other proprietary data and public domain bathymetry data. These are quality assessed, then edited to remove bad data points. The merged data set is then gridded to derive a model of the seafloor shape. The operation is highly automated, with parameters able to be varied to meet the needs of individual clients. Security is handled by encryption of the data and charts and by the use of rigorous database procedures to track data ownership.

The development of sophisticated database editing and automation of software means that SMI is able to produce a cost-effective, high-quality product that can be delivered quickly, anywhere in the world. The technologies and methodologies used for this project are an extension of those GNS uses for subsurface mapping for the petroleum exploration industry and those developed as part of GNS research funded by the Foundation for Research Science and Technology.

SMI and GNS plan further developments to increase the capabilities and user-friendliness of the system. For more information see www.seabed.co.nz

Enquiries about the charts and 3D images should be directed to Declan O'Toole at Seabed Mapping International Ltd,

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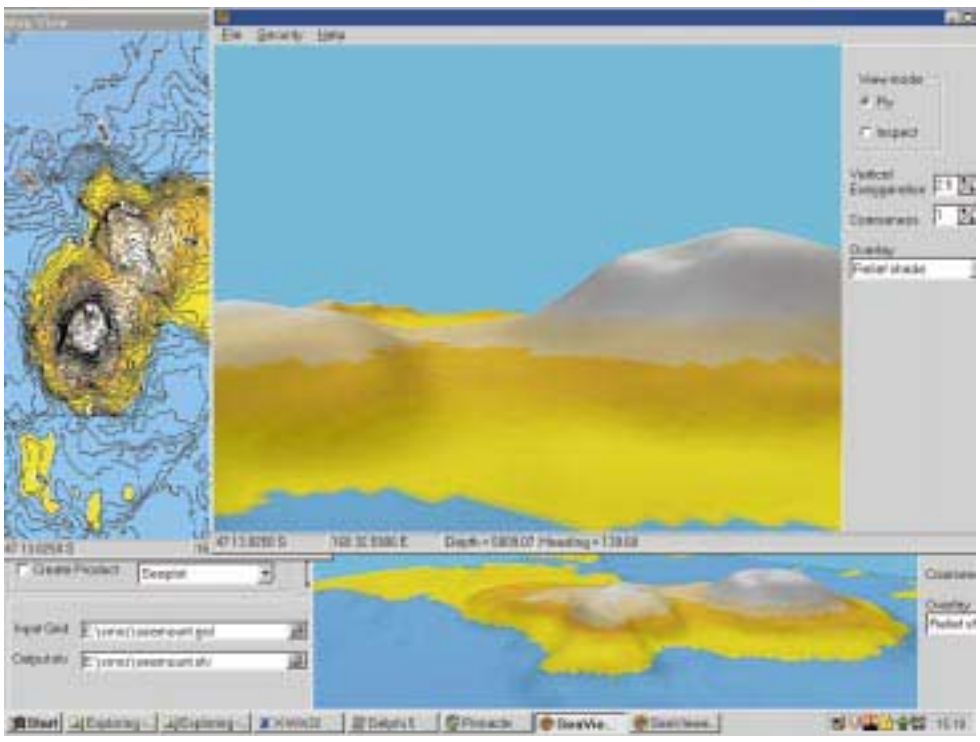

Seaviewer 3D in action showing 3D and map views of the ocean floor derived from public domain data.

Recent marine data acquisitions

Chatham/Hikurangi region

Earlier this year GNS scientists took advantage of an UNCLOS seismic survey vessel to collect data from east of New Zealand including the Chatham/Hikurangi Plateau area. The GNS data will be used for PGSF funded research programmes as well as part of New Zealand's UNCLOS submission.

GNS and NIWA have taken a leading role in designing and overseeing this deep-crustal seismic reflection survey programme that extends hundreds of kilometres outside the EEZ. The survey is part of New Zealand's UNCLOS continental shelf delineation programme, managed by Land Information New Zealand, which aims to maximise the extent of the seafloor beyond the EEZ over which New Zealand will have jurisdiction.

