

GNS Science

TE PŪ AO



Our Statement of Corporate Intent

JULY 2023 – JUNE 2028

**OUR PEOPLE
OUR SCIENCE
OUR OUTCOMES**

Ō tātou tāngata
Tō tātou pūtaiao
Ō tātou putanga

**Mai i te rangi, ki te nuku o te
whenua, ka puta te ira tangata i te
po, i te whaiao, i te ao marama.**

Nau mai, haere mai ki Te Pū Ao

From the sky and the land came people,
from the night, to the old world, to the world of light.

Welcome to GNS Science

Above: Tectonic deformation
survey using GNSS methods:
Mt Pender, Fiordland National Park

Cover: GNS Science technician working on a GeoNet sensor site

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Introduction from the Chair and CEO

We are pleased to introduce the GNS Science Statement of Corporate Intent for 2023-2028. This Statement of Corporate Intent reaffirms GNS Science's strategic direction and our commitment to achieving a cleaner, safer, more prosperous Aotearoa New Zealand. It describes our strategy for the future and our key initiatives and performance measures for the 2023/24 year.

GNS Science continues to deliver globally influential science. This Statement of Corporate Intent advances and refines our organisational and science strategy. It reaffirms our ongoing commitment to delivering quality science for the nation's benefit through collaboration, investing in our people and assets, and sustaining our financial performance.

Our Strategic Direction

GNS Science is committed to maintaining and developing the critical scientific capability, services and support the Government needs to ensure evidence-based decision-making, and to making a contribution to the nation's economy. A particular focus is to support key Government priorities and initiatives associated with the research, science and innovation system, including Te Ara Paerangi – Future Pathways programme. Te Ara Paerangi is providing an opportunity for Aotearoa New Zealand's science system, GNS Science and our partners and stakeholders to reimagine the system. We are excited to engage with Te Ara Paerangi – Future Pathways and to play our part in delivering a modern, future-focused research system for Aotearoa New Zealand.

In recent years, there have been significant challenges for organisations and communities across Aotearoa

New Zealand and the world. The COVID-19 pandemic, the intensifying effects of climate change and ongoing natural hazards are all causing disruptions and changing the lives of all New Zealanders. This has reinforced the importance of evidence-informed policy and decision-making, along with the role of science in generating new knowledge to help mitigate these threats and safeguard our lives, livelihoods and the future of our planet.

GNS Science is actively responding to these drivers in our operating environment, and our strategy and operations are adapting at pace. This is particularly evident in areas such as climate change, natural hazards and Te Tiriti. Our priorities for the next five years reflect the direction provided by our Science Roadmap to 2032 and Te Punawai o Rangiatea – our Māori Strategic Plan. We will focus on our core strengths, while investing in expertise and ways of working to navigate the changing nature of science, technology and society. By making clear strategic choices about the research we do, GNS Science is able to deliver more tangible benefits to address Aotearoa New Zealand's changing needs.

In the 2022/23 year we began development of a new strategy to refresh our approach to engagement, and we see significant opportunities to reconnect and re-engage with stakeholders as we emerge from the pandemic to create even greater impact. Alongside this, we have started development of an international strategy – our ambition is to grow our international partnerships to leverage and develop expertise, attract resources, and address global challenges. GNS Science, and our scientists, are part of a global community and the work we do contributes to science globally.

We already work internationally, and the strategy will help focus our efforts for maximum impact. Our geothermal coalition with Geo40 and the establishing of a physical presence in Tokyo in the last year is a demonstration of our commitment to delivering on Aotearoa New Zealand's global ambitions.

Alongside the implementation of the Science Roadmap, we will continue to invest in people and infrastructure to maintain capability and capacity in key areas. Ensuring we have modern facilities to enable the delivery of great science, minimise health and safety risks to our staff, and bring people together to enable connection, collaboration, and innovation will continue to be a priority. Progressing the GNS Science Property Strategy is an area of focus, and we will continue to constructively engage with the Ministry of Business, Innovation and Employment, other Wellington-based research organisations and end-users on the 'Wellington Science City' initiative. This collaboration seeks to optimise the design and use of the region's existing and proposed science infrastructure and facilities, and human capital. The redevelopment of our Wairakei site remains a priority, including the design of a new Volcanology and Visitor Centre and consideration of a proposal for a Geothermal Innovation Centre.

Challenges

Like all organisations, GNS Science requires the financial capacity to meet our business needs. We are aiming to achieve new levels of success and growth in the coming years, and to achieve this success, resources will need to be dedicated to meeting our goals and plans. This will require improved financial performance by ensuring there is an appropriate level of margin from our research and

He Kupu Whakataki Mai I Te Tiamana Me Te Tumuaki

commercial work, and that our costs for supporting our operations are optimised. In the short term, inflationary pressures are adding to this challenge. GNS Science is working towards achieving long-term financial resilience and sustainability. This will require focused financial leadership from the Board and Management, including improved financial planning, monitoring, reporting and advice.

Following the December 2019 eruption on Whakaari White Island, WorkSafe laid two charges against GNS Science under the Health and Safety at Work Act 2015. The primary charge was dismissed in October 2022.

On 30 May 2023, GNS Science pled guilty to a reduced charge, acknowledging that we failed to sufficiently consult, co-operate and co-ordinate with the helicopter operators which took GNS Science staff to and from, and landed on, Whakaari between 4 April 2016 to 4 December 2019 – the date of the last such trip. This charge is unrelated to the tragic events which occurred on 9 December 2019. A sentencing date in respect of the charge against GNS Science is still to be set by the Court.

Our staff have not landed on Whakaari since the 2019 eruption and specialised real-time monitoring stations on the Island are no longer operational. GNS Science will continue to work with stakeholders and government officials on possible approaches to monitoring the volcanic activity on the Island.

GNS Science has unique capability and an excellent track record in preparing for and responding to extreme weather and natural hazard events. This includes significant expertise, resources and networks, as well as a



long-term commitment to preparing for and assisting with response and recovery efforts. This capability was demonstrated in recent responses to Cyclone Gabrielle and other recent weather events where GNS Science, in collaboration with other agencies, played a crucial role in New Zealand's response. In the coming year, we will continue to work in close collaboration with stakeholders on hazards monitoring and advisory services, and to secure long-term sustainable funding for monitoring infrastructure, datasets and data models. We are pleased that funding has been confirmed for the 2023/24 year for this vital national infrastructure.

GNS Science will continue to operate effectively and efficiently by taking opportunities to collaborate, coordinate, share resources and align strategic agendas with our customers, partners and collaborators across Aotearoa New Zealand's research system.

In this way, we will contribute to the Government's goals of building a resilient and robust economy, improving the wellbeing of all New Zealanders, and protecting and enhancing our country's assets.

GNS Science is committed to delivering the strategies and initiatives set out in this Statement of Corporate Intent in order to deliver on our aspiration for a cleaner, safer, more prosperous Aotearoa New Zealand for current and future generations.



David Smol
Chair



Chelydra Percy
Chief Executive

Our Changing Environment

GNS Science has a strong track record of working collaboratively with industry, Government and other participants in the science system. We are also actively working to develop stronger and more strategic links with Māori through Te Punawai o Rangiatea – our Māori Strategic Plan. While we are pleased with the progress that has been made, we believe there are significant opportunities to create even greater impact.

GNS Science has created engagement pathways for those working across our organisation to respond to the Government's Te Ara Paerangi – Future Pathways programme. This multi-year programme, being run by the Ministry of Business, Innovation and Employment, is focused on the future of Aotearoa New Zealand's Research, Science and Innovation (RSI) system. To date, it has included a wide-ranging conversation about the issues facing the system, and how these might be addressed, and how to take advantage of emerging opportunities within the sector. It has provided the opportunity for GNS Science to work with the Ministry, other Crown Research Institutes (CRIs) and others in the Research, Science and Innovation sector towards a robust innovation system for Aotearoa New Zealand.

The key policy directions for the reform are set out over four objectives:

- Creating new futures through new National Research Priorities and incentivising connections with the private sector to create impact.
- Valuing our people so we can attract, develop and retain an excellent and diverse workforce.
- Building system agility so that funding, institutional and governance structures support an adaptable, resilient and future focused system.
- Embedding Te Tiriti across the design of the RSI system to address the current system's poor responsiveness to Māori.

As we developed the ongoing and new initiatives outlined in this Statement of Corporate Intent, the expectations contained in Te Ara Paerangi – Future Pathways White Paper were very much top of mind. While GNS Science's revenue continues to grow at a good rate, we are mindful that some of our funding streams are coming to an end in the next two years and we therefore face some funding uncertainty into the future. The economic climate is challenging, and we are operating in a complex environment with significant inflationary pressures. We are endeavouring to improve our bottom-line so we can reinvest in our future, including looking closely at our external costs, exploring growth opportunities, and making the most of collaborative working and investments. As we focus on delivering the 2023/24 year initiatives, we will also be mindful of the ongoing programme of work under Te Ara Paerangi programme and will seek opportunities to further our contribution to the Research, Science and Innovation system, and discuss opportunities for improvement and change.

GNS Science's Science Roadmap sets out our future science direction to 2032. The Roadmap aligns our strategic direction with long-term Government priorities and with the future mapped out in Te Ara Paerangi White Paper, along with the needs of our stakeholders, industry partners, and iwi/Māori interests. It ensures our outcome-focused Science Themes are driving the delivery of impactful and relevant science for Aotearoa New Zealand. While the Roadmap's primary focus is to aid GNS Science in developing its future research direction, it also enables our shareholder, stakeholders and iwi/Māori to see our shared challenges and to collaborate with us in developing innovative solutions.

We are participating in the Wellington Science City initiative to explore a collective approach to capital planning and co-locating with other relevant parties where this opportunity exists, with a pan-CRI approach to the use and sharing of resources, services, capability, assets and people, making the RSI system more agile. Ensuring we have modern facilities to enable innovative and integrative research and support new ways of working will continue to be a priority in the years ahead. GNS Science's Property Strategy provides a high-level planning framework across our portfolio of research laboratories, workshops, office accommodation and public interface property. In the coming year, the redevelopment of our Wairakei site remains an ongoing priority.

Tō Tātou Taiao Hurihuri

GNS Science recognises that a system-wide perspective in collective strategic planning, and meaningful engagement with key participants in the RSI system is imperative. We also recognise that collaboration and interdisciplinary research partnerships are key in enabling us to deliver on our Science Themes, and we work hard to ensure such collaboration is part of our culture. We seek to collaborate with CRIs and other partners whenever possible for mutual benefit and to improve the outcomes for Aotearoa New Zealand, forming connections between research, industry and other end-users to help take research through to impact. GNS Science recently collaborated with ESR on the replacement of our Finance, Human Resources and Project Management systems with a

new enterprise resource planning tool (Workday). This collaboration reduced implementation costs and ongoing licensing fees for both organisations. We are in discussions with other science organisations about the potential for further cooperation in mutually beneficial investments in property and infrastructure.

GNS Science continues to respond and adapt to the drivers of change in the science and innovation system, and will continue to build on our strengths, to deliver independent science advice and commentary that meets the needs of policy-makers, decision-makers and the public. As we implement our Science Roadmap and research Theme Plans, we will ensure our future focus is well placed within the national and international research ecosystem and

able to deliver on the wide-ranging needs of our stakeholders.

Te Punawai o Rangiātea – Our Māori Strategic Plan aims to better understand and act on iwi/Māori science needs and expectations. By focusing on increasing our engagement and our commitment to co-development in our science programmes, developing effective science partnerships with iwi/Māori, and integrating mātauranga Māori concepts into our Science Themes to support iwi/ Māori aspirations, we will ensure research relevance, societal trust in science, and higher uptake of research findings.



Working with Ngāti Rangi to undertake a land-based magnetotelluric survey at Ruapehu

Risk, Resilience and Wellbeing

Science has been at the heart of Aotearoa New Zealand's response to the COVID-19 pandemic. The centrality of scientific evidence to Government decision-making has also highlighted the importance of our CRIs in national emergency preparedness, response and recovery.

New Zealanders live in a high-risk zone with an active plate boundary running directly beneath our feet. This produces geological hazard events that can have a significant impact on the country's economy and social wellbeing. GNS Science plays an important role in cross-system research to better understand and manage our exposure to natural hazards, with a focus on geological hazards but also including climate change impacts.

Our scientists have played a vital role supporting responding agencies and stakeholders during the ex-Tropical Cyclone Gabrielle response. We have been monitoring the damage from both up in the air and on the ground, and forecasting the impacts of the cyclone. GNS Science is also developing a data clearing house database to collect data from across all the responding organisations and coordinating the research and science function through the Resilience to Nature's Challenges (RNC) Kia manawaroa – Ngā Ākina o Te Ao Tūroa National Science Challenge.

The National Geohazards Monitoring Centre continues to play a vital role in providing around-the-clock monitoring of major geological hazards to help keep New Zealanders safe. Our research aims to generate critical scientific knowledge for the benefit of Aotearoa New Zealand, providing scientific support to decision-makers at national, regional, business, community and individual levels. We are also supporting the development of early-warning systems, such as the DART®

(Deep-ocean Assessment and Reporting of Tsunamis) buoy tsunami warning system, which was used following the March 2021 Kermadec earthquakes and tsunami and the more recent eruption of the Hunga Tonga-Hunga Ha'apai volcano and resulting tsunami. These recent events have highlighted the fractured nature of the hazard risk management system in Aotearoa New Zealand, including the funding approach. We are working with other organisations, including government agencies, to ensure there is clarity about roles and responsibilities across the hazard risk management system and how science advice supports risk reduction, readiness, response and recovery. Te Ara Paerangi White Paper indicates that public good services and critical infrastructure will be permanently funded. Our hope is that this also includes putting in place permanent sustainable funding for important aspects of the hazard risk management system such as GeoNet and hazard models.



