

GEOLOGY AND GEOPHYSICS

At present, the Earth and its atmosphere are all that we humans have to live with. In order to make the most of it, we need to understand what the Earth has done over some four billion years and is doing to itself today. We also need to understand what we have done to the Earth over thousands of years, and what we're doing to it today. Geologists and geophysicists are scientists who study the Earth. They observe, measure and monitor; they calculate and predict; they hypothesise and maybe try again; they scrutinise the rocks beneath their feet and the air above their heads; they are both rigorous and creative.

Geology is the study of the Earth, its history and the processes that shape it. It covers such topics as plate tectonics; mountain building; the origin and evolution of life; landscape evolution; climate and sea level change; understanding, predicting and reducing risk around natural hazards, and exploration and sustainable use of Earth's natural resources: minerals, fossil fuels, soils, wind and water.

Geophysics uses physics and mathematics to examine the structure, properties and processes of the Earth and its atmosphere. These include the Earth's gravity and magnetism; its heat flow processes and volcanoes, its oceanographic and atmospheric processes; its deformation and earthquakes. Many of these processes manifest in what we call weather, hence the connection between geophysics and meteorology. More generally, geophysics is central to understanding and predicting natural hazards and exploring for energy and mineral resources.

WHY STUDY GEOLOGY AND GEOPHYSICS?

Both branches of Earth Science are fascinating, complex and multi-dimensional. Geology connects with other science and social science disciplines such as Geography, Physics, Biology and Anthropology as it looks at why the impacts on the lives of humans and other species occur. Geophysics brings together expertise in mathematics and physics with a love of the outdoors to understand the atmosphere around us and the ground beneath our feet. Geophysicists work at understanding some of the biggest and most exciting physical phenomena we know; earthquakes, volcanoes, mountain building, the Earth's magnetism, gravity, and deep structure.



For the Geology or Geophysics graduate, there is the potential to make a real contribution in terms of climate change and biodiversity as well as economic development and innovation. The work of geologists and geophysicists often entails international travel and a variety of physical environments as well as the opportunity to collaborate with scientists of other disciplines.

Career View explores how degrees and courses relate to employment opportunities and to life/work planning. It includes graduate destination information and current employment issues. Your comments and suggestions are always welcomed.

Wellington Careers and Employment.
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WHAT SKILLS DO GEOLOGY AND GEOPHYSICS STUDENTS DEVELOP?

Geology and Geophysics are multidisciplinary areas of study and their graduates are typically multi-skilled.

Analytical and abstract reasoning skills include understanding and interpreting large data sets, problem solving, innovation and creativity and an ability to handle ambiguity. Consistent with the study of mathematics and physics, is the ability to swing mentally from theory to practice and back again.

Three-dimensional conceptual skills are the ability to decode the graphical language of a map, to piece together what is under, behind and around objects and the imagination to conjecture what happened and is likely to happen over time. Geologists and geophysicists have been described as being like '3D detectives'.

Observation skills are developed and honed during a range of course activities. These include field trips where natural structures and phenomena are studied in detail, and laboratory work involving the use of specialised equipment such as recording and measuring instruments.

Critical and logical thinking skills are developed due largely to the multidisciplinary nature of the courses of study. Graduates will have become experienced at bringing concepts together from a range of disciplines including physics, chemistry, biological sciences, mathematics and information technology, and integrating this information into a logical, constructive whole.

Communication skills are consistently high-priority for most employers. Geology and Geophysics graduates write laboratory and field work reports, assignments and postgraduate research papers, all of which emphasise writing style and structure. They also prepare talks and posters to enhance their verbal and presentation skills. These skills are important for

any work that involves giving specialised information to clients, consumers or readers who may not have a science background.

Relationship management skills are honed when Geology and Geophysics students participate in a range of field trips, where getting on with people under pretty basic conditions is vital. Team work is essential and a general sense of camaraderie and shared purpose prevails.