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Canterbury Bight

In February GNS undertook a high-resolution seismic reflection survey in the Canterbury Bight, off the South Island's east coast. The area covered was from the Rakaia River in the north to the Rangitata River in the south. The aim was to acquire a detailed grid of seismic data of relatively young Quaternary age sediments in the region to determine how sea level and sediment supply changes over the past one million years have influenced the geometry of these units.

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East Coast

Also in February GNS, in collaboration with colleagues from Victoria University of Wellington, Cambridge University (UK), and Hokkaido University (Japan), collected 350km of crustal seismic data along a transect east of Hawke Bay. As well as hundreds of portable recording stations onshore, scientists also used 16 ocean bottom seismographs to collect the active source data. These data will enable scientists to build a two-dimensional image of the crust and plate boundary structure through the North Island. The project also acquired additional seismic lines to provide information on methane gas hydrates, which are known to be prevalent along this part of the east coast margin.

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Auckland Harbour

GNS recently acquired seismic data from Auckland's Waitemata Harbour. The aim was to look for volcanic structures, including buried cones, to identify where volcanic activity and eruptions may have occurred in the past. Scientists hope the information will help in determining if there are structures under Auckland's harbour that might influence the future activity of the Auckland Volcanic Field. These data also gave an insight into faulting under Waitemata Harbour.

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Isotope technology

Major upgrade for isotope facilities

A $2.3 million upgrade of isotope facilities over the next three years will help ensure that GNS continues to offer New Zealand's science community internationally ranked capabilities in isotope sciences.

The investment will be used to renovate GNS' two Van de Graaff particle accelerators and buy a state-of-the-art mass spectrometer for environmental analysis.

Activities to benefit from the upgrade include radiocarbon dating, ion beam analysis, production of short-lived isotopes for horticultural and soil nitrate analysis, and stable isotope measurement for mineral, geothermal, and groundwater analysis. Measuring ratios of stable isotopes determines sources and movements of minerals, geothermal fluids and groundwater, and can also trace organic pollutants.

Ion beam analysis is an essential tool in developing new materials such as ceramics, microelectronics, and plastic and metal composites.

GNS' Rafter Radiocarbon Laboratory is a leader in areas of radiocarbon research such as archaeology, oceanography, environmental studies, groundwater research, geology, and dating antiquities. In 1986 it was the first facility in the Southern Hemisphere to offer accelerator mass spectrometry dating services. It provides radiocarbon dating services to clients in more than 15 countries and has processed over 10,000 samples in the past decade.

The research portfolio of Rafter staff includes textile dating, paleodietry studies, paleoenvironmental reconstruction, pollen dating, and studies of atmospheric pollutants.

With the upgraded facilities, GNS will play an expanded role in teaching tertiary-level earth sciences, physics, environmental sciences, archaeology and anthropology. GNS will also widen its links with research organisations in New Zealand and internationally, strengthening the capabilities of GNS staff.

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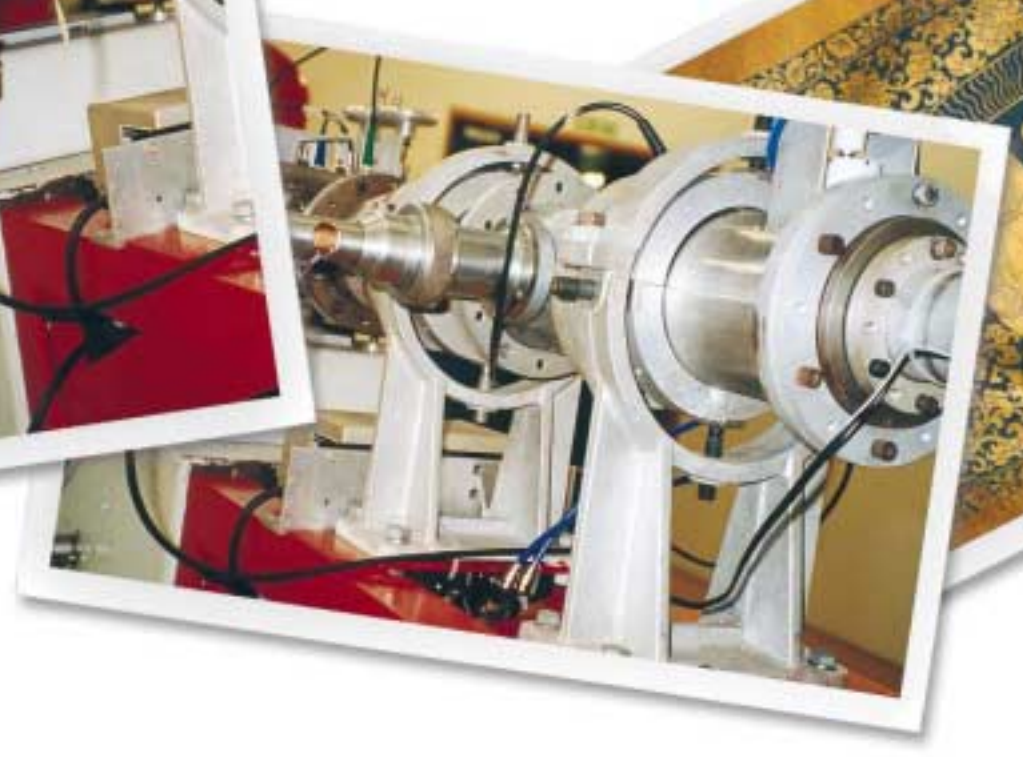


