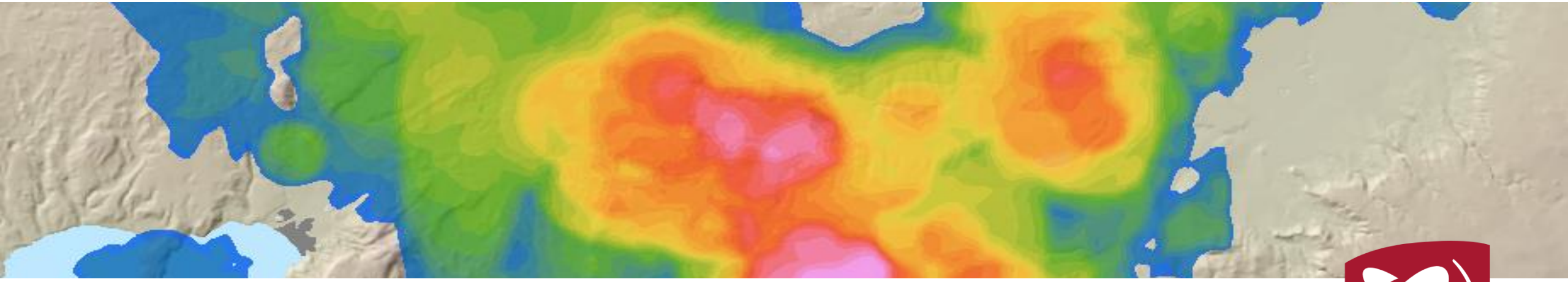
Critical minerals research in Aotearoa New Zealand