Measuring CO₂ flux at a beach on Moutohora (Whale Island)

The Global Environment

Like most sectors, science has continued to be affected by the impacts of COVID-19. Science is a global endeavour, particularly for the large-scale, complex Earth systems that are core to the research GNS Science undertakes. GNS Science is highly interconnected with international science institutions, particularly for our geological hazards, climate change, alternative energy, Antarctic and Southern Oceans research. The reopening of the borders during the last year has enabled us to begin renewing our international connections in person, and alongside this, we have been developing an International Strategy to ensure GNS Science's place in the international Earth and materials science research and commercial environment. The International Strategy will capitalise on the international nature of the research we are engaged in and bring the best international practice to bear on Aotearoa New Zealand's Earth and materials science research challenges, through growing our international profile, attracting international resources and funding, building strong international research and commercial partnerships, and delivering on Aotearoa New Zealand's international ambitions.

GNS Science is also highly dependent on international recruitment for our expertise, including our earlier-career staff. We will continue to increase our capability and diversity now that borders are reopening, alongside our focus on retaining and developing our existing capability. In collaboration with CRIs, universities and wānanga, we will continue to work through how we can attract and develop more 'home-grown' expertise and ensure that science remains a valued and accessible career for our increasingly diverse society, including for Māori through our outreach programmes in schools and Ahunuku Māori Scholarship Programme.

Across all CRIs, the pandemic has highlighted a common purpose and set of challenges. We will continue to build on the growing collaboration and commitment to pan-CRI approaches, working with other CRIs to identify how best we might contribute to a sustainable, resilient, and future-facing economic recovery.

Our Purpose

To undertake research that increases Aotearoa New Zealand's resilience to natural hazards, enhances our understanding of geological and Earth-system processes, drives innovation and sustainable economic growth in Aotearoa New Zealand's energy sector and develops new materials, products and approaches to assist other agencies with sustainable management of risk, environment, and natural Earth and groundwater resources.

(GNS Science Purpose)



Preparing a sediment corer for deployment on RV Tangaroa

Tō Tātou Tumanako

Our Vision

A Cleaner, Safer, More Prosperous Aotearoa New Zealand.

Our expertise contributes to this vision by:

- understanding freshwater, energy and mineral resources to enable their wise custodianship and building of intergenerational wealth and wellbeing
- reducing the impacts on society (physical and economic) from geological hazards, including through forecasting, improved hazard awareness and preparedness, enhanced geohazards monitoring, and developing more resilient communities and buildings
- understanding past climates in order to improve global models that are used to forecast the future impacts of a changing climate, including critical tipping points
- developing and applying novel technologies such as nano-scale devices and isotope measurements to create new value for industry
- ensuring Earth science data and physical collections have enduring value to our Earth science research and through wider utilisation of data streams and collections.

About Us

GNS Science, Te Pū Ao, is one of seven Crown-owned research institutes. As the National Institute for Geological and Nuclear Sciences, we are focused on delivering benefits for the people of Aotearoa New Zealand from natural processes occurring in the Earth's crust and Earth surface processes that directly affect our infrastructure, industry and environment.

With around 500 staff at six sites across Aotearoa New Zealand and a representative in Japan, GNS Science draws on a heritage of over 150 years of excellence in Earth sciences. We undertake a wide range of activities from basic research through to applied science, technology development and knowledge translation.

Our work is highly collaborative, with deep local and global partnerships across the full spectrum of our research. This partnering approach enhances our contribution to world-leading science and enables us to adapt it for Aotearoa New Zealand's benefit, to deliver highly relevant, tailored research, science and technology to central and local government, industry and iwi/Māori.

As host of the Resilience to Nature's Challenges Kia manawaroa – Ngā Ākina o Te Ao Tūroa National Science Challenge and as a lead contributor to its research programmes, GNS Science champions the value of cross-system and interdisciplinary research collaborations. To deliver meaningful solutions to those who most need our science, we form teams across institutions and research disciplines, reflective of the growing diversity of Aotearoa New Zealand society.

Our Direction

Science Roadmap

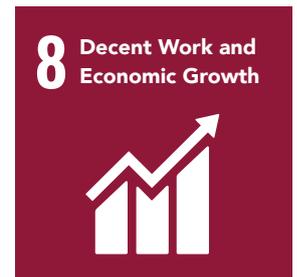
GNS Science's direction is defined by the research required to enable a cleaner, safer, more prosperous Aotearoa New Zealand. That is, a country more resilient to natural processes, a more sustainable environment, and a better quality of life for all who live here.

GNS Science's Science Roadmap identifies where we can best deliver benefit through our research for future stakeholders and New Zealanders, and realise our vision.

We are contributing to a 30-year vision for Aotearoa New Zealand aligned with Treasury's Living Standards Framework and United Nations (UN) Sustainable Development Goals. Our contribution will help Aotearoa New Zealand:

- achieve its long-term energy needs
- meet climate action goals (carbon net zero 2050)
- have sustainable and resilient environments, ecosystems and societies
- secure its freshwater
- enable industry, innovation, infrastructure and economic growth.

When mapped to the UN Sustainable Development Goals (SDGs), our science direction contributes to the goals on the right.



Tō Tātou Ahunga

The Roadmap outlines the scientific research that GNS Science will put in place to ensure that our projected impact is delivered.

The Science Roadmap aligns our strategic direction to the priorities of our stakeholders in central and local government, major industry partners and iwi/Māori interests. Investing purposefully to ensure we are a strategy-led organisation is a key element of our approach. It describes our future science direction and focus to 2032, ensuring our outcome-focused Science Themes are driving the delivery of impactful and relevant science for the country.

Our Impact by 2032

GNS Science will contribute to the following:

Energy



A science-led transition to locally produced low-carbon energy which is expected to bring more than \$5 billion back into the Aotearoa New Zealand economy by 2032 and reduce our annual energy emissions by up to 30 million tonnes.

Hazard and Risk



Greater resilience to a significant geohazard event through a range of planning, regulatory, and education measures, improved response, and improved forecasting of scale and breadth of impact. Combined, these efforts could save hundreds to tens of thousands of lives and reduce economic shock by billions of dollars.

Environment and Climate



The connectivity of environmental systems is understood and a plan in place to protect our groundwater. We will be able to forecast and minimise the impact of our activities on the environment and adapt effectively to unavoidable change. We will contribute scientific knowledge and implement actions to reduce anthropogenic atmospheric CO₂ which could have an Emissions Trading Scheme value of \$2 billion by 2032.

Kaitiakitanga



Not only will the potential resources, energy, environments, hazards and origin of Te Riu-a-Māui / Zealandia be valued, understood, respected, protected and restored, we will have a comprehensive plan to monitor our changing environment so current and future generations can live sustainably and resiliently in Aotearoa New Zealand.

Strategic Plan

GNS Science is developing an overarching strategic plan that will set out and weave together our overall vision and mission, along with all our goals and objectives. It will bring together our strategy documents, and fill any strategy gaps, to provide a clearer picture of what we want to be as an organisation, and how that can be achieved.

The Science Roadmap gave us clarity about our direction, and the strategic plan and accompanying primary and enabling strategies being developed will allow us to deliver on our vision for the future, draw out the top priorities across GNS Science, and provide clarity as to how all these areas of work are integrated.



 Materials team PhD student Zulfitri Rosli working in GNS Science's ion beam facility

Te Punawai o Rangiātea – Our Māori Strategy

GNS Science is genuinely committed to increasing our understanding of Māori science needs and expectations. To support this outcome, last year we released Te Punawai o Rangiātea, our Māori Strategy.

Meaning ‘the flourishing pool of knowledge’, Te Punawai o Rangiātea provides critical guidance and direction to enable GNS Science to create enduring and sustainable relationships with tangata whenua – iwi, hapū, whānau and Māori. It details our

shared moemoea (vision), whaingā (mission), tikanga (values), kawa (actions) and kaupapa (outcomes).

Developed with GNS Science staff and reflective of the organisation’s Science Roadmap and Theme Plans, Te Punawai o Rangiātea guides our approach to engagement and establishes ‘MAHIA’, a GNS Science Māori cultural model to support staff in their engagement with iwi/Māori.

By explicitly weaving the future interests of iwi/Māori into our Science Roadmap, building Vision Mātauranga into our research and actively using mātauranga Māori in our work, we are demonstrating

our commitment to the principles of participation, protection, and partnership.

Our goal is to build more opportunities for iwi/Māori to lead significant research programmes and grow capability and capacity to contribute to long-term intergenerational wellbeing and change. We continue to gain a deeper understanding of mātauranga Māori and how it contributes to our work, but there is much to do. We are on a journey with our iwi/Māori partners and are committed to bold leadership and delivery of mutually beneficial outcomes.

Mahia Framework

Manaaki

Showing respect, support, care, generosity and protection for others.

Our Iwi-Māori relationships demonstrate a robust Māori engagement process while implementing our long-term science direction.

Ara

Awaken the past, rise, path, be open with purpose.

Acknowledge and enable mātauranga Māori-led, GNS Science-enabled research development activities to shape Vision Mātauranga outcomes that produce world-class research.

Hinengaro

Thoughts, ideas, mind, heart, feelings.

Describe how we engage with Iwi-Māori to develop research, technical and cultural expertise to recognise and support mātauranga Māori and shared outcomes with and for our ongoing relationships with Iwi-Māori.



Āhua

Character, nature, condition, appearance.

Enable innovative approaches that enhance both internal and external expertise and capability in Earth sciences, Te Pū Ao me te Ao Māori.

Ihi

Essential, dynamic force and excitement.

Develop our people and processes with Iwi-Māori through increased research, technical and cultural skills to support both mātauranga Māori and science thought leadership outcomes through our relationships.

Our Science

Excellent science, where it matters most

We make clear, strategic choices about the areas of research we prioritise and invest in to progress towards a cleaner, safer, more prosperous Aotearoa New Zealand.

As discussed above, GNS Science's strategic Science Roadmap enables us to focus our research to support national and international collaborative science initiatives, enhancing capability and science value. Delivery of our Science Roadmap is supported by our Theme Plans that have been designed to ensure we play our part in delivering impactful and relevant science for the country.

Through our four Science Themes, we are building on the strong foundations of our world-renowned expertise to contribute international thought-leadership and deliver practical solutions of high relevance to our major stakeholder sectors and end-users. Our investment in multi- and interdisciplinary methods, such as Data Science and Social Science, enables us to provide linkages and threads across our Science Themes to provide data-driven, outcome-oriented science for the benefit of all New Zealanders.

Driven by Te Punawai o Rangiatea – our Māori Strategic Plan we seek to strengthen our engagement with iwi and hapū, providing avenues to collaborate and/or partner in research planning, execution and outputs, and therefore to benefit more directly from the science. Where possible, we involve local iwi/Māori in research prioritisation, design, planning, implementation, and report writing. Results are discussed and disseminated to relevant groups through hui and other information transfer mechanisms.

Social Science

To maintain social, environmental, economic and cultural wellbeing in Aotearoa New Zealand's geological landscapes, we have to understand the interplay between geological resources and processes, and the people who live on and with them. Through a better appreciation of how society functions, including governance and policy frameworks, we expect there will be a greater uptake of the physical science that GNS Science invests in, to ensure our research results are useful, usable and used.

We apply our social science expertise to mitigate risks and build resilience to natural hazards by understanding how to influence individuals, communities, and organisations, and supporting the development of Māori resilience frameworks. Embedding social science approaches across our Science Themes allows us to better understand public perceptions and values, identify barriers to adopting new practices and technologies, and ensure effective public discussion on critical issues.

Data Science

Leading-edge techniques and expertise in data science (including Deep Learning, Decision Support Models, Data Lens, and trust in Artificial Intelligence (AI)) can be applied across our Science Themes to make the most of our information and insights. These are applied to all GNS Science databases (many of which are nationally significant), GeoNet and satellite data to address science problems with AI and machine learning methods. We are investing in data science, firstly to build capability and capacity in relevant disciplines, and secondly to integrate data science approaches across the Science Themes. This enables us to extract more value from GNS Science's significant data resources, for the benefit of the wider science community, and to deliver greatest value and impact for Aotearoa New Zealand.

Strategic Science Investment Fund

GNS Science's Strategic Science Investment Fund (SSIF) investment is an important element in the delivery of our Science Roadmap. This public funding provides a stable revenue source to maintain, enhance and foster current or new scientific and research capabilities. Each Science Theme is underpinned by SSIF programmes that provide long-term strategic research to support end-to-end science delivery along the value chain (Appendix One).

Additional funding from the SSIF Advanced Energy Technology Platform is enabling us to progress our work in creating next-generation knowledge-intensive opportunities for New Zealanders, delivering transformative technologies that will drive Aotearoa New Zealand's future as a globally connected 'green-hydrogen' economy.

Tō Tātou Pūtaiao

In the coming year, we will continue to focus on building critical research capabilities and capacity for the future through strategic training and development.

