Powering a better future

Presented to the House of Representatives
pursuant to the Crown Research Institutes Act 1992.

Our Annual Report is presented in two parts –
GNS Science Annual Report and GNS Science
Annual Report: Performance and Financials Appendix.
Together, these documents fulfil our annual reporting
responsibilities under the Crown Research Institutes
Act 1992 for the year ended 30 June 2024.

The Performance and Financials Appendix
includes performance information, the report
of the directors, financial statements, and
independent auditor's report.

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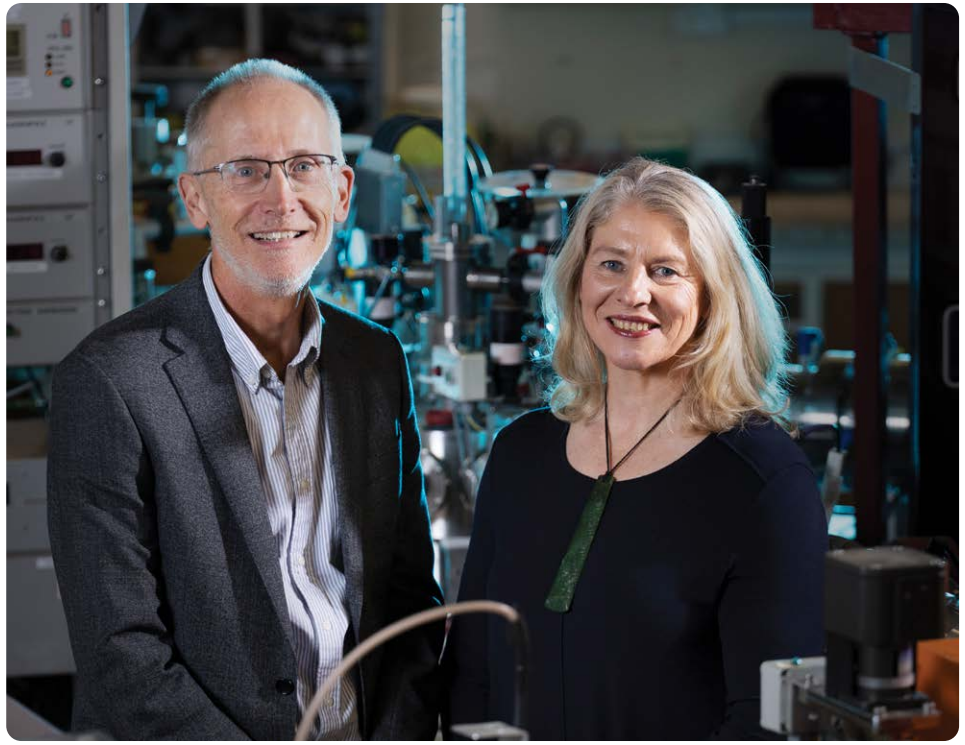


Chair David Smol and Chief Executive Chelydra Percy in the Ion Beam lab.

The theme of our annual report this year is 'powering a better future'. We're incredibly proud to celebrate the deeply relevant and impactful work that GNS Science people are doing to power a better future; a future where GNS' science, innovation and technology supports economic growth and informs good decision-making for Aotearoa New Zealand.

New Zealand's current and future energy needs have been front of mind for many this year.

Globally, the increased demand for energy makes the challenge of transitioning energy systems away from fossil fuels towards low-carbon sources of energy even more important. While New Zealand is fortunate to have abundant natural resources, innovative science solutions are needed to unlock their potential and transform them into abundant, affordable, and sustainable energy supplies.

GNS is rising to the challenge, helping to transition New Zealand's energy ecosystem to low-carbon, resilient, and cost-effective alternatives. We do this by developing new technologies and novel approaches, building relationships with industry partners to facilitate market uptake of geothermal energy (for direct use and electricity generation), and developing energy storage methods. With this approach, GNS aims to support New Zealand to increase the resilience of our energy supply, decrease energy associated spending, and reduce our energy emissions profile. We understand the power of global collaboration.

This year we have continued to deepen our international partnerships and establish long-term agreements with complementary organisations. Our presence in Japan and strong leadership in connecting the Pacific Ring of Fire demonstrates our commitment to delivering on Aotearoa New Zealand's global ambitions. We have supported geothermal development for over 60 years in more than 35 countries, exporting home-grown geothermal research and initiatives.

Green hydrogen will be part of New Zealand's transition to a low-carbon economy. GNS is supporting the development of a home-grown hydrogen ecosystem to help enable this transition. This year GNS opened a new green hydrogen laboratory, the first of its kind in New Zealand. The laboratory is poised to play a critical role in the country's energy transition by providing hydrogen purity testing. This capability has long been sought by the industry, which previously had to access international services. The GNS team is working in lockstep with leaders across industries, business, and science to target our future research and ensure alignment with commercial need.

By pursuing deeper, hotter geothermal resources, New Zealand can unlock unprecedented energy security and economic growth. Our ambitious research initiative 'Geothermal: The Next Generation' has investigated how superhot geothermal resources could offer a near-limitless baseload energy supply for New Zealand. Now in its final stages, the programme has verified the immense potential of superhot geothermal over the coming decades.

Science tells us that we must act now to mitigate the worst impacts of the changing climate. The accelerating effects of extreme weather, rising sea levels, and coastal erosion are examples of climate change impacts being felt by households, businesses, and our economy. GNS provides research, modelling, and innovative tools that can help keep communities and infrastructure safe, including strengthening our preparation for, and response to, future extreme weather events. GNS' work focuses on the natural systems that underpin our environment and climate, such as the carbon cycle, the changing balance of ice and water on the planet, and groundwater.

GNS is rising to the global energy challenge, helping to transition New Zealand's energy ecosystem to low-carbon, resilient, and cost-effective alternatives

We're also a nation of natural hazards. The earthquakes, volcanoes, tsunami, and landslides that have shaped our dramatic landscapes also have the capacity to destroy. In New Zealand and across the globe, the impacts of hazard events are intensifying. Climate change is causing some of these events to become both more severe and more likely, with rainfall-induced landslides a recent and costly example. Estimates for landslide damage from Cyclone Gabrielle alone are close to $1.5 billion.

Cam Asher works on a volcano monitoring site near Mt Ruapehu.

GNS' recent contribution to a holistic, multi-hazard forecast of Dunedin's future challenges with groundwater was produced in partnership with Otago Regional Council. The report examined what causes changes to groundwater levels, such as tides, storm surge and rain. This information can be used to develop multi-hazard forecasts of where and when groundwater will rise and cause problems.

This will help the Council to understand how hazards will evolve, enabling planning for the future. It will be an important tool in determining adaptation options for the future of South Dunedin.

GNS has unique capability and an excellent track record in supporting New Zealand's readiness, response, and recovery. We engage in cross-system research to better understand and manage exposure to geological hazards and the compounding impacts of climate change. Our significant expertise, data, tools, and monitoring networks are critical to New Zealand's economic and social wellbeing, and we have an unwavering commitment to our role. The Government's 2024 Budget confirmed a multi-year funding allocation for GeoNet and the National Seismic Hazard Model. Securing a multi-year allocation is a positive outcome and reflects the critical value and impact of both services.

GNS continues to respond to opportunities and challenges outlined in our Science Roadmap, as well as in our operating environment. Becoming a higher performing organisation, both financially and operationally, is a critical focus. This year, we began developing a new organisational strategy to enable the business decisions and financial performance that will deliver our vision. Once in place, this strategy will anchor our efforts, investments, planning, and reporting. It will guide us in maintaining and developing our critical scientific capability and services that drive evidence-based decision-making and economic growth, and in realising the commercial potential of our science. We look forward to working with our people to complete and confirm the strategy in the coming year.

We drive impact by partnering closely with end users, including iwi / Māori. Te Punawai o Rangiātea, our Māori Strategy, guides all of us at GNS to engage well with iwi / Māori. We are committed to being a trusted partner, building relationships and collaborations that unlock shared aspirations. For example, our work with Ngāhina Marae, a remote marae in Eastern Bay of Plenty, is supporting their aspiration to become a sustainable and reliable community hub and civil defence shelter. Together we aim to develop a template that can support other rōpū / communities across the motu to become more energy independent and resilient in future.

Our support for Māori participation in science continues. And this year we once again saw excellent uptake and success with our Ahunuku Māori Summer Scholarship programme, a partnership with Te Herenga Waka Victoria University. Within GNS Science, our Te Reo, Tikanga and Te Tiriti o Waitangi training programmes remain well-supported.

"GNS continues to respond to opportunities and challenges outlined in our Science Roadmap, as well as in our operating environment. Becoming a higher performing organisation, both financially and operationally, is a critical focus."

In March 2024 we acknowledged and accepted a sentence related to legal proceedings that followed the 2019 eruption at Whakaari / White Island. The charge, under section 49 of the Health and Safety at Work Act 2015, was not related to the tragic 2019 eruption. At the time of the trial, the recommendations of an independent health and safety review that we commissioned were either already, or in the process of being, implemented. A coronial inquiry into the 2019 eruption is underway and GNS Science is supporting this process.

In June 2024 GNS embarked on a Financial Sustainability Change Programme that aims to address current and future challenges for the organisation. The economic challenges facing the country are impacting many public and private organisations, including GNS. As a Crown Research Institute, GNS has an obligation to be financially sustainable. More importantly, growing our financial sustainability is critical if we are to make strategic investments – in our people, and in the assets, technologies, and capabilities required to deliver our critical science and science services now, and for years to come.

We have been focused on operating with fiscal prudence, seeking cost savings where possible and looking hard at discretionary spending. Considering the size of our workforce alongside other cost saving measures has been a difficult but necessary step on a longer journey to financial sustainability. GNS has been committed to a rigorous consultation process, and staff feedback has been considered as part of final decision-making.

This year we made a profit after tax of $4.0 million following two years of losses. These green shoots demonstrate that the work underway to improve our financial performance will better position the organisation to reinvest in our people and our science.

GNS supports the Government's ambition to grow economic productivity through science and innovation. Contributing to the Science System Advisory Group's work has been a welcome opportunity for us, and our partners and stakeholders, to shape transformational system change. We look forward to engaging in further robust discussions and will continue to play our part in delivering a modern, future-focused research system for Aotearoa New Zealand.

We are grateful to everyone at GNS – the Board, the Executive Team, and all of our people – for their tireless work and commitment to excellence and impact. And to all of our partners – industry, government agencies, iwi-Māori, and others in the science sector – who enrich our work with their insights and help to translate our science to achieve impact.

Neville Palmer prepares seafloor pressure sensors.

We look forward to continuing to work with you in the year ahead.

David Smol
Chair

Chelydra Percy
Chief Executive

01

Innovating technology to transform critical mineral extraction. Meeting the market with PowerMatch technology advancement. Leading the world in comprehensive urban emissions mapping. Pioneering science readying Aotearoa for the next 'big one'.

GNS Science is powering technology and innovation for today, and for tomorrow.

Powering innovation and technology

Innovative technology set to transform critical mineral extraction

Transitioning to net-zero carbon emissions will place unprecedented demand on natural resources across the globe. GNS Science is recovering rare earth elements from deep magmatic fluids to help address this challenge and transform critical mineral extraction.

Material recycling alone will not be able to meet market needs, especially for the critical metals and minerals used to create vital energy technology. Global demand is increasing for these critical elements, and many countries, including New Zealand, will struggle to start or scale-up extraction to secure a national supply.

GNS is working with Oxford University to develop a new geochemical technology that could transform critical mineral extraction. This new technology could unlock a national supply of rare earth elements and power a new future for local manufacturing and industry.

Rare earth elements (REE) are metals with high lustre and electrical conductivity, and are used in most modern technologies like LEDs, fuel cells, and computer components. REE are never found as free metals in the Earth's crust, instead they naturally occur within mixtures of metals and non-metals. Current conventional REE extraction methods from these mixtures are energy-intensive and economically non-viable.

The project, led by GNS Geothermal Chemist, Lucjan Sajkowski, aims to create geochemical technology that can be implemented in geothermal wells to recover rare earth elements sustainably and safely. Its success would allow New Zealand to harness a REE supply with significantly less resource wastage and environmental impact than conventional methods.

"With GNS' expertise in experimental geochemistry and Oxford's expertise in volcanic systems and ore formation, we are looking at ways to enhance the metals endowment of geothermal fluids through reactions between reinjected fluids and the geothermal reservoir rocks," says Jon Blundy, Royal Society Research Professor from Oxford University.

"The value of dissolved metals in geothermal fluids, both in New Zealand and beyond, may exceed the value of the electricity these fluids produce."

This exciting work has the potential to underpin the development of new vital energy technologies and power a new future for local manufacturing and industry. It is currently in a pilot testing phase overseas, led by Oxford University. GNS' contribution is supported by the Ministry of Business, Innovation and Employment Strategic Science Investment Fund, and Royal Society Te Apārangi Catalyst Fund.

Lucjan Sajkowski in the geothermal experimental lab.

On the road to comprehensive urban emissions mapping

A custom-designed mobile greenhouse gas measurement lab is poised to gather vital emissions information from across the country and help Aotearoa New Zealand meet its net-zero 2050 target.

From the outside it may look like a humble van, but GNS Science's CarbonWatch-Urban mobile lab is anything but. Housed within the electric vehicle is an innovative array of state-of-the-art instrumentation, modified to be road-trip ready, enabling a range of atmospheric measurements.

The mobile lab will gather measurements from urban areas across the country, spanning varying climates, geographies, and population sizes, visiting multiple times to account for seasonal variation.

Understanding how much carbon dioxide (CO_2) is released by cities and towns, and how much is absorbed by green spaces is key for effective mitigation policies, and to inform urban development choices that support our transition to a low-carbon economy.

