GNS SCIENCE TE PŪ AO

OUR STATEMENT OF CORPORATE INTENT

JULY 2022 – JUNE 2027

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: Using a hot water drill during a seismic survey of Discovery Deep on the Ross Ice Shelf, Antarctica

Cover: GNS Science and NIWA scientists examining 10 million-year-old rocks deposited by an underwater landslide at Rapanui Beach, North Taranaki. These ancient deposits serve as analogues to the more modern underwater landslides studied by the Te Tai-o-Rēhua Project: Assessing silent tsunami risk in the Tasman Sea

Presented to the House of Representatives pursuant to section 39 of the Public Finance Act 1989

CONTENTS

INTRODUCTION FROM THE CHAIR AND CEO

We are pleased to introduce the GNS Science Statement of Corporate Intent for 2022-2027. This Statement of Corporate Intent reaffirms GNS Science's strategic direction and our commitment to achieving a cleaner, safer, more prosperous Aotearoa New Zealand, and describes our strategy for the future and our key initiatives and performance measures for the 2022/23 year.

Over the past few years, Aotearoa New Zealand and our regional neighbours have been impacted by a series of almost unprecedented and unpredictable events: the COVID-19 pandemic and supply line disruptions, numerous extreme weather events, the Whakaari White Island and Hunga Tonga-Hunga Ha'apai eruptions and tsunami, and the Russian invasion of Ukraine and its economic impact. In different ways, these events have highlighted the need for resilience and adaptability. They also underscore the critical role of science and technology in mitigating their impacts and building greater resilience to future shocks. Perhaps now more than ever, science investment needs to be highly responsive to current and future needs.

STRATEGIC DIRECTION

GNS Science is committed to playing our part in delivering a modern, future-focused research system for Aotearoa New Zealand, and over the last 12 months we have continued to work with our partners across a range of sectors towards this goal. The Board is confident that GNS Science's vision, supported by its scientific capability, will deliver the transformative knowledge and innovations needed by the Government for a resilient society, sustainable environment and strong economy.

The Board and management have been working to refine GNS Science's strategic direction. We have recently completed the development of a strategic Science Roadmap to guide our research priorities in the coming years and ensure our organisation is set up for success. The Roadmap builds on work previously undertaken within GNS Science to align our strategic direction with long-term government priorities and the needs of our stakeholders, industry partners, and iwi/Māori interests. Aotearoa New Zealand's future success will be dependent on how we innovate and use technology to meet the challenges before us. GNS Science is well placed to make a significant and enduring contribution through relevant, agile and adaptable science, and innovative thought leadership as guided by the Roadmap. The direction it provides will also allow us to align and invest in the right people and infrastructure to maintain capability and capacity in key areas for Aotearoa New Zealand.

Aligned with the Science Roadmap is Te Punawai o Rangiātea, our recently completed Māori Strategic Plan, which we will begin to implement in the coming year. Te Punawai o Rangiātea sets out how we will go about becoming a trusted research partner with Māori, supporting shared aspirations and contributing to the wellbeing of Aotearoa New Zealand.

In November 2021, the Government started a discussion on the future of Aotearoa New Zealand's Research, Science and Innovation sector with the release of Te Ara Paerangi – Future Pathways Green Paper. We support the vision of a modern, future-focused research system that is adaptable, resilient and connected, and the direction provided in our new strategy documents means that we are well placed to work with the Government and other science organisations to shape the future of science in Aotearoa New Zealand into the future.

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. The Government released its preliminary report for Aotearoa New Zealand's Research, Science and Innovation Property Strategy in the last year, which has implications for the future location of our Wellington region facilities in particular. In the coming year, we will be primarily focused on engaging with relevant partners, including mana whenua, others in the science system and government agencies, to ensure that all co-location possibilities are considered and that together our property plans present a coherent picture for the Wellington region in line with the review. The redevelopment of our Wairakei site is a priority, including the design of a new Volcanology and Visitor Centre and a proposal for a Geothermal Innovation Centre.

CHALLENGES

Following the tragic events of 9th December 2019, we continue to prepare for the prosecution resulting from the WorkSafe investigation into the Whakaari White Island eruption and response. The trial is scheduled to be heard in 2023. This process continues to have a significant impact on the organisation and requires a substantial commitment of time and financial resources.

During the 2021/22 year, the GeoNet programme celebrated its 20th anniversary. Originally resourced to underpin research, GeoNet's purpose has grown to providing real-time monitoring and response to natural hazard events. Over the past twelve

HE KUPU WHAKATAKI MAI I TE TIAMANA ME TE TUMUAKI

months the importance of this role has been demonstrated in our response to the Hunga Tonga-Hunga Ha'apai eruption and tsunami and our ongoing monitoring of volcanic activity. We have been working with our stakeholders to develop secure, dedicated funding from central government for the GeoNet programme to ensure ongoing sustainability of the programme. In our view, it is crucial that vital national infrastructure like GeoNet, essential to public safety and resilience planning, is adequately funded for its expanding role.

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 land and water assets.

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

Dr Nicola Crauford
Chair

Ian Simpson
Chief Executive

VISION MĀTAURANGA

is at the core of GNS Science's strategic framework

CURRENT ENVIRONMENT

In recent years, there have been significant changes and developing needs across Aotearoa New Zealand. GNS Science has played a big part in responding to these needs. The COVID-19 pandemic, the intensifying effects of climate change and ongoing natural hazards are changing the lives of all New Zealanders. The importance of evidence-informed policy and decision-making has been heightened, along with the role of science in safeguarding our lives, our livelihoods and the future of our planet.

OUR SCIENCE IN A CHANGING WORLD

The role of science in society is changing, with new technologies and 'citizen science' bringing science closer to the everyday lives of New Zealanders. This brings opportunities for our communities to engage with science and understand its value in helping create the future. It also brings growing expectations of communication, participation and transparency in science. Increasingly, science is also being asked to deliver 'whole solutions' to complex issues.

GNS Science's recently completed Science Roadmap sets out our future science direction to 2032. The Roadmap builds on the work done in our strategic review process to align our strategic direction with long-term government priorities and the needs of our stakeholders, industry partners, and iwi/Māori interests. It describes our future science direction and focus to 2032 and will ensure 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.

The direction provided by the Roadmap will also guide our investment in the right people and infrastructure to maintain capability and capacity in key areas for Aotearoa New Zealand. It also demonstrates our contribution to the national discussion around the future of the Research, Science and Innovation sector in Aotearoa New Zealand. We support the vision of a modern, future-focused research system that is adaptable, resilient and connected, and in particular the concept of setting national priorities to guide the sector. We look forward to continuing our contribution to the work being undertaken by the Ministry of Business, Innovation and Employment (MBIE) on this.

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 recently completed Property Strategy provides a high-level planning framework across our portfolio of research laboratories, workshops, office accommodation and public interface property. In particular, the redevelopment of our Wairakei site is a priority in the coming year.

GNS Science recognises 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 Crown Research Institutes (CRIs) and other partners whenever possible for mutual benefit and to improve the outcomes for Aotearoa New Zealand.

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. Implementation of our Science Roadmap and Research Theme Plans 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.

Our Māori Strategic Plan – Te Punawai o Rangiātea, developed in conjunction with our Science Roadmap and Theme Plans, has recently been completed and 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.

TŌ TĀTOU TAIAO

RISK, RESILIENCE AND WELLBEING

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.

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 hazards and risks 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. This work also includes putting in place sustainable funding for important aspects of the hazard risk management system such as GeoNet and hazard models.

COVID-19 PANDEMIC

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 national CRIs in national emergency preparedness, response and recovery.

Like most sectors, science has continued to be significantly 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. Restricted international travel has, by necessity, taken our knowledge exchanges with international collaborators 'online' whenever possible. With the reopening of the borders, we will be able to renew our connections in person.

GNS Science is also highly dependent on international recruitment for our expertise, including our earlier-career staff. The opening up of international travel will allow us to increase our capability and diversity, 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.

