GEOTHERMAL
THE NEXT
GENERATION

# Supercritical Geothermal

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IAPWS Symposium Rotorua

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# Kia ora koutou katoa

## Greetings and welcome

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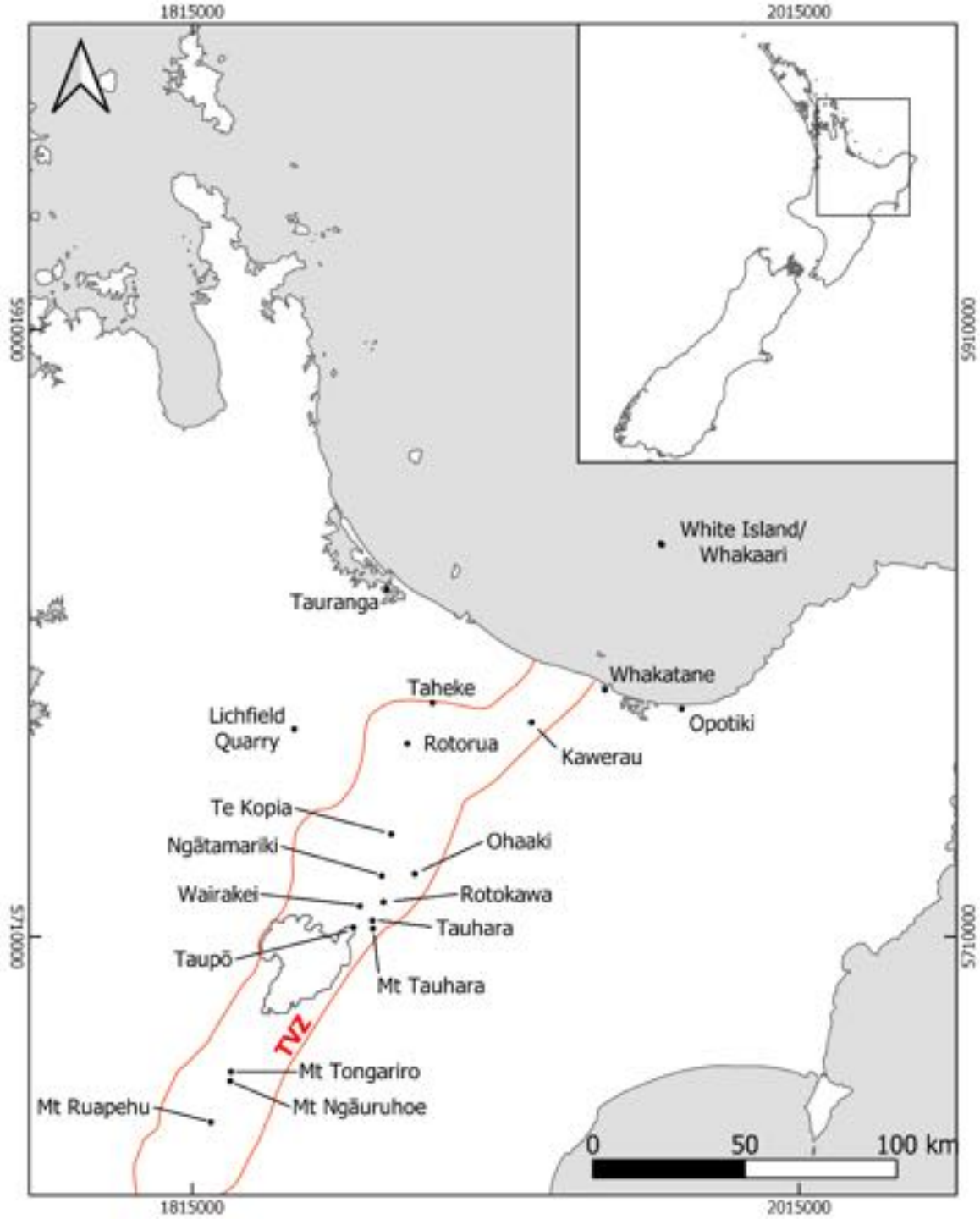
# Assisting Today at the Symposium