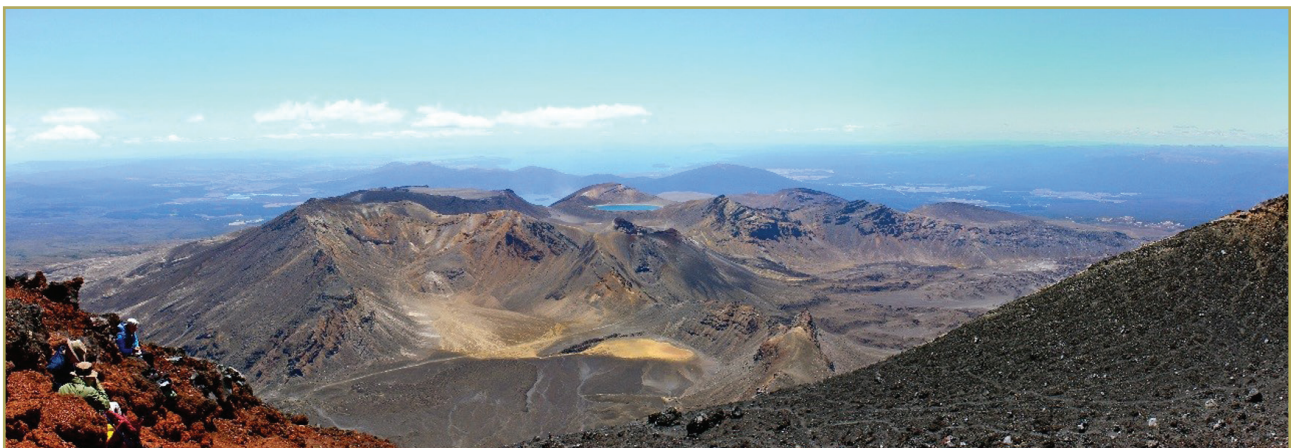
Research skills: Students develop skills in research design and learn methodologies which cover qualitative and quantitative approaches. Geology and Geophysics are science subjects and are underpinned by scientific methodologies.

Computer skills are basic to most jobs, and Geology and Geophysics graduates are computer-savvy. Typically they know how to manage and interrogate sophisticated databases, use technical software and undertake computer modelling. From this they will generally be able to find their way around a number of different systems and data sets.

WHERE DO GEOLOGY AND GEOPHYSICS GRADUATES FIND WORK?

Because the forces and resources of nature tend to be national and/or global in scale, many of the work opportunities for Geology and Geophysics graduates are within government-related organisations or companies with international operations, for example in oil and gas exploration, drilling services or environmental engineering.

GIS (Geographic Information Systems) is used for capturing, storing, checking and displaying data related to positions on Earth's surface. Skills in using GIS applications are relevant for a range of organisations, including central and local government, regional councils, research organisations, consultancies, utility companies, and forestry and agricultural companies.



New Zealand Petroleum & Minerals (NZP&M) is part of the Energy and Resource Markets branch at the Ministry of Business, Innovation and Employment (MBIE). They lead and manage the New Zealand government's petroleum and mineral estate. NZP&M grant access to New Zealand's oil, gas and Crown owned minerals, manage compliance and collect royalties on behalf of the Crown. They employ Geology and Geophysics graduates to manage technical databases, evaluate new permit applications, monitor and assess permit performance and provide technical advice to Crown Minerals management.

Research Institutes. In general, research institutions consider a Bachelor's degree appropriate for technician and support roles. A Bachelor of Science (BSc) graduate could undertake basic technician tasks such as laboratory work and also field work which involves taking samples and organising field sampling equipment. Master's and PhD degrees are required for research work. A Master of Science (MSc) graduate would most likely begin as a research associate, while research scientists are normally post-doctorate positions. Laboratory and field experience, either course-related or voluntary is very helpful preparation for working in research.

Institute of Geological and Nuclear Sciences (GNS Science) specialises in the geosciences and related technologies, including geology, geophysics, geochemistry and geochronology. Opportunities for Geology and Geophysics graduates are centred on three main divisions:

- Geological Resources including geological time (palaeontology), hydrocarbons, petroleum geoscience, geothermal, minerals and marine geoscience
- Natural Hazards monitoring and researching earthquakes, volcanoes, tectonics, mapping, developing geohazard solutions
- Environment and Materials particularly researching around climate change.

National Institute of Water and Atmospheric Research (NIWA) is an environmental research organisation and a provider of atmospheric and marine sciences. It has eleven national centres with a range of employment niches for both Geology and Geophysics graduates. Of these, Coasts and Oceans is probably the most relevant centre for Geology and Geophysics graduates. Climate and Atmospheric Hazards is also interested in those who have a hydrology component to their studies, as well as atmosphere, fluid motion and oceanography. Freshwater and Estuaries provide public information



on river, lake and groundwater conditions across New Zealand including water quantity and quality. They are interested in graduates whose degrees have an emphasis on hydrology and geomorphology (sedimentation processes). Environmental Information uses sophisticated technologies and numerical modelling techniques to capture, collate and analyse data that measures greenhouse gases, to better manage marine ecosystems or improve weather forecasting. Graduates strong in mathematics or with an additional computer science degree are more likely to be found working in this area.