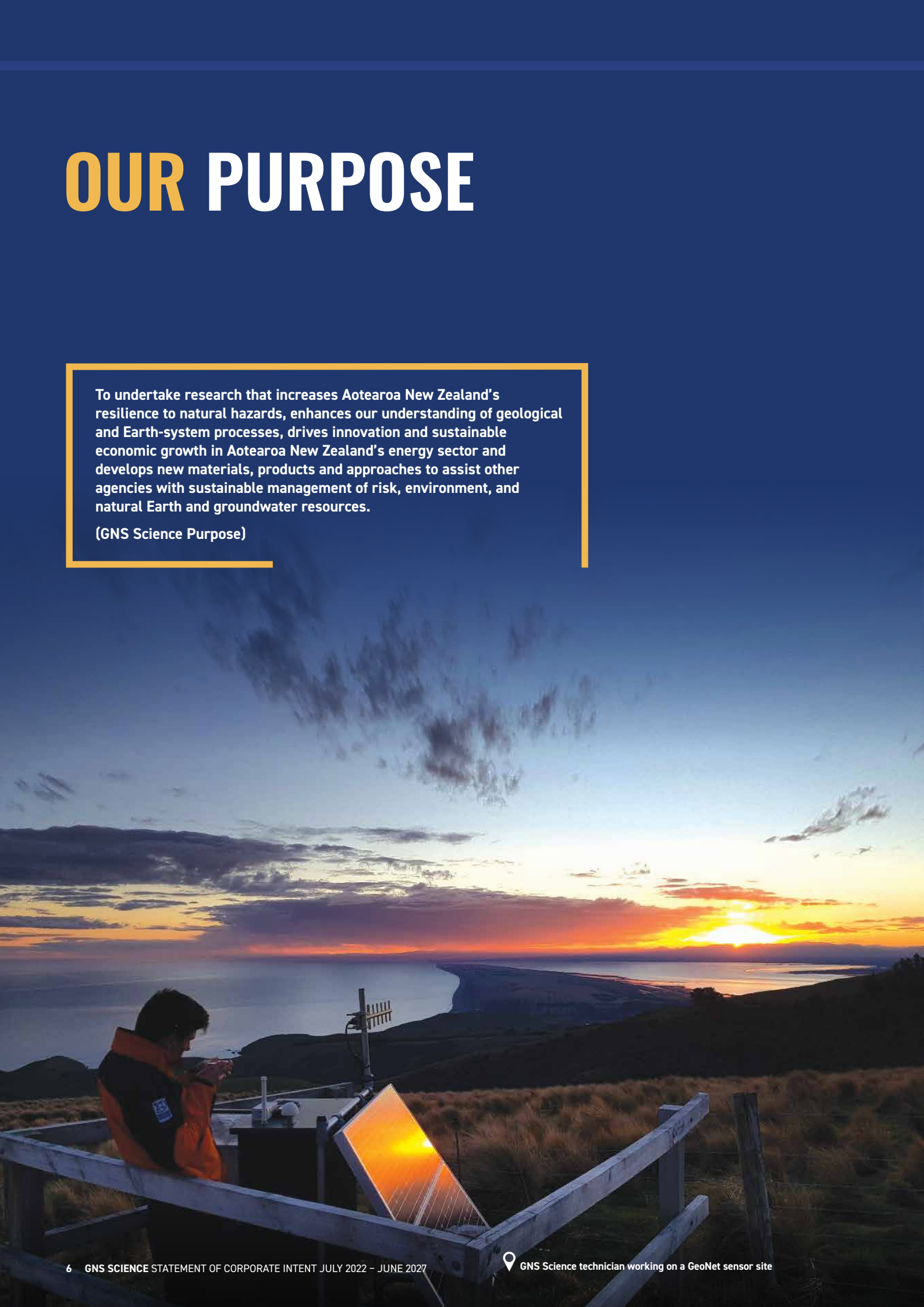
Across all CRIs, the pandemic has highlighted a common purpose and set of challenges. We will continue to build on the growing collaboration and commitment to pan-CRI approaches, working with other CRIs to identify how best we might contribute to a sustainable, resilient, and future-facing economic recovery.

Preparing the wave glider for deployment offshore from Hawke's Bay for a GPS acoustic survey that will be used to measure deformation of the seafloor near the Hikurangi subduction plate boundary

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)



GNS Science technician working on a GeoNet sensor site

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 five sites across Aotearoa New Zealand, 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 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 Ia 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.

GNS Science understands Māori success is Aotearoa New Zealand's success. Thus, Vision Mātauranga is at the core of our organisation's strategic direction. Over the next five years, GNS Science will continue to build enduring partnerships with tangata whenua. We aim to do so by deepening engagement activities with iwi/Māori agencies to identify collective benefits and enable a higher level of impact for Māori and all New Zealanders. Through our partnerships, we will continue to identify opportunities for co-designed programmes that respond to the unique and distinctive contribution that tangata whenua can make to research outcomes. We will do so through strong leadership, a clear research strategy and consistent engagement approaches and workforce development capability.

Since 2019, our focus has been to build internal Māori capability to develop a strong strategic direction that aligns with core business and complements the broader GNS Science strategic direction.

In 2021 we consulted with staff and Māori organisations to explore opportunities to incorporate mātauranga Māori into our research programmes. From this work, we have developed GNS Science's Māori Strategic Plan – Te Punawai o Rangiātea, which will focus our efforts on maintaining our connections with tangata whenua and recognising and resourcing mātauranga Māori as part of our research programmes, partnering with Māori to understand their aspirations and to generate new perspectives. These include building homegrown talent by developing our Māori scholarship initiatives and developing tailored staff cultural awareness training.

As a proactive science thought leader, GNS Science will ensure that our partnerships continue to create and contribute to bold and aspirational outcomes for Aotearoa New Zealand aligned with iwi/Māori goals and aspirations. Iwi/Māori have a growing interest in our science and research, and by co-designing research initiatives that recognise mātauranga we can jointly build resilience and develop new commercial and economic opportunities for Māori and all Aotearoa New Zealand communities.

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.

OUR DIRECTION

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 recently completed 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 following SDGs.

TŌ TĀTOU AHUNGA

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

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 CO_2 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.**

The Science Roadmap better aligns our strategic direction to the priorities of Aotearoa New Zealand 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.

GNS SCIENCE STRATEGIC FRAMEWORK

The GNS Science Strategic Framework highlights our research direction and enables clear line-of-sight throughout the organisation. It shows how our research themes, ways of working, plans and performance are aligned to deliver benefits for Aotearoa New Zealand. Vision Mātauranga permeates all our activities, as we work in partnership with Māori on their science needs.

In response to our shareholder expectation, stakeholder views and our engagement with iwi, our work is focused on four research Science Themes associated with the natural settings and geological challenges facing Aotearoa New Zealand and its people.

ENVIRONMENT AND CLIMATE

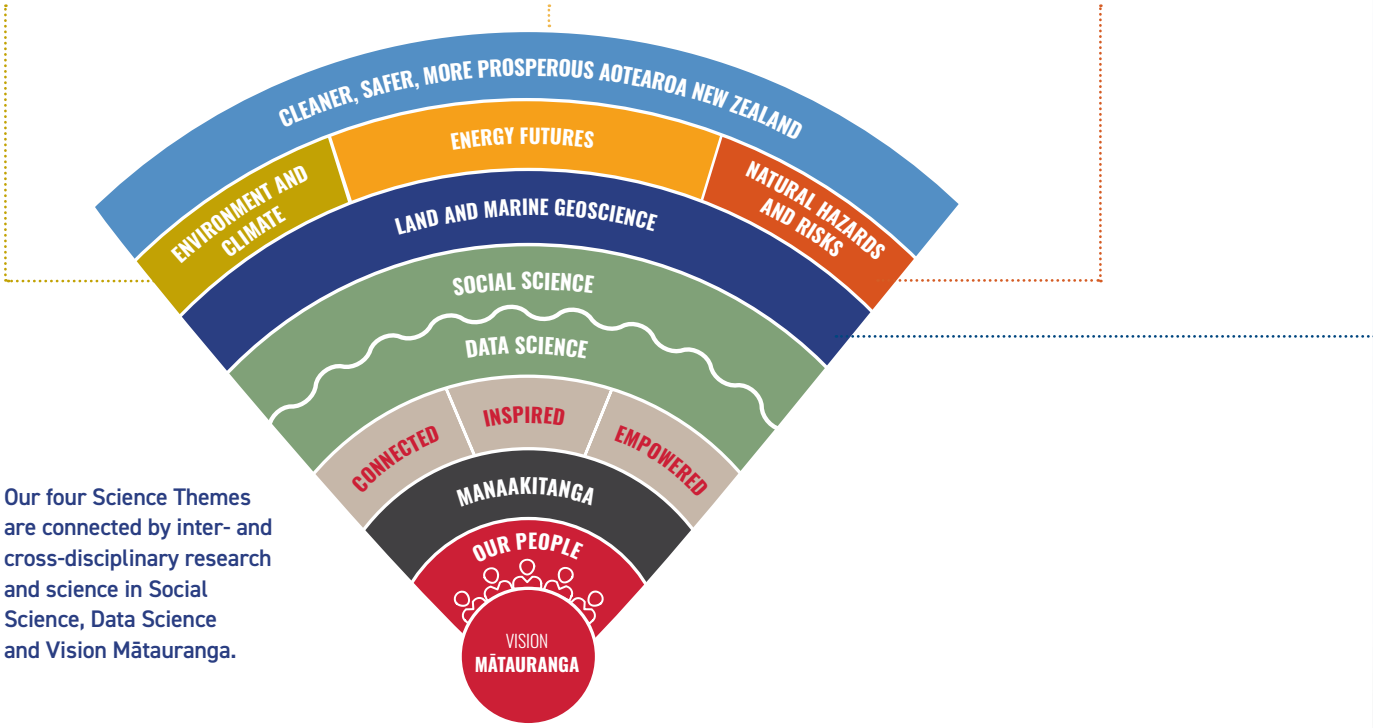
Our work in Environment and Climate focuses on sustainable management of the environment, and effective adaptation to climate change. Our work on natural Earth systems, such as the carbon cycle, sea level change and groundwater, underpins our global response. From our work on geological records, we will reveal the fundamental drivers and interactions of our global ocean and climate system.

