



47th New Zealand
GEOHERMAL WORKSHOP

Handbook

11-13 November 2025

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Welcome

47th New Zealand Geothermal Workshop

It is our great pleasure to welcome you to Rotorua for the 47th New Zealand Geothermal Workshop. This annual gathering continues a proud tradition of bringing together researchers, industry leaders, and innovators to share knowledge and advance geothermal science and technology. The global energy landscape is changing rapidly, and geothermal is experiencing a remarkable resurgence as nations seek secure, reliable, low-carbon solutions. Breakthroughs in Enhanced Geothermal Systems are opening new frontiers worldwide, and here in Aotearoa, we are embarking on one of the most ambitious steps yet: the development of supercritical geothermal resources in the Taupō Volcanic Zone. These projects promise several times the energy output of conventional wells and position New Zealand at the forefront of next-generation geothermal innovation. As we explore these opportunities together, we invite you to engage, challenge, and collaborate to shape the future of sustainable energy. A special thank you to all our sponsors. Your generous support allows us to keep registration fees low and subsidise social functions, making this workshop accessible and enjoyable for all participants. Thank you for joining us, and welcome to what promises to be another inspiring and productive event.

Conveners:

Sadiq J. Zarrouk

John O'Sullivan

Bridget Lynne

Mike O'Sullivan

Michael Gravatt

2025 Partners



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and Biomedical Engineering**

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2025 Awards

Bay of Plenty Regional Council and Waikato Regional Council

Best paper on environmental, social and Mātauranga Māori

New Zealand Geothermal Association

Best Overall Paper Award | Best Student Paper Award | Best Poster Award

Geothermal Institute

Best Geothermal Earth Sciences Award

General Information

The following information is provided as a guide to the Workshop. If you have any queries, please visit the registration desk.

Registration desk

For any questions, please visit the registration desk during Workshop hours.

If the registration desk is unattended, please call 027 287 5183.

Workshop catering

Lunches, morning, and afternoon teas will be served in Te Whakaruruhau (Catering and Exhibition zone) of the Sir Howard Morrison Centre.

Dietary requirements

Care has been taken to ensure all advised dietary requirements are catered to. If you specified your dietary requirements when registering, please make yourself known to the catering staff.

Mobile phones

During all presentations please switch off or turn your mobile phones to silent.

Presentations

As a courtesy to our presenters, please ensure you arrive at each session venue prior to the start of presentations.

Presenting authors

Presentation slots are 15 minutes long with 3 minutes scheduled for questions. Each session chair will be keeping strictly to time.

If you are scheduled to give a presentation, please ensure your PowerPoint is uploaded well in advance of your presentation time, preferably during the catering breaks or prior to the start of each day. Visit the registration desk for details on how to upload your presentation.

Cameras and electronic recording

No electronic recording of presentations is permitted in any form without the express written permission of Workshop organisers and speakers.

Urgent messages and lost property

Urgent messages for delegates and lost property can be directed to the registration desk.

Messages and lost property will be held there for collection until the conclusion of the Workshop.

Wi-Fi Access

Sir Howard Morrison Centre Wifi

Name: Event Network

Password: BoxlikePerch

Social Events

There are a number of social events available to attendees. If you have not already arranged your tickets to these events, please visit the registration desk.

Field Trip | Government Gardens–Ngāpuna thermal area

The Government Gardens – Ngāpuna, on the southern edge of Lake Rotorua, is a unique location where geothermal activity and a variety of geothermal direct uses coexist sustainably and in harmony. It is also a modern tourist destination set against a rich cultural and historical backdrop – the result of a shared vision between Ngāti Whakaue and European settlers to establish Rotorua as a national spa and wellness town in the late 1800s.

This tour will showcase a selection of direct-use sites and some of the most beautiful and well-preserved geothermal features and landscapes of New Zealand. It offers the participants a high-level understanding of the environmental management strategies – and challenges – involved in fulfilling the aspirations of the Rotorua community. These efforts aim to protect the area's significant cultural and environmental value while supporting low-impact, sustainable use of the geothermal resources for great socio-economic benefits.

There is a cost of \$100NZD to attend. Spaces are limited.

Welcome Function

Monday, 10th November 2025

5:30pm – 7pm

**Sir Howard Morrison Centre
1170 Fenton Street**

This will be a 'drinks and nibbles' event open to all registered Workshop delegates. No ticket required.

Workshop Dinner

Wednesday, 12th November 2025,

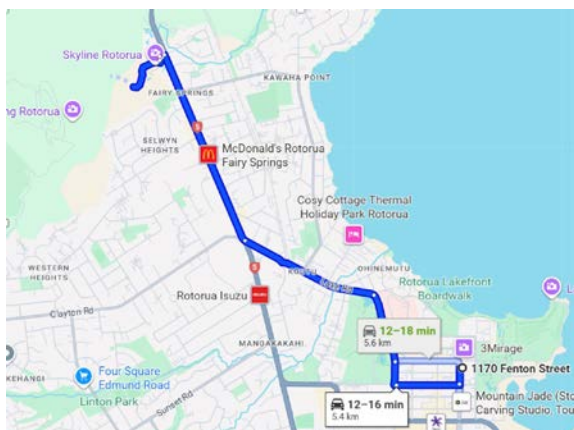
6:30pm – 10:30pm

Stratosfare Restaurant and Bar

178 Fairy Springs Road

**Please note that transport to the workshop dinner venue is provided this year via buses. Please meet at the Sir Howard Morrison Foyer by 6pm for bus departures.*

The venue is a 12-18 minute drive from the workshop venue.



Rotorua Information



The following information is provided as a guide to Rotorua. If you have any queries, please visit the registration desk.

Emergencies, medical needs and illnesses

If you have an emergency you can contact the police, paramedics and fire department by calling 111 from any landline or mobile phone.

The workshop venue is:

Sir Howard Morrison Centre
1170 Fenton Street
Rotorua 3010

If you require non-emergency medical attention during the workshop, please inform the registration desk.

Getting around Parking and Buses

Parking

The Sir Howard Morrison Centre is located on Fenton Street in the heart of Rotorua. There is no road parking in the area, and the Pukuatua Street parking building is also located within the CBD.

For more parking options, please visit www.rotorualakescouncil.nz/roads-transport/parking/where-to-park

Mobility Parking

Rotorua Lakes Council run a mobility parking scheme and this provides specific parking spaces and other parking privileges for people with disabilities. Rotorua has at least 2 mobility parks per street in the Rotorua Centra; District (CBD). The only people who may use mobility parks are those who display current permits.

Buses:

For matinees there are 11 bus routes which cover the Rotorua urban area, visit the www.baybus.co.nz/routes/2 to plan your trip. Please note the bus service stops shortly after 6pm.

Nearby Services

Rotorua Library

1127 Haupapa Street (200m)

NZ Police Station

1190 Fenton Street (100m)

Lakes Care Pharmacy

1155 Tutanekai Street (300m)

Visitor Information Centre

1167 Fenton Street (100m)

Eat & drink in Rotorua

Rotorua has a vast array of eateries on offer. Check out the **Rotorua NZ** website for more details on Cafes, Restaurants, Bars & Pubs, and much more!

Places to Visit

Rotorua is bursting with unforgettable experiences, just waiting for you to discover. Check out www.rotoruanz.com for more details.



Keynote Speakers



Saied Jalilinasrabady

GNS Science

Dr. Saeid Jalilinasrabady is a Senior Scientist at GNS Science, with over two decades of international experience in geothermal energy development and engineering. In addition, he serves as an Associate Editor for Geothermics. His expertise spans subsurface energy storage, geothermal reservoir simulation and engineering, surface facility optimisation, and direct-use applications, with extensive contributions across Japan, Iran, Iceland, El Salvador, Indonesia, the Philippines, New Zealand and Africa, including countries such as Kenya, Ethiopia and Rwanda.

Dr. Saeid Jalilinasrabady holds a Doctor of Engineering in Earth Resources Engineering from Kyushu University, Japan (2011). He also holds a Master's in mechanical engineering from the University of Iceland (2008), a certificate in geothermal reservoir engineering from the University of Auckland (2009), and a certificate in geothermal utilisation from the United Nations University – Geothermal Training Programme (GRO-GTP) in Iceland (2004).

At Kyushu University, Japan, Dr. Saeid Jalilinasrabady led research in geothermal plant design and optimisation, applying exergy-based models to a wide range of geothermal systems including flash, binary, combined, and hybrid cycles. This work supported case studies in countries such as Iran (Sabalan), Japan (Takigami), Kenya (Olkaria), Indonesia (Dieng), and the

Philippines (Biliran), delivering practical insights for improved feasibility and investment decisions.

He has also been deeply involved in geothermal reservoir simulation and forecasting, contributing to reservoir models for geothermal fields such as Takigami (Japan), Sabalan (Iran), Olkaria (Kenya), and Kotamobagu (Indonesia). Their research has helped bridge subsurface and surface systems in geothermal operations, supporting more effective resource management.

He held academic and research positions at Kyushu University from 2008 to 2014, starting as a PhD researcher, followed by a prestigious JSPS Postdoctoral Fellowship, and later as Assistant Professor in the Faculty of Engineering. From 2014 to 2017, he served as an Associate Professor at Akita University. He then returned to Kyushu University from 2017 to 2024 as an Associate Professor in both the School of Interdisciplinary Science and Innovation and the Faculty of Engineering. Additionally, from 2016 to 2024, he served as a Lecturer at the JICA Geothermal Training Program, where he delivered lectures to geothermal professionals from developing countries and supervised their projects. Throughout these roles, he was actively involved in international collaborations focused on sustainable geothermal development at the international level.

DeepHeat: unlocking superhot geothermal and national energy security through advanced permeability modelling

Aotearoa-New Zealand's (NZ) electricity demand is rising rapidly, driven by increasing energy use, the shift to electric transport, and the transition to cleaner industries. By 2050, we will need 82% more electricity than we do today. While renewable sources like wind and solar will play an important role, their reliability and large land use limit their contribution to establishing energy security.

Harnessing deeper superhot geothermal resources offers a potential solution, as a new, low-carbon, small footprint way to generate 24/7 base load electricity.

NZ is well-positioned to lead the world in developing this next-generation energy source, with the discovery of superhot geothermal resources in the Central Taupo Volcanic Zone (CTVZ). Combined with global expertise and government-backed drilling efforts, NZ has a rare opportunity to pioneer a breakthrough in clean energy production.

Our DeepHeat Programme uses advanced technologies like AI to better understand and harness superhot geothermal energy. We're focused on:

- developing new methods to understand how geothermal fluids move in the brittle-ductile transition zone, where rock behaves both like brittle and flexible material;
- assessing the CTVZ's energy potential to guide well placement and design;
- studying the performance of superhot geothermal utilisation; and
- developing safe and sustainable extraction methods for commercial energy production.

Our diverse team of scientists, engineers, AI experts, and Māori advisors will work with established international partners from the USA, Japan, Switzerland and Iceland. Collaborations with drillers, well designers, and energy stakeholders ensure practical solutions for NZ's energy needs. Additionally, the Programme supports Māori-led development, promoting indigenous wealth and sustainable resource management.

Unlocking superhot geothermal resources will transform our energy future, drive environmental goals, create new economic opportunities, and establish NZ as a leader in sustainable energy.

Notes



Eva Schill

Geothermal Systems Program Lead, Energy Geosciences, Lawrence Berkeley National Lab

Eva Schill is a Staff Scientist in the Geophysics Department of Berkeley Lab's Earth and Environmental Sciences Area (EESA) where she serves as the Lead of the Geothermal Systems Program of the Energy and Geoscience Division. At the Technical University of Darmstadt, Germany, Dr. Schill is Professor for Geophysics in Reservoir Systems. She obtained her Ph.D. from the Eberhard Karls University in Tübingen in Germany. After her postdoctoral research at ETH Zürich, Switzerland and Johannes Gutenberg University Mainz, Germany, where she was appointed first Junior Professor for Geothermics. After serving as Professor for Geothermics at the University of Neuchâtel, Switzerland, she was a leading scientist at the Karlsruhe Institute of Technology, Germany, before joining LBNL.

Dr. Schill is a geologist and geophysicist and deals with geothermal issues from exploration to reservoir behavior. She combines various geological and geophysical methods to understand the structure of the subsurface. In combination with hydromechanical experiments, Dr. Schill is developing new monitoring methods that go beyond the monitoring of induced seismicity and shed light on reservoir processes. She is also working on new technologies to mitigate induced seismicity.

Unlocking Earth's Deep Heat: The Next Frontier of U.S. Geothermal Energy

Geothermal energy is emerging as a cornerstone of the U.S. future energy mix, providing reliable and dispatchable baseload power. Over the past decade, major advances in Enhanced Geothermal Systems (EGS) and Superheated EGS have expanded the boundaries of geothermal development far beyond naturally convective hydrothermal systems. These innovations promise to unlock vast heat resources across the continental United States. Research funded by the Department of Energy's Geothermal Technology Office has played a leading role in this development, pioneering both the scientific foundations and the enabling technologies of next-generation geothermal systems. From early modeling of reservoir stimulation and induced seismicity to cutting-edge developments in geophysical monitoring, reactive transport modeling, and supercritical water-rock interaction, LBNL's research has shaped national strategies for safe and efficient EGS deployment. Recent demonstrations—such as EGS Collab and Utah FORGE—illustrate the transition from laboratory to field scale, where LBNL's tools for subsurface characterization, multiphase flow, and stress monitoring are being applied in real time. Looking forward, the Lab's new initiatives aim to access temperatures above 400°C, dramatically increasing energy density and efficiency. This keynote will highlight the scientific breakthroughs, charting the path toward commercially viable EGS systems that could redefine geothermal's role in the U.S. energy portfolio.

Notes

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Our commitment to **quality, safety, and sustainability** ensures **efficient and reliable operations**, helping clients achieve their project goals with precision and excellence.

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 janderson@condorenergy.com.au

47th New Zealand Geothermal Workshop Programme

** Programme subject to change*

Monday 10 November			
3:00	Registration Open		
5:30	Welcome Reception Sir Howard Morrison Centre, Rotorua Drinks and canapés		
7:00			
Tuesday 11 November			
8:00	Registration Open, Te Haumihi Foyer		
8:45	Mihi whakatau: Te Taru White and Kingi Biddle		
8:55	Housekeeping: Sadiq J. Zarrouk		
9:00	Welcome and Opening: Hon. Shane Jones, Minister for Regional Development, Minister for Resources, Associate Minister for Energy, Associate Minister of Finance, and Minister for Oceans and Fisheries (recorded), Sadiq J. Zarrouk & John O'Sullivan, Co-Directors, Geothermal Institute, The University of Auckland		
9:15	KEYNOTE TITLE: DeepHeat: unlocking superhot geothermal and national energy security through advanced permeability modelling Keynote Speaker Dr Saeid Jallinasrabady, Senior Scientist, Earth Sciences New Zealand. Sponsored by Nikkiso		
10:00	MORNING TEA		
	Session 1.1 - INDUSTRY UPDATES SESSION CHAIR Mason Jackson ROOM: Matangi Rau	Session 1.2 - RESERVOIR MODELLING 1 SESSION CHAIR Ryan Tonkin ROOM: Haumaku Theatre	Session 1.3 - ENVIRONMENTAL ASPECTS SESSION CHAIR Alexander Catalinac ROOM: Matatea - paneke
10:30	TUWHARETOA GEOTHERMAL INDUSTRY UPDATE Robbie Watt	91 Enhancing early-stage geothermal resource assessment through uncertainty modelling of the clay cap - Ken Dekkers	39 Greenhouse gas emissions reduction: Global geothermal catalogue update 2024 - Ian Richardson

10:45	ECOLAB INDUSTRY UPDATE Fritz Monterozo	56 Integrating geological uncertainty into geothermal reservoir simulations with Bayesian optimization workflows - Jeremy Rihet	38 Rotorua geothermal surface feature monitoring data: An innovative approach to a unique database - Mariama Zuquim
11:00	SOLENIIS INDUSTRY UPDATE Dan Wilson	106 Resource assessment of the Tecuamburro geothermal system using reservoir simulation - Julian Guillermo Xicara Lopez	77 Geyser activity at Geyser Flat, Te Puia, Rotorua: Insights from the second geyser monitoring deployment - Brook Keats
11:15	AQUIFER MAPPING INDUSTRY UPDATE Michael Du Preez	99 The new geological and natural state model of Hululais geothermal field - Sotarduga Sahat Nainggolan	95 Can geothermal vegetation monitoring be standardised in New Zealand? - Sarah Beadel
11:30	AQUAMAX INDUSTRY UPDATE Hamish Coop	72 Application of numerical simulation method with experimental design in the Sibayak geothermal field, Indonesia - Eric Firanda	96 Ecology of geothermal vegetation and habitats at the Waimangu-Rotomahana geothermal site, Rotorua - Chris Bycroft
11:45	ESSITY INDUSTRY UPDATE Mark Steven	37 The use of numerical modelling for characterising deep geothermal reservoirs: a case study of the Upper Rhine Graben - Berenice Vallier	112 Preliminary investigation on the suitable scope of geothermal Life Cycle Assessment - Gloria Gladis Sondakh
12:00	LUNCH AND POSTER SESSION		
		76 Hydrothermal alteration exploration and heat flux monitoring of the Guelma Basin geothermal field using ASTER data - Brahim Ayad	
		19 Pioneering geothermal energy potential study in Sudr oil field, Sinai, Egypt - César Chamorro	
		44 The Geochemical Properties of the Geothermal Fluids of Northwestern Algeria: A revised conceptual framework - Brahim Ayad	
		70 Optimisation of Ulubelu Unit 1&2 PLTP electricity production realization against cyclic well using main setting pressure mode - Nizar Muslim (e-poster)	
		10 Geothermal operators are embracing geothermal multifinger caliper technology [BR1] for derisking well interventions and workovers - Reza Khastoo	
		26 Theoretical study of conditions for generation of periodic wellbore flow: Dependence on two-phase flow models - Mitsuo Matsumoto	

	Session 2.1 - INDUSTRY UPDATES SESSION CHAIR Nataly Castillo Ruiz ROOM: Matangi Rau	Session 2.2 - GEOCHEMISTRY / SCALING & CORROSION 1 SESSION CHAIR Bei Nugoro ROOM: Haumaku Theatre	Session 2.3 - MĀTAURANGA MĀORI / COMMUNITY ENGAGEMENT 1 SESSION CHAIR Michael Gravatt ROOM: Matalea - paneke
1:30	EARTH SCIENCES NEW ZEALAND INDUSTRY UPDATE Isabelle Chambefort	46 Review of chemical cleaning methods in geothermal wells - Paul Siratovich	14 The Waitangi Tribunal & geothermal resource management - Loretta Lovell, Melissa Climo
1:45	MB CENTURY INDUSTRY UPDATE Alan Stewart	65 Formation factor analysis of the silica scale precipitated from geothermal waters by machine learning - Tadahiro Naritomi	73 The interface of Māori geothermal development in Rotorua with national and regional policy: Case studies for low enthalpy initiatives - Betsan Martin
2:00	MTL INDUSTRY UPDATE Richard Belcher	89 Development of prevention strategies for silica scaling based on neural network supervised machine learning - Saefudin Juhri	3 Māori values and uses of low temperature geothermal in Tauranga Moana
2:15	SLB INDUSTRY UPDATE Hans Dick, Noel Pereira	90 Geothermal potential of the Amagmatic Aswa Shear Zone in Uganda: An assessment using geochemical signatures - Benjamin Twesigye	108 An iwi-inspired system management plan for Tikitere geothermal system - Greg Bignall
2:30	UPFLOW INDUSTRY UPDATE Paul Siratovich	12 Natural state chemistry of the Ijen geothermal field – A blind geothermal system - Fikri Dermawan	15 Ohinemutu Village: geothermal past, present & future - Aleisha Mitchell
2:45	CASIL TECHNOLOGIES INDUSTRY UPDATE Jim Johnston	103 Monitoring changes in geothermal springs chemistry at Kuirau Park and Ohinemutu, Rotorua geothermal system - using field physical measurements as a cost-effective proxy for chemistry changes - Mariana Zuquim	
3:00	AFTERNOON TEA		