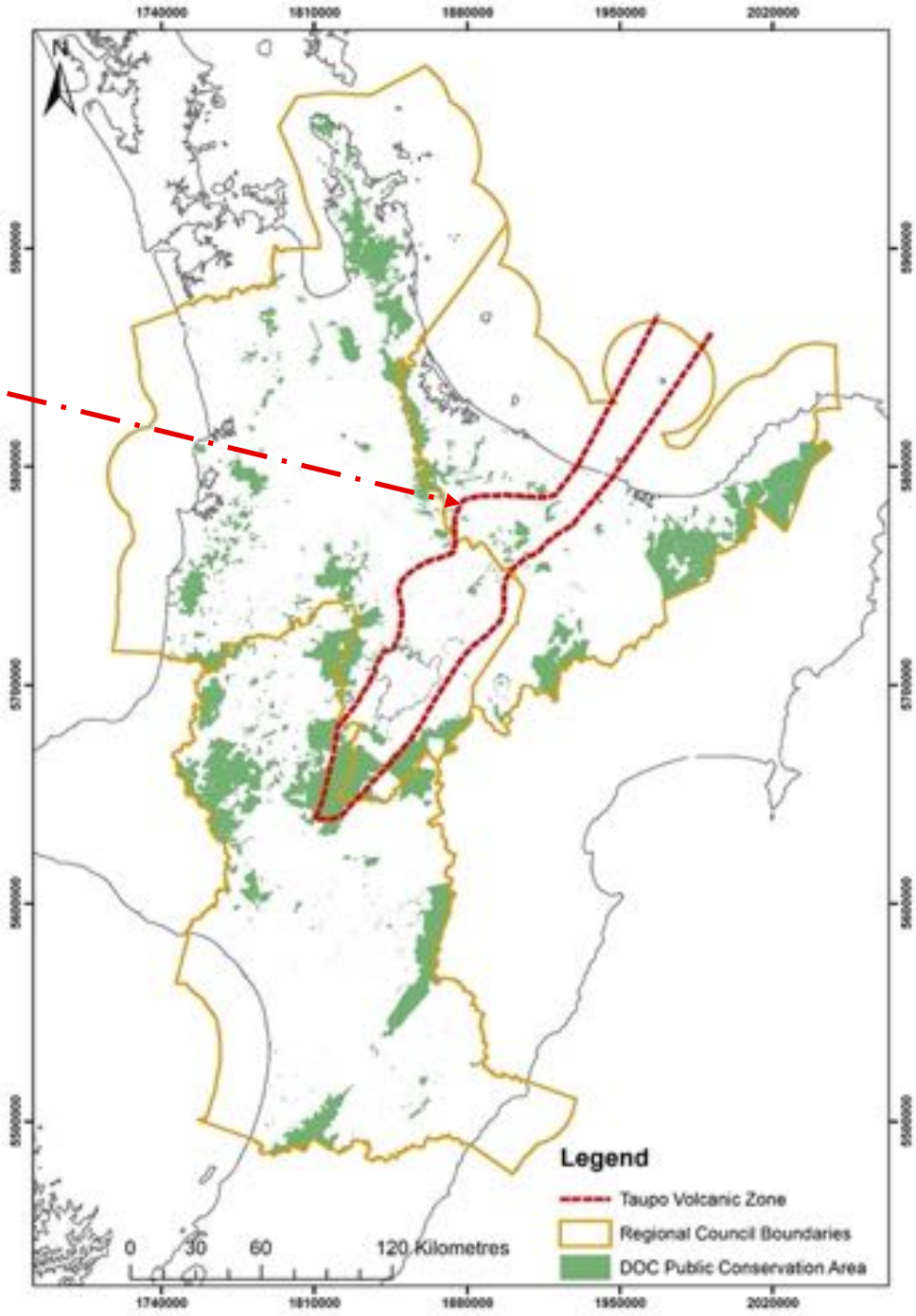
- Bruce Mountain
- Peter Rendel
- John Burnell
- Warwick Kissling
- Julius Rivera
- Others have sent video presentations