Landcare Research specialises in sustainable management of natural resources including environmental monitoring, improving measurement of greenhouse gases, and management of soil and water resources. Geology is particularly relevant for the Soil and Landscapes, Greenhouse Gas and Managing Land and Water portfolios. Jobs have a specialised focus, such as geomorphology, erosion or GIS. People with modelling skills and experience in handling large datasets are very sought after. There is preference for PhDs but technical roles are possibilities for those with an Honours or Master's degree.

ESR (Institute of Environmental Science and Research Ltd) provides specialist science solutions related to public and environmental health (also forensic science). The Water Science group, in particular the groundwater research team, is an area for which Geophysics graduates at Master's level and above would be suitable.

MetService is a global leader in weather; gathering, analysing and providing weather intelligence to



Environmental Engineering and Consultancy Services include multidisciplinary consultancies, geological services companies, environmental engineering, infrastructure companies such as energy and telecommunications, or mining and drilling operations.

An undergraduate is most likely to start with geotechnical, geometrics, and water and wastewater groups as a technician. A Master's degree is preferred by most companies as it demonstrates the ability to work independently. Hydrogeologist and engineering geologist positions exist for those with a postgraduate degree

the public and private sectors. Qualifications in Mathematics, Physics or Geophysics are essential to be considered for meteorological training. While working as a trainee with MetService, you are required to complete a sponsored Master of Meteorology.

Regional Councils typically cover a wide catchment area and deal with large-scale environmental, land management issues and disaster preparedness. Geology and Geophysics degrees are relevant for a variety of operational areas. These include policy, science and regulatory functions relating to the environment and land management. An undergraduate qualification can lead to environmental monitoring roles, essentially field officers involved with sampling although most scientist positions are at postgraduate level.

City Councils vary in the way they structure their operations, but Geology and Geophysics graduates typically have useful skills for a range of areas including ecology and biodiversity planning, environment strategy, GIS systems and land information. Much of the technical and science work of councils is contracted out to GNS Science.

Government Departments, Ministries and Government Agencies. Policy development and advice is a possible career option for those who want to move away from the technical or scientific side of things. If they have other qualifications in Law, Public Policy or other humanities, some Geology and Geophysics graduates can be drawn to roles in policy analysis, communications, writing and editing, project development, business, GIS or data analysis with organisations such as the Ministry for the Environment, Ministry of Civil Defence and Emergency Management or Department of Conservation.

in Geology predominantly, although Geophysics graduates would certainly be considered. In either discipline a thesis topic that had some relevance to the company's operations would be an advantage. GIS skills are also very useful.

It is common for larger organisations to have a graduate development programme, and work on off-shore projects is a possibility after some practical experience has been acquired. There are also summer holiday work experience programmes where undergraduate students can gain valuable experience. Such companies include Aecom, Beca, GHD, Opus International Consultants and Tonkin + Taylor.

Oil and Gas Exploration and Production are subject to factors such as pricing that can drive demand for skills. However there are opportunities for Geology and Geophysics graduates in the oil and gas industry, either in New Zealand or overseas. The future challenge for the industry is likely to be in exploration, especially of the ocean floor, seeking to access more unconventional oil and gas reserves. Both New Zealand-based and multi-national companies currently operate largely from the Taranaki Basin, though some are located in the South Island.

Graduates mostly work as geologists and geophysicists with exploration teams as exploration geologists, using seismic, petrophysical and other geological data to work out where the company should be exploring. Where the oil fields are being developed for production, production geologists use essentially the same data for planning the development of the reserves.

A postgraduate qualification is more likely to become a selection criterion in a tight job market. It is

GRADUATE PROFILES

common for oil companies to have comprehensive graduate development programmes so that graduates can gain a wide variety of experience to support career development.

Some of the oil and gas companies operating in New Zealand include Todd Energy, Shell Petroleum Mining (NZ), Methanex, Origin, Greymouth Petroleum and OMV.

Drilling and Exploration companies support mineral exploration, mining, infrastructure projects and research. Based on or offshore, they employ Geology and Geophysics graduates, preferably with a postgraduate degree. Drilling work is hands-on and largely outdoors involving planning and preparation, designing, water and waste control, and soil sampling.