In addition to the SSIF Programme and SSIF Advanced Energy Technology Platform funding, the SSIF Infrastructure Fund provides support for:

- The eight Nationally Significant Collections and Databases GNS Science is custodian of. We manage these collections and databases and enhance their ongoing value to Aotearoa New Zealand (see Appendix Three).
- Enhanced Geohazards Monitoring, which allows GNS Science to provide more timely and accurate advice on geohazard events to responsible agencies. This enables those agencies to issue faster, more effective warnings to improve public safety and protect lives and property.

Measuring Our Science Performance

Our Science Theme priorities were identified in our Theme Plans using an outcome-oriented approach and following stakeholder engagement. The global and national drivers, focus and impacts of the four Science Themes are described in more detail in the following sections, along with the measures that will demonstrate the impacts of our work over the next five years. The overall performance of GNS Science is monitored against the set of GNS Science Key Performance Indicators (KPIs) shown in Appendix Two.

External Advice

Our Strategic Scientific and User Advisory Panel has an important role in evaluating our science excellence and delivery for and with stakeholders. Reporting directly to our Board, the Panel meets annually to review our performance, future research directions and capability needs to ensure our research is both excellent and relevant, and that we are taking advantage of key developments in international science and technology.



Natural Hazards and Risks



Research priority areas:

- Understanding Geohazards Processes
- Stewardship of National Capability
- Trusted Science Advice
- Knowledge Exchange
- Building Community Resilience
- Natural Hazard Risk Management System Improvement

The Challenge

High rates of natural hazards and significant consequences are to be expected in a nation straddling a plate boundary in the middle of the Southwest Pacific. There is growing evidence that climate change and sea level rise is exacerbating weather-related and coastal hazards. At the same time, the impacts of hazard events are intensifying through population growth and ageing, continued urbanisation, and business vulnerabilities of fast-moving consumer goods and just-in-time supply chains. Risk is increasing and Aotearoa New Zealand's ability to respond to events such as ex-Tropical Cyclone Gabrielle and manage future impacts from natural hazards is being tested.

GNS Science's Role

GNS Science has a national leadership role for research on the causes, consequences and risks of geological hazards to increase Aotearoa New Zealand's resilience. We have extensive scientific knowledge in Earth processes, and globally and nationally recognised expertise in hazard and risk modelling, forecasting

socio-economic impacts of events, and system modelling of consequences and resilience options. We apply our social science capability to increase community resilience, improve risk communication and support development of tools for hazard preparedness.

Through GeoNet, and with the support of our underpinning science, we are building on two decades of operating a world-class geohazards network delivering data for geohazards research and monitoring, and are aiming to deliver even greater benefit to Aotearoa New Zealand, our Pacific neighbours and beyond. As an integral component of GeoNet, and supported by GNS Science's world-class work, the National Geohazards Monitoring Centre Te Puna Mōrearea i te Rū provides 24/7 active monitoring of Aotearoa New Zealand's geological hazards.

We provide science advice on geological hazards to support Civil Defence and Emergency Management (CDEM) through the CDEM Act. This means that when an event occurs, we may be required to provide advice on consequences and risk.



Remote monitoring sites are vital for keeping a close eye on our active volcanoes, requiring regular upgrades and maintenance. At this site, communications upgrades allow for a more robust data signal back to our data centres

Ngā Matepā Me Ngā Tūraru Ā Taiao



Working Together

We work with other organisations and experts to deliver excellent and impactful science. We have strong strategic partnerships across the natural hazards risk management system with other research organisations, government agencies and international collaborators.

GNS Science is working across the resilience and science systems as a major coordinator of key research providers and data suppliers in the university, CRI, central and local government, and private sectors. Our work involves collaboration with a wide range of users, through engagement with communities, iwi/Māori, industry bodies, government agencies and the hazard management sector, and communication through multiple channels to ensure stakeholders understand and manage the risks in their areas/roles.

The Natural Hazards and Risks theme, which works closely with the Resilience to Nature's Challenges Kia manawaroa – Ngā Ākina o Te Ao Tūroa National Science Challenge, also works with Centres of Research Excellence and other major collaborative programmes, to ensure that GNS Science's work complements and adds value to the work of others across the Aotearoa New Zealand science and innovation system. Our aim is to facilitate an integrated view of 'who is doing what,' leading to a coherent scientific evidence base for hazard risk management.

Research Direction

Our research aims to generate important scientific knowledge for the benefit of Aotearoa New Zealand and drive its uptake and use to improve resilience to natural hazards at national, regional, business, community and individual levels.

Our outcome-oriented research spans the full value chain of information, from underpinning knowledge to better understand Aotearoa New Zealand's natural hazards, through to risk management options to help communities mitigate their destructive effects, and advice on policy and regulation.

We are committed to continuous improvement and aim to adapt our approach to increase the benefits to society from our science. This will require some strategic shifts over the coming years. We want to move:

- **From hazards monitoring to impact forecasting.**

Over the two decades of GeoNet we have been highly successful in developing a world-class geohazards monitoring system. We will be extending monitoring to include the ability to provide timely impact information and forecast what will happen next (over timeframes of hours to weeks to decades).

- **From fragmented to connected.**

Currently, the science system has necessitated piecemeal and competing funding bids, partly guided by strategy, but largely driven by individual ideation. This has resulted in fragmented programmes and reluctance to collaborate across boundaries. There are excellent examples of cross-disciplinary and cross-organisational coordination, and this needs to increase to deliver maximum benefits for science investments.

- **From reactive to strategic.**

Step changes in natural hazards science are often triggered by events. We must continue to react to events, collect time-critical data and build our understanding in response and recovery. However, we also need to better anticipate the requirements of stakeholders and prioritise the most important research to deliver over the next decade.

- **From transactional to trusted.**

For much of our work with stakeholders, our approach has been contractual, based on short-term financial imperatives. For some agencies, we have built excellent relationships over many years, and we will continue to nurture these relationships. We will also identify and develop partnerships with other agencies, both in Aotearoa New Zealand and internationally.

Natural Hazards and Risks



Beach erosion caused by the September 2009 Samoa tsunami

Natural Hazards and Risks Impacts and Priorities 2023-28

1. Understanding Geohazards Processes

- Increasing our understanding of the complex physical processes that generate natural hazards.

2. Stewardship of National Capability

- Stewardship of critical geohazards data, hazards models and risk tools, monitoring infrastructure and nationally important capability.

3. Trusted Science Advice

- Providing trusted science advice for effective risk reduction, readiness, response to and recovery from emergencies.
- Being more strategic and both anticipating and understanding the requirements of stakeholders to prioritise the delivery of the most important research.

4. Knowledge Exchange

- Being knowledge brokers for the hazard risk management system.
- Increasing cross-disciplinary and cross-organisational coordination to deliver maximum benefits for science investments.

5. Building Community Resilience

- Applying a social science and people-centred systems approach to enable, empower and support communities to build resilience.

6. Natural Hazard Risk Management System Improvement

- Improving natural hazard risk management policy and practice.
- Moving to impact forecasting by extending monitoring to include the ability to provide timely impact information and forecast what will happen next (over timeframes of hours to weeks to decades).

Ngā Matepā Me Ngā Tūraru Ā Taiao



Key Deliverables

The following research initiatives represent some of the key deliverables for the year, as we progress towards our measures of success.

1. Finalise the commercial model for RiskScape™ with four early adopter subscriptions agreed.
2. Develop a business case for sustainable funding of GeoNet and national hazard and risk models as Public Good Science Services.
3. Develop a workplan for implementing Geohazards Event Response Framework Strategy to ensure depth of capability and capacity for providing science advice.
4. Develop a strategic framework for delivering impact-based multi-hazard forecasting.

Measures of Success

By June 2024, mapped landslides from ex-Tropical Cyclone Gabrielle will be publicly available to recovery agencies.

By June 2024, a decadal work plan for geological hazard and risk model development and regular revision cycles will be completed, including the use of RiskScape™, MERIT and other socio-economic tools for assessment of both qualitative and quantitative risk metrics.

By June 2025, deliver a discussion paper on the requirements for impact-based forecasting for engagement with decision-makers.

By June 2026, improvements will be made in how risk messages are communicated, understood and actioned clearly for long-term mitigation and short-term dynamic responses as measured by surveys of communities at risk.

By June 2026, short courses for different areas within the theme will be developed e.g., tsunami, landslide, risk assessment so that we can build understanding of natural hazards and risks in our stakeholder sectors.

By June 2027, hazards and risk data will be findable, accessible, interoperable and reusable; our infrastructure will be robust, secure and fit-for-purpose; our hazard and risk models will use best available science and will be comprehensive, and outputs will be co-created with end-users.

By June 2027, mātauranga Māori will be integrated into all our programmes, so a holistic and integrated understanding of our environment is developed.

By June 2028, integrated system models for why, how and when geohazards occur will have been developed, using complementary statistical analysis, physical science and mātauranga Māori.

Environment and Climate



Research priority areas:

- Freshwater Security and Quality
- Antarctic Climate and Ice Dynamics
- Ecosystems and Biodiversity
- Our Climate System through Time
- Carbon Cycle and Atmospheric Emissions
- Sea Level Rise and Coastal Change
- Contaminant Pathways in the Earth System

The Challenge

Groundwater is essential for environmental integrity, social wellbeing and economic productivity. Aotearoa New Zealand's extensive groundwater resources account for roughly 40% of our drinking water and contributes up to 80% to the annual river flow volume. However, groundwater resources are under threat. Approximately 40% of our groundwater catchments are vulnerable to shortage or contamination, and 71% of monitored groundwater quality sites are not meeting drinking water standards. Emerging organic contaminants and nutrients from land use could make some groundwater resources unusable, and reducing groundwater quality and quantity will increasingly impact on mahinga kai and cultural practices. In addition, climate change and sea level rise will increasingly impact Aotearoa New Zealand's groundwater resources, for example by increasing salinity and groundwater inundation in coastal aquifer areas.

The impact of anthropogenic carbon emissions on our climate is unequivocal, with average temperatures on track to reach 1.5°C warmer than pre-industrial temperatures between 2030 and 2052.

Warming is likely to continue to increase through the 21st century, unless large emissions reductions are achieved, and significant quantities of carbon dioxide are ultimately removed from our atmosphere. We need to improve our ability to project and forecast how our climate may change and identify tipping points and thresholds in the system so that we can reduce or avoid climate surprises. We need to find ways to measure and account for our greenhouse gasses while developing mechanisms to reduce our emissions. We need to adapt to unavoidable change as our oceans warm, pressure on freshwater resources increases, sea level rise affects coastal communities and infrastructure, and extreme weather events become more common and intensify.

Addressing these challenges requires an interdisciplinary approach to include researchers, policy-makers, educators, engineers, and communities across Aotearoa New Zealand. The challenge impacts all New Zealanders as stakeholders and requires a nationally coordinated effort with engagement across a number of research institutes. Our aim is to provide leadership to ensure this connected approach is realised.



Our tritium and water dating laboratory

Te Taiao Me Te Āhuarangi



GNS Science's Role

We are developing a more comprehensive understanding of freshwater systems to provide new insights and improve policy, management and restoration approaches. New technologies and science methods enable us to better document Aotearoa New Zealand's groundwater resource and evaluate its vulnerabilities. Using a values-based approach, we will make sure that our research is fit-for-purpose for those who need it.

Our Earth system scientists uncover geological data to extend our environmental knowledge well beyond the short but detailed datasets collected from instruments over recent decades. Earth's long-term environmental archives allow us to examine how our marine and terrestrial ecosystems, coastal environments, and Antarctica's ice sheets responded during previous intervals of time when average surface temperatures were like those we will experience in the coming decades. This insight improves our ability to anticipate and adapt to future change.

We have world-leading expertise in analysing and monitoring carbon budgets for our major Aotearoa New Zealand cities, to better inform decisions on emissions mitigation approaches. Our proven capability in air particulate matter research enables us to monitor air quality and guide local government in better understanding and managing air contaminants and their sources.

As sea levels rise, we must understand the effects on our coastlines and the communities living there. By studying the response of our coastal systems to previous episodes of warmer-than-present climate and major environmental change we anticipate how coastal ecosystems will change in the future. Our work on ice sheets allows us to reduce uncertainty regarding the rate and magnitude of sea level change. By measuring and modelling coastal land movement we can provide location specific sea level projections for planning and adaptation to rising or falling seas.

Working Together

GNS Science is part of the Groundwater Science and Research Alliance Aotearoa, a platform which brings together all Aotearoa New Zealand's research providers. Working alongside regional council partners and the Ministry for the Environment, the Alliance provides a coordinated and strategic approach to identify and resolve groundwater research priorities and enable sustainable management of Aotearoa New Zealand's precious water resources.

As part of a wider system of environmental and climate change research, we are committed to deepening collaborations with selected research teams nationally and internationally to achieve better outcomes. In part, this will be achieved through cooperative research enabled by various large-scale research

initiatives like the Antarctic Science Platform, MBIE Endeavour research programmes (e.g., Our Changing Coast | Te Ao Hurihuri; Te Ao Hou, Te Whaka Heke o Te Wai, Future Coast Aotearoa) and joint initiatives with other environmental CRIs, such as the National Environmental Data Centre.

Working in more connected ways will enable our research contributions in groundwater, air quality and climate change to complement efforts by others. Together, we will develop and refine more accurate environmental and climate models and forecasts, more effectively communicate expected future impacts, and provide tailored guidance, models and tools to mitigate the risks to and from our changing natural world.