# Some of the places we are talking about today



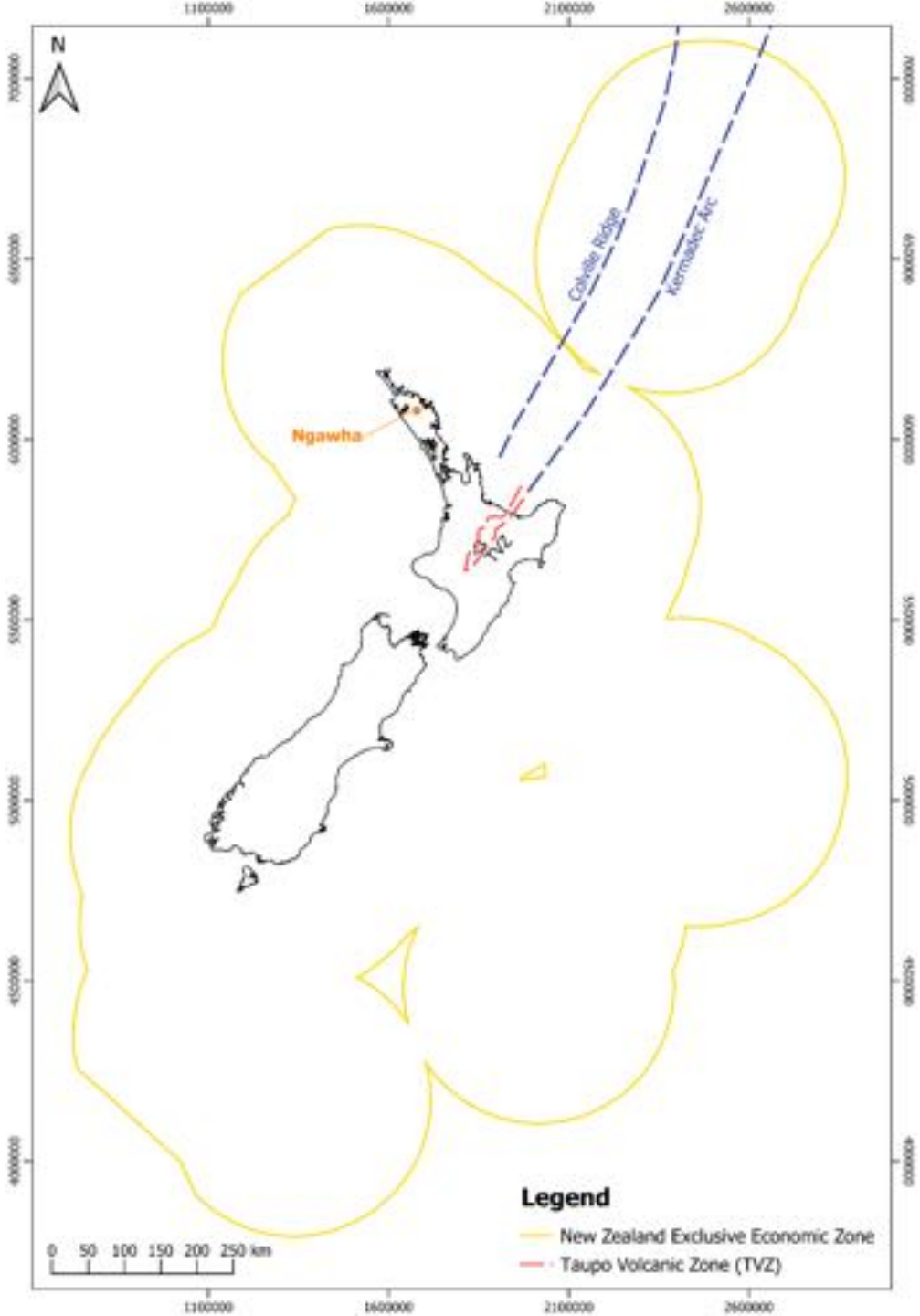
# Where and What is this

- Geothermal deeper down in the Taupō Volcanic Zone
  - 4 to 10 km
- Looking for Temperatures > 400 C
  - Where the rocks are becoming more ductile
    - Closer to where they are mushy
- Are these opportunities for:
  - Expansion of existing geothermal operations
  - Accessing entirely new resources
  - More efficient heat to work transformation

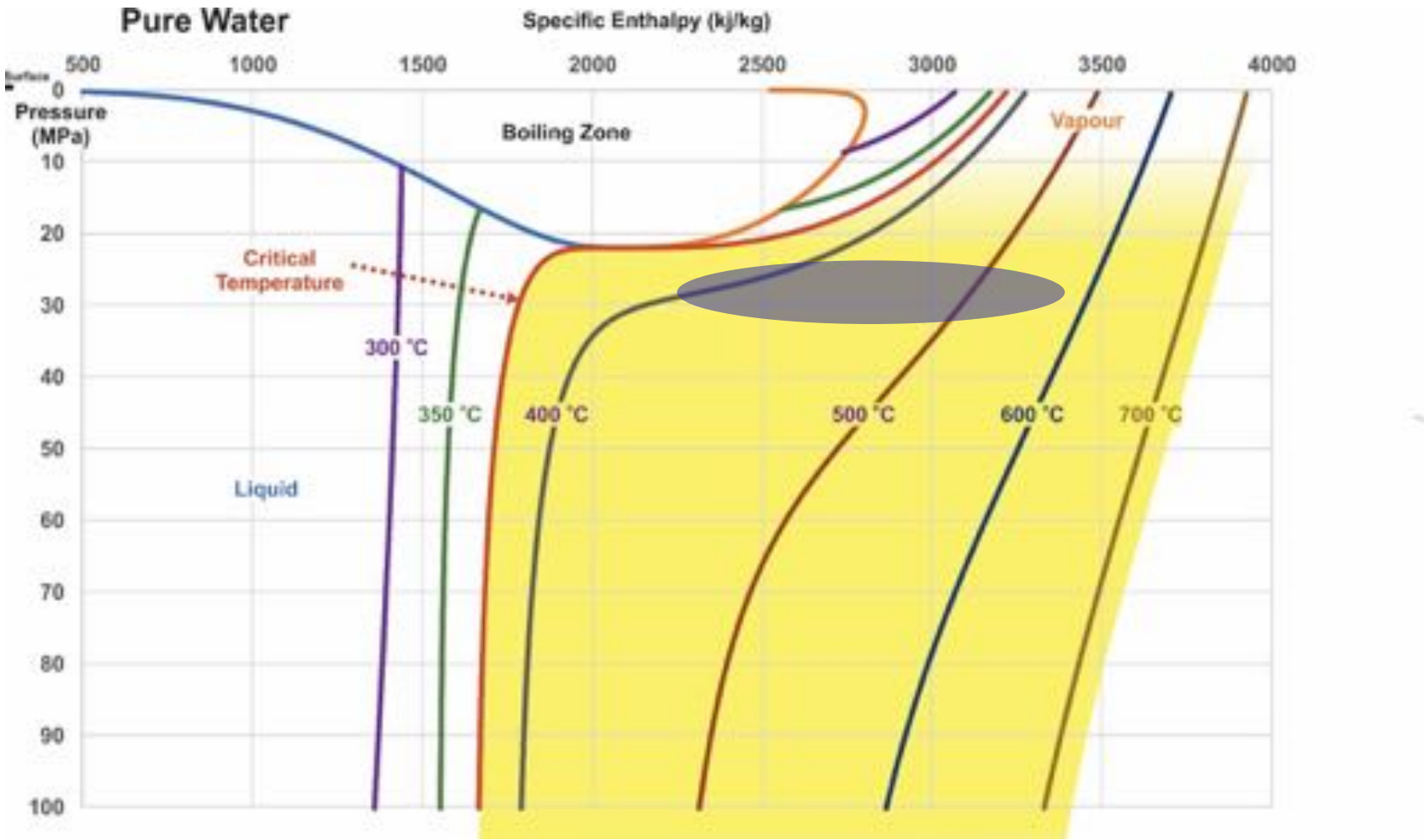


# And other locations

- 30 plus volcanoes on the Kermadec Arc
- Ngawha



# In situ fluid in the supercritical / ultra hot state



# GEOTHERMAL THE NEXT GENERATION

- Scientific Research
- MBIE Endeavour Funded research
  - Contract C05X1904
- 5 year Programme
  - Completion October 2024
- Published outputs along the way
  - www.geothermalnextgeneration.com
  - Updates tab
  - Knowledge tab

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- Programme lead
- Isabelle Chambefort
- i.chambefort@gns.cri.nz