	Session 3.1 - INDUSTRY UPDATES	Session 3.2 - GEOPHYSICS / GEOTHERMAL GEOLOGY	Session 3.3 - PRODUCTION & MANAGEMENT 1
	SESSION CHAIR Robert Mandjes ROOM: Matangi Rau	SESSION CHAIR: Théo Renaud ROOM: Haumaku Theatre	SESSION CHAIR Eylem Kaya ROOM: Matalea - paneke
3:30	BAY OF PLENTY REGIONAL COUNCIL INDUSTRY UPDATE Penny Doorman	21 Linking fracture networks to geophysical observations through numerical modelling - Alison Kirkby	20 Risk analysis in the geothermal potential assessment - Case study Croatia - Daria Karasalihović Sedlar
3:45	WAIKATO REGIONAL COUNCIL INDUSTRY UPDATE Katherine Luketina	30 Enhanced gravity anomaly separation using a Wiener and Preferential Bandpass Butterworth Filtering for structural identification in Telomoyo geothermal area - Indira Arifianto	79 Geo-loop: A novel system for characterising multiphase flow of saline geothermal fluids at elevated pressures & temperatures - Adolph Jr. Bravo
4:00	MITCHELL DAYSH INDUSTRY UPDATE Mason Jackson, Mark Henry	22 Investigating structural controls on the heat flux and steam release from the Waiotapu Geothermal Field using the Landsat 9 dataset- Emmanuel Tuirininmana	33 Near-supercritical behaviour of LHD-47 Well, Lahendong Geothermal Field, North Sulawesi, Indonesia- Imam Muhammad Prasetyo
4:15	GEOTHERMAL INSTITUTE INDUSTRY UPDATE Sadiq J. Zarrouk, John O'sullivan	34 Preliminary geothermal conceptual model of Salve Faccha-Oyacachi prospect, Chacana caldera-Ecuador- Xavier Asimbaya	16 Delivering commercially attractive geothermal coiled tubing operations - Ben Drew
4:30	JACOBS INDUSTRY UPDATE Aimee Calibugan	81 The view from orbit: Discoveries and challenges of hydrothermal deposition in a large impact crater on asteroid Ceres- Paul Schenk	101 Calcite Inhibition Systems Tubing Recovery - Dan Wilson
4:45	SEEQUENT INDUSTRY UPDATE Clare Baxter	57 Deep learning for instantaneous inversion of SkyTEM data Alison Kirkby	18 SWOT analysis of geothermal power plants- Hakki Aydin

Wednesday 12 November			
8:45	Housekeeping		
9:00	KEYNOTE TITLE: Unlocking earth's deep heat: the next frontier of U.S. geothermal energy Keynote Speaker Professor Eva Schill, Geothermal System Programme Lead, Lawrence Berkley National Laboratory, USA		
9:45	MERCURY NEW ZEALAND INDUSTRY UPDATE Emily Collis		
10:00	MORNING TEA		
	Session 4.1 - INDUSTRY UPDATES SESSION CHAIR Chris Horan ROOM: Matangi Rau	Session 4.2 - PRODUCTION & MANAGEMENT 2 SESSION CHAIR Oliver MacLaren ROOM: Haumaku Theatre	Session 4.3 - SOCIAL ENGAGEMENT / COMMUNITY ENGAGEMENT 2 SESSION CHAIR Michael Gravatt ROOM: Mataatea - paneke
10:30	EASTLAND GENERATION INDUSTRY UPDATE Ben Gibson	49 Optimising reinjection capacities for Nga Tamariki Power Plant - Qiao Zhu	52 Investigating the variance in activity of the Lady Knox Geyser, Waioatapu Thermal Wonderland, New Zealand - Buna R. Rachman
10:45	CONTACT ENERGY INDUSTRY UPDATE Bridget Ayling	29 An introduction of Kyuden Group's geothermal power plants in Kyushu Island, Japan - Noriko Nii	25 Development of a web-based tool to identify geoheat opportunities for covered crops - Anya Seward
11:00	WESTERN ENERGY INDUSTRY UPDATE Marcus Prestney	62 Purification of geothermal gases for use in pilot and demonstration scale facilities - Samuel Wiseman	40 Combining low grade geothermal heat with heat pumps, an opportunity to decarbonise industrial districts - Celia Wells, Yale Garden
11:15	CONDOR ENERGY INDUSTRY UPDATE Josh Anderson	100 Cleaning and Stimulating Geothermal Well with Oil and Tar Residue Downhole - Esteban Rodriguez (presented by Dan Wilson)	11 Preparation of the Abaya Project for Geothermal Sustainability Assessment Protocol (GSAP) in Ethiopia - Muhammed Adem
11:30	WING INDUSTRY UPDATE Nyssa Brewer	35 J SHAPED Double Energy Input - Daniel Ramirez Ordas	67 Driving agricultural sustainability through geothermal energy: A CSR case study of programme Gemah Karsa by PT PGE Tbk Kamojang Area - Erwandi Yanto

11:45	LUNCH		
1:00			
1:45	HALLIBURTON INDUSTRY UPDATE Sam Abraham		
	Session 5.1 - INDUSTRY UPDATES SESSION CHAIR Abbie Dean ROOM: Matangi Rau	Session 5.2 - SCALING & CORROSION 2 SESSION CHAIR Yeftamikha Siahaan ROOM: Haumaku Theatre	Session 5.3 - COLLABORATION SESSION CHAIR Sadiq J. Zarrouk ROOM: Matatea - paneke
2:00	Fieldtrip: Government Gardens-Ngāpuna thermal area. Hosts: Katherine Luketina, Miriana Zuquim, Rob Ranger Departing at 2pm returning by 4:30-5pm approx. This is a ticketed fieldtrip, see registration desk if you wish to join		
	MARUBENI-TOCHU TUBULARS OCEANIA (MITO) INDUSTRY UPDATE Soroush Tehrani	50 Concept of the development of scale inhibitors - Kotaro Yonezu	87 2024 annual Aotearoa New Zealand geothermal review - Ted Montague
2:15	VALLOUREC INDUSTRY UPDATE Francois Penven	4 New chemistry development to address stibnite scale inhibition in geothermal plants - Eric Koay	27 International collaboration on research into deep superhot roots of geothermal resources through IEA Geothermal - Chris Bromley
2:30	GEO40 INDUSTRY UPDATE Mathew Hunt	5 New highly thermally stable corrosion inhibitor for geothermal applications - Erik Koay, Johnson Kuy	31 International collaboration involving New Zealand through the IEA Geothermal Technology Collaboration Programme - Chris Bromley
2:45	SPD GROUP INDUSTRY UPDATE Colin Finnegan	102 Novel method of dissolution of scale in the inaccessible geothermal wellbore - Arsyian Sasoni	
3:00		43 The CaSil technology at the He Ahi/Tauhara geothermal field: Silica scale elimination in the presence of a calcite Inhibitor - Michael Schweig	
3:15	AFTERNOON TEA		
3:45	Session 6.1 - INDUSTRY UPDATES SESSION CHAIR Mike Roger ROOM: Matangi Rau	Session 6.2 - DRILLING & WELL TESTING SESSION CHAIR Rony Nugraha ROOM: Haumaku Theatre	Session 6.3 - RESERVOIR MODELLING 2 SESSION CHAIR John O'Sullivan ROOM: Matatea - paneke

3:45	NZGA INDUSTRY UPDATE Abbie Dean, Jess Bradley	23 The shallow geothermal energy potential in Auckland: An exploratory study - Yufei Liu	97 An integrated Python-based workflow for geological and geothermal fluid flow modelling to investigate lateral fluid movement in the Taupō Volcanic Zone - Sophie Pearson-Grant
4:00	NZTE - INDONESIA INDUSTRY UPDATE Putri Wuningsari	107 What to expect when you're not expecting - Drilling in the Tauranga Geothermal System - Shell Gardner	55 The effect of a temperature-dependent permeability limit on the convective upflow and temperature in a numerically modelled geothermal system - Dona Banerjee
4:15	NZTE - PHILIPPINES INDUSTRY UPDATE Maricon Popanes-Lim	78 Using advanced bit sensor modules for measuring vibrations, torque, and weight on bit to optimise PDC bit drilling efficiency in geothermal applications - Aira Aspiras, Andrei Rebrikov	75 From natural description to simulation: Large language models for geothermal engineering - Siying Huang, Zhi Hui Celina Kan
4:30	NZTE - TAIWAN INDUSTRY UPDATE Minchen Pan	111 Recent subsurface insights at Rotokawa: Case study of a new well - Beth Murphy & Matt Kelley	48 Analytical models of degassing and regassing geothermal systems - David Dempsey
6:30	NZGW CONFERENCE DINNER – STRATOSFARE RESTAURANT AND BAR, ROTORUA		
10:30	Buses departing Sir Howard Morison Centre from 5.30pm to the dinner venue, return buses starting from 9.30pm		
Thursday 13 November			
9:00	Housekeeping		
9:15	AWARDS		
10:00	MORNING TEA		

	Session 7.1 - PRODUCTION & MANAGEMENT 3	Session 7.2 - RESERVOIR MODELLING 3 / DIRECT USE	
10:30	SESSION CHAIR Angus Yeh ROOM: Matatea - paneke 109 Controlled mineralisation of carbon dioxide: laboratory assessment - Risa Prameswari Putri	SESSION CHAIR Adrian Croucher ROOM: Haumaku Theatre 113 Assessing groundwater impacts of geothermal development through Integrated modelling: Insights from Ulumbu with broader application - Angela Horta	
10:45	24 Utilising a digital twin for the troubleshooting of a geothermal power station - Ben Strode-Penny	82 Techno-economic study of Taiwan advanced geothermal systems technology - Ke-Chieh Chou	
11:00	13 The use of Computational Fluid Dynamics (CFD) for slugging prediction in a two-phase geothermal production system - Andrew Marsh	59 Wider benefits from ambient and low temperature geoheat. Why don't we get it? - Anya Seward	
11:15	58 Hybrid thermodynamic & machine learning model to predict Kawerau geothermal station output live - Lydia Hingston	63 Biological transformation of geothermal gases to biomass: a case study - Andrew Mitchelmore	
11:30	41 Rejuvenizing aged conventional geothermal reservoirs with supercritical geothermal energy - James Zhilin Dong	45 Evaluating geothermal-derived mineral production for sodium-ion batteries for utility scale energy storage in New Zealand - Karan Titus, Mathieu Ricketts	
11:45	88 An application of autonomous vehicles to manage high-risk exposure in geothermal operations - Emily Collis, Ben Gibson		
12:00	Workshop close - Sadiq J. Zarrouk, John O'Sullivan		

Abstracts

3 | Māori values and uses of low temperature geothermal in Tauranga Moana

Awhina Ngatuere¹ and Penny Doorman²

1 Toi Kai Rawa Trust, Tauranga Moana, Aotearoa

2 Bay of Plenty Regional Council, Whakatāne, Aotearoa

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Keywords: *Tauranga Moana, geothermal, Māori, mātauranga Māori, kaitiakitanga, Tauranga Geothermal System*

The Tauranga Geothermal System is a low temperature geothermal system in the Bay of Plenty Region, with temperatures ranging from 30°C to 77°C. The geothermal heat is used for commercial, domestic and municipal space and water heating, and bathing. With advancements in heat pump technology and a focus on renewable low carbon energy, there is growing interest in the use of low-temperature geothermal resources. As a potential accessible source of geothermal heat, the Tauranga Geothermal System is increasingly seen as a value proposition for social and economic development in the region.

To help manage the system, Bay of Plenty Regional Council (Council) is developing a Tauranga Geothermal System Management Plan, building on previous work to characterise the system, reservoir modelling, iwi and hapū management plans, and an economic assessment of geothermal values in the region. The Council is also working towards greater partnership with Māori in geothermal management, and to ensure that Māori are well positioned to benefit from geothermal development. This paper describes the outcomes of targeted engagement with Māori on the

Tauranga Geothermal System, to identify values associated with the geothermal system, and Mātauranga Māori (Māori knowledge) on the health of the resource. Opportunities and strategies to build iwi and hapū capabilities about low temperature geothermal, and its use for social and economic wellbeing, such as Papakāinga housing, are also explored.

Session: 2.3



4 | New chemistry development to address stibnite scale inhibition in geothermal plants

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Keywords: *Stibnite, Antimony, Sulfide, Geothermal, Scale Inhibition*

Among all the inorganic scale species that affect geothermal applications, stibnite is one of the most difficult to treat due to its extremely low solubility constant. Stibnite typically occurs in binary systems and is more commonly found in geothermal fields in countries such as Italy, Turkey, and the USA. Its precipitation in the heat exchangers of geothermal plants often reduces heat exchange efficiency, leading to a decrease in power output and increased operational costs.

Various methods, such as offline mechanical cleaning, offline chemical cleaning with acid or caustic, and the continuous application of scale inhibitors and dispersants, have been applied to prevent or eliminate stibnite precipitation. However, these approaches can be expensive when plant downtime is considered and may pose safety risks due to the formation of H₂S.

While chemical treatment can offer a more cost-effective and safer solution, only a few technologies are currently available on the market, and many of them fail to provide complete inhibition, particularly under severe conditions.

This paper introduces a new stibnite inhibitor, providing a detailed description of its development, with a focus on the challenges and testing conditions designed to mimic real-world scenarios. An analysis of the mechanism of action of this innovative technology is also discussed. Preliminary results indicate that the new inhibitor outperforms standard solutions, functioning effectively under more severe conditions and achieving a reduction in the Minimum Inhibitor Concentration (MIC) by 2x to 3x. It has demonstrated the ability to control

stibnite in brine containing approximately 10 ppm of antimony—around twice the maximum antimony level found in geothermal brines.

Ongoing field trials in Europe and North America are validating the lab results, showing a significant improvement in mitigating stibnite scaling compared to previously adopted solutions. The technology's ability to reduce environmental risks, such as H₂S formation, and its potential to save up to 30-50% in operational costs, make it a promising solution for broader industrial applications beyond stibnite control.

Session: 5.2



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5 | New highly thermally stable corrosion inhibitor for geothermal applications

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Keywords: corrosion, CO₂, geothermal, high temperature, inhibitor

Corrosion can often happen in geothermal plants due to high temperature and the presence of significant number of chlorides in the liquid phase and CO₂ and H₂S in the gas phase. In some cases, the use of acid to reduce pH to delay amorphous silica formation, can increase the risk of corrosion issues that could eventually lead to loss of power or heat generation or, in severe cases, shutdowns to replace the corroded part of the plant. The use of corrosion resistant alloys is a currently used approach, but it increases CAPEX associated with a new geothermal plant. For this reason, effective treatment based on a corrosion inhibitor is becoming attractive. Due to the high

temperature, most of the film forming corrosion inhibitor cannot be used as they rapidly degrade. In this work, to identify the most suitable solution, high temperature weight loss coupon test has been performed on several different technologies and the most promising was then evaluated under different conditions. Another important aspect is the interaction between scale and corrosion inhibitors that in some cases could lead to unexpected loss of performance in the field. A proper selection of these chemicals is crucial for obtaining the desired protection in the plant. This aspect was also evaluated in this paper, with both scaling and corrosion tests carried out in the presence of corrosion and scale inhibitors. After this extensive lab work, a field trial to confirm corrosion properties under real field conditions was scheduled. Details and results are discussed and analyzed in the paper.

Session: 5.2



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10 | Geothermal Operators are Embracing Geothermal Multifinger Caliper Technology for Derisking Well Interventions and Workovers

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Keywords: well interventions, workovers, geothermal, well integrity, multi-finger caliper, casing inspection, corrosion, deformation

Since the commercialisation of a digital geothermal multi-finger caliper in early 2020, operators have been transforming the decision making behind highly critical well intervention and workover operations. Previously, operators were either forced to quench their high temperature well in order to acquire data that informs the condition of the casing or resorted to deploying a limited analogue-based caliper measuring tool. The quenching operation incurs cost and subjects the casing to potentially damaging thermal cycling. Technological limitations and the burden of quenching often deterred operators from conducting any data acquisition as part of the decision-making process behind well interventions and workovers. Since the technological breakthrough of the geothermal casing inspection caliper, operators have been embracing data to plan activities with confidence, de-risking operations in the process. Pre-workover evaluation and well integrity diagnostics are the two key areas benefiting from digitally enabled data acquisition that eliminates quenching as a pre-requisite. In pre-workover evaluation, wellhead maintenance is being made safer through the appropriate selection of plugs as a well control barrier based on accurate and reliable data that informs where

the plug should be set and areas to avoid. Wells with compromised casing can be treated with re-lining remedies which can save a well from abandonment. The geothermal MFC enables pre-rig mobilisation assessments, flagging internal diameter restrictions, scale build-up, or deformations. In wellbore integrity diagnostics, the geothermal MFC is becoming a key tool in diagnosing issues that cause wellbore integrity failure, resulting in improved best practices that help prevent recurrence. This digitally-fueled, data-driven transformation of geothermal well operations are helping operators extend the lifespan of wells, reducing inefficiencies that can add risk and cost to the management of their assets.

Session: Lunch and Poster Session



11 | Preparation of the Abaya Project for Geothermal Sustainability Assessment Protocol (GSAP) in Ethiopia

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Keywords: Sustainability, protocol, environment, social, community, and resources.

The primary aim of this study was to assess the Abaya Geothermal Development Project in Southern Ethiopia using the Draft Geothermal Sustainability Assessment Protocol (GSAP). The Abaya project is being developed by Reykjavik Geothermal and there are plans for the installation of a 300 MW geothermal power plant with prospects for future expansion. The GSAP, adapted from the Hydropower Sustainability Assessment Protocol, provides a comprehensive

framework designed to evaluate geothermal projects across various environmental, social, and technical criteria.

This assessment, conducted collaboratively with Reykjavik Geothermal management, focused on evaluating the GSAP's suitability within the Ethiopian context, given the region's unique socio-economic and regulatory conditions. The project was evaluated on six crucial sustainability dimensions, achieving basic good practice (Level 3) on five topics, while one topic scored slightly lower (Level 2), highlighting specific improvement needs.

The findings confirm that GSAP is highly applicable to the Ethiopian setting, demonstrating significant potential for guiding future geothermal projects towards international standards of sustainability. The protocol effectively facilitates stakeholder engagement, ensuring environmental and social considerations are adequately addressed, thereby enhancing community support and long-term project viability. The results underscore GSAP's importance as an essential tool for sustainable geothermal resource management and development in Ethiopia.

Session: 4.3



12 | Natural State Chemistry of the Ijen Geothermal Field – A Blind Geothermal System

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Keywords: *Ijen, Blawan-Ijen, Java, Indonesia, Natural-State, Chemistry, Blind Geothermal System, Kawah Wurung*

In February 2025, Ijen Unit 1 achieved Commercial Operation Date with a declared capacity of 34.5 MWnet. The Ijen geothermal project is operated by Medco Cahaya Geothermal (MCG), as part of a joint venture (JV) between Medco Power International (MPI) and Ormat Technologies (ORA). The Ijen geothermal project is located in the Blawan-Ijen concession area, and the geothermal prospect that has been explored to-date is within Kawah Wurung area.

This paper will discuss the natural-state chemistry of the Ijen resource which is located within the Kendeng Caldera of the Ijen volcanic complex, situated in the eastern end of Java, Indonesia. Flow testing of wells during exploration and development drilling, plus early operational data, have been collated and analyzed. The flow testing and operational results support the existence of a two-phase, liquid dominated, >300°C resource with low total dissolved solids (TDS) (<0.3% Na-Cl fluid) and relatively low dissolved gas in the liquid phase.

Session: 2.2





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13 | The use of Computational Fluid Dynamics (CFD) for slugging prediction in a two-phase geothermal production system

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Keywords: CFD, two-phase, production system, slugging, simulation, process design, separator

Slugging is a flow phenomenon that occurs when gas and liquid phases coexist in a pipeline under certain conditions, causing pressure fluctuations and operational challenges. In geothermal production systems, slugging can compromise stable operation and safety of the power plant and separation equipment. It is important to predict and avoid slugging conditions in two-phase geothermal pipelines.