The upgraded isotope facilities will enable GNS to offer an expanded range of services to the research community and clients. The improved facilities will also see GNS playing a greater role in teaching tertiary-level science.

Every lab should have one

GNS operates one of New Zealand's most advanced X-ray diffraction facilities, which can produce and analyse an X-ray diffraction pattern from almost any solid material.

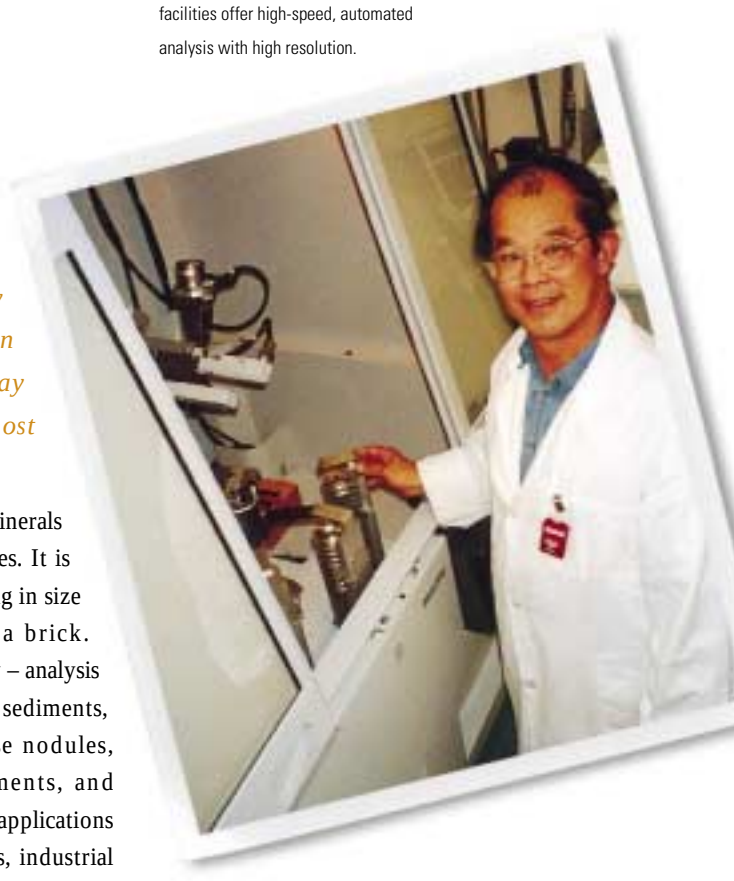
Rapid and precise, it determines minerals present in unprocessed rock samples. It is capable of analysing samples ranging in size from a few grains of sugar to a brick. Geological applications keep it busy – analysis of rock and clay samples, marine sediments, ore-bearing deposits, manganese nodules, geothermal and volcanic sediments, and petroleum geology studies. Other applications include forensics, pollution studies, industrial products, and engineering geology.