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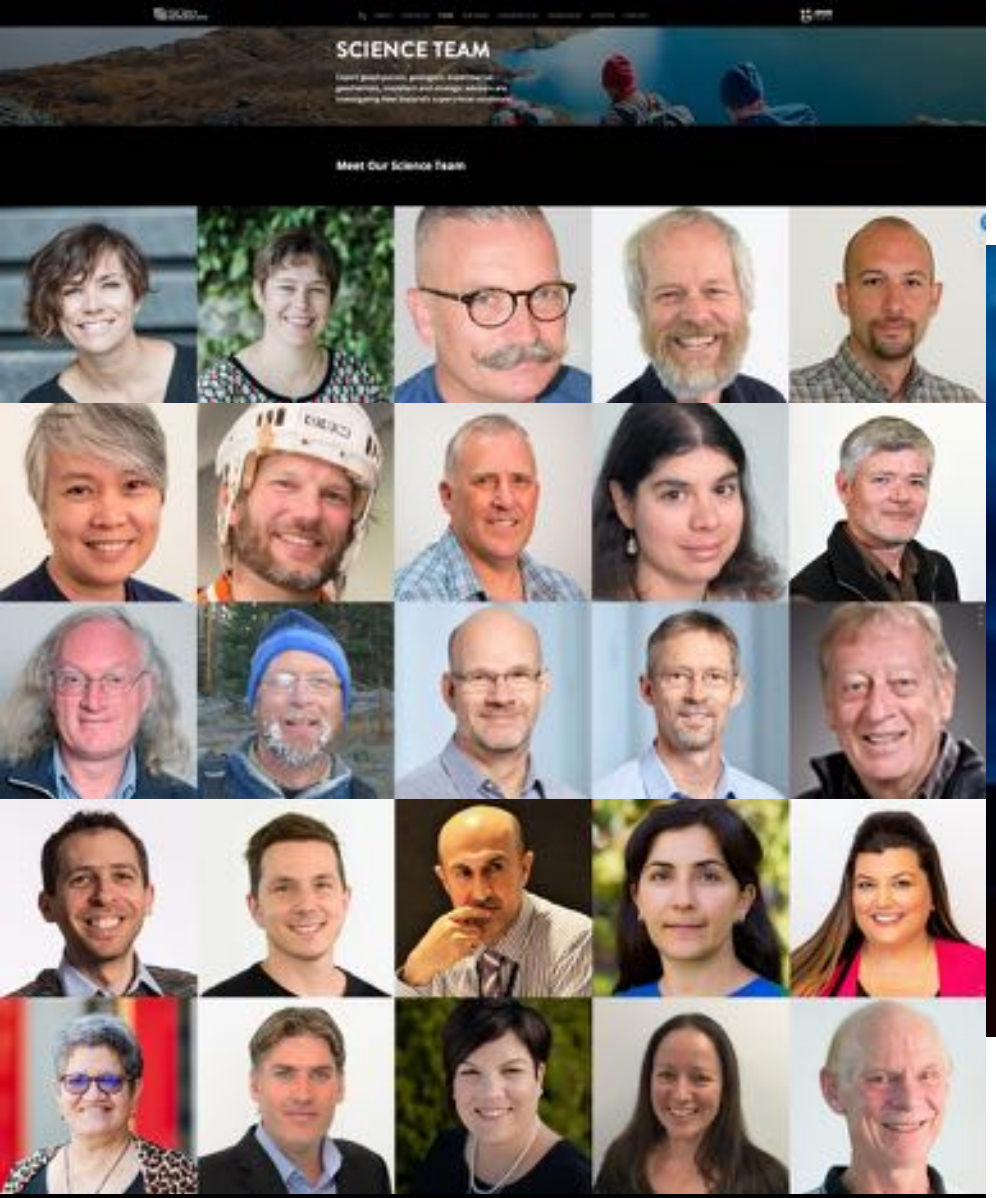


INCLUDES STUDENT THESIS WORK AT MASTERS AND PHD LEVEL

# GEOTHERMAL THE NEXT GENERATION

**Explore** for future geothermal resources

**Understand** thermochemistry of supercritical resources

**Integrate** And translate knowledge

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Upflow

traverse

THE UNIVERSITY OF AUCKLAND

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

ETH zürich

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# EXPLORE

## Geophysics and geology

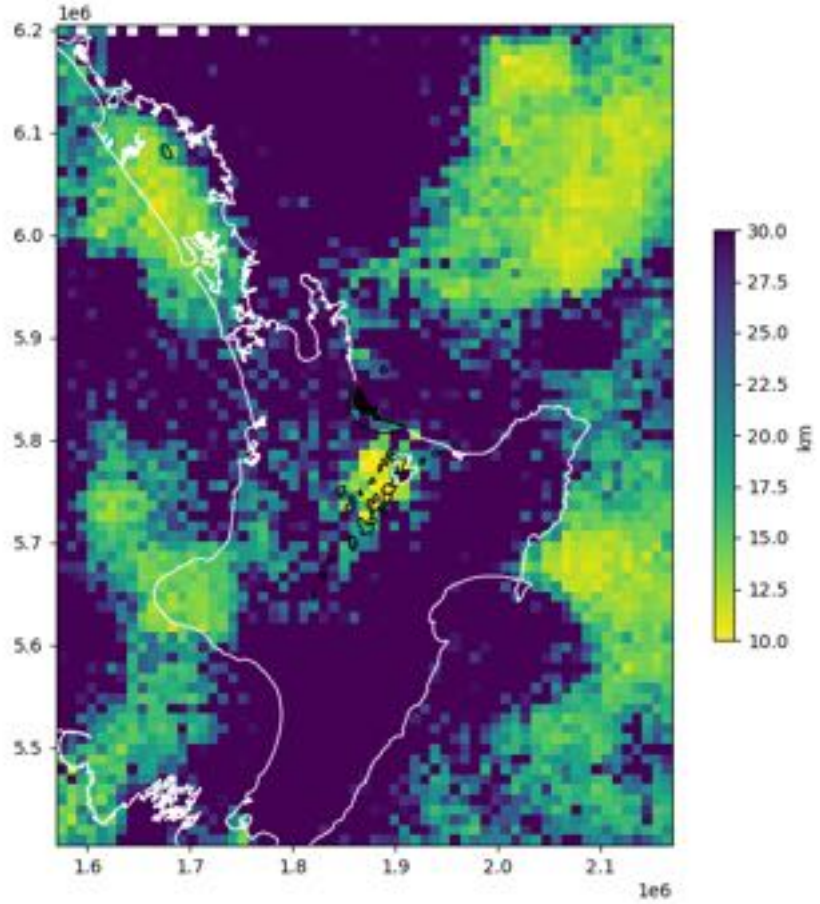
Understanding the role of buried structures