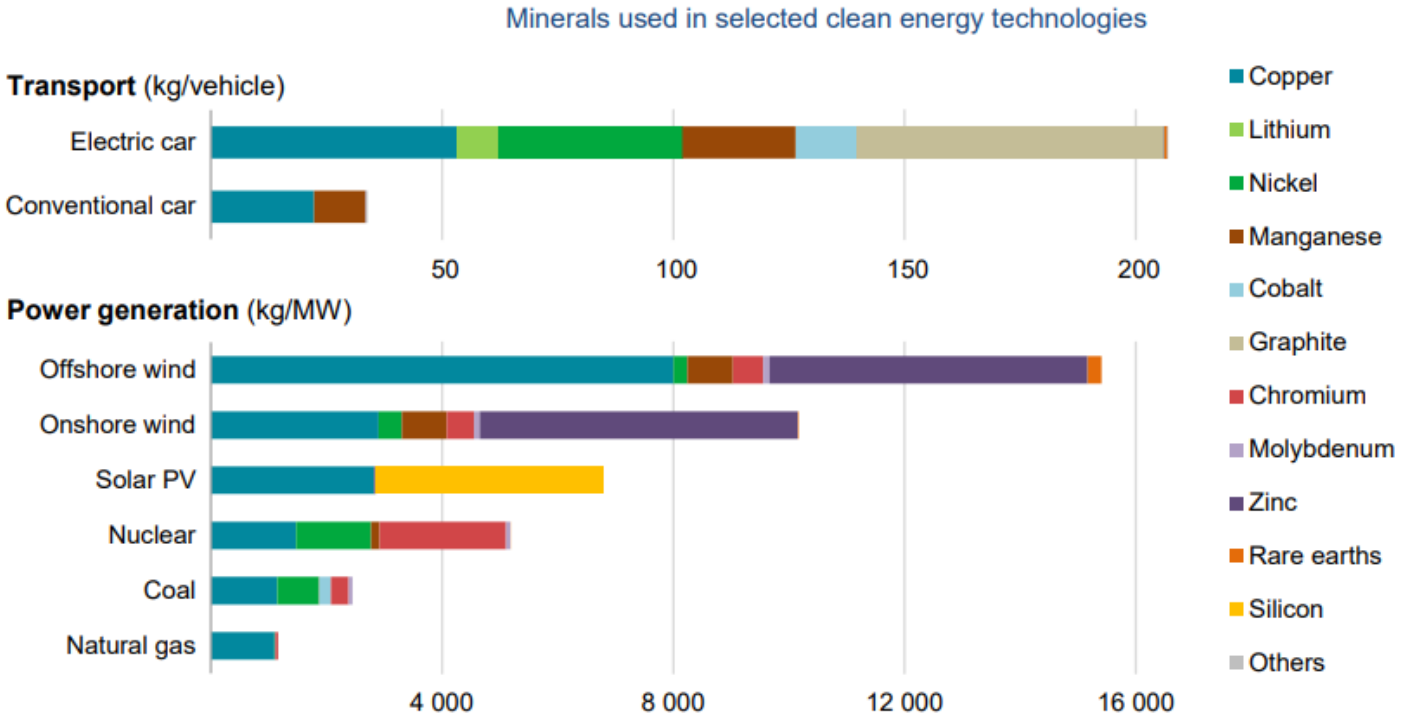


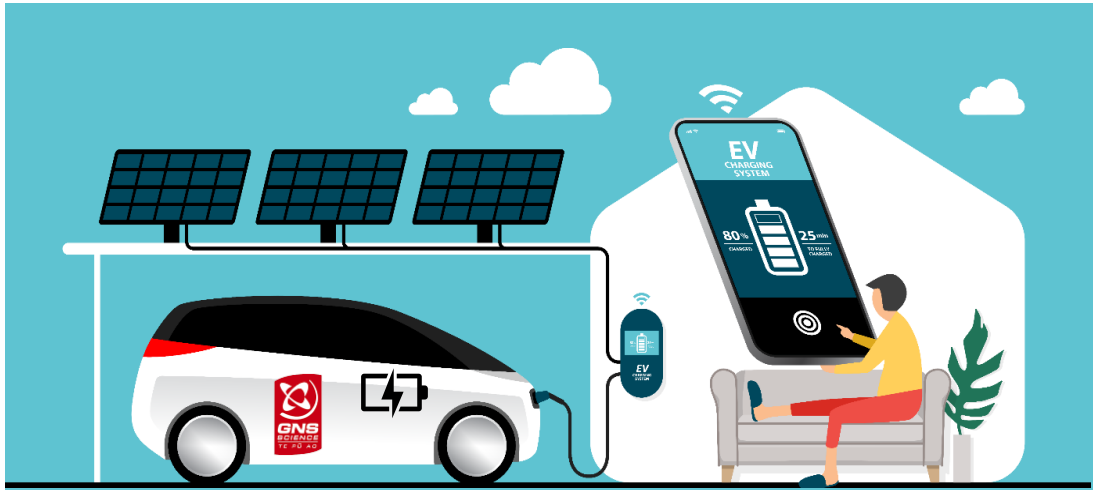
AusIMM 2023, Christchurch, New Zealand

Rose Turnbull, **Matthew Hill**, Regine Morgenstern, Lucjan Sajkowski

Critical minerals and the road to net zero 2050

Clean-tech requires a significant increase in demand for minerals

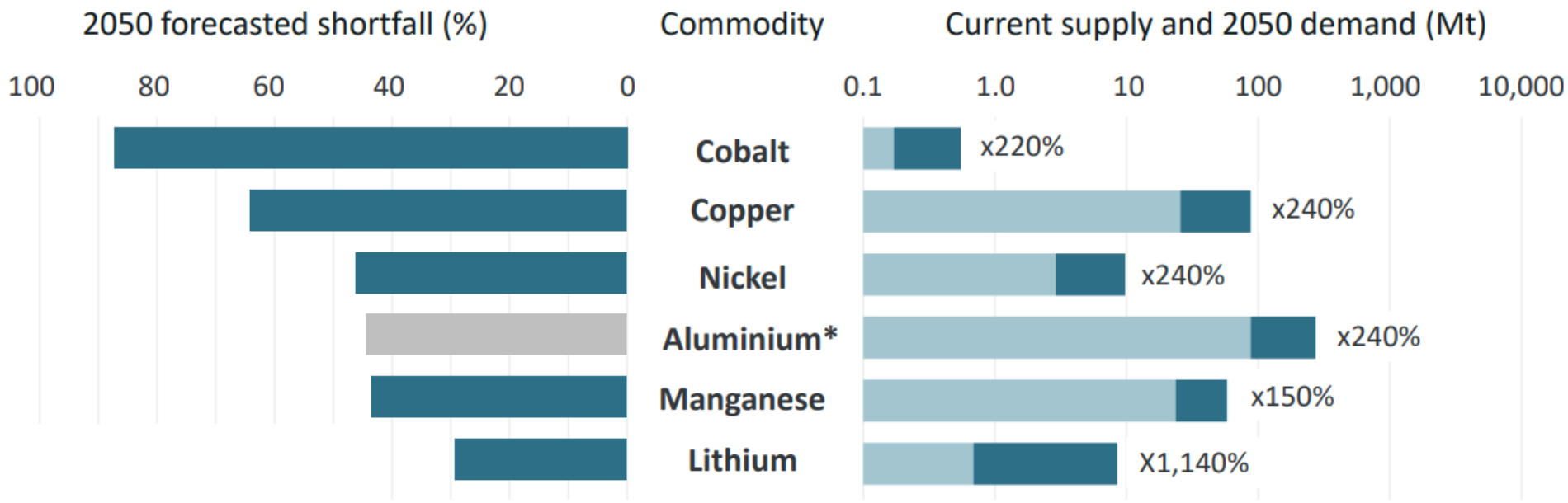




Critical minerals and the road to net zero 2050

Metal recycling will play an important role BUT – predicted demand by 2050 will far exceed current supply

Forecast global resources demand and shortfalls under a net zero scenario



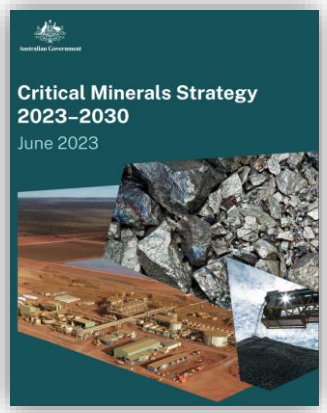
We cannot have a clean-tech low carbon future without mining

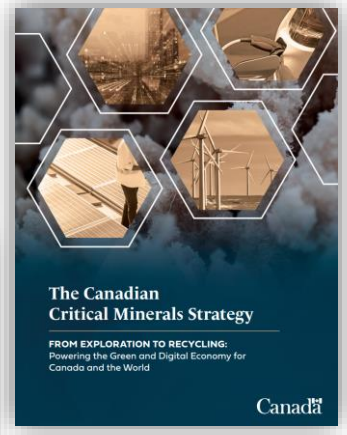
Sources: IEA 2021; Geoscience Australia 2023 *Resourcing net zero*

What are we doing in New Zealand

- No published list of what NZ considers are ‘critical minerals’
- Government / industry focus on electrification of the energy & transport sectors (great!)

  …but reliant on importation of all critical minerals / clean-tech to support this (not so great).





Are we missing an opportunity?