ENERGY FUTURES

As the 'Energy CRI', we play a major role in enabling Aotearoa New Zealand's transition to a low-carbon future through the development of alternative energy and heat sources (geothermal, hydrogen, solar), Earth system energy storage, new materials for energy systems and storage, and cross sector support needed for enhanced energy security and resilience.

NATURAL HAZARDS AND RISKS

Natural hazards are part of our country's DNA and climate change is increasing both the risks and the impacts of hazard events. Managing our increasing exposure to natural hazards is critical to our future wellbeing and prosperity. GNS Science's extensive knowledge of Earth sciences, combined with social science research in resilience and preparedness, helps us span the full value chain to support response and grow resilience.



Our four Science Themes are connected by inter- and cross-disciplinary research and science in Social Science, Data Science and Vision Mātauranga.

LAND AND MARINE GEOSCIENCE

We generate knowledge about our continent and oceans recognising kaitiakitanga to improve forecasting capability for hazards and disasters, understand global-scale environmental change, variability and impacts, identify new sustainable natural resources, and be custodians of our databases and collections.

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, including 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.

Temporary GPS equipment being installed to monitor slow-slip earthquakes on the Hikurangi subduction zone

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.

SCIENCE ROADMAP

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 inter-disciplinary 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.

TE PUNAWAI O RANGIĀTEA – MĀORI STRATEGIC PLAN

We are seeking 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. This work will be driven by Te Punawai o Rangiātea, our new Māori Strategic Plan. GNS Science's Māori Strategy and Partnerships team are working with science leaders to develop processes and tools which seek to inform and work with iwi regarding consultation of field activities. Durable and mutually beneficial relationships will underpin this research delivery. Where appropriate, local iwi/Māori will be involved in research prioritisation, design, planning, implementation, and report writing. Results will be discussed and disseminated to relevant iwi groups through hui and other information transfer mechanisms.

STRATEGIC SCIENCE INVESTMENT FUND

GNS Science's Strategic Science Investment Fund (SSIF) investment is an important element in the delivery of our Science Roadmap. 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.

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:

Tūhura Papatūānuku Geo Noho included Panguru taitamariki and was an opportunity for them to learn about te taiao, supported by Māori knowledge holders and GNS Science experts

TŌ TĀTOU PŪTAIAO

- 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 allows 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 Southern Ocean. 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 manage future impacts from natural hazards is being tested.

GNS SCIENCE'S ROLE

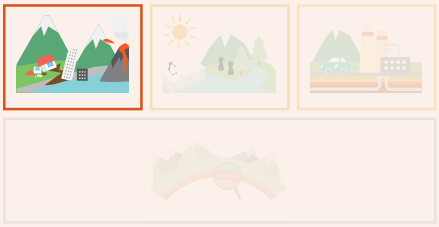
GNS Science has a national leadership role for research on the causes, consequences and risks of geological hazards to increase Aotearoa New Zealand's resilience. We have extensive scientific knowledge in Earth processes, and globally and nationally recognised expertise in hazard and risk modelling, 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 develop 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 and are aiming to deliver even greater benefit to Aotearoa New Zealand, our Pacific neighbours and beyond. As an integral component of GeoNet, 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.

Installing seismic equipment in coastal southern Hawke's Bay to record small earthquakes associated with a slow-slip event on the Hikurangi subduction zone under the east coast of the North Island

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* 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.

RESILIENCE TO NATURE'S CHALLENGES KIA MANAWAROA – NGĀ ĀKINA O TE AO TŪROA NATIONAL SCIENCE CHALLENGE

GNS Science hosts *Resilience to Nature's Challenges*, one of 11 National Science Challenges. The mission of the Challenge is to accelerate Aotearoa New Zealand's resilience to natural hazards through innovative, collaborative research.

Phase 1 of the Resilience Challenge ran from 2014-2019, with ten research programmes that sought to tackle key challenges in natural hazard resilience, and which were complementary to the existing Natural Hazards Research Platform.

In Phase 2 (2019-2024) we have organised our work around two central themes that address the Government's National Disaster Resilience Strategy and harness the combined research strengths of Phase 1 of the Resilience Challenge and the Natural Hazard Research Platform.

The **Understanding Hazard and Risk** theme comprises new modelling to advance our understanding of natural hazards (such as earthquakes and tsunami, volcanoes, coastal hazards, high impact weather, and wildfires).

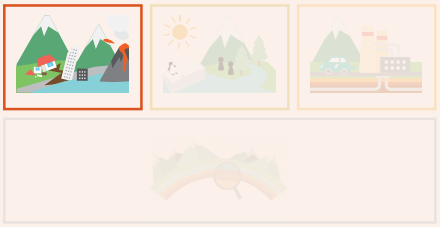
The **Resilience, Policy and Governance** theme comprises mātauranga Māori, social science, and engineering research to develop policies, tools and methods to ensure new resilience knowledge becomes part of daily decision-making in Aotearoa New Zealand.

As in Phase 1, the Resilience Challenge brings scientists, economists, mātauranga Māori experts and engineers together with research users to co-create new knowledge and solutions to accelerate Aotearoa New Zealand's resilience to ever-changing natural hazards.

Over the next two years the Resilience Challenge is focusing on five strategic priorities: integrated multi-hazard science, stronger partnership with Māori, elevated and embedded mātauranga Māori, maximising our impact and telling our story well through quality, effective science communication.

RESILIENCE TO NATURE'S CHALLENGES | Kia manawaroa – Ngā Ākina o Te Ao Tūroa | National SCIENCE Challenges

NATURAL HAZARDS AND RISKS



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).

Waves in Lowry Bay

- ***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 hazard 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 IMPACTS AND PRIORITIES 2022-27

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 anticipating the requirements of stakeholders in order to prioritise the delivery of the most important research.

4. Knowledge Exchange

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

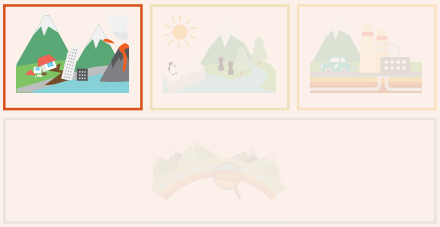
5. Building Community Resilience

- 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



RESEARCH OUTPUTS 2022/23

Progress towards measures of success is delivered through the following research outputs in the coming year:

1. Complete the GeoNet Strategic Review.
2. Complete the revision of the National Seismic Hazard Model (NSHM) and communicate results to key stakeholders.
3. Develop a Geohazards Event Response Framework.
4. Through CASCADE[1] engage with both GNS Science and external programmes to understand gaps in how science advice on geological hazards is developed and delivered to decision-makers, build links and identify opportunities for improving science advice about natural hazards and risk management.
5. Engage with Treasury to develop risk and resilience metrics aligned with changes to the Living Standards Framework.
6. Strengthen capability and capacity to better understand how iwi/Māori have built and maintained resilience and to support iwi/Māori priorities and initiatives for disaster risk reduction.
7. Engage with government to support a process for the development of risk tolerability/acceptability frameworks and risk treatment options including clarity on which agencies have accountability for different risks.
8. Ensure communication and uptake of physical science is enabled through integration with social science.
9. Collaborate closely with others to understand and publish information on the emerging technologies and methodologies resulting from the Hunga Tonga–Hunga Ha'apai eruption.

MEASURES OF SUCCESS

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 tsunami 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, a scientific review of risk tolerability and acceptability is being used to support an ongoing national conversation about geological hazard risk including clarity on which agencies have accountability for different risks.

