



IESE
Institute of
Earth Science
and Engineering
Aotearoa

GEOHERMAL

Research, Exploration, Assessment and Monitoring

GEOPHYSICS | GEOCHEMISTRY | GEOLOGY | SEISMOLOGY



IESE Overview

The Institute of Earth Science and Engineering (IESE) is a research, development and training institute of The University of Auckland, New Zealand with affiliation to the Geothermal Institute. The academic home of IESE is with the Faculty of Engineering and the Faculty of Science.

IESE's innovative research focuses on the study of active tectonics and hydrothermal systems. The Institute seeks to apply resulting knowledge and technology to geothermal exploration, resource evaluation, volcanic and seismic geological hazards, and surface and subsurface monitoring.

The IESE team brings together experience of more than 30 years in research, consultancy and training, with input for its geothermal programme from 3 University of Auckland teaching faculty, 9 full time professional research staff, 3 postgraduate students, and 4 IESE-associated geothermal consultants.

The Institute has built close international partnerships with other institutes, governments and industry. IESE works on both public and private concerns, delivering project-relevant research, professional short course training, and commercial services with has a strong track record in managing major geothermal and geological projects around the world.

Research and Innovation

More than half of IESE's research activities are associated with improving geothermal exploration success, reservoir development, modelling, and seismic monitoring instrumentation.

IESE has a strong focus on geothermal systems covering areas of geothermal geophysics, geology, geochemistry and mineralogy. The Institute also actively studies earthquakes, including induced seismicity and volcanic hazards. Similarly, IESE is interested in the impact of both natural changes as well as industrial and cultural activities on geothermal systems.

The Institute is also collaborating with Maori (indigenous people of New Zealand) to progress a geothermal development model that accounts for kaitiakitanga principles (a Maori concept of guardianship) for sustainable development.

Joint Geophysical Imaging (JGI)

IESE has developed JGI, a unique technology which involves combining data from seismographs and other geophysical instruments for analysis and interpretation, and takes advantage of signal polarisation effects produced by subsurface fractures. JGI is designed to significantly lessen geothermal development risks, and therefore costs, by locating optimum drilling targets or high permeability zones, and therefore doubling well output. JGI improves resolution of reservoir boundaries, upflow, fault and fracture zones, and fracture density and orientation. For developers it offers a way to reduce the risk-against-returns in geothermal exploration.

Engineered Geothermal Systems Modelling & Monitoring

IESE staff have been developing advanced, data based models of the complex interactions of hot rocks and fluids, erratic flow pathways, and the deformation effects of temperature and pressure changes for Engineered Geothermal Systems (EGS). By deploying a borehole seismic network at project sites, the location of micro-earthquakes can be readily detected and magnitudes monitored. This valuable seismic data is then interpreted for accurate well targeting and safety precautions.

Custom Seismometers

A new cableless, downhole seismometer and data acquisition array has been developed with an industrial partner. Data recording is within each sonde, minimising data losses due to transmission noise. This new tool is especially well suited for recording the faintest seismic signals, perhaps the smallest ever detected in deep boreholes.

Geophysical Observatory & Exploration System (GOES)

GOES is a multi-purpose magnetotelluric, seismic and micro-seismic recording system that is self-contained, extremely rugged and can be handled like a large geophone. Its innovative design supports the joint geophysical imaging method used by IESE in geothermal exploration and well targeting.

Geothermal Development Services

IESE provides services in geophysical measurement and interpretation, in support of basic and applied geological studies, geothermal geosciences and technology, volcano and earthquake hazards, and borehole geophysical instrumentation.