GNS carbon cycle scientists have developed an innovative method using atmospheric tracers to separate CO_2 into its sources – photosynthesis and respiration from urban vegetation, wood burning, fossil fuels from traffic, and other fossil fuel sources such as industry.

The five-year research programme is also extending the existing measurements and instrumentation at four Auckland sites.

Programme lead, Dr Jocelyn Turnbull says that the mobile lab is a game-changer in the mission for robust urban emissions information.

"Getting accurate information into the hands of decision-makers is essential for emissions reduction. But, until now, only a handful of cities around the world – including Auckland – have had the instrumentation to achieve this. Our mobile lab is a world-first, enabling us to provide this same information for every town and city in New Zealand."

CarbonWatch-Urban combines these atmospheric measurements that characterise total emissions attributed to CO_2 source sectors, with cutting-edge flux modelling.

The flux modelling draws upon economic data such as fuel imports, vehicle counts, building information, and manufacturing data, as well as satellite measurements of 'greenness' to create maps of emissions and plant uptake over space and time. But it is limited by the quality of the underlying data.

Combined, the two techniques give highly detailed and spatially-resolved information that will allow government, iwi, urban planners, and industry to better monitor their emissions, enable targeted mitigation, and inform low-emissions policy.

New Zealand will be the first country in the world to have high-resolution information for all our urban centres.

Leigh Fleming preps sample flasks for the CarbonWatch-Urban mobile lab.

Haydon Young and Leigh Fleming sample atmosphere as part of the five-year CarbonWatch programme.

CarbonWatch-Urban is funded through the Ministry of Business, Innovation and Employment Endeavour Fund. The project is led by GNS Science, with research partners NIWA, Manaaki Whenua Landcare Research, University of Auckland, DotLovesData, Ministry for the Environment, StatsNZ and Ngāti Whātua Ōrākei.

Discover more

- Research project: CarbonWatch-Urban | GNS website
- Scientists create real-time carbon maps of NZ cities | RNZ website
- Real-time carbon map inspires students to change transport behaviour | RNZ website
- World-first project to map the emissions of every town and city in Aotearoa | GNS website

Pioneering science readying Aotearoa for the next ‘big one’

A hive of activity in the NEMA ‘bunker’ during the recent Rū Whenua exercise.

GNS Science joined Exercise Rū Whenua 2024, a national response exercise led by the National Emergency Management Agency (NEMA) and involving 150 organisations. The exercise simulated a magnitude 8.1 rupture of the Alpine Fault and GNS had a critical role to play in responding – rapidly developing accurate earthquake and tsunami insights, providing this advice to responding agencies and communicating the science.

Central to GNS’ advice was a new suite of innovative products, developed under the Rapid Characterisation of Earthquake and Tsunami (RCET) programme. RCET is developing and deploying state-of-the-art tools and techniques to monitor and rapidly provide critical information on earthquake and tsunami events.

The new tools use the most advanced science to determine the extent of an earthquake rupture and its magnitude, evolution, shaking, and impact. They can quickly contribute to the developing picture of the scale of damage, potential landslide risk, tsunami threat, and loss of life. The RCET tools proved essential during Rū Whenua, building understanding of the event and its impact, and supporting decision-makers deploying resources on the ground.

Earthquake insights

Within seconds of the earthquake occurring, RCET’s FinDer tool was tracking the rupture evolution, determining the magnitude, direction, and significant extent of the fault rupture. The team was able to confirm the simulated earthquake started in Te Anau and propagated several hundred kilometres northeast towards Hokitika.

Aftershock forecasting

Repeating patterns of seismicity from similar events in the New Zealand earthquake catalogue were used to detect and analyse simulated aftershocks and inform aftershock forecast models. This high precision method detects hidden aftershocks difficult to identify during periods of high seismicity where earthquake events overlap.

During Rū Whenua, many smaller magnitude (M<3) and a few larger (M>4) aftershocks were discovered among the noise. Being able to include these otherwise unidentified events improves the accuracy of the aftershock forecast.

Shaking Layers (developed in partnership with the GeoNet programme)

Within 10–20 minutes of the exercise beginning, a Shaking Layers map indicated the strong to severe ground shaking intensity near the epicentre in Fiordland. Maps were updated as critical information came in from other RCET products, illustrating the severe to violent ground shaking intensity and the urban damage expected in Southland, along the West Coast, and extending into Canterbury. Shaking Layers was also used to spatially map earthquake-induced landslides.

Bill Fry, GNS Seismo-tectonophysicist and RCET programme lead, said Rū Whenua was a welcome opportunity to test RCET tools in a simulated high-pressure environment.

"We were ecstatic with the increased situational awareness RCET tools and products provided for the exercise. The enhanced intelligence enabled more effective rapid response decision-making. Resources could be safely directed to the places where the greatest damage occurred from shaking and from secondary hazards – such as landslides and aftershocks," Dr Fry said.

"We are encouraged knowing how well RCET products will serve emergency response agencies for the next 'big one'. With the advancements being made under RCET, we also open up pathways for future research to tackle ongoing hazard challenges – such as earthquake early warning and forecasting locally generated, fast-approaching tsunami."

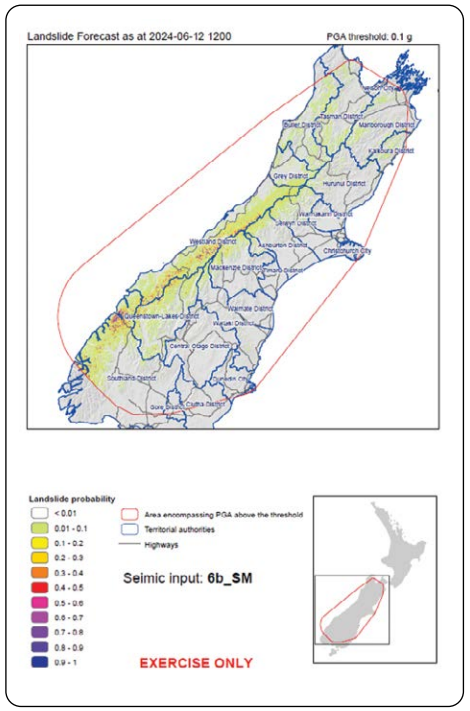
NEMA's Chief Science Advisor, Professor Tom Wilson, said RCET innovations, as part of the well-integrated and trusted science advice from GNS, were highly valued and timely for Rū Whenua.

"The RCET products were part of a superb wider contribution from GNS Science and the Aotearoa New Zealand science system."

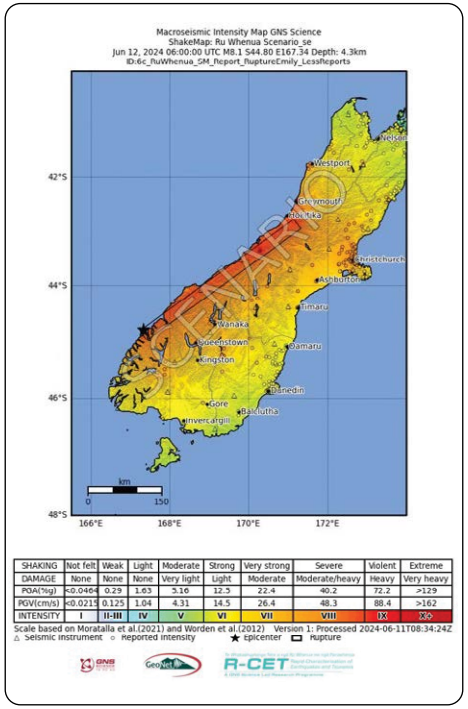
"The science advice provided essential situational awareness and immediately helped inform wider response priorities. The RCET products were part of a superb wider contribution from GNS Science and the Aotearoa New Zealand science system – which included standing up the 'Science Desk' sub-function within the National Crisis Management Centre and formal use of the Aotearoa Earthquake Science Advisory Panel," Professor Wilson said.

NEMA's Director of Civil Defence Emergency Management, John Price, said any capabilities that enable emergency managers to keep communities safe is a good thing for all.

"In an emergency, especially with the scale we exercised through Rū Whenua, science is critical in providing the evidence base needed to manage the emergency well," John said.



A RCET powered landslide forecast and macroseismic intensity map.



These RCET powered maps were prepared for a national exercise, responding to a simulated significant Alpine Fault earthquake.

RCET is funded by the Ministry of Business, Innovation and Employment Endeavour Fund and is delivered in partnership with iwi, a national network of researchers, local and national government, and international organisations.

Discover more

- New generation science transforming earthquake monitoring and tsunami forecasting | GNS website
- RCET: Rapid Characterisation of Earthquakes and Tsunami | GNS website

Meeting the market with PowerMatch

Vedran Jovic in the new green hydrogen lab.

Technology advancements developed by GNS Science aim to drive down the cost of green hydrogen and position New Zealand as a global leader in affordable green hydrogen solutions.

Cost reduction is pivotal to making green hydrogen commercially viable. The largest single cost driver of green hydrogen is the power consumption required for its production.

In today's market, electricity makes up approximately 70% of the total cost of green hydrogen, followed by the system's capital cost of around 17%. Seeking solutions to the power problem is fundamental to lowering its operational costs and establishing it as a competitive fuel alternative.

The most energy demanding step for green hydrogen production is splitting water into oxygen and hydrogen gas. This process, called water electrolysis, is performed by an electrolyser.

Current electrolysers on the commercial market require iridium-based catalysts composed of costly and rare materials.

Using an advanced particle accelerator, GNS scientists are producing next-generation catalysts to reduce material costs. They have also discovered a new type of magnetism that improves an industry gold standard catalyst.

As well as developing more energy-efficient and cost-effective materials, GNS scientists are investigating the operational mechanics of electrolysers. They're seeking to lower the electrical energy they need and extend the life of the rare materials within them.

Recently awarded Tier 2 KiwiNet funding, GNS' "PowerMatch" technology is a promising innovation. The PowerMatch system is designed to optimise the amount of electrical energy needed to produce green hydrogen. In addition to reducing operational costs, PowerMatch could also help slow the degradation of catalyst materials.

"The team is developing the technology so that it can be both retrofitted to existing plants and added to new plants," said Vedran Jovic, PowerMatch Science Lead at GNS.

"It's important we can help everyone in the market address the operational costs of green hydrogen," said Campbell Barnes, PowerMatch Commercial Lead at GNS.

As well as addressing production costs, the team is pioneering advancements in hydrogen storage and distribution through ammonia-based solutions, including demonstrating the first electrochemical production of ammonia in New Zealand. This breakthrough not only supports energy storage solutions but also contributes to reducing the overall cost of green hydrogen by making energy storage more feasible and cost-effective.

02

Leading homegrown resilience to landslide risk. Exploring understudied hazards of nearshore volcanoes. Strengthening Dunedin's climate resilience. Unearthing contamination insights. Caring for our geothermal systems. Monitoring space weather to boost resilience.

GNS Science is powering policy and decision-making that protects our people, our infrastructure, and our economy.

Powering good decisions

Empowering homegrown resilience to landslide risk

Landslides currently cause $250 to $300 million worth of damage a year in New Zealand on average, and are responsible for more fatalities than all other geohazards combined.

Estimates for landslide damage from Cyclone Gabrielle alone were close to $1.5 billion, highlighting the importance of considering not just the likelihood, but the consequences of landslides from large storm events, particularly with a changing climate.

Chris Massey and landowner Gary Peddle at one of the 100,000 Hawke's Bay landslides caused by Cyclone Gabrielle.

To support New Zealand to be safe, resilient, and prosperous in a future of increasing landslides, GNS has developed Landslide Planning Guidance that encourages landslide risk to be considered early in the land-use planning process. Doing so will help avoid costly and potentially dangerous developments that could pose a risk to people, property, and the environment.

This award-winning guidance encourages a risk-based approach that considers climate change, as well as current legislation and practices. It is designed to align with other natural hazard guidance, like the liquefaction and coastal hazard guidance, to complement other planning priorities.

Engineering Geologist, Dr Saskia de Vilder, said that while the guidance's primary audience is planning, policy and building compliance staff, it also considers the requirements of engineering geologists, geotechnical engineers, developers, and professionals – who are all essential to planning development.

"From the beginning we knew that if we wanted the guidance to be adopted in practice, we needed to bring policymakers and planners on the journey with us," Dr de Vilder said.

"Throughout its multi-year development, the guidance was informed by a steering committee drawn from city, district and regional councils, central government ministries and the Natural Hazards Commission Toka Tū Ake.

"Winning an award recognising best practice in 'Strategic or non-statutory Planning' by the New Zealand Planning Institute demonstrates this was the right approach. We have delivered a product that will have impact across the planning sector, improving the lives and livelihoods of New Zealanders."

The guidance has received positive international attention, including from landslide expert Professor Dave Petley (University of Hull, UK) who writes that it is:

"...the most brilliant exposition of practical landslide risk analysis that I have seen" (The Landslide Blog, *Eos* magazine, 21 March 2024).

Senior Natural Hazards Planner, Scott Kelly said it is important landslides and their consequences are considered early in the planning process.

"It's not about preventing development; it's about having the right information to inform the right development in the right place."

The guidance has been developed under the Ministry of Business, Innovation and Employment Endeavour-funded Earthquake-Induced Landscape Dynamics programme and the Strategic Science Investment Fund.

Discover more

- New guidance encourages planners not to let landslide risk reduction opportunities slip by | GNS website
- GNS Science Landslide Planning Guidance | Eos website
- 2024 NZPI Best Practice Award – Non-Statutory Planning | YouTube
- Global lessons from New Zealand's updated landslide risk reduction guidance | Ground Engineering website
- Landslides in New Zealand kill more people than earthquakes, tsunamis and volcanoes | Newshub website
- Nick Smith: Nelson Mayor on scientists urging councils to create landslide risk maps | Newstalk ZB website

Digging into Aotearoa's soils to unearth contamination insights

The Geochemical Atlas of Aotearoa New Zealand provides the first national baseline of the concentrations of elements in our near-surface soils, identifying where human activities have increased heavy metals and where elements important for soil health are low.