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 2027, integrated system models for why, how and when geohazards occur will have been developed, using complementary statistical analysis, physical science and mātauranga Māori.

1 CASCADE is a programme aimed at delivering improvements in the assessment and communication of geohazard risk, and enhancing the science advice that is provided to risk managers.

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.

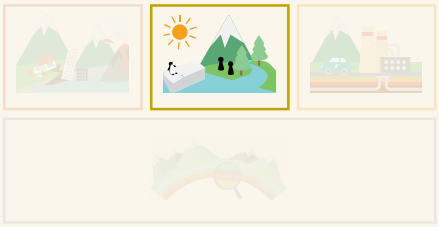
The impact of anthropogenic carbon emissions on our climate is unequivocal, with average temperatures on track to reach 1.5°C warmer than pre-industrial temperatures between 2030 and 2052.

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.

Collecting sediment cores during Lakes380 fieldwork on Lake Kahuparere, Northland

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.

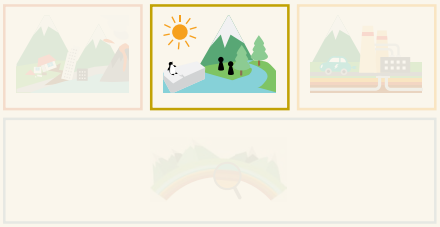
WORKING TOGETHER

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., NZ SeaRise, Carbon Watch, Future Coast Aotearoa) and joint initiatives with other environmental CRIs, such as the National Environmental Data Centre.

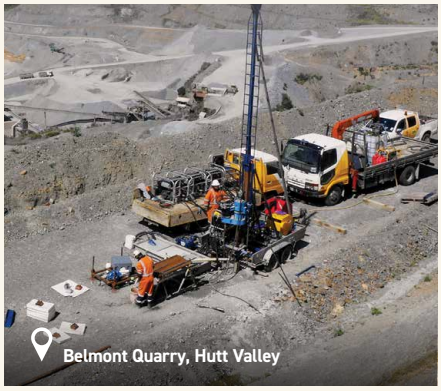
Working in more connected ways will enable our research contributions in groundwater, air quality and climate change to complement efforts by others. Together, we will develop and refine more accurate environmental and climate models and forecasts, more effectively communicate expected future impacts,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

ENVIRONMENT AND CLIMATE



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.



Testing an Antarctic drilling rig

ENVIRONMENT AND CLIMATE IMPACTS AND PRIORITIES 2022-27

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 land-based ecosystems.

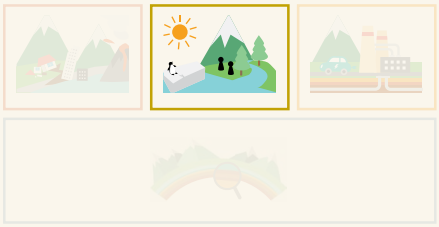
6. Sea Level Rise and Coastal Change

- 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).
- Develop mechanisms to mitigate or inhibit the transit of contaminants through our Earth system.

TE TAIAO ME TE ĀHUARANGI



RESEARCH OUTPUTS 2022/23

Progress towards measures of success is delivered through the following research outputs in the coming year:

1. Establishment of a world-class noble gases analytical machine at the Avalon Water Dating Laboratory, which will significantly enhance our capabilities with regard to understanding, e.g., denitrification, identifying groundwater recharge sources (drinking water standard), geothermal processes, etc.
2. A data release procedure is in place and used by the project team for the Groundwater SSIF programme to publicly release SSIF-created datasets.
3. SkyTEM processing, modelling, interpretation and visualisation capability has been developed at GNS Science, resulting in SkyTEM data being used to create three 3D hydrogeological models in Hawke's Bay. Resulting information and models are readily available for public access and guidance has been provided to Hawke's Bay Regional Council for utilisation of these data within numerical groundwater models.
4. New regional scale models of circum-Antarctic Ocean response to a retreating Antarctic Ice Sheet are completed. Apply advanced AI/Data Science techniques (such as automated classification, deep learning) in our paleoenvironmental research.
5. A full set of sea level projections at 2km spacing around Aotearoa New Zealand's coastline to include Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6) climate data and the local influence of vertical land movement is published online.
6. Co-designed field-based activities to enhance iwi involvement in Geosciences are completed and lead to a new iwi-led research partnership that aims to investigate climate change impacts on local communities in Northland.

MEASURES OF SUCCESS

By June 2023, the carbon budgets across our four major urban centres are accurately monitored.

By June 2023, improved climate projections are integrated into national climate change policy and at least one Regional Plan.

By June 2024, a revised ocean model is being used to simulate future changes in primary productivity in the oceans around Aotearoa New Zealand.

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.

ENERGY FUTURES

Research priority areas:

- Growing the Use of Geothermal Energy, with a Particular Focus on New Resources such as Supercritical Fluids
- 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

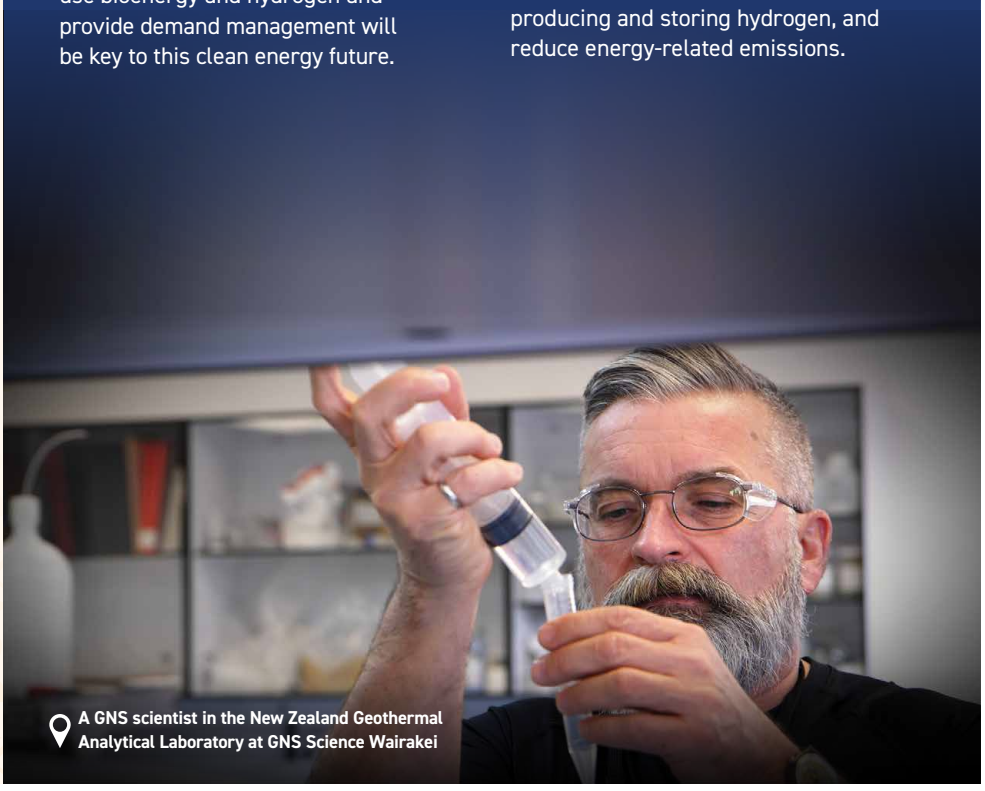
Energy powers our economy and underpins the wellbeing of our communities. It enables us to live healthy, fulfilling lives. We use it to power our homes and workplaces, grow and manufacture our food, building materials, clothes and other necessities, and move our people. It is critical for clean water, 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 CO_2 to the atmosphere from energy production and use.

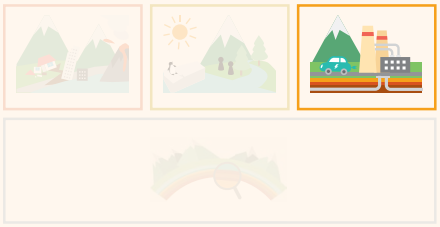
GNS SCIENCE'S ROLE

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.



A GNS scientist in the New Zealand Geothermal Analytical Laboratory at GNS Science Wairakei

PŪNGAO MŌ ANAMATA



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 such as supercritical fluids.
- 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.

This portfolio of research includes two new areas (Earth Energy 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 economic competitiveness.

As Aotearoa New Zealand increases the use of intermittent energy sources such as wind and solar in our energy mix, the need for energy storage will become more important. We are developing research projects into multiple solutions for storing energy in Aotearoa New Zealand – hydrogen, batteries and 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.