In this paper, we present a Computational Fluid Dynamics (CFD) approach for slugging prediction in a planned two-phase delivery pipeline for the Ngati Tuwharetoa Geothermal Asset (NTGA) Geothermal Field in Kawerau, New Zealand. We use CFD to model the pipeline geometry and the multiphase flow conditions and examine the results. A weakness in the results presented is that the pipeline being modelled has not yet been built, so the accuracy of model predictions has not yet been validated with field data

We also present a study of two-phase flow into a separator and how this can lead to structural vibration. The focus was on adjusting the incoming pipework to reduce unsteady loads

from the high liquid fraction. Achieving smooth, steady liquid entry helps prevent wall splashing and cyclic loading. The results were calibrated to movements measured in the operating separator.

One of the historic challenges of setting up a CFD model for slugging prediction is managing the size of the model and the calculation time for such large and complex systems. Our results show that, with the assistance of cloud-computing, a CFD approach to slugging prediction is now feasible and cost-effective. Our premise is that the CFD approach can provide useful insights for the design and operation of two-phase geothermal pipelines.

Session: 7.1



14 | The Waitangi Tribunal and Geothermal Resource Management

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Keywords: geothermal energy, Indigenous voices, Māori, iwi, hapū, consultation, Fast-track Approvals Act, Resource Management Act, Local Government Act, environmental legislation, permitting, consenting, regional planning, Treaty of Waitangi, Waitangi Tribunal, legislative reform

For over 30 years, the Resource Management Act (1991) (RMA) has required that resource management decisions “take into account” the principles of Te Tiriti o Waitangi (the Treaty of Waitangi), New Zealand’s founding document. Subordinate instruments such as Regional Policy Statements, Regional Plans and District Plans must also recognise and provide for Māori

cultural values, ancestral connections to land and water, wāhi tapu, and other taonga. Local authorities, including territorial and regional councils, are required to engage proactively with iwi and hapū, reinforced by obligations under the Local Government Act 2002 (LGA).

Recent legislative reforms, including the Fast-track Approvals Act 2024 (FTAA) and Resource Management (Consenting and Other System Changes) Amendment Bill 2024, are reshaping this framework. Iwi and Māori have raised concerns that these reforms may erode their Treaty rights and limit Māori participation in environmental decision-making, including in the geothermal sector. This paper explains the role of the Waitangi Tribunal and how its inquiries and recommendations can influence geothermal resource management, particularly through the interaction of Treaty obligations, local authority responsibilities, environmental planning frameworks, and ongoing legislative reform.

Session: 2.3



15 | Ōhinemutu Village: Geothermal Past, Present & Future

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Keywords: *geothermal energy, community, indigenous knowledge, home heating, bathing, history, Rotorua, New Zealand, energy security, geothermal features*

Ōhinemutu, a traditional Māori pā (village), is located in central city Rotorua, and is home to around 200 residents who whakapapa to Ngāti Whakaue, one of the Te Arawa confederation of tribes. Within Ōhinemutu there are three marae, two churches, a community māra kai (garden), urupā (cemetery) and nationally significant geothermal features and heritage buildings.

A proliferation of warm baths, boiling springs and steam to cook food, and warm ground to heat homes and grow crops such as kumara, potato, maize and tobacco, were once a source of wealth amongst the tribe. However, whilst ample heat, hot water and steam continue to exist within Ōhinemutu, successive government policies, regulations and actions (or lack of), coupled with the resultant prohibitive costs of maintaining bores, hot water pipes, infrastructure and consents, now means a majority of whānau within the village have lost their ability to access geothermal home heating, cooking and bathing. This has had significant negative and long-lasting implications on health, social and cultural wellbeing.

This paper shares the Ōhinemutu community's history of living with and using geothermal resources, and their long-lasting relationship with this taonga, as well as how this has changed over time and the consequences of this. The community's goal is to restore their energy security and sovereignty whilst protecting the geothermal taonga, through revitalization of the geothermal features and infrastructure at Ōhinemutu.

Session: 2.3



16 | Delivering commercially attractive geothermal coiled tubing operations

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Keywords: *Geothermal, Coiled Tubing, Well Workover, Risk Analysis Risk Mitigation*

Although geothermal coiled tubing (CT) operations are performed globally, making them commercially attractive everywhere is a challenge.

New technology uptake with the geothermal industry suffers from low project count, technically challenging environments, historically low success ratios and the ever-present need to keep costs down. These hurdles keep many well technologies on the fringes of widespread geothermal adoption.

Adoption of coiled tubing technology for geothermal well maintenance is no different. Some geographies where CT units (CTU) are readily available, such as New Zealand or the USA perform weekly CTU operations which regularly boast the generation savings they deliver. Other geographies do not seem to have the same continuous success. How can more locations reach that flash point where CTU workovers become a routine cost-effective maintenance activity?

This paper will share & discuss the results of a geothermal CT operational data review. It includes data from 10 years of geothermal CT operations in New Zealand. It will share statistics and discussion surrounding root causes for geothermal CT incidents and CT job costs. It will provide recommendations to well operators on how to reduce their CTU workover costs and job cost variability.

The conclusions of this study include reducing CTU equipment failures, noting that every well operator has a unique job cost model & implementing a continuous improvement culture.

For geothermal energy to remain competitive in the global energy market, innovation must be ongoing and deliver generation cost reductions. Uptake of the recommendations presented here presents a great opportunity to achieve this aim.

Session: 3.3



18 | SWOT Analysis of Geothermal Power Plants

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Keywords: *SWOT analysis, geothermal power plants, Alaşehir field,*

Electricity generation from geothermal resources is achieved through various power plant technologies, including flash steam plants (single, double, or triple), binary cycle systems (ORC or Kalina), dry steam plants, back-pressure turbines, and combined plants that integrate multiple cycles. The selection of the power plant type is primarily determined by the temperature and characteristics of the resource, along with efficiency considerations of each technology. However, each type of plant presents its own set of challenges and advantages. This study employs a SWOT analysis to identify and evaluate the specific strengths, weaknesses, opportunities, and threats relevant to each plant type. A case

study is presented from the Alaşehir geothermal field in western Anatolia, Türkiye. Furthermore, the research provides an in-depth technical perspective on power plant technologies and their implications for resource management. The findings indicate that although combined geothermal power plants offer the highest efficiency, substantial changes in the resource can lead to significant reductions in operational efficiency due to the use of specialized equipment. In contrast, binary power plants demonstrate greater operational stability and safety from both resource management and operational perspectives.

Session: 3.3



19 | Pioneering Geothermal Energy Potential Study in Sudr Oil Field, Sinai, Egypt

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Keywords: Gulf of Suez Rift, Sinai, Sudr Oil Field, 3D Structural Model, Geothermal Gradient, Resistivity Logs, Abandoned Oil Wells, Geothermal Power Potential

Sudr oil field hosts one of Egypt's most significant geothermal features: Sudr-22 well (Ras Sudr

sulfur water), originally drilled for oil and now producing 86 °C hot water. Located along the Gulf of Suez Rift, the area benefits from a high geothermal gradient due to its position on a structural high at the footwall of a major rift-related fault (AMSF) and its proximity to a significant hotspot just west of the field.

This study presents a comprehensive 3D geological model of the field, developed through seismic interpretation and well log data analysis. The model delineates the structural architecture, elaborating three northwest-trending rift-parallel faults that encompass a significant horst and secondary intra-horst structures. These structures facilitated the formation of localized geothermal compartments, where thermal water rises from wells accessing different geothermal reservoirs. Temperature data and gradient analysis reveal a geothermal gradient of 50 °C/km, indicating the potential to access a 70-80 °C reservoir within the Eocene reservoir at a depth of approximately 1 km. Higher temperatures of more than 120 °C may be reached by penetrating the deeper Nubian reservoir, located at a depth of approximately 2 km.

Additionally, resistivity analysis using well logs reveals distinct trends in the studied wells related to the geothermal environment. Notably, resistivity increases in front of the Eocene geothermal reservoir and evaporite zones in the Miocene strata, while cap rocks primarily composed of shaly and marly materials exhibit lower resistivities. This information was crucial for predicting additional geothermal reservoirs within the field.

The geothermal potential assessment estimates a recoverable thermal energy of approximately 6.3 PJ (6.7 MW) for the P50 scenario, with P10 and P90 estimates of 2.9 PJ (3 MW) and 12.1 PJ (12.8 MW), respectively, over a 30-year project lifespan. This power plant would be very beneficial to supply clean power to nearby households and touristic resorts. Sudr field thus emerges as one of Egypt's most promising sites for geothermal development. The opportunity to repurpose

abandoned oil wells -especially those already producing thermal water- could significantly lower development costs. Additionally, the site offers a unique case study for geothermal–oil co-production, emphasizing the potential of oil fields to support sustainable energy initiatives.

Session: Lunch and Poster Session



20 | Risk analysis in the geothermal potential assessment - Case study Croatia

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Keywords: *geothermal projects, risk assessment.*

The purpose of the techno-economic assessment of geothermal potential is to determine the possibility of exploiting geothermal energy. All geothermal exploration areas in the Republic of Croatia are located in the hydrocarbon exploration areas. The knowledge about the existence of geothermal water is mostly related to exploratory drilling for oil and gas and related infrastructure. This paper considers one geothermal exploration area in the northwestern part of Croatia with old oil and gas well data. These data were analyzed to obtain a clear picture of geological structures, distribution and thickness of the formations, water saturation and to determine geothermal characteristics at the potential location. A preliminary assessment of the exploitation of geothermal water for thermal purposes, geothermal plant installed power, as well as an economic analysis of the project have been analyzed.

For more precise analyses, hydrodynamic test data were missing which would give a better assessment of the geothermal potential and the project's implementation. The costs of work and equipment were also missing due to large price fluctuations in the global market. The project is also accompanied by environmental restrictions. The qualitative risk analysis is the research goal of this paper according to the aforementioned project prerequisites, within which potential risks were identified. The risk analysis took into account the main techno-economic, environmental, and institutional obstacles and their possible impact on the implementation of the project itself or its results. During the risk analysis, it was necessary to define critical variables and their probability, impact, and overall level of risk. As part of the research results, measures were proposed to prevent the occurrence of risks and mitigate the consequences in the event of their occurrence. The main aim of the proposed measures was to reduce the uncertainty of the geothermal project's critical variables assessment.

Session: 3.3



21 | Linking fracture networks to geophysical observations through numerical modelling

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Keywords: *Permeability, resistivity, numerical model, fractures*

Fractures are often a key control on geothermal reservoir permeability. Knowing their orientation can help design wells with the best chance

of intersecting them. Borehole image log analysis can provide this information but relies on boreholes being drilled first and provides information only in a small region around the borehole. Electrical resistivity and acoustic velocity are both direction-dependent properties that may be sensitive to the orientation of subsurface features at wider scales and without the need for drilling. Shear wave splitting has been applied in some New Zealand geothermal fields and may provide an estimate of fracture orientation but is not directly sensitive to permeability. Electrical resistivity of a rock can vary with orientation, and the electrical resistivity of a reservoir containing aligned open fractures with a preferred orientation may be resolved by geophysical methods as effective anisotropy. However, most subsurface resistivity models assume isotropic resistivity. Geothermal fields in the Taupō Volcanic Zone (TVZ), New

Zealand, have been developed for electricity for >50 years and as such, the TVZ contains a wealth of scientific publications from which to define fracture parameters and fluid properties. This paper presents numerical modelling of the permeability and resistivity of a fractured rock volume containing a fluid with typical salinity and temperature for TVZ fields, to determine effective (direction-dependent) resistivity and permeability, and ground truth the models by comparing with permeability values calibrated from reservoir models. This is the first step to designing a geophysical survey that could image fracture orientation.

Session: 3.2

The advertisement features the Western Energy logo at the top left, consisting of a stylized blue 'W' and the company name in orange. Below the logo, the text reads: '// POWERING THE GLOBAL GEOTHERMAL INDUSTRY', 'World-leading geothermal well services provider, revolutionising the geothermal industry with innovation, collaboration, and Kiwi ingenuity.', and 'Based in New Zealand, our expertise reaches wells across the globe.' The background is a night-time photograph of a geothermal well site with various pieces of heavy machinery, including a large blue crane and a truck. A website URL, www.westernenergy.co.nz, is displayed in a blue box at the bottom of the image.

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In the photo: Casing Repair Operations using Coiled Tubing

22 | Investigating Structural Controls on the Heat Flux and Steam Release from the Waiotapu Geothermal Field using the Landsat 9 Dataset

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Keywords: *Structure, heat, steam, rift, Landsat.*

Geological (tectonic and volcanic) structures control the flow of hot fluids in rift settings. Geothermal fluids transported to the surface through permeable pathways bring heat energy associated with steam release that can be examined by mapping anomalously hot areas. This study explores the structural influence on the spatial pattern of the surface heat flux and the total heat and steam released from the ground at the Waiotapu geothermal field. We investigated structural fabrics and spatial patterns of surface heat flux from the Waiotapu geothermal field, the largest of 20 major high-temperature geothermal fields in the Taupō Volcanic Zone (TVZ), New Zealand. Landsat 9 datasets and ground measurements were processed and analysed using Python and QGIS to calculate land surface temperatures for the Waiotapu area and its surroundings. Land surface temperatures are used to estimate heat fluxes. The spatial distribution of heat fluxes at Waiotapu and its surroundings correlates well with mapped structural features using the 30 m-resolution Shuttle Radar Topography Mission (SRTM) DEM dataset. This indicates that tectonic and volcanic structures control the spread of heat flux anomalies. The total heat flux from the land surface and associated steam release at Waiotapu is calculated as 547.5 ± 20.1 MW. This high value underscores the role of the geothermal field contribution to the heat and steam budget of this rift and the overall

importance of the Taupō Volcanic Zone influence on the atmosphere.

Session: 3.2



23 | The Shallow Geothermal Energy Potential in Auckland: An Exploratory Study

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Keywords: *Shallow geothermal energy, ground temperature, borehole heat exchanger, Auckland*

Shallow geothermal energy offers a clean, widely applicable, and cost-effective resource. A practical field assessment of this resource is essential for designing a subsurface heat extraction system. A 20 m monitoring well was drilled in Takanini, Auckland and installed with 15 temperature sensors to evaluate its shallow geothermal potential over 12 months.

Temperature profiles exhibited clear seasonal and diurnal variations near the surface, stabilising at approximately 18 °C below 8 m depth. These observations suggest that Auckland's subsurface thermal regime is richer than that of comparable temperate cities such as Melbourne and London. Concurrent monitoring of domestic water temperatures supports preliminary feasibility for geothermal-heated water supply. Ongoing field experiments will further assess the performance of borehole heat exchangers under local

geological and climatic conditions. This research will effectively promote the development of sustainable geothermal energy in New Zealand, especially in the broad application of shallow geothermal heat.

Session: 6.2



24 | Utilising a Digital Twin for the Troubleshooting of a Geothermal Power Station

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Keywords: *Digital Twin, Symmetry Modelling, ORC*

A digital twin of the Rotokawa power station is under development. The quasi-empirical model is intended to replicate the behaviour of the real plant, based on process engineering first principles. This paper highlights how an initial version of the model was successfully used to troubleshoot a performance decline in the plant's Organic Rankine Cycle (ORC) bottoming units. Calculation of key plant parameters highlighted potential causes of this decline, and the initial model could then be used to quantify the impacts of different changes. The study results have been used to inform and direct a campaign to restore plant performance.

Session: 7.1



25 | Development of a web-based tool to identify geoheat opportunities for covered crops

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Keywords: *Geoheat, Greenhouse decarbonisation, co-design decision tool, resource mapping,*

77% of New Zealand's covered crop growing operations are currently reliant on fossil fuels (62% natural gas; 15% coal) for space conditioning of greenhouses. The recent rise in the cost and decline in availability of natural gas, along with the global transition to renewable and environmentally friendly energy, has sparked the interest of local growers to the opportunity of geoheat. The transition from natural gas to geothermal heating observed in several European countries has inspired interest in achieving a similar transformation within New Zealand.

Most greenhouses in New Zealand currently rely on piped hot water heating systems designed to operate at temperatures of between 60 and 80°C, to maintain adequate growing temperatures

and manage greenhouse humidity. These water temperatures are commonly found at depths of 2-3 km in non-geothermally active areas, however, they can often be found at shallower depths in locations around New Zealand. Information regarding where these shallow resources are located and how the subsurface heat can be utilised is hard to find, resulting in missed opportunities for low temperature heat users.

This project focusses on developing an online prototype tool which will provide relevant and easy to understand information regarding the potential of geothermal heat in the greater Auckland, Bay of Plenty and upper Waikato regions of the North Island. The project collates subsurface information, case-studies, and technological and financial feasibility estimates, in a publicly available web-based tool. It is being developed through close collaboration between earth-scientists, engineers and growers, ensuring that the tool is accurate, informative and useable.

Session: 4.3



26 | Theoretical Study of Conditions for Generation of Periodic Wellbore Flow: Dependence on Two-Phase Flow Models

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Keywords: *cycling wells, two-phase flow model, slip, transient wellbore flow, numerical simulation*

The periodic flow generated in a wellbore intersecting two reservoirs was theoretically investigated by performing numerical experiments of 200 runs in total. In particular, the condition for generating periodicity, established by one of the authors using the homogeneous flow model, was validated using the slip model, which considers the slip between the liquid and vapor phases. This condition is described based on the mean specific enthalpy of the shallow and deep reservoirs weighted by their productivity indices. The inflow of the low-enthalpy fluid at the shallow feed zone triggers periodic wellbore flow.



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The slip limits the upflow of the liquid phase in the wellbore and significantly affects the appearance of constant, periodic, and unstable flow patterns. Nevertheless, the results of the numerical experiments supported the generality of the condition for generating periodicity, regardless of the two-phase flow models, and its applicability to actual wells. This finding will facilitate sustaining the output of geothermal power plants by developing effective measures to stabilize the wellbore flow.

Session: Lunch and Poster Session



27 | International Collaboration on Research into Deep Superhot Roots of Geothermal Resources through IEA Geothermal

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Keywords: *superhot geothermal, supercritical, IEA Geothermal, Geothermal TCP, collaboration, deep roots of geothermal systems.*

Research into the deep, superhot roots of geothermal systems, which potentially host supercritical fluids, has been actively pursued by several member countries of the International Energy Agency Geothermal Technology Collaboration Program (IEA-Geothermal TCP), including New Zealand, Iceland, USA, Italy and Japan. To date the work has been focused on: a) identification and delineation of superhot geothermal resources that are prospective and accessible by drilling; b) advancing technology to enable reliable energy production from these superhot prospects; and c) a realistic assessment

of the potential thermal energy that might be available from these deeper geothermal resources to sustainably support the low carbon energy futures that member countries are all actively pursuing.

Recent advances have seen significant improvements in knowledge of the geochemical and physical conditions to be expected in these superhot settings through experiments in fluid-rock interactions and advanced simulation models. Improvements in deep drilling and well completion technology are also progressing. This paper discusses these aspects, especially from a New Zealand perspective, and summarizes lessons learnt from past superhot geothermal projects, seeking to share knowledge acquired, inform interested parties and direct future enquiry.

In addition, this paper introduces a new collaboration task that was initiated by IEA-Geothermal in 2025. The purpose of the new task is to encourage further collaborative activity to help accelerate novel geothermal energy technology development. Although the focus is on >400 oC, the scope is inclusive of >300 oC where novel fracture stimulation efforts are informative. Key components will include: a) develop reliable and cost-effective technology that can be used in the superhot energy production infrastructure; b) inform appropriate regulatory regimes and economic frameworks that will provide adequate certainty to support the investment needed; c) construct a shared data repository; and d) promote global testbed activities. The overall goal is to achieve expanding impact by reducing costs and increasing deployment through innovation and demonstration.

Session: 5.3



29 | An Introduction of Kyuden Group's Geothermal Power Plants in Kyushu Island, Japan

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Keywords: Japan, Kyushu, binary system, single-flash, double-flash, local community

Kyushu island, located in the southern part of Japan, is one of Japan's most famous geothermal resource areas.

Kyushu Electric Power Company, a major power company in Japan, supplies over 16 GW of electricity to Kyushu island. Together with its subsidiaries, the company forms the Kyuden Group, which owns geothermal power plants with a combined capacity of 224 MW across eight sites in Japan. In addition to domestic operations, the group is also actively investing in overseas geothermal power plants.