Researchers from GNS Science, Manaaki Whenua – Landcare Research, and the University of Auckland have measured the concentrations of 65 elements in our soils. The team analysed more than 800 samples taken from the top 30 cm of soil. The atlas presents the results using maps which show changes in the concentration of each element across the motu, from Cape Reinga to Rakiura Stewart Island.

"The atlas is a valuable resource. It provides vital information about the location and concentration of key elements as they are today so that we can monitor and manage them in future."

Dr Mark Rattenbury, GNS Geologist, says that while similar resources exist internationally, this is the first study of this scope and scale for New Zealand.

"It's a foundational resource that provides context for more detailed investigations and 'state of the environment' assessments."

Metals that can be hazardous to human health, including arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc are included in the atlas. The work helps us understand where human activity has changed the naturally occurring concentrations, allowing for easier monitoring of future changes to mitigate the potential impact on human health and the environment.

The study data has also been compiled as a digital table and spatial dataset, to ensure analytical flexibility for end-users, such as regional and local councils and environmental consultants.

The atlas forms part of GNS' work to map geochemical soil variation across New Zealand. It sits alongside published geochemical atlases for Wellington, Dunedin City, and southern New Zealand, and geochemical surveys undertaken for Auckland City, Buller-east Nelson-Marlborough, and Otago-northern Southland.

GNS Science Interim Environment and Climate Theme Leader, Dr Giuseppe Cortese says the atlas is an important addition to GNS' wider work to quantify the contaminants present in our air, freshwater, ocean, and soil, and to understand how these contaminants move through our environment.

"The atlas is a valuable resource. It provides vital information about the location and concentration of key elements as they are today so that we can monitor and manage them in future."

"It also offers a starting point from which we can explore and model how these elements may move through our environment as the climate changes and land use shifts," says Dr Cortese.

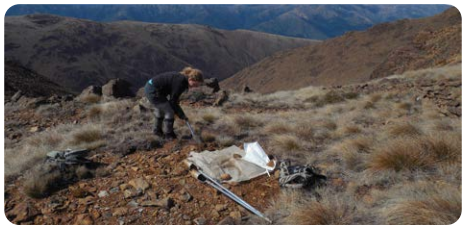
GNS' contribution to this research was principally funded through the Ministry of Business, Innovation and Employment, including through the Strategic Science Investment Fund. Archival sample material was provided by GNS and Manaaki Whenua - Landcare Research.

Discover more

- New atlas maps metals and other elements across Aotearoa's soils | GNS website
- Maps of heavy metals in Wellington's soils show impacts of urbanisation | GNS website
- Contaminants: Soil contaminants | GNS website

Mark Rattenbury collects a soil sample for geochemical analysis in the Red Hills.

More than 800 soil samples from across the country were analysed for the atlas.



Rose Turnbull taking a soil sample for geochemical analysis in the hills above Lake Wakatipu.

Groundwater study strengthens Dunedin's climate resilience

"It's an important tool in determining adaptation options for the future of South Dunedin."

GNS Science is providing vital information on the behaviour of groundwater beneath South Dunedin, that sheds light on the need to plan for some of the lesser-known impacts of sea-level rise.

As sea levels rise due to climate change, the water table will also rise in areas near the coast where groundwater is shallow and the ground is permeable, reducing the ground's capacity to absorb rainfall. Impacts may include inundation of stormwater and wastewater systems, weakening of building foundations, and increased liquefaction vulnerability. Eventually, groundwater could emerge at the surface and cause localised flooding.

A GNS Science study, produced in partnership with Otago Regional Council (ORC), has forecast when and where groundwater-related hazards are likely to occur in the region. Based on analysis of four years of data from the ORC-operated groundwater monitoring network, the research explored the causes of groundwater level changes, and used modelling to understand how sea-level rise will alter the future fluctuations and elevation of groundwater levels.

The research is informing the South Dunedin Future programme – an ORC and Dunedin City Council partnership that tackles climate change, sea-level rise and flooding problems in South Dunedin.

Otago Regional Council Manager Natural Hazards, Dr Jean-Luc Payan, says, "This unique research builds on monitoring work ORC and GNS have been doing together since 2009, and provides a detailed picture of where and when issues will arise. It's an important tool in determining adaptation options for the future of South Dunedin."

Dr Simon Cox, GNS Science Principal Scientist, says the study shows that groundwater impacts can be expected before any inundation directly from the sea, and is groundbreaking in its focus on episodic and acute hazard conditions rather than long-term, permanent flooding.

"This study integrates and forecasts all of groundwater's contribution to flood hazards, including the episodic issues that arrive first, such as an area becoming more prone to flooding during heavy rainfall," says Dr Cox.

Jean Luc Payan (Otago Regional Council) and Simon Cox (GNS) at one of the Dunedin groundwater monitoring sites.

This new understanding of the interplay of groundwater hazards will be vital for strengthening Dunedin's climate resilience.

The approach is now being applied in Tauranga and can serve as a template for the many coastal areas, both in New Zealand and internationally, that will face similar challenges in the future.

The research was funded by the Ministry of Business, Innovation and Employment Strategic Science Investment Fund, the Endeavour-funded NZSeaRise programme, and co-funding from ORC.

Discover more

- Dunedin research forecasts groundwater challenges as the sea level rises | GNS website
- Dunedin research highlights groundwater challenges as sea level rises | 1News website
- South Dunedin not as prone to sea level rise as feared, research shows | RNZ website

Vital ‘care plan’ established for Rotorua geothermal system

Brad Scott records temperatures of geothermal fluid.

Lauren Coup sampling geothermal fluids at Te Puia thermal park, Rotorua.

GNS Science has helped ensure a sustainable future for the Rotorua geothermal system with the Rotorua Geothermal System Management Plan (SMP) Ngā Wai Ariki o Rotorua He Mahere Whakahaere Pūnaha now approved by the Toi Moana Bay of Plenty Regional Council.

Working with tangata whenua, consent holders, the community, stakeholders, and Bay of Plenty Regional Council, GNS has contributed to the new ‘care plan’ for the Rotorua geothermal system.

The plan outlines a shared vision for the future, “*Ka ora te mauri o Ngā Wai Ariki o Rotorua. The Rotorua geothermal system is healthy*”.

Though immensely powerful and valuable, the fragility of the Rotorua geothermal system has been widely documented in mātauranga Māori, scientific and historical records of the system.

> “Bay of Plenty Regional Council now has a model they can use to test and predict the potential effects of geothermal use and development, and guide sustainable geothermal allocation.”

Strong signs of the system’s deteriorating health were observed during the 1970s, when uncontrolled extractions of geothermal fluids degraded the system. Many springs stopped flowing, some even drying out, and geysers like Waikite and Papakura ceased to erupt.

The system’s decline instigated a protection and recovery plan in the 1980s. Over the past 40 years, the system has largely recovered and stabilised, however some features have not, and may not ever, fully recover.

Te Ahi Kā Roa Rōpū, a haukāinga working group with representatives from Ngāpuna, Whakarewarewa, Ōhinemutu and Tarewa / Kuirau, was established to work alongside the Regional Council on the development of the SMP.

Collaborating on the SMP provided “a ground-breaking opportunity to be involved in decision-making about our wai ariki,” said Te Ahi Kā Roa Rōpū member Sharon Porter.

The new ‘care plan’ has drawn on extensive research and monitoring to identify and cover the gaps in the management of the Rotorua system.

To form the evidence base for the plan, Bay of Plenty Regional Council engaged a GNS team of multi-disciplinary specialists, who compiled decades of geothermal research, monitoring, and climate data from the region.

Combining this data with analyses of the surface geothermal features has created a much deeper understanding of the shallow and vulnerable portions of the Rotorua system.

“Bay of Plenty Regional Council now has a model they can use to test and predict the potential effects of geothermal use and development, and guide sustainable geothermal allocation,” says Robert Reeves, GNS Geophysicist.

The SMP will inform changes to the Regional Natural Resources Plan and the Rotorua Geothermal Regional Plan. These plan changes are part of a regular review process under the Resource Management Act and clarify how the geothermal (ngāwha) resources of the Rotorua Geothermal System are to be used.

Discover more

- Rotorua Geothermal System Management Plan | Bay of Plenty Regional Council website

Getting better prepared for the impact of volcanic hazards

Setting sail for Whakaari and Tūhua islands.

Seabed sediment samples give insight to past eruptions.

Over the past 12 months, two successful research voyages have sailed to Whakaari / White and Tūhua / Mayor Islands, completing a series of four seafaring expeditions to survey the island volcanoes from seafloor to summit.

This GNS Science-led Beneath the Waves programme research is the first to comprehensively map the structure of the islands and study the multiple hazards they pose, including their potential to generate tsunami, ashfall, and pyroclastic flows of hot ash and gas.

GNS Science Senior Volcano Geophysicist and programme lead, Craig Miller said the new data will be used to build robust simulations and models that can help monitor, assess, and forecast possible hazard scenarios for the Bay of Plenty from future volcanic events.

"If we can determine the probability and impacts of these volcanic hazards, we can better prepare for them."

The programme is working closely with local emergency managers, industry, iwi, councils, and schools to guide future work to reduce the vulnerability of communities, infrastructure, and cultural taonga along the Bay of Plenty coast.

Dr Miller said findings from the voyages have already provided new insights into the frequency, size, and drivers of past eruptions.

"Early analysis of subsurface imaging of the crust indicates evidence of deep fluids, possibly magma, to the northwest of Whakaari," Dr Miller said.

"If correct, the location of this offset magma reservoir could have implications for how we monitor this volcano in the future. These fluids occur close to an area of active faulting, so monitoring seismic activity in this area could signal an increased level of volcanic activity.

"Preliminary results from seabed sediment samples suggest larger eruptions in the last few thousand years compared to the ones we know about from records extending back to the 1800s. We now want to investigate whether these eruptions were large enough to deliver ash to the mainland."

"If we can determine the probability and impacts of these volcanic hazards, we can better prepare for them."

The voyages set sail with researchers from GNS Science, Victoria University of Wellington, Scripps Institute of Oceanography and two BLAKE GNS Ambassadors. The team deployed advanced instruments to image the magmatic plumbing systems that feed the mostly submerged volcanoes, and to identify areas of active hydrothermal venting. They also gathered data on the volcanoes' geologic history, including previous eruptions and flank collapses.

Beneath the Waves is a GNS-led Ministry of Business, Innovation and Employment Endeavour-funded programme delivered collaboratively with our partners from University of Canterbury, Massey University, Victoria University of Wellington, Scripps Institute of Oceanography, East Coast Labs and the Waikato and Bay of Plenty Civil Defence and Emergency Management groups.

Real-time space weather monitoring tool boosts resilience

Extreme solar events pose risk to Earth's electronics and infrastructure.

"Transpower is continuing to work with research scientists and organisations, including GNS Science and Otago University, to develop this monitoring network and ensure we are armed with the quality information we need to respond to this natural hazard."

Space weather is best known for the spectacular displays it creates in our skies – but behind the beautiful images is a darker side. Someday an unlucky outburst from our sun could strike Earth and damage our electronics and infrastructure.

An extreme solar event, like a coronal mass ejection, is an explosion of plasma and magnetic fields from the sun. Ejected out into space, such events can be detected when they are directed towards Earth.

Keeping a close eye on space weather is essential for organisations like New Zealand's national grid provider Transpower. They need to be aware of induced currents during geomagnetic storms which could cause disruption and damage to the national grid.

GNS Science plays a critical role in this monitoring, continuously recording changes in the Earth's magnetic field at geomagnetic observatories using magnetometers. These instruments reveal rapid changes in the Earth's magnetic field associated with solar storms, as well as other geologic processes.

Powered by the Solar Tsunamis Programme, GNS is part of an international collaboration, led by University of Otago, that is endeavouring to understand how Aotearoa New Zealand's energy infrastructure will be impacted by space weather events.

Critical data from this research is now giving real-time advice to Transpower to help prepare power transmission systems for when extreme solar events take place.

Monitoring dashboards that provide data from two GNS operated geomagnetic observatories in Canterbury and Scott Base now allow control room operators at Transpower to verify how their systems may be impacted by a solar event.

Combined with Transpower network sensors, this programme has shown a correlation between Transpower measurements, and the intensity of the magnetic field measured at our geomagnetic observatory in Canterbury.

"Transpower is continuing to work with research scientists and organisations, including GNS Science and Otago University, to develop this monitoring network and ensure we are armed with the quality information we need to respond to this natural hazard," says Transpower New Zealand Head of Grid and System Operations, Matthew Copland.

Continuing to power good decision-making, the data from our two magnetic observatories is now available through the GeoNet programme.

The data is freely available, allowing organisations to make the necessary preparations at the onset of a solar event. This was successfully put to the test during the May – June 2024 sunspot cluster that produced a visually spectacular solar storm.

Discover more

- Natural Hazards and Risks: Space Weather | GNS website
- Geomagnetic Data | GeoNet website

A novel technique adopted to survey seismic activity

The team deploying Dense Nodal Seismic Arrays.

147 buried seismometers recorded data for a month.

GNS Science, in collaboration with the Australian National University, adopted an innovative surveying technique to measure seismic activity on the Paeroa Fault. The insights gained will support local decision-makers to understand the risks of rupture, and how to prepare for them.

Just south of Rotorua in Reporoa, 147 seismometers were buried about a foot deep in soil and left for a month. These Dense Nodal Seismic Arrays (DNSA), about the size of a one litre tub of ice cream, were deployed in a five square kilometre area spanning the main and secondary segments of the Paeroa Fault.