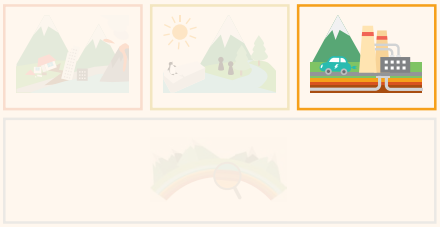
Increasing the domestic supply of energy has the potential to produce negative environmental and social effects. We intend to undertake new research into the sustainable use of energy that is connected to the Earth, such as geothermal or hydro. This work aims to develop methods to incorporate community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

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.

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.

ENERGY FUTURES



RESEARCH DIRECTION

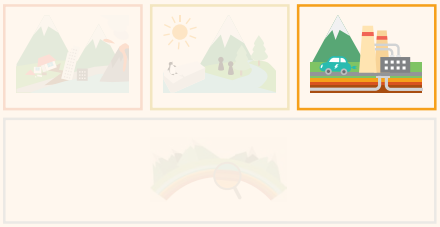
Our research aims to increase opportunities to use renewable resources and efficiency gains to reduce carbon emissions from energy use and to grow energy resource security. This will be achieved through increased use of geothermal energy for electricity generation, direct use of geothermal energy, improvements 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.

Wairakei power station

ENERGY FUTURES IMPACTS AND PRIORITIES 2022-27

1. **Growing the Use of Geothermal Energy, with a Particular Focus on New Resources such as Supercritical Fluids**
   - 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.
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 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



RESEARCH OUTPUTS 2022/23

Progress towards measures of success is delivered through the following research outputs in the coming year:

1. Maps of low-temperature geothermal resources are developed through new models of heat flow, subsurface temperatures, thermal rock properties and curie point depths for Aotearoa New Zealand's land mass.
2. New understandings of the impacts of reinjection of CO_2 on high-enthalpy geothermal reservoir dynamics and power station infrastructure.
3. A method will be developed using curie point and heatflow analysis of Te Riu a Māui / Zealandia to assess geothermal prospectivity.
4. A new prototype model of the electricity system in Aotearoa New Zealand will be developed.
5. GNS Science will organise and contribute to a workshop focused on implementing direct heat infrastructure in Taupō that will demonstrate the value of geothermal energy to the Taupō public, government and developers.
6. An electrocatalytic testing facility is developed for researchers and industries to test materials for hydrogen production.
7. Integrated capability will be developed in the field of thermal materials and engineering that will enable research and industry consultancy to improve energy efficiency and renewable energy utilisation.

MEASURES OF SUCCESS

By June 2023, new geoscience data and modelling of low enthalpy geothermal systems are being used to unlock greater direct use of geothermal energy.

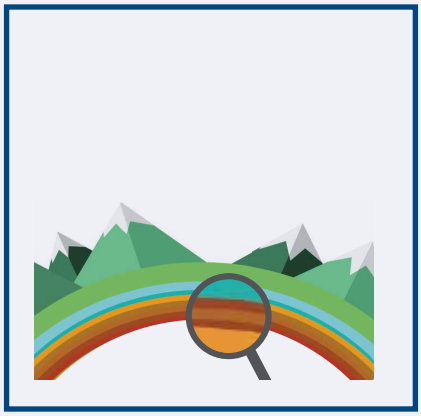
By June 2024, R&D created by GNS Science is taken up and used by at least one primary industry or manufacturing company.

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.

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

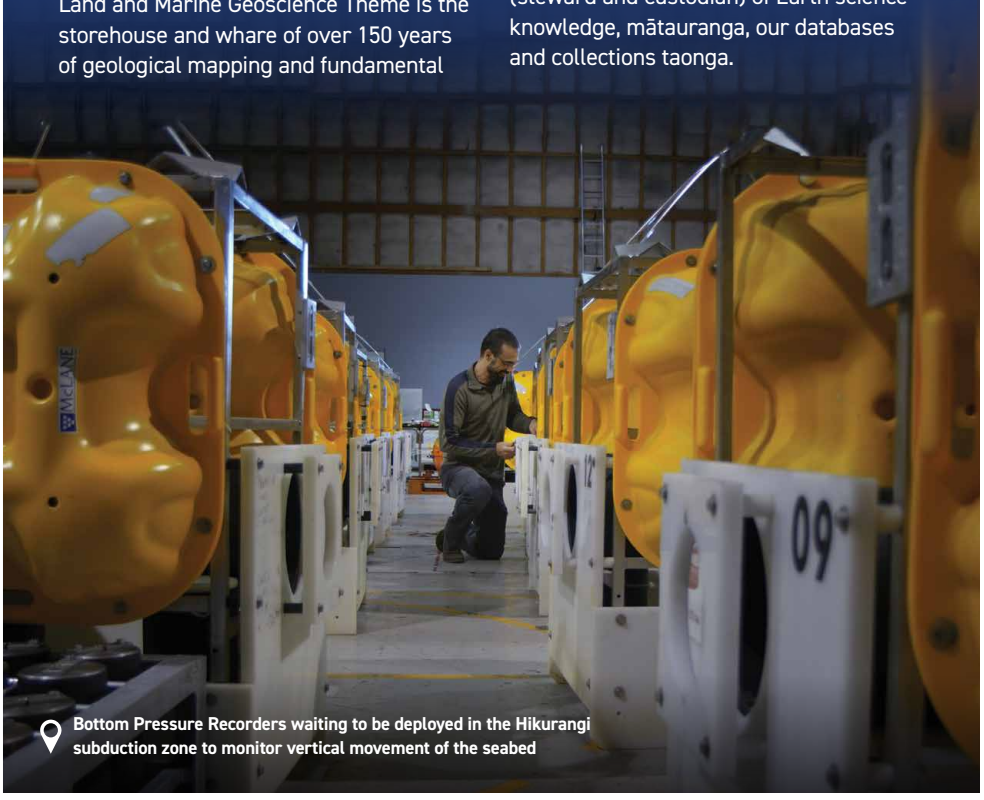
THE CHALLENGE

The islands of Aotearoa New Zealand represent the small portion 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 beneath the ocean, 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.

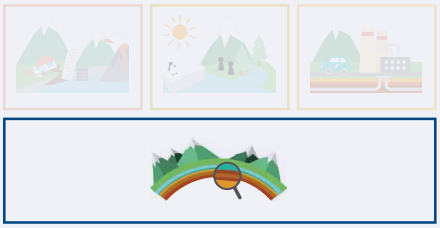
GNS SCIENCE'S ROLE

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.



Bottom Pressure Recorders waiting to be deployed in the Hikurangi subduction zone to monitor vertical movement of the seabed

PŪTAIAO ARONUKU
Ā-WHENUA, Ā-MOANA



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.

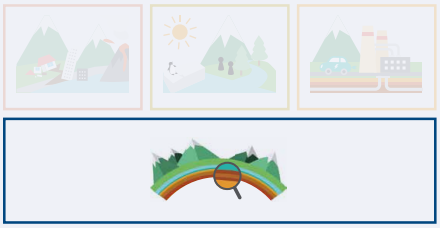
In a low-carbon future, there will be continuing demand for a sustainable, secure supply of energy and critical elements. GNS Science work provides accurate appraisal of Aotearoa New Zealand's on-land and offshore resource potential to enable sustainable custodianship of the continent's natural resources.

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 Drilling Program (ICDP), enables us to grow capability, 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 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 delivers a richer perspective on current and future environmental change. Our partnerships are supported by Memoranda of Understanding and subcontracts, and are based around student co-supervision and international science programme relationships.

LAND AND MARINE GEOSCIENCE



RESEARCH DIRECTION

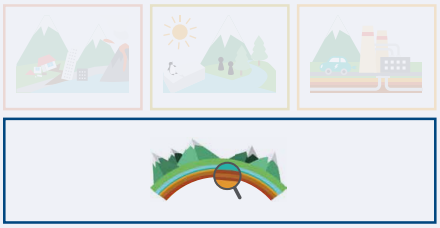
We are investing in an extensive research programme to address fundamental questions about the composition and architecture of the continent Te Riu-a-Māui / Zealandia and understand the geological processes that have shaped it. Our foundation programme aims to close critical knowledge gaps that relate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

LAND AND MARINE GEOSCIENCE IMPACTS AND PRIORITIES 2022-27

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 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 accessed by everyone.
5. **Shared Solutions**
   - Greater public understanding of the shared values of the natural environment stemming from underpinning Earth science is needed to foster engagement, collaboration, and solutions for a safer, cleaner and more resilient Aotearoa New Zealand.