Research Direction

Our research focuses on freshwater resources, sea level rise and coastal change, climate change impacts on ecosystems and biodiversity, the carbon cycle, the climate system through time, and contaminant pathways, to understand and mitigate the impact we are having on the world's environment and how they will affect our communities both now and for generations to come. Working with our major partners, we have designed our programmes to meet their current and future needs.

Environment and Climate



Using X-Ray Fluorescence (XRF) spectroscopy to determine particle composition in our Air Particulates and XRF Laboratory, National Isotope Centre

Environment and Climate Impacts and Priorities 2023-28

1. Freshwater Security and Quality

- Measuring, mapping and modelling groundwater systems.
- Recognising the social, environmental and cultural value of Aotearoa New Zealand's groundwater.

2. Antarctic Climate and Ice Dynamics

- Developing and improving understanding of how ice shelves, ice sheets and sea ice will change as temperatures increase and how this will impact the Southern Ocean and Aotearoa New Zealand.

3. Ecosystems and Biodiversity

- Enhancing tools and models to increase understanding of the effect of previous episodes of climate change on plankton in our oceans and native terrestrial flora.
- Characterising the state of our lake systems prior to the influence of human activity and analysing the signals of environmental change in these systems.

4. Our Climate System through Time

- Generating highly resolved records of past climate from sediment layers and ice cores to identify and examine patterns not currently captured in short-term datasets (e.g., thermometers and satellites).
- Identifying thresholds and tipping points in the climate system to improve our ability to model and project future climate.

5. Carbon Cycle and Atmospheric Emissions

- Improving Aotearoa New Zealand's national and regional carbon budgets in order to meet its global commitments.
- Examining carbon uptake and/or release in the Southern Ocean and our coastal- and land-based ecosystems.

6. Sea Level Rise and Coastal Change

- Understanding the causes, rate, and magnitude of past, present, and future sea level change and its impact on Aotearoa New Zealand and the South Pacific.
- Connecting our ice sheet research with global sea level datasets and coastal vertical land movement to improve regional projections of sea level.
- Incorporating sea level research results into groundwater, coastal hazard and risk models to guide climate change adaptation policy and planning.

7. Contaminant Pathways in the Earth System

- Understanding the processes that allow contaminants to enter and transit through the geosphere (rock and soil), atmosphere, and hydrosphere (oceans, lakes, and groundwater).
- Developing mechanisms to mitigate or inhibit the transit of contaminants through our Earth system.

Te Taiao Me Te Āhuarangi



Key Deliverables

The following research initiatives represent some of the key deliverables for the year, as we progress towards our measures of success.

1. Complete SkyTEM processing for Aupouri Aquifer (Northland), Northern Plains (Southland), and Ruamāhanga catchment (Wellington) utilising the increased capability developed within GNS Science.
2. Model national carbon fluxes from Aotearoa New Zealand's biosphere and compare to atmospheric observations, improving our understanding of Aotearoa New Zealand's total carbon balance and the potential for its indigenous forest to offset emissions.
3. Develop a Bayesian Network modelling tool to support management and long-term planning for future coastal inundation and shoreline change due to climate change and sea level rise in Pacific Island countries.
4. Perform a critical review and synthesis of literature on adaptation pathways to help inform future research design, improve methodologies to better engage with stakeholders' concerns, and enhance learning for climate adapted futures.
5. Recover a new geological record of West Antarctic Ice Sheet response to past increases in global surface temperature from beneath the Ross Ice Shelf.

Measures of Success

By June 2024, new models of the groundwater systems in three areas are being used to better manage this critical resource.

By June 2025, estimates of sea level rise commitments from Antarctic Ice Sheet melt are integrated into at least one long-term environmental management plan.

By June 2026, Aotearoa New Zealand's systems-based coastal research capacity has been enhanced and includes Māori researchers.

By June 2027, knowledge gained from the Lakes 380 assessment of our national lake system health is being integrated into several long-term environmental management plans.

By June 2028, we are actively and accurately measuring the impact of carbon mitigation measures across our major urban centers.

Energy Futures



Research priority areas:

- Growing the Use of Geothermal Energy, with a Particular Focus on New Resources
- Growing an Aotearoa New Zealand Hydrogen Economy
- Developing New Clean Technology Industries Based on Advanced Materials Research
- Using the Earth for New Energy Storage
- Modelling and Analysing Aotearoa New Zealand's Energy System

The Challenge

Energy powers our economy and underpins the wellbeing of our communities. It enables us to live healthy, fulfilling lives. We use it to power our homes and workplaces, grow and manufacture our food, building materials, clothes and other necessities, and move our people. It is critical for clean water, health care, transport, reliable lighting, and telecommunications.

Energy generation and use are inextricably linked to environmental impacts, including greenhouse gas emissions. Like other countries, Aotearoa New Zealand is grappling with how it can meet changing demands for energy, without causing irreversible impact to our environment. There is growing demand for a low-carbon energy

supply and more equitable access to energy resources. Technologies that increase electrification, use bioenergy and hydrogen, and provide demand management will be key to this clean energy future.

Aotearoa New Zealand has committed to a path with net-zero carbon emissions by 2050. With current policies the major load for reducing emissions falls to the energy system, which is currently heavily reliant on fossil fuel products. Progress towards this goal and international commitments to reduce energy emissions, that have been set since the early 1990s, falls short of the targets. Science can play a critical part in identifying and developing innovative solutions to reduce the emissions of CO₂ to the atmosphere from energy production and use.



 GNS Science Field Technician Lauren Coup performing geothermal steam line sampling at Wairakei Power Station

Pūngao Mō Anamata



GNS Science's Role

As 'the Energy CRI', GNS Science plays a major role in enabling Aotearoa New Zealand's transition to a low-carbon energy future. We invest in diverse research to grow Aotearoa New Zealand's renewable energy supply, develop new materials for producing and storing hydrogen, and reduce energy-related emissions.

We are well placed to take a lead in developing and undertaking the necessary research required to support the transition to a low-carbon energy future, including a broad portfolio of energy research:

- Growing the use of geothermal energy, with a particular focus on new resources.
- Growing an Aotearoa New Zealand hydrogen economy.
- Developing new clean technology industries based on advanced materials research.
- Using the Earth for new energy storage (Earth Batteries).
- Modelling and analysing Aotearoa New Zealand's energy system (Energy Systems).

This portfolio of research includes two newer areas (Earth Batteries and Energy Systems), which will require collaborations with energy researchers from around Aotearoa New Zealand and can leverage current GNS Science research capabilities in reservoir characterisation, complex systems modelling, resilience and social science research. The solutions that result from our research will reduce our national carbon footprint, while enhancing Aotearoa New Zealand's energy security and resilience and economic competitiveness.

As Aotearoa New Zealand increases the use of intermittent energy sources such as wind and solar in our energy mix, and climate change impacts hydroelectric supply, the need for energy storage will become more important. We are developing research projects into multiple solutions for storing energy in Aotearoa New Zealand through hydrogen, new battery technologies and the novel use of the Earth as a battery.

Our research into materials will capture the benefits of advances in global research and development (R&D) to develop regional opportunities to produce and export green hydrogen and will provide Aotearoa New Zealand with options for the distributed storage of energy.

Efficient use of renewable energy is another area where our science contributes to the way Aotearoa New Zealand reduces its carbon emissions. We focus our research in new materials to reflect increasing demand for new technologies, processes and materials that reduce energy demand (and carbon intensity) and develop new paradigms for energy generation on the supply-side.

2022/23 has demonstrated the vulnerability of energy systems to climate-related and socio-political events. This has emphasised the need for a secure, resilient indigenous energy supply in Aotearoa New Zealand. This outcome is a focus of the energy research GNS Science is currently undertaking.

We have begun research related to reducing atmospheric CO₂ concentrations. This research focuses on experiments and modelling of the effects of returning emitted CO₂ from a geothermal power station to the reservoir of origin. We are also using our material science capability to develop new cements that can use and absorb atmospheric CO₂.

Increasing the domestic supply of energy has the potential to produce negative environmental and social effects. We intend to undertake new research into the sustainable use of energy that is connected to the Earth, such as geothermal or hydro. This work aims to develop methods to incorporate community values into the assessment of the impacts of utilising energy resources.

Energy Futures

Working Together

In line with Government goals to grow private-sector-led R&D activity, we foster external partnerships in order to focus our research where there is high industry demand. This will assist Aotearoa New Zealand industry and homes to transition to low-carbon emissions.

We expect our research in this area to be central to GNS Science's work that will enable the creation of new, high-value industries in Aotearoa New Zealand and also develop new value streams for export. Our expertise in geothermal energy is sought by companies in Aotearoa New Zealand and overseas. We are building on our international agreements including the GNS Science-JOGMEC (Japan) Memorandum of Understanding (MOU) on geothermal energy technical cooperation, the Ministry of Business, Innovation and Employment (NZ)-Department of Energy (USA) agreement on R&D of geothermal technologies and the New Zealand-Japan MOU to develop hydrogen technologies. These agreements enable us to collaborate with overseas researchers and to provide our expertise to government bodies and companies to help reduce global carbon emissions.

Through thought leadership and robust science, we are well placed to ensure that Aotearoa New Zealand understands the opportunities and risks relating to a changing energy mix into the future. We will play an important role in bringing a science voice to national conversations alongside central and local government, industry, iwi/Māori and community interests.

Research Direction

Our research aims to increase opportunities to use renewable resources and efficiency gains to reduce carbon emissions from energy use and to grow energy resource security. This will be achieved through increased use of geothermal energy for electricity generation, direct use of geothermal energy, improvements in hydrogen production, the development of enabling technology to increase the use of renewable energy, and the identification of new energy sources that contribute to a low-emissions energy future.

Energy Futures Impacts and Priorities 2023-28

1. Growing the Use of Geothermal Energy, with a Particular Focus on New Resources

- Build capability and provide understanding that supports increased sustainable and innovative use of geothermal energy to reduce Aotearoa New Zealand's carbon emissions and enhance wellbeing. This includes both hotter supercritical fluids and shallow geothermal energy that can be used directly for industrial process heat.

2. Growing an Aotearoa New Zealand Hydrogen Economy

- Design and development of materials, tools and technologies to overcome the scientific, engineering, social and economic barriers in implementing hydrogen as a zero-carbon energy carrier and industrial feedstock.

3. Developing New Clean Technology Industries Based on Advanced Materials Research

- Create, characterise and integrate new materials systems to underpin the clean technologies that will deliver a sustainable and resilient net-zero carbon energy future for Aotearoa New Zealand.

4. Using the Earth for New Energy Storage

- Use the subsurface as a machine for storing or producing energy.

5. Modelling and Analysing Aotearoa New Zealand's Energy System

- Provide information and data that propels Aotearoa New Zealand to a just transition to a net-zero carbon energy future.



Pūngao Mō Anamata



Key Deliverables

The following research initiatives represent some of the key deliverables for the year, as we progress towards our measures of success.

1. An assessment will be undertaken of the market proposition for developing and utilising supercritical / superhot geothermal resources.
2. New 3D models will be developed coupling temperature and geochemical vectors to refine utilisation of productive geothermal systems.
3. New integrated rapid materials synthesis capabilities will be developed that follow materials performance simulations.
4. A study will be undertaken to identify potential subsurface energy storage options in the North Island of Aotearoa New Zealand.

Measures of Success

By June 2024, R&D created by GNS Science is taken up and used by at least one primary industry or manufacturing company.

By June 2025, GNS Science will have developed new capability into understanding and modelling energy systems that contributes to national policies regarding energy.

By June 2026, our R&D on green hydrogen production will have been used for a demonstration project by a hydrogen production company in Aotearoa New Zealand.

By June 2027, GNS Science will be leading a national Centre for Zero Carbon Energy Solutions.

By June 2028, GNS Science will have applied our capability related to risk and resilience from natural hazards to developing a framework for assessing resilience of Aotearoa New Zealand's energy system.

Land And Marine Geoscience



Research priority areas:

- Improved Resilience to Natural Hazards
- Adapting to Changing Climate
- Managing Natural Resources Sustainably
- Wider Use of Collections and Databases
- Shared Solutions

The Challenge

The islands of Aotearoa New Zealand represent the small portion (around 6%) of Earth's eighth continent of Te Riu-a-Māui / Zealandia that emerges above sea level. The vast majority of Te Riu-a-Māui / Zealandia's nearly 5 million square kilometre area is submerged, and 60% of this area is within Aotearoa New Zealand's jurisdiction.

There is still much to discover and understand regarding Aotearoa New Zealand's onshore geology and active geological processes, and how they relate to a sustainable economy and resilient society. There are even greater frontier continental-scale challenges, opportunities and stewardship responsibilities in revealing and managing the portion of Te Riu-a-Māui / Zealandia that underlies the South Pacific Ocean.

Pūtaiao Aronuku ā-Whenua, ā-Moana Land and Marine Geoscience Theme is the storehouse and whare of over 150 years of geological mapping and fundamental underpinning Earth science, skills, knowledge, mātauranga, and learning. That broad authoritative knowledge has a crucial role in determining how successfully Aotearoa New Zealand manages understanding global-scale environmental change, variability and impacts, improving predictive capability for hazards and disasters, identifying new sustainable resources, and developing transformational new technologies to make new discoveries.