Defining targets for exploratory drilling

# Explore

Craig Miller

# Rocks loose magnetic properties at ~580 °C



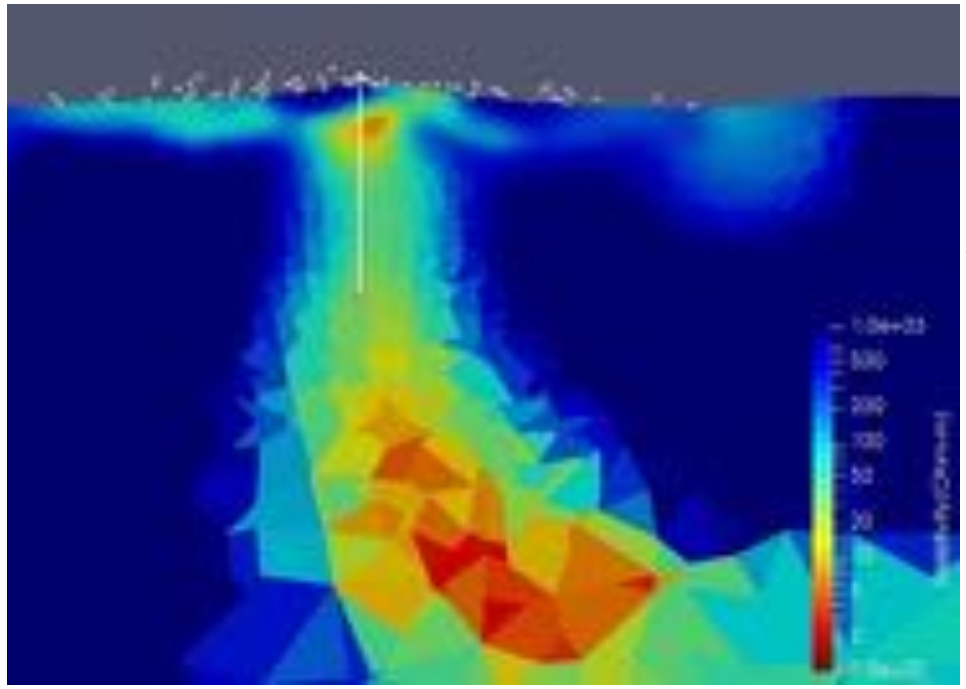

Magnetic

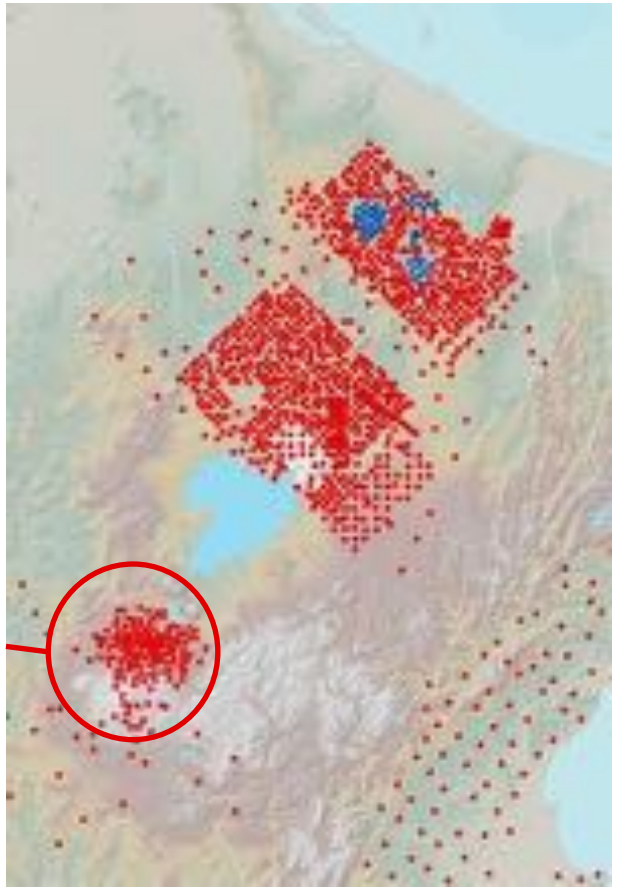
# Magnetotellurics

Ted Bertrand

# Magnetotellurics

Uses natural magnetic and electric signals



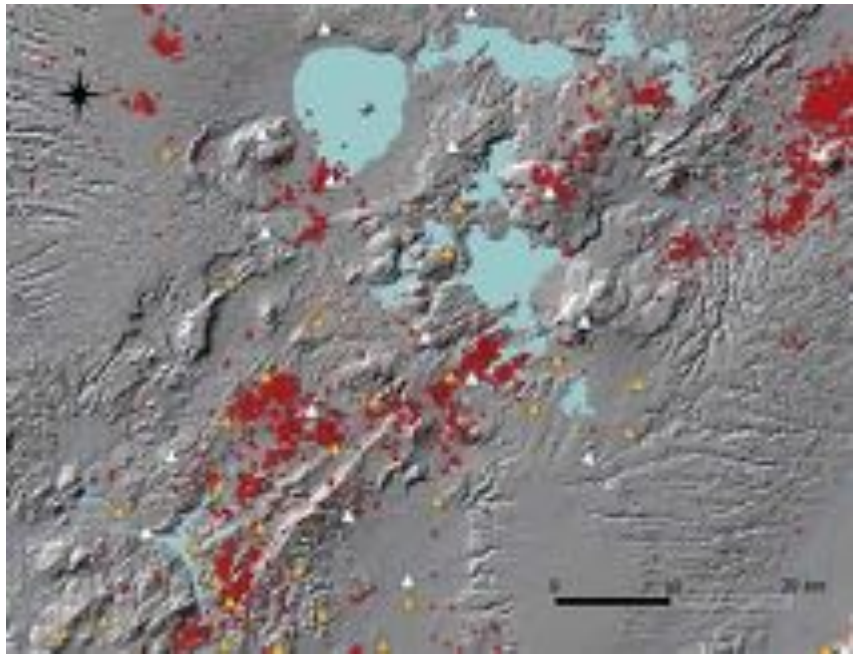


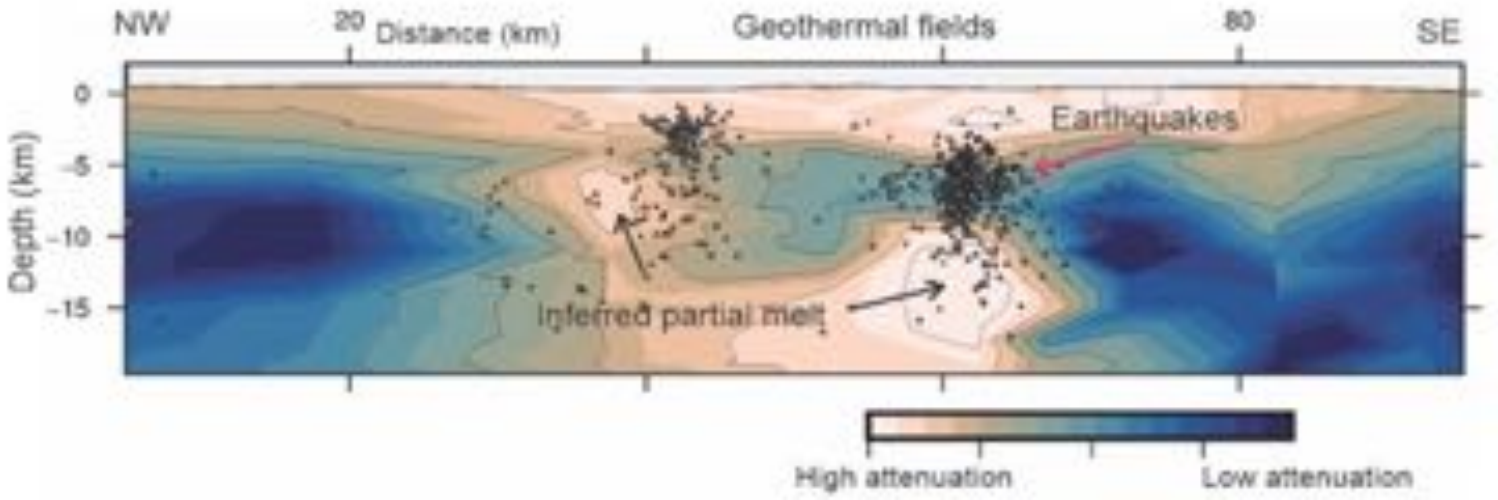
# Seismic Attenuation

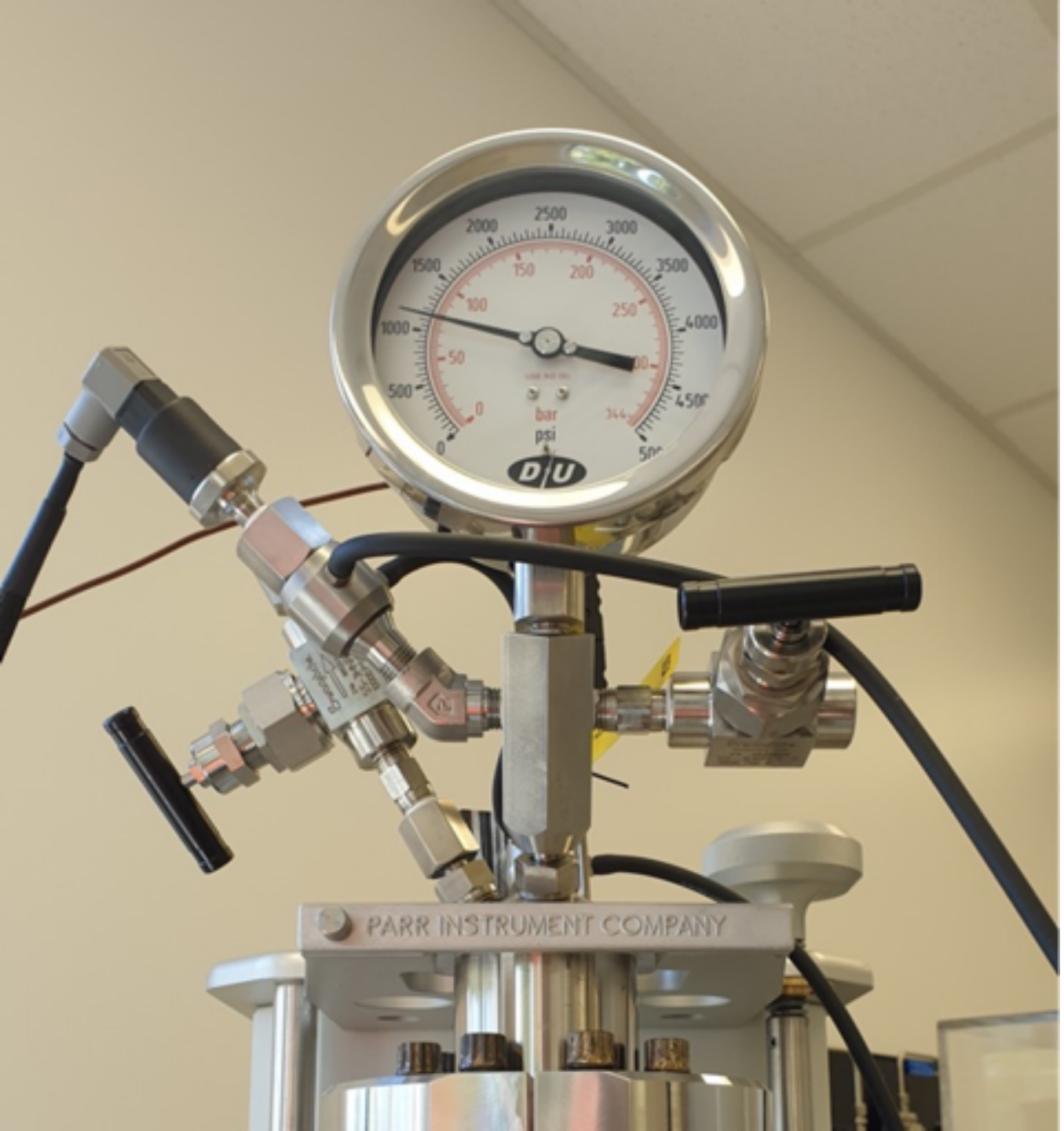
Stephen Bannister

# Seismic Attenuation

Solid





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## UNDERSTAND

### Geochemistry

Understanding the interactions between fluids and rock at high temperature and pressure

Develop fundamental species relationships