The Paeroa Fault is one of the longest and most active faults in the Taupō Rift. It is mainly surrounded by farmland, making it a prime candidate for the use of DNSA. Measurements from the seismometers will help scientists understand more about the structure of the fault as it descends into the Earth and how steeply it dips. This will build a better understanding of the earthquake hazard posed by the fault.

"This research will provide us a greater awareness of how, and how often, the Paeroa Fault will rupture – information we can use to support local iwi, councils, communities and lifelines organisations to prepare for the risks and build resilience," said Dr Natalie Balfour, Head of Research, Natural Hazards Commission Toka Tū Ake (NHC).

The project team appreciated the opportunity to work with local iwi. Particularly, the collaboration with Ngāti Tahu-Ngāti Whaoa, which recognised their aspirations for education and employment opportunities for their rangatahi. The team of scientists were joined by two students from Ngāti Tahu-Ngāti Whaoa who were employed to assist with the survey, and a GNS Science summer student from Otago University.

Provided by the Australian National Research Facility for Earth Sounding, the devices continuously record the background vibrations in the Earth. The project was co-funded by NHC, and marks one of the first uses of DNSA in New Zealand.

"Nodal seismic surveys are the future of seismic exploration, and this project provided an exciting step forward for GNS Science. We hope that the data that we've acquired, and the analytical methods that we apply, will provide the basis for more such surveys in the future," said Brook Keats, GNS Geophysicist.

With the seismometers now collected, GNS and the Australian National University will analyse the data. The results will feed into future iterations of the New Zealand National Seismic Hazard Model and provide a knowledge base to build on for future DNSA surveys.

Ten years of Resilience to Nature's Challenges

In 2014 GNS Science had the privilege of becoming host to one of the brand new National Science Challenges. The eleven Challenges were ten-year collaborative research programmes set up to tackle some of Aotearoa New Zealand's biggest science questions.

Resilience to Nature's Challenges National Science Challenge (RNC) aimed to accelerate resilience to natural hazards through collaborative, innovative research. Hundreds of researchers were involved from organisations across the country, with expertise in physical science, social science, mātauranga Māori, economics, and engineering. RNC helped grow the next generation of natural hazards experts, supporting over 150 PhD and Master's students.

As a mission-led science programme, RNC transformed the way natural hazard research is done in Aotearoa New Zealand – involving users from the outset, enabling deep collaboration across disciplines and organisations, prioritising science communication, learning from knowledge held by mana whenua, and addressing Māori research needs.

This disruptive decade has included a large earthquake, a deadly volcanic eruption, and numerous big storms and floods, including the most recent North Island severe weather events of 2023. It has been an apt time to put natural hazards and resilience under the spotlight.

RNC has generated new knowledge and tools to power good decisions for resilience – enabling better investment choices, responsible community actions, robust adaptation planning, and future-focused policies and legislation. The programme has established a secure foundation for future resilience research to build on.

Jon Procter and RNC Volcano team researchers and stakeholders, Ruapehu, 2021.

Social scientists working with the RNC Rural programme studied the social and economic recovery from the 2016 Kaikōura earthquake and identified important lessons regarding disasters and tourism. They noted the regulatory changes that could be implemented to enable cut-off regions to unlock their local food resources to feed the community. This has developed into policy advice to enhance food security following disruptive events.

Engineers from the University of Auckland and the University of Canterbury were heavily involved in the science response following the Kaikōura earthquake, and numerous storm and floods including the 2023 severe weather events. The researchers learned how critical infrastructure networks respond to these natural hazard impacts. They pioneered new approaches to design and repair, and informed better decision-making and investment.

RNC provided science support for the Alpine Fault earthquake preparedness and response planning programme, AF8. As well as directly boosting the resilience of South Island communities and infrastructure, researchers invested in community engagement, including the award-winning AF8 Roadshow.

A team from the University of Auckland has completed the first comprehensive assessment of coastal change (patterns of erosion and accretion) since the 1970s. It took five years, involved more than 40 researchers, and provided a nationally consistent baseline against which future coastal change can be assessed. The dataset is already being used by councils to inform adaptation planning.

GNS Science has made significant advancements in impact-based forecasts and warnings. These types of warnings communicate potential impacts, such as traffic disruptions or power cuts, rather than the magnitude of a hazard, such as rainfall intensity. They are more meaningful, more relevant, and motivate and enable people to act. With the researchers' help, MetService has shifted to issuing impact-based warnings and forecasts for severe weather.

The Earthquakes and Tsunami programme has developed New Zealand's first earthquake cycle simulator. Using physics-based computer models, a catalogue of hundreds of thousands of years of earthquakes now exists. It illustrates New Zealand's full earthquake cycle, describing how earthquakes cluster in time, and how faults interact with one another. It provides a clearer picture of what future large, damaging quakes might look like.

This knowledge is critical for multi-hazard and impact modelling, and the genesis of early warning systems and other initiatives that will keep New Zealanders safer.

Work from the RNC Volcanoes programme has enabled better impact forecasting for the range of volcanic hazards typical of the cone volcanoes in Taranaki and the Central Plateau. Strong relationships with local iwi, in particular with Ngāti Rangi near Mt Ruapehu, have seen the scientists and Ngāti Rangi kaitiaki learning from each other – bringing together traditional observational techniques and modern volcanic science. This valuable shared knowledge enhances resilience-building efforts in and by the local community, and numerous other partnership projects with hapū and iwi have produced tools to support Māori communities to prepare better for, and fend better during, natural hazard events.

Road damage at Mounsey's Creek bridge, SH1 caused by Kaikōura Earthquake 2016.

Resilience to Nature's Challenges has been a driving force for collaborative, user-focused resilience research – and it doesn't stop here. In the 2024 Budget, $70 million over seven years was set aside for a new Natural Hazards and Resilience Platform hosted by GNS Science. This will enable the resilience research community to build on the strong foundations established by RNC, powering into the future with all the momentum of the last decade driving us forward. We're proud to know our science is keeping people safer and making the economy stronger.

03

Boosting Ōpōtiki economy with science insights. Supercharging superhot geothermal. Building a green hydrogen economy. Powering critical loss modelling tools for New Zealand. Tapping into heat potential for Bay of Plenty. Unlocking energy and economic opportunities with Japan.

GNS Science is powering economic growth for our local and national economies.

Powering economic growth

Trade mission to Japan unlocks energy and economic growth opportunities

In June 2024, GNS Science joined the New Zealand Prime Minister's trade mission to Japan. It was a welcome opportunity to assist with the Government's goal to lift engagement with Japan, diversify trade, and accelerate New Zealand's economic growth.

In 2023, two-way trade between New Zealand and Japan totalled $9.9 billion, with exports growing in many of New Zealand's key sectors. The business delegation was made up of a diverse cross section of New Zealand's top companies engaged in Japan as well as those looking to enter the market. Participation in the trade mission enabled GNS to connect with valued partners, to grow new relationships, and to showcase the strength of New Zealand's science, innovation, and technology sectors.

New Zealand and Japan are geologically alike, with similar geohazards and geothermal resources. Currently, fossil fuels account for 88% of Japan's electricity supply, and over 96% of Japan's energy consumption is satisfied by foreign imports. In contrast, Aotearoa New Zealand has more than 80% of electricity coming from low emitting renewable energy sources, with 20% of baseload generation coming from geothermal energy. But, like Japan, New Zealand needs to secure more reliable, low-carbon electricity generation to meet the growing demands.

A newly signed MOU strengthens ties for joint geothermal innovation between New Zealand and Japan.

Chelydra Percy speaks on a panel during New Zealand's trade mission to Japan.

Growing commercial partnerships and sharing science knowledge with Japanese organisations benefits both nations. The Tokyo trade mission was an opportunity for GNS to connect in the Japan market, further positioning ourselves as a partner of choice for energy technology and research development – especially in geothermal innovation. Chief Executive, Chelydra Percy represented GNS on the trip.

"With New Zealand's established leadership in the global geothermal industry, our expertise will bridge gaps in the Japanese market. Japan's innovation capability, particularly in engineering, will also help grow New Zealand's capability. Working together we can accelerate much-needed progress in securing affordable, reliable, and renewable energy for both nations," she said.

During the trip, GNS Science, Geo40, and Western Energy signed a memorandum of understanding with Mitsubishi Gas Chemicals. This new agreement streamlines collaboration and knowledge sharing for all parties, accelerating progress towards a secure and sustainable energy future.

The partnership will leverage shared expertise to boost Japan's geothermal power generation and provide opportunities for further development in both New Zealand and Japan.

Powering ahead with green hydrogen

With the launch of Australasia's first green hydrogen refuelling network and other burgeoning business ventures across our industries, New Zealand is well positioned to realise a strong green hydrogen powered economy.

Green hydrogen has demonstrated immense growth over the past year and offers significant economic opportunity for Aotearoa New Zealand.

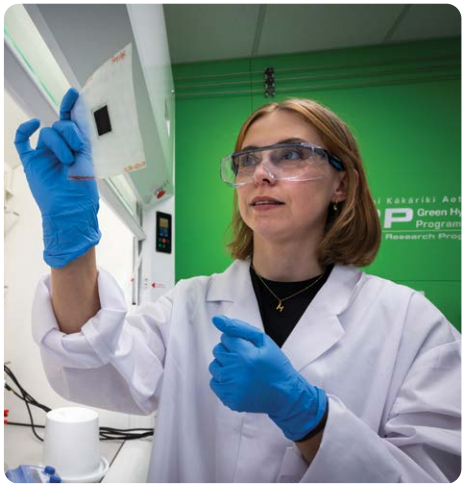
Green hydrogen can be leveraged to significantly decarbonise our highest emitting sectors, particularly transport and industry. With its high energy content, green hydrogen offers a zero-emissions fuel solution where electrification is not viable. By upscaling green hydrogen use at a national level, New Zealand can position itself to attract partnerships and investment from other countries.

GNS Science is supporting New Zealand's green hydrogen development through Endeavour Fund and Advanced Energy Technology programmes. In January, GNS hosted the New Zealand Hydrogen Symposium, bringing together over 200 hydrogen experts and innovators.

"The team at GNS has not only been supporting us with respect to producing quality and validation results, but also helping us interpret those results, which has been really helpful along the way."

GNS' brand-new Green Hydrogen and Ammonia Research and Testing Lab is a dual-purpose research and testing facility. Funded and operated by GNS, it is the first dedicated green hydrogen lab in New Zealand. It will provide critical services to support New Zealand's green hydrogen progress. Through GNS' collaboration with end-users, the lab's research arm will be at the forefront to drive innovation and support growth.

In addition to research, the lab provides New Zealand's only green hydrogen purity testing service, speeding up and independently verifying the green hydrogen supply. This service ensures providers like Hiringa Energy and Halcyon, are maintaining production quality. GNS can rapidly help problem-solve the causes of any anomalies, which is not a typical offering from international testing services.



Michelle Cook in New Zealand's first dedicated green hydrogen lab.

"The team at GNS has not only been supporting us with respect to producing quality and validation results, but also helping us interpret those results, which has been really helpful along the way," said Dan Kahn, Chief Technology Officer and Co-Founder of Hiringa Energy.

GNS uses advanced gas chromatography techniques to ensure hydrogen meets purity requirements, preventing contamination and ensuring the safe operation of fuel cells. By supporting and testing the integrity of the supply chain, GNS helps to ensure New Zealand businesses and their assets are kept safe as they transition to green hydrogen.

As we move towards carbon neutrality by 2050, GNS is committed to supporting green hydrogen's growth. Together with our commercial and research partners, GNS is powering economic growth and helping pave the way for a cleaner, more sustainable future for all New Zealanders.

Discover more

- Powering ahead with green hydrogen | RNZ website
- A new chapter begins for the future of Green Hydrogen | GNS website
- Celebrating New Zealand's biggest hydrogen event | GNS website

Superhot geothermal – a sleeping giant worth waking

Aotearoa New Zealand can unlock unprecedented energy security and economic growth by tapping into our deeper, hotter geothermal resources.

New Zealand faces a substantial increase in electricity demand, with forecasts showing a 50% rise by 2050. To secure the electricity generation needed and to meet emissions reduction targets, planning tends to focus on expanded use of existing renewable technologies like wind and solar.

GNS Science investigated what near-future technologies New Zealand could be overlooking. With our 'Geothermal: The Next Generation' research programme in its final stages, the immense potential of harnessing deep, superhot, geothermal energy, also known as supercritical geothermal, is now verified.

When pure water exceeds 373°C and 220 bars of pressure, it becomes supercritical, a state that offers up to three times more production potential than conventional geothermal.

In the Taupō Volcanic Zone, these supercritical conditions are as shallow as 4 km, making it one of the rare places in the world where supercritical development is both accessible and technically feasible.

With a unique laboratory facility and global geothermal development expertise, GNS Science will play a key role in developing superhot geothermal technology to meet commercially viable standards. GNS' Experimental Geochemistry Lab is the only lab in the world that can simulate these superhot conditions.

An independent evaluation by Castalia Limited demonstrates that supercritical geothermal is an economically viable near-future opportunity for New Zealand. Its report affirms supercritical geothermal could improve the security, sustainability and affordability of energy and provide abundant baseload, zero emissions, and reliable electricity for New Zealand.

Castalia's modelling explored a spectrum of energy development scenarios and accounted for research and regulatory timelines and conservative exploration costs. The results outlined the massive electricity generation New Zealand could achieve from this resource.

Supercritical geothermal could provide up to 2,050 MW of new electricity generation capacity for the national grid. This would see geothermal energy contributing approximately 35% of New Zealand's energy needs by 2050 – similar to hydroelectric generation's current contribution.

Growing the use of geothermal energy will help to ensure New Zealand meets peak winter demand and offsets a growing dependence on batteries to supply our national grid.

Peter Rendel and Bruce Mountain run an experiment to simulate superhot geothermal conditions.

