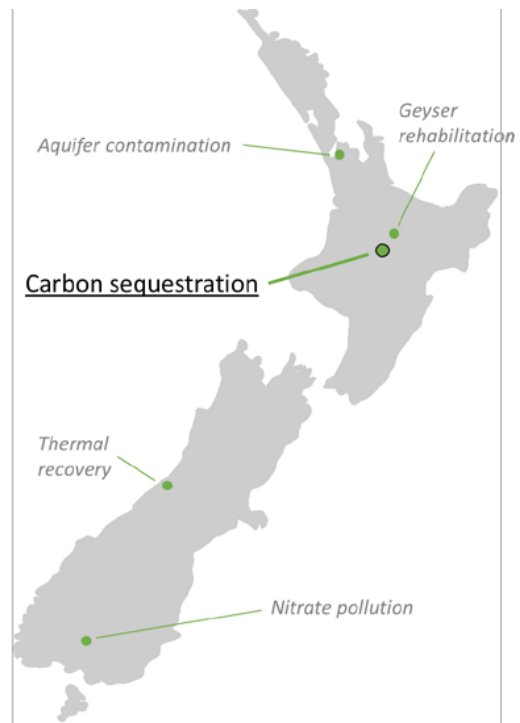


CO₂ injection at Ohaaki geothermal field

Geothermal-biomass cogeneration uses forestry waste burners to superheat geothermal steam for electricity generation. The CO₂ produced by combustion can be captured, compressed to a liquid and then reinjected back into the geothermal field: a carbon negative cycle.

A pilot cogeneration study has been operating at Ohaaki geothermal field since 1998. This field is ideal to test the technology because it has a high amount of natural CO₂ (3 wt%) and the extra reinjection is useful to avoid pressure decline that would otherwise reduce field output. This happened in the early 1990's, which severely impacted electricity generation.



Changes in pressure at Ohaaki are a result of net mass extraction/injection, pressure driven recharge and slow drainage (Fradkin et al., 1981). In addition, CO₂ injected into the reservoir reacts with rock to produce carbonates, which is a good way to lock the carbon up for long periods of time. This reaction proceeds when the concentration of CO₂ is larger than some equilibrium value for the geothermal system, and the reaction rate is proportional to the over-supply of CO₂.

Given its success to date, Contact Energy Ltd. (CEL) are looking to expand cogeneration at Ohaaki. They have applied to the Waikato Regional Council (WRC) for consent to quadruple CO₂ injection rates for their operation. For their part, WRC are concerned about the security of underground storage, given the appearance of new CO₂ seeps in some waterways. CEL have claimed that no CO₂ escapes the reservoir because the pressure has always remained below the pre-exploitation value.

You have been retained by WRC to conduct a computer modelling study of pressure and CO₂ changes in the Ohaaki reservoir. They are interested to understand the effects of expanded CO₂ injection on pressure, CO₂ escape, and whether concentrations will exceed values corrosive to CEL's pipe network (about 10 wt% CO₂). Although the consent application is not currently opposed, Ngati Tahu have indicated that groundwater quality impacts due to the operation represent an unacceptable red line (both under the government's new freshwater standards, and regarding their own decision to oppose).

To support your study, the following data have been made available to you:

- Mass extraction rates from the reservoir for the last 50 years.
- CO₂ injection rates into the reservoir since 1998.
- Regular measurements of pressure and CO₂ concentration.

Project expectations:

You should undertake a computer modelling study that will assist the applicant in their resource consent application, in particular addressing the noted concerns of other stakeholders where they are relevant to the study. The model you develop should be defensible, reflective of reality, and take appropriate account of uncertainty. You will be required to communicate the model findings in both oral and written formats.

Some useful references:

Background on Ohaaki CO2 fluxes

Rissmann, C, et al (2012), Surface heat flow and CO2 emissions within the Ohaaki hydrothermal field, Taupo Volcanic Zone, New Zealand, *Applied geochemistry* 27: 223-239.

Compressibility model for pressure changes, Eqs. (7-8) in

Fradkin, L. J., M L. Sorey, A. McNabb (1981), On Identification and Validation of Some Geothermal Models, *Water Resour Res*, 17: 929-936.