Model geochemical reactions

Effect of reinjection into supercritical conditions

# Bruce Mountain

- After lunch presentation
- Along with Peter Rendel

# Geochemists will cover

- GNS Science experimental equipment for Supercritical conditions
- Fluid rock interaction experiments at Supercritical conditions
  - Basalt
  - Water, brine and seawater
- Quartz solubility experiments
  - 375 - 600 $^{o}$C and 200 – 300 bar

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## INTEGRATE

# Integrate

- Integration of Activities
- Developing a strategic approach to NZ's ultra-hot geothermal
- Communication
  - Stakeholder Engagement
  - International Engagement
- Regulatory Planning Aspects
  - Participating in NZ Resource Management Reform
  - Consenting requirements for exploratory drilling
- National Supercritical Inventory and some modelling talks this afternoon
  - Chris Bromley, John Burnell, Warwick Kissling and Julius Rivera.
- Preparatory and pre-planning work for drilling a deep exploratory well
    - Well prognoses for two wells
    - Some Preliminary Well design

# Communication

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

# International

- GNG International Advisory Group

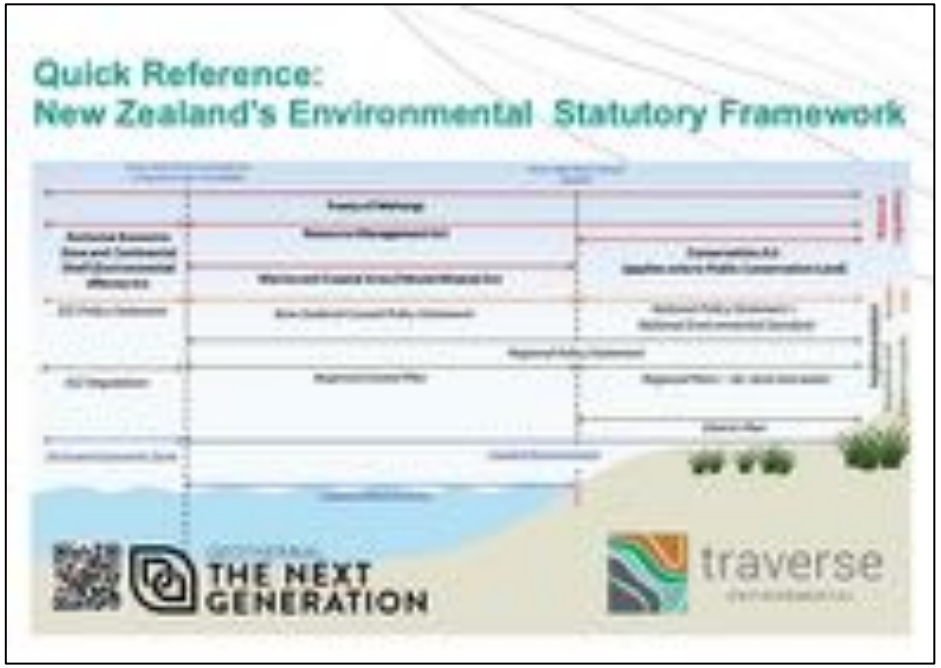
- Strong connections with IEA Geothermal
- Deep Roots of Geothermal Systems - Working Group 12
  - Chris Bromley will introduce more on this after the afternoon break.