Titahi Bay Fossil Forest, near Porirua, Wellington

Pūtaiao Aronuku Ā-Whenua, Ā-Moana



GNS Science's Role

This theme generates knowledge about our continent and oceans which enables us to improve predictive capability for hazards and disasters, understand global-scale environmental change, variability and impacts, and identify new sustainable natural resources. Under this theme, GNS Science is the pre-eminent kaitiaki (steward and custodian) of Earth science knowledge, mātauranga, our databases and collections taonga.

Fundamental geoscientific research undertaken by GNS Science plays an essential part in providing an accurate and up-to-date framework for Aotearoa New Zealand's natural geological and biological environment. It also adds to iwi/Māori knowledge of culturally, environmentally and economically significant solid Earth materials and processes.

Deeper knowledge of fundamental Earth deformation and plate boundary structure and processes is critical for research on the causes and impacts of geological hazards such as earthquakes, landslides and volcanoes. As we develop greater understanding of the planet's dynamic processes, we will be able to strengthen our resilience to risk.

In a low-carbon future, there will be continuing demand for a sustainable, secure supply of energy and critical elements. GNS Science work provides accurate appraisal of Aotearoa New Zealand's on-land and offshore resource potential to enable sustainable custodianship of the continent's natural resources.

Working Together

Successful collaboration relies on trust and long-standing relationships. Under this theme, GNS Science coordinates geoscience research initiatives in Aotearoa New Zealand, collaborating with government agencies, universities, CRIs, iwi/Māori, and other providers, and leads international initiatives of benefit to Aotearoa New Zealand. Our participation in major international collaborative consortia, for example, the International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Program (ICDP), enables us to grow capability and leverage co-funding, and brings significant new knowledge and critical thinking, as well as additional scientific infrastructure and equipment, to Aotearoa New Zealand. These partnerships have allowed us to leverage well over \$150 million of international investment in Land and Marine Geoscience science themes.

Land and Marine Geoscience provides the data and underpinning research needed for enabling research and accelerating innovation in our other Science Themes. It provides a wider context for tectonic and volcanic hazards, delivers an improved framework for energy, supports management of natural resources, and provides a valuable historical perspective on current and future environmental change. Our international partnerships are supported by Memoranda of Understanding and subcontracts, including student co-supervision.

Land And Marine Geoscience

Research Direction

We are investing in research that addresses fundamental questions about the composition and architecture of the continent Te Riu-a-Māui / Zealandia and provides understanding of the geological processes that have shaped it. Our foundation programme aims to close critical knowledge gaps that relate to societal challenges, including undertaking research on the physical processes that control geohazards, characterising natural resources and appreciating the consequences of past environmental change. We do this through five research areas:

- *Plate boundary*

Refine our knowledge of the processes associated with plate boundary hazards to enable more reliable forecasts of earthquakes, tsunamis, volcanic eruptions, and landslides.

- *Natural resources*

Develop models of heat and magma generation to improve understanding of how renewable geothermal energy can be utilised. Quantify how critical elements and materials are distributed in the subsurface to support the transition to a low-emissions future.

- *Our changing landscape*

Enhance our understanding of surface processes in coastal and urban environments through integrated geological, geochemical, and geophysical investigations to inform predictive modelling of sedimentation and erosion.

- *Our past*

Improve the geological timescale to reveal the primary drivers of Earth change and improve understanding of the rates and scale of change and climate impacts.

- *Our continent*

Te Riu-a-Māui / Zealandia

Knowledge of Te Riu-a-Māui has enduring value. Mātauranga, embodied in part through our databases, samples, and collections, informs geological processes that shape Te Riu-a-Māui as well as enriching Māori and Pasifika narratives of exploration and discovery.

Land and Marine Geoscience Impacts and Priorities 2023-28

1. Improved Resilience to Natural Hazards

- To be better prepared, and to make informed decisions to reduce disaster risk, Aotearoa New Zealand depends on availability of hazard, vulnerability and exposure information.

2. Adapting to Changing Climate

- Understanding the connection between natural processes and systems, including climate change, are critical to Aotearoa New Zealand's infrastructure and regional development.

3. Managing Natural Resources Sustainably

- Understanding Aotearoa New Zealand's available natural resources is a prerequisite for formulating sound policies and management of energy, and land and oceans use.

4. Wider Use of Collections and Databases

- Earth science data and physical collections have enduring value and can be easily understood and used.

5. Shared Solutions

- Greater public understanding of the shared values of the natural environment, including from underpinning Earth science, is needed to foster engagement, collaboration, and solutions for a safer, cleaner and more resilient Aotearoa New Zealand.



Pūtaiao Aronuku Ā-Whenua, Ā-Moana



Key Deliverables

The following research initiatives represent some of the key deliverables for the year, as we progress towards our measures of success.

1. Develop more accurate models of the earthquake history, rates of modern deformation and state of stress of the plate boundary zone to provide better constraints for earthquake and tsunami risk assessment.
2. Constrain the links between tectonism, volcanism and geothermal systems in Aotearoa New Zealand to enhance geothermal resource potential and management.
3. Develop capability in landscape evolution modelling and exploring the land-to-sea boundary to understand the source-to-sink system of sediment transfer with a focus on low-lying coastal zones which are particularly vulnerable to the dynamics of natural and human-induced changes.
4. Be kaitiaki of Te Riu-a-Māui / Zealandia geoscience by ensuring our data, knowledge and understanding of the fundamental processes is of excellent quality and used by many.
5. Work closely with international scientific organisations, especially IODP and ICDP, to enhance understanding of global-scale environmental change, variability and impacts, and improve predictive capability for hazards and disasters.

Measures of Success

By June 2024, geological mapping and geophysical information of high-temperature geothermal systems is utilised in geothermal resource development and management.

By June 2025, a refined geological timescale will provide age control of past climate events to improve understanding of the rates and scale of environmental change.

By June 2025, our important geological hazard databases meet FAIR Data Principles, as appropriate, and are routinely used by government, industry and Māori for risk mitigation strategies and practice.

By June 2026, advanced understanding of diverse submarine landslide tsunami sources around Aotearoa New Zealand will refine existing hazard assessment and mitigation strategies.

By June 2027, knowledge of our continent, Te Riu-a-Māui / Zealandia has enduring value. Mātauranga, embodied in part through our databases, samples and collections, informs geological processes that shape Te Riu-a-Māui / Zealandia, as well as enriching Māori and Pasifika narratives of exploration and discovery.

By June 2027, advanced ability to measure and model surface processes across land, coastal, and marine settings will provide essential insight into changing environments. Our data and models support the effectiveness of Aotearoa New Zealand's response to hazards and climate change.

By June 2028, combined knowledge of earthquake phenomena through system-level, physics-based modelling and communicating understanding of seismic hazards will help reduce earthquake risk and promote community resilience.

Our Organisation

How we work

Our values signal how we want to work to achieve continued growth and success for GNS Science and to deliver greater value and impact. They serve as focus areas for shaping our culture, guiding our decision-making and priorities, as well as assessing the effectiveness of our organisation.

Our values articulate who we are, what matters to us and how we operate at GNS Science. Our values are centred around **Manaakitanga** – we do the right thing.

At GNS Science, Manaakitanga is about respecting and supporting our people and those we work with. We want people to not only feel a sense of belonging but know they are cared for and valued.

Manaakitanga is underpinned by the following values:

- We are **Connected** in our purpose with each other, with partners and stakeholders, and with our communities.
- We are **Inspired** by our work to explore, challenge, innovate and aim higher.
- We are **Empowered** to be our best – valued for our differences, encouraged to contribute, enabled to grow and develop.



Our 2022/23 summer interns and Ahunuku scholars with some of our GNS Science staff members

Tō Tātou Roopū Whakahaere

Embedding Vision Mātauranga in our work

GNS Science is committed to developing enduring and mutually beneficial partnerships with iwi and Māori. Te Punawai o Rangiatea, our long-term Māori Strategic Plan, aims to focus our research efforts on building strong connections with tāngata whenua that recognise and resource mātauranga Māori research efforts across all our research programmes. This includes building career pathways and developing homegrown talent through outreach education and scholarship initiatives with academic partner institutes. In addition, efforts to develop staff engagement and cultural awareness skills can help improve our research approaches, insights, and impact for our communities.

Partnering for Success

A critical component of our success at GNS Science is building Māori workforce capacity and deepening staff capability to effectively implement Vision Mātauranga. To do this we will:

- Provide more learning opportunities for young Māori in the science system through outreach events, camps, our Ahunuku internship scheme and post-graduate scholarships for Master's and PhD students.
- Deepen existing partnerships with iwi and Māori entities to collaborate on research bids that increase our shared understanding of research, mātauranga and science aspirations.
- Align our Māori research efforts with agreed national research priorities by developing a clear line of sight to our core themes and science

programmes and to guide future research opportunities.

- Collaborate with CRIs, universities, iwi/Māori authorities and other relevant agencies to strengthen cross-sector pathways that contribute to Vision Mātauranga outcomes.
- Build on existing Vision Mātauranga capability training for staff to enhance our engagement skills when working with iwi/Māori audiences for research development.
- Contribute to iwi research capability development through secondments, kura whenua, fieldwork and iwi-led research planning and resourcing.

GNS Science is committed to exploring how mātauranga Māori research is recognised and is part of the research we undertake. By connecting with research leaders within iwi/Māori groups and with cultural practitioners, we will explore how we ensure mātauranga Māori is part of the design and achievement of outcomes that provide scientific and broader cultural and community benefits. Engaging with iwi/Māori to describe how we interface and integrate Te Ao Māori perspectives into research is a critical component of facilitating both staff and iwi/Māori research partners as we develop research proposals.

As we continue to build meaningful partnerships with iwi/Māori, we will increase our reputation and visibility amongst Māori communities. This will assist us in attracting emerging Māori talent both within GNS Science or contracted to work within Māori agencies to build Earth science capability that contributes to

innovative and shared research outcomes in the future.

We are working with other CRIs to develop standard policy around Māori Data Sovereignty. GNS Science holds much data of interest to Māori and our emerging projects will benefit from having consistent CRI-wide approaches and protocols around collecting, managing, safeguarding and returning data that are sovereign to our Māori partners.

Key Initiatives for 2023/24:

- Continue our Māori workforce initiatives including:
 - Recruiting the 2023/24 Ahunuku programme student summer interns through our newly established Memorandum of Understanding with Te Herenga Waka Victoria University of Wellington.
 - Providing Māori Master's and PhD scholarships to support research to achieve Earth, energy, climate and/or natural hazards related qualifications.
- Deepen our regional engagement efforts to ensure local Māori priorities and research interests are enabled for ongoing kaitiaki and commercial interests of tāngata whenua.
- Work with Te Ara Pūtaiao (the pan CRI Māori network), to develop a present collective policy statement on research matters such as Indigenous Intellectual Property and Māori Data Sovereignty.

Valuing Our People

We are set to position GNS Science as the Science Employer of Choice, by building a diverse and inclusive culture, developing our people, and recognising the important and unique value they deliver to Aotearoa New Zealand.

Ensuring our workforce is aligned to our strategy and Science Roadmap, our focus is on developing a safe and inclusive workplace, growing skilled, inspiring and visible leaders, building capability for all staff, preparing for the workplace of the future, and recognising and rewarding high performance.

The Value of Diversity

We are working towards providing a workplace where people feel they can bring their “whole self” to work and be valued for their diverse life experience and perspectives. We will harness this diversity to continually improve our research capability and ability to serve communities.

We continue to encourage greater representation of Māori in our workforce and are working to create a bi-cultural welcoming and supportive culture to support Vision Mātauranga with our engagement and collaborative work with iwi and Māori.

Our standing and connections with science globally remain vital as does our need to attract high quality talent in Aotearoa New Zealand and internationally. We will use our people to create an irresistible employment proposition to attract the brightest and the best to work and collaborate with us.

Our Equity, Diversity and Inclusion Committee meet regularly, and their initiatives include speakers to highlight issues and experiences from a diverse range of perspectives, particularly on national days of importance such as Pride week. We also provide unconscious bias training for all people leaders and new employees.

The Early Career Network has a commitment to enhance connectivity supporting our early-career people and pastoral care for our Ahunuku scholars and summer students. We see our young scientists as the people to realise the future of our work as we continue our legacy of science excellence for future generations.

Pay equity will be a continued focus for 2023/24, and more work is being done to capture the data we need to measure and monitor our progress.



Recent GNS Science Ahunuku Māori scholarship students Shontelle Nahona, Te Aomania Te Koha, and Courtney Sanson, sharing their enthusiasm and knowledge at the 2023 Te Rarawa Noho Taiao, north Hokianga

Investment in Capability Planning and Development

We see all our people as leaders, regardless of position, and this is being supported through Tūhono, our leadership programme. This significant investment is blended learning with real world assignments used to bring learnings to life. Projects focus on innovation across science, processes, and all areas of organisational development.

We launched our Management Essentials module as part of the Workday launch. These provide managers with access to a wide range of 'essentials' to develop their manager capabilities.

The Science Roadmap is central in developing the planning for our future workforce. We will be supporting capability through formal training, mentoring, collaboration and connectivity to the wider science community.

Culture and Engagement

We recognise that our brand and our culture form the basis of our intent to become a science employer of choice. We will be building a road map to define our desired culture and engage our people to become our advocates. As 'One GNS' evolves, we will promote pride in our organisation as science leaders and kaitiaki, and work together to take this message to Aotearoa.