Using an electronic tape to measure the depth to groundwater at a monitoring borehole. Sitting just 50 cm below the surface, the water table's response to extreme weather events and sea level rise is of great concern to the community

PŪTAIAO ARONUKU
Ā-WHENUA, Ā-MOANA



RESEARCH OUTPUTS 2022/23

Progress towards measures of success is delivered through the following research outputs in the coming year:

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. Develop methods for informing the expansion of the next generation of GeoNet land and marine seismic and geodesy instrument arrays to enable more reliable forecasts and warning of natural hazards.
3. Contribute to an Earth science understanding of the Hunga Tonga–Hunga Ha'apai eruption to inform future tsunamigenic volcanic eruptions in Aotearoa New Zealand and the South West Pacific.
4. Constrain the links between tectonism, volcanism and geothermal systems in Aotearoa New Zealand to enhance geothermal resource potential and management.
5. Be kaitiaki of Te Riu-a-Māui / Zealandia by improving understanding of the fundamental processes that formed the continent and controlled its evolution through time.
6. Ensure GNS Science's high-value geoscience databases are increasingly interconnected and interoperable, resulting in a significant upsurge in their use in data science applications.
7. 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 2023, the justification for GeoNet expansion will be supported by well posed science questions and validated by numerical models.

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, inform geological processes that shape Te Riu-a-Māui / Zealandia, as well as enriching Māori and Pasifika narratives of exploration and discovery.

VISION MĀTAURANGA

GNS Science is committed to developing enduring and mutually beneficial partnerships with iwi and Māori. In recent years we have focused on ensuring our internal processes are aligned with the aspirations of our iwi/Māori partners, in order to promote meaningful and beneficial outcomes for Aotearoa New Zealand. Our commitment to exploring the potential of Vision Mātauranga is at the core of our GNS Science Strategic Framework placing our people and place in the heart of our organisation. This ensures that Vision Mātauranga contributes to all GNS Science work areas in a proactive and genuine way, leading to positive social, environmental, economic and cultural outcomes for Aotearoa New Zealand.

Te Punawai o Rangiātea, our long-term Māori Strategic Plan, will focus our efforts on maintaining our connections with tangata whenua to recognise and resource mātauranga Māori research as part of our research programmes. This includes building career pathways and homegrown talent by developing Māori scholarship initiatives with academic institutes and developing tailored staff cultural awareness training.

Mihi whakatau for our 2021-22 summer interns and Ahunuku scholars

PARTNERING FOR SUCCESS

EMBEDDING VISION MĀTAURANGA IN OUR WORK

A critical component of our success is building Māori workforce capacity and the staff capability of GNS Science to effectively implement Vision Mātauranga. We will do this by:

- Promoting and providing learning opportunities for young Māori in the science system through our Ahunuku internship scheme and scholarships for Master's and PhD students.
- Building on our existing partnerships with iwi and Māori entities to increase our understanding of their research and science aspirations.
- Updating our Māori research strategy that includes shared national outcomes and aligns with science drivers to guide our future work and will inform all our science programmes.
- Collaborating with CRIs, universities, iwi/Māori authorities and other relevant agencies to deliver meaningful Vision Mātauranga outcomes.
- Building on existing Vision Mātauranga capability by running staff courses and workshops to support our internal workforce development initiatives and bid strategies.
- Contributing to iwi research capability development through secondments, kura whenua, fieldwork and iwi-led research planning and resourcing.

Through our partnerships and a targeted application of Te Punawai o Rangiātea, we will deliver on the strategic aspirations of Vision Mātauranga for both GNS Science and our partners. GNS Science is committed to exploring how mātauranga Māori research is part of the science research we undertake. We will do this by connecting research leaders with iwi/Māori groups and cultural practitioners to explore how we embed mātauranga Māori to help achieve shared outcomes and provide 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 attract 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 2022/23:

- Launch Te Punawai o Rangiātea – GNS Science Māori Strategic Plan 2022-2032, using it as an opportunity to build communications with our staff and iwi/Māori groups on how GNS Science aims to unlock the potential within and across our broad GNS Science research themes and contribute to mātauranga outcomes for Aotearoa New Zealand.
- Embed Te Punawai o Rangiātea through workshops to guide GNS Science staff when engaging with iwi/Māori for research and to grow a Māori workforce with technical Earth and energy science skills.
- Recruit the 2022/23 Ahunuku programme student summer interns through our newly established Memorandum of Understanding with Te Herenga Waka Victoria University of Wellington.
- Develop an engagement plan for the Bay of Plenty region that sets out how we engage in the region and with whom. This will serve as a blueprint for other regions and aims to ensure Māori priorities and activities are enabled for ongoing kaitiaki and commercial interests of tangata whenua.
- Provide Māori Master's and PhD scholarships to support research to achieve Earth, energy, climate and or natural hazards related qualifications.
- With other CRIs, develop a standard policy on Intellectual Property and Māori Data Sovereignty matters.

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.

Performing maintenance on the GeoNet Clarence Middle Hill site, North Canterbury

TŌ TĀTOU ROOPŪ WHAKAHAERE

Valuing Our People

GNS Science is progressing its change journey and taking key steps to establish itself as a science employer of choice, meet our strategic goals and deliver value to Aotearoa New Zealand.

Our investment and focus in the areas of leadership development, strategic workforce planning, recognising and rewarding high performance, building capability and diversity, and focusing on Health and Safety ensures our workforce is aligned to our strategy.

THE VALUE OF DIVERSITY

We are committed to creating an inclusive work environment that will contribute to our productivity and impact as well as strengthen the relationships between science and society.

There is still more work to do to encourage greater representation of Māori in our workforce and we are developing capacity to support Vision Mātauranga and our engagement with iwi/Māori and working collaboratively with them. Our standing and connections into science globally remain vital as does our need to attract high quality talent in Aotearoa New Zealand and internationally.

Our Diversity and Inclusion Committee is meeting regularly and plans for the year include a speaker series to highlight issues and experiences from a diverse range of perspectives and 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. The Early Career Network Programme has been designed to offer development opportunities that provide mentoring and inspiration. This includes providing pastoral care for our Ahunuku scholars and summer students.

CAPABILITY PLANNING AND DEVELOPMENT

As we continue our investment in the development of our people, key areas of focus are leadership development and strategic workforce planning.

Our flagship leadership programme, Tūhono, is focused on the delivery of the change required at all levels of the organisation. In our approach we place significant investment in ensuring our leadership development is integrated with 'real work' and aligns expectations, promotes innovation, supports organisational processes and forums, and targets development opportunities.

At GNS Science, leadership development goes beyond personal development – it is about leveraging the impact of our science, and overall organisational development.

To develop the workforce GNS Science will need in the future we are equipping our leaders to build the capability of their current teams. The development of the Science Roadmap will determine and drive the capabilities we will need and will provide the basis for our strategic workforce planning.

CULTURE AND ENGAGEMENT

We are maintaining our focus on our people leading the culture change by embedding our expectations in 'the way we do things here', embracing our values, championing cross-team collaboration, and encouraging new ways of thinking to shape the organisational culture that is right for GNS Science and the people that work here.

We will continue to measure our progress on this journey through staff surveys and targeted actions to develop the culture that will best support the achievement of our strategy.

Key areas of focus to enhance our capability, make us easier to work with and develop our culture are captured in our People and Culture Strategy and Implementation Plan, which focuses on:

- **Strategic workforce planning** – to ensure we have the right capability to meet the needs of the future including initiatives that build a diverse and inclusive workforce.
- **Leadership development** – growing leaders at all levels of the organisation and providing the opportunity for all staff to gain a solid foundation and establish a shared leadership language across GNS Science.
- **Reward and recognition** – addressing pay equity, recognising and investing in high performing talent, and valuing the diversity of our people and their contribution to our success.

KEY INITIATIVES FOR 2022/23:

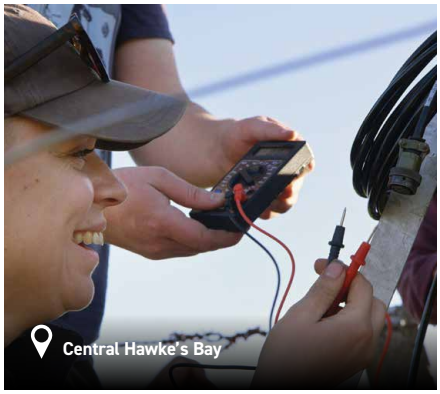
The focus for 2022/2023 is to embed the progress we have made:

- Implement our new Workday system into business as usual and use this as a key enabler for Human Resources to build its business partnering capability.
- Continue implementation of our People and Culture Strategy, with a key focus on strategic workforce planning, lifting leadership capability and shaping the diversity of our workforce.
- Embed our new Career and Capability Framework with a focus on refining the Performance Development Framework to ensure alignment with behavioural descriptors of our values, required competencies and continue to refine the criteria and process for the promotion framework.
- Continue the implementation of the Remuneration, Reward and Recognition Strategy, with a particular focus on addressing the underlying conditions that lead to gender and ethnic pay gaps, to create sustained and long-lasting change.

