An Australian Geothermal Renaissance?

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ABSTRACT

Australia had high hopes for geothermal energy – with high profile enhanced geothermal projects (e.g. Paralana and Habanero) ultimately being unsuccessful. Is now the time for an Australian geothermal renaissance? The use of binary units offers scope to generate electricity from lower temperature resources, admittedly at lower efficiency than higher temperature resources. What will it take for geothermal to flourish in Australia? Have the recent issues at the Winton plan put a "chill" into the sector?

This paper summarises the current state of geothermal permit applications in Australia and where possible overlays the boundaries of permit applications onto a basemap of temperature at 5km depth. The nature of the commercial entities applying for permits is also considered.

1. INTRODUCTION

Australia's dependence on coal and other fossil fuels for electricity must change. Timetables have been announced for the closure of major coal-fired plants (Briggs, 2022). The potential for hydrogen production is being embraced (Australian Government, 2022) – with an underlying need for sources of clean energy to run elecrolysers. State governments have renewable energy targets, e.g. Queensland's government has aspirations for the state to reach 50% renewable energy by 2050 – from 21.4% currently (Queensland Government, 2022).

The Australian Renewable Energy Agency (ARENA) are not an active proponent of geothermal on their website (https://arena.gov.au/renewable-energy/geothermal/) noting challenges around locating, flowing and financing geothermal electricity production. However, ARENA (2018) compared the levelized cost of various technologies and found that (at least in 2018) geothermal energy production in Australia (from hot sedimentary aquifers) was modelled to have the lowest levelized cost of electricity over a 24 hour period as shown in Figure 1.

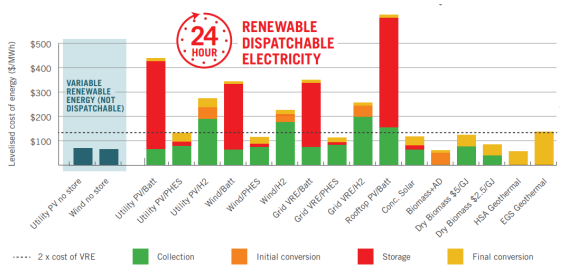

Figure 1: Levelised Cost of Energy (LCOE) for systems at 100MWe nominal capacity evaluated with a 6.5% weighted average cost of capital. from (ARENA, 2018).

Recent energy market chaos in both Queensland and New South Wales highlighted the need for reliable, affordable baseload energy in the market. A combination of weather conditions, fuel prices, and plant availability caused the market operator to intervene to cap prices during the winter of 2022, with calls to conserve electricity use to prevent blackouts (ABC, 2022).

A recent review of geothermal in Australia is offered in the 2020+1 World Geothermal Congress country update (Beardsmore et al, 2021). Readers seeking an overview of the underlying geology are referred to that work. Beardsmore et al. (2021) discuss recent direct use applications in Australia (bathing/tourism) but in their closing remarks foresee "Several small ORC electricity plants to come online in western Queensland, perhaps amounting to a total capacity of around 1 MWe" This manuscript offers a state-by-state review of geothermal permit activity – with the finding that there have been many permit applications made since Beardsmore et al. (2021).

Use of geothermal energy for ground source heat pumps is an important potential use for geothermal energy in Australia but has not been considered in this review of the current state of the Australian geothermal sector.

2. AUSTRALIAN GEOLOGICAL CONTEXT

To orient readers to the geological context of Australia Figure depicts temperatures interpreted in the OzTemp project at 5km depth (Gerner & Holgate). Areas in blue imply temperatures at depth of less than 85ºC, and areas in red have temperatures at depth greater than 235ºC. Note that this does not imply wells proposed at any location will be drilled to 5km, nor does it guarantee that a well at a given location will produce fluid at the interpreted temperature.

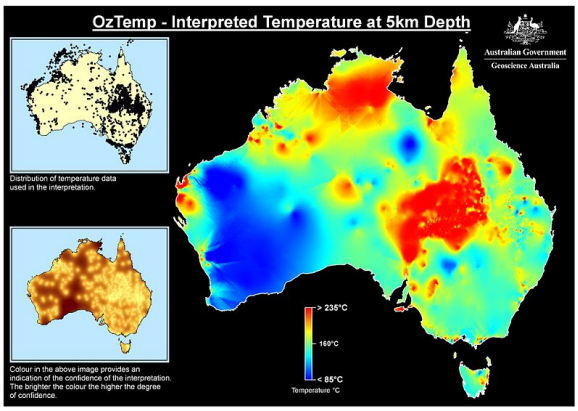

Figure 2: OzTemp – Interpreted temperature at 5km depth.

