New Zealand's Pathway to Supercritical Geothermal Energy Use: Moving Forward to Exploration Drilling

New Zealand Geothermal Workshop - 2nd and 3rd February 2022

Paper 64 – Presented by Brian Carey

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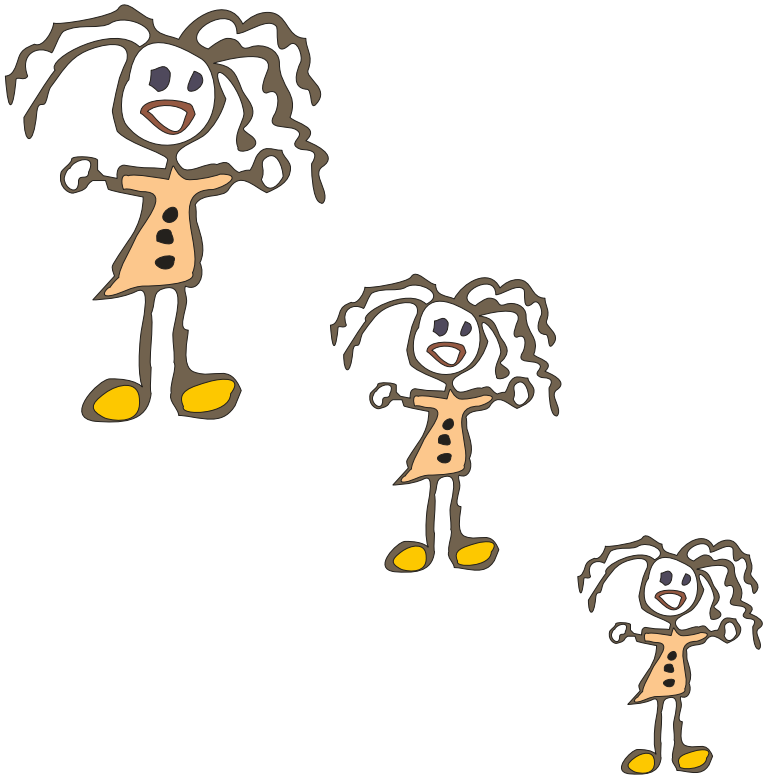
Don’t need your covid app for access

- Have your QR reader ready
- Pick up some useful URL’s

Today …. Hotter and Deeper Geothermal Exploratory Drilling

- **What is this ….**
- **Preparatory work**
  - Geothermal the Next Generation
  - Paper 64
  - 6 km deep well design
- **Connections**
  - GNG Website
  - Social media
- **Opportunities**
  - To participate
    - Ultra Hot – Supercritical Seminar Series



What is this Hotter and Deeper Geothermal

- **Geothermal deeper down in the Taupō Volcanic Zone**

  (Ngawha ?, and offshore ?)
- **Looking for Temperatures > 400 C**

  (where the rocks are becoming more ductile)
- **Are there opportunities for:**
  - Expansion of existing geothermal operations
  - Accessing entirely new resources
- **Can these:**
  - Renewable energy resources be counted on for New Zealand
  - Assist in moving NZ into our low carbon economy

Preparatory Work - Research

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THE NEXT GENERATION

MBIE Endeavour Research Programme
Contract C05X1904

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Ngatamariki Power Station, Taupo,
Photo credit: Chris Sisarich