- Lots of water, clean electricity (>80% renewable)
- Strong regulatory controls

NZ needs critical minerals plan - Straterra

Colin Williscroft - Thu, 27 Oct 2022

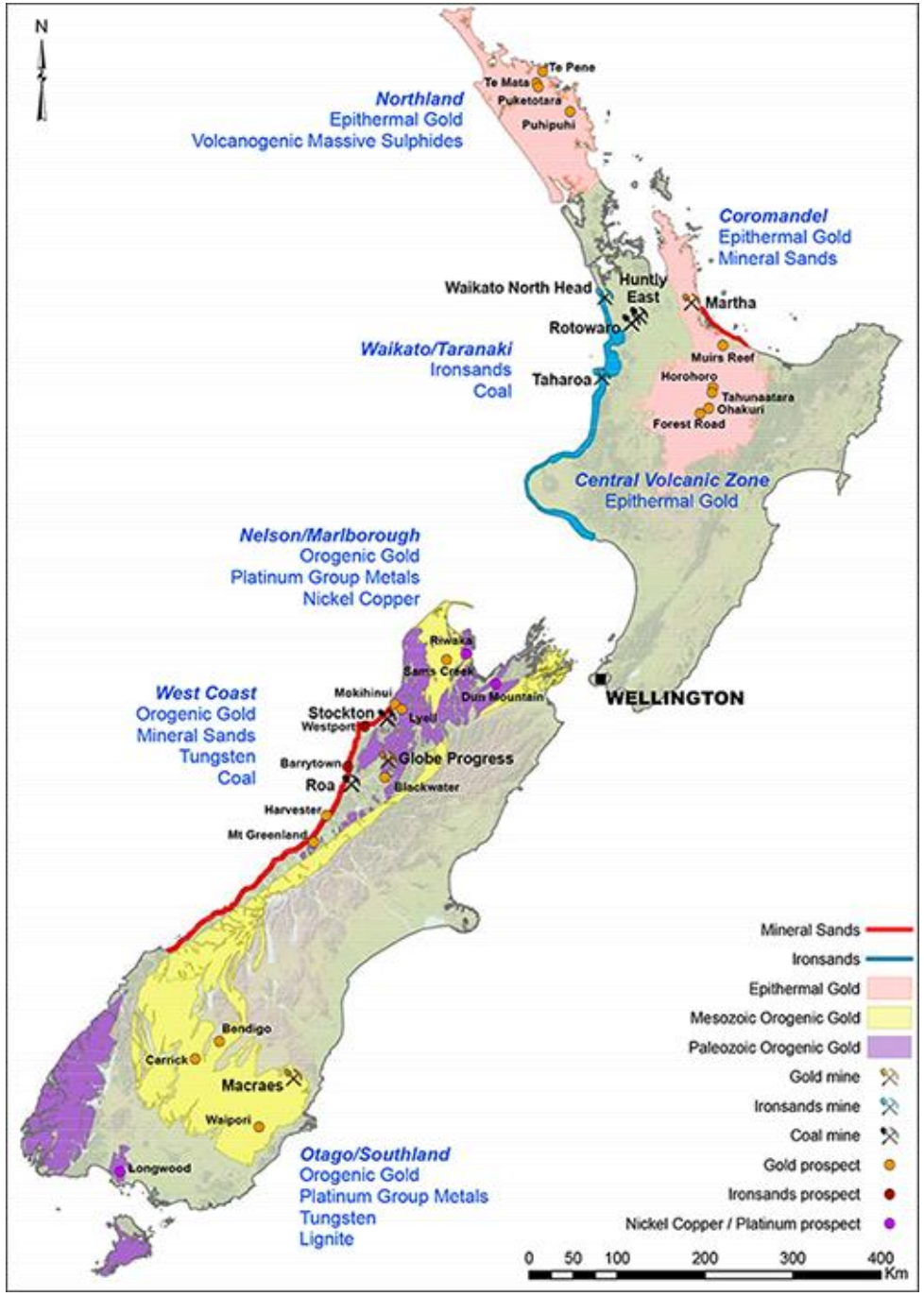
New Zealand is falling behind Australia as it plans for a low emissions future, Straterra chief executive Josie Vidal says.

INSIDE RESOURCES
MINING AND QUARRYING INTELLIGENCE

Potential for NZ to be an ethical and sustainable supplier of critical minerals?

Critical minerals scene in New Zealand

- Minerals mining restricted to a handful of regions
- But, historical mining for:
  - Cu, W, Cr, Sn
- Mineral exploration for a range of other commodities = potential for many more minerals to be discovered and extracted
  - Mineral sands (garnet, REE)
  - Lithium in clays
  - Tungsten by-product of orogenic Au
  - Silica-sands



Critical Minerals research at GNS Science

- National critical minerals studies (2018)
- A follow-up TVZ lithium study (2019)
- Determining the concentration of clean-tech elements in geothermal fluids, and their life cycle (2022-23)
- Research on public perceptions and management of critical mineral resources within New Zealand (2022)
- Assessment of NZ's copper resource potential (2022-23)
- Pluton Map project (2019-25)
- Aggregate opportunity modelling - aggregate for domestic infrastructure and for carbon capture (2018-2024).

MR5543 - Rare Earth Element Mineral Potential in New Zealand
MR5544 - Lithium Mineral Potential in New Zealand
MR5545 - Nickel and Cobalt Mineral Potential in New Zealand
MR5633 - Lithium mineral potential in the Taupo Volcanic Zone

Sajkowski, L. et al. 2023. A Review of Critical Element Concentrations in High Enthalpy Geothermal Fluids in New Zealand. https://doi.org/10.3390/resources12060068

Glassey PJ. et al. 2022
https://shop.gns.cri.nz/sr_2022-62-pdf/

Turnbull RE. et al. (2023)
https://shop.gns.cri.nz/sr_2022-43-pdf/

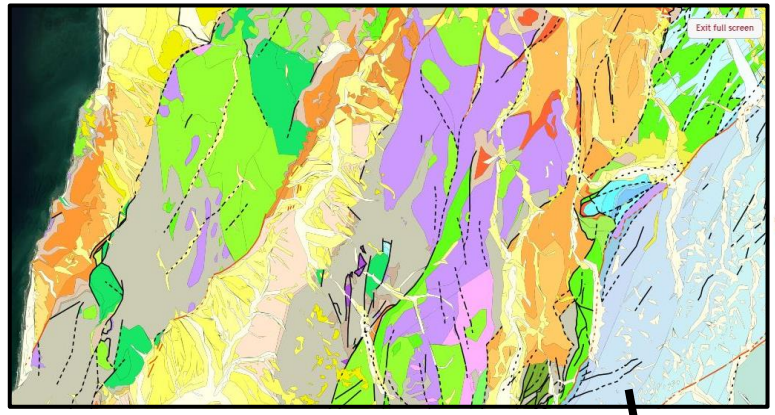
https://www.gns.cri.nz/research-projects/pluton-map-of-zealandia/

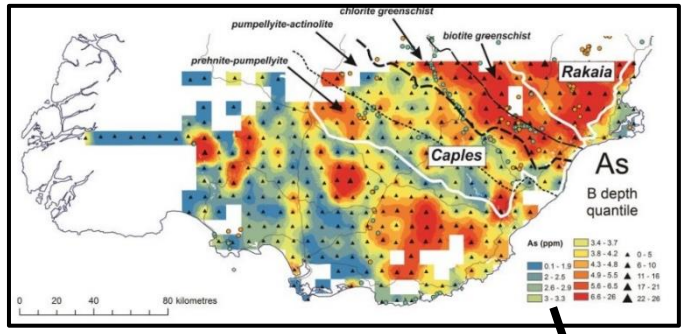
Hill MP. 2021. Aggregate Opportunity Modelling for New Zealand. 106 p. + maps and GIS. GNS Science Report 2021/10.