The instrument is versatile, with easy exchanges of components for fast reconfiguration. An automated sample changer allows 45 samples to be analysed without human intervention, so it can be set to run overnight or during a long weekend with GNS staff monitoring results from home computers.

GNS can do search-match analysis on unknown samples using a database containing 120,000 XRD mostly inorganic reference data. Modular upgrades will keep the facility technically up to date.

Recent projects have included identifying semi-precious stones and defining minerals in fine-grained rocks including shales, mudstones, clays, and air particulates. It is also being used for petroleum reservoir studies.

Mineralogist Ray Soong.... the new XRD facilities offer high-speed, automated analysis with high resolution.



Its versatility means GNS staff can easily handle variable workloads and a huge variety of sample types without compromising precision and reliability.

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Chinese silk tapestry, dated from tufts of threads at early 13th century AD.

Accelerator to get new 'heart'

Radiocarbon dating services at GNS will receive a boost with a $314,000 upgrade of the six million volt tandem Van de Graaff accelerator, workhorse for GNS' Rafter Radiocarbon Laboratory.

GNS' dating services are sought after internationally for their accuracy and reliability, which will be further enhanced by the upgrade to the accelerator's charging system.

The canvas/rubber charging belt inside the instrument is being replaced by a nylon and metal chain system – known as a Pelletron – bought as a kitset from the United States. The six million volt potential generated by the rapidly rotating belt propels sub-atomic particles through the accelerator. The chain will generate the same potential, but both the terminal voltage and the particle beam will be more stable.

"The now-obsolete belt charger is increasingly difficult to maintain and the Pelletron will provide more stable charging," says Rodger Sparks, leader of the Rafter Laboratory. "The more precise the charge, the better the overall performance of the accelerator."

This will improve the quality of the results of carbon-14 and other measurements made by the accelerator, which is dedicated to accelerator mass spectrometry (AMS) measurements – mostly radiocarbon and a growing amount of beryllium-10 dating. GNS operates the only age-dating service in New Zealand using AMS and beryllium-10.

Only a few milligrams of material are needed for dating, so rare or precious objects can be dated without significant damage. Very small samples, such as pollen grains or trace gases, can also be dated. For more information see www.gns.cri.nz/atom/rafter/rafter.htm

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This carved ivory knife handle was dated at 900BC by taking scrapings from the interior.

Samples dated by GNS' Rafter Radiocarbon Laboratory during the last 12 months.

Sample	Application
Air – CO	Atmospheric studies
Air – CO_2	Atmospheric studies
Air – Methane	Atmospheric studies
Air – Particulates	Atmospheric studies
Bone	Archaeology
Carbonate	Marine & geological studies
Charcoal	Archaelogy & geological studies
Forams	Geology
Groundwater	Hydrology & geology
Methane	Atmospheric studies
Mineral	Geology
Peat	Geology
Pollen	Archaeology & geology
Rock varnish	Archaeology & geology
Seawater	Geology
Sediment – land	Geology
Sediment – marine	Geology
Shell – freshwater	Archaeology & geology
Shell – marine	Archaeology & geology
Soil	Geology
Textile	Archaeology
Tissue – animal	Archaeology & geology
Tissue – plant	Archaeology & geology
Wood	Archaeology & geology

The new chain charging system will extend the life of the accelerator and improve the quality of its measurements.

Rafter Radiocarbon Laboratory dated this 2500 year-old chinese wood carving (left) by taking a tiny fragment from its base.

ION BEAM TEAM: Andreas Markwitz (above), and at right Bill Trompetter, V. John Kennedy, and Chris Purcell.... testing elemental distributions of new materials on a nanometer scale without destroying the samples.

Ion beam analysis shows its versatility

Ion beam analysis and nanotechnology are the tools GNS is using to help develop cost-effective blue-light-emitting devices for electronic equipment.

Blue-light emitters such as light-emitting diodes and lasers for electronic equipment are made from crystalline gallium nitride. The technology is relatively expensive and there is a worldwide push to develop a less expensive alternative.