Health and Safety

Providing and supporting a safe, healthy and productive work environment is central to our beliefs. Our people have responded well to the changing pandemic environment with managers putting an increased focus on mental wellbeing and the importance of a healthy and supportive work environment.

We have increased capability within the Health and Safety team to support our focus on improving our wellbeing, critical risk management, Health and Safety systems, documented processes, education and training. This has resulted in improved understanding of health and safety and increased levels of health and safety leadership, ownership, engagement and collaboration throughout the organisation. Demand for health and safety support has significantly increased, confirming a growing integration of health and safety into GNS Science's day-to-day work.



Checking the voltage of a solar panel being used to power a seismometer station

We have made good progress on developing a more inclusive and responsible health and safety culture in support of GNS Science's vision '**Health and Safety is at our core, empowering everyone, every day, everywhere**'.

We remain committed to ensuring our staff have the capability, as well as the behaviours, that will ensure they look after themselves and others wherever they are working.

KEY INITIATIVES FOR 2022/23:

- In consultation with staff, continue to review and improve our existing critical risk management framework, including the identification of additional critical risks.
- Build on our wellbeing initiatives and develop procedures to manage psychosocial hazards and risks into a critical risk management framework.
- Continue to engage with and educate staff on the value of health and safety leadership, collaboration, critical risk management and wellbeing.
- Continue to improve GNS Science contractor management procedures across our procurement process, including how we collaborate with our contracted partners and monitor performance.

Connectivity and Innovation

GNS Science has completed the Science Roadmap and this document provides us with a clear direction on how we deliver meaningful value with and for our major stakeholders. The focus is to engage our major stakeholders/partners and end-users early in the research process.

GNS Science continues to rely on international research collaborations and partnerships to deliver high-quality research outcomes. The leveraging of international capability and large-scale facilities has been maintained through COVID-19 processes. The strategic agreements with other national geoscience and isotope science agencies in Australia, Japan, Germany, Italy, and the USA remain intact. 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 Innovation Hub supports GNS Science's aims to invest with purpose and to build deep partnerships. Our focus is to firmly place people at the centre of our science. Our innovation initiatives provide our people with new ways to identify research opportunities that are valued by our stakeholders and generate impact for Aotearoa New Zealand. The Innovation Hub will support more nuanced engagement with stakeholders including co-creation, co-design and more targeted collaborative initiatives in order to build deeper partnerships with stakeholders.

GNS Science has provided significant groups of scientists opportunities to develop their skill sets within the Innovation Hub.

The Innovation Hub activity has been mostly virtual, the success of these activities will require innovation spaces to be developed within GNS Science to support ideation and the development of an innovation community of practice across the organisation.

We have adapted the way we engage with many of our major stakeholders, especially our international stakeholders and partners, as a result of the COVID-19 pandemic. We will continue to utilise these new structures as we continue to focus on:

- Expanding the Stakeholder Engagement programme to capture more stakeholder connections.
- New engagement approaches to augment existing avenues as we seek to evolve stakeholder relationships.
- Digital methods will also be enhanced with more face-to-face meetings so we can really deliver value to our international customers.
- Our major international partnerships and research agreements will be a key focus to ensure our science stays relevant as global connectivity gathers speed.
- International forums, and leadership in major international collaborations will continue including International Ocean Discovery Program (IODP) and International Continental Scientific Drilling Program (ICDP).

KEY INITIATIVES FOR 2022/23:

- Continue to broaden and deepen external stakeholder engagement approaches to reflect stakeholder needs.
- 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:

- **Security by design** – Implementing our Long-term Security Uplift Roadmap as part of a CRI wide initiative to raise our CyberSecurity maturity, providing greater protective systems, response capability and structured governance, planning and measurement of our work programme.
- **Collaboration and knowledge dissemination** – continuing to improve information management, providing better tools and practices, with a focus on dataset availability and management, will enable our people to work from any external organisation or scientific disciplines to deliver shared goals.
- **Organisational intelligence and efficiency** – providing better contract, project, financial and performance management information across our organisation. This involves improved information flow management tools and practices through the newly implemented Enterprise system.
- **ICT Infrastructure modernisation** – continuing our programme of consolidation and redesign of the GNS Science ICT Infrastructure to better provide resiliency, immediacy, scalability and cost savings.

KEY INITIATIVES FOR 2022/23:

- Expand the scope of our use and implementation of the new Enterprise system for GNS Science and ESR.
- Start 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.
- Conduct a domain map of science technology platforms needed by GNS Science in the next 3-10 years and prioritise their sustainable design and implementation.
- Deliver our "Year 2" 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).
- Support and implement the changes from the New Zealand Research Information System (NZRIS) project as required.

Financial Services

Financial Services support GNS Science in achieving financial sustainability through the delivery of a range of accounting and financial services, including leadership of the financial strategy and goals of the organisation, financial and management information reporting, development of the budget and business plans, transactional processing, and providing information and advice to project leaders and managers throughout GNS Science that supports strong decision-making.

Like many organisations, GNS Science has been through a period of significant disruption to business-as-usual and ongoing financial uncertainties due to the COVID-19 pandemic. This has required focused financial leadership, including improved financial monitoring, reporting and advice.

KEY INITIATIVES FOR 2022/23:

- Complete the implementation for a long-term replacement of the finance system as part of the Enterprise system initiative (noted under Information Technology), phase 2.
- Continue improvements to financial modelling and forecasting and build these into the new finance system (Adaptive Planning).
- Continue improvements in Procurement through review and implementation of strategy, capability and savings opportunities.

Property

Over the 2021/22 year, GNS Science has been working towards completion of our Property Strategy that will provide the high-level framework for coordinated planning across our national portfolio of research laboratories, workshops, office accommodation and public interface property. This work is being progressed within the context of a wider Research, Science and Innovation Property Strategy for Aotearoa New Zealand being prepared by central Government.

It integrates the operation, maintenance, improvement, adaptation, construction and disposal of buildings and infrastructure, and is set within the context of the people, places, processes and technologies required to create a built environment that underpins the delivery of our science. Our objective of developing a strategic asset plan will support our Property Strategy.

GNS Science requires contemporary facilities to enable the delivery of great science, 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 coming year, we will be primarily focused 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 2022/23:

- Engage with partners, key stakeholders and government on the proposed Property Strategy.
- Complete the design for the new Volcanology and Visitor Centre at Wairakei, and (subject to approval) initiate construction.
- Develop a proposal for a Geothermal Innovation Centre at Wairakei as Stage 2 of the Campus Development Plan.
- Build our strategic asset management capability and use the digital facilities asset management tool to optimise maintenance renewal and improvement decisions, which align with the Property Strategy.
- Develop a business and investment plans for new Wellington facilities as permitted within the outcome of the Research, Science and Innovation Property review conducted by MBIE.

Collecting magnetic measurements

FINANCIAL PROJECTIONS

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

These are resulting in a strengthening financial performance, which is particularly pleasing given the challenges of COVID-19 in the past two years. GNS Science's revenue is projected to increase by 12.7% during 2022/23 compared to 2021/22. The main increases arise from the GeoNet programme ($4.5m) and a large commercial contract of $5.5m. Approximately 93% of our revenue is contracted or awarded.

This is reflective of the success achieved with new research grants over the past 12 months, and solid progress in relation to New Zealand commercial work. However, the international commercial market continues to be difficult, and is likely to remain so until the economic conditions improve.

Operating expenditure is projected to increase, reflecting an investment in more science staff to support the growing level of research and commercial work. In addition, a number of new projects include significant subcontracts expenditure. Otherwise, department costs remain constrained during the next few years, with base expenditure levels consistent with 2021/2022. 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 the first stage building development at our Wairakei campus, which is subject to 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 commercial revenue.

SHAREHOLDER CONSENT FOR SIGNIFICANT TRANSACTIONS

The Board will obtain prior written consent 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):

- 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	2022 Forecast	2023 Outlook	2024 Outlook	2025 Outlook
%	49.0%	47.6%	47.5%	47.9%

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 2021 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 2021 was $41.1 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 2022-27.