The development of Japan's first commercial geothermal power plant began with a resource survey at the Otake site in 1949. Initial findings revealed that the geothermal fluid was hot water dominated, which at the time was considered unsuitable for power generation, leading to the suspension of the project. Meanwhile, New Zealand succeeded to operate a single flash geothermal power plant with the separation of steam and hot water. Kyushu Electric Power was encouraged by this fact and resumed the development of the geothermal power plant in

Otake area and completed it in 1967. This power plant is still in operation as of today, following a major upgrade in 2020, that increased the capacity from 12.5 MW to 14.5 MW. The success of the Otake power plant led to further development of flash geothermal power plants such as Hatchobaru (55 MW x 2 units), Yamagawa (30 MW), Ogiri (30 MW), Takigami (27.5 MW) and binary power plants (totaling approximately 12 MW).

This paper presents a historical overview and the latest developments of geothermal power generation by the Kyuden Group, with a particular focus on Otake and Yamagawa Power Plant, which includes both flash and binary systems.

Session: 4.2



30 | Enhanced Gravity Anomaly Separation Using a Wiener and Preferential Bandpass Butterworth Filtering for Structural Identification in Telomoyo Geothermal Area

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Keywords: Anomaly Separation, Wavelength filtering, Wiener filter, Butterworth filter, Gravity data processing.

Accurate anomaly separation in gravity data is crucial for geophysical investigations, particularly in resource exploration and subsurface analysis. Traditional wavelength filtering techniques often struggle to effectively balance noise suppression with anomaly preservation. In this study, we evaluate different wavelength filtering methods to identify the most effective approach for gravity anomaly separation. We propose a technique that combines the strengths of Wiener and Butterworth filters to achieve more accurate residual anomaly extraction than common high-pass and regular bandpass filtering. The Wiener filter is utilized for efficient noise reduction, i.e., mitigating terrain-induced effects, while the Butterworth filter is applied to isolate regional and residual anomalies. The methodology is first validated using synthetic gravity data generated from forward modeling of subsurface density variations, incorporating realistic terrain noise. Comparative analysis with common high-pass filtering techniques and

regular bandpass filtering demonstrates the better performance of the proposed method in terms of accuracy and noise suppression. The approach is then applied to gravity data from the Telomoyo region, successfully extracting smoother residual anomalies with enhanced geological interpretability, especially in the subsurface structure delineation using edge detection analysis (e.g., Second Vertical Derivative and Improved Normalize Horizontal Tilt Angle). This method provides a robust and efficient tool for geophysical data processing, with significant implications for geothermal exploration, mineral prospecting, and subsurface structural analysis.

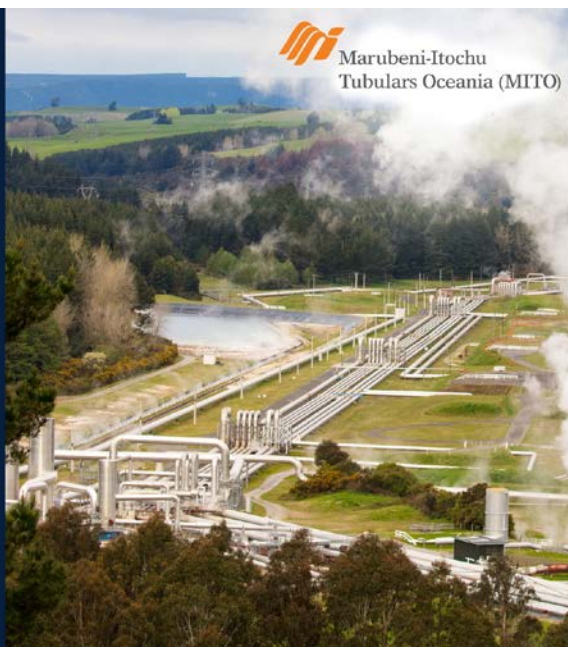
Session: 3.2



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31 | International Collaboration involving New Zealand through the IEA Geothermal Technology Collaboration Programme

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Keywords: *Technology Collaboration Programme, Geothermal TCP, IEA Geothermal, IEA-GIA, international collaboration, geothermal, geothermal energy, shallow geothermal, deep geothermal, superhot geothermal, underground thermal energy storage, mine water geothermal energy, New Zealand.*

New Zealand was a founding participant in the International Energy Agency Geothermal Technology Collaboration Programme (IEA Geothermal TCP) when it was established back in 1997. The 16 participants in IEA Geothermal meet regularly to share and discuss technology and policy advances, and to facilitate information dissemination fostering the uptake of geothermal energy across the globe. Since 1997, GNS Science has represented New Zealand on the Executive Committee (ExCo). New Zealand members and alternates have been active in

many leading roles within Tasks and Working Groups. In a separate contracted role GNS Science also operates the Secretariat for IEA Geothermal, with the current contract expiring at the end of June 2028.

The Geothermal TCP puts in significant effort to advance technologies and appropriate policy that will enable greater utilisation of geothermal energy in nations across the globe. This is particularly relevant as nations transition to low carbon energy as part of their net zero 2050 energy transitions. The paper will summarise pertinent aspects of the work undertaken.

Three Tasks currently underway that are particularly relevant for New Zealand are a:

- Geothermal Carbon Management Task
- Wider System Benefits of Geothermal Energy Task, and
- Superhot Rock Geothermal Task.

The paper canvasses aspects of these Tasks and identifies the Task leaders. This provides a connection point should there be an interest in actively becoming involved in any of them.

Session: 5.3



33 | Near-Supercritical Behaviour of LHD-47 Well, Lahendong Geothermal Field, North Sulawesi, Indonesia

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Keywords: *Supercritical, Lahendong, wellbore characteristic*

The Lahendong geothermal field is located in North Sulawesi Province approximately 30 kilometers south of the capital city, Manado. The field has been a key site for Sulawesi Island's geothermal exploration and development since early 1980s. Initial exploration, led by PT Pertamina, identified two primary prospects: Lahendong in the northern area and Tompasu in the southern area. As the first geothermal power generation facility in North Sulawesi, the field is currently operated by PT Pertamina Geothermal Energy (PGE) with an installed capacity of 4 x 20 MW.

The Lahendong geothermal system consists of two main reservoir compartments: Linow and Kasuratan (Prasetyo, 2024). Production is primarily sourced from the Kasuratan compartment, which features a two-phase reservoir and more benign fluid derived from an ultra-high-temperature reservoir, particularly in the southern block. The reservoir temperatures reach approximately 300°C, with some wells recording maximum temperatures of up to 361°C at 2.5 km vertical depth, nearing supercritical condition. These temperatures represent the highest recorded among PGE-operated fields across Java, Sumatra, and Sulawesi Islands.

This study focuses on the performance and challenges associated with well LHD-47, which

has produced from this near-supercritical temperature reservoir. Although the well demonstrated promising initial output, operational challenges arose, including a 76°C superheat condition, high total dissolved solids (TDS), and significant corrosion issues. The insights gained from operating this well provide valuable lessons for the future development and management of extremely high-temperature geothermal reservoirs as well as the potential of producing supercritical fluid at relatively shallow depth.

Session: 3.3



34 | Preliminary Geothermal Conceptual Model of the Salve Faccha-Oyacachi Prospect, Chacana Caldera, Ecuador

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Keywords: *Chacana caldera, Oyacachi, Salve Faccha, geothermal exploration.*

Located at about 60 km east of Ecuador's capital, Chacana is an eroded Plio-Holocene resurgent caldera complex, considered one of the largest rhyolitic centers of the northern Andes. Between 2011 and 2012, two main geothermal prospects in the southern part of Chacana were identified. However, the northern part of the caldera remains unexplored, despite the existence of several geothermal manifestations in Salve Faccha and Oyacachi. Detailed geological

mapping was conducted, focused on the identification of structural features, volcanic deposits, and hydrothermal features. Field observations were supplemented by XRD analysis, kinematic analysis, dilation potential estimation and literature review to refine the geochemical interpretation.

The volcanic deposits in the northern part of the Chacana Caldera record a prolonged period of activity during the Quaternary, with sequences of volcanic rocks overlying Paleozoic metamorphic basement. The Rosaspungo center, in particular, exhibits evolved magmatic activity, suggesting the presence of a shallow heat source capable of sustaining a convective geothermal system. Within the caldera, volcanoclastic deposits have developed secondary permeability due to a trans-pressure tectonic regime (ESE-trending σ_1), hosting a high-temperature ($\sim 230^\circ\text{C}$) geothermal reservoir controlled by NW-SE normal-sinistral faults. These structures, with the E-W faults, also facilitate fluid migration toward a secondary lower-temperature reservoir

($\sim 150^\circ\text{C}$) located beneath Oyacachi village, ~ 10 km to the east. Overlying the primary reservoir, the geothermal system develops a substantial cap rock characterized by Illite alteration which extends across ~ 2 km in diameter around the Salve Faccha lake. Approximately 17 hot springs were reported around and beneath the lake, discharging mostly Cl-Na type waters. In addition, HCO_3 -type hot springs and travertine deposits at Oyacachi village suggest the peripheral part of the system. These results confirm the existence of a convective geothermal system with favorable permeability and high enthalpy, positioning the Salve Faccha–Oyacachi prospect as a strategic resource for renewable energy generation for the capital city of Ecuador.

Session: 3.2





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35 | J SHAPED-DEI

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Keywords: *Geothermal energy, supercritical water, geothermal system, deep thermal storage, low-cost electricity, modular heat exchangers, J-DEI, geothermal heating, high-enthalpy geothermal, geothermal-hydraulic hybrid, New Zealand geothermal resources.*

J-DEI Rosetta (J-shaped Double Energy Input – Rosetta Configuration) is an innovative geothermal power system that combines ultra-deep thermal absorption with hydraulic elevation to deliver supercritical water directly to surface-level turbines. Unlike traditional geothermal systems, which rely on subsurface steam or fluid loops, J-DEI Rosetta accumulates heat through modular “thermal arms” located at depths ranging from 1 to 6.5 kilometers. These arms are isolated heating chambers filled with water and partially surrounded by high-temperature thermal salts or geologic formations.

Once a target temperature (~500°C) is reached under constant flux conditions, the pressurized fluid is released upward through a dedicated vertical shaft, maintaining high pressure (~14–15 MPa) and temperature until it reaches the surface. Each cycle delivers a burst of usable energy, and by installing multiple synchronized modules, the system achieves continuous power delivery.

The modularity of J-DEI Rosetta enables scalability, redundancy, and staged deployment. By using smaller-diameter steel alloy pipes (~35 cm) instead of single large conduits, it also mitigates material stress and reduces construction costs. The system is designed to minimize thermal losses and eliminate reinjection, operating as a one-way conversion of deep thermal energy into surface-level electricity.

Preliminary models estimate a net electrical output of up to 2 GW with a Levelized Cost of Electricity (LCOE) as low as US\$5.54/MWh, surpassing both conventional geothermal and nuclear benchmarks. J-DEI Rosetta is especially suited for geologically active regions like New Zealand’s Taupō Volcanic Zone, offering a novel alternative for base-load, high-efficiency, and low-cost clean energy.

This paper outlines the thermodynamic principles, architectural layout, material challenges, and economic implications of the system, providing the first detailed public analysis of its Rosetta configuration.

Although the system benefits from the hydrostatic head of the water column to maintain pressure, the sole external energy input is geothermal heat. The term ‘double energy input’ is thus used conceptually, but the system is fundamentally geothermal-driven.

Session: 4.2



37 | The use of numerical modelling for characterising deep geothermal reservoirs: a case study of the Upper Rhine Graben

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Keywords: *Geothermal reservoir, Thermal conductivity, Permeability, Numerical modelling, Cap-rock, Thermal gradient, Gravimetry, Brine rheology*

Over the last few decades, numerous numerical models of deep geothermal reservoirs in the Upper Rhine Graben (URG) have been developed

to study natural hydrothermal circulation and the effects of industrial exploitation. However, there is a lack of numerical methods that incorporate multi-physical and multi-scale measurements. This research examines a natural, large-scale hydrothermal circulation and its associated multi-physical and multi-scale data through a homogenized thermo-hydro-mechanical (THM) model. The aim of this research is to develop a THM model that provides useful engineering tools for the exploration of future geothermal sites. To validate this approach, inversion of key rock physical properties has been conducted using observed temperature and stress depth profiles. The model provides new insights into the relationship between geophysical data and hydrothermal circulation. It also highlights the crucial impact of brine viscosity on circulation. Furthermore, the model provides a practical tool for linking measurable surface thermal gradients with reservoir temperature in relation to cap-rock depth. This method could be very useful for exploring future geothermal reservoirs in New Zealand.

Session: 1.2



38 | Rotorua Geothermal Surface Feature Monitoring Data: An innovative approach to a unique database

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Keywords: *Rotorua Geothermal System, geothermal surface features, environmental monitoring, data management*

The Bay of Plenty Regional Council (BOPRC) manages the Rotorua Geothermal System (RGS) to support its sustainable use, while protecting its valuable natural and intrinsic qualities. Regional councils have obligations under the Resource Management Act (RMA) to collect information on the state of the environment and ensure the integrity and public access of information (including data) in a transparent way and to foster public participation.

The BOPRC Geothermal Surface Features Monitoring Programme continues to generate vast datasets that require careful management to ensure accuracy, reliability, availability and meaningful interpretation. Geothermal surface feature data has been collected once every two months for over ~20 years, with some datasets going back to the 1980s, with isolated datapoints from the 1940s. These historical datasets are an invaluable source of information on what the Rotorua Geothermal System 'looked like' in a nearly undisturbed state, at its environmental bottom-line and at its current much improved state.

BOPRC migrated data from a previous ineffective data storage system, bringing data out to the community in an effective, transparent, meaningful way. Several systems already adopted by BOPRC were used, including AQUARIUS Time-series (AQTS) and AQUARIUS WebPortal (AQWP). BOPRC now have all the data import process automated using language codes R and python. Developing these codes was a key part of this project.

The project successfully imported all historical data and photographs into AQTS, establishing 38 new locations, each with ~13 geochemistry and ~10 field observation time series. Qualitative data was introduced into AQTS for the first time, necessitating the creation of new data legends for three parameters (water colour, visual clarity and odour).

End users can now access and interact with comprehensive information on geothermal surface features, fostering greater engagement and understanding of this specific type of environmental data. This is a significant improvement on data management workflow, supporting BOPRC in delivering key functions under the RMA and other statutory or non-statutory requirements.

This paper describes the steps taken to develop this bespoke database, from data automation, storage, presentation, and opportunities for meaningful use of similar datasets – especially those containing qualitative information. Similar processes could enable storage and display of other types of knowledge information beyond modern science, for example, from Mātauranga Māori monitoring, which are strongly based on sensorial *tohu*.

Session: 1.3



39 | Greenhouse Gas Emissions Reduction: Global Geothermal Catalogue Update 2024

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Keywords: Carbon dioxide, hydrogen sulfide, greenhouse gas, reinjection, emissions reduction, ESG

Geothermal power generation typically (but not always) results in greenhouse gas emissions as a result of these gases being naturally present in geothermal fluids. Globally, there is an increasing focus on reducing naturally occurring emissions from geothermal electricity generation to contribute to wider decarbonization goals and efforts. Several countries have already implemented carbon emissions pricing, generally as a carbon-dioxide equivalent (CO₂e) value, or are in the process of considering doing so. Three major factors will increase the focus of operators in reducing emissions: (1) increased direct costs due to carbon pricing, (2) societal pressure from the general public, and (3) investment funds or funding institutions with ESG targets that influence the pricing and availability of funding for both new and existing projects.

This paper provides an updated (to 31 December 2024) catalogue of global geothermal power plants that have meaningful greenhouse gas emissions reduction technologies in place, with details on the methods employed. Additionally geothermal power projects under development with emissions reduction technology, and existing plants undergoing retrofitting of emissions reduction technology are also included in this update.

The authors intend to republish this paper with an updated catalogue regularly, and we encourage feedback from readers to ensure this catalogue is updated accurately.

Session: 1.3





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- Monitoring to measure the health of the resource
- Classifying geothermal systems to determine the management purpose for each system.

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40 | Combining Low Grade Geothermal Heat with Heat Pumps, An Opportunity to Decarbonise Industrial Districts

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Keywords: *Geoheat, district heating, low temperature geothermal, ground source heat pump, energy security, decarbonizing.*

In Aotearoa New Zealand, district heating networks for commercial and industrial applications are notably scarce. Prominent examples, such as Kawerau and He Ahi, leverage site specific high-temperature geothermal resources to support industrial processes. However, the concept of shared thermal energy infrastructure is overlooked, despite its potential to offer significant economies of scale and cost efficiencies for businesses.

Low-grade geothermal heat is widely available across Aotearoa New Zealand but remains underutilised, partly due to perceptions of limited applications and its overshadowing by high-temperature systems primarily used for electricity generation. Recent advancements in industrial ground source heat pump (GSHP) technology are shifting this paradigm. Modern GSHPs can now deliver process heat at temperatures up to 160°C, with prototypes reaching 180°C and expectations of achieving 200°C within this decade. These developments position low-grade geothermal resources as viable and valuable for a broader range of industrial applications.

The high capital investment required for individual GSHP systems can be a barrier to adoption. This paper proposes that district scale low-grade geothermal infrastructure could mitigate these costs, thus maximising uptake and impact. There is opportunity for public investment in such infrastructure, as it supports the electric

transition being promoted by the Government by reducing reliance on the national electricity grid, particularly during peak demand periods. A private model, where heat is supplied as a service to industrial customers, is equally viable and has been commercially implemented internationally.

This paper will explore regions where district geoheat presents the most compelling potential and examine the roles that both the geothermal community and government can play in facilitating its development.

Session: 4.3



41 | Rejuvenizing Aged Conventional Geothermal Reservoirs with Supercritical Geothermal Energy

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Keywords: *Supercritical, superhot geothermal, innovation, strategy.*

New Zealand has set an ambitious target to achieve 100 percent renewable electricity generation by 2030 and net-zero emissions by 2050. In addition to hydro, solar and wind energy, geothermal is also expected to play a more important role in achieving these goals. But the problem we are facing is that the conventional geothermal energy potential for further development is limited and unlikely to meet the demand. Most of New Zealand's conventional high temperature geothermal fields have already been developed for electricity generation and the remaining are restricted for commercial development due to environmental concerns. Some of the developed geothermal fields have

been expanding their generation capacity or have plans to do so already. While concerning the limited resource potentials and some of them are approaching the late stage of life spans, significantly largescale increase in power generation seems to be impossible with current development patterns.

A prospective solution to this problem is to develop deeper supercritical geothermal energy for electricity generation to make up the extra energy demand. Even though geothermal communities throughout the world have been trying to extract superhot fluids from the deeper heat source in the past two decades, and have indeed made some achievements, building a power plant making use of supercritical fluids still has a long way to go. The main obstacle, among lots of others, is the temperature and pressure being too high for the well-casing and

wellhead equipment to cope with, resulting in well casing collapse and wellhead equipment failure. The author in this paper has proposed some innovative ideas to develop supercritical geothermal energy by using the existing conventional geothermal power generation facilities without directly coping with the super high temperature and pressure fluid. This new development strategy will greatly benefit the existing power plants by expanding their life spans and production capacities. The technical challenges we are facing in coping with supercritical geothermal fluids can also be by-passed, though not be solved at the early stage of supercritical development.

Session: 7.1



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43 | The CaSil Technology at the He Ahi/Tauhara Geothermal Field: Silica Scale Elimination in the Presence of a Calcite Inhibitor

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Keywords: *Geothermal, Silica Scaling, CaSil Technology, Calcium Silicate, Silica Extraction, Calcite Inhibitor, Direct-Use, Heat Utilisation, Reinjection*

Silica scaling is a major problem in the utilisation of geothermal resources worldwide. It blocks valves, heat exchangers, and reinjection wells, severely limiting the energy that can be extracted. Current mitigation efforts are not wholly successful in preventing scale from forming, so costly and time-consuming cleaning and maintenance efforts are still required.