Victoria University of Wellington and fellow Crown Research Institute, Industrial Research Limited, are collaborating with GNS in this project. GNS uses ion beam analysis to determine percentages of oxygen, gallium and nitrogen in amorphous films produced at IRL. Light-emitting properties of the thin film depend on the distribution of these elements through the film. Success hinges on producing film with a low oxygen content.

Typical thickness of the gallium nitride film on a glass base is 100 nanometres, equivalent to the thickness of 400 to 500 atoms. Passing a small electric current through the film excites the electrons, which get rid of their excess energy by emitting blue light.

The developers of this new technology are using GNS expertise to optimise their production process. GNS' ion beam analysis service has a number of advantages. It:

- has high sensitivity for light and heavy metals
- has a fast turnaround
- requires no sample preparation
- is non-destructive.

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Volcanoes

Auckland hosts volcano conference

Auckland was an appropriate venue for the recent 2nd International Cities on Volcanoes conference. A significant volcanic event there is as likely to happen as a significant earthquake in Wellington, says GNS hazard management scientist David Johnston.

Over three days in February, 240 attendees from over 20 countries studied such explosive topics such as "...the day the sky fell ..." and "Earth, fire, water and fluoride". The varied group included scientists, emergency managers, risk managers, insurance managers, health officials, and other stakeholders interested in an array of volcanic risk factors.

Scientific papers outlined volcanic hazards for volcanoes around the world, modelled tsunami generated by pyroclastic flows, studied the geochemistry of ash and evaluated monitoring technologies.

Health hazards associated with volcanic ash and toxic volcanic gases, including fluoride, were identified in one series of presentations. Chronic exposure to fluoride compounds in volcanic gas emissions is of concern to health officials. Excess fluoride exposure can lead to dental fluorosis (staining) and serious tooth decay. Another potential hazard are the fluoride aerosols attached to volcanic ash, which can pose significant animal health problems.

Social issues were also underlined with many concerned about prolonged eruptions and the uncertainties in the behaviour of volcanoes. The stress on emergency managers, government officials, the public and scientists, was a recurring theme.

Some speakers highlighted inconsistencies in the way scientists present risk information to the public. To help overcome this, a comparison of relative risks was made for New Zealand. "The chance of a significant volcanic impact in Auckland is comparable to a significant earthquake impact in Wellington," says Robin Falconer, one of the GNS conference speakers. "In turn, these probabilities are comparable to the chance of an individual suffering a heart attack or breast cancer in their lifetime!"

This conference was a fascinating smorgasbord of talks and international networking to grow the science and boost our understanding of how we communicate and deal with this hazard.

The next conference is scheduled for July 2003 in Hilo, Hawaii.

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(Left) Lohar debris filled the ground floor of these apartments in the Toya Hot Spring area, Abuta Town, Hokkaido.
Courtesy of Professor Hiromu Okada, Hokkaido University

(Below) Mt Usu's eruption plume rose to 3.2km. Heavy ashfalls blanketed nearby residential developments.
Courtesy of Hokkaido Development Bureau

Lessons from eruption in Japan

Mt Usu's eruption last year in Hokkaido, Japan, gave GNS volcanologist Tony Hurst a chance to study how Japanese officials handle a volcanic crisis in a heavily populated area. With support from the Earthquake Commission, he visited Japan to observe the aftermath of the eruption and learn lessons that could apply to New Zealand.

Mt Usu's eruption was quite modest, producing only a few million cubic metres of ash. Over 10,000 people in the area were safely evacuated thanks to precursory earthquakes and deformation monitoring.

"Direct damage from the eruption was mainly from ashfall, mudflow (lahar), and ground deformation," says Dr Hurst. "Indirect losses, particularly in tourism revenue, are likely to far exceed losses from direct damage."

A written record of eruptions at Mt Usu goes back many centuries, showing a clear association between swarms of felt earthquakes and an eruption within days of the beginning of earthquake activity. New Zealand's brief written history of eruptions does not give the same advantage, so forecasting likely eruption scenarios is more difficult here.

Local authorities at Mt Usu stayed in charge of the crisis and the evacuations, supported and influenced by regional and national government officials coming to the local headquarters.

