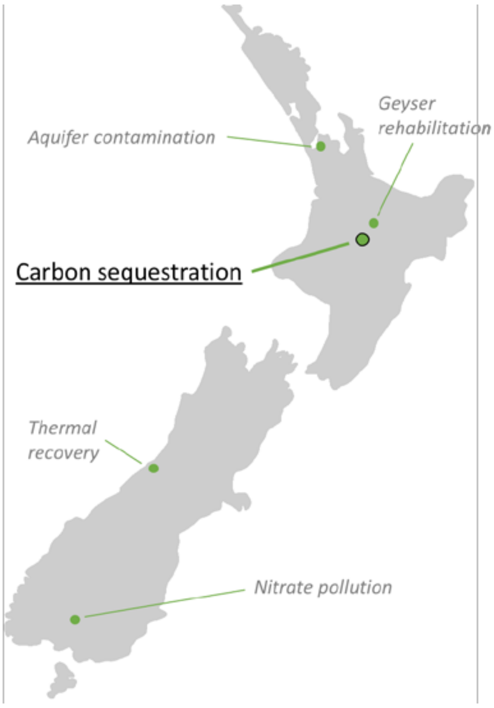
CO_2 injection at Ohaaki geothermal field



Geothermal-biomass cogeneration uses forestry waste burners to superheat geothermal steam for electricity generation. The CO_2 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 CO_2 (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, CO_2 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 CO_2 is larger than some equilibrium value for the geothermal system, and the reaction rate is proportional to the over-supply of CO_2.

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 CO_2 injection rates for their operation. For their part, WRC are concerned about the security of underground storage, given the appearance of new CO_2 seeps in some waterways. CEL have claimed that no CO_2 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 CO_2 changes in the Ohaaki reservoir. They are interested to understand the effects of expanded CO_2 injection on pressure, CO_2 escape, and whether concentrations will exceed values corrosive to CEL's pipe network (about 10 wt% CO_2). 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.
- CO_2 injection rates into the reservoir since 1998.
- Regular measurements of pressure and CO_2 concentration.

<u>*Project expectations:*</u>

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.

<u>*Some useful references:*</u>

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.