IEA Geothermal

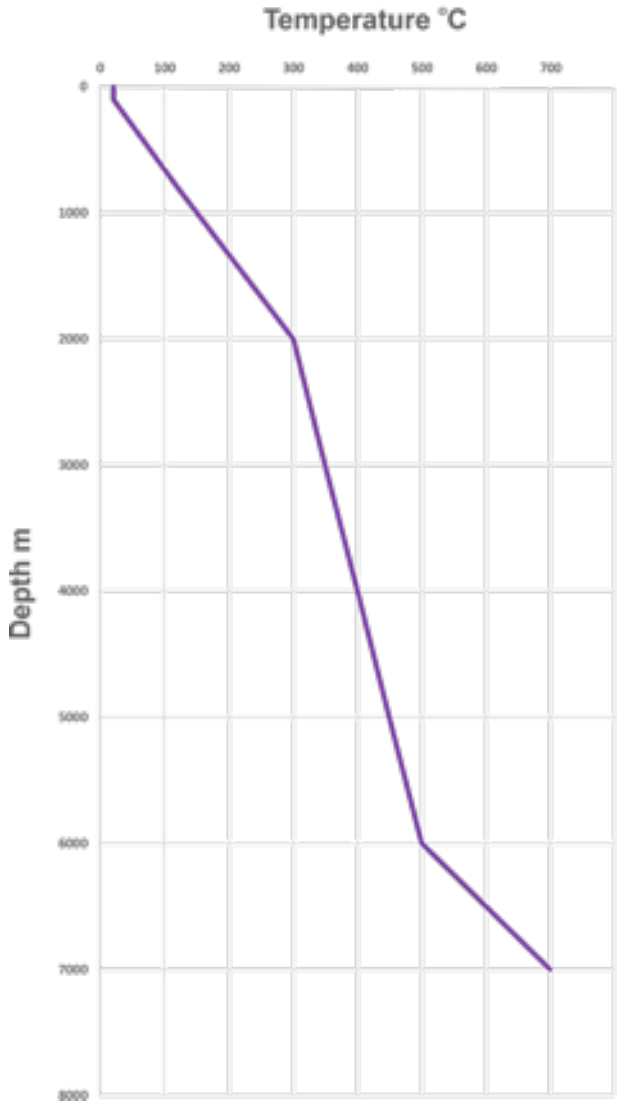
c.bromley@gns.cri.nz

# NZ Regulatory Planning

- Focus is
  - Seeking to ensure NZ's SC opportunity can be accessed at the right time
- Reports
    - Overview
    - Consents required for a 6 km exploratory well (in prep)
- Papers
    - NZGW 2020, 2022
    - WGC 2023

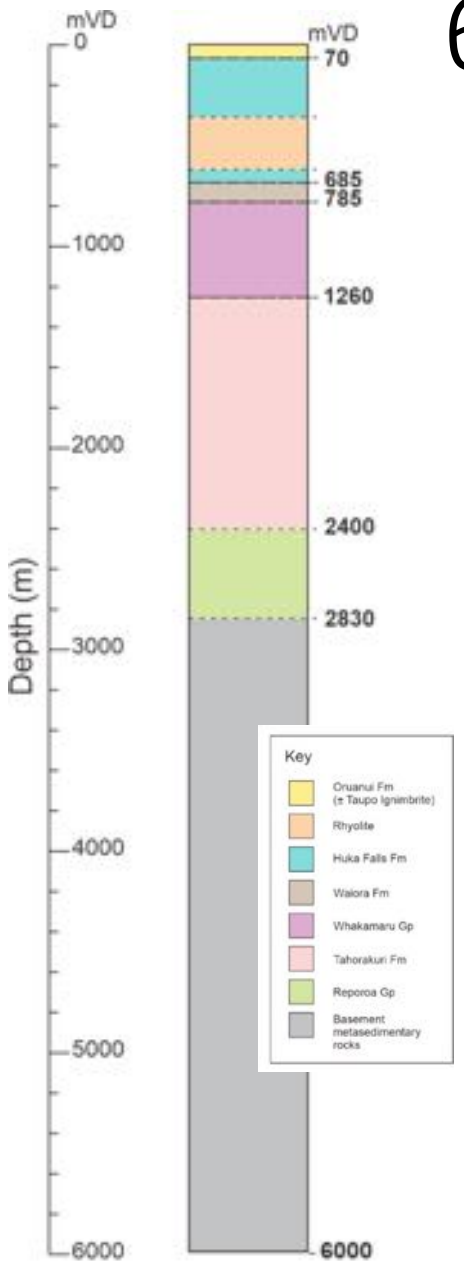



# GNS Preparatory - 6 km Exploratory Well




- GNS has prepared two 6 km well prognoses
  - One temperature profile shown
- Access the report and a 2021 presentation video

# 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 (<340C)
  - 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

# Surface Technology

- Higher temperatures open the opportunity to have more efficient processes
  - What fluid state is likely at the surface ?
    - Presentation later in the day – Julius Rivera
- How to make use of the fluids once produced ?
  - Fluid chemistry will be instrumental in process choices
    - Oxygen is not expected to be present in the native fluids
    - And what species are will be better understood from the exploratory / testing activity.
  - Higher operating temperature binary plant?
  - What sort of pre-processing might be required ?
  - Talk later today

# Next steps - Exploratory Drilling

- A 6km well to be drilled by 2032 ?
- Research and studies
    - Geoscience
        - What might be useful ahead of actually accessing ultrahot geothermal fluids ?
    - More engineering is needed
    - Location identification
    - Land Access
    - Consents to facilitate drilling
- How to finance
    - Consortium ?

# But what is the real driver …

- Tectonic and Volcanic Activity
- Geoff Kilgour - GNS Volcanologist
- Presentation on Drivers of geothermal systems in New Zealand

View this presentation

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# EXPLORE

## Geophysics and geology

Understanding the role of buried structures

Defining targets for exploratory drilling

# Explore

## Craig Miller

Presentation Pdf

View this presentation

# Magnetotellurics

## Ted Bertrand

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# Seismic Attenuation

## Stephen Bannister

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# Concludes – Session 1