CaSil Technologies Ltd has developed a novel and transformative technology that approaches the problem of silica scaling in a different way. Instead of sequestering or delaying the precipitation of silica, the CaSil technology chemically captures dissolved silica and transforms it into a new calcium silicate hydrate (CaSil) material. With rapid reaction kinetics, the Silica Saturation Index is lowered significantly below 1, effectively eliminating silica scaling. The CaSil material forms discrete and finely dispersed particles which can freely flow through heat exchangers and pipework, without sticking to metal surfaces.

The CaSil technology has been previously proven at automated pilot scale at three different New Zealand geothermal resources (Wairakei, Kawerau, Mokai). Contact Energy Ltd invited CaSil Technologies to demonstrate the technology at the He Ahi Eco-Business Park, located on the Tauhara geothermal resource near Taupo. The

field is designed for the supply of direct-heat to industry and is serviced by a single well. To prevent calcite scaling in the production well, a calcite inhibitor is dosed downhole. This was the first time the CaSil technology was trialled in the presence of a calcite inhibitor, which may interfere with the calcium containing treatment agent dosed for the CaSil reaction.

This paper presents performance data of the pilot plant and complementary batch experiments performed on-site which demonstrate the robustness and effectiveness of the CaSil process. The Silica Saturation Index was reliably reduced < 1 across the trial period and a good compatibility between CaSil and the calcite inhibitor established.

Session: 5.2



44 | The Geochemical Properties of the Geothermal Fluids of Northwestern Algeria: A revised conceptual framework

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Keywords: *Hydrothermal fluids, Northwestern Algeria, Geochemical models, Intrusive bodies, geothermometers.*

The intense tectonic activity in northwestern Algeria has given rise to Mio-Plio-Quaternary volcanism and triggered the development of numerous thermal manifestations. Two of these – Geochemical analyses of 21 thermal spring water samples reveal considerable variability in water mineralization across the region, identifying four major water types. $\text{Na}^+ - \text{Cl}^-$ and $\text{Na}^+ - \text{SO}_4^{2-}$ are characterized by high salinity levels (up to 3794 mg/L) and elevated concentrations of F, B, Li⁺, Br, and Cs, likely sourced from halite- and gypsum-rich evaporites in the surrounding lithology. The other two types – $\text{Ca}^{2+} - \text{HCO}_3^-$ and $\text{Na}^+ - \text{HCO}_3^-$ – are linked to interactions with local carbonate formations.

Stable isotope analyses ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) suggest the waters are of fossil origin, as their significant isotopic depletion relative to modern meteoric waters cannot be fully explained by “inland” or “altitude” effects alone. These findings imply recharge under colder climatic conditions. Gas composition modeling ($\text{N}_2 - \text{He}1000 - \text{Ar}100$ vs. $\text{O}_2 - \text{CO}_2 - \text{He}^*1000$) supports a meteoric origin, showing air-saturated water (ASW) signatures.

The samples are classified as ‘immature’, with estimated deep geothermal reservoir temperatures reaching approximately 133 °C. The updated geochemical conceptual model proposes two main flow paths for the fossil meteoric waters. (1) In the Bouhdjar geothermal zone, meteoric waters are conductively heated at depth due to high heat flow (~120 mW/

m²). During their ascent through hydrothermal conduits, the fluids may be further influenced by advective heat transfer from underlying magmatic sources or by interactions with intrusive bodies. (2) In other zones, meteoric waters originate from high-altitude recharge areas of the Atlas Mountains, undergo deep circulation and heating, and may mix with cooler, Mg-rich waters or mobilize Mg^{2+} through water-rock interactions during their ascent.

Session: Lunch and Poster Session



45 | Evaluating geothermal-derived mineral production for sodium-ion batteries for utility scale energy storage in New Zealand

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Keywords: *Sodium-ion batteries, minerals, future geothermal, energy storage, energy security*

Deriving minerals such as lithium from geothermal brine has garnered notable interest in recent years. Lithium is a critical component in batteries, and therefore increasingly valuable to the energy transition. Traditional deposits of lithium are locked to a handful of geographic locations. Thus, the production of lithium from geothermal brines can enable wider supply while generating additional revenues for geothermal operations.



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Sodium-ion batteries are an emerging counterpart to lithium-ion batteries, quickly approaching technological parity with lithium-ion batteries for utility scale storage. Given that the relative abundance of sodium in the Earth's crust is three orders of magnitude larger than lithium, sodium-ion batteries can greatly improve scalability variable renewable energy technologies. This relative abundance is also reflected in the dissolved mineral concentrations of geothermal water, warranting further investigation.

Here, we estimate the potential sodium-ion demand to supply utility scale battery storage for New Zealand by 2040. Further, we calculate the production potential of sodium-ions from New Zealand's geothermal brines. A major advantage of geothermal-derived sodium-ions is the access to onsite energy from the geothermal plant.

Due to the nature of metallic sodium, CO₂ and ammonia are needed to facilitate the extraction. The former can be sourced directly from the geothermal fluid while the latter can be derived through a parasitic load.

New Zealand's utility scale battery demand is expected to grow up to 700 MWe by 2040. Assuming standard cycles of 4-hours per day and current energy densities of ~140 kWh/kg, this could require 528 kt of sodium. Our results show that Wairakei alone could supply this and provide enough electricity to facilitate all stages of cathode production.

Session: 7.2



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46 | Review of Chemical Cleaning Methods in Geothermal Wells

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Keywords: *Acid, Cleaning, Scale, Drilling, Chemicals*

We have reviewed technologies and techniques applied to geothermal well cleaning to recover lost productivity from wells using chemical cleaning methods. We have undertaken a review of the publicly available literature on geothermal well cleaning and adjacent technologies in the petroleum industry. Whilst many hypothetical solutions are proposed in laboratory-based studies, we found that the predominance of real-world applications is limited to the use of simple Hydrochloric (HCl) and Hydrofluoric (HF) acid blends.

Acid treatments are usually accompanied by mechanical cleaning operations using drilling rigs and coiled tubing units as part of well

intervention programmes. To decouple pure chemical cleaning from mechanical cleaning is difficult as the combined effects are intended to achieve more than a pure chemical or pure mechanical treatment alone.

The predominant use of HCl and HF acids for chemical cleaning is likely due to the availability of these chemicals, the cost of transport and the relatively well-known and understood reactions that take place between scale materials and these acids. On reviewing more than 112 well workover examples, 89 of these cases used a blend of HCl/HF. The rest of the wells were cleaned using blends of either Sodium Hydroxide (NaOH), Formic Acid, proprietary organic acids, condensate waters, or acetic acids.

As a corollary, the global petroleum well cleaning industry is also dominated by the use of HCl/ HF acids for cleaning scale and stimulating production formations, even though many proprietary acid blends are offered through service providers; we found no evidence that exotic chemical blends have achieved significant uptake in cleaning geothermal wells.

Session: 2.2



48 | Analytical Models of Degassing and Regassing Geothermal Systems

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Keywords: Carbon dioxide, emissions, lumped parameter model, depressurisation, analytical solution, degassing.

Geothermal systems naturally contain dissolved carbon dioxide, which may be present in the liquid reservoir at concentrations up to saturation. Observations from several geothermal systems have identified a degassing trend over time associated with production. More recently, attention has turned to the reinjection of CO₂ into the reservoir or adjacent aquifers.

The dynamics of CO₂ in a geothermal reservoir are influenced by several physical processes. Changes in pressure and temperature can reduce solubility in the liquid phase and may lead to exsolution if concentration is already close to saturation. CO₂ may escape the reservoir by migrating vertically through pathways in the caprock or via lateral outflow. CO₂ can be directly extracted from the reservoir through wells and may in some cases be partially or fully returned through reinjection. Finally, CO₂ can participate in geochemical reactions with the host rock.

Given the potential for complex physical interactions, numerical reservoir modelling is often the preferred method for characterising the state and trajectory of a given geothermal system. However, under certain simplifications a set of closed-form analytical solutions can be developed. This study describes a lumped parameter ODE model of a liquid geothermal reservoir subject to pressure decline, degassing, production-reinjection and mineralisation.

Solutions are developed for a high-gas system where CO₂ concentration is solubility limited, and a low-gas system that hosts negative emissions (carbon removal) and mineralisation.

The high-gas system undergoes an early period of degassing as pressure declines and then reaches a new equilibrium where net total emissions exceed the pre-production baseline due to an induced upflow effect. The low gas system with additional CO₂ reinjection is only able to achieve negative emissions over the long-term when mineralisation is present.

Session: 6.3



49 | Optimising Reinjection Capacities for Ngā Tamariki Power Plant

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Keywords: reinjection capacity, hydraulic modelling, calibration, pressure-flow balance

The Ngā Tamariki (NTM) geothermal power plant relies on a northern and southern reinjection pipeline system to return geothermal fluids to the reservoir. Commissioning of the Ngā Tamariki OEC5 unit will see the station's reinjection demand increase from 2,300 t/h to 3,150 t/h. Reinjection capacity through the southern reinjection system will be constrained by significant pressure drop along the common DN450 pipeline. This paper presents a case study using a steady-state hydraulic model developed in AFT Impulse to evaluate the reinjection system from the station's reinjection pumps through to the reinjection wells. The model incorporates as-built piping layouts and recent well injectivity

data. Then it was calibrated using recent operating data from October 2024 pump trials to accurately reflect the pressure-flow profile. Various system modifications and scenarios were evaluated to meet the increased injection capacity, including:

- Reinjection pumps online and offline (bypassed) operation.
- Minor system modifications (New flow meters orifice plates and removing northern reinjection pipeline NCG static mixer).
- Major system modifications (New pipelines and repurposing redundant pipelines).
- Additional injection well cases (New wells and repurposing redundant wells)

The output of the hydraulic modelling was used to update the NTM Integrated Model (Reservoir, Steamfield and Station), enabling each case to be evaluated and ranked according to a 25-year project NPV. The overall analysis identifies optimal strategies and timing to enhance the reinjection capacity, ensuring reliable reinjection capacity at 3,150 t/h.

Session: 4.2



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50 | Concept of the development of scale inhibitors

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Keywords: Scales, Calcium mineral, Silica, Inhibitor Geothermal power plant.

Referring the inhibition effect of polyacrylic acid (PAA) against the formation of calcium carbonate scale, a concept for search of silica scale inhibitor was tried to build up. To elucidate the inhibition mechanism of PAA, the interaction between calcium ion (Ca²⁺) and PAA was investigated. It was found that only slight complexation of Ca²⁺ to carboxyl groups (COOH) occurred, suggesting that the inhibition may possibly be caused by inhibition of growth of nuclei due to adsorption of PAA on its surface. For the formation of silica scale, two models for the nuclei of silica scale were designed: (1) aluminum hydroxide (Al(OH)₃) with positive surface charges and (2) silica containing the trace amount of Al with negative surface charges. According the properties of nuclei of silica scale, two polymer reagents (acumer 5000 and tiron type DADMAC) were selected as silica scale inhibitors.

Session: 5.2



52 | Investigating the Variance in Activity of the Lady Knox Geyser,

Waiōtapu Thermal Wonderland, NZ

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Keywords: geothermal springs, geysers, geothermal monitoring, geothermal resource management, Waiōtapu, machine learning, feature engineering, time-series analytics

The Lady Knox Geyser is within the tourist complex of Waiōtapu Thermal Wonderland (WTW), and is soap-induced to erupt for the entertainment of tourists. Currently, the height and duration of the eruption vary. The Thermal Park Management deems the eruption duration to have become shorter. The WTW management and the Waikato Regional Council would like to have the variability investigated. Understanding Lady Knox Geyser's behaviour is part of the landowners, the Iwi of Ngati Tahu – Ngati Whaoa, commitment to Kaitiakitanga (Guardianship, Conservation, and Sustainability). This study examines hot-spring temperature time series data from the Lady Knox Geyser. The geyser shows a distinct peak around the same time every day, as it was induced by the Park Rangers using soap to trigger the eruption. During its quiescent period, the spring temperature mean at several metres depth is 103°C.

Detailed scrutiny of data shows that a different pattern of temperature data is distinguished between a short eruption duration and a long one. However, some eruptions do not abide by this distinct pattern. The correlation between peak spring temperature and weather data was

analysed to determine whether there are any correlations between eruption duration and intrinsic factors and/or external perturbations. The peak spring temperature and air pressure are correlated with Lady Knox Geyser's eruption duration during the 3 months the geyser was investigated. In addition to correlations, time-series spring temperature datasets were used to build a machine-learning model that would predict the duration of eruption events in the future. A reasonable model would allow the WTW Management to know the duration of the eruption before it is induced and to help decide any actions to preserve the Lady Knox Geyser better.

Session: 4.3



55 | The Effect of a Temperature-dependent Permeability Limit on the Convective Upflow and Temperature in a Numerically Modelled Geothermal System

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Keywords: Brittle-ductile, flow, temperature-dependent permeability, convection, geothermal

High-temperature (>220 °C) geothermal fields within the Taupō Volcanic zone (TVZ) are among the most promising resources for clean energy production and present a significant opportunity for sustainable energy development. An emerging frontier is the exploitation of geothermal fluids at superhot or supercritical temperatures higher than 350°C.

In this work, numerical simulations of geothermal convection cells are used to investigate how thermal and physical rock properties influence heat transfer and geothermal accessibility at supercritical conditions. The focus of this work is the influence of thermally controlled brittle-ductile transition on the permeability properties of rock, that reduces fluid transport below a threshold temperature value.

A range of convection cell scenarios has been investigated with varying circulation depth, Brittle-Ductile Transition (BDT) temperature range, and permeability anisotropy. For a BDT across the range 340 to 440°C, the estimated temperatures in convection cells at a depth of 2 km exceeded the highest recorded TVZ temperatures (340°C). As flow was permitted at progressively higher temperatures, shallow temperatures reached those consistent with supercritical wells in Krafla, Iceland.

These preliminary results suggest that, to be consistent with New Zealand geothermal characteristics, heat transfer is likely to be conduction-dominated at supercritical temperatures and depths. However, future analysis of alternative mechanisms of permeability creation and loss, improved descriptions of temperature varying fluid properties, and better models of shallow permeability under transient simulations may require that we revisit this finding.

Session: 6.3



56 | Integrating Geological Uncertainty into Geothermal Reservoir Simulations with Bayesian Optimisation Workflows

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Keywords: *Modelling framework, Geothermal Reservoir Simulation, Waiwera, Automation, Aspen SKUA, Aspen Tempest ENABLE.*

Geothermal reservoir predictions are typically done under a high degree of uncertainty. Hence, accurately understanding and factoring in all uncertainties is critical for robust resource development and management. This study presents an integrated workflow that combines geological uncertainty quantification, Bayesian optimization, and automated history matching for geothermal reservoir simulation. Using a fully controlled modelling environment – SKUA for geomodelling and Waiwera for simulation – we construct a synthetic geothermal reservoir exhibiting typical features such as a clay cap and heterogeneous lithologies. In addition to flow-governing reservoir uncertainties such as rock permeability and upflow rate, we account for spatial uncertainty in geologic features such as clay cap depth, clay cap hole size, permeable reservoir extent, and fault dip/strike/extent, which are progressively constrained through Bayesian Optimisation techniques.

The approach leverages a workflow orchestrator to automate the Natural State Calibration and the dynamic History Matching phases. Multiple realisations of the reservoir model are generated and compared against synthetic production data. To address the high computational cost of ensemble methods, we use established assisted history matching tools that support uncertainty sampling, ensemble management, calibration point setup, and efficient matching with several

optimisation algorithms available. The result is an ensemble of calibrated, geologically consistent reservoir models with quantified predictive uncertainty.

This work demonstrates a proof of concept for a systematic and practical approach for geothermal reservoir forecasting. Because the workflow is built around a modular, software-agnostic orchestrator, a wide number of setups using different modelling approaches can be efficiently integrated within the larger history-matching framework. This flexibility offers a scalable path for researchers and operators wanting to integrate the impact of geological uncertainty into their reservoir predictions.

Session: 1.2



57 | Deep learning for instantaneous inversion of SkyTEM data

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Keywords: *Deep learning, inversion, electromagnetic*

The widespread application of Airborne Time-domain electromagnetic (ATEM) data, including the SkyTEM system (Sorensen and Auken 2004), to imaging shallow geothermal fluid pathways, is limited by the computational expense of inverting these large datasets. We present an approach using a physics-informed neural network to invert SkyTEM data in 1D and show early results of the application of the method to survey datasets. Neural network model predictions are several orders of magnitude

faster than traditional inversion and produce very similar results. Future work will expand the neural networks to higher dimensionality, providing opportunities for large-scale 2D inversion, which is currently not computationally feasible yet is required for improved management of complex geothermal and hydrothermal systems.

Session: 3.2



58 | Hybrid Thermodynamic & Machine Learning Model to predict Kawerau Geothermal Station Output Live

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Keywords: *Geothermal Production Optimisation, Generation, Digital Twin, Hybrid Model, Machine Learning First Principles Thermodynamics*

Previously the Mercury Optimisation Engineering team has been able to predict a geothermal station's MW production to ± 0.5 MW for one given time period, using station, steam field and integrated models. The Mercury Generation Optimisation Engineering and Decision Science teams saw an opportunity to create a digital twin to simulate various scenarios and accurately predict the net MW production at Kawerau live.

Using an agile approach, the joint team created a hybrid model that uses both engineering principles and Machine Learning (ML) to predict Mercury's geothermal flash plant Kawerau's net MW production live. The new model takes and predicts many inputs, including ambient weather forecasts (humidity and temperature), predicted available fuel, station derates, maintenance at the station and station operating states. The hybrid model has been tuned to be able to predict the net MW output to an accuracy of ± 0.3 MW (Kawerau Gross MCR 113.67 MW).

The production model provides:

- A model that provides Operators with optimised set points to maximise generation, without putting the station into constant alarm.
- A forecasting model that improves MW prediction accuracy. This provides Wholesale and Trading greater accuracy MW inputs for their Waikato River scheme model, particularly pertinent in dry years.
- A hindcasting tool to help account for lost MW for various operating scenarios, which can be used to better prioritise projects to improve the station's efficiency and minimise downtime.

The optimised hybrid model helps maximise Mercury's geothermal baseload electricity generation, helping to address New Zealand's energy trilemma.

Session: 7.1



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59 | Wider benefits from ambient and low temperature Geoheat. Why don't we get it?

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Keywords: *geothermal, low temperature, ambient temperature geothermal, heat pumps, geothermal heat pumps, high temperature heat pumps, decarbonisation, process heat, renewable energy, horticulture, Geoheat.*

Decarbonising NZ's energy system is complex and costly, using local energy resources reduces the need for capacity in the interconnected energy delivery systems, with low temperature Geoheat providing an opportunity waiting to be harvested, being present across virtually all of the nation.

The broader Tauranga area has an expansive low temperature geothermal system that is currently used for heating pools, space and water heating, and irrigation, but has potential for so much more. The Mount Industrial area contains a number of large heat users, of which a number currently burn gas. The area has electrical network capacity constraints. Heat pumping can provide medium temperature process energy replacing gas in some applications.

New Zealand's horticultural sector is transitioning from gas and coal. Work is underway to raise the awareness of using ambient and low temperature geothermal as a base energy source.

Commercial and residential heating and cooling networks can share subsurface infrastructure and resources, allowing more efficient energy use, lowering carbon footprints, and contributing to healthier work and living environments.

Ambient and low temperature local geothermal resources can contribute now to reducing system capacity growth required as part of NZ's decarbonisation. The challenge is to "get it" and to understand what using these geothermal energy resources across the nation means for individual users, energy networks, the network capital required and for our nation overall.

Session: 7.2



62 | Purification of Geothermal Gases for Use in Pilot and Demonstration Scale Facilities

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Keywords: *geothermal gas, NCG treatment, pilot scale, demonstration scale, glasshouses, microbe cultivation, H₂S removal*

Geothermal non-condensable gases (NCGs) represent a promising and underutilised source of CO₂ and CH₄ that has potential application in horticulture and microbial cultivation, among other industries. However, these gas streams contain H₂S and mercury that can inhibit microbial and plant growth or compromise biomass safety. Effective removal of these substances is essential, yet many existing treatment technologies are prohibitively expensive, overly complex, or generate excessive

solid or liquid waste—making them unsuitable for small-scale applications.