Discover more

- GNS Science submission on potential solutions for peak electricity capacity issues consultation paper | Electricity Authority website
- Tapping into the Next Geothermal Frontier | Castalia website
- Geothermal Next Generation website
- Drilling down into limitless clean energy | The New Zealand Initiative website
- Podcast: The massive energy potential of deep geothermal | The New Zealand Initiative website

RiskScape's rich data powers critical loss modelling tool, PRUE

Understanding the impact of natural hazards on people and property is critical for the Natural Hazards Commission (NHC) Toka Tū Ake. Knowing what to expect from future natural hazard events allows them to plan and prepare for New Zealand's physical and economic security.

This enhanced knowledge is possible thanks to RiskScape, which now proudly powers the Commission's loss modelling tool, 'PRUE'. Co-developed by GNS Science and NIWA in partnership with NHC Toka Tū Ake, RiskScape provides a modern software platform for risk modelling, underpinned by the latest scientific research.

Using a custom-built web interface, NHC Toka Tū Ake can produce a custom view of loss assessment from a natural hazard event in minutes. PRUE provides its stakeholders with robust estimations of losses after an earthquake event. It can model residential housing damage costs for any given future earthquake and give a view of that risk to reinsurers.

Working with a collaborative platform like RiskScape allows local authorities and reinsurers to operate from the same data, ensuring a shared understanding and common operating platform, and supporting aligned decision-making.

The scale and value of this was demonstrated during Exercise Rū Whenua 2024, a national response exercise simulating a magnitude eight rupture of the Alpine Fault. The NHC Toka Tū Ake team was able to quickly calculate residential loss and costs, and provide that advice to decision-makers to inform response and recovery efforts.

RiskScape easily integrates new research as it is developed, which makes it, and the GNS team, a key partner for NHC Toka Tū Ake in the ongoing delivery of their loss modelling development roadmap. GNS is excited to support PRUE as it progressively expands to model losses relating to other hazards, like volcanic activity, liquefaction, and tsunami, as well as complex multi-hazard events, like earthquake-induced landslides.

Understanding potential impacts and loss allows better planning and preparation.

GNS Science and NHC Toka Tū Ake are currently working to develop an understanding of losses posed by the Auckland Volcanic Field. Once complete, data from projects like this will be woven into RiskScape to provide an increasingly enhanced view of the impact we might expect from hazard events across the motu.

RiskScape's robust modelling is largely thanks to years of long-term investment in scientific research through the Ministry of Business, Innovation and Employment Strategic Science Investment Fund.

Discover more

- Research project: RiskScape | GNS website

Greater geothermal potential for Bay of Plenty

This year's low hydro production and declining gas supplies have contributed to what the Government is calling an 'energy security crisis'. Winter 2024 has seen New Zealand creep towards an energy shortage, with both energy demand and prices way above average.

In the face of a changing climate and significant projected growth in electricity demand, New Zealand needs solutions now that take the pressure off the grid, reduce carbon emissions, and increase our energy affordability.

The Energy Efficiency and Conservation Authority's (EECA) Regional Energy Transition Accelerator (RETA) report for the Bay of Plenty outlines how geothermal, and specifically geoheat, is one of those 'ready now' solutions. But New Zealand has yet to realise its geoheat potential – and it's costing us.

GNS Science contributed to the report, which highlights the potential of geothermal to reduce the region's reliance on fossil fuels and supply more cost-effective heat for industry needs.

GNS scientists found that introducing geothermal heat pumps (GHPs) could meet the region's heat needs and reduce Bay of Plenty's emissions across a range of applications and locations. Case studies looked at the feasibility of geothermal heat, also called geoheat, to supply Whakatāne Hospital's heating and Whakatāne growers' greenhouse production.

Geothermal heat energy can significantly reduce carbon emissions and produce cost savings for business.

The research suggests GHPs could replace fossil fuels for producing heat, significantly reducing electricity demand and emissions. Despite GHPs having higher initial costs than other heating methods, the reduced electricity demand and expected future upgrades would produce cost savings for businesses within three to five years.

"We found that using geothermal heat energy significantly reduces carbon emissions by hundreds, sometimes thousands, of tonnes per year," said Brian Carey, Geothermal Resource Management Specialist.

EECA is working with big energy users to reduce carbon emissions, meet energy demands, and support them to transition to renewable energy sources.

EECA's Bay of Plenty report found that 28 of the region's large energy users consume 14,741 TJ of energy and produce 281 kt of CO_2 every year to generate heat. Most of these emissions are from fossil gas.

Bay of Plenty is rich in geothermal resource, offering a broad scope of opportunity with temperatures widely available in the low to ambient range, right through to high temperature systems.

The RETA report provides recommendations to streamline technology and infrastructure investments for regional businesses and energy suppliers, supporting them to commit to and implement their low-carbon transition plan.

GNS will support EECA and regional development agencies nationwide to include geoheat in plans as a low-carbon alternative heat supply.

Discover more

- Action Plan 2024-2025: Geoheat Strategy for Aotearoa NZ | New Zealand Geothermal Association website
- Bay of Plenty Regional Energy Transition Accelerator | Energy Efficiency and Conservation Authority website

A clever look at regional rock resources delivers economic boost for Ōpōtiki

GNS Science has played an important role in the Ōpōtiki Harbour Development Project.

The Ōpōtiki Harbour Development Project is set to revitalise Ōpōtiki, bringing new jobs and millions of dollars to the economy. GNS Science played a role in this significant project, helping to show how clever science and a fresh look at a region's rock resources can boost economic and social outcomes.

The Ōpōtiki Harbour Development Project is a $100 million redevelopment of Ōpōtiki Harbour, supported by MBIE's regional economic development and investment unit, Kānoa, and Ōpōtiki District Council. It involves re-establishing the harbour, building two sea walls, and opening a new harbour entrance while closing the existing one.

GNS Science and the Aggregate and Quarry Association (AQA) were tasked with assessing aggregate potential in the Ōpōtiki area to determine sources for the large amount of rock required. Around half a million tonnes of high-grade armour rock (large boulders used to protect the harbour from coastal erosion and waves) and compactable core rock are needed to ensure the harbour can stand up to tides, floods, and earthquakes over its planned 100-year lifetime. With the identified supply of rock around 90km away, transporting the 500,000-tonne volume was cost prohibitive, requiring an innovative solution.

GNS used a variety of existing geological maps and data, including QMAP, PETLAB, and GERM, to assess rock properties and information about existing quarries in the area.

On reviewing the local geology and undertaking on-site inspections, GNS found that the whole of the Eastern Bay of Plenty was in short supply of local armour quality rock. The setup and expansion of new and existing local quarries would significantly benefit the wider region, creating hundreds of jobs, boosting the local economy, and enhancing the overall quality of life for residents.

The economic and social benefits contributed to the Ōpōtiki Harbour Development Project winning the Overall Supreme Award for Economic Development New Zealand 2023 at the 2023 Economic Development New Zealand Awards.

"This project shows just what can be achieved with clever science and a fresh look at a region's rock resources. The overwhelming support from the council and local community was a real highlight of this project," said Matt Hill, GNS Science Geologist.

As well as winning the Overall Supreme Award, the project also secured first place in Best Practice for Inclusive Development and Wellbeing Outcomes and third place in Best Practice for Collaboration.

04

Ensuring our people are engaged, empowered and able to deliver their best. Developing successful, human-centred leaders. Planning for the future workforce we need to meet the challenges of tomorrow. Supporting equity, diversity, and inclusion. Keeping people healthy and safe.

GNS Science is powered by people, applying their expertise and collaborating to deliver our vision of a cleaner, safer, more prosperous New Zealand.

Powered by people

Our people at a glance

Total headcount

528

Female

236

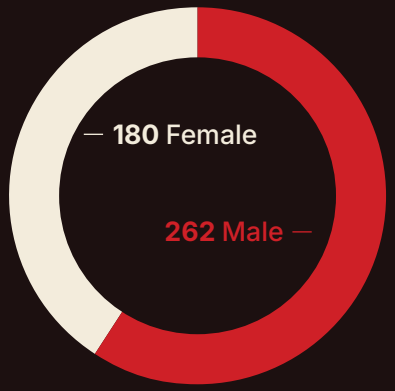
Male

290

*Two staff members preferred not to state a gender

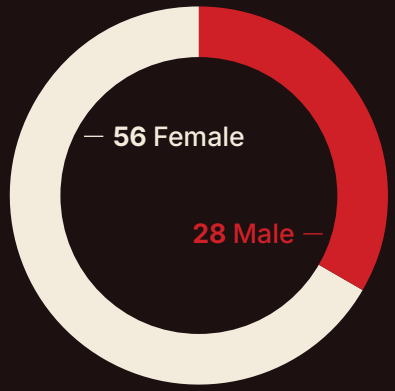
Fulltime employees*

444



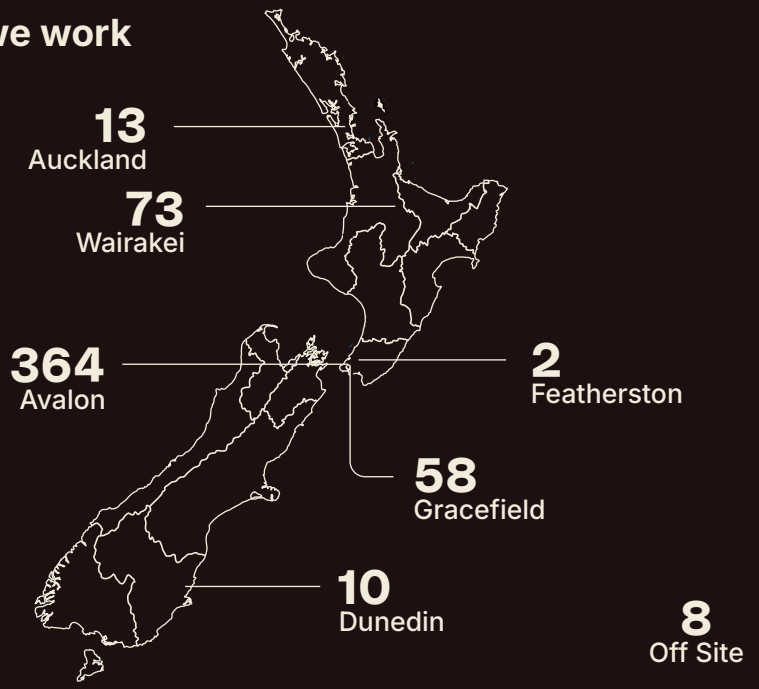
Part-time employees

84



*Two fulltime staff members preferred not to state a gender

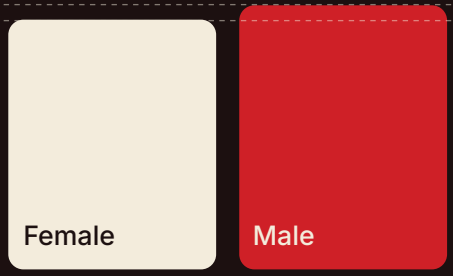
Where we work



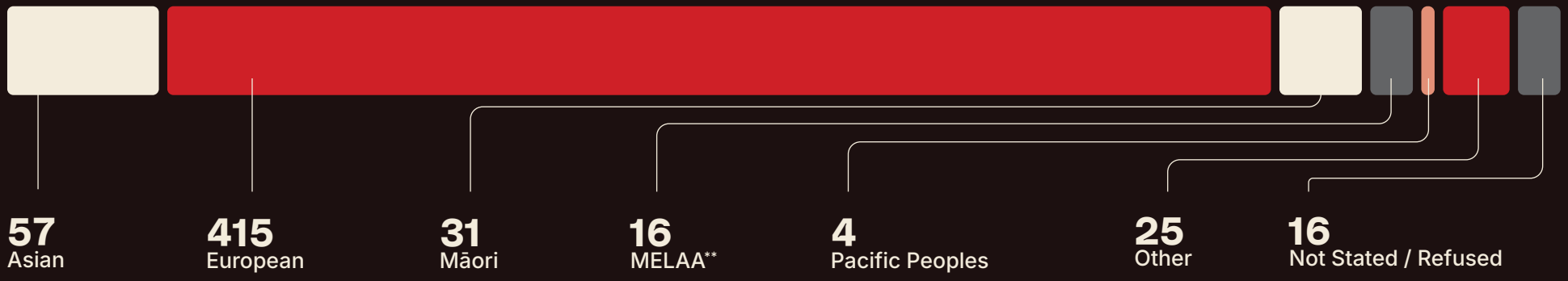
Age range

Pay gap

5.43%
between male and female pay



Ethnicity*



*Some employees select multiple ethnicities. **MELAA stands for Middle Eastern / Latin American / African.

Empowering our people

Luana Alves analyses gases in the geochemistry lab.

Our people are at the heart of GNS Science. Our people and culture practices and policies are consistent with the fair and proper treatment of our people in all aspects of their employment. We are committed to the good employer requirements of the Crown Entities Act 2004.

GNS continues to focus on developing our workforce to meet our strategic goals and deliver value to Aotearoa New Zealand. Our investment in people and our commitment to being a good employer is evidenced through our focus on leadership development, strategic workforce planning and capability, and equity, diversity and inclusion. These initiatives are aimed at nurturing talent and ensuring our people feel valued for their work.

Developing our leaders

We continue to invest in building the capability of our leaders to have a positive impact on the organisation's success.

This year we rolled out our Manager Essentials training, New Leaders Forum, and Kōrero Mai. These in-house programmes and forums focus on improving core people leadership skills and traverse a range of topics relevant to our people leaders. Our people accessed over 620 learning opportunities this year, including online learning, face-to-face internally facilitated learning and externally facilitated learning (not including technical or Health and Safety training).

Another key pillar of our leadership capability building is our quarterly Leaders Forum. The forums draw our people leaders together to grow a common leadership approach and language, with practical tools and takeaways. This year, leaders focused on self-awareness, including accountability, impact, ownership, and human-centred change leadership.

