

# GNS Science : 2012-13 Activities



**Dr. Greg Bignall**

Department of Geothermal Sciences

Wairakei Research Centre



# GNS Science : Who we are ...



- Independent, government-owned Crown Research Institute
- New Zealand's leading supplier of earth science research and consultancy services
- 320 staff in Wellington, 95 in Taupo and 20 in Dunedin
- Clients include private sector, government organisations, international funding agencies, research groups in New Zealand and overseas
- Revenue: ~50% Research; ~50% Commercial (15% GeoNet)

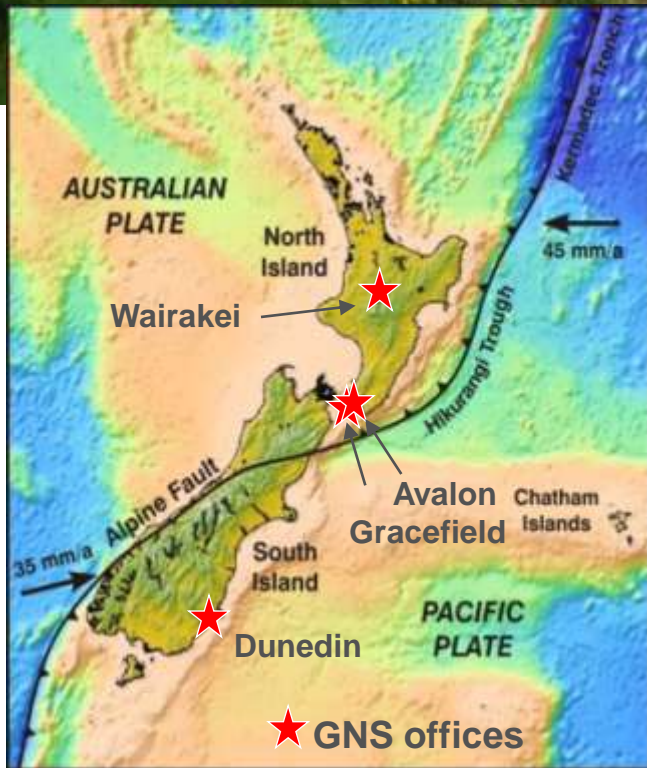


# GNS Science : Mission



**To understand natural Earth system processes and resources, and to translate these into economic, environmental and social benefits**

## Wairakei Research Centre



## Departments of Geothermal Sciences, Volcanology and Hydrogeology

~95 geoscience and support staff

>35 geothermal specialists

Commercial Projects

Industry and Post-graduate Training

Core-funded Geothermal Research

# GNS Geothermal – what we do ...

- Broad Geoscientific Expertise
- Resource Delineation, Exploration & Development Advice
- Core funded, Multidisciplinary Research
- Permitting / Resource Consenting (Independent Geoscience Opinion)
- NZGAL, Isotope, Mineral Laboratory Services
- Training (student / industry internships)



## geothermal team

Geoscientific research, expertise and consultancy advice.



The GNS Science geothermal team is internationally recognised for innovative, robust geoscientific research, expertise and consultancy advice. We have been supporting the geothermal sector in New Zealand and internationally for over 50 years.

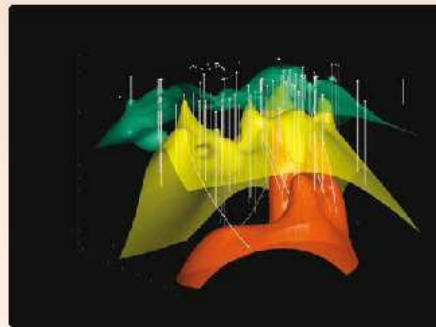
Our experienced professionals integrate geology, geophysics, geochemistry and modelling expertise for exploration, drilling, environmental sustainability, field development, optimal production, and ongoing resource management.

### leadership →

 <p>→ <b>Brian Carey, M.E.</b> Geothermal resource management, environmental planning, field development programmes. 33 years experience.</p>	 <p>→ <b>Colin Harvey, PhD.</b> Clay mineralogy, geothermal exploration and resource assessment. 44 years experience.</p>
 <p>→ <b>Ed Mroczek, PhD.</b> Reservoir and power station chemistry, scaling and corrosion, and environmental monitoring. 30 years experience.</p>	 <p>→ <b>Chris Bromley, MSc.</b> Geophysical exploration, resource and environmental assessments, micro-seismicity, and long-term utilisation strategies. 32 years experience.</p>
 <p>→ <b>Greg Signall, PhD.</b> Fluid-mineral interactions, petrology and well services. Resource assessment, exploration and development. 19 years experience.</p>	

www.gns.cri.nz Geothermal science - power renewed.

An integrated approach to understanding geothermal reservoirs.