This study draws on work conducted during the conceptual design phases of a pilot-scale photobioreactor utilising geothermal CO₂ and CH₄ to grow extremophilic microbes, and of a geothermal CO₂ supply for glasshouse CO₂ enrichment. The facilities considered are a 1000 L pilot-scale bioreactor, and a 1 hectare, venlo-style glasshouse. This study reviews purification technologies currently in use, assesses their viability at the relevant scales, and presents practical and low-cost approaches for purifying geothermal gases that are less well-known than systems for large-scale purification.

The results demonstrate the technical feasibility of purifying geothermal gases for a pilot scale bioreactor without costly infrastructure, high chemical consumption, or the generation of substantial solid or liquid waste. The CO₂ supply for a 1-ha glasshouse requires H₂S removal on the order of 0.1 tonne/day, nearing the threshold where systems producing elemental sulphur are often recommended. Optimal process selection must therefore consider several factors specific to the glasshouse site. This study aims to support the development of sustainable bioproduction systems that utilise geothermal NCGs and the findings are generally applicable to pilot-scale and demonstration-scale efforts in gas purification and conversion.

Session: 4.2



63 | Biological transformation of geothermal gases to biomass: a case study

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Keywords: food security, greenhouse gas emissions, protein, pilot plant, gas-to-food, biotechnology, extremophiles, process design, engineering, New Zealand.

Geothermal electricity generation releases waste gases, including the greenhouse gases methane and carbon dioxide. These gases are currently vented to the atmosphere or re-injected, however there is potential to turn this waste stream into commercial products. This case study profiles the first project to couple the production of a protein with geothermal gases and extremophilic microorganisms sourced from geothermal environments.

Laboratory scale-research experimentally demonstrated proof of concept, showing that a co-culture of endemic geothermal microorganisms (a bacterium and a microalga) can consume the industrial gases, carbon dioxide (CO₂) and methane (CH₄) as a food source for growth. This generates a biomass that is rich in protein (ca. 60%) and was shown to be non-toxic, nutritious, and digestible (in mice). The biomass produced also contains several potentially

valuable components, which could be extracted to enhance commercial viability.

To advance towards commercialisation, we are scaling up from laboratory (80 L) to pilot scale (ca. 900 L) to optimise operating conditions and test with actual geothermal gases on a geothermal steam-field site. The scale-up will generate sufficient volumes to trial the biomass on larger, commercially-farmed animals and/or fish, as well as allow for fractionation experiments to explore the viability of premium products. Concurrent with the technical development, we are evaluating target markets and pathways to

these markets, including regulatory requirements and analysis of the techno-economics. This paper and presentation shares the project history, goals and learnings to date.

Session: 7.2



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65 | Formation factor analysis of the silica scale precipitated from geothermal waters by machine learning

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Keywords: silica scale, machine learning, neural network

Silica scale problem at geothermal power plants is one of the biggest issues to be solved to promote much install capacity because of decrease in power generation efficiency. However, the formation mechanism of silica scale has not yet been clarified. Previous geochemical investigations show that Al and Fe in geothermal water are closely associated with the promotion of silica scale formation. However, no study has been done to quantitatively estimate the contribution factors of each geochemical parameter to assess the countermeasure. Therefore, the purpose of this study is to create a machine learning model based on geochemical data and conduct factor analysis using partial derivative method. As for the geochemical data, the input data is geothermal water properties, and the output data is the weight of silica scale. Preliminary results showed that the time has positive contribution (46.0%), and the kinetics of monosilicic acid and reactive aluminum are also positive contribution (SiMKinetic_05_10: 5.7%, SiMKinetic_20_30: 3.3 %). Though some of the Al parameters negatively contributes to weight of silica scale (AIRKinetic_45_60 : 4.0 %, AIR : 2.1%, Al-slope: 1.0%), there is no contribution

of Fe parameters. The results from machine learning indicated that the silica scale weight is promoted with time past, and the Kinetic parameter is significant to predict. In addition, the chemical state of responsible species such as reactive Al may play an important role to inhibit the formation of silica scale as well based on the machine learning.

Session: 2.2



67 | Driving Agricultural Sustainability through Geothermal Energy: A CSR Case Study of Program Gemah Karsa by PT PGE Tbk Kamojang Area

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Keywords: Geothermal Energy, Direct Use, CSR, Agricultural Sustainability, Gemah Karsa

This study examines Corporate Social Responsibility as a resource strategy in assisting the sustainability of Kamojang local community agriculture. The research is based on Pertamina Geothermal Energy (PGE) Kamojang Area's GEMAH KARSA programme, which consists of three major efforts: Geothermal Organic Fertiliser (GeO-Fert), Geothermal Farming, and Green Watering. These initiatives aim to emphasise renewable energy through the direct use of geothermal waste to support sustainable agriculture and the creation of environmentally

friendly irrigation systems.

This research uses a qualitative method with content analysis and relies on secondary data from PGE's CSR reports and accompanying documents. These include social mapping study documents, programme implementation documents, social return on investment study documents and social innovation documents. This study also conducted a literature review on CSR programmes based on renewable energy companies, especially geothermal, as an effective strategy to support sustainability, especially in agriculture.

The research findings prove that GEMAH KARSA has a two-way positive impact, positively impacting the local economy and environment and helping to make PGE stand out as an innovative green energy leader. CSR

is committed to contributing to sustainable resource utilisation, improving community welfare levels, and building strong relationships with stakeholders. In addition to these benefits, challenges related to regulatory compliance and community engagement were also found in this study. For more effective CSR, greater collaboration and sustainable geothermal innovation are essential. This research contributes to the development of CSR strategies in the field of renewable energy and provides insights for companies seeking sustainable development.

Session: 4.3



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70 | Optimisation of Ulubelu Unit 1&2 PLTP Electricity Production Realisation against Cyclyc Well using Main Setting Pressure Mode

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Keywords: *Geothermal energy, cyclic well, ulubelu, main setting pressure.*

The Ulubelu Geothermal Power Plant, operated by PT Indonesia Power-PLN and PT Pertamina Geothermal Energy Tbk, plays a key role in Indonesia's renewable energy sector. Units 1 and 2 each have an installed capacity of 55 MW and rely on two-phase geothermal fluid from production wells such as UBL-56. However, UBL-56 exhibits cyclic pressure behavior, fluctuating between 6.14 barg and 11.27 barg, which affects the stability and availability of steam supply. As a result, Ulubelu Unit 1&2 often operate below their optimal capacity. To address this issue, the operational mode was shifted from Power Mode to Main Setting Pressure (MSP) Mode. MSP Mode prioritizes stable steam pressure delivery to the turbine, allowing for more efficient energy conversion during high-pressure phases. Implementation of MSP Mode resulted in a significant improvement, with an additional 44,329 kWh generated per day (~2% increase). This paper presents the methodology, operational adjustments, and results of this optimization, highlighting the potential of pressure-responsive strategies for enhancing electricity generation in geothermal systems with cyclic well behavior.

Session: Lunch and Poster Session



72 | Application of Numerical Simulation Method with Experimental Design in the Sibayak Geothermal Field, Indonesia

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Keywords: *Numerical simulation, experimental design, Sibayak field.*

This paper presents a comprehensive method for estimating geothermal field resources through numerical simulation, demonstrated through a case study of the Sibayak field. However, due to limited available data and the need to reduce subjectivity, significant uncertainties remain that must be addressed. To manage these uncertainties, an experimental design approach is employed.

The primary objective of applying experimental design in geothermal simulation is to systematically assess the impact of uncertain reservoir parameters such as liquid saturation, permeability, porosity, and fracture properties on model outputs that influence pressure, enthalpy, and production sustainability. By generating a structured set of simulation scenarios, this approach helps identify the key parameters that have the greatest effect on field performance and quantifies the probability of achieving long-term production targets.

The simulation process begins with data preparation, model construction, and the conversion of the static Sibayak model. This is followed by natural state simulation and

calibration using available production history data from wells such as SBY-3, SBY-5, SBY-6, and SBY-8. Once a satisfactory history match is achieved, the model is used to forecast future production. The experimental design method is then applied to evaluate the probability of the Sibayak field sustaining production throughout the contract period.

The integration of numerical simulation and experimental design offers a structured and quantitative framework for addressing subsurface uncertainties. This combined approach improves confidence in decision making by providing a more realistic estimate of the field's long-term production potential.

Session: 1.2



73 | The Interface of Māori geothermal development in Rotorua with national and regional policy: Case Studies for low enthalpy initiatives

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Keywords: *geothermal system, iwi, geothermal system management plan, regulatory framework, sustainable system utilization, low enthalpy.*

Several Te Arawa communities, under the umbrella of Tiaki Te Taiao, are collaborating to prepare resource management plans with special focus on geothermal development. This presentation is a case study of those Māori community aspirations for geothermal heat and energy, while holding to ancestral knowledge of geothermal taonga. In particular the Tiaki Te Taiao

ropū are focused on the opportunities of low enthalpy heat systems. Low enthalpy heat offers amazing opportunities of renewable energy without the major infrastructure investments of super-critical heat – a vital pathway for climate resilience through local heat and energy supply.

The communities in this case study include Ngāti Rangiteaorere, Ngāti Wāhiao, Ngāti Rangitihī, Horohoro / Waipupumahana, Ngāti Whakaue, and Tarewa. Each hapū group has distinct and interconnected knowledge, varied issues for development, and different levels of scientific knowledge.

An issue for Māori land owners, informed by mātauranga and science, is that the proposition; while geothermal surface features may be seen as distinct, for Māori geothermal fields are below-surface inter-connected taonga. Wells drilled by one set of owners can impact the surface features and development interests of adjoining owners, both physically and metaphysically.

There are a number of matters of policy to consider: the matter of below-surface interconnected geothermal fields and private property rights; access to investment funds for Māori geothermal development; policy focused on super-critical energy rather than low enthalpy systems; regional council designations of geothermal sites – e.g., Ngāti Rangitihī's Waimangu field is designated as protected, hence restricting renewable energy development opportunities.

There are multiple matters to be grappled with for plans: documentation of mātauranga Māori and the responsibilities as kaitiaki of the geothermal system, access to relevant expertise and scientific information, engaging with relevant communities and, working with the Regional Council.

Session: 2.3



75 | From Natural Description to Simulation: Large Language Models for Geothermal Engineering

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Keywords: Artificial Intelligence, Large Language Models, JSON, Validation, Semantic Accuracy, Retrieval Augmented Generation, Chain of Thought, Prompt Engineering, Fine-tuning, Waiwera

Computational modelling in geothermal engineering presents many opportunities for improved automation and validation. For example, manually editing configuration files and meshes for computational modelling is time-consuming and error-prone. In this study, we explore the potential of using large language models (LLMs) to automate typical tasks in geothermal engineering, focusing on generating and modifying structured simulation inputs (in JavaScript Object Notation or JSON format) for Waiwera, a modern geothermal simulator. However, these artificial intelligence (AI) tools come with risks in an engineering context, where precision, reliability and accuracy are crucial. Hence, we consider both syntactic

validity and semantic accuracy of LLM generated configuration files. This article first reviews various core concepts of LLM workflows and AI engineering relevant to geothermal engineering. We then present preliminary results of experiments using LLMs for various geothermal modelling tasks, in particular knowledge base retrieval and JSON generation. We consider both open-source and commercial LLMs (e.g., OpenAI GPT-4o, Meta LLaMA 3.3, DeepSeek R1) and discuss progress towards developing a validation framework and implementing AI engineering techniques to improve performance. Initial results indicate improved knowledge retrieval through retrieval-augmented generation (RAG) and consistent generation of structurally valid JSON inputs by LLMs, with minor sensitivity in smaller files. Ultimately, we aim to develop a “virtual geothermal assistant” that improves accessibility and efficiency in geothermal simulation, while documenting best practices for LLM integration in engineering workflows.

Session: 6.3



76 | Hydrothermal Alteration Exploration and Heat Flux Monitoring of the Guelma Basin Geothermal Field Using ASTER Data

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Keywords: ASTER, LST, RHF, Hydrothermal alteration, Guelma basin.

The Guelma Basin in northeastern Algeria is a prominent geothermal province, hosting numerous thermal springs with surface

temperatures reaching up to 98 °C and a geothermal gradient of up to 50 °C/km. This study investigates the spatio-temporal variability of geothermal surface activity in the basin by leveraging ASTER satellite imagery, emphasizing the potential for renewable energy applications and sustainable resource management.

Thermal monitoring was conducted using ASTER's Thermal Infrared (TIR) bands 13 and 14, employing the split-window algorithm to derive Land Surface Temperature (LST) while accounting for atmospheric interference such as water vapor and aerosols. The LST estimates were then integrated into the Stefan–Boltzmann equation to calculate surface radiative heat flux (RHF), enabling the assessment of geothermal heat discharge over time. Additionally, ASTER Shortwave Infrared (SWIR) data was utilized to detect hydrothermal alteration zones, supporting the identification of active geothermal features and potential fluid pathways.

This methodology provides a cost-effective, continuous, and non-invasive means to monitor geothermal heat flux variations. Preliminary results indicate notable spatial variability in RHF across the Guelma basin, particularly around high-discharge springs such as Hammam Debagh and Hammam N'bails. Vegetation indices derived from ASTER VNIR bands suggest a correlation between vegetation stress and shallow subsurface thermal anomalies.

This approach represents a replicable framework for geothermal field assessment in other tectonically active regions and supports strategic planning for direct-use geothermal applications such as district heating, aquaculture, and thermal tourism. The results contribute to Algeria's broader goals of sustainable energy development.

Session: Lunch and Poster Session



77 | Geyser activity at Geyser Flat, Te Puia, Rotorua: Insights from the second geyser monitoring deployment

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Keywords: geyser, temperature, surface features, geothermal monitoring.

The Rotorua Geothermal System (RGS) covers an area of ~15 km², with about 1,500 geothermal surface features mapped to date. Geothermal features, including geysers, are a key driver for tourism in Rotorua, and hold significant cultural, economic, and environmental value. Thermal activity in the RGS was in severe decline from the 1960s through to the mid-1980s due to overexploitation. A state of the environment monitoring programme was instated in early 1980s to collect data on the state of the system. However, data on the state of the geysers was ad hoc and not suitable for quantifying the geyser's state of health. A temperature sensor-based monitoring system was developed at Te Tohu and Pohutu geysers and Te Horu pool in 2022 to record temperature spikes from erupted fluids and translate this data into a record of eruptive activity that could be compared to historic periods. The trial was a success, and a second monitoring deployment was undertaken in 2024. This deployment redeployed redundant sensors from Te Tohu and Pohutu to the nearby Mahanga and Waikorohihi geysers, which had recently started erupting again, and added a submerged sensor at 3 m depth in Te Horu pool to investigate basal inflows.

Analysis of data from these deployments confirmed the resumption of activity at Mahanga

and Waikorohipi, after two decades of dormancy, and showed that recent geysering at Te Tohu and Pohutu geysers to be amongst the most active on record. The submerged sensor at Te Horu pool provided evidence of a connection to Pohutu-Te Tohu, and confirmed that Te Horu is an active feature in its own right.

The geyser monitoring programme is now integrated to the State of Environment programme for Rotorua, ensuring regular data on the state of geysering activity here is available to inform the future management of the RGS.

Session: 1.3



78 | Using advanced bit sensor modules for measuring vibrations, torque, and weight on bit to optimise PDC bit drilling efficiency in geothermal applications

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Keywords: *PDC bit, geothermal drilling, in-bit sensor, downhole weight on bit measurement vibration, bit wear, offset analysis, Drill bit design, performance improvement, continuous improvement, drilling optimization.*

Vibration is one of the major contributors that reduce bit performance in geothermal

drilling, resulting in excessive wear, low rates of penetration (ROP) and pulling out of hole before reaching total depth (TD). Conventional surface and downhole tools fail to detect vibrations occurring directly at the bit, with sensors located above in the bottomhole assembly (BHA). An advanced in-bit sensor system was developed to record memory-based measurements of vibration types, downhole torque (DTQ), and downhole weight on bit (DWOB). This integration of the in-bit sensor system offers valuable insights into the subsurface conditions during PDC bit drilling in geothermal applications, thus enabling reduced bit wear and improved drilling performance in challenging environments.

Data collected from the in-bit memory module revealed that torsional vibrations were most prominent during hard rock drilling, while stick-slip vibrations frequently occurred in transition zones where the BHA unwinds due to reduced formation resistance. Analysis of in-bit measurements also indicated that bit damage on the shoulder and gauge areas was primarily caused by lateral impact while rotating off-bottom. The results also showed that managing bit aggressiveness within a controlled critical depth of cut (DOC) effectively reduced stick-slip amplitudes.

Insights gained from the data will impact subsequent drill bit design improvements and operational adjustments, enhancing both technical and economic performance in geothermal drilling operations. Accurate identification of vibration sources during drilling facilitated the creation of a targeted drilling parameters roadmap aimed at ensuring dynamic stability of the bit/BHA combination across varying lithologies, significantly reducing bit wear and optimising ROP.

Session: 6.2



79 | Geo-loop: A Novel System for Characterising Multiphase Flow of Saline Geothermal Fluids at Elevated Pressures and Temperatures

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Keywords: *Multiphase flow; Geothermal fluids; Fluid flow experiments; Flow loop*

The effective design, operation, and optimization of geothermal wells and surface facilities depend on the accurate understanding of multiphase flow. While extensive research has characterized such flows, most studies have been limited to near-ambient conditions using simplified systems like air–water or oil–gas. Applying these models to geothermal fluids with high temperatures, pressures, and salinities often leads to significant inaccuracies. This paper introduces Geo-loop, the first dedicated experimental facility designed to directly observe and investigate multiphase flow in geothermal fluids. The Geo-loop enables experiments at temperatures up to 200 °C, pressures up to 25 bar, and salinities up to 11 wt% NaCl. Equipped with an optical window and gamma densitometers, the system allows for direct visualization of flow regimes and precise void fraction measurements. These capabilities provide critical insights into multiphase flow under geothermal conditions and support the development of more accurate predictive models specifically for high-temperature, high-salinity systems.

Session: 3.3



81 | The View from Orbit: Discoveries and Challenges of Hydrothermal Deposition in a Large Impact Crater on Asteroid Ceres

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Keywords: *Hydrothermal, planetary, Ceres, Occator, carbonates, ice.*

Mapping of hydrothermal deposits in the 92-km Occator impact crater on Ceres provide a unique opportunity to examine hydrothermal processes and deposits from a planetary perspective. Bright deposits of carbonates and hydrated salts occur on the central uplift and in a cluster of isolated bright spots on the eastern crater floor. Formation was likely by innumerable small seeps of brine that coalesced to form larger contiguous deposits. Isolated bright spots also occur on the crater rim, and small domes and pits occur elsewhere on the floor but are not common, indicating hydrothermal output was spatially limited. Occator and its hydrothermal deposits are considered a prime target for future exploration.

Session: 3.2



82 | Techno-Economic Study of Taiwan Advanced Geothermal Systems Technology

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Keywords: *Geothermal Energy, U-shaped Closed-loop Geothermal System, Numerical Simulation, Advanced Geothermal System, Geothermal Techno-economic Assessment*

As global efforts to mitigate climate change intensify, demand for renewable energy technologies has increased substantially. Taiwan has established comprehensive energy transition policies, with geothermal energy recognized as a strategic renewable resource. However, conventional hydrothermal systems (CHS) face substantial exploration risks and limitations in scalability, creating a need for next-generation geothermal technologies. The U-shaped Closed-loop Geothermal System (UCGS), categorized as an Advanced Geothermal System (AGS), not reliant on groundwater and with minimal environmental impact, emerges as a promising technology with potential for scalable deployment.

This study utilizes the CMG STARS simulator to evaluate the modeling capabilities of UCGS through validation against the internationally recognized Eavor-Lite™ project. Subsequently, case studies incorporating geothermal reservoir parameters representative of Taiwan are conducted to assess UCGS performance.

Sensitivity analyses are applied to investigate the impact of various geological and engineering parameters on heat extraction efficiency and power generation output. In addition, a preliminary techno-economic evaluation of UCGS implementation is performed.