Other leadership development initiatives included supporting our Early Career Science Network and continuation of our mentoring initiative. We have also started work to create a leadership framework and competencies.

Workforce planning

Our annual organisation-wide workforce planning process considers capability and capacity requirements for all employees, including considering market and workforce dynamics. This year we reviewed our Career and Capability framework and identified critical roles within most of the organisation. A Tier Three capability review was also completed, setting critical role mitigation and development plans.

Equity, diversity, and inclusion

Our workforce Equity, Diversity, and Inclusion policy benefits all areas of our work, including the development, delivery, and enabling of science and the way we work with our client-base and communities. This is reflected in our ethos of Manaakitanga. It is through connecting with, being inspired by, and empowering each other that we realise our own potential, and this enables us to partner effectively with a wide range of people and communities. This policy is supported by and enacted through a variety of initiatives, reporting, resources, and training for our people, such as unconscious bias and neurodiversity awareness training, and working towards a rainbow inclusive workplace.

As with other CRIs, GNS has traditionally had much greater numbers of men in senior scientist and leadership roles than women. This has impacted both our gender pay gap and development opportunities for our people.

Our Career and Capability framework provides an overview of the available career paths and job families, so everyone has choice and flexibility building their career with us. This framework, and the associated performance, development, and promotion processes, have been developed with an equity, diversity, and inclusion lens. This has enabled us to identify those unintentional but systemic issues that create disadvantage within organisations. We have overhauled the way we assess promotion, and we have seen more women moving into senior scientist and leadership roles. Since November 2016, our average gender pay gap has moved from 21.6% down to 5.43% (6.8% excluding the Chief Executive) by 30 June 2024.

This year, our Kia Toipoto working group and our employee-led Equity, Diversity and Inclusion Committee recognised the opportunity to bring their work together. They have jointly developed a draft action plan for the 2024 / 25 year, and implementation is underway. The plan and progress report are published on our website.

Cathy Ginnane and Andy Phillips collect CO_2 from an Elemental Analyser, preparing gas for radiocarbon measurement.

Our support for Māori participation in science has progressed well with the continuation of the Ahunuku Māori Summer Scholarships programme, as well as our internship programme. We have great participation in our ongoing Te Reo (levels 1-3), Tikanga and Te Tiriti o Waitangi training programmes. An employee-led Waiata group has been established, and they have sung at formal and informal events, such as conference openings and inductions.

The whole organisation gets behind celebrations and events such as Matariki and Te Wiki o te Reo Māori, with interactive events and opportunities for our people to participate and learn. We have a Māori Engagement database and intranet toolkit, making information, maps, and advice available to our people to support engagement with Māori and iwi.

Engaging our people

The Executive Leadership Team holds quarterly Q&A sessions with all staff. They update staff on current topics of interest and importance, before spending time answering wide-ranging questions posed by our people. These are recorded and provided on the intranet for those who cannot attend. The sessions have been very well received, as has the CE's weekly update email, particularly with the more recent addition of a 'what's on your mind' button to ask questions or suggest topics for future communications.

Our employee engagement 'pulse' survey ran in November 2023. Participation in the engagement survey was high with an 80% completion rate. The overall engagement score was 77%, which is an increase from 68% in the April 2023 engagement survey. The increase in engagement levels this year was attributable to a new question asked in the survey – 'I am proud to work at GNS', which scored very highly.

Other GNS employee-led groups include our site health and safety committees and very active social clubs. As well as site Christmas events, the social club has organised an international dinner, mid-winter plunge, Olympics challenge, and Halloween for our people and their families.

Keeping people safe

Our staff conducted more than 480 field trips in the past year. This includes work in hazardous environments, such as on volcanoes and in geothermal areas, in alpine and bush areas, and in and around water. Sometimes it involves extensive off-road driving and working with helicopters. We also undertake a significant amount of laboratory work with all the risks and protocols that this involves. The broad scope of our mission also means that we occasionally have staff in Antarctica, on Raoul Island, and elsewhere around the world.

GNS has developed a new system to review and manage its key risks, which we term Critical Risk Activities (CRA). As a component of CRA management, we have procured a new system to monitor the safety of field teams, in real time, via the Iridium satellite system.

Keeping our people safe is a key priority. To support this, we continue to expand our Health and Safety capability and strengthen our collaborative culture that promotes Health and Safety as part of everyday work. We strive for a workplace that is free of psychosocial stressors such as fatigue and workplace bullying. We regularly review and discuss best practice risk management with other Crown Research Institutes and relevant agencies that face similar hazards to ours, as part of a continual improvement process.

GNS Science invests in role-specific Health and Safety training for all workers, and provides protective equipment, safety monitoring systems and occupational health monitoring, as appropriate to specific work types.

There is currently a particular emphasis on both wellbeing and the active management of identified critical risk. Staff participate in our Health and Safety management system, including consultation on policies and procedures, via active participation in Health and Safety committees. This inclusion has resulted in improved understanding and increased levels of Health and Safety leadership, ownership, and collaboration throughout the organisation.

Demand for Health and Safety support is increasing, confirming a growing integration of Health and Safety into our day-to-day work. We are confident we have made good progress in developing a more inclusive and responsible culture in support of our vision "Health and Safety is at our core, empowering everyone, every day, everywhere".

Celebrating excellence at GNS and Science New Zealand Awards

Every year we celebrate outstanding staff achievements at our GNS Science Excellence Awards. It's our chance to recognise the very best of our science impact, and recognise staff living our values of Manaakitanga, Connected, Inspired and Empowered.

Staff are nominated by their peers, and a panel of senior staff and executive leaders select the winners. This year, the awards were celebrated at a series of events across our sites, and staff gathered to watch a pre-recorded video event featuring our winners.

Winners in our Early Career, Team, and Lifetime Achievement categories were also our Science New Zealand Awards winners.

GNS' 2023 nominees for the Lifetime Achievement Award.

Excellence in Making a Difference: Empowered

Katie Jacobs

For her brilliant example of leadership – empowering everyone from voyage crews and field teams to people in our communities by sharing her time and expertise.

"Good leadership recognises people as a fundamental building block of science, so not just their knowledge and skills, but them as people." – Katie Jacobs

Excellence in Health and Safety

Rachel Bell

For her tireless efforts to support health and safety at GNS, often working well beyond the remit of her core role.

"Health and safety is such an important component of what we do here at GNS. Keeping people safe in the lab and out in the field is something I've really enjoyed being a part of." – Rachel Bell

Excellence in Early Career Achievement

Jess Hillman

For her exceptional leadership and widely sought-after expertise that belies her career stage.

"Jess' outstanding research record reads like that of a long and successful career scientist, yet she has achieved this unmatched success within just eight years of being awarded her PhD."– SNZ award nomination

Also a winner of Science New Zealand early career researcher award

Excellence in Making a Difference: Connected

Taupō Volcanic Unrest Team | Volcano Monitoring Group, Communications, Social Science

VMG: Nico Fournier, Geoff Kilgour, Brad Scott, Ery Hughes, Sigrún Hreinsdóttir, Paul Jarvis, Craig Miller, Steve Sherburn, Ian Hamling, Jackson Shanks, Michael Rosenberg, Cam Asher, Yannik Behr, Karen Britten, Bruce Christenson, Tony Hurst, Agnes Mazot, Oliver Lamb, Josh Hayes, Graham Leonard, Rebecca Fitzgerald.

Communications: Anna Cardno, Sara Horne, Eleanor Deacon, Lesley Wild, Jeff Brass, Jeff Lyall.

Social science: Mary Anne Clive, Lucy Kaiser, Sally Potter, Danielle Charlton, Rachel Lawson, Sara Harrison.

For excellent, deeply connected work with partners to ensure updates and public safety messages were heard by the people who needed them.

"Keeping locals informed during this uncertain time relied on strong relationships between GNS Science, the local community, and iwi." – Sara Horne

Excellence in Vision Mātauranga

Te Whakaheke o te Wai Team

Led by Cath Moore and Uwe Morgensten.

GNS Modellers: Brioch Hemmings, Wes Kitlasten, Paul Oluwumni, Mike Taves, Susana Gusman.

GNS Groundwater isotopes: Magali Moreau, Matt Cobol.

ESR Modellers: Theo Sarris, Alannah Kenny, David Scott.

Groundwater Mātauranga VUW: Amber Aranui and Ocean Mercier.

For their pioneering work with Ngāti Kahungunu to grow understanding of groundwater flow, quality and pressures that impact our land, people, and economy – including support provided in the aftermath of Cyclone Gabrielle.

"We learnt a shared language so that we could communicate across the disciplines of Mātauranga and science, find the connection between those areas, and use that knowledge to take the whole environmental decision-making process forward in a way that was new." – Cath Moore

Excellence in Team Achievement

New Zealand National Seismic Hazard Model Team

Matt Gerstenberger, Chris DiCaprio, Gill Jolly, Anna Kaiser, Russ Van Dissen, Elizabeth Abbott, Sanjay Bora, Ngaire Burley, Anna Cardno, Chris Chamberlain, Danielle Charlton, Annemarie Christophersen, Kate Clark, Genevieve Coffey, Susan Ellis, Kenny Graham, Ian Hamling, Matt Hill, Andrew Howell, V Jurgens, Rachel Kirkman, Robert Langridge, Nicola Litchfield, Elena Manea, Sepideh Rastin, Mark Rattenbury, David Rhoades, John Ristau, Chris Rollins, Hannu Seebeck, Kiran Thingbaijam, Pilar Villamor, Laura Wallace, Charles Williams.

For delivering a gold standard revised hazard model that will support a variety of stakeholders to build resilience and reduce seismic risk across Aotearoa.

"The resulting model has been described by international colleagues as 'world leading' and is thought to be setting the example for science." – SNZ award nomination

Also a winner of Science New Zealand team award

Excellence in Making a Difference: Inspired

Research and Contracts Partnerships Team

Carolyn Walker, Kate Sloane, Sally Armitage, Victoria Farmer, Leo Peters, Melissa Rotella, Anthony Young, Liz Kennedy.

For working incredibly hard to review and improve our approach to bidding, working with researchers across the organisation to lift our success rates in contestable funding rounds.

"We support our researchers to develop their research bids for government funding and that in itself is an adventure that requires a number of internal stakeholders in order to get our bids across the line." – Carolyn Walker

Excellence in Lifetime Achievement

Mark Chadwick

For his contributions to major advances in earthquake science, seismic analysis, and data management. A founding member of GeoNet, Mark's remarkable expertise in computer programming talents remain at the heart of this vital platform.

"He has earned enduring respect and gratitude from his colleagues, nationally and internationally, for his generosity in sharing his time and knowledge, and for his remarkable career. Mark's tireless work spans three decades, and continues to underpin the success of GeoNet, New Zealand's core platform for geohazard data." – SNZ award nomination

Also a winner of Science New Zealand individual / lifetime achievement award

Matariki: highlighting how we work better together

This year, GNS Science celebrated Matariki with the theme of mahi-tahi (better together) and a series of staff engagement events.

Our priority for the week was for staff to experience Matariki through Manaakitanga, allowing connection, reflection and celebration, and knowledge growth. As well as cultural activities, staff received Māori engagement guidance and updates and information about our Māori strategic plan and our MAHIA framework.

The objectives for Matariki week aligned with Te Punawai o Rangiātea (our Māori strategic plan) kaupapa outcomes. Te Punawai o Rangiātea means "the flourishing pool of knowledge". It provides direction for GNS to create enduring and sustainable relationships with tangata whenua – iwi, hapū, whānau, and Māori. The plan details our shared moemoea (vision), whainga (mission), tikanga (values), kawa (actions), and kaupapa (outcomes).

Our MAHIA values framework is a way of expressing our organisation's values. It guides our staff about how we focus our work.

MAHIA stands for:

- **Manaaki** – We enhance the mana of others.
- **Ara** – We act with purpose and intention.
- **Hinengaro** – We value knowledge.
- **Ihi** – We are courageous and innovative.
- **Āhua** – Our achievements reflect our partnerships.

GNS strives to be a trusted research partner for Māori. We're endeavouring to support shared aspirations and to align our current and future research efforts with national priorities. Matariki was a great opportunity to further this goal through staff engagement.

Our Matariki Awards ceremony recognised leadership when working with Iwi-Māori research partners and celebrated individuals and teams who have particularly shown our values in their work.

Congratulations to our winners:

- **Ngāhina Marae Renewable Energy project** – Michelle Cook and John Kennedy
  Iwi-Māori partners: Ngāhina Marae – Eastern Bay of Plenty
- **Northland Outreach team** – Joe Prebble, Kyle Bland, Malcolm Arnot and Jess Hillman
  Te Rarawa and Te Hiku Iwi – Northland
- **'Why is pounamu tough?' team** – Simon Cox and Nick Mortimer
  Ngāi Tahu – South Island
- **East Coast Hazard Response team** – Chris Massey, Brenda Rosser, and Andrea Wolter
  Ngāti Porou – Gisborne

Phaedra Upton announces an award during Matariki celebrations.

Discover more

- Partner with us: Māori Partnerships and Relationships | GNS website
- Our science: Vision Mātauranga | GNS website
- GNS Science Statement of Corporate Intent | GNS website

Committed and closer to an emissions-free future

Toitū Envirocare's carbonreduce programme encourages organisations in Aotearoa New Zealand to manage and reduce their carbon emissions. In 2023, GNS achieved our fifth certification from the programme.

The carbonreduce programme requires organisations to set reduction goals and measure their emissions against these goals each year. Those meeting the programme's requirements are rewarded with certification.

"It's important for GNS Science to continue showing leadership in helping New Zealand reduce carbon emissions. We've seen the impact a changing climate is having on our country, and while we may be small on the world's stage, we all need to play our part."

