Geothermal Energy Potential at Paralana, Northern Flinders Ranges, South Australia

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Extended Abstract

Australia has an enormous identified energy potential from known high heat producing granites. As a result, the main types of energy produced in Australia are geothermal and Hot Fracture Rock (HFR) energy. Hydrothermal systems are extensively studied for their potential as geothermal reservoirs for power generation. The present day activity of the Paralana radioactive springs in the northern Flinders Ranges, South Australia, has attracted attention as a prospective geothermal energy site and is currently being prospected for HFR exploration by Petratherm Limited who have purchased a Geothermal Exploration Licence (GEL 178) for the Paralana region[1].

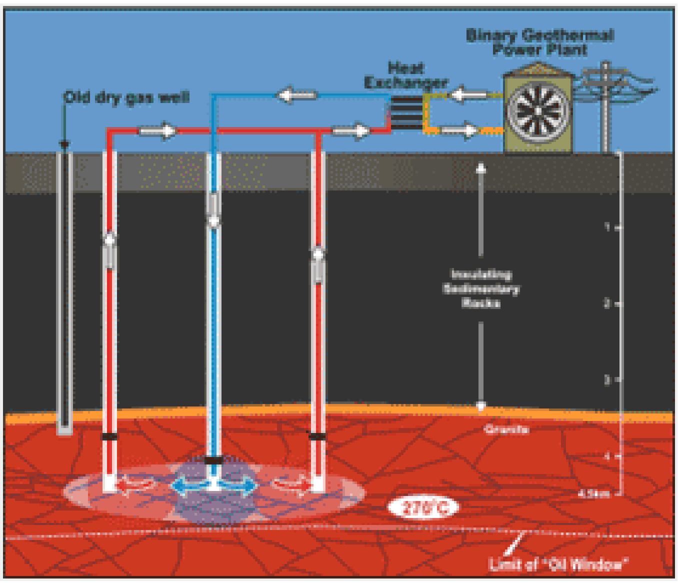
Recent Australian interpretive heat flow studies have highlighted a broad, anomalously high surface heat flow of $92\pm10 mWm^{-2}$ over the eastern part of South Australia, including the Flinders Ranges region. This is commonly referred to as the South Australian Heat Flow Anomaly or SAHFA (Neumann et al., 2000; Holgate and Chopra, 2004)[1]. This high sub-surface thermal gradient is predominantly associated with the Palaeoproterozoic(?) and Mesoproterozoic granites and gneisses that comprise the basement of the northern part of the Flinders Ranges (Neumann et al., 2000; Long et al., in press). The Mt Painter granites are the youngest granites within the thermally anomalous region and generate the highest known heat production of $16 \mu Wm^{-3}$, more than 3 times greater than the upper crustal average (McLaren et al., 2002a). The granites are 2-3 times more enriched than normal Proterozoic granites in the radioactive decay elements uranium and thorium. This is suggested to be a reflection of the crystallisation and fractionation of the primary melt from a near-surface crustal source with an exceptional concentration of heat producing elements (Neumann et al., 2000).

Paralana covers a 500 kilometre square region, near Arkaroola of the Northern Flinders Ranges. It is situated along a major thrust fault bounding the eastern margin of the ranges and incorporates the eastern periphery of the Mt Painter granites. The Paralana hot springs are the only documented active Palaeozoic hydrothermal springs within the SAHFA (Mawson, 1927). They are the result of a naturally occurring system of faults and fractures that have formed migration pathways for hot circulating meteoric groundwater to reach the surface as hot radioactive springs (page 73 in Holgate and Chopra, 2004).

The source of hydrothermal activity has been attributed to the thermally anomalous Mt Painter granites (Neumann et al., 2000; Long et al., 2005). Petratherm Ltd have described the Paralana hot springs as an "enhanced natural thermal system", which is economically attractive for HFR geothermal exploration as it provides an already existing thermal fluid flow.

The basic concept behind Hot Fracture Rock geothermal energy is that it requires a combination of sufficiently hot basement rocks, such as the Mt Painter granites, together with an adequate insulating sedimentary rock cover to trap the heat in. Generally, HFR targets are regions of high heat producing rock, which generate temperatures >220°C at depths at or greater than 3km, enabling efficient heat exchange (www.geodynamics.com.au). Pressurised fluids are injected into the impermeable host rock through an engineered hydraulic fracture system that provides an optimal pathway for circulating fluid. Successful heat extraction is dependent on efficient heat transfer and transport and therefore the overall effectiveness of hydraulic stimulation of fluid circulation. Production wells extract the super heated water from the system and pass it through a heat exhanger. Finally, the resultant cooled water is re-injected underground to be reheated (see Figure 1).

Figure 1. Hot Fracture Rock system.



Basic Hot Fracture Rock system showing the injection of pressurized fluid and extraction of heated fluid via production wells tapped into the granite reservoir[2].

Geothermal energy produced from Hot Fracture Rock (HFR) systems is renewable and has a low environmental impact relative to other traditional energy sources such as fossil fuels. HFR therefore provides a sustainable and environmentally attractive alternate energy resource for Australia. Potential problems are the economic factors associated with the development of a viable HFR system. Recently, Petratherm Limited began the development of the Paralana HFR exploration site. In March 2005, preliminary shallow temperature logging confirmed the sub-surface high temperature gradient that was predicted by geophysical and geological studies for the area. Unstable bore hole conditions have temporarily halted drilling at Paralana, placing limitations on the current geothermal data available, however a larger capacity rig has been contracted to complete the hole in the near future[3].

[1] http://www.petratherm.com.au/projects/paralana.htm

[2] www.geodynamics.com.au/IRM/content/02 hotdryrock/02.html

[3] www.petratherm.com.au

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