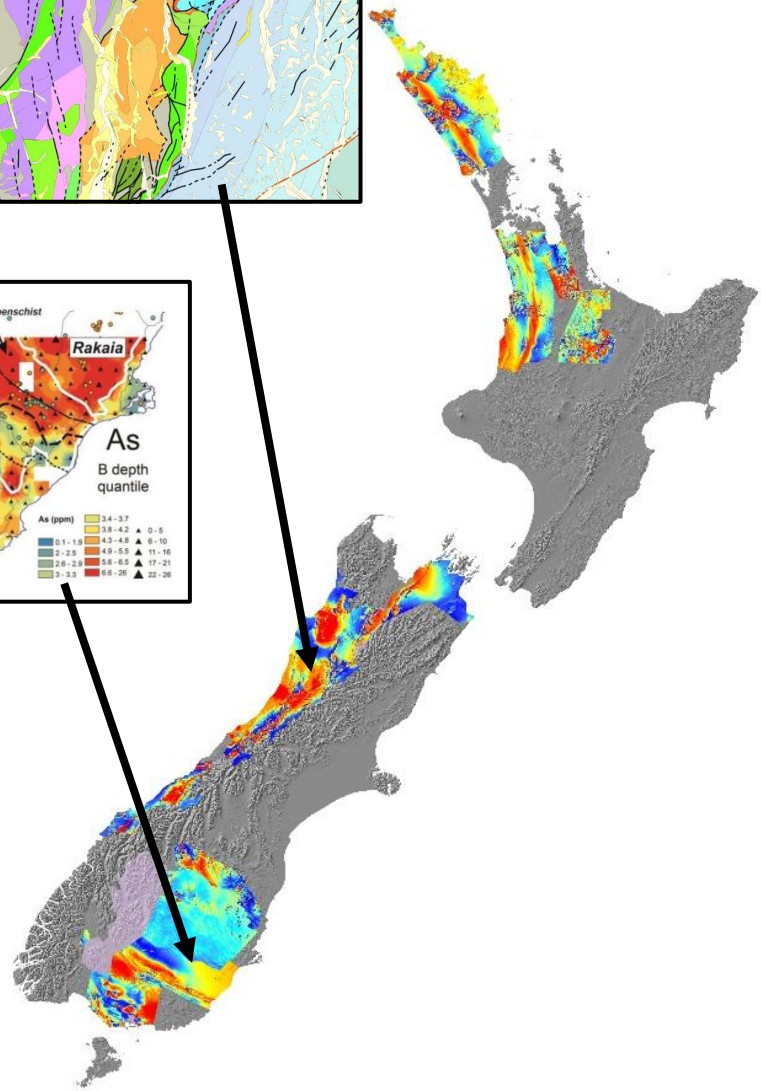
Digital data supporting research & industry

- New Zealand well placed to undertake mineral potential studies:
  - Regional geochemical soil surveys
  - Extensive airborne geophysical data
  - Critical mineral potential studies
  - 1:250,000 Geological maps
  - Pluton Map
  - Well resourced online geodatabases

- These data and studies are useful in that they provide the framework for undertaking similar studies on other minerals.
  - Definition of a ‘critical mineral’ will change with rapidly evolving technology.