The research demonstrates the applicability of numerical simulation for UCGS assessment and provides a quantitative foundation for evaluating thermal efficiency and power generation potential. The results show that the Levelized Cost of Energy (LCOE) for UCGS in Taiwan's present industrial environment exceeds the established geothermal Feed-in Tariff (FIT), limiting commercial feasibility in the current market context. Analysis of cost factors shows that drilling expenditures are the most influential factor for improving overall project economics. As drilling technology advances and costs decrease, UCGS could become a vital resource of Taiwan's renewable energy portfolio and support its net-zero emissions goals.

Session: 7.2



87 | 2024 Annual Aotearoa New Zealand Geothermal Review

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Keywords: *New Zealand, Aotearoa, geothermal, annual review, 2023.*

During 2024, geothermal electricity generation rose 13% to a record 8,741 GWh due to the commissioning of two new power plants at Tauhara Field. Over the year, geothermal generation lifted to 19% of New Zealand's electricity supply. Due to unfavourable hydrological conditions, total renewable generation fell to 85% of national power generation.

The net installed geothermal capacity increased by 17% to 1,207 MWe from 22 power stations in eight fields. Roughly 56% of the capacity is older than 10 years, and the proportion greater than 30 years fell to 16%.

During 2025 generation capacity will likely increase a further 8% with the commissioning of two new binary plants. This will boost system reliability and resiliency amid continuing hydro variability. Operators have deferred additional projects in development due to adverse market and deteriorating macro economic conditions.

Over the year, operators drilled ten deep conventional wells supporting power generation as well as twelve small diameter wells supporting direct use and resource observation. Drilling activity is expected to relax during 2025 as construction of new capacity wanes.

With the significant increase in generation, the geothermal industry's total CO₂e emissions rose slightly (1.3%) from 2023. However, the downward trend in emissions intensity continues, due in part to ongoing reinjection success at Ngāwhā, Ngā Tamariki, and Te Huka.

Although developers did not commission new high-temperature, direct-use facilities during the year, projects to increase heat use remain in active development.

The services sector continued to evolve with the strengthening of the domestic and international well services sector and the continued success of software services exports.

New Zealand universities continued to support the industry. Geothermal student enrolments

at the NZ Geothermal Institute increased with strong support from MFAT Manaaki scholarships. Concurrently, the number of research Masters and PhD enrolments reached a record high.

Session: 5.3



88 | An Application of Autonomous Vehicles to Manage High-Risk Exposure in Geothermal Operations

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As part of an effort to keep people safe, Mercury is developing an autonomous inspection vehicle (AIV) as a proof-of-concept project alongside New Zealand company Wrybill Robotics. The aim is to reduce personnel exposure to high-hazard environments on geothermal and hydro power generation sites. The initiative leverages autonomous robotics, thermal imaging, hydrocarbon (pentane) cameras and post-image analysis to allow comprehensive monitoring of site environments.

The primary objective of this project was to minimise human exposure to hazardous areas on site, by using a remote autonomous inspection vehicle that allows for safer monitoring of plant. In addition to scheduled inspections, the autonomous vehicle will be deployable in emergency scenarios which will allow operators to assess the plant and make decisions from a safe area.

Another key objective was the successful execution of reliability trial runs on Mercury's Rotokawa site. These trials tested the autonomous vehicles navigation system and provided photo and video data for analysis. Results from these trials will guide further technology enhancements and validate the autonomous vehicle's reliability and readiness for regular full-site routes.

Following the Rotokawa site deployment, the project is proposed to expand to Mercury hydro generation site Ohakuri by trialling two indoor autonomous vehicles using a different navigation technology. This aligns with Mercury's strategy to use digital solutions to reduce risk to their people.

This initiative aims to show the potential of using autonomous systems to transform how power generation sites are monitored, and risk is managed.

Session: 7.1



89 | Development of prevention strategies for silica scaling based on neural network supervised machine learning

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Keywords: *machine learning, silica scale, mitigation, inhibitor*

Scaling is a persistent challenge in geothermal energy extraction, affecting the subsurface and surface facilities of geothermal power plants. However, a universal prevention method has not been established due to the complexity of scale formation and diverse types of scale deposition. Recently, artificial intelligence (AI) has been vastly used in various disciplines of science, including geothermal exploration and optimization of energy utilization. Our previous work attempted to utilize supervised machine learning (SML) to accurately predict the formation rate of silica scale in a geothermal environment. The produced models yielded error values of < 0.15 , as root mean squared error (RMSE), suggesting the applicability of the models to predict silica scale formation.

In this study, we utilize the SML models to develop mitigation strategies against silica scaling. The strategies were developed based on the contribution factors of the chemical parameters of geothermal water. Then, three scenarios were evaluated: (1) pH modification only, (2) pH modification with removal of metals, and (3) pH modification and polymerization of oversaturated silicic acid. In addition to the modeling, onsite experiments of batch metal immersion were also conducted at the Hatchobaru geothermal power plants to examine the strategy and the development of a new silica scale inhibitor. The experiments were conducted at a temperature of $\sim 90^\circ\text{C}$, simulating the aging tank's condition. This study exhibits the potential of a machine-learning model to predict and assist in the mitigation of silica scale formation. With further and more experiments in more diverse properties of geothermal water, future models are expected to be applicable to more geothermal fields.

Session: 2.2



90 | Geothermal Potential of the Amagmatic Aswa Shear Zone in Uganda: An Assessment Using Geochemical Signatures

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Keywords: *shear zone, amagmatic,
geochemistry*

Okidi and Elegu, located in the Aswa Shear Zone of Northern Uganda are few of the amagmatic geothermal prospects situated outside the western arm of the East African Rift System. The two areas were first documented in 1935 and 2014 respectively. According to a reconnaissance survey done in 2023, Okidi thermal area is marked by hot springs issuing at a maximum temperature of 80°C from a riverbed covered with alluvial sediments. Conversely, Elegu is a blind system proven by shallow boreholes discharging mineralized anomalously warm fluids (44.7°C) and H₂S gas. Geological and geochemical data showed an extensional-type system controlled by tectonism and slightly alkaline (pH 7.5-8.3) thermal fluids with relatively low TDS compared to other areas of similar surface temperatures. Detailed geochemical and hydrogeological surveys conducted in 2024 show Na-Cl or Na-SO₄-Cl or Na-SO₄-HCO₃ type thermal fluids of meteoric origin and equilibrium reservoir temperatures of 150-170°C for Okidi

and 90-120°C for Elegu.

Session: 2.2



91 | Enhancing Early-stage Geothermal Resource Assessment through Uncertainty Modelling of the Clay Cap

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Keywords: *reservoir modeling, greenfield,
resource assessment, geological uncertainty,
automated clay cap generation*

The development of new geothermal fields faces high subsurface uncertainty and economic risks. This study builds on a new numerical method developed at the University of Auckland for early-stage resource assessment. We introduce an automated tool designed to enhance this method by generating variable geometries of the clay cap. The tool interpolates between two given clay cap geometries, typically an optimistic and a conservative estimate, based on magnetotelluric (MT) data and expert knowledge, extending the range of possible resource potential estimates.

The methodology was validated using a synthetic teaching model and a small-scale model of the undeveloped Maritaing geothermal

field in Indonesia. Additionally, the tool was applied to the Kotamobagu geothermal field model, which is larger in scale and currently being explored for development. The tool successfully generated interpolated clay cap geometries for each model. Early results indicate a significant influence of the size of the clay cap on the magnitude of the total upflow and its location at the bottom of the model. This highlights the importance of early-stage resource assessment, as the estimated clay cap geometry depends on limited and uncertain data combined with expert interpretations.

By automating the generation of the clay cap geometry, this tool enhances the new resource assessment method by incorporating additional geological uncertainty. Future research will focus on including this tool in a full resource assessment of an undeveloped geothermal field.

Session: 1.2



95 | Can Geothermal Vegetation Monitoring be Standardised in Aotearoa New Zealand?

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Keywords: *Monitoring, geothermal, ecosystem, vegetation, biodiversity, trend.*

Standardised monitoring protocols for measuring ecosystem integrity across Aotearoa New Zealand's diverse environments are under active development. However, no recommendations have been made for ecosystems considered dangerous to sample due to their intrinsic hazards, including geothermal ecosystems that contain heated and unstable ground. Waikato Regional Council commissioned a review of geothermal ecosystem monitoring, including consideration of options for implementing quantitative monitoring methods compatible



NZGA's members are part of a diverse and skilled network of people working and living with our unique geothermal resources.

NZGA is a non-political, non-governmental and not-for-profit organisation. Our focus is on providing leadership, connection and facilitation to support and grow sustainable geothermal opportunities in Aotearoa New Zealand.

NZGA also connects with global geothermal communities, and is well positioned to positively influence geothermal initiatives on the world stage.

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with the national monitoring framework. Monitoring of geothermal ecosystems has occurred since the 1970s. Methods and data collected vary among studies and the most widely used method may not be fit for all purposes to which it is applied. Monitoring of geothermal vegetation presents a range of challenges: difficulty of access, high habitat diversity within sites, and habitats and species susceptible to trampling impacts. These challenges are discussed. Using our experience in survey and monitoring of geothermal systems, we designed a methodology and undertook monitoring using the standardised protocols at a number of sites in the Waikato Region. This paper discusses the challenges and advantages of using a national approach for this monitoring.

Session: 1.3



96 | Vegetation, Ecology and Management of the Waimangu Rotomahana geothermal site

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Keywords: *Waimangu, Rotomahana, Waikite-Waiotapu-Waimangu Geothermal System, Waimangu-Rotomahana-Tarawera Geothermal Field, Tarawera eruption, ecology, monitoring, pest plants, pest animals, restoration*

The Waimangu-Rotomahana geothermal area is part of the Waikite-Waiotapu-Waimangu Geothermal System (WWWGS) which is located in the Taupō Volcanic Zone, which extends across the Bay of Plenty and Waikato Regions. WWWGS is a protected geothermal system.

The Waimangu-Rotomahana geothermal area includes the Waimangu Geothermal Valley, and the margins and cliffs of Lake Rotomahana. The Waimangu Geothermal Valley is considered to be one of the youngest geothermal areas in Aotearoa New Zealand, and all current geothermal vegetation has developed since the Tarawera eruption in 1886. Despite its young age, the area contains some of the most important populations of the special plants and habitats present within the geothermal areas of the Taupō Volcanic Zone. Geothermal vegetation is of high ecological significance, and almost all the geothermal vegetation within the area is in good condition. However, there are ongoing pressures from pest plants and pest animals which threaten ecological integrity. This paper presents information on important plants and fauna at the Waimangu-Rotomahana geothermal field (including Threatened and At Risk species), endangered ecosystem types, ecological pressures, and management requirements. A brief ecological history and a summary of geothermal vegetation and habitats present at other sites in this geothermal field is presented.

Session: 1.3



97 | An integrated Python-based workflow for geological and geothermal fluid flow modelling to investigate lateral fluid movement in the Taupō Volcanic Zone

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Keywords: *TVZ, geological modelling,
geothermal fluid flow, reservoir modelling,
AUTOUGH, GemPy.*

Lateral fluid flow within geothermal systems significantly affects reservoir sustainability, resource targeting, and surface expressions, but remains challenging to predict in structurally complex volcanic settings like the Taupō Volcanic Zone (TVZ). This study introduces a python-based workflow that couples 3D geological models with supercritical heat and fluid flow simulations to investigate geological conditions that promote lateral geothermal fluid movement.

We are developing a methodology to couple structural and stratigraphic modelling with multiphase fluid and heat flow simulations using open-source tools where possible. Geological models are constructed in GemPy, with custom Python scripts employed to extract rock types and fault geometries. Geological units are then parameterised for fluid flow modelling, building on the University of Auckland's modelling framework. Finally, we use the supercritical AUTOUGH simulator to model the high-temperature, high-pressure environments characteristic of the deep roots of geothermal systems. This approach enables dynamic, repeatable population of reservoir models, supporting flexible natural state simulations and quantification of geological uncertainty.

Modelling the deep roots of the Ohaaki geothermal system provides a case study for this work. Unusually, magnetotelluric imaging suggests that fluids beneath Ohaaki move ~5 km laterally between 8 and 3 km depth. Geological structures inferred from gravity and magnetics provide possible fluid pathways or permeability contrasts that redirect fluid flow. Our preliminary models are exploring variations in lithological properties, fault permeability, intrusive heat sources, and anisotropy, allowing systematic

analysis of how different geologies influence lateral flow.

Session: 6.3



99 | The New Geological and Natural State Model of Hулulais Geothermal Field

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Keywords: *3D Geological Model, Numerical
Simulation, Natural State*

Hулulais Geothermal field, operated by PT Pertamina Geothermal Energy (PGE), is situated in the Province of Bengkulu, Sumatra Island, Indonesia. This volcanic-high terrain geothermal system is controlled by the Sumatra Fault System, which provides a high-enthalpy, liquid-dominated reservoir. As of 2025, the pre-exploitation phase is still underway in this field, with production scheduled to commence in the near future.

This paper aims to update the previous work by Nusantara et al. (2017) and Sisminardi (2019) by implementing the latest real subsurface datasets, hence yielding a well-constrained geological and

natural state model of the Hululais field. Leapfrog geothermal software was used to create the three-dimensional geological model, while PyTOUGH coupled with AUTOUGH2 software was used to run the numerical simulations.

The geological model shows the lithology and stratigraphy sequences of the field, as well as the faults and alteration zone. The geological model was discretized and converted into the model grid for the numerical simulation. Temperature and pressure data acquired from previously conducted surveys were used for calibration. After extensive trial and error with manual calibrations, the natural-state model provided a satisfactory and reasonable temperature match. The average RMS error of the natural-state model is 15.1°C, meaning that 80% of the model is within 20°C difference with the downhole temperature.

The model shows that the high-temperature reservoir in the vicinity of well pads A, C, and E has a temperature of > 250 °C. In contrast, the lower temperature outflow zone lies in the vicinity of well pads B, D, P, and Q with a maximum temperature of 210°C. The temperature distribution also corresponds with the conceptual model, proving the relationship between the high-temperature upflow zone around Mount Beriti and Mount Gedang in the South with the lower temperature outflow zone in the Mount Cemeh area in the North.

Session 1.2



100 | Cleaning and Stimulating Geothermal Well with Oil and Tar Residue Downhole

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Keywords: *Injection well stimulation, oil and tar residue removal.*

A geothermal company in the Alaşehir region of Turkey contacted Solenis for cleaning an injection well. A significant challenge for this geothermal power producer's plant is that its production wells typically contain trace residues of oil and tar. These residues eventually make their way into the injection wells, thereby reducing the injection capacity of the well and effectively repelling any chemicals aimed at stimulating production and removing mineral deposits.

After studying the composition of the oil/tar residue, Solenis developed a product, a tar solvent, to eliminate the residue downhole. Additionally, a bespoke solution was developed for the specific geology of this well and its fluid dynamics.

In total, 25.6 tons of tar solvent were pumped downhole without suspending the operation of the well. Then the Solenis team completed the online well cleaning, targeting the deposits found downhole and at the formation of the wellbore.

Prior to the online cleaning, this well had an injection pressure of 44 bar at an approximately 125 ton/h injection rate, giving the well an injectivity index of 2.8 ton/h-bar. The final wellhead pressure recorded shortly after the cleaning was 30.6 bar at a flow rate of 409.1 ton/h, resulting in an injectivity increase of 13.4 ton/h-bar. This represents an injectivity increase of 480%.

Session: 4.2



101| Calcite Inhibition Systems Tubing Recovery

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Keywords: *Calcite Inhibition System, Geothermal, Well Intervention, CIS Tubing Recovery, Solenis, Acidising.*

Chemical Inhibition Systems (CIS) are widely used in geothermal wells to deliver antiscalant chemicals that mitigate mineral scaling. Over time, CIS tubing can become stuck due to scale buildup, caused by inappropriate chemical selection, changes in fluid chemistry, and lack of routine maintenance. This paper presents field-proven results using the Solenis chemical cleaning method to dissolve scale and recover immobilized CIS tubing in high-temperature geothermal wells.

The method has been successfully deployed in geothermal fields in New Zealand and the Philippines, with each case involving different scale types—primarily silica, calcite, and mixed mineral compositions. We detail the assessment process, tailored chemical program design, and

safe retrieval procedures that avoided more costly well intervention methods involving a rig or coiled tubing unit. These interventions restored injection capability, improved well performance, and extended system life. The paper discusses practical recommendations for preventing stuck tubing and optimizing CIS reliability across a variety of geothermal environments.

Session: 3.3



102 | Novel Method of Dissolution Scale in The Inaccessible Geothermal Wellbore

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Keywords: *acidizing, calcite, scaling, Silangkitang, well recovery and stimulation.*

SIL1-2, an old well drilled in 1997 located in Indonesia, initially produced up to 420 t/hr at 22 barg. By 2023, its production rate had declined to approximately 80-90 t/hr. A scaling simulation indicated that calcite deposits likely formed near the wellbore. Limited by wellbore accessibility, the only feasible stimulation method was Solenis patented well recovery and stimulation novel method. Since the wellbore was inaccessible, the acid stimulation was initiated under less-than-ideal conditions, with no scale deposit removal or pressure-temperature logging

performed beforehand. The goal was to dissolve scale buildup within the wellbore and nearby formation, sweep the solution into the formation, and prevent calcium ions from redepositing, thereby expecting permeability enhancement. Laboratory tests on core samples, the only physical reference, involved exposing them to acid and alkali chemicals. After several days of preparation, SIL1-2 was brought back online, and production recovered to about 290–300 t/hr, nearly its original capacity, as confirmed by the production separator. The well recovery and stimulation successfully increased production while also minimizing equipment requirements and reducing loss generation compared to other stimulation methods previously attempted.

Session: 5.2



103 | Monitoring changes in geothermal springs chemistry at Kuirau Park and Ōhinemutu, Rotorua Geothermal System - using field physical measurements as a cost-effective proxy for chemistry changes

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Keywords: Rotorua Geothermal System, environmental monitoring, Geochemistry, Kuirau, Ōhinemutu.

Kuirau Park and Ōhinemutu, located in the northwest of the Rotorua Geothermal System

(RGS), experienced increased geothermal activity between 1998 and 2002 following the 1986 bore closure programme aimed at restoring the RGS's health. Despite their proximity, the geothermal features of these areas differ in geochemistry and field attributes such as temperature.

A review of geochemical and field measurements, including recent data, shows agreement with previous surveys but highlights changes in two features. Feature RRF3014 (JC Fountain) shows signs of recovery, similar to features at Ōhinemutu, while Feature RRF0715 (Mayor's Mouth) has declined in pH, temperature, and electrical conductivity (EC) since 2017, indicating potential deterioration.

Historical analysis reveals that increased geothermal activity between 1998 and 2002 correlated with rising pH, temperature, and EC in several features. These relationships were used to generate correlations with total dissolved solids (TDS), though dataset constraints limited further analysis. Changes in TDS can indicate adverse effects like groundwater dilution due to pressure decrease within the supporting geothermal aquifer.

Electrical conductivity, pH, and temperature are easily measured in the field, while TDS and geochemistry require significant investment. Developing correlations between these parameters could be a powerful tool for screening the geothermal system and guiding further investigation with targeted chemical sampling. Focused work concentrating on changes and correlations between pH, EC and bicarbonate could be a cost-effective tool to monitor CO₂ reinjection returns to geothermal surface features and monitoring wells.

Future work should focus on improving models and correlations between field parameters and chemistry through more concurrent field measurements and geochemical sampling. Historical data has helped identify changes in pH and conductivity related to increased geothermal activity, which could warn of future

activity spikes that pose health and safety risks and potential damage to property and infrastructure.

