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Paralana Engineered Geothermal Systems Project 3.5MW Development Plan

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ABSTRACT

The Paralana Engineered Geothermal System (EGS) Project is an exploration and development project with a high level of research and development. The Project is located 600 kilometres north of the city of Adelaide in South Australia (Figure 1). The project is testing for viable geothermal sources generated by the radiogenic decay of high heat producing basement rocks. Petratherm Limited in joint venture with a major oil and gas company, Beach Energy, are initially seeking to build a 3.5MWe commercial power development to supply a local off-grid mine, with the long term objective of providing large scale (300MWe+) power through the national electricity grid.

1. PROJECT SUMMARY

Work to date at Paralana has been highly successful at identifying, defining and quantifying the strong geothermal potential from greenfield exploration to the completion of a 4 kilometre deep well and its hydraulic fracture stimulation. The Paralana Joint Venture has achieved significant milestones that include:

- measuring optimum operating temperatures for efficient binary power production (190°C at 4km depth);
- creating an extensive complex fracture stimulation to allow the circulation of waters through the hot rock;
- discovering pre-existing over-pressured fluids in fractures that allow natural flows.

The work undertaken has enabled the preparation of an Independent Resource Statement (refer to www.petratherm.com.au for full statement) that quantifies a very large recoverable resource available at Paralana. The resource could potentially provide the energy potential for generating 600MWe into the National Electricity Market (NEM).

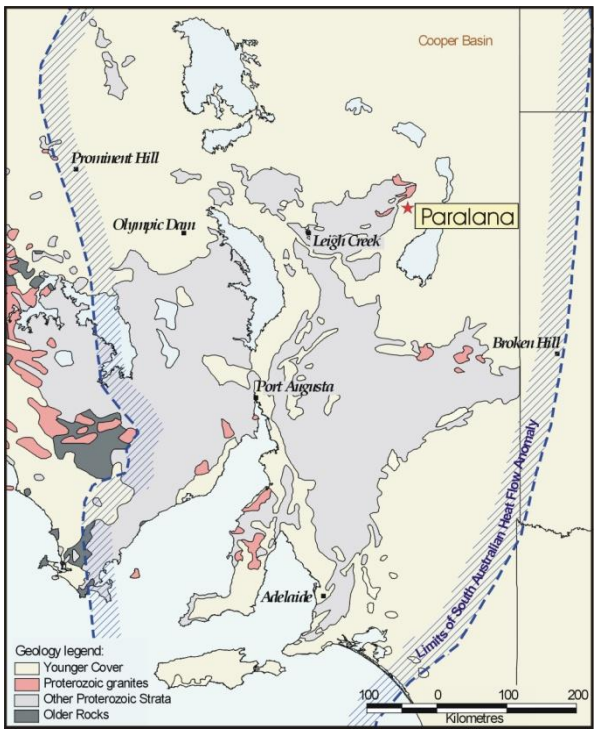

Figure 1: Regional Locality Map

In addition to the project's strong technical successes to date, it has a clear commercialisation path with a local off grid market for earlier pilot stage developments (Beverley Uranium Mine - 11km away). At each stage of development the Joint Venture Partners have sought to reduce risk through careful project management and by taking a pragmatic cost effective approach.

2. NEXT STAGE OF WORKS

A second deep production well needs to be drilled into the fractured zone to complete the circulation loop. Further reservoir stimulation works and prolonged flow testing is to follow with the aim of demonstrating commercial energy extraction from the drilled doublet. This next stage of work is the subject of a $13 million Emerging Renewables Program (ERP) Grant provided by the Australian Renewable Energy Agency (ARENA) which will fund 47 % of the budgeted works program.

If a sustainable high production flow rate can be achieved, then a 3.5 MW Organic Rankine Cycle (ORC) power plant is to be installed. Concurrently, the connection of the new 3.5 MW plant to the local customer, Beverley Uranium Mine, will occur via an 11km underground 33kV transmission line. This second phase of work is subject to a Commonwealth Government Renewable Energy Development Program (REDP) Grant, which will provide funds on a $1 for every $2 spent basis. The project has been fully budgeted and financial modelling show this initial development will be commercially viable inclusive of grants.

