THE UNIVERSITY OF AUCKLAND
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Re: Carbone Capture and Storage in Geothermal Reservoirs

Carbon capture and storage (CCS) in depleted oil and gas reservoirs have been implemented in many countries for over two decades. Oil and gas reservoirs have a clear cap rock, and the reservoir is very confined (almost like a tank). Commonly oil and gas reservoirs do not have Oil or natural gas springs at the ground surface (only a few do).
Oil and gas reservoirs are normally abandoned when the oil and gas run out (the tank is empty) or production is not commercial. Therefore they generally provide good targets for CCS.

Geothermal reservoirs are less confined. They depend on water recharge from the top (we call this counter-flow), the sides and some from the bottom, and some geothermal reservoirs may not have a continuous cap rock. This cap rock is often fractured; hence, we get those nice natural thermal features at the surface around the Waikato, the Bay of Plenty and Ngawha. Therefore, geothermal reservoirs last longer than oil and gas because they are being recharged with more water, as 90 % of the heat in the geothermal reservoir is in the rock and 10% in the original fluid. When we produce this fluid, more cold water picks up the heat and longer generation and production are possible.

Some geothermal systems have natural CO_2 fountains (e.g. Kawerau), where nothing grows in this area (about 200 m^2), while the grass is all around it, and it has been like this for as long as the local Iwi know. The CO_2 in geothermal reservoirs occurs naturally along with much smaller quantities of other gases (H_2S, N_2, H_2, NH_3 and CH_4) from deep magmatic origins. This CO_2 is captured in the condensers of geothermal power plants and commonly released into the atmosphere. There have been several trials of CCS in geothermal fields in the USA (Coso and Puna), Iceland (Hellisheidi) and Turkey (Umurlu and Kizildere). The field trial in Coso (USA) was terminated after ten years for unknown (unreported) reasons. The latest information from Turkey suggests that these field trials are relatively recent (injecting a small quantity of CO_2 ~10 tonnes/hour), with no published information on impact. The CCS trials in Iceland have been going on for about ten years with reported success related to the basaltic reservoir rock with favourable chemistry, which provides the ideal environment for permanent mineral entrapment of the injected gases.

In New Zealand, there are currently several field injection trials by Top Energy, Eastland, Mercury Energy and Contact Energy. However, given the unfavourable reservoir rock in New Zealand (to mineralise the carbon), we can't be sure of the long-term success of these trials. We may not know the impact for several years as they will vary from field to field and require unique consideration (testing and monitoring). The fractured and non-continuous cap rock in geothermal reservoirs may allow the injected fluids to travel to the ground surface (during or after the termination of carbon injection), creating undesired CO_2 fountains.

Based on the above and given New Zealand's seismic active geological setting, capturing the injected CO_2 and other gases in solid and binal mineral form is more desirable. This is a subject of new MBIE-sponsored research to help the geothermal industry and possibly other industries through controlled mineral entrapment to reduce carbon emissions while lowering the risk of longer-term carbon storage.

Please do not hesitate to contact me should you need to discuss this further or if you need more information

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Yours Sincerely

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