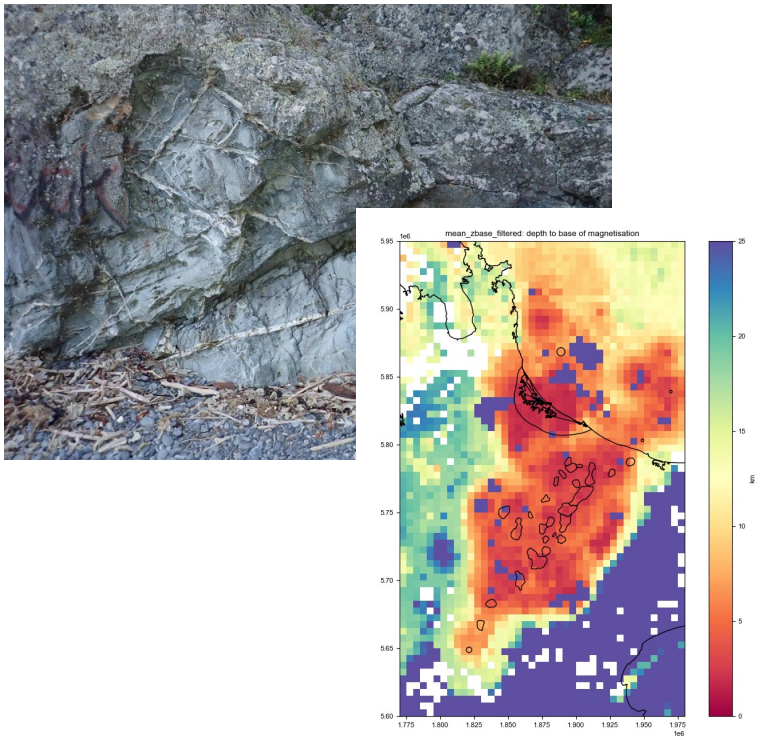
GEOTHERMAL
THE NEXT GENERATION

- **Three Work Streams**
  - Explore
  - Understand
  - Integrate
- **5 year Programme**
  - Completion October 2024
- **35 Tasks**
- **Published outputs along the way**
  - Papers - NZGW 2019 and 2020
  - 2 presentations & poster at NZGW 2021
- **GNG Workshop at 2020 NZGW (Pahia)**

Three Work Streams

GEOTHERMAL THE NEXT GENERATION

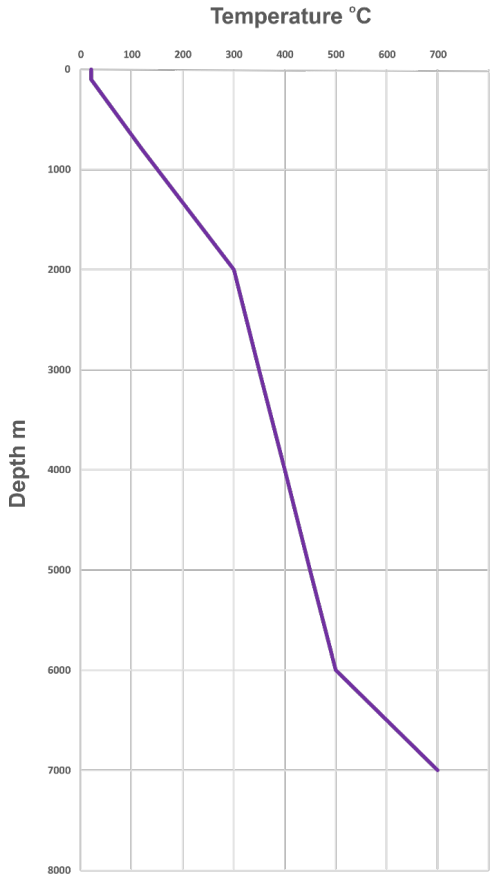
- **Explore**
  - Geology and Geophysics
- **Understand**
  - Geochemistry
- **Integrate**
  - Work out the steps to realisation
    - Strategy
  - Approach
  - Communication



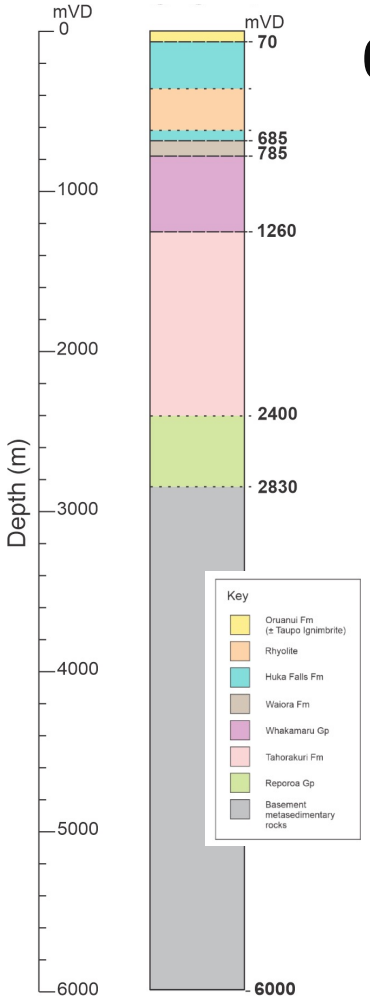
Paper 64 - Discusses

- **Developing a strategic approach to understanding NZ's supercritical geothermal opportunity**
- **Geoscience to locate exploratory drilling targets**
- **Preparatory and pre-planning work for drilling a supercritical exploration well**
  - Well prognoses for two wells (discussed later in this presentation)
  - Preliminary Well design
- **Regulatory Planning Aspects / Consents for exploratory drilling**
- **Surface plant for energy transformation**