Session: 2.2



106 | Resource assessment of the Tecuamburro geothermal system using reservoir simulation

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Keywords: *Approximate Bayesian Computation, geothermal modeling framework, digital conceptual model, reservoir model, resource assessment, uncertainty quantification, Waiwera.*

The Tecuamburro geothermal area is located in southeastern Guatemala along the Central American chain of volcanos. Thermal surface manifestations are found over an area of nearly 400 km². Major hot springs and fumaroles are located at Laguna Ixpaco, along Rio Los Esclavos, and east and northeast of the volcano. Geothermometry analysis of these manifestations yields temperatures of 150 – 300oC. Previous work done by Los Alamos National Laboratory, the US Geological Survey, and the Instituto Nacional de Electrificación in geology, geochemistry, geophysics, and the drilling of one cored well, named TCB-1, suggests

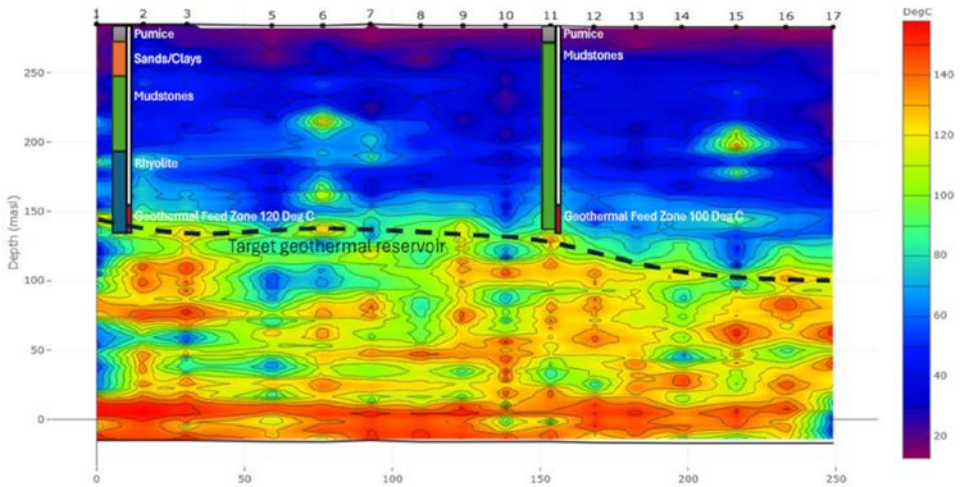
that there could be a promising geothermal resource. The geoscience information was reviewed, the conceptual model was updated, and a digital conceptual model was developed to create a new reservoir model. This paper describes the model creation based on our geothermal modeling framework; this model can be run either in AUTOUGH2 or Waiwera. The new model integrates geology, geophysics, faults or structures, alteration zones, reservoir engineering and drilling data, resulting in a robust reservoir model. The model produces good results in matching the temperature profile of well TCB-1, surface features, and temperatures below the clay-cap in Tecuamburro and Infernitos. Base on this new model, an uncertainty quantification analysis was performed with 1000 sample models for the natural state. The models were filtered based on the temperature profile of the well and temperatures below the clay cap using Approximate Bayesian Computation (ABC) resulting in 100 acceptable sample models that were used to perform a resource assesment applying an innovative method that ran each filtered model for a maximum potential production scenario over 25 years. Results provided by this novel approach give a resource assessment that includes the same information used in traditional stored heat calculations but also takes account of reservoir and wellbore physics and a realistic energy extraction and injection strategy, thus providing a more accurate forecast.

Session: 1.2



Geothermal Temperature Mapping

Mapping of shallow geothermal reserves under the town park Rotorua, New Zealand.



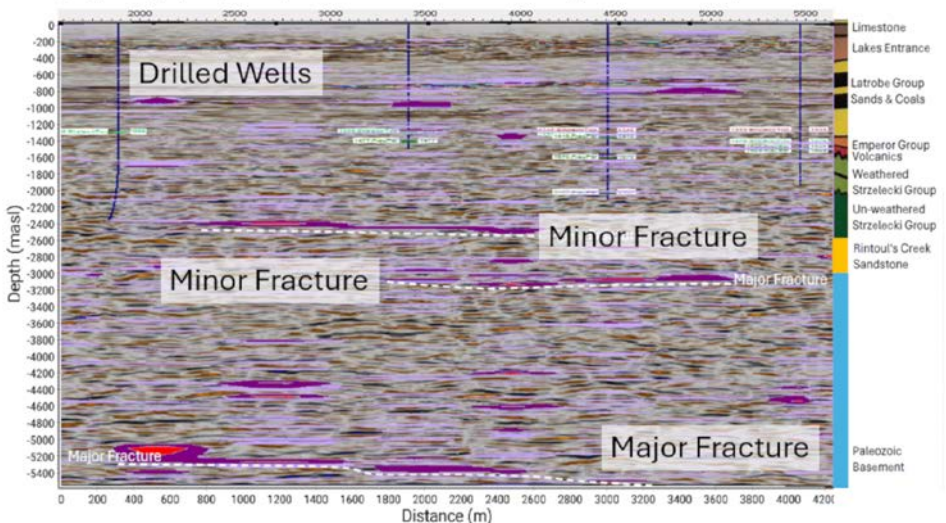
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Deep Earth Enhanced Geothermal Fracture Mapping

Mapping of major, deep earth, fracture networks for enhanced geothermal developments in Australia



107 | What to expect when you're not expecting - Drilling in the Tauranga Geothermal System

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Keywords: *Low temperature geothermal,
Tauranga Geothermal System, Drilling Standards,
new geological formation*

Under the Resource Management Act 1991 (NZ), Bay of Plenty Regional Council (BOPRC) is responsible for managing the groundwater and geothermal resources of the region. The Council undertakes an ongoing drilling program throughout the region to improve its understanding of groundwater, low temperature and high temperature geothermal resources through its state of the environment (SOE) monitoring networks. Council uses the lithological information collected during drilling to improve 3-D geological modelling, which is key to setting aquifer allocation limits.

As part of this programme, in 2024 BOPRC planned to drill in 2024, three new monitoring wells in the west of the Te Puke region. Planned drilling targets were the deeper aquifers, represented by the Aongatete, Waiteariki, and the Pokai-Chimp-Pokopoko formations, to better monitor effects from inland takes by horticulture operations. Based on the existing drilling, modelling and consented data, the targeted completion depth was approximately 480 metres for the deepest of the wells, anticipating a maximum water temperature of approximately 40–45°C, which is elsewhere typical for the Tauranga Geothermal System.

During drilling of the first well, artesian flow of 8 litres per second was unexpectedly encountered at 318m below ground, with a temperature

of 68.6°C. A Pressure, Temperature, Spinner (PTS) survey was subsequently undertaken to determine downhole temperature, and to locate the main flow/fractures. The highest temperature recorded was 76.34°C, with the spinner indicating flows at 310 – 312m and from below 320m (the maximum clear depth). Shut in pressure on the well was recorded as approximately 0.7 bar (10psi) and the maximum downhole pressure was 32.5 bar (471psi).

Analysis of the drill chip samples (collected at 1m intervals) indicated the hot main feed zone occurs in a previously unknown lava of the Minden Rhyolite Subgroup. Council is currently working with local iwi to name the new rhyolite.

Session: 6.2



108 | An Iwi-inspired System Management Plan for Tikitere geothermal system

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Keywords: *Tikitere geothermal system,
iwi, geothermal system management plan,
regulatory framework, sustainable system
utilisation.*

Work toward a Tikitere Geothermal System Management Plan (GSMP) is a forward-looking initiative by Ngāti Rangiteāorere, working with Bay of Plenty Regional Council, with the intention any future use of the geothermal system is sustainable, addresses iwi, hapū and

landowner aspirations, kaitiakitanga and the needs of future generations.

Tikitere occurs in a rural setting, north-east of Lake Rotorua, with surface thermal activity dominated by steaming ground, fumaroles and warm to vigorously boiling, steam-heated muddy pools. Geoscience investigations show the Tikitere geothermal system extends over ~10 km².

Here, we set the stage for a collaborative approach to establishment of a GSMP, that is informed by traditional knowledge, scientific research and the aspirations of local communities. At its core is our goal to seek a balance of customary practices and environmental stewardship, ensuring the Tikitere geothermal system is managed holistically. Special attention is paid to integrating mātauranga Māori, upholding kaitiakitanga and recognising the interconnectedness of land, water and people. Our proposed framework aims to provide clarity and adaptability for all stakeholders, supporting enduring benefits and responsible guardianship.

'Hells Gate Geothermal Reserve and Spa' is an internationally recognised tourist attraction. Its surface manifestations have been used for centuries by Māori for bathing, heating, mineral extraction and domestic use. The Tikitere geothermal system is not developed for electric power, industrial heat-utilisation or large-scale direct use, but is classified in the Bay of Plenty Regional Council Policy Statement (RPS) as 'Group 3', for conditional development.

Geothermal system management plans can take different forms. In this instance there is an opportunity to proactively develop a whole system approach, which can help guide future resource consenting and management decisions. While the final form of the GSMP is not yet determined, we aim it will accommodate system wide objectives, management of relationships, sound decision-making processes, effective monitoring and reporting frameworks.

Other issues for the Tikitere geothermal system are strategies to monitor system health and integrate Mātauranga Māori to mitigate / avoid effects from any future fluid extraction or injection (including at hydrologically connected developments nearby), consistent with guiding principles and vision of Ngāti Rangiteaorere.

Session: 2.3



109 | Controlled Mineralisation of Carbon Dioxide: Laboratory Assessment

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Keywords: Carbon capture, CO₂, NCG reinjection, controlled mineralisation, hydroxide, calcite.

NCG reinjection has been implemented in several geothermal power plants to reduce greenhouse gas emissions and support New Zealand's net-zero emissions targets. A major challenge for this system is that there is a potential for NCG breakthrough to the surrounding wells and leakage to the ground surface, which could result in high CO₂ gas emissions. Therefore, effective CO₂ mineralisation is essential to mitigate those risks. This study presents a series of laboratory experiments designed to evaluate suitable and cost-effective materials for CO₂ mineralisation.

Hydroxide compounds—including calcium hydroxide (Ca(OH)₂), potassium hydroxide (KOH),

and sodium hydroxide (NaOH)—and industrial waste products were tested by injecting CO₂ into aqueous solutions of these materials. The efficiency of mineralisation was assessed via the composition and mass of solid CaCO₃ deposits formed. The tests were performed under varied conditions of temperature (25–60 °C), CO₂ flow rate (0.1–0.2 L/min), and reactant concentrations.

Based on the results, the most effective hydroxide mineral that has been tested for CO₂ mineralisation is Calcium Hydroxide (Ca(OH)₂) since it produces solid carbonate. However, due to the relatively high cost of pure Ca(OH)₂, other alternatives could be used for the CO₂ capturing. Waste products (e.g., burned lime and NSSC) containing 75–85% Ca(OH)₂ are proven to be effective in CO₂ mineralisation by precipitating CaCO₃ minerals from the carbonation of Ca(OH)₂ aqueous solutions. These waste-based sources

produced significant CaCO₃ precipitation and present a promising low-cost alternative.

From these laboratory experiments, it is concluded that waste products containing significant Ca(OH)₂ can be effective for CO₂ sequestration in geothermal reinjection systems, helping to reduce the risk of NCG breakthrough by promoting near-complete mineralisation before subsurface injection.

Session: 7.1



111 | Recent Subsurface Insights at Rotokawa: Case Study of a New Well

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Keywords: *Rotokawa Geothermal Field,
geothermal well drilling, geothermal geology,
reservoir conditions, casing design*

In 2024, an injection well was drilled at the Rotokawa Geothermal Field, targeting feed zones indicated by offset wells. The injection well was designed to replace a previous injection well which had wellbore integrity issues. By re-targeting feed zones from offset wells, the new well provided an opportunity to validate current reservoir models and gather fresh subsurface data.

The well design leveraged learnings from nearby wells to improve the likelihood of success and reduce drilling risk. The planning included both primary and contingency completion options to address potential challenges associated with expected high subsurface temperatures and weak rock strength conditions. With both primary and secondary completion designs prepared in advance, the drilling team was able to “dynamically” install the design that fitted the formation characteristics collected as the well was drilled. The drilling program was completed on schedule and to plan. The target feedzones were successfully intercepted, with excellent permeability encountered. The maximum measured temperature of this well was 338°C after heat-up, possibly the hottest so far recorded in New Zealand.

Although the well was drilled near existing wells, the encountered subsurface conditions highlighted that significant changes in reservoir characteristics can occur over short distances in the field. Data from the new injection well

revealed, in particular, more detailed information about the potential nature of the deep reservoir boundary and new insights on stratigraphic and structural controls on reservoir conditions in the injection area. These results will be used to refine the conceptual model and support future well planning at Rotokawa.

Session: 6.2



112 | Preliminary Investigation on the Suitable Scope of Geothermal Life Cycle Assessment

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Keywords: *Life Cycle Assessment, Life Cycle Inventory, Guidelines for Geothermal Life Cycle Assessment (LCA) stands as a critical tool for evaluating the environmental performance of geothermal energy systems, comparing to alternative energy generation and providing information for improvement. However, the geothermal industry does not have a standardized approach to LCA scope and other definitions, resulting in inconsistent methodologies and limited comparability across studies. These inconsistencies pose a challenge for practitioners, regulators, and researchers seeking reliable environmental data.*

This paper presents a preliminary investigation into the challenges of defining suitable LCA scope, as well as environmental dimensions for geothermal applications. A literature review of

geothermal LCA studies and methodological guidelines highlights variations in system boundaries, data availability, and technology-specific assumptions. To address these gaps, we propose a framework for engaging geothermal stakeholders through targeted surveys and expert consultations, integrating practical perspectives on scope relevance.

As part of an ongoing PhD program, this study seeks to identify critical gaps and outline research pathways that can advance the harmonization of LCA practice in the geothermal industry. The ultimate objective is to build a more consistent and robust foundation for assessing the environmental performance of geothermal energy across technologies and contexts.

Session 1.3



113 | Assessing Groundwater Impacts of Geothermal Development through Integrated Modeling: Insights from Ulumbu with Broader Applications

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Keywords: *Geothermal, Modelling, Groundwater, Agriculture.*

Social issues such as agricultural disruption, water scarcity, health risks, and natural disasters remain key challenges in geothermal energy development in Indonesia, often delaying project implementation and reducing public acceptance. This study investigates the impact of geothermal production at the Ulumbu Geothermal Field on the local water table and its potential implications for nearby agricultural areas.



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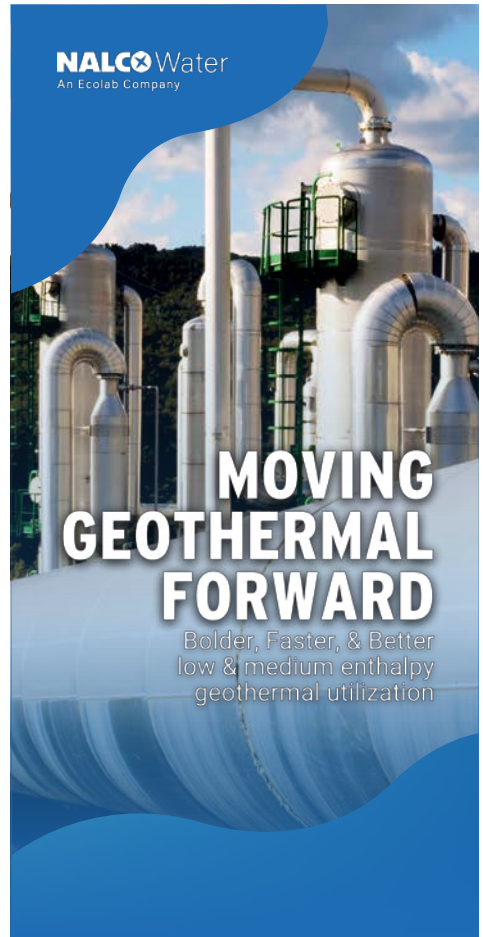


A three-dimensional conceptual model was constructed using Leapfrog™, incorporating geological, structural, and alteration data. This model was then translated into a numerical reservoir model using AUTOUGH2. Refinements were applied to the shallow subsurface to ensure simulation stability and accurately capture water table responses.

Two calibration phases were performed. The first involved natural-state calibration by adjusting permeability values and introducing a hot plate to simulate subsurface heat input. This confirmed that Ulumbu is a vapor-dominated system with reservoir temperatures ranging from 220–240°C. The second phase matched production history by refining porosity and relative permeability to reproduce the enthalpy and mass flow of well ULB-02, which produced dry steam with enthalpy values between 2803 and 2787 kJ/kg from 2012 to 2025.

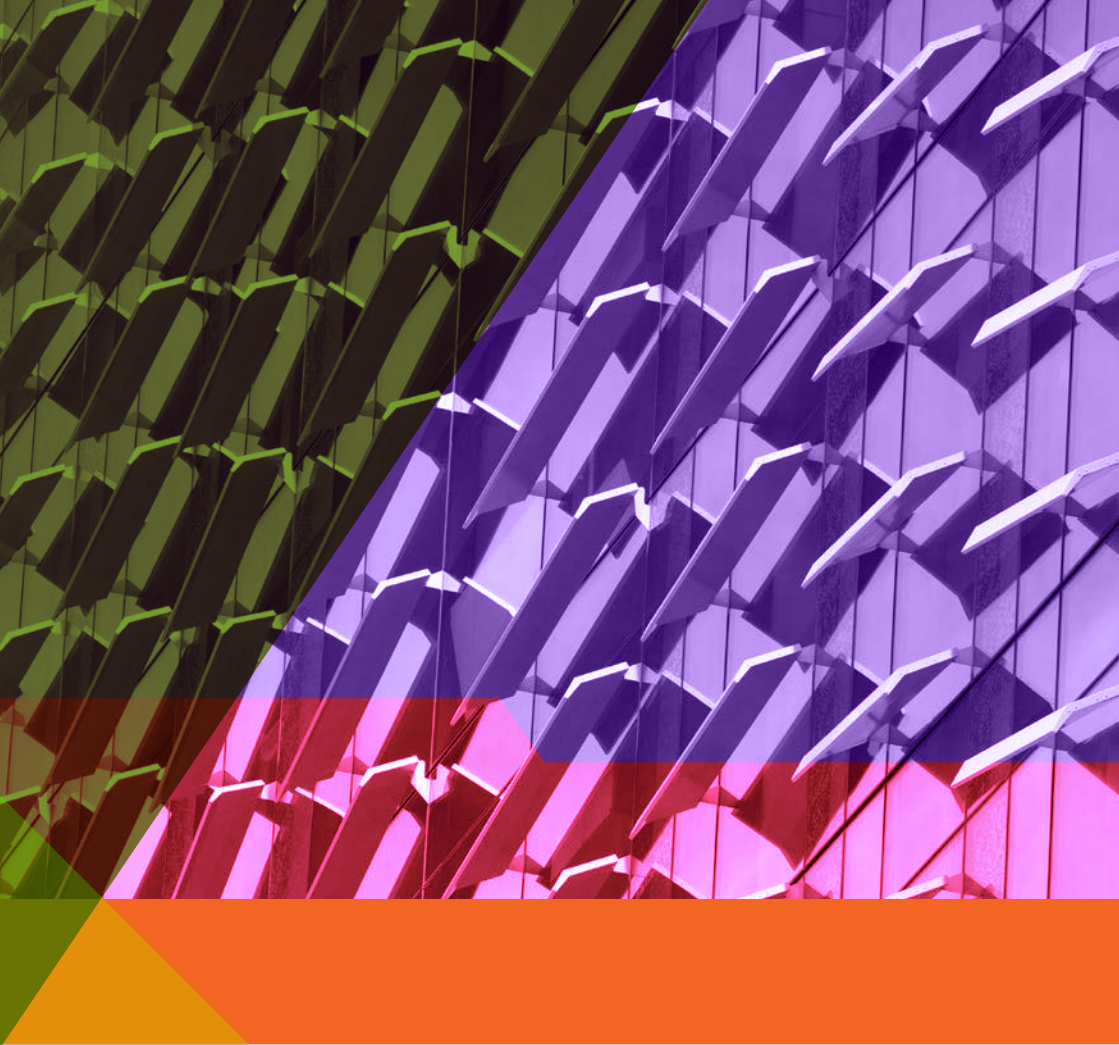
After calibration, pressure changes in blocks associated with agricultural zones were evaluated and converted into water table variations. Results indicate a maximum water table decline of only 4.6 mm, considered negligible and unlikely to impact agricultural sustainability. This study provides a robust modelling framework for assessing the groundwater impacts of geothermal production and contributes to addressing critical social concerns associated with geothermal development in Indonesia.

Session 7.2



Notes

Notes



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