GNS Science's total emissions in 2022 / 23 were 22% lower than our 2021 / 22 total and 45% lower than our 2018 / 19 baseline total.

Angela Griffin, GNS Carbonreduce Project Leader, explains what that means. "This shows that GNS is acting in an environmentally ethical and responsible manner and supporting an environmentally conscious culture while continuing its science."

"It's important for GNS Science to continue showing leadership in helping New Zealand reduce carbon emissions. We've seen the impact a changing climate is having on our country, and while we may be small on the world's stage, we all need to play our part."

GNS is committed to reducing our overall carbon emissions by 20% by 2025 and we aim to be carbon neutral by 2050. We have set internal sub-targets to help us achieve these goals, including reducing air travel by 15%, vehicle fuel consumption by 35%, and electricity and natural gas by 10% each.

One of GNS' electric fleet vehicles parked in front of Mount Ruapehu.

Our strategies to meet these sub-targets:

- encouraging online meeting attendance
- adopting the "why fly" guidelines
- implementing rideshare and EV parking preferences
- installing more EV charging stations
- supporting the electrification of our vehicle fleet
- commissioning an energy audit for the sites we own.

Sheena Thomas, Interim GM Research Strategy and Partnerships, said that given GNS Science's first-hand understanding of the impact of emissions locally and globally, and particularly on our Pacific neighbours, we need to be role models.

"Our scientists have been involved in climate science research for decades, as well as playing a major role in enabling New Zealand's transition to a low-carbon future," Sheena said. "As leaders in climate research and renewable energy, we need to 'walk the talk' on emissions reduction."

Our Executive Team

Chelydra Percy
Chief Executive

Chelydra joined GNS Science in May 2023, after nine years as Group Chief Executive of BRANZ (Building Research Association of New Zealand). Chelydra's career has seen her work with a range of technology, education, and research organisations over the last 25 years, nationally and internationally.

She has significant experience in the CRI sector, having held senior roles at Industrial Research Ltd, Callaghan Innovation, and Scion. She has a Bachelor of Arts and Bachelor of Laws from Victoria University of Wellington.

Peter Benfell
General Manager Science

Peter re-joined GNS Science in October 2018 as General Manager Science. He is responsible for the leadership and management of our research teams, as well as the quality and performance of our research projects and geohazard monitoring activities. Peter has had more than 30 years' experience in research, science and technology and its successful application, as well as in establishing several major Research and Development partnerships. He previously worked at GNS Science as Group Manager, Environment and Natural Resources Group between 1998 and 2001.

Prior to re-joining GNS Science, Peter was Chief Executive at the Infrastructure Industry Training Organisation, Connexis.

Peter has held senior management roles at the Foundation for Research, Science and Technology, AgResearch, and Opus International.

Peter holds a BE (Hons) from the University of Auckland, and a DipBusAdmin from Victoria University of Wellington.

Trish Casey
General Manager People and Culture

Trish came to GNS from Nelson Marlborough District Health Board where she held the role of General Manager People and Capability. She has over 20 years' experience in executive leadership across industries in the private, public, and not-for-profit sectors in both New Zealand and Australia.

She has a Master of Management from the Macquarie Graduate School of Management.

At GNS, Trish is responsible for the people-centric functions of HR and Health and Safety along with key organisation enablers Communications, Administration and Stakeholder Relations.

Tania Gerrard
General Manager Māori and Stakeholder Relations
Te Whānau-a-Tāpuhi, Ngāti Porou

Tania joined GNS Science in November 2018. She is responsible for the development and management of our external relationships and partnerships, including with government, iwi / Māori and industry. Tania's role recognises the interconnectedness of the science system, and her team is keenly focused on the benefits our research must deliver to both end users and New Zealand communities.

Prior to joining GNS Science, Tania was Acting Director of Water at the Ministry for the Environment. Here she also held roles specialising in iwi rights and interests, and water rights and interests. She has also held senior roles at the Waitangi Tribunal, the Office of Treaty Settlements, and Ministry for Primary Industries / Fisheries.

Tania is currently the Chair of Te Ara Pūtaiao, the pan-Crown Research Institute Māori Leadership Group, and she is an Associate of the New Zealand Institute of Directors.

Tania holds a BA from the University of Otago.

Richard Levy
Interim Chief Science Advisor

Richard joined GNS in 2008 upon his return to Aotearoa following 15 years in the United States where he was engaged in Antarctic research. Richard is a glacial stratigrapher and paleoclimatologist, whose work to understand climate change is widely respected in New Zealand and around the world. As well as providing strategic science advice and guidance at GNS, Richard is also a Professor of Geoscience at Victoria University of Wellington. His passion for discovery is evidenced through his leadership of major climate research projects in Antarctica and New Zealand, including the New Zealand SeaRise, Our Changing Coast, and Antarctic Ice Dynamics programmes, which aim to predict the magnitude and impacts of sea-level rise on New Zealand communities.

Richard is committed to actively engaging people in science and has worked extensively with Māori, iwi, hapū, and whānau on a range of climate-related programmes. His background and interest in education has helped develop projects that support New Zealanders to explore science relevant to their communities.

Richard is a member of the Melting Ice and Rising Seas team, which was awarded the Prime Minister's Science Prize in 2020 in recognition of their "transformative scientific discovery or achievement, which has had a significant economic, health, social, and / or environmental impact on New Zealand."

BSc, MSc (Geology), Victoria University of Wellington; PhD (Geoscience), University of Nebraska-Lincoln; Master's in Science Teaching (Curriculum and Instruction), University of Nebraska-Lincoln.

Kaetrin Stephenson
General Manager Business Services and CFO

Kaetrin came to GNS Science from BRANZ where she held the role of General Manager Corporate Services / CFO. She has over 20 years of executive leadership experience across a broad range of listed (NZX and FTSE), private, not-for-profit and public benefit organisations in New Zealand and the UK.

She is a qualified Chartered Accountant (FCA) and Associate Member of the Institute of Directors. She has a Bachelor of Science from Edinburgh University.

Sheena Thomas
Interim General Manager Research, Strategy and Partnerships

Sheena is Interim General Manager Research, Strategy and Partnerships at GNS Science, where she leads the organisation's research direction and strategy, innovation, business development and the generation of new revenue streams.

She was previously the Commercial and Business Partnerships Manager, leading the teams responsible for commercialisation of research IP, as well as business partnerships both locally and internationally.

Prior to joining GNS in 2022, Sheena was Strategy Manager at Z Energy, where she led the strategy development and delivery of low-carbon fuel options, including hydrogen, biofuels and synthetic fuels.

Sheena holds a BA (Hons) from Victoria University of Wellington.

Our Board of Directors

David Smol (Chair)
BA, M.Phil.

David has over 40 years' experience in New Zealand and the United Kingdom in the public and private sectors. He has worked in the energy sector in both countries, encompassing public and regulatory policy, commercial and consulting roles.

David has a deep understanding of the science ecosystem in New Zealand and has served as Chair of the GeoNet Advisory Panel.

In 2008 David was appointed Chief Executive of the Ministry of Economic Development. From 2012 to 2017 he was the inaugural Chief Executive of the Ministry of Business, Innovation and Employment, where he was responsible for the stewardship of multiple regulatory systems.

David is a Director of Contact Energy, NZTA, the Cooperative Bank and Wellington UniVentures. He is a member of the Council of Victoria University of Wellington. He was made a Companion of the Queen's Service Order in 2018.

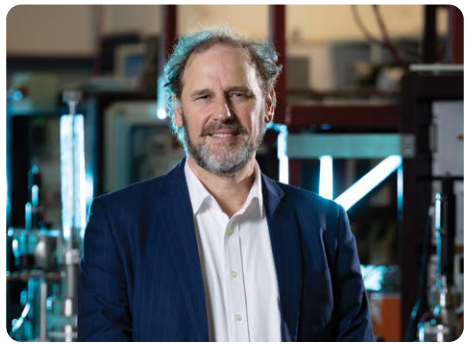
Felicity Evans (Deputy Chair)
CMInstD, GAICD

Felicity has more than 25 years' experience in the Banking industry.

She was formerly the General Manager Talent and Culture for ANZ New Zealand and Pacific.

She is a graduate of the Australian Institute of Company Directors, a Chartered member of NZ Institute of Directors, an Associate of the Bankers' Institute of New Zealand, Chair of ANZ National Staff Superannuation Limited,

Member of the Defence Employee Support Council, a former Trustee of Diversity Works, and a former Director of Global Women NZ.



Andrew Cordner
LL.B (Hons); LL.M; B.Com

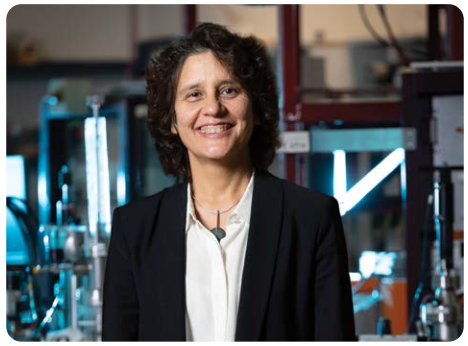
Andrew is currently the Chief Legal Counsel at Health New Zealand | Te Whatu Ora. In this role, Andrew serves as Health NZ's General Counsel and leads the highly experienced Health NZ Legal Team, which provides legal advice and support to the Health NZ Commissioner, executive leadership team and operations. Andrew joined Health NZ in late August 2023.

Andrew was previously the General Counsel at Fonterra Co-operative Group and Company Secretary to the NZX-listed Fonterra Shareholders' Fund (NZX:FSF). Prior to joining Fonterra, Andrew was a partner at Foley Hoag LLP, a leading US corporate law firm (with offices in Boston, New York, Washington DC, Denver, and Paris) specialising in corporate and commercial advisory work, venture capital, bankruptcy, intellectual property, mergers and acquisitions, securities law, and international transactions.

Livia Esterhazy
Founder and CEO The Thrive Collective, Programme Director A Lighter Touch

Livia has been a strategic business leader for much of her career across various sectors. She spent many years working in Marketing, Communications, and Advertising, including in agencies such as Clemenger BBDO, The Assignment Group, Saatchi & Saatchi, and Ogilvy.

She has led brands including Kiwibank and Commonwealth Bank of Australia. Livia has experience working in and around science, including five and a half years as CEO of WWF New Zealand. She is also a director of the National Institute of Water and Atmospheric Research and the Programme Director of A Lighter Touch, a programme working directly with New Zealand food growers to enable sustainable practices. Livia is also the founder of The Thrive Collective, a nutritional, science driven health and wellness coaching business.



Wendy Venter
FCA, MInstD

Wendy is an independent consultant and director with expertise in governance, finance, risk management, organisational change and assurance. She is a former partner at EY, deputy chief executive at the Ministry of Social Development and assistant auditor-general.

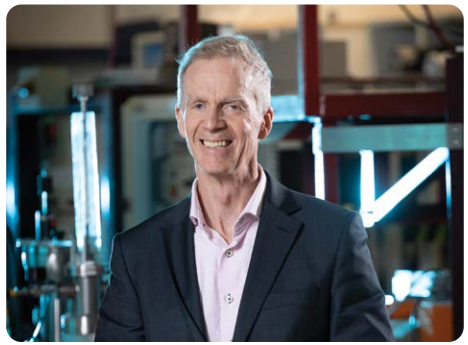
Wendy serves on several boards and chairs a number of audit and risk committees. She is a Fellow of Chartered Accountants Australia and New Zealand and a member of the Institute of Directors and the Institute of Internal Auditors.

Paul White
B Arch, MBS

Paul is from the Ngāi Tūpoto hapū of Te Rarawa iwi and has had a 30-year background in Māori development and governance, and wide experience in the public service. He is currently a management and development consultant and professional director and lives in Rawene in the Far North.

Over the past 20 years, Paul has served on the boards of Housing New Zealand, Canterbury District Health Board, FITEC, Health Sponsorship Council, Top Energy and the asset holding group of Te Rarawa iwi. He is currently on the Executive of Te Matapihi – a national Māori housing body, a trustee on the Top Energy Consumer Trust, and the chairman of the Ngāi Tūpoto hapū development trust.

Previously Paul was the Chief Executive of Ngāi Tahu Development Corporation, Regional Director for Te Puni Kōkiri in Te Tai Tokerau, and Regional Manager for the Housing Corporation in Northland.



Brian Young
PhD, CMInstD, MRSNZ

Brian Young is a neuroscientist, with extensive experience in science leadership and diplomacy. He began his career with a BSc (Hons) degree in psychology at the University of Canterbury, followed by PhD study in behavioural neuroscience at Dartmouth College (USA).

He held subsequent research positions in the USA at UNC-Chapel Hill and SUNY-Stony Brook, and at the University of Otago and HortResearch in New Zealand.

Brian held a diplomatic posting as the inaugural Science and Technology Counsellor in the New Zealand Embassy (Washington DC). Subsequently, he was Director-Research at the University of Otago, and the Director of the Defence Technology Agency. He is currently the Chief Executive of International Accreditation New Zealand (IANZ).

Strategic Scientific and User Advisory Panel

Dr Chris Pigram (Panel Chair)
AM FTSE

Dr Pigram is a geologist with over 50 years' experience. He was the Chief Executive Officer of Geoscience Australia from 2010-2017. Dr Pigram was made a Member of the Order of Australia in 2019. In 2016 he was elected a Fellow of the Academy of Technological Sciences and Engineering (ATSE).

Dr Pigram was a member of the 2018 Australian Government Resources Taskforce that delivered a report containing 29 recommendations designed to ensure the future of the resources sector in Australia. Dr Pigram chairs several committees including the Independent Expert Scientific Committee that advises government on water issues related to large coal mines and unconventional gas developments, the MinEX CRC. He is Chair of AuScope Limited, a company that manages research infrastructure funds for the geoscience research community on behalf the Australian Government and Chair of the Australian Urban Research Infrastructure Network (AURIN).