6 km Deep Well - accessing > 400 C



- **Approach**
  - A good way forward is to plan / design
  - Identifies issues to resolve
- **GNS has prepared two 6 km well prognoses**
  - One temperature profile shown
- **Access the report - download via the QR**



6 km Deep Well - accessing > 400 C

- **Taupō Volcanic Zone Geology**
  - 2000 – 3000 m of volcanic sequence
  - Metasedimentary beneath
- **Fluid Geochemistry**
  - Likely less mineralised than currently encountered at lower temperatures (<350C)
  - Species solubility changes with Phase change
  - Chemistry and phase change issues important to understand for plant longevity and process reliability
- **Reservoir Engineering**
  - A range of challenges
  - Temperatures and pressures require tool development

6 km Deep Well - accessing > 400 C

- **Well Testing**
  - At
    - WHP of 250 bar (plus)
    - and temperatures of 400 C
  - What equipment is needed ?
  - What residual fluids need to be managed ?
    - Is the discharge just superheated vapour once at atmospheric pressure
- **Surface Plant**
  - What does this look like
  - How best to make use of the higher pressures and temperatures

Targeting

- 6km well to be drilled by 2032
- Possible ?
- Time now to accelerate investment

Stay Connected – keep watch

- **GNG Web site**
- **Social Media Connections**
  - Facebook
  - LinkedIn

Participative Opportunities

geothermalnextgeneration@gns.cri.nz

- **Advise your interest**
  - Geoscientific Research
  - Financing / investment
  - Well Drilling
  - Reservoir Engineering
  - Down Hole tools
  - Surface Plant
- **Keep watch**
- **Opportunities are here now to get involved**

Participative Opportunity

- **Ultra Hot – Supercritical Geothermal Symposium Series**
  - Mid this month
- **Three Webinars**
  - Modelling
  - Geochemistry
  - Smorgasboard

Modelling		
LBNL	Pat Dobson	Review of conceptual models of supercritical systems
ETH	Thomas Driesner	Numerical modelling of magma-driven geothermal systems, including their supercritical parts
ETH	Alina Yapparova	Modelling supercritical resource utilization
ETH	Benoit Lamy-Chappuis	Advanced well models for supercritical reservoir modeling
LBNL	Eric Sonnethenal	Reactive-transport modeling of high-temperature/supercritical magma-hydrothermal systems.
GNS	John Burnell	Flows from supercritical wells, what can we expect?
UoI	Samuel Scott	Modeling the power generation potential of EGS at 15-20 km depth
AIST	Norihiro Watanabe	Current approach and limitations to model supercritical geothermal systems from MT survey in NE Japan
Geochemistry		
ETH	Thomas Driesner	Review of the status of thermodynamic modeling of supercritical chemistry
GNS	Peter Rendel	Supercritical Water-NZ Basement Rock interaction
GNS	Bruce Mountain	Supercritical Water-Basalt interaction
GNS	Isabelle Chambefort	Supercritical geothermal exploration in New Zealand: Understanding the magmatic-hydrothermal conditions of the Taupo Volca Zone
UoI	Andri Stefánsson	Fingerprinting the signals of deep and supercritical fluids using second generation of geothermometry
UoI	Andri Stefánsson	Thermodynamic modelling and experiments of supercritical fluid chemistry – crossing T-P-h "boundaries"
AIST	Norio Yanagisawa	Estimation of Geochemistry and Material Corrosion for Supercritical Geothermal Development
Other		
ETH	Thomas Driesner	Permeability of porous and fractured media at "supercritical" resource conditions
NREL	Amanda Kolker	Exploration for superhot geothermal resources
ENEL	Geoffrey Giudetti	Drilling experience and methodology in superhot system: the DESCRAMBLE project in Larderello.
IDDP	Gudmundur Omar Fridleifsson, Wilfred A. Elders, and Robert A. Zierenberg	The Iceland Deep Drilling Project, lessons learned, and next steps towards commercialisation
RE	Vala Hjörleifsdóttir and Gunnar Gunnarsson	IDDP-3: Reaching into the resource below.
Georg	Hjalti Páll Ingólfsson and John Eichelberger	Drilling into Magma and the KMT project
CICESE	Zayre Ivonne González Acevedo	Importance of Social Informed Communication to the Acceptance of Geothermal Project
GNS	Chris Bromley	Global perspective on sharing lessons learnt and mitigating environmental risks of future supercritical development strategies
UNSW	Klaus Regenauer-Lieb	Hybrid Analytical-Numerical-Experimental Laboratory Testing needed to Advance Supercritical Geotherm