Dr Hurst says the volcano-monitoring programme on Mt Usu involves many more instruments than are likely to be found on any one volcano in New Zealand. But Japanese officials still see the need for a lot more equipment when a particular volcano is showing signs of an eruption.

The most interesting new monitoring technique used at Mt Usu was remote sensing methods, from helicopter and satellite, for rapid measurement of large deformations produced when volcanoes develop new active vents. GNS is investigating the use of this technology in New Zealand.

Dr Hurst's full report can be viewed at: www.gns.cri.nz/earthact/volcanoes/usu_report.pdf

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Mt Eden, one of 49 volcanic vents in Auckland.

Groundwater

AI modelling analysis aids Auckland aquifers

Artificial intelligence modelling techniques are helping improve the understanding of storm water disposal and urban ground-water flows in Auckland.

In central Auckland's Mt Eden, GNS groundwater modeller Timothy Hong has been using AI techniques such as an artificial neural network, neuro-fuzzy and evolutionary algorithms to analyse the effect of storm water when it is disposed through soak-holes drilled into fractured basalt.

Soak-holes help reduce surface water contamination in urban streams. But this storm water disposal method can harm groundwater resources by changing natural groundwater flow patterns and by increasing the concentration of pollutants such as suspended solids, nutrients, heavy metals, pathogens, toxins, and oxygen-demanding substances.

Timothy has applied an artificial neural network-based pattern analysis technique – a new, powerful multivariate nonlinear analysis and modelling tool – to study groundwater quality after storm water infiltration. Using his own visualisation software, he has seen a strong correlation between heavy metals and storm water infiltration due to high rainfall. Only relatively high rainfall intensities (greater than 6mm/hr) have had an impact on the heavy metal concentrations. Low rainfall has no effect.

The fuzzy local modelling technique using a neural network is based on combining a number of local models, developed to better understand the effect of storm water infiltration on the groundwater flow. The simulation results show that rain falling at a rate of more than 2mm/hr for longer than two hours increases the groundwater level. The delay between a change in the rainfall and the observed response in the groundwater flow was estimated at two hours.

The GNS studies will help decision-makers in the sustainable management of Auckland's groundwater system.

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Secure groundwater supplies

Changes to the standards for the security of public water supplies have kept GNS busy helping water supply companies and territorial authorities. Recent changes introduced by the Ministry of Health mean it is now important to show that groundwater has been underground for at least one year before it is available for human consumption.

GNS, with its wide experience in determining the security of groundwater, is well placed to supply the information needed to meet the new criteria. The new standard says groundwater security can be shown by either:

- Water residence times in the aquifer being greater than one year (ie, showing by tritium or CFC dating methods that less than 0.005 percent of the water has been present in the aquifer for less than one year); or
- Coefficients of variation of chemical parameters not exceeding:
  - 3.0 percent in conductivity
  - 4.0 percent in chloride concentration
  - 2.5 percent in nitrate concentration

  when measured at specific intervals and duration.

GNS is a leader in water chemical analysis and interpretation, as well as dating techniques and hydrogeological reporting. For more information see:
www.gns.cri.nz.earthres/groundwater/index.html

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Update

Rocky outcrop holds clues to mass extinctions

The greatest mass extinction event of all time is being put under the microscope by Japanese and New Zealand geologists studying a rocky outcrop off Northland's east coast.

Around 250 million years ago, a catastrophic event – possibly a comet impact – destroyed 90 percent of all life forms on Earth. Oruatemanu or Arrow Rocks, in Whangaroa Bay east of Kaitaia, are among the oldest rocks in the North Island and contain one of the best Southern Hemisphere records of this event.

Geologists and paleontologists from seven Japanese universities have Japanese government funding for a three-year study of the rare sedimentary outcrop, in collaboration with scientists from GNS and the University of Auckland.

"We want to establish what caused this and to find out if it was luck or special attributes – or a combination of the two – that allowed some species to survive," says GNS paleontologist Hamish Campbell.

Thin, brightly-coloured layers of chert, argillite and volcanic ash accumulated on the seafloor of a deep ocean between 260 and 230 million years ago. Resting on basalt lava flows that erupted on the sea floor during Permian time, this remarkable pile of sediments is less than 150 metres thick yet represents a 30 million year record of oceanic history.