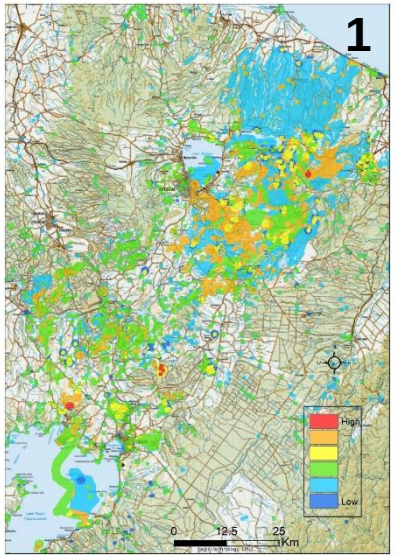


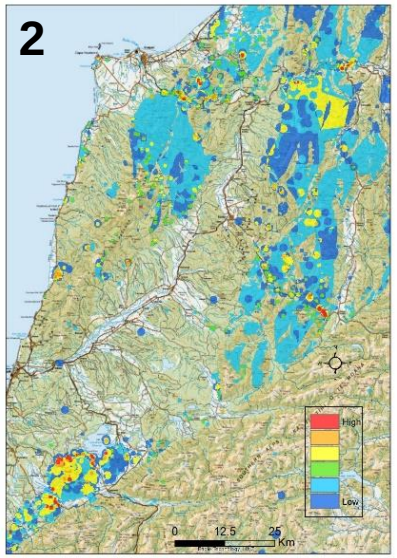


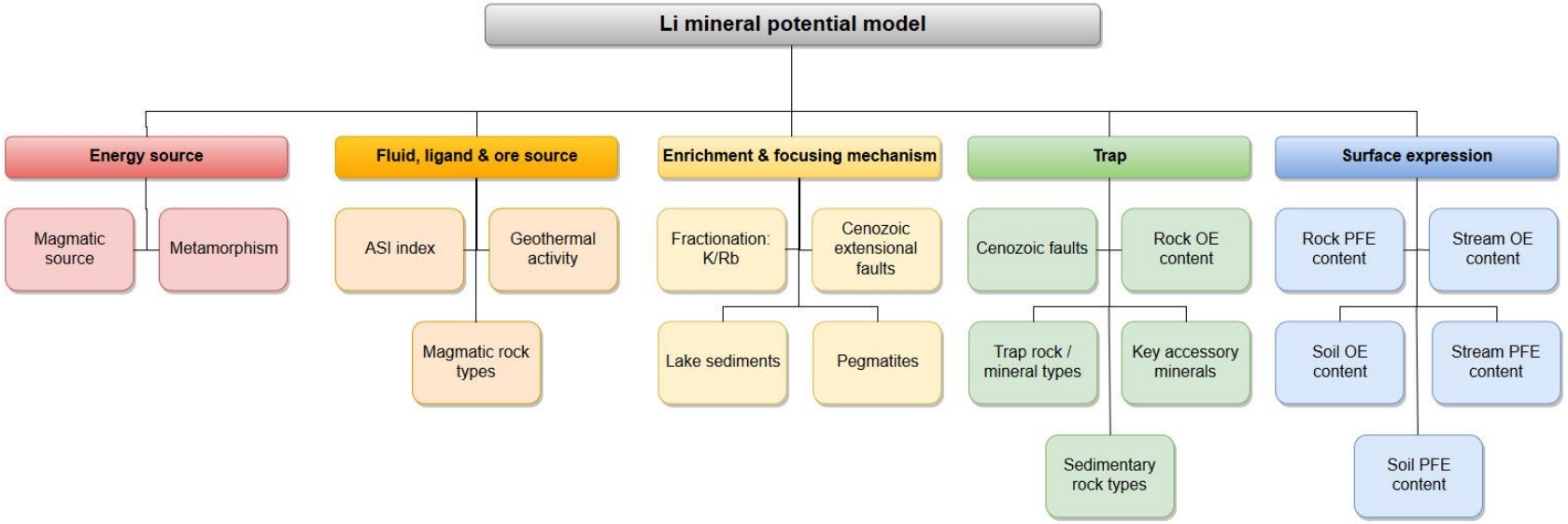
Mineral potential map for lithium

Most prospective districts:

1. Taupo Volcanic Zone (lake sediments)
2. Hohonu & Lyell ranges (pegmatites)

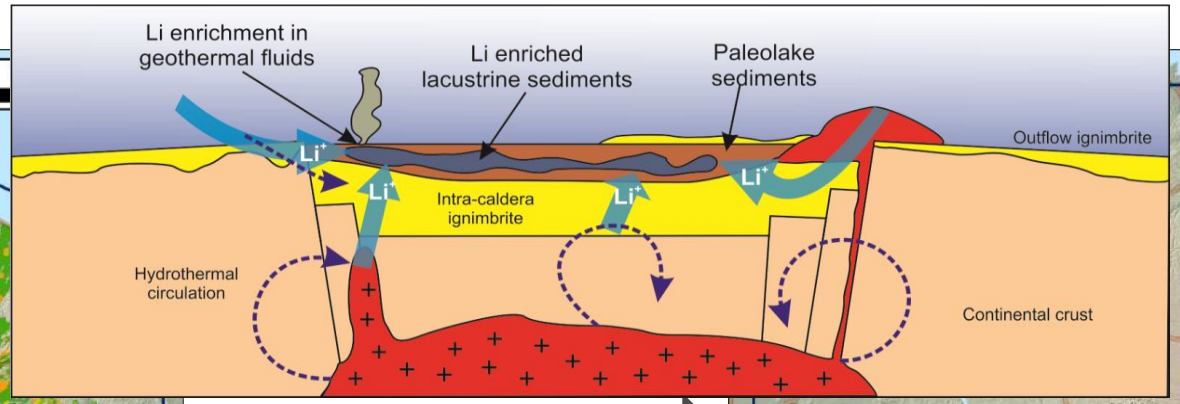






GIS-based, expert-weighted fuzzy logic spatial modelling approach was used to create the mineral potential maps

Source: Turnbull et al. 2018 Lithium mineral potential in New Zealand. GNS Science consultancy report 2018/63, 210p.



Increase in data and refined model:

- Focus on one deposit type: ***hydrothermally altered lake sediments***
- More time spent data-mining of historic geochemical data.
- Use of high-resolution geophysical data.
- 189 new geochemical analyses included one sample with ***3,510 ppm Li*** and 31 samples >200 ppm Li