3. WESTERN AUSTRALIA

Western Australian ran an acreage release for geothermal permits which closed in April 2022. In January 2022 the Acting Mines and Petroleum Minister Rita Saffioti said "It's encouraging to see industry's renewed interest in this clean energy resource since the last geothermal acreage release more than 10 years ago." The process released 21 onshore areas with a total area of 81,900 km^2 released.

Permit information in Western Australia is made available through WAPIMS (Petroleum and Geothermal InformationManagement System) – see https://wapims.dmp.wa.gov.au/WAPIMS/ The areas released are mapped in green in Figures 3 to 5 (with the colour in the underlying basemap reflecting temperature at depth from Figure 2).

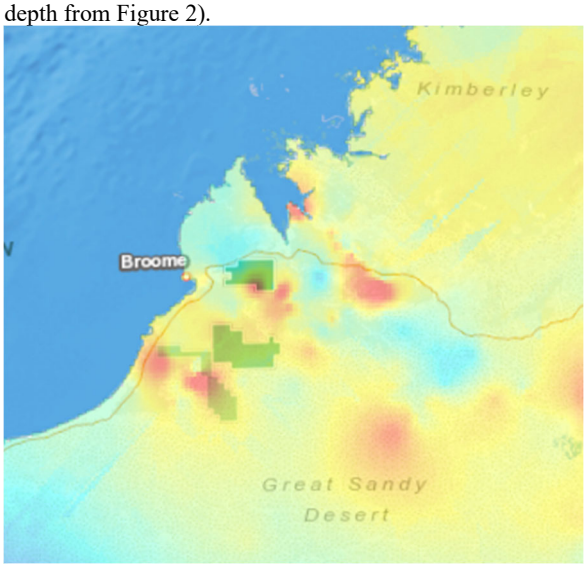

Figure 3: Geothermal acreage release – Western Australia (northern part of the state) – areas released near Broome shaded in green.

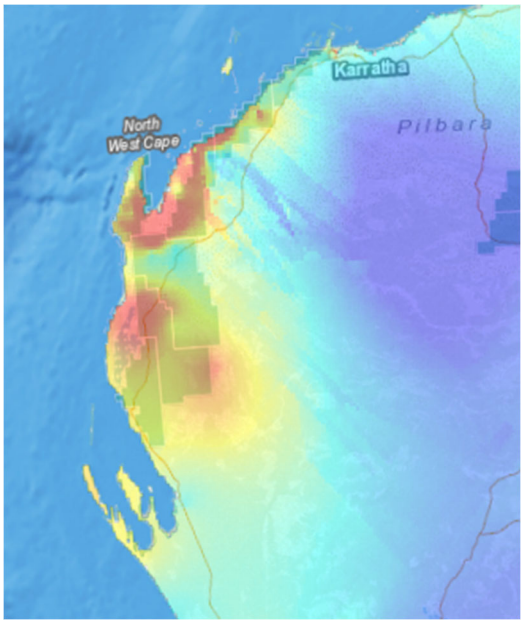

Figure 4: Geothermal acreage release – Western Australia (western part of the state) – areas released west of Karratha shaded in green.

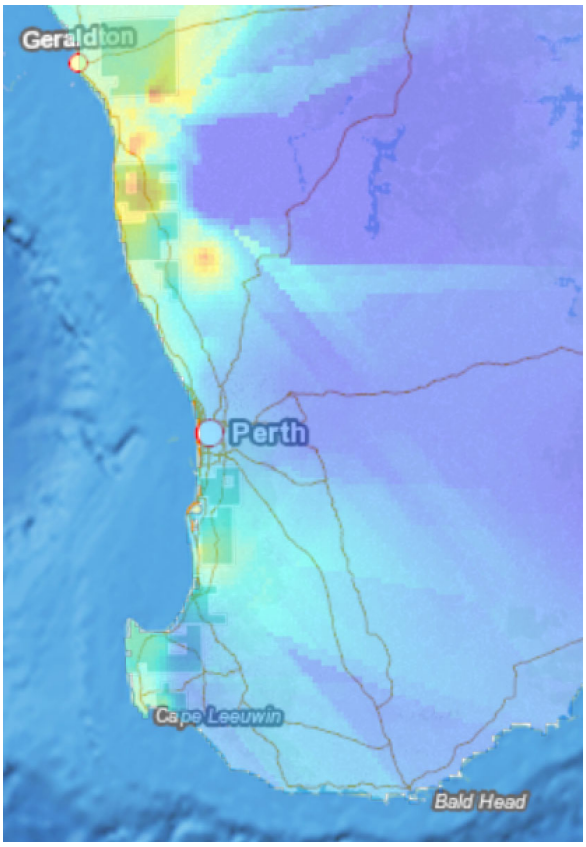

Figure 5: Geothermal acreage release – Western Australia (southern part of the state) – areas released from Geraldton to Cape Leeuwin shaed in green.