Key Initiatives for 2023/24:

The focus for 2023/24 is to build on the progress made in 2022/23:

- Building GNS Science as an **Science Employer of Choice** by implementing a new remuneration process, addressing pay parity issues, and culture mapping to define the workplace we want to be.
 - Preparing for the **Future of Work** by embedding Workday as an enabling technology, building capability through targeted development of leaders, implementation of a science mentoring framework and delivery of a strategic workplace plan with an accompanying talent management and succession planning framework.
 - Promoting **Equity, Diversity and Inclusion**, by implementing the development of bi-cultural awareness, greater use of te reo, increasing our collection of demographic data, and active planning to address identified pay equity gaps.
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Health, Safety and Wellbeing

GNS Science workers are exposed to some very hazardous environments and working conditions. Ensuring a work environment that is safe and healthy so far as is reasonably practicable is a recognised organisational priority. GNS Science further strives for a workplace that is free of psychosocial stressors such as fatigue and workplace bullying. We regularly discuss best practice risk management with other Crown Research Institutes and agencies that face similar hazards to ours, as part of a continual improvement process.



Taking Ph measurements in our New Zealand Geothermal Analytical Laboratory (NZGAL), Wairakei

GNS Science invests in health, safety and wellbeing training for all workers, and provides protective equipment, safety monitoring systems and 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 the health, safety and wellbeing management system, via consultation on policies and procedures, and active participation in health, safety and wellbeing committees. Such inclusion has resulted in improved understanding, and increased levels, of health, safety and wellbeing leadership, ownership, and collaboration throughout the organisation.

We remain committed to ensuring our staff have the capability, as well as the understanding of the influence of their behaviours in ensuring safe outcomes for themselves and others. We are confident we have made good progress in developing a more inclusive and responsible health, safety and wellbeing culture in support of GNS Science's vision 'Health and Safety is at our core, empowering everyone, every day, everywhere'.

Key Initiatives for 2023/24:

- Implement the findings of the KPMG baseline review of the GNS Science Health, Safety and Wellbeing Management System against ISO 45001 (Occupational Health and Safety Management systems), with a view to achieving full accreditation within three years.
- Implement a practicable enhanced solution to the management of critical risk at GNS Science, including a system to manage and audit performance and integrity of critical risk controls and to ensure effective control ownership.
- Implement a wellbeing framework to manage psychosocial hazards and risks.

Connectivity and Innovation

Our Science Roadmap challenges everyone at GNS Science to work with and deliver meaningful value for our major stakeholders. The focus is to understand the needs of our major stakeholders/partners and end-users in order to inform the very early stages of all our research activities.

During the 2022/23 year, we began the development of our Engagement Strategy, aligned to our Science Roadmap. We aim to be a proactive, responsive, and widely trusted partner to our stakeholders, known for our focus on mission-led science and creating impact and value for Aotearoa New Zealand, and with the guidance of the Strategy, we will continue to evolve the way we engage with our major stakeholders, while also ensuring our commitment to stakeholders is grounded in mutual respect, meaningful connections and organisational consistency.

The leverage GNS Science (and Aotearoa New Zealand's research capacity) receives from international research collaborations and partnerships remains high and delivers quality research outcomes. The strategic agreements with our international geoscience and isotope science partner agencies in Australia, Japan, Germany, Italy, and the USA remain strong and hold significant potential. The examples of the strategic national memberships continue to enable national access to collaborative resources, including the International Ocean Discovery Program (IODP) and the International Continental Scientific Drilling Program (ICDP).

The focus of our Innovation Hub is to establish innovation as a practice within GNS Science, one that involves identifying problems and finding new solutions, and that when implemented creates value for our stakeholders and impact for Aotearoa New Zealand. Our innovation practice recognises the importance of stakeholder engagement to co-create and co-design initiatives that will deliver impact for them.

We continue to deliver programmes of innovation training and support for our scientists, to establish new agile work methods and to actively challenge and disrupt our existing ways of working. We will continue to roll out new designs to manage our science programmes, methods that actively promote diversity within our projects and greater connectivity across our themes.

This year our Early Career Networks will form the core of a cohort of innovation champions who will exemplify and promote new innovation tools and methods. We are also looking to include new workspace designs to foster innovation activities in the design and construction of any new facilities.

Key Initiatives for 2023/24:

- Deliver the new stakeholder Engagement Strategy. The Engagement Strategy identifies and targets the priority stakeholders GNS Science must focus on to deliver outcomes prescribed in the Science Roadmap.
 - Enhance the GNS Science sponsorship process to deliver on the four Science Themes' mission-led science as outlined by the Engagement Strategy. The focus will be on reflecting the science needs of our priority stakeholders and their science outcomes.
 - Develop a monitoring framework based on the value propositions developed for the priority stakeholders identified by the Engagement Strategy.
 - Continue to allocate capability development funds to help drive our innovation practices.
-

Information Services and Technology

GNS Science is investing in its Information and Communication Technologies (ICT) infrastructure to ensure that we are well-positioned to take advantage of the growing opportunities across the Aotearoa New Zealand science and innovation system for high-performance computing and associated data science opportunities.

Key elements of our Information Services and Technology strategy are:

- **Science technology.** To support the delivery of the GNS Science Data Strategy, we will provide tools and services to enable the much greater application of Data Science in our work. We will provide an increased engagement capability to better support our science staff in the use of data across its full lifecycle. We will consolidate and standardise these services to increase their availability and improve the cloud readiness of the work that GNS Science conducts, so that we can easily take advantage of the scalability and resiliency that provides. Over the next four years our work in fields such as machine-learning and big data/analytics will enable greater capability to discover insights and provoke better decisions.

- **Organisational intelligence and efficiency.** The theme of this focus area is on providing better information to support decision-making. This will help GNS Science to enhance delivery of our research programmes and contract commitments at all levels and better understand financial and capability drivers.
- **Collaboration and knowledge dissemination.** The provision of better collaboration tools and practices will enable seamless programme and project teams to work from any external organisation and scientific disciplines to deliver shared goals. An increased focus on the availability of our datasets and improved data management of them will also lead to better outcomes for our stakeholders and partners.
- **ICT infrastructure modernisation.** This is an enablement theme, continuing our programme of consolidation and redesign of the GNS Science ICT Infrastructure to better provide security, resiliency, immediacy, scalability and cost savings.

Key Initiatives for 2023/24:

- Continue the staged implementation of a Content Management System to improve upon the consistent management and accessibility of our information for staff and GNS Science partners.
- Review our hybrid-cloud needs to provide the best path forward for future GNS Science science technology activities.
- To support enhanced Data Science capabilities at GNS Science, standardise and centralise our scientific computer usage for greater efficiency and better cloud readiness.
- Deliver our 'Year 3' CyberSecurity uplift programme and report on its measurable impact to the service, availability, readiness and response capability of GNS Science (as measured by the National Institute of Standards and Technology (NIST) framework).



Gas sampling from a fumarole on Moutohora (Whale Island)

Financial Services

GNS Science aims to achieve a level of financial capacity that enables the fulfilment of our vision and delivery of our strategic goals and objectives. During the 2022/23 year, we completed the development of a draft long-term Financial Strategy that aims to achieve new levels of success and growth.

Key elements of the draft Strategy are:

- **Improved financial capacity.** Ensuring GNS Science has the financial resources to meet our goals and plans, alongside a resource allocation process that delivers our priorities.
- **Delivering improved financial performance.** Ensuring an appropriate level of margin from our research and commercial work and that our costs for supporting our operations are optimised.
- **Delivering financial information and advice for decision-making.** Supporting our people with the best information and tools to navigate their work.
- **Managing our public resources in an appropriate manner.** While GNS Science's revenue continues to grow at a good rate, we are mindful that some of our funding streams are coming to an end in the next two years and we face some funding uncertainty into the future. In addition, the economic climate is challenging – we are operating in a complex environment with significant inflationary pressures. We are endeavouring to improve our bottom-line so we can reinvest in our future, including looking closely at our external costs, exploring

growth opportunities, and making the most of collaborative working and investments.

Key Initiatives for 2023/24:

Focused on achieving the full benefits of the new Enterprise System, including reduced administrative burden, improved resource allocation, more accurate costing and budgeting, and improved reporting and business insights, we will:

- Complete improvements to financial modelling and forecasting and build these into the new finance system (Adaptive Planning).
- Complete improvements in Procurement through review and implementation of strategy, capability and savings opportunities.
- Improve delivery of financial information and advice for decision-making, ensuring our people have the best information and tools to navigate their work.

Property and Facilities

Advancement of the GNS Science Property Strategy continues to be a priority. GNS Science requires contemporary facilities to enable the delivery of great science into the future, to minimise health and safety risks to our staff and support their wellness, to create connection both internally and externally, and to bring our people together under a 'one GNS' vision where our facilities enable connection, collaboration, and innovation.

In the 2023/24 year, we will be progressing plans for our new Volcanology and Visitor Centre and further considering the opportunity for a Geothermal Energy Innovation Centre at our Wairakei campus.

Over the past year, GNS Science has been actively contributing to the Research, Science and Innovation Property Strategy for Aotearoa New Zealand being prepared by central government. This work on the Wellington Science City Proposal will continue as progress is made to implement the Government's vision of creating science and research hubs. We will retain a focus on engaging with relevant partners, including mana whenua, others in the science system and government, in particular on the developed design of the renewal of our Wairakei facilities to ensure we deliver the best possible facilities and environments for our people, and to facilitate collaboration and innovation wherever possible.

Key Initiatives for 2023/24:

- Progress plans for of the new Volcanology and Visitor Centre at Wairakei, which forms Stage 1 of the Campus Development Plan.
- Continue to engage with and respond to the Wellington Science City proposal and support the implementation of any decisions made by the Government in relation to facilities in Wellington.

Financial Projections

The Financial Projections for the next three years reflect the continued organisational advances being implemented to improve the performance of GNS Science.

GNS Science's revenue is projected to increase by 6.9% during 2023/24 compared to 2022/23. The main increases arise from the GeoNet programme (\$7.4m). Approximately 92.5% of our revenue is contracted or awarded.

Department costs remain constrained during the next few years, with base expenditure levels consistent with 2022/23. This is to provide the financial capacity to support new strategic initiatives necessary for GNS Science to continue its growth and improved performance.

The projections also include additional capital investment per annum to enable further development of fit-for-purpose assets over time. The capital programme includes an estimate for the first stage building development at our Wairakei campus, which is subject to Board and the Minister's approval. There is sufficient actual and forecasted cash flows to meet business needs over the Statement of Corporate Intent period, dependent on the increase of activity levels in research and commercial revenue.

Shareholder Consent for Significant Transactions

The Board will obtain prior written consent of Shareholding Ministers for any transaction or series of transactions involving full or partial acquisition, disposal, or modification of property (buildings, land, and capital equipment) and other assets with a value equivalent to or greater than \$10 million or 20% of the Company's total assets (prior to the transaction), whichever is the lesser.

The Board will obtain the prior written consent of Shareholding Ministers for any transaction or series of transactions with a value equivalent to or greater than \$5.0 million or 30.0% of the Company's total assets (prior to the transaction) including:

- the acquisition, disposal, or modification in a joint venture, partnership, or other similar association;
- the acquisition or disposal in full or in part of shares or interests in external companies, subsidiaries, and business units;
- transactions that affect the Company's ownership of a subsidiary or a subsidiary's ownership of another equity;
- other transactions that fall outside the scope of the definition of the Company's core business or may have a material effect on the Company's science capabilities.

The Board will advise the Shareholding Ministers in writing (in the Quarterly Report) before entering into any transaction below this threshold related to property or to a specific commercialisation venture which involves change in intellectual property ownership or control.

Ratio of Shareholders' Funds to Total Assets

The target ratio of 'shareholders' funds to total assets' is as follows:

| Target ratio | 2023 Forecast | 2024 Outlook | 2025 Outlook | 2026 Outlook |
|--------------|---------------|--------------|--------------|--------------|
| % | 46.4% | 45.8% | 45.7% | 45.9% |

Shareholders' funds are defined as the sum of the 'share capital' and 'equity reserves' (otherwise called 'total equity'). Total assets are defined as the sum of the net book value of 'current' and 'non-current assets'. This is 'as disclosed' in the Company's balance sheet as per the Annual Report, prepared in accordance with the accounting policies adopted by the Board.

Commercial Value

Section 16(3) of the CRI Act requires the Company to furnish an estimate of the current commercial value of the Crown's investment.

The Board is satisfied that the net asset position (or shareholders' funds) as at 30 June 2022 is a fair and reasonable indication of the commercial value of the Group. The net asset position as shown in accordance with the Company's accounting policies for 30 June 2022 was \$40.1 million.

Dividend Policy

The GNS Science dividend policy states that the Company may elect to return surplus cash to shareholders in the form of a dividend when no sound investment opportunities exist (including reinvestment, commercialisation, capital expenditure, and the retention of important capabilities).

GNS Science is investing in people, systems and science infrastructure to enable delivery of its research strategies over the longer term. Therefore, no dividend is proposed in the short to medium term.

Activities where Shareholder Compensation would be Required

The Board would look to seek compensation from the shareholders in the following circumstances:

- Where the shareholders instruct GNS Science to undertake activities or assume obligations that would result in a reduction of the Company's profit or net realisable value;
- Where the Board may consider undertaking strategic investments for the wider benefit of the New Zealand public, involving financial outlays beyond those incorporated within the Company's Statement of Corporate Intent or financing capabilities.