Education. Universities are research institutions in their own right and have strong collaborative relationships with other research institutions, such as Crown Research Institutes. If you're considering an academic career which will involve both research and teaching, you would need a PhD and a record of publication to be competitive for junior positions. Teaching is also very viable, particularly as the range of disciplines that underpin Geology and Geophysics, such as Chemistry, Physics, Mathematics and Geography transfer well into the science curriculum of secondary, intermediate and even primary schools. Teacher training is also required.

JOB TITLES

The following is a sample of job titles taken from our graduate destination surveys. Some roles may require postgraduate qualifications and training.

Analyst • climate scientist • climatologist • data modeller • engineering geologist • environmental geologist • environmental officer/adviser/planner/consultant • environmental technician • exploration geologist • exploration geoscientist • field engineer • geologist • geophysicist • geospatial analyst • geotechnician • geothermal scientist • GIS software developer • GIS technician • hazard planner • hydrogeologist • hydrologist • lecturer • meteorologist • oceanographer • operations scientist • palaeontologist • palynologist • petrologist • policy advisor • programme manager • ranger • researcher • research scientist • risk manager • science writer • secondary school teacher • seismologist • technician • tutor • water resource specialist.

Matt Paterson

Engineering Geologist
Beca



I decided to study Geology because I enjoyed the outdoors and often wondered how the landscape around me came to be. I enjoyed the field courses and the labs because of the way they built up a strong camaraderie between everyone in our class and gave us a hands on introduction to geology. The lecturers actively encouraged us to get involved with the broader science industry and their links to organisations such as GNS Science were invaluable.

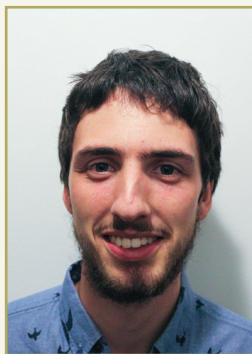
I gained the ability to forever ruin road trips with friends and family by demonstrating a great working knowledge of geological processes in the New Zealand geological setting and pointing it out wherever I saw it. I also developed technical skills such as geological mapping, logging and analysis.

My current role as an Engineering Geologist is directly related to what I studied. I use the logging skills, mapping skills and general knowledge of New Zealand geology every day to help explain the ground conditions on projects to engineers, clients and stakeholders. I'm primarily involved with large scale infrastructure projects in New Zealand and overseas where having a good understanding of what you're building on can make or break a project.

If you are interested in the outdoors, or just like the idea of figuring out how the landscape you're staring at came to be, then seriously consider Geology. It can be combined very well with other majors to make it even more flexible. Geology graduates crop up in all sorts of industries from government to private consultancies. Think about where you want to go with your career after university and actively work towards getting there the whole way through, don't wait until the end. Most of all I found it was crucial to enjoy my time at university and make good friends. Geology is a small industry and you're bound to run into your classmates in the future in all sorts of exciting places.

Tui McInnes

Meteorologist
MetService



When I first enrolled at Wellington University, I knew I wanted to study Physics and Geophysics. Growing up, aviation was my absolute passion, fostering an interest in physics. Learning to fly in my weekends during high school not only was I at the behest of the laws of physics, but I was also under the strong influence of the weather. In Wellington this was often spectacular. When I learnt that I could study both of these at university I enthusiastically enrolled.

Throughout university, I studied my interests. This in itself made the coursework enjoyable. Sure, there were assessments and exams, but at the end of the day I was learning the aspects of the world that interested me the most. Studying science provides a great mix of theory and lab or field work. In lectures you learn the theory, the details and the foundations. In the lab you see first-hand what you actually learnt!

My interest in meteorology flourished throughout my studies. As I neared the end of my undergraduate degree, I applied for the position of Trainee Meteorologist at MetService. The following year, I was in a 12-month course where I was taught everything there is to know about meteorology. Following this, on-the-job training taught me even more. The coursework included completing a Postgraduate Diploma in Meteorology through Victoria University. This involved physics and geophysics based courses teaching the foundations of meteorology and how forecasts are actually possible.

My studies gave me a number of skills invaluable to the job. Studying science helped develop good logic thinking, along with enforcing an attention to detail. These skills are very important because, as meteorologists, we have to digest information from a plethora of sources including weather models, weather stations, weather radar, aircraft and boats. We take this information and combine it to form a detailed mental picture of the atmosphere's current state and how it will evolve with time. To any future students looking at studying these subjects, if it's your interest then dive in! There's something particularly special and rewarding in learning about and understanding the world around us.