Professor Rob Dunbar

Rob is the WM Keck Professor of Earth Sciences and a Senior Fellow of the Woods Institute for the Environment at Stanford University. He leads a research group that works on past, present, and future climate change and its impact on oceans and coastal environments.

He works with governments, the United Nations and several NGOs to help develop and implement solutions to environmental and resource problems. In 2016, he was awarded the medal of Antarctic Research by the Scientific Committee for Antarctic Research (SCAR).

He currently serves on the US National Academies Board on Atmospheric Science and as a Trustee for the Consortium for Ocean Leadership.

Dr Andrew Heap

Dr Andrew Heap is the Chief of the Minerals, Energy and Groundwater Division at Geoscience Australia, where he plays a pivotal role in shaping the nation's geoscience agenda.

With more than two decades' experience in leading geoscience initiatives in the public sector, he collaborates with industry, academia and government ensuring the benefits of precompetitive geoscience are maximised for Australia.

In his current role, Andrew oversees priority research programmes to develop a national prospectus of Australia's mineral, energy and groundwater resources that will maximise Australia's resource wealth now and into the future.

Under his leadership, these programmes will stimulate exploration investment, underpin new resource discoveries, advance clean energy technologies to support the transition to net zero, and enable the sustainable management of Australia's water resources.

Andrew provides expert advice to government and industry stakeholders both in Australia and internationally through various boards and committees. He has published over 100 scientific papers and technical reports.

Dr James Hutchinson

James is passionate about the important role that science and the scientific community have to play in growing our economy into new high-tech and knowledge-based sectors, informing public policy and in changing our world for the better.

James is Chief Executive Officer of Kiwi Innovation Network (KiwiNet), a national organisation that funds and supports commercialisation of publicly-funded research for the benefit of Aotearoa New Zealand.

James has international experience in supporting research and innovation, with a particular focus on life sciences, global societal challenges and entrepreneurship.

Dr Lucy Jones

Dr Lucy Jones is the founder of the Dr. Lucy Jones Center for Science and Society, with a mission to foster the understanding and application of scientific information in the creation of more resilient communities. Lucy is also a Research Associate at the Seismological Laboratory of Caltech.

With a BA in Chinese Language and Literature from Brown University and a PhD in Seismology from MIT, Lucy furthers resilience to natural hazards through scientific research and collaborations with policy makers, including 33 years with the US Geological Survey, where she created the first Great ShakeOut drill, now a worldwide event with over 60 million participants in 2018.

She created methodologies for assessing earthquake probability that have been the basis for all earthquake advisories issued by the State of California.

Lucy has extensive governance experience. Her pioneering science has been recognised with numerous awards, including the 2015 Samuel J. Heyman service to America Medal and the 2018 frank press medal from the Seismological Society of America.

Professor Te Kani Kingi

Te Kani is Executive Director of Research and Innovation at Te Whare Wānanga o Awanuiārangi.

Te Kani has previously been a member of the AKO Aotearoa Assessment committee, the Board of the Joint Centre for Disaster Research, a Research Associate of the National Institute for Economic and Demographic Research, and currently Chair of Tane Ora.

He was recently appointed to the Veterans' Health Committee, the Prime Minister's Science Awards Panel, the Royal Society of New Zealand's Council, the Independent Science Panel (Sustainable Seas National Science Challenge) and to the Australian Physiotherapy Council Accreditation Board.

Te Kani was born and raised in Poroporo (near Whakatāne) and educated at St Stephen's School (South Auckland). He has tribal affiliations to Ngāti Pukeko, Ngāti Awa, and Ngāi Tai.

Prof Claire Lenehan

Claire is a materials scientist with expertise in, amongst other things, natural materials and fluids, surface and structure modification, isotope and nuclear methods, with applications to Earth system, biological and natural and artificial materials. Claire was a Director of the Australian Institute of Nuclear Science and Engineering (AINSE) between 2014 and 2019 and Chair from 2016-2019.

AINSE is the interface between the Australian and New Zealand research entities and the Australian Nuclear Science and Technology Organisation (ANSTO). She was awarded the Robert Cattrall Medal for early career success by the Analytical Chemistry Division of the Royal Australian Chemical Institute. Claire has also served as interim dean of the School of Physical and Chemical Sciences at Flinders University.

Namouta Poutasi
MNZPI BSc (Hons), BA

Namouta is the Strategy & Science General Manager for Bay of Plenty Regional Council – Toi Moana, specialising in strategy and resource management policy development. She has over 20 years' experience in leadership, strategy and policy, natural hazard risk management, science, urban growth planning, transport (including Public Transport) and regional economic development.

Namouta has worked for a range of organisations including – local councils, central government agencies, the University of Auckland, several iwi and in the Pacific.

Namouta is passionate about creating thriving and resilient communities. She is part of teams receiving awards for supporting iwi in strategy development, natural hazard policy development and climate change adaptation work in Samoa.

She is a founding member of NZPI Papa Pounamu (Māori Special Interest Group) and Taeao Moana Pasefika Aotearoa Pasefika Environmental Practitioners. Further, Namouta is an alumni of the Senior Executives in State and Local Government at Harvard University.

Sarah Stuart-Black
QSO

Sarah Stuart-Black joined New Zealand Red Cross as the Secretary General in December 2020 and was made a Companion of the Queen's Service Order for services to emergency management in 2021.

Prior to her current role, Sarah was the Deputy Chief Executive and held the statutory role of Director Civil Defence Emergency Management in the National Emergency Management Agency, which was established in December 2019. She joined the Ministry of Civil Defence & Emergency Management in 2003 and held a number of different roles during her time with the Ministry.

Sarah has had a diverse range of experience within New Zealand and England, as well as Ethiopia, Niue and the Solomon Islands. She was a member of the United Nations Disaster Assessment & Coordination Team for nine years and has represented New Zealand at a variety of international forums, bilateral, regional and global meetings, exercises and forums. Sarah has published a number of papers in international journals and has co-edited three books.

Associate Professor Ting Wang

Ting is an Associate Professor in the Department of Mathematics and Statistics at the University of Otago. Her research field is multidisciplinary, centring on the interface of statistics and geosciences. Her main focus has been on the development of statistical models for geophysical hazards such as earthquakes and volcanic eruptions.

Ting has led, managed and participated in national and international collaborative multidisciplinary research projects, including projects funded by Marsden, MBIE, EQC, the Natural Hazards Research Platform, and Resilience to Nature's Challenges.

She received the Worsley Early Career Research Award from the New Zealand Statistical Association in 2013, a University of Otago Early Career Award for Distinction in Research in 2017, and the Littlejohn Research Award from the New Zealand Statistical Association in 2022.

Our financial year at a glance

Recorded profit (after tax)

$4.0m

GNS Science recorded a profit after tax of $4.0m compared to a budgeted profit of $3.0m for the year ended 30 June 2024.

Operating expenditure

$117.3m

Operating expenditure for the year was $117.3m, $3.5m (3.1%) more than the prior year and $4.0m below budget. This reflects the continued investment in our people and the challenging inflationary environment, alongside deliberate and disciplined cost management.

Total revenue

$129.6m

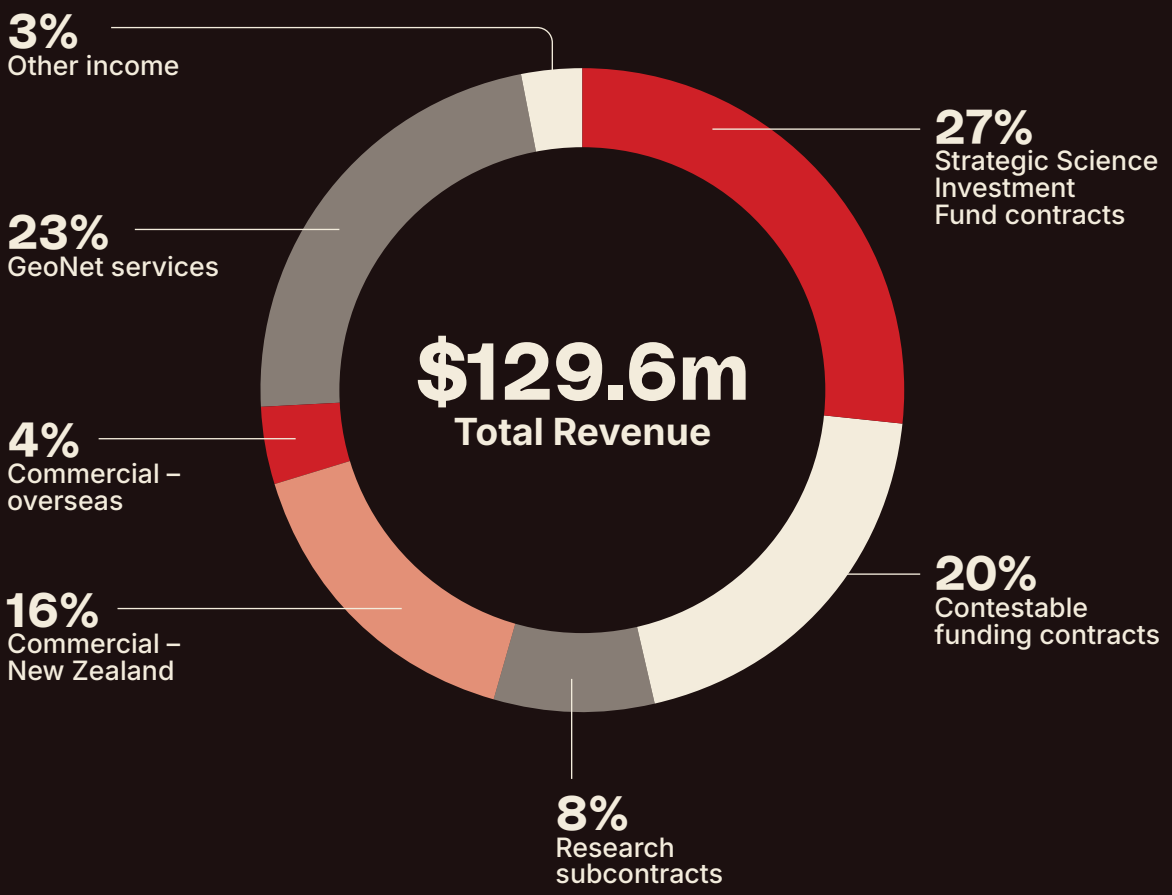
Revenue at $129.6m grew by $10.9m (9.2%), however it was $2.0m below budget due to delayed project expenses and sub-contract costs and less anticipated time recorded against projects slowing deliverables down.

Capital expenditure

$9.7m

GNS Science continued to invest in the replacement and renewal of our assets, including our facilities and equipment, with $9.7m capital expenditure in the past 12 months.

Revenue by category



How we spent our money

Directory

Principal location and registered office

1 Fairway Drive, Lower Hutt 5010,
PO Box 30368, Lower Hutt 5040,
New Zealand
Tel: +64 4 570 1444
Email: avalon@gns.cri.nz

Other locations

National Isotope Centre
30 Gracefield Road, Lower Hutt 5010,
PO Box 31312, Lower Hutt 5040,
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Tel: +64 4 570 1444
Email: gracefield@gns.cri.nz

Wairakei Research Centre
114 Karetoto Road, RD4, Taupō 3384,
Private Bag 2000, Taupō 3352,
New Zealand
Tel: +64 7 374 8211
Email: wairakei@gns.cri.nz

Dunedin Research Centre
764 Cumberland Street,
Private Bag 1930,
Dunedin 9054,
New Zealand
Tel: +64 3 477 4050
Email: dunedin@gns.cri.nz

Auckland
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Tel: +64 4 570 1444
Email: auckland@gns.cri.nz

Directors

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Chair

Felicity Evans
Deputy Chair

Andrew Cordner

Livia Esterhazy

Wendy Venter

Paul White

Brian Young

Executive Leadership Team

Chelydra Percy
Chief Executive

Peter Benfell
General Manager, Science

Trish Casey
General Manager, People and Culture

Tania Gerrard
General Manager, Māori and
Stakeholder Relations

Richard Levy
Interim Chief Science Advisor

Kaetrin Stephenson
General Manager,
Business Services and CFO

Sheena Thomas
Interim General Manager,
Strategy and Partnerships

Bankers

ANZ

Auditor

Silvio Bruinsma
Deloitte Limited
On behalf of the Auditor-General

Solicitors

Chapman Tripp

Websites

www.gns.cri.nz
www.geonet.org.nz

Photo acknowledgments

Cover
Marie Halliwell, GNS

P2
Jeff Brass, GNS

P4
Jeff Brass, GNS

P5
Jeff Brass, GNS

P6
Alex Wallace Photography

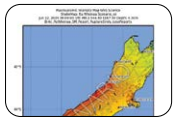
P7
Alex Wallace Photography

P8
Jeff Brass, GNS

P8
Jeff Brass, GNS

P9
Rachel White, GNS

P10
GNS



P10
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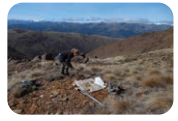
P11
Jeff Brass, GNS

P12
Otago Regional Council

P13
Janine Bidmead, GNS

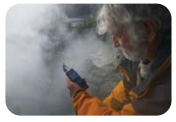
P14
Rose Turnbull, GNS

P14
Adam Martin, GNS



P14
Mark Rattenbury, GNS

P15
Otago Regional Council



P16
Jeff Brass, GNS

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Jeff Brass, GNS

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Jenny Stein, GNS

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Jenny Stein, GNS

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Nicolas Speziali, GNS

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Brook Keats, GNS

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Brook Keats, GNS

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Delia Tamsen

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Julian Thompson, GNS

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Alex Wallace Photography

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HEB Construction

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New Zealand Trade and Enterprise

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New Zealand Trade and Enterprise

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Annual Report **2024**