Little is known about this Permian-Triassic event compared to the more widely studied Cretaceous-Tertiary mass extinction of 65 million years ago. Arrow Rocks are valuable because they span the entire Permian-Triassic boundary and are rich in microscopic fossil plankton. "The original deep-sea sediments that make up these rocks are comprised almost exclusively of the tiny, exquisitely sculptured skeletons of radiolarians," says Hamish.

These single-celled marine animals are providing a huge amount of new knowledge about the history of the oceans and life on Earth.

"They were the very base of the food chain in the animal kingdom, sucking nutrients out of the ocean to create skeletons from which we can deduce a huge amount. Isotope studies can give us clues about the chemical, physical and biological nature of the ocean – its productivity, oxygen supply, availability of light and so on.

"We are looking at rocks virtually unknown anywhere else in the world and filling a gap about an important period in the history of life on Earth."

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Radiocarbon dating goes micro

Dating individual growth rings of New Zealand shellfish is one of the latest examples of trailblazing work in micro-sampling being carried out by GNS' Rafter Radiocarbon Laboratory.

"This would not have been possible two years ago, but the Rafter team's successful development of ultra-small sampling means that new areas of radiocarbon research keep opening up," says archaeometrist Christine Prior, who is leading the sampling work.

"Our focus on micro-sampling means that radiocarbon dating sub-milligram samples is now feasible. So when a client comes to us with a unique problem or an unusual sample, we are able to tailor a lab procedure to solve the problem."

Rafter has established a good track record in dating individual pollen grains for geological and archaeological applications. "Although we've dated shells or shell parts before, this is the first time we have attempted to date annual shell growth rings," says Christine.

The shells in question, *Austrovenus stuchbury*, have a lifespan of up to 40 years, so multiple dating measurements can be performed on each shell.

The drill bit used to extract samples from the growth rings is just 0.35mm in diameter. As well as establishing the absolute age of the shells, the research will also determine if it is possible to detect variations in the level of ^{14}C between the annual growth rings. Counting the number of years between growth rings sampled means there is a built-in calibration for the work.

Sampling for other stable oxygen and carbon isotopes in the growth rings can also be used to study a range of environmental factors such as changes in climate and water temperature.