## at a glance →

- **Integrated** Geological, geochemical and geophysical expertise are combined to delineate and characterise geothermal reservoirs.
- **Innovative** Novel approaches such as: innovative 3D geological modelling of the geothermal reservoir; using 3D models to populate TOUGH2 model grids; borehole image logging to map downhole permeable structures; combined MT/seismic models to delineate resources.
- **Targeted** Geological investigations are used to recognise key problems within the reservoir. Targeting of permeability structures including faults, fractures and stratigraphic formations.
- **Detailed** Evaluation of geothermal water and gas chemistry provides clarity on the geology and energy potential of the geothermal reservoir.

www.gns.cri.nz



# geothermal geochemistry

Supporting geothermal exploration and improving production



GNS Science analytical capabilities of geothermal development projects in overseas. We have pioneered and applied techniques in evaluation, and services with. Our experts in and isotopic of the nature of reservoir temperatures, and issues which utilisation of the

## at a glance →

- **Reconnaissance** Review of existing geoscientific data. Recommendations for exploration programmes and feasibility studies.
- **Integration** Combination of geochemical understanding with geological and geophysical expertise for an integrated approach to understanding geothermal reservoirs.
- **Equipment** design, acquisition of equipment, experiment sampling as well, pipelin condenser
- **Exploration** Detailed geochemical survey design and sample collection. Chemical characterisation of surface features and reservoir fluids for interpretation of subsurface temperatures, processes and flow paths.
- **Field management** Advice for optimising production and injection strategies. Environmental surveys, pre-commissioning baseline determination.
- **Power station** analysis, pre-modelling to scaling and

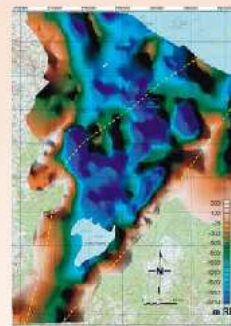
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Geotherm



# geothermal geophysics

Combined geophysical methods for exploration and monitoring.



GNS Science can design geothermal exploration and monitoring programmes, undertake geophysical surveys, and process and interpret geophysical data.

Geophysical understanding is integrated with geological and geochemical expertise for accelerated geothermal exploration, and improved field management.

We can provide a comprehensive understanding of geothermal reservoirs in New Zealand and internationally.

GNS Science has pioneered many aspects of geophysical techniques used in geothermal investigation. We underpin these services with broad ranging research in the use of geophysical techniques to identify heat sources, locate permeability, understand time-spatial changes to fields, characterise rock properties, understand shallow thermal conditions, investigate deformation mechanisms and induced seismicity

## at a glance →

- **Reconnaissance** Review of existing geoscientific data. Recommendations for exploration programmes and feasibility studies.
- **Interpretation** Data processing, modelling and interpretation for reduced exploration risk and improved field monitoring.
- **Field management** Geophysical monitoring of heat flow, subsidence, micro-seismicity, field depletion and cold water intrusion.
- **Exploration** Detailed survey design and data collection for MT, TDEM, seismics, gravity, thermal infrared and magnetics to identify heat sources, permeability structures, fluid flow and drilling targets.
- **Integration** Combination of geophysical understanding with geological and geochemical expertise for an integrated approach to understanding geothermal reservoirs.
- **Research** Development of new methods and interpretive capability. Use of geophysical techniques for exploration, development and field monitoring.

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Geothermal science - power renewed.

## Engagements in :

- Japan
- Chile
- Philippines
- Indonesia
- PNG
- and elsewhere ...

# NZGAL

New Zealand Geothermal Analytical Laboratory

The New Zealand Geothermal Analytical Laboratory is a world leader in geothermal & groundwater analysis. Expertise is available to both new and existing geothermal and groundwater projects, and can also be applied to a wide range of non-routine analyses.

- Refurbishment completed in 2013
- NZS/ISO 17025:2005 accreditation
- NZ's most comprehensive and extensive set of geothermal and groundwater databases.



## New Zealand Geothermal Analytical Laboratory

Gas and water analyses for geothermal, volcanic and groundwater environments



NZGAL is a world leader in geothermal and groundwater sampling and analysis. Our domestic and international clients are provided with world class service and benefit from our specialist interpretive services.

We offer a range of routine and non-routine analyses, and can cater for difficult or unusual samples. Specialist treatment methods can be developed for your applications that are beyond our usual analytical methods.


Our laboratory team are supported by in-house multidisciplinary research and interpretation expertise, and can advise on sampling, exploration and monitoring programmes.

### at a glance →

<b>→ World-leading</b> Analytical facilities ranking amongst the best in the world.	<b>→ Fast</b> Routine turnaround time of 15 working days from receipt of samples. Priority turnaround can be arranged.	<b>→ Varied</b> Supporting projects for the geothermal industry, government agencies, industrial and agricultural clients, consultancies, iwi and others.
<b>→ Accredited</b> IANZ accreditation NZS/ISO/IEC 17025:2005; for analysis of groundwaters and geothermal waters, and for geothermal/volcanic gases.	<b>→ Specialist</b> Extensive experience handling geothermal and volcanic gas and water samples. Specially developed analysis methods can be developed.	<b>→ Integrated</b> Analytical services are closely aligned to GNS Science multidisciplinary research programmes.
<b>→ Robust</b> Highly qualified technical staff ensuring precision and quality.		

[www.gns.cri.nz](http://www.gns.cri.nz) Geothermal Science - Power Renewed.

