Draft version of Geopower Independent Geologists Report North East Tasmania

Does not include figures from other sources

GEOTHERMAL ADVISORY LETTERHEAD

10 March 2010

The Directors
Geopower Limited
52 Channel Highway
Kingston, TAS 7050

Dear Sirs

Geopower Limited ('Geopower' or 'the company') have commissioned Geothermal Advisory Pty Ltd to write an Independent Geologist's Report (the 'Report') on the geothermal prospectivity of Geopower's tenement SEL 37/2007 in north-eastern Tasmania. After final consent is given, the Report is to appear in a prospectus for the issue of shares in Geopower Limited, expected to be lodged with the Australian Securities and Investments Commission (ASIC) in the first half of 2010. It should not be relied upon for any other purpose.

The Report considers only the geological aspects of SEL37/2007 as they relate to the prospectivity of the tenement for the production of geothermal energy and in particular the 'hot rocks' model for geothermal energy put forward by Geopower. I express no opinion whatsoever whether or not the shares to be offered in Geopower offer fair value, or whether geothermal energy will ultimately be produced by Geopower from SEL37/2007. The technology for producing geothermal energy from 'hot rocks' is very much in its infancy in Australia and has yet to be achieved commercially. Readers of this report should obtain separate advice as to whether the geology described here is appropriate to the particular above ground energy conversion technology to be employed by Geopower.

The Report is based on information provided by Geopower and a range of publically available sources, both in hard copy and on-line. I have benefited from discussions with staff at Mineral Resources Tasmania and workers in the geothermal sector throughout Australia.

Summary

Geopower have proposed a model of producing 'hot rock' geothermal energy at the surface via hydraulic stimulation of sedimentary rocks above a high heat producing granitoid, then passing fluids through the fracture system and delivering them to the surface at approximately 150°C. This is both a lower production temperature and a different reservoir location and rock type for the fracture system than most other 'hot rocks' geothermal projects in Australia and these in turn bring about advantages and disadvantages in a geological technical sense.

SEL37/2007 is dominated by Devonian granitoid bodies, a number of which exhibit 'high heat producing' characteristics. However in the majority of the area, the granitoids are outcropping and therefore not suitable for a commercial geothermal system, as their heat is lost to the atmosphere. Geophysical modelling indicates that there are granitoids buried beneath Mathinna Super Group ('Mathinna') sediments within the lease and if any of these granitoids are also high heat producing, then the first technical component of a geothermal system may be present. Readings from boreholes outside the southern boundary of the Geopower lease indicate that elevated (>90 mW/m^2) heat flows are present there, and likely sourced by buried high heat producing granitoids. The adjacent south-eastern portion of the Geopower tenement contains similar geology, but the heat flow estimations are on too coarse a grid and the detailed geology is too variable to allow direct extrapolation across the tenement boundary.

The 'insulating blanket' for a geothermal system would be provided by the Mathinna sediments, which are a package of quartzose to pelitic rocks, dominated by turbidite sequences. The rocks have been folded and at least one prominent cleavage is usually present. Laboratory measurements indicate that the mudstone rich portions of the Mathinna at least have attractive insulating qualities, however laboratory work also indicates that the insulating qualities drop if the heat flow is parallel to cleavage and/or if the quartz content rises. The fact that the Mathinna package is folded means that within a given three to four kilometre vertical section, there may be a range of insulating qualities as the lithotype and cleavage orientations change. On balance, and supported by work published by others in Tasmania, the Mathinna can be considered an adequate insulating blanket, providing the package is thick enough, with three km being considered the minimum, and cleavages orientations are favourable. On published work, areas of four kilometre thickness of Mathinna rocks do occur within the Geopower tenement within the south-eastern portion of the tenement but cleavage orientations here tend to be steep at the surface.

The Geopower model relies on the Mathinna rocks immediately above a high heat producing granitoid being fractured to produce the geothermal reservoir and underground 'heat exchanger'. The successful propagation of fractures for 'hot rocks' geothermal systems relies on enhancing pre-existing fracture sets, preferably close to horizontal in orientation and usually within the hot granitoid. In the Geopower case, the propagation of fractures will be influenced not only by pre-existing fracture sets, but by cleavages and deformed bedding planes, and a presently uncertain contact metamorphosed lithology at the reservoir location. The presence and orientation of the pre-existing fractures and the effect of deformed bedding and cleavage on bedding plains on fracture propagation is highly uncertain at the depth of the proposed reservoir but at the surface at least, sets of fractures with dips <30° are present. Overall, whilst bedding and cleavage will probably enhance porosity, the direction and extent of the enhanced fracture network cannot be predicted at depth with any certainty on present information.

On balance, the Geopower tenement has the potential to host rock temperatures at around 150°C at the base of the Mathinna sedimentary package, if a high heat producing granitoid has intruded below it. The most prospective area appears to be along the southern boundary. However the quality of a stimulation-enhanced fracture network within the sediments to allow heat exchange between the rocks and the working fluid is less clear. Likely enhanced porosity over granitoid reservoirs might be mitigated by less control over where the fractures propagate.

Geothermal Energy

Geothermal energy is the natural energy of the earth expressed as heat. There are several types of source of this heat energy:

- Heat energy remaining from the original formation of the earth. The surface layers of the earth have cooled substantially due to heat dissipating from its surface since the formation of the earth over four billion years ago and are mostly hard and brittle. However the central portions – the core, molten inner mantle and outer mantle - remain very hot (around 6,000°C in the core) due to the insulating effects of the rocks above them;

- Heat energy produced by friction of the earth's mostly brittle tectonic plates moving against one another and the substrate below; and

- Heat energy produced by the radiogenic decay of Uranium (U), Thorium (Th) and certain isotopes of Potassium (K) and other elements contained in rock-forming minerals.

The latter heat source is by far the greatest contributor to the heat energy presently flowing out from the earth – over 80% according to one source (Turcotte 1980 quoted in Beardsmore and Cull 2001), with the residual heat of the earth contributing under 20%, and plate friction only a minor component.

How much heat energy does the earth emit? This can be expressed in terms of how much energy (measured in Watts) is passing through a square meter of the earth's surface, therefore W/m^2 or, because the amount is usually very small, mW/m^2.

The earth has a global average surface heat flow of about 87 mW/m^2 (Pollack *et al* 1993), but the earth's surface is far from uniform