International Partnership for Geothermal Technology

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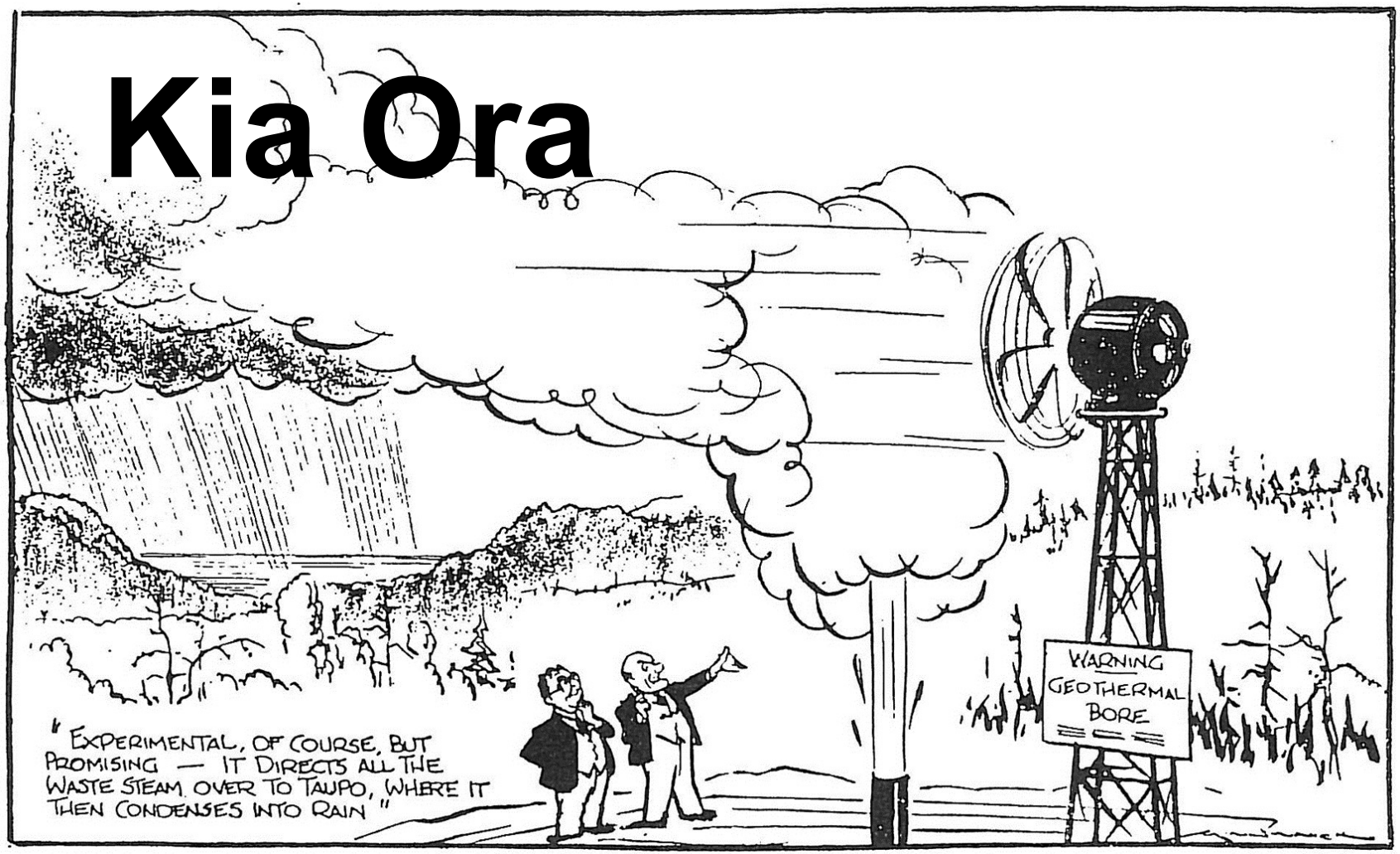
IEA Geothermal

Ultra Hot – Supercritical Symposium Series

- **Webinars**
- **Three x 3 hour sessions**
  - 15th, 16th and 17th February (NZ time)
- **Access the programme and register for each event through this web page**

Kia Ora


"EXPERIMENTAL, OF COURSE, BUT PROMISING — IT DIRECTS ALL THE WASTE STEAM OVER TO TAUPO, WHERE IT THEN CONDENSES INTO RAIN"
WARNING GEOTHERMAL BORE