# Training



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**Training**

GNS Science provides practical training for the geothermal industry, from introductory to specialist level to build capability and transfer knowledge. Individual or small group training can be delivered in New Zealand and internationally, and tailored to client requirements.


**Introduction to geothermal exploration**  
Introduction to geothermal systems and the process of geothermal exploration, exploration drilling and resource evaluation. Participants gain capability to understand and develop the exploration of geothermal prospects. 3-day generic short course.



**Leapfrog Geothermal: 3D geological modelling**  
Integrated 3D geological modelling and visualisation software for the geothermal industry. Participants can create comprehensive 3D models of field geology, including stratigraphy and structures, rock properties and reservoir parameters. 3-days generic course or 5-day course customised to client data.

[Leapfrog Geothermal Indonesia 2012.pdf](#) (989.09 KB)


**Geothermal borehole image interpretation**  
Overview of wireline logging, acoustic borehole imaging, geological interpretation and integration with other techniques. Participants will be able to critically assess interpretations, and understand the applications of data from acoustic borehole imaging technology in the geothermal industry. 1-day course.



**Field training**  
Tailored training courses in geological methods, geophysical techniques and chemical sampling. Participants are mentored within our laboratories and in the field so that they gain a clear understanding of, and confidence using, a range of specialist equipment.

**Customised training**  
A specific training programme tailored to suit client needs. Targeted industry training for all stages of geothermal exploration, development and production, including geology, geochemistry, geophysicists, and reservoir engineering.

**Studentships**  
Geothermal education and training for undergraduate and postgraduate students. Delivery of short courses, laboratory and field training, as well as internships. Introductory level or specialist subjects.

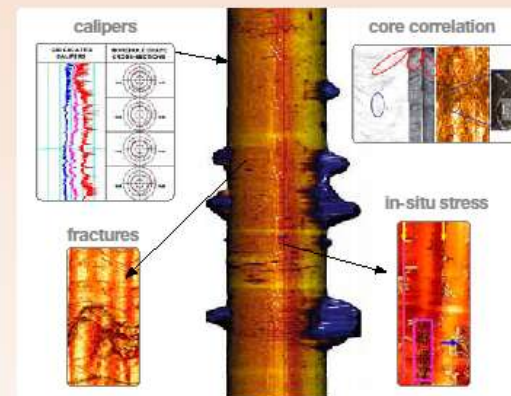


## integrated 3D modelling using Leapfrog Geothermal

3D modelling and visualisation for the geothermal industry.

## integrated geothermal borehole image analysis

Interpretation and integration of borehole images with wireline, core, geological and drilling data obtained in high temperature resources.



GNS Science provides independent third party interpretation of borehole image data from fractured geothermal reservoirs, with a focus on providing client solutions.

We work closely with logging operators to ensure high data quality and continuous improvement to image interpretation. Analyses are tailored to answer specific questions and geothermal field management issues that help add fiscal and scientific value to a project.

Image analysis is carried out using industry-recognised RECALL™ and WellCAD software, and performed by a team of experienced geothermal and structural geology specialists, with expertise in interpreting images and wireline information from a geothermal perspective.

### at a glance →

→ **Quality control** Rigorous and verifiable QC procedures are performed, and data can be repaired if applicable.

→ **Borehole quality** Corrected caliper calculations and 3D borehole displays allow assessment of borehole quality, and identification of damaged zones.

→ **Structural analysis** Determination of structural trends, fracture characterisation, and in-situ stress assessment.



# GNS Geothermal Research

Geothermal Resources of New Zealand  
Core Research

PL : Greg Bignall  
GNS Wairakei Research Centre

Waste to Wealth  
MBIE Contestable

PL : Ed Mroczek  
GNS Wairakei Research Centre

Geothermal Supermodels  
MBIE Contestable

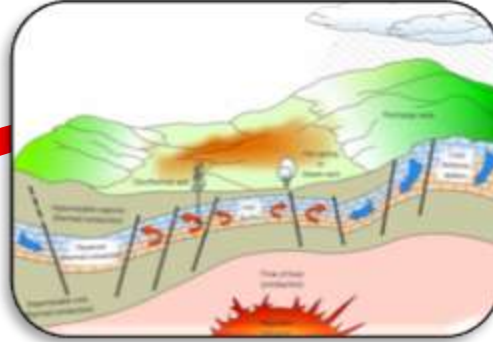
PL : John Burnell  
GNS Avalon Research Centre



MBIE : Microbial Bioinventory of Geothermal Ecosystems (MBG) to Sep. 2014

RSNZ Marsden : Tracking the Magmatic Signature (TMS) to Mar. 2016

Resource  
Characterisation



# Geothermal Resources of New Zealand

Sustainable  
Development



Geomicrobiology

Environmental Effects  
Low Enthalpy Systems



Currently NZ\$4.4M/annum  
Programme Leader: Greg Bignall

# Acknowledgements

Thank you, to the developers, iwi, regional authorities and Government departments, institutional and individual collaborators, who in many direct and indirect ways engage with GNS, and support the research undertaken by GNS staff.

GNS acknowledge the many commercial partners with whom we engage, in New Zealand and internationally.



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**THANK YOU**