Rachel Skudder

Geoscientist
Shell New Zealand



I started university not really knowing what to study. I enjoyed sciences at school and loved the outdoors so in my first year I took a range of courses to keep options open for later. I decided on Geology after a fieldtrip to Golden Bay spent exploring stream gullies, climbing hills and walking along beaches. I thoroughly enjoyed subsequent fieldtrips to the Kaikouras, Nelson Lakes, Taupo, the Wairarapa and South America. The large component of fieldwork cemented what was learnt in classes and getting to some neat places was a bonus. Geology is always interesting because no matter where you are in the world, you'll never come across the same thing twice.

Postgraduate study was challenging but really extended me and put all the skills learnt in my undergraduate years to good use. For my Master's thesis I used paleoecological proxies to look at past climate during the Holocene. It was a project with quite a lot of breadth which I enjoyed as there was something different to think about every day. Organising and conducting original research gave me a huge sense of ownership and accomplishment. I would highly recommend it.

During my last year of study I was offered a graduate position with Shell. I am currently working as a Geoscientist as part of the subsurface modelling team. Our focus is to build and maintain subsurface models which help inform the future of our fields. I am currently working on Maui and Pohokura, both extremely important in terms of meeting New Zealand's gas demand. I have learnt so much about the energy industry, the integration of different disciplines and how safety and caring for the environment comes first. I was given tasks and responsibilities from day one but the amount of support, mentoring and training I have received is unlike anything else I have heard of. Last year I visited Perth and The Hague, in the Netherlands, for training!

My advice to anyone considering a career in geology would be to go for it, get as many diverse experiences as you can, both academic and non-academic, seek out help when you need it and don't be afraid to ask.

Aitana Forcén-Vázquez

Oceanographer
NIWA



I have always been interested in the ocean. Because I grew up by the coast and used to sail every weekend, I became curious about how the ocean moves. When I finished my degree in Marine Science, I wanted to know more, so I decided to come to New Zealand to complete a PhD in Physical Oceanography. To me, this seemed like a great opportunity to learn “everything” about ocean currents, water masses and variability of the Southern Ocean. I enjoyed my PhD very much. I love learning and in the four years of my studies I never gave up. It can be a lonely and difficult journey sometimes, but when I found myself solving problems it was one of the most rewarding things I have ever felt.

Of course, having the opportunity to do field work in the Southern Ocean during my PhD was rewarding as well. During my PhD I spent most of my time in front of a computer, so going to sea on a research vessel to collect oceanographic data gave me a new perspective on how oceanography works. One of the best skills I obtained during my studies was the ability to think critically – how to ask an interesting science question, finding the best data to answer it and ultimately finding the solution to the problem. I also learned other skills that are valuable in my everyday life such as time management and efficiency needed to meet deadlines as well as never giving up until the work is done.

I now have a postdoctoral fellowship at NIWA where I continue to develop my understanding of the Southern Ocean. I would recommend a PhD in Oceanography if you enjoy learning different things to solve one problem, if you like to work through your own ideas and also if you are willing to move around the world with your job.

Jenni Hopkins

Postdoctoral Research Scientist
Department of Hazard and Risk
GNS Science



At secondary school I had two favourite subjects, Geography and Chemistry. I had great teachers who inspired me and built on my love of the outdoors. It wasn't until undergraduate study that I really believed a career in doing what I loved was possible. I found I could be outdoors questioning, learning and understanding the environment around me. This really drove my passion for Geology, but I felt I had left behind the chemistry that I had loved so much in school. So, for my MSc I decided to specialise in geochemistry, and two passions collided. After completing my MSc, which focused on volcanic hazard, I accepted a PhD position at Victoria in collaboration with GNS Science and relocated from the UK to the other side of the world.

My time studying for my PhD offered me the ability to further my research skills into hands-on geochemical techniques, running various analytical machines which are located within the university's geochemistry department. I taught various geology courses, both in-class and in the field and especially enjoyed the camaraderie that field courses create between the staff and students. Funding grants have also allowed me to travel during my research, presenting at conferences in both Europe and the USA.

It was important to me that my research had relatable applications and so when the opportunity to work within the Hazard and Risk division at GNS Science became available it seemed the perfect step for me. My current position is as a postdoctoral researcher, with my research focusing on the volcanic hazard that is posed on the city of Auckland. This job involves a wide range of tasks including fieldwork, laboratory work, data analysis and interpretation, and writing up reports of findings. I love the variety of the job because I have never been someone who could sit behind a desk all day. The job also uses transferable skills including people management, teamwork, understanding and working to deadlines, and good communication, to name just a few!