No request for compensation is currently being sought from the shareholders. At this time no such investment has been identified, nor have any financial projections for such investment been included in GNS Science's Statement of Corporate Intent 2023-28.

Group ratios and statistics

| Year ending 30 June | Forecast 2022/23 \$000 | Outlook 2023/24 \$000 | Outlook 2024/25 \$000 | Outlook 2025/26 \$000 |
|---|------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Revenue (\$000s) | | | | |
| Total revenue | 123,287 | 131,738 | 135,314 | 140,930 |
| Revenue growth | 13.9% | 6.9% | 2.7% | 4.2% |
| Operating results (\$000s) | | | | |
| Operating expenditure (excluding depreciation) | 115,580 | 121,220 | 122,615 | 126,386 |
| Earnings before interest, tax, depreciation and amortisation (EBITDA) | 7,707 | 10,518 | 12,699 | 14,544 |
| Earnings before interest and tax (EBIT) | 493 | 3,284 | 4,493 | 5,625 |
| Net profit/(loss) before tax | 1,423 | 4,214 | 5,093 | 5,925 |
| Net profit/(loss) after tax | 1,025 | 3,034 | 3,667 | 4,265 |
| EBITDA per FTE | 16 | 20 | 24 | 27 |
| Total assets | 88,628 | 96,429 | 104,763 | 113,491 |
| Total equity | 41,129 | 44,163 | 47,830 | 52,096 |
| Capital expenditure | 9,384 | 18,495 | 19,345 | 19,637 |
| Liquidity | | | | |
| Quick ratio | 1.5 | 1.2 | 0.9 | 0.8 |
| Interest coverage | n/a | n/a | n/a | n/a |
| Profitability | | | | |
| Return on equity | 2.6% | 7.4% | 8.3% | 8.9% |
| Operating margin | 6.3% | 8.0% | 9.4% | 10.3% |
| Operating risk | | | | |
| Profit volatility | 52.4% | 47.1% | 42.4% | 32.9% |
| Forecasting risk | 4.7% | 4.0% | 3.9% | 1.2% |
| Growth/Investment | | | | |
| Capital renewal | 1.3 | 2.6 | 2.4 | 2.2 |
| Financial strength | | | | |
| Equity ratio | 46.4% | 45.8% | 45.7% | 45.9% |

Accounting Policies

Reporting entity and activities

The Institute of Geological and Nuclear Sciences Limited is established under the Crown Research Institutes Act 1992 and the Companies Act 1993. Its subsidiary companies are established under the Companies Act 1993. The financial statements are prepared in accordance with the Crown Research Institutes Act 1992, the Public Finance Act 1989, the Companies Act 1993, the Crown Entities Act 2004 and the Financial Reporting Act 2013.

Consolidated financial statements for the group comprising the Institute of Geological and Nuclear Sciences Limited (the Company) and its subsidiaries are presented, and the effects of intra-group transactions are fully eliminated in the consolidated financial statements. Subsidiaries are those entities controlled by the Company.

Control is achieved where the Company has the power to govern the financial and operating policies of an entity to obtain benefits from its activities.

The subsidiaries of the Company are:

- Isoscan Limited
- Isoscan Food Limited
- Geological Surveys (New Zealand) Limited
- Geological Risk Limited
- GNS Science International Limited.

The principal activities of the Group are to undertake geoscience and isotope science research, development and commercial projects, predominantly in New Zealand.

Revenue

Strategic Science Investment Fund

The Company is party to a Strategic Science Investment Fund (SSIF) agreement with the Crown to perform research activities. Revenue under this contract is treated as a Government Grant under NZ IAS 20.

Revenue from other Research and Commercial Contracts

Revenue from other research and commercial contracts are accounted as revenue from contracts with customers under NZ IFRS 15.

Revenue earned from the supply of goods and services is measured at the fair value of consideration received and is recognised when the significant risks and rewards of ownership of the goods have been transferred to the buyer.

Revenue from services is recognised based on the percentage of work completed. Any amounts received in relation to work not yet commenced are recorded as revenue in advance.

Funding of the GeoNet Programme's Assets and Operating Costs

Assets previously owned by the Earthquake Commission (EQC) were transferred to the Company on 1 July 2021.

Funding received from EQC relating to asset purchases and operating costs is treated as Capital and Operating Government Grants respectively under NZ IAS 20.

Property, plant and equipment

Property, plant and equipment are stated at cost less accumulated depreciation and impairment. Cost includes expenditure that is directly attributable to the acquisition of the item. Assets are depreciated on a straight-line basis at rates calculated to allocate the assets' cost over the estimated remaining useful lives. Freehold land is not depreciated.

The estimated useful lives, residual values and depreciation methods are reviewed annually, with the effect of any changes in estimate accounted for on a prospective basis. The gain or loss arising on the disposal or retirement of an item of property, plant and equipment is recognised in profit or loss.

Heritage Assets – Collections, Library and Databases

The Company owns various collections, library resources and databases that are an integral part of the research work undertaken by the Company. These collections are highly specialised and there is no reliable basis for establishing a valuation. The major collections are:

- The National Paleontological Collection
- The National Petrology Reference Collection
- The Historical Geological Map Archive.

Intangible assets

Software, patents and capitalised development costs have a finite life and are included at cost less accumulated amortisation and impairment. Software as a Service (SaaS) configuration and customisation costs ceased to be an intangible asset.

Amortisation is charged on a straight-line basis at rates calculated to allocate the assets' cost over their estimated remaining useful lives.

The estimated useful life and amortisation method are reviewed annually, with the effect of any changes in estimate being accounted for on a prospective basis.

The following useful lives are used in the calculation of amortisation:

- Software 4–8 years
- Patents 4–17 years
- Capitalised development costs 4–8 years.

Deferred tax

Deferred tax is accounted for using the comprehensive balance sheet liability method in respect of temporary differences arising from differences between the carrying amount of assets and liabilities in the financial statements and the corresponding tax base of those items. In principle, deferred tax liabilities are recognised for all taxable temporary differences. Deferred tax assets are recognised to the extent that it is probable that sufficient taxable amounts will be available against which deductible temporary differences or unused tax losses and tax offsets can be utilised. The carrying amount of deferred tax assets is reviewed and reduced to the extent that it is no longer probable that sufficient taxable profits will be available to allow all or part of the assets to be recovered. Deferred tax assets and liabilities are measured at the tax rates that are expected to apply in the period in which the liability is settled or the asset realised.

Under Section OB1(2)(d) of the Income Tax Act (2007), the Company is not required to maintain an imputation credit account.

Following changes to tax depreciation rules in 2020, the Company now recognises a deferred tax asset in respect of its buildings.

Employee entitlements

Liabilities for wages and salaries, annual leave, long service leave and retirement leave are recognised when it is probable that settlement will be required, and they are capable of being reliably measured. Employee benefits to be settled within twelve months are reported at the amount expected to be paid and are classified as current liabilities. Employee benefits not expected to be settled within twelve months are reported at the present value of the estimated future cash outflows.

Provisions for long service leave and retirement leave depend on a number of assumptions such as the expected employment period of employees, salary levels and the timing of employees taking leave. When measuring employee benefit liabilities risk-free discount rates provided by The Treasury are used as the appropriate discount rates, the salary increase factor is based on forecast information and employee pattern of leave has been determined after considering historical data.

Financial instruments

Capital Management

The Group manages its capital to ensure that entities in the Group will be able to continue as going concerns while maximising the return to shareholders through the optimisation of the debt and equity balance. The capital structure of the Group consists of cash and cash equivalents, and equity attributable to equity holders of the parent, comprising issued capital and retained earnings.

The Group is not subject to any externally imposed capital requirements.

Currency Risk

The Group undertakes certain transactions denominated in foreign currencies.

Exchange rate exposures are managed within approved policy limits using forward foreign exchange contracts. These derivative financial instruments are initially recognised at fair value on the date the derivative contract is entered into and are subsequently remeasured to their fair value at the end of each reporting period.

Derivatives are carried as assets when the fair value is positive and as liabilities when the fair value is negative. The resulting profit or loss is recognised in profit and loss immediately, unless the derivative is designated effective as a hedging instrument, in which event the timing of the recognition in profit or loss depends on the nature of the hedging relationship.

The effective portion of changes in the fair value of cash flow hedges is recognised in other comprehensive income and accumulated in a cash flow hedge reserve.

The gain or loss relating to any ineffective portion is recognised immediately in profit or loss.

Interest Rate Risk

The Group operates a call account and has short-term deposits on which interest is earned. Where possible the Group manages exposures to interest rate fluctuations through prudent management of its treasury operations. In managing interest rate risks the Group aims to reduce the impact of short-term fluctuations on earnings. Over the longer term, however, permanent changes in interest rates will have an impact on profit.

Credit Risk Management

The financial instruments which expose the Group to credit risk are principally bank balances, short-term investments and accounts receivable. The Group monitors credit risk on an ongoing basis. Bank balances and short-term investments are held with New Zealand registered banks in accordance with the Group's treasury policy. No collateral is held by the Group in respect of bank balances, short-term investments or accounts receivable. The maximum exposure to credit risk is represented by the carrying value of each financial asset in the Balance Sheet.

Liquidity Risks

The Group manages liquidity risk by maintaining adequate reserves, cash deposits and reserve borrowing facilities, by monitoring forecast and actual cash flows and matching the maturity profiles of financial assets and liabilities, all of which are of a short-term nature. The Group continues to generate sufficient cash flows from operations to meet financial liabilities.

Trade and other payables

Trade and other payables are non-interest bearing. In recognition of the Government's requirements to support the economy by ensuring prompt payment, we are now targeting to make payments within 10 working days from receipt of invoice.

The carrying value of creditors and other payables approximates their fair value.

Related party transactions

The Crown is the ultimate shareholder of the Company. No other transactions with New Zealand government owned entities are considered as related party transactions in terms of NZ IAS 24.

Leases

GNS Science considered adopting NZ IFRS 16 Leases during the financial year ended June 2021. Given that the value of leases is not material to the overall Balance Sheet, and the impact on profit and loss was negligible, it was decided not to adopt NZ IFRS 16.

Preparation disclosures

Statement of Compliance

The financial statements are prepared in accordance with New Zealand generally accepted accounting practice. They comply with New Zealand equivalents to International Financial Reporting Standards and other applicable Financial Reporting Standards, as appropriate for profit-oriented entities. The financial statements also comply with International Financial Reporting Standards.

Accounting policies are applied consistently to all periods presented in the financial statements unless otherwise stated.

Measurement Basis

The financial statements of the Group are prepared on an historical cost basis, except that derivative financial instruments are measured at their fair value. Transactions in foreign currencies are converted at the New Zealand rate of exchange ruling on the date of the transaction. Monetary assets and liabilities at year end are converted to New Zealand dollars at the exchange rate ruling at balance date. The financial statements are presented in New Zealand dollars, which is the Group's functional currency. All values are rounded to the nearest thousand dollars.

Interest in Joint Arrangements

A joint arrangement is an arrangement whereby the Company or its subsidiaries have joint control over an entity. Joint control is the contractually agreed sharing of control of an arrangement, which exists only when decisions about the relevant activities of that entity require the unanimous consent of the parties sharing control. A joint arrangement is either a joint operation or a joint venture. For a joint operation the Group recognises its share of assets, liabilities, revenues and expenses on a line-by-line basis using the proportionate method. For a joint venture the Group recognises its interest in a joint venture as an investment and accounts for that investment using the equity method.

Classification of Financial Assets and Liabilities

The Group holds loans and receivables. These are measured at cost less impairment, or in the case of trade receivables, reduced by an allowance for doubtful debts.

Financial liabilities, excluding derivative financial instruments, are classified as 'other financial liabilities'. Other financial liabilities are initially measured at fair value, net of transaction costs. Other financial liabilities are subsequently measured at amortised cost, with interest expense recognised on an effective interest basis.

Critical Accounting Estimates and Judgements

In applying the accounting policies, there is the requirement for judgements, estimates and assumptions to be made about the carrying amounts of some assets and liabilities. The estimates and assumptions are based on historical experience and other relevant factors. Actual results may differ from these estimates.

Accounting policies where critical estimates have been made include property, plant and equipment, intangible assets, impairment of assets and liabilities, and employee benefits. Judgement has been applied in determining not to value heritage assets for financial reporting purposes.

New Standards and Interpretations Not Yet Adopted

There are no new accounting standards affecting the 2023/24 Financial Year.