3. PARALANA 3 DRILL PLAN

The information collected specifically from the drilling, fracture stimulation and flow testing of Paralana 2 has helped with characterising and defining the geometry and distribution of the engineered reservoir. The final configuration of this well cannot be set at this point and may differ significantly in design from Paralana 2. Several scenarios can be recognised at this stage:

- The well has a design similar to Paralana 2, or with a larger diameter completion. Full steel casing and cementing is set from the surface to the bottom of the hole for each drilling section. Perforation at target intervals is to be performed prior to stimulation.
- The well is secured with steel casing – similarly to Paralana 2 – but only to the top of the sub-surface heat exchanger and the rest of the well projecting into the heat exchanger left as an open hole or fitted with slotted liner to maximise connection between the reservoir and the well bore.
- Hung casing is set for all or some of the drilling phases. These measures reduce the hook load capacity, offer another means to accommodate thermal expansion issues and potentially allow the use of a less powerful rig, while still ensuring a safe completion.

The final rig selection will be dependent on the well design option for Paralana 3. Following the learning's of Paralana 2, both on geological and engineering levels, the drilling time is expected to be significantly reduced to a period of 3 months.

4. LARGE SCALE FRACTURE STIMULATION PLAN

Fracture Stimulation works to follow are to be on a large scale and designed to yield commercial rates of energy extraction by achieving sustainable high flows of approximately 70 l/s or better. The stimulation programme at Paralana 2 involved an interval of 6 metres. About 3 million litres of water were injected over a period of 5 days. While the stimulated volume as imaged by the micro-seismic interpretation has shown excellent results, with a complex fractured zone extending more than 1km away from the injection point, final injection rates remained just below 30 l/sec. There was a steady increase in flow rate with time and a prolonged stimulation coupled with the options presented below has been considered to achieve a commercial flow.

- Install a frac string in Paralana 2. As the casing and the wellhead are rated to maximum pressures of 10,000 psi, limiting the injection pressure during the stimulation, this operation would allow an increase of injection pressure by about 50%. Higher injection rates would therefore be achieved causing larger amounts of formation break down and improved fluid flow rates with respect to pressure.
- The casing at Paralana 2 was perforated along a 6m interval. The flow is limited on the number of perforations, and also depends on the success of the perforation and hence the connectivity of the perforation to the rock formation. Performing extra perforations in Paralana 2 and multi-zone fraccing would increase the chances of an improved flow rate.
- When Paralana 2 was completed, the bottom of the well could not be cased due to well break out issues. Below the cased section, the state of the interval 3720 to 4000m is unknown, but is likely partly filled with rock cavings and cement. It is probable that there is a significant permeability within this open portion of Paralana 2 as large fluid filled open fractures where encountered during drilling. A coil tubing unit would be able to drill out the cement plug and allow the access to the deeper and hotter segment of the well.

The fracture stimulation of Paralana 3 is dependent on the well completion (full casing, open hole completion, hung casing) and on the results obtained from the stimulation of Paralana 2. It is likely that multiple zones would be stimulated in order to yield a commercial flow rate. Simultaneous stimulation in both the producer and injector will be considered as it greatly increases the far field pressures between the wells allowing better connection to occur. The potential to utilise chemical stimulation techniques to increase injectivity/productivity will be considered dependent on the formation chemistry. The experience has shown that acid treatment improved the injection rates in Paralana 2.

5. CONCLUSION

Commercialization and large scale deployment of EGS globally has been held back by resource risk centered principally on achievement of high rates of flow. Paralana offers an excellent opportunity to overcome this hurdle as initial fracture stimulation works defined a large complex stimulation zone, and demonstrated that future expanded fracture stimulation works has a good chance of achieving high flows. In addition the project offers relatively low risk standard drilling methods, optimum temperatures for binary power development and a local off-grid market. This next critical phase of works at Paralana is scheduled to begin in early 2014.