GROUP RATIOS AND STATISTICS

Year ending 30 June	Forecast 2021/22	Outlook 2022/23	Outlook 2023/24	Outlook 2024/25
Revenue				
Total revenue ($000s)	110,732	124,847	129,790	134,789
Revenue growth	3.2%	12.7%	4.0%	3.9%
Operating results ($000s)				
Operating expenditure (excluding depreciation)	104,057	114,227	116,619	120,131
Earnings before interest, tax, depreciation and amortisation (EBITDA)	6,675	10,620	13,171	14,658
Earnings before interest and tax (EBIT)	(1,219)	2,376	3,551	3,679
Net profit/(loss) before tax	(1,035)	2,526	3,701	3,829
Net profit/(loss) after tax	(745)	1,819	2,665	2,757
EBITDA per FTE	14	22	26	28
Total assets	82,455	88,619	94,473	99,364
Total equity	40,379	42,198	44,863	47,620
Capital expenditure	6,541	14,205	18,102	15,041
Liquidity				
Quick ratio	1.6	1.3	1.1	1.1
Interest coverage	n/a	n/a	n/a	n/a
Profitability				
Return on equity	-2.1%	4.5%	6.3%	6.1%
Operating margin	6.0%	8.5%	10.1%	10.9%
Operation risk				
Profit volatility	48.5%	50.5%	44.5%	40.0%
Forecasting risk	6.7%			
Growth/Investment				
Capital renewal	2.0	2.8	2.5	2.1
Financial strength				
Equity ratio	49.0%	47.6%	47.5%	47.9%

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 have been 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.

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 have been 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

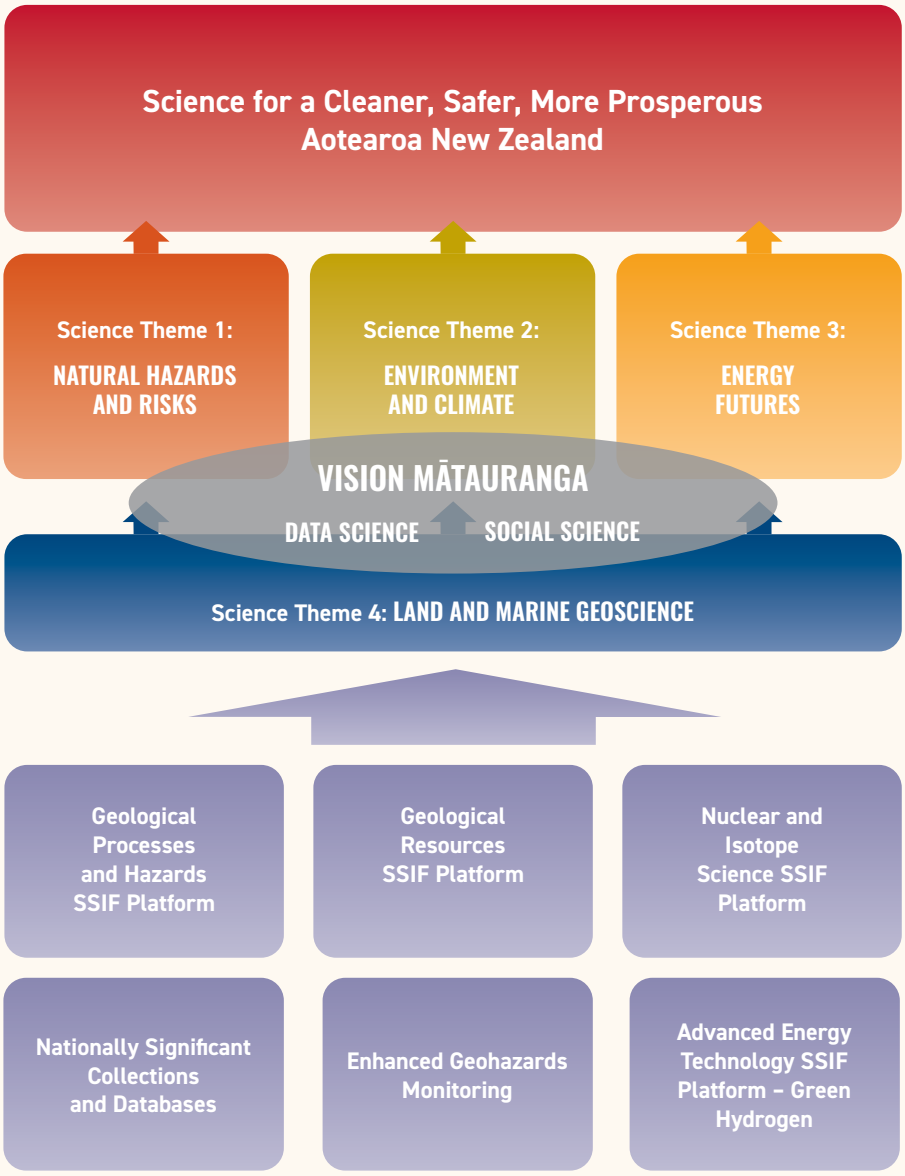
There are no new accounting standards affecting the 2022/23 Financial Year.

Dr Nicola Crauford
Chair

Dr John Sharpe
Director
23rd June 2022

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 2021/22	TARGET 2022/23
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%	>90%
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)	62	84
Technology & knowledge transfer	Commercial reports per scientist FTE	1	1
FINANCIAL			
Revenue generation	Revenue per FTE ($000)	230	245
EMBEDDING VISION MĀTAURANGA			
Māori engagement	Projects with Māori stakeholders embedded in the research	5	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%	>72%

* 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. 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** is the national repository of geological maps and regional geological information for Aotearoa New Zealand and its territories, generated over the past 150 years by GNS Science and its predecessors. The geological maps and information cover a wide range of scales and are used for many purposes by researchers, resource exploration and engineering companies, hazard and risk assessors, and government.
- The **National Petrology Reference Collection and PETLAB Database** is a curated archive of more than 100,000 rock, soil and mineral samples, mostly from Aotearoa New Zealand and its territories, collected since 1865. The samples and associated geoanalytical data are used by Aotearoa New Zealand and international industry and research geoscientists to better understand Earth composition and resource prospectivity.
- The **NZ National Paleontological Collection and Associated Databases** is a collection of fossil samples from Aotearoa New Zealand and its territories dating back to the early 19th century. It includes vertebrate, invertebrate and plant macrofossils, animal and plant microfossils, trace fossils, and fossil-bearing rocks or rocks that have been sampled for microfossils. Together with the NZ Fossil Record File, and a number of other paleontological databases, the collection provides key biostratigraphic data to refine the geological time scale, with broad benefits to the resources industry, evolutionary biologists, paleo-ecologists and climate modellers. It also contains the raw data on past environmental change.
- The **NZ Fossil Record File** is a register of more than 100,000 fossil locations in Aotearoa New Zealand and the Ross Dependency described since 1865. The data provide essential information for biostratigraphic analysis and refinement of the geological time scale, which is used by stakeholders across the resources, geohazards and environment sectors.
- The **National Groundwater Monitoring Programme**, operating since 1998, provides water quality indicators, including major ions, nutrients, metals and arsenic, for groundwater sampled regularly in all 15 regions of Aotearoa New Zealand. The data provide critical information to water regulators, researchers and consultants to effectively manage water resources.
- The **National Earthquake Information Database** contains essential data on all significant earthquakes recorded in Aotearoa New Zealand since 1840. Accessed via the GeoNet website, these data are used extensively by earthquake hazard modellers and risk analysts, as well as insurance companies and CDEM agencies in Aotearoa New Zealand and overseas.
- The **NZ Volcano Database** is a data resource containing various databases and datasets, including photographs, that are critical to volcano science. The data are used for volcanic unrest detection and eruption forecasting, setting Volcanic Alert Levels and Aviation Colour Codes, and research into magmatic and eruptive activity.
- The **NZ Geomagnetic Database** is a vehicle for transferring critical Southern Hemisphere geomagnetic data collected at Scott Base (Antarctica), West Melton (Canterbury) and Apia (Samoa) to the global INTERMAGNET database. The near real-time data plays an important role in constructing and testing global reference models of the geomagnetic field. Geomagnetic reference field models are widely used by scientists, by the military, in transport, and by the community in smartphones and other mobile devices to provide orientation information.

PHOTOGRAPH ACKNOWLEDGEMENTS

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Jess Hillman	P12
John Pearman, Cawthron	P18
Glenn Evans	P30
Daniel Whitaker	P32
Duncan Graham	P36

Camp at Discovery Deep on the Ross Ice Shelf, Antarctica

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