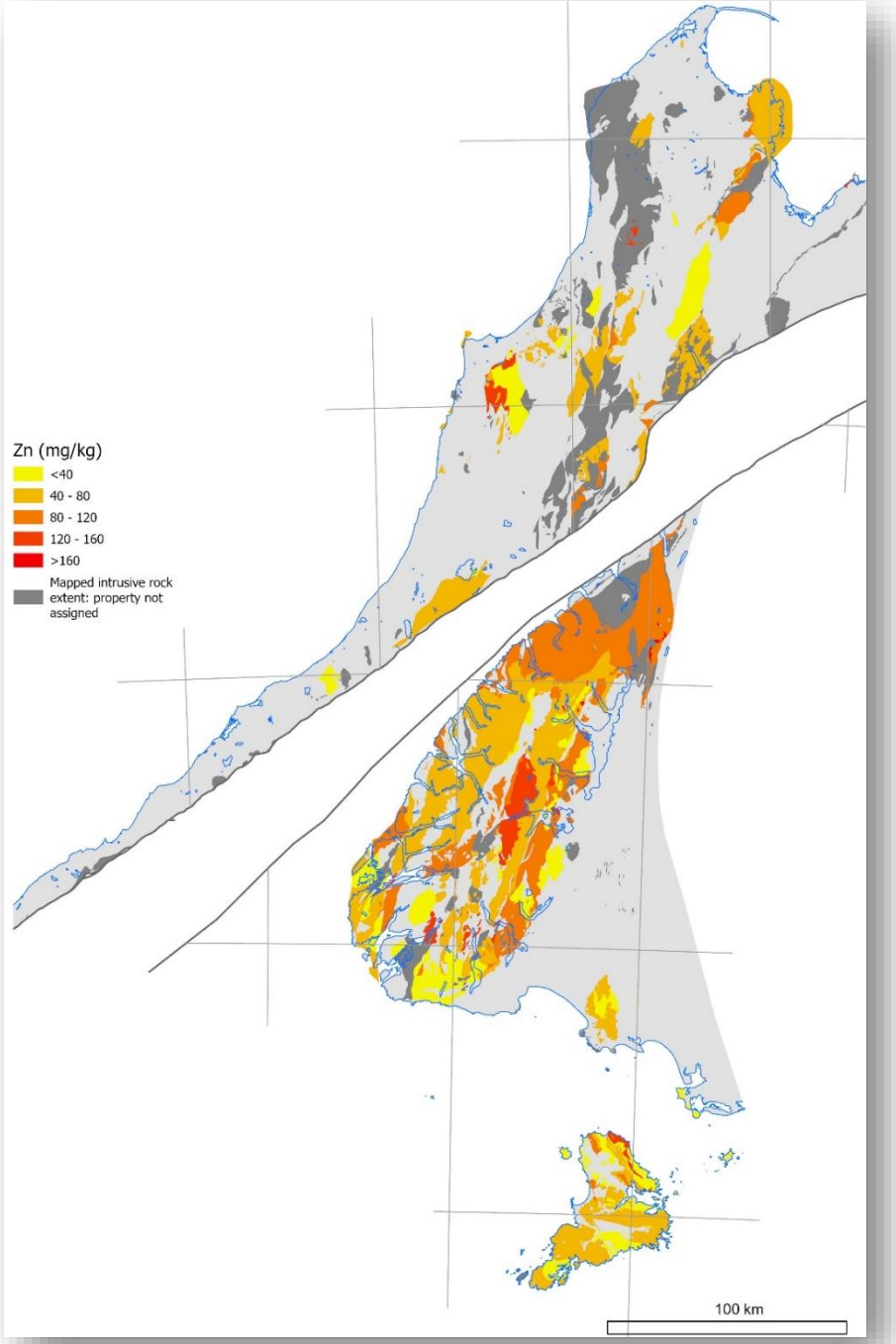
(values considered prospective for this deposit type)

Pluton Map of Zealandia

(Pre-Quaternary Magmatism)

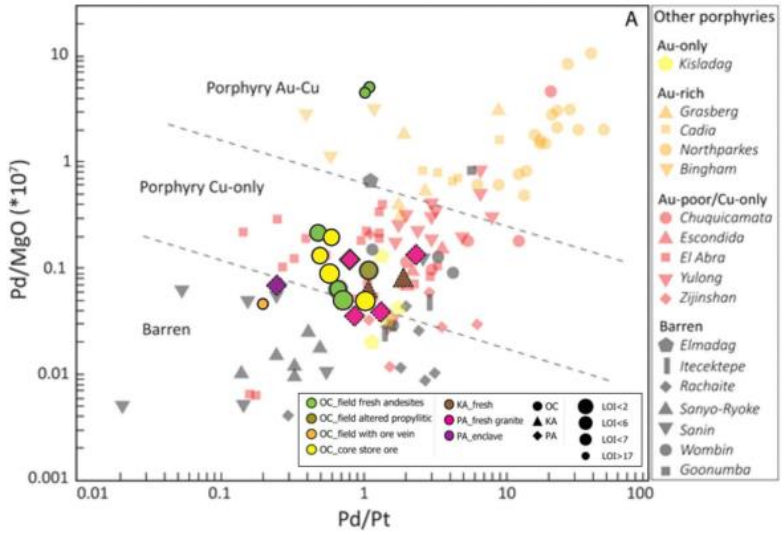
- Characterise the 370+ mapped plutons.
- >90 mineralogical, textural, structural, geochronological, geochemical, isotopic and other physical properties characterised.
- Enables rendering of symbolised maps of plutons according to selected properties or calculations.
- End product useful as a layer in mineral potential modelling.

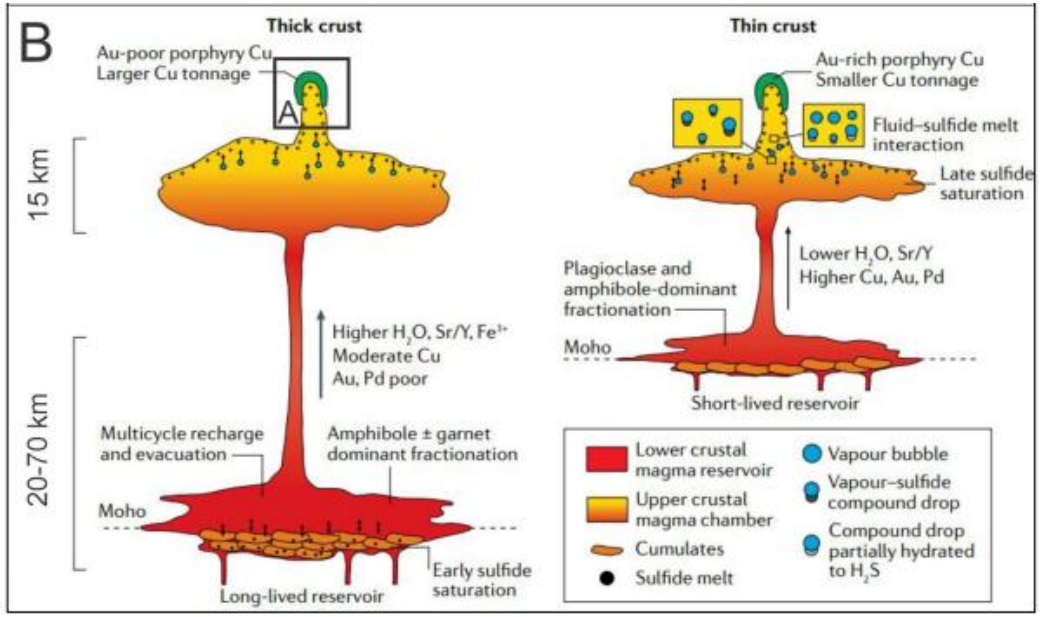
A piece of felsic granite from the Karamea Batholith



Copper in the Coromandel – assessment of porphyry-Cu potential

- Known sub-economic/economic deposits (Ohio Creek, Tui Mine).
- Used a mineral systems approach and new research to assess Cu ‘fertility’.
- Coromandel shown to have the right geochemical signatures with respect to porphyry-Cu prospectivity.
- Additional sampling and analyses required across Coromandel to better assess Cu mineral potential.