David Smol, Chair

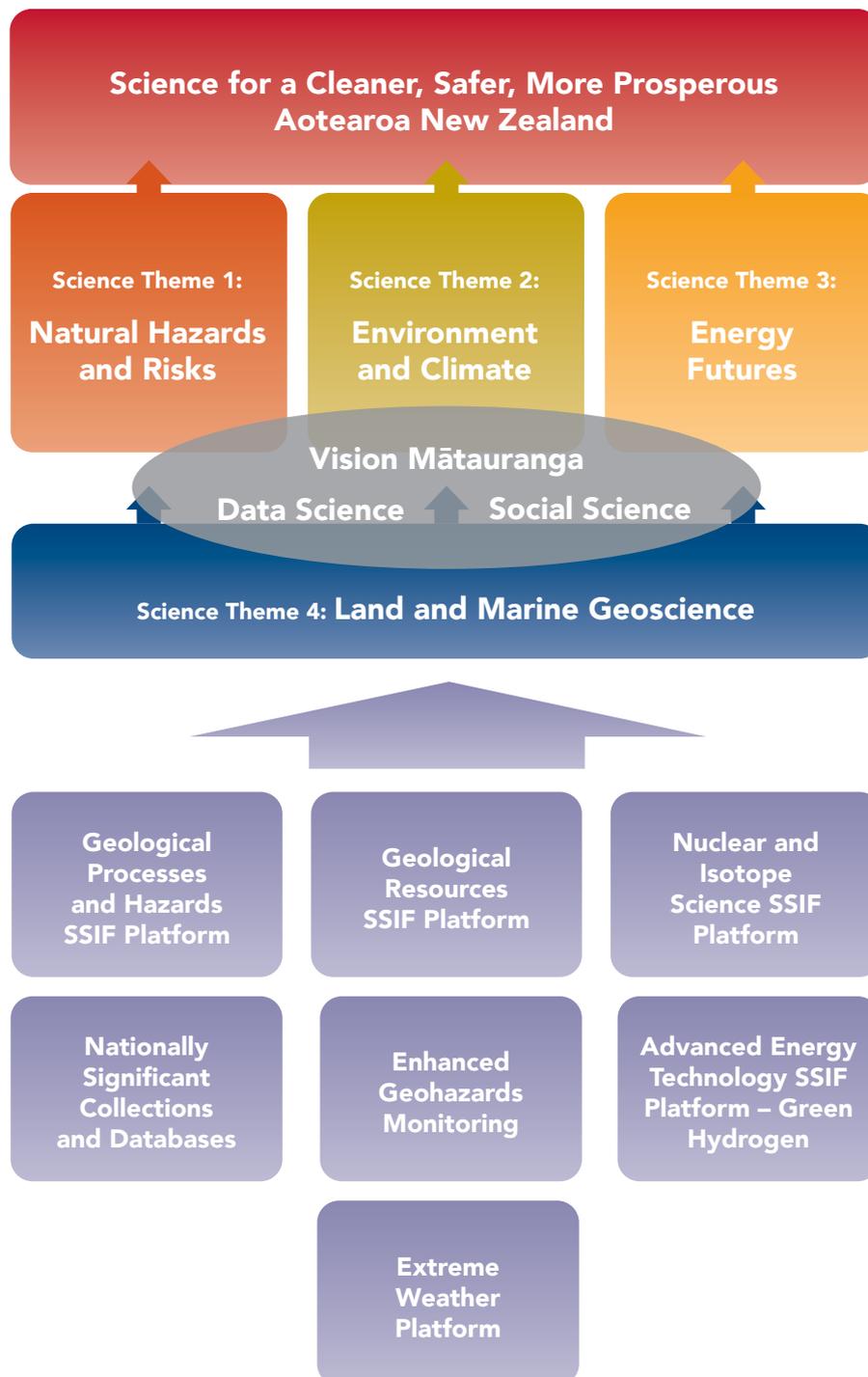


Dr John Sharpe, Deputy Chair

28th June 2023

Appendix One

Alignment of SSIF Investment to our Vision and Science Themes



Appendix Two

GNS Science Key Performance Indicators

| Indicator | Measure Year ending 30 June | Target 2022/23 | Target 2023/24 |
|------------------------------------|--|----------------|----------------|
| Strategic Intent | | | |
| Priority setting | Surveyed end-users have confidence that GNS Science considers their sector's priorities when setting their research priorities (%) | >70% | >70% |
| Team selection | Surveyed end-users have confidence that GNS Science has assembled 'best' teams for research delivery (%) | >85% | >85% |
| Science Impact | | | |
| Research delivery | Research milestones (critical steps) on track or completed | >87% | >87% |
| Impact case studies | Impact case studies published | 3 | 3 |
| Knowledge transfer | Surveyed end-users have adopted knowledge from GNS Science in the past three years (%) | >90% | >75% |
| Science Excellence | | | |
| Peer-review | Programme reviews carried out | 3 | 3 |
| Science quality | Impact of scientific publications (weighted citation index)* | 3.2 | 3.2 |
| Research collaboration | Papers co-authored with collaborators | 92% | 92% |
| Science Relevance | | | |
| End-user collaboration | Revenue per FTE from commercial sources (\$000) | 84 | 80 |
| Technology & knowledge transfer | Commercial reports per scientist FTE | 1 | 1 |
| Financial | | | |
| Revenue generation | Revenue per FTE (\$000) | 245 | 265 |
| Embedding Vision Mātauranga | | | |
| Māori engagement | Projects with Māori stakeholders embedded in the research | 8 | 8 |
| High Performance Culture | | | |
| Health & Safety | Recordable injuries per 200,000 work hours (rolling 12-month average) | <2 | <2 |
| Staff engagement** | Percentage of staff engaged in working for GNS Science | >72% | ≥73% |

* Mean 2-year impact factor for SCImago-assessed journals, weighted by the number of GNS Science publications.

** Based on the Qualtrics Survey cluster of questions and definition for staff engagement.

Appendix Three

Our Nationally Significant Collections and Databases

We are the custodian of eight Nationally Significant Collections and Databases (NSCD). As well as ensuring that the databases and collections are kept up to date with newly acquired samples and data, we will maintain and improve system functionality and infrastructure to ensure ready access both internally and externally for research, commercial applications, and public information.

- The **Regional Geological Map Archive and Data File (RGMAD)** is a collection of nearly 7,000 published and unpublished geological maps in hardcopy as well as digital image and GIS formats for Aotearoa New Zealand, its offshore territories and Antarctica. The maps range from field sheets to draft compilations to complete maps as published, vary in scale and extent from national to local, and range in emphasis, including general, urban, volcano, resource and tectonic. The collection includes maps dating back to the mid-19th century and is regularly added to when new geological maps are completed.

The hardcopy maps are stored in the Historic Geological Map Archive dataset at GNS Science's Lower Hutt building and some of the oldest maps are stored with the National Library. The maps in the archive are available as high resolution, georeferenced scans available for viewing and download via a map image server.

Vector GIS format geological and geomorphological maps, as well as 3D geological models, created since the mid-1990s are part of the Geological Map of New Zealand dataset, stored on GNS Science servers and available through web services and web map applications. These include digital GIS-based national geological maps at 1:1,000,000 (less detailed) and 1:250,000 (more detailed) as well as post-2012 geological map products for Christchurch-eastern Canterbury, Middlemarch, Napier-Hastings, Tongariro National Park, Victoria Range, northeastern Otago and Pukekohe.

- The **National Petrology Reference Collection and Petlab Database.** The National Petrology Reference Collection (NPRC) contains around 93,000 rock and mineral samples collected from Aotearoa New Zealand and its territories dating since the mid-19th century. The collection contains representative and less common rock types.

Petlab is Aotearoa New Zealand's national rock, mineral and geoanalytical database. It is operated by GNS Science, with GNS Science plus Auckland, Waikato, Massey, Victoria, Canterbury and Otago universities all contributing data. There are sampling data for all rocks and minerals in the NPRC and information for a further 120,000 or more samples with analytical data extracted from published literature. The database contains information on sample locations, descriptions and geochemical, geochronological and petrophysical analyses for rocks and minerals within the NPRC and from other published information on samples from on- and offshore Aotearoa New Zealand, Antarctica and worldwide.



 Henry Gard curates material in the National Paleontological Collection, Aotearoa New Zealand's largest and most comprehensive collection of fossils

- The **NZ National Paleontological Collection and Associated Databases** (NPC) contains fossil samples collected from Aotearoa New Zealand and its territories dating since the early 19th century. The collections include vertebrate, invertebrate and plant macrofossils, animal and plant microfossils, trace fossils, and fossil bearing rocks or rocks that have been sampled for microfossils. In addition to systematic reference collections of macro- and micro-fossil taxa from Aotearoa New Zealand and surrounding areas, including Antarctica and New Caledonia, the NPC includes a large number of type and figured specimens, as well as some important historical collections and a small amount of foreign reference material. Notably, the NPC also hosts the only International Ocean Discovery Program (IODP) Micropaleontological Reference Centre located in the Southern Hemisphere.

Included in this NSCD are two important databases that are founded in part on paleontological information: the New Zealand Stratigraphic Lexicon and the New Zealand Geological Time Scale. The Stratigraphic Lexicon records usage of stratigraphic nomenclature in Aotearoa New Zealand and is organised hierarchically. The lexicon can be viewed and searched through a web application. The New Zealand Geological Time Scale is the official record of important geological age boundaries and their definitions for the Aotearoa New Zealand region.

- The **NZ Fossil Record File** (FRF) comprises a comprehensive archive of fossil collections made from >110,000 locations around Aotearoa New Zealand and surrounding areas, including Antarctica and New Caledonia, recording detailed locality information, stratigraphic data, age and paleoenvironmental interpretations and, for many records, taxonomic lists of the fossils collected. The FRF has a digital equivalent Fossil Record Electronic Database (FRED) hosted by GNS Science that enables searches, analysis and downloads of fossil-related data. The New Zealand Fossil Record File is jointly managed by the Geoscience Society of New Zealand and GNS Science.



Chris Clowes holds a *Maoricardium spatiosum* fossil mollusc, part of our NZ National Paleontological Collection

- The **National Groundwater Monitoring Programme** (NGMP) is a groundwater quality dataset, collected regularly through collaborations with regional council personnel from 110 sites across all 15 regions of Aotearoa New Zealand, since 1990. The network attained national coverage in 1998. Information stored in the NGMP dataset includes groundwater source location, groundwater quality indicators (e.g., major ions, nutrients, dissolved metals), groundwater age tracer measurements (e.g., chlorofluorocarbons, tritium, and sulphur hexafluoride), mean residence time age interpretation at each site and key hydrogeological properties, where available. Samples are collected according to a national, dedicated protocol (published in 1999, updated in 2006, national environmental Monitoring Standards for discrete water quality 2009).

The NGMP assets are preserved and enhanced through dedicated quality assurance procedures, maintaining the viability and longevity of the network, adding new samples and data, undertaking research to enhance the assets, and ensuring that curation facilities are appropriate for long-term protection and availability. The NGMP dataset is stored in the broader Geothermal Groundwater Database (GGWD).

- The **National Earthquake Information Database (EID)** provides raw and derived data related to earthquakes in Aotearoa New Zealand, to the public, government agencies, industry and researchers. The EID includes the Earthquake Catalogue containing information on the epicentre location, depth and magnitude of earthquake occurrences. Acquisition of new data falls to GeoNet through their monitoring network of >190 seismographs and processing of the measured waveforms. The strong motion data product results from a national network of >260 sensors. Other EID datasets include moment tensors, felt reports, the digital waveform archive, seismograph station metadata, the national velocity model and a fault rupture model. Legacy seismograms recorded on paper or film are being scanned and digitised to help extend the record of seismicity further back in time.

- The **NZ Volcano Database** is largely a virtual collection of volcano-related data covering Aotearoa New Zealand's active and dormant volcanoes. Volcano-related images and videos, and data such as seismic, acoustic, geochemistry, ground deformation and geological maps are all stored as part of larger databases, many supported by the GeoNet hazard monitoring network. Volcano-specific datasets include the Eruption History Database.
- The **NZ Geomagnetic Database** enables the acquisition and transfer of critical Southern Hemisphere Earth's magnetic field measurements continuously collected at the Eyrewell (Canterbury), Scott Base (Antarctica), and Apia (Samoa) geomagnetic observatories to the global INTERMAGNET (International Real-time Magnetic Observatory Network) database. Through INTERMAGNET the data are easily accessible and

freely available to the public. Scientists around the globe use INTERMAGNET data to improve the understanding of the dynamics within the Earth's core that drive our protective shield and how it changes over time. Geomagnetic storms as potential hazards to power grids and therefore to society are of particular interest for Aotearoa New Zealand.

The database includes paper records of geomagnetic field values collected at Apia in 1908-1994, at Scott Base in 1957-1994, and in Canterbury in 1916-1995 (at Amberly until 1977, at Eyrewell from 1978) and these are being scanned and digitised. Digital records for Eyrewell (EYR), Scott Base (SBA) and Apia (API) geomagnetic observatories are available since 1951 with formats and sampling rates changing over time.

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 Iceberg in Tasman Glacier Lake

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Principal Location

GNS Science
1 Fairway Drive, Avalon
Lower Hutt 5010
PO Box 30368
Lower Hutt 5040
New Zealand

T +64-4-570 1444
E avalon@gns.cri.nz

Other Locations

National Isotope Centre
30 Gracefield Road
Lower Hutt 5010
PO Box 31312
Lower Hutt 5040
New Zealand

T +64-4-570 1444
E gracefield@gns.cri.nz

Dunedin Research Centre
764 Cumberland Street
Dunedin 9016
Private Bag 1930
Dunedin 9054
New Zealand

T +64-3-477 4050
E dunedin@gns.cri.nz

Wairakei Research Centre
114 Karetoto Road
Wairakei 3377
Private Bag 2000
Taupo 3352
New Zealand

T +64-7-374 8211
E wairakei@gns.cri.nz

Auckland GridAkl
12 Madden St
Wynyard Quarter
Auckland 1010
New Zealand

T +64-4-570-1444
E auckland@gns.cri.nz