Exploration Surveys

- Seismic tomography
- Geological and geochemical surveying
- MT, TEM and CSAMT surveys
- Data integration, interpretation and processing

Micro-seismic Monitoring Networks

- Permanent and temporary installation, real time data solutions
- Borehole and surface array optimisation
- Radio telemetry and automatic event detection
- Mobile rental network for fast deployments
- Advanced and basic data analysis, including fracture distribution

Custom Seismic Instrumentation

- Very deep borehole seismometers, up to 5 kms
- High pressure (80 Mpa) and high temperature (160°C)
- High reliability using passive sensors

Geothermal Engineering

- Reservoir modelling
- Geothermal well-test analysis
- Subsidence modelling

Geothermal Geology

- Hydrothermal alteration, water chemistry, mapping of thermal surface expressions and heat and mass flow studies
- **Innovative techniques developed:**
 - Using sinter architecture in extinct hot spring sites to recreate hot spring paleo-flow conditions and locate high temperature upflow zones.
 - The application of Ground Penetrating Radar to determine the volume of sinter present, find buried sinters, and determine vent connectivity and directionality.
 - Determining processes behind subsidence involving a dual approach using SEM and compressibility testing.

Short Course Professional Training

IESE provides customised training covering a range of geosciences including geochemistry, reservoir modeling and structural geology, with a focus on resources, exploration, development and assessment. Recent courses have been taught in Chile, Indonesia, New Zealand, Australia, Kenya.



Project Experience Highlights

Montserrat Geophysical Survey, Caribbean

As part of an assessment of the geothermal resource on the island, IESE conducted both MT and TDEM surveys which helped delineate the structure of the geothermal reservoir and identified prospective areas of the field. A zone of apparent high permeability was found near Saint George's Hill. This site has now become the focus of a potential high temperature geothermal power development.

Coso Geothermal Field Monitoring, USA

Deployment, operation and analysis of a 12 station monitoring network in 100m boreholes, led to the development of S-wave splitting tomography for locating fractures as drilling targets. Subsequent electromagnetic and drilling studies confirmed the locations and sizes of potential high permeability zones.

Krafla Volcanic Field Well Targeting, Iceland

Deployment of a network of borehole and surface seismometers, and electromagnetic (MT and TEM) soundings. The integrated model of the field provided optimum drilling targets, and subsequent drilling yielded one of the most productive wells in the field.

Wairakei Geothermal Field Monitoring, New Zealand

Installed a world-class borehole seismic array in New Zealand's oldest operating geothermal field, to provide real-time micro-earthquake data. Data is used to monitor, manage and possibly expand future operations.

Olkaria Geothermal Exploration, Kenya

A UNEP funded project to pioneer Joint Geophysical Imaging (JGI). Before the survey, the target area had an average productivity of 2MW/well. By using JGI, the developer realised an increase in average productivity to 5MW/well.

Sumatra Geothermal Exploration, Indonesia

JGI was utilised to determine drilling targets for a geothermal power development. A seismic survey using a combination of surface and borehole instruments, with emphasis placed on S-wave splitting associated with zones of aligned, high permeability, fractures. Following JGI interpretation, and in combination with geological data, several potential drilling targets were identified.

Utah and Nevada Geothermal Exploration, USA

Geophysical and geological data acquisition and analysis of the geothermal prospect at Box Elder County, Utah and at Nye County, Nevada.

Puna Geothermal Field Monitoring, USA

Installed an 8 station borehole network at 30m, designed as a standalone geothermal field monitoring system.

Basel Engineered Geothermal System Monitoring, Switzerland

Constructed a 6 station seismometer and accelerometer monitoring network, including instruments at 1.2 and 2.7km deep, followed by the collaborative analysis of induced seismicity.

Paralana Engineered Geothermal System Monitoring, Australia

Installed of a network of 8 borehole stations at a depth of 1.8kms, providing real-time feedback on the field during drilling and hydro-fracturing.



CONTACT US

Institute of Earth Science and Engineering

The University of Auckland
Level 5 & 6, 58 Symonds Street
Auckland, New Zealand

Email: enquiries@iese.co.nz

Email: shortcourses@iese.co.nz

Web: www.iese.co.nz

For New Zealand: phone +64 9 373 7599

For United States: phone +1 760 608 7542



uniservices