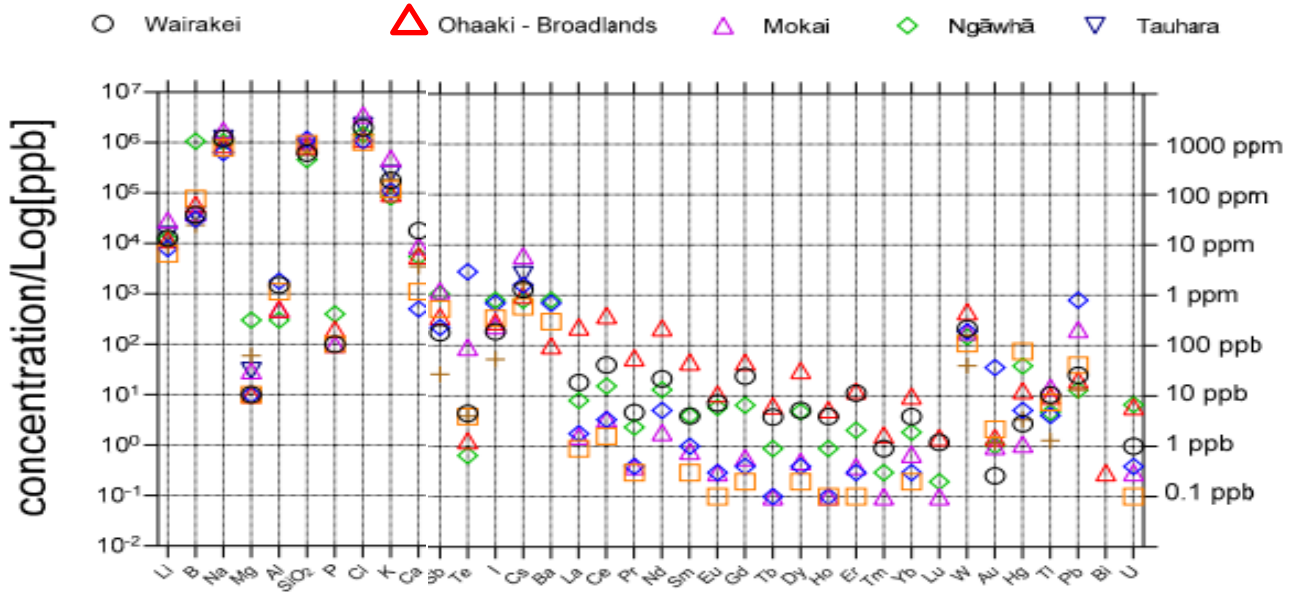


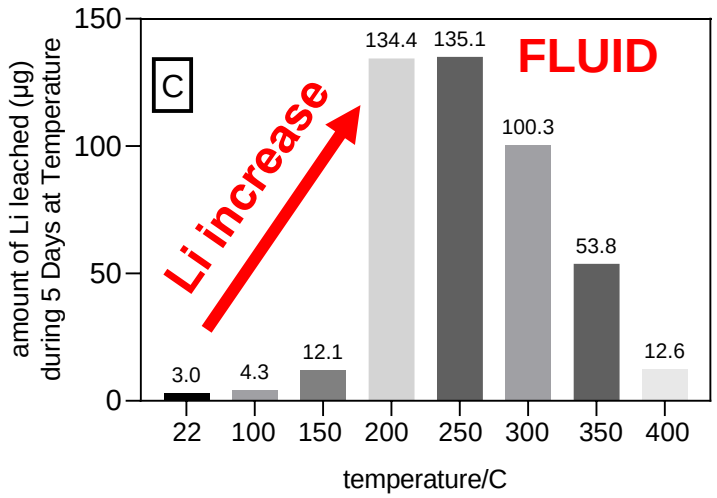
Source: Turnbull et al. 2023. Copper as a critical metal for New Zealand’s transition to a low-carbon economy.

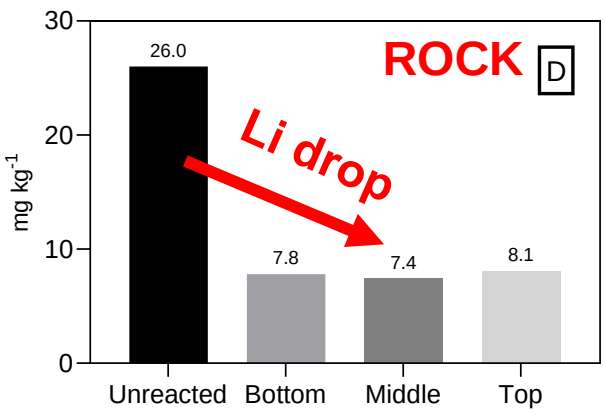
Thinking smarter – extracting elements from geothermal fluids

- Many critical elements found in NZ geothermal fluids of varying amounts: potential for sustainable mining?
  - Geo40 extracting Si, pilot plant set up to extract Li.
  - Ohaaki elevated in REE, Mokai in Li.

- Experiment run to assess if element extraction is sustainable
  - depleted reinjected fluid has no Li.
  - At 200°C Li leached from host rhyolites, fluid reaches 135ppm Li.
  - Drop in Li from host rhyolite to reacted rhyolite also observed.