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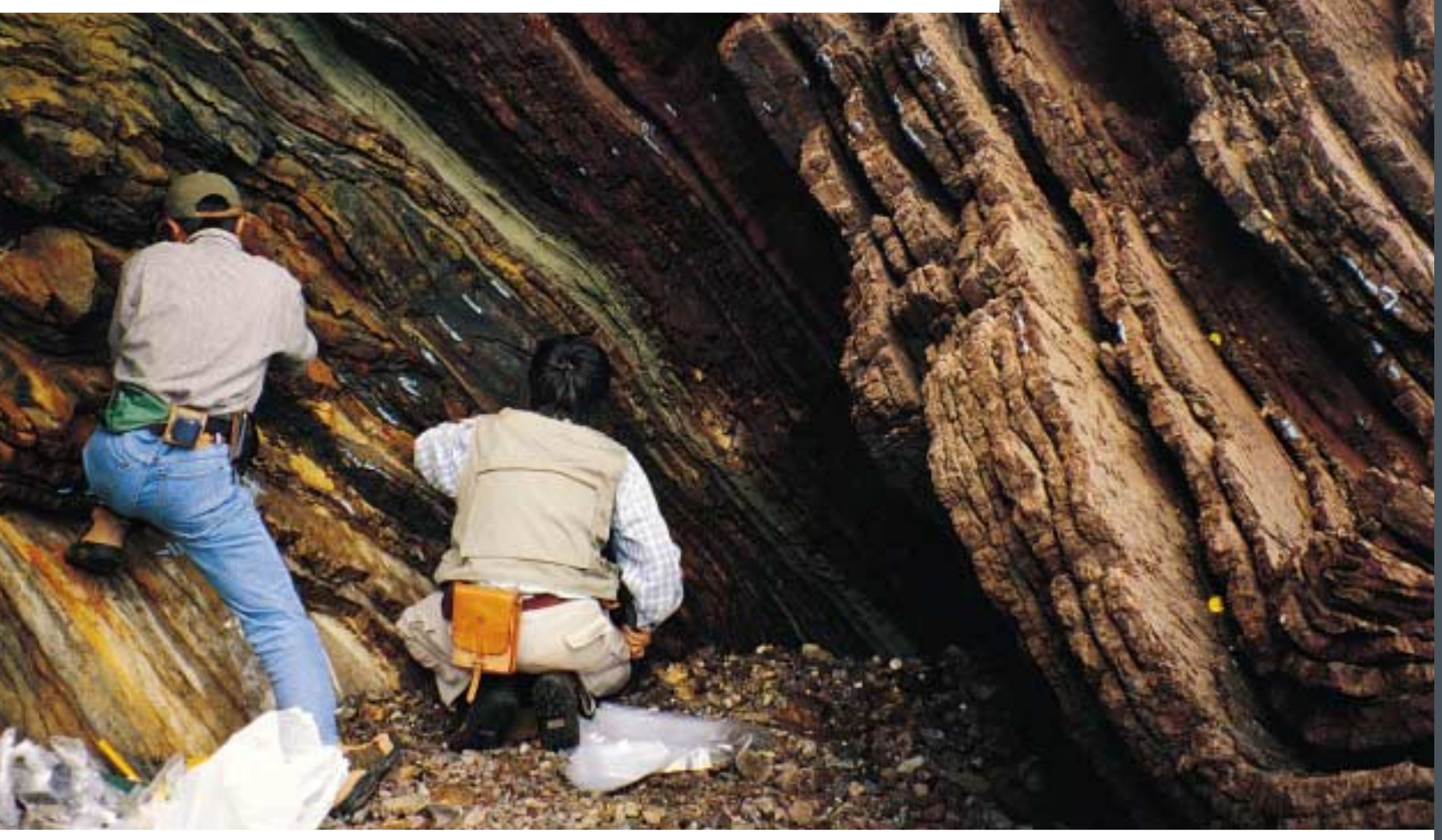

Scientists tap rich memory banks of planet Earth – a tilted stack of ancient sea floors dating back 250 million years at Arrow Rocks in Northland.

CEO moves on

Dr Andrew West, Chief Executive of GNS for the past four years, left the organisation in March to head the New Zealand Qualifications Authority. The GNS Board is in the process of appointing a new Chief Executive.

50 years of scientific publishing

Geologists are known for being hardy individuals, but few can match the durability of Pat Suggate who is still publishing scientific work at the age of 79. Dr Suggate started work with the New Zealand Geological Survey in 1947 and spent his early years at Greymouth on the South Island's West Coast. This shaped his long-term research interests, particularly in neotectonics, coal, and Quaternary stratigraphy and chronology.

In the late 1950s and early 1960s he played a major part in compiling a landmark geological map called the "Four Mile" project – a series of maps covering the whole of New Zealand at 1:250,000 scale. In the 1970s he edited *Geology of New Zealand*, which remains the definitive account of New Zealand geology.

Long before GPS technology was available, Dr Suggate developed ways of measuring and analysing the deformation of the Earth's surface. Under his leadership of the New Zealand Geological Survey between 1974 and 1986, the organisation expanded rapidly to meet widening activities including petroleum exploration, the evaluation of coal resources, and the building of hydro-electricity facilities. As a research associate with GNS, he continues to produce geological maps and papers on Quaternary geology and coal rank related to hydrocarbon generation.

A special issue of the New Zealand Journal of Geology and Geophysics was recently published to mark Pat Suggate's contribution to earth sciences in New Zealand.

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Coming up...

Preparing for a volcanic crisis in New Zealand

When: 15 – 16 October 2001
(Optional field trip, 17 October 2001)

Where: Wairakei Research Centre, SH1, Wairakei, New Zealand

Who: Aimed at people involved in all aspects of natural hazards management, including planners, engineers, local and central government administrators, insurance managers, civil defence officers, and emergency managers.

What: GNS and Massey University have developed this two-day course to explore the relationship between the physical, social, and economic aspects of natural hazards and their management.

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