At the date of writing the outcome of this acreage release is unknown.

Strike Energy (who are better known as an onshore gas producer) holds an existing permit in the Perth Basin as shown in Figure 6. Their acreage overlies the Waitsia gas field (which is one of the largest onshore gas fields discovered in Australia). Strike (2022) announced that in testing of the Kingia Sandstone at West Erregulla 4 that well head temperatures of more than 115°C were observed (in co-production of brine and natural gas). If Strike's geothermal project is successful it could provide 226 MWe of baseload electricity (Market Herald. 2022). This project appears to be part of an important shift in Australia's geothermal sector with oil and gas companies actively exploring geothermal potential.

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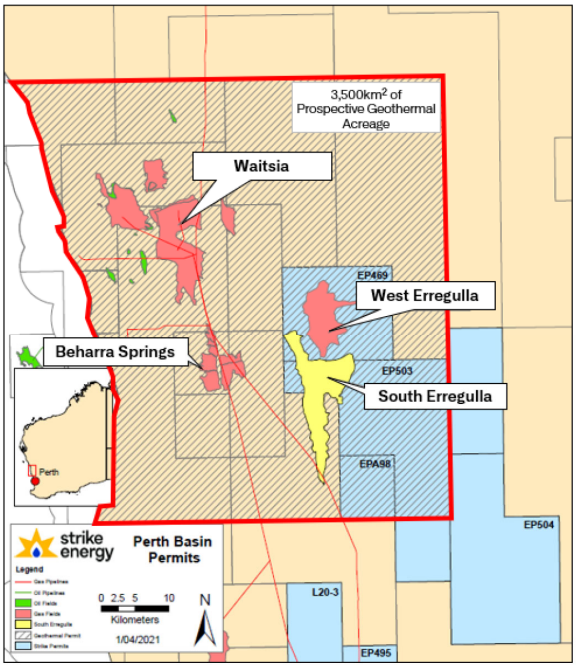

Figure 6: Strike Energy's geothermal acreage (Strike Energy, 2022)

4. NORTHERN TERRITORY

In the Northern Territory natural resource data is available from https://nrmaps.nt.gov.au/. Unfortunately permit boundaries were not able to be downloaded (i.e. to combine them with other GIS data sets). There has been a significant amount of recent permit activity in the Northern Territory with all (except one) of the geothermal exploration applications for the acreage shown in Figure 7 being applied for since late 2021.

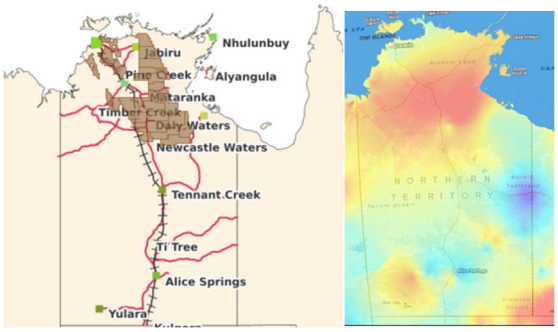

Figure 7: Geothermal exploration permit applications in the Northern Territory (shaded in brown) – left panel and temperature at 5km depth in the Northern Territory – right panel.

The majority of the exploration permit applications were made Hydro X Gen Pty which was incorporated in late 2021. The company appears to be a sister company to H2U who describe themselves as a pure-play, specialist developer of green hydrogen infrastructure. This underlines the potential role for geothermal in the hydrogen economy in Australia. Good H2 Darwin Pty and Allasso Energy have also applied for one exploration permit each in the Northern Territory.

5. QUEENSLAND

Geospatial data for Queensland is held in the GeoResGlobe system (https://georesglobe.information.qld.gov.au/). Geothermal exploration permits have been recently applied for in Queensland by three companies – Greenvale Mining, Alpha Resources (a subsidiary of Greenvale) and Within Energy. The majority of the applications were made very recently (May 2022). Greenvale and Alpha's applications are near Clonclurry, Winton, Longreach and Quilpie as shown in Figure 8.

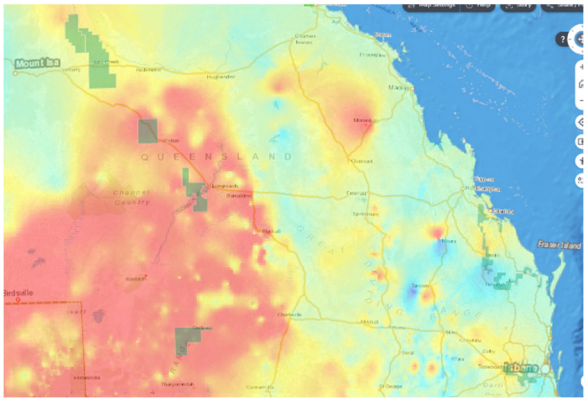

Figure 8: Inland Queensland geothermal exploration permit applications (shaded in green) and temperature at 5km depth.

Within Energy has applied for permits over a total of 11,000 km^2 on Queensland's east coast (Figure 9). Their Gladstone, Biggenden and Lockyer applications are close to major population centres and close to transmission lines which a re depicted in Figure 9 as thick lines (typically purple or red). The location of their Gladstone application is notable in that it surrounds Fortescue's proposed billion-dollar hydrogen development at Gladstone.

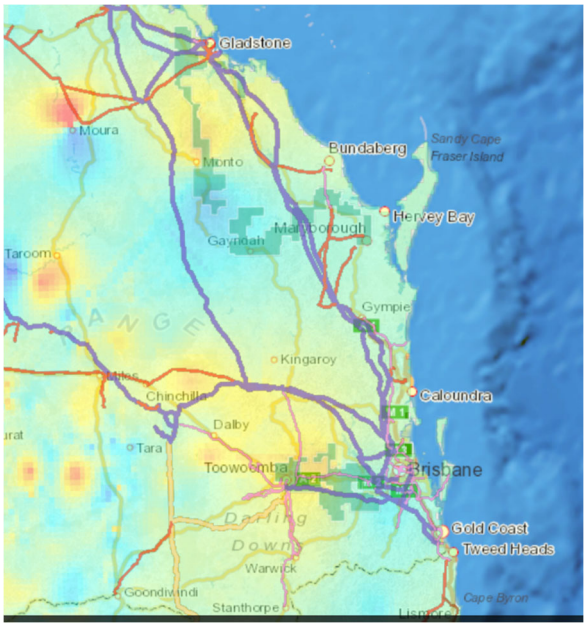

Figure 9: Geothermal exploration permit applications in coastal Queensland areas (shaded in green) and temperature at 5km depth.

6. NEW SOUTH WALES

When compared to other states discussed so far there is less exploration permit application activity in NSW. However there have been two application lodged. The boundaries of those applications can be viewed (but not readily downloaded) from NSW's MinView system (https://minview.geoscience.nsw.gov.au/) Figure 10 and 11 show applications from GeoGen (near Lismore) and Spa*ark Energy.

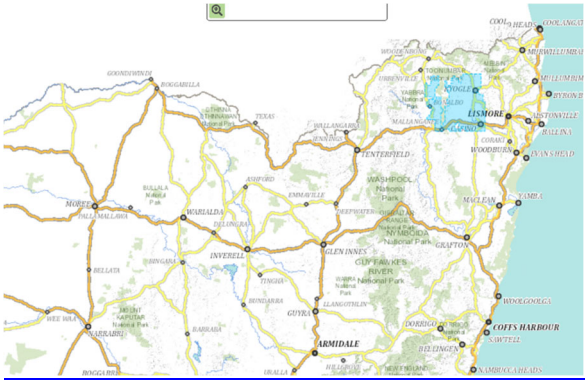

Figure 10: GeoGen exploration permit application – northern NSW (shaded in blue)

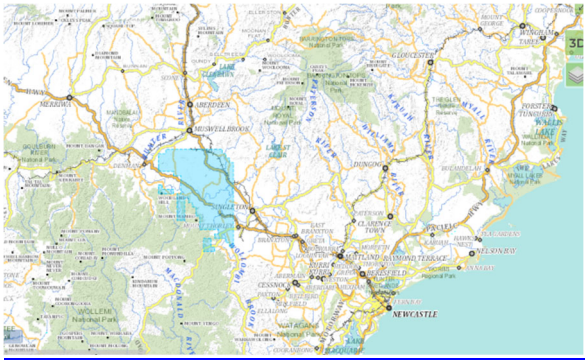

Figure 11: Spa*ark Energy exploration permit application – east of Newcastle (shaded in blue)

While this study is not focusing on direct use, one recent direct use announcement in NSW is notable. A hybrid geothermal/solar system has been proposed for the poultry industry – with support from ARENA, and scope to reduce greenhouse gas emissions by 160,000 tonnes if 15 to 20% of the industry adopted it (Global Ag Media, 2022)

7. VICTORIA

The state of Victoria also appears to have limited activity in terms of application for exploration permits. Victoria's GeoVic (https://gsv.vic.gov.au/sd_weave/anonymous.html) system appears to only have one geothermal exploration permit application lodged at the moment – focusing on the Warnambool area (and held by the Victorian Geothermal Energy Company Pty) as shown in Figure 12.

Figure 12: Warnambool exploration permit application – Victoria (red outline)

Victoria (like Queensland) has numerous hot springs which are being utilized for bathing and tourism.

8. TASMANIA

There are two active geothermal license applications in Tasmania (documented in Minerals Resources Tasmania online database at https://www.mrt.tas.gov.au/products/database_searches/tenements_search)

Figure 13: Tasmanian licence applications (coloured in red) – with Tasmanian terrain as a basemp. Left – Spa*ark Energy application (Fingal area), right privately held application (Lemont area).

9. SOUTH AUSTRALIA

There has been a great deal of recent permit activity related to geothermal exploration in South Australia. Figure 14 shows the areas for which exploration permits have been recently sought. Data for South Australia is accessible from the South Australian Resources Gateway (https://map.sarig.sa.gov.au/). Like the Northern Territory the bulk of the applications are from Hydro X Gen whose heritage suggests an interest in use of geothermal energy to produce hydrogen. Torrens Energy held permits in this area (near Lake Torrens) but recently let them lapse. Permit activity also includes another new company – Volt Geothermal who were incorporated last year and hold two permit applications in the set pictured in Figure 14.

Finally Santos Ventures (a subsidiary of Adelaide headquartered Santos Ltd, an oil & gas company with a market capitalization of over $26 billion AUD) applied for exploration permits in the Innamincka area on August 12, 2022.

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Figure 14: Geothermal exploration permit applications in South Australia (outlined in grey).

10. CONCLUDING REMARKS

This summary of geothermal permit application activity implies there is a new renaissance in the geothermal sector in Australia. This activity is a good fit for Australia's wider aspiration to reach net zero emissions by the year 2050.

Recent exploration permit applications have come from a wide of companies – from small companies specializing in geothermal to oil/gas companies and mining companies (or subsidiaries. Hydro X Gen's substantial number of permit application demonstrates the linkage that is anticipated by some in the sector between geothermal electricity generation and hydrogen production. Figure 15 shows the locations of proposed hydrogen export hubs.

Companies involved appear confident that modular organic Rankine cycle technology can offer a route to electricity generation which is scalable and cost competitive. The sector is seeing interest from companies whose traditional domain is oil and gas. These companies bring a good understanding of the sedimentary basins involved from their oil and gas activities.

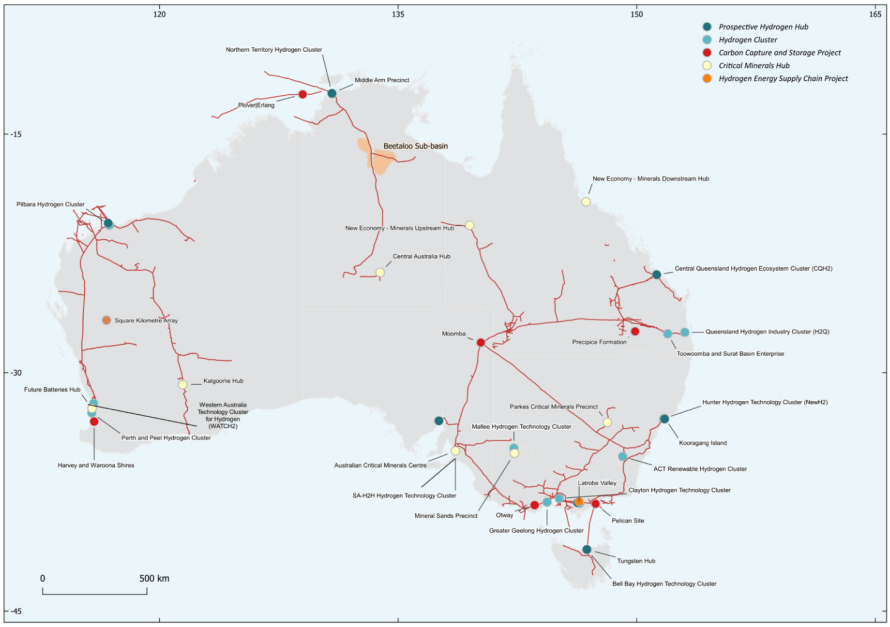

Figure 15: Hydrogen hub locations (Australian Government, 2021)

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