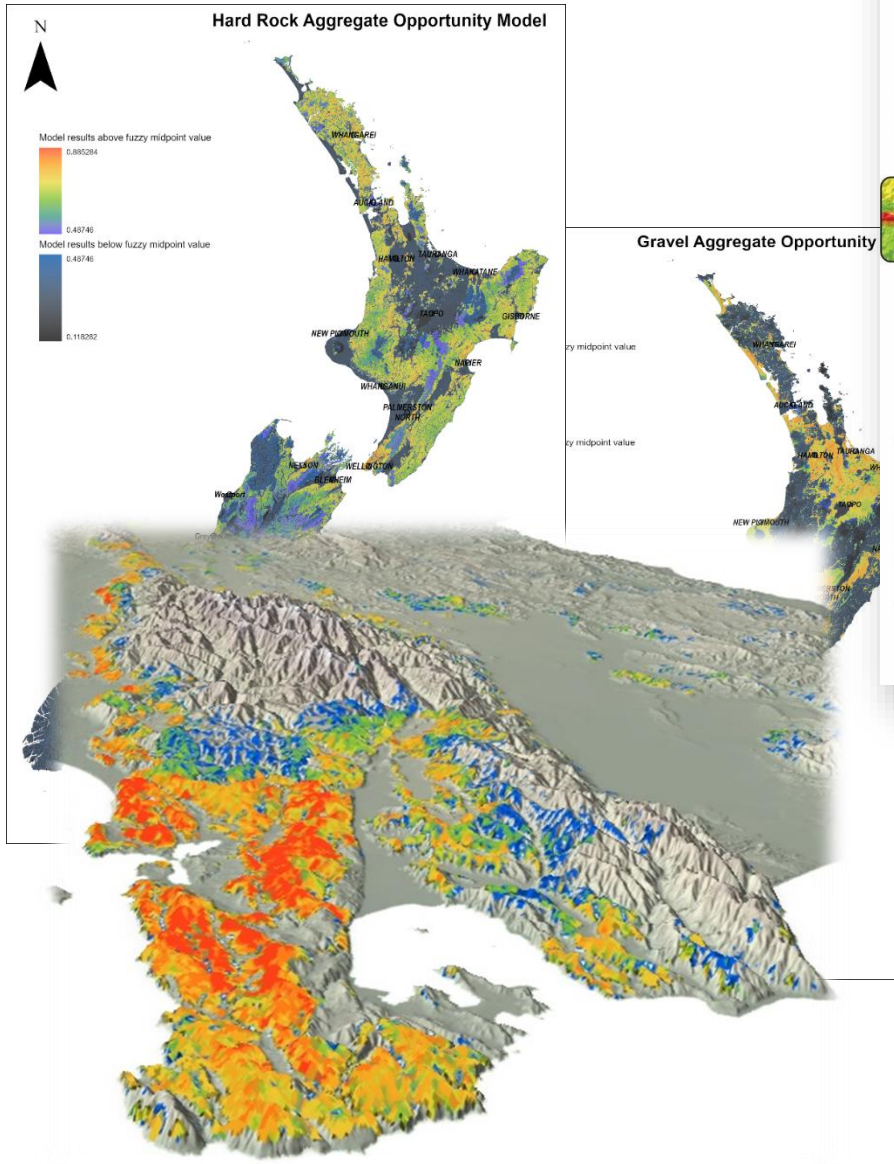


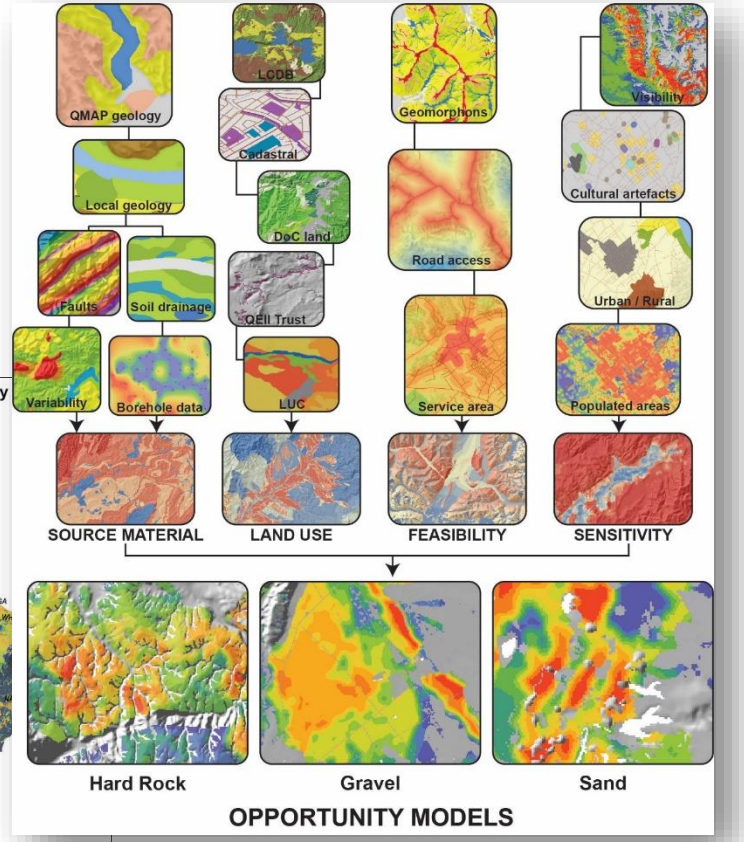
Source: Sajkowski et al. 2023. A review of critical element concentrations in high enthalpy fluids in New Zealand.

Aggregate Opportunity Modelling

- Started by GNS Science in 2018 and refined over several years with input from industry experts.
- Designed to provide a national-scale model of where aggregate opportunities exist so they can be investigated before allocated to other land use.
- National-scale modelling was published in 2021 in collaboration with the NZ Infrastructure Commission. Regional-scale modelling is underway.
- The project locates areas where aggregate opportunity exists and where follow-up studies would provide more insight into the resource potential.

National-scale modelling





Regional-scale modelling

Hill MP. 2021. Aggregate Opportunity Modelling for New Zealand. 106 p. + maps and GIS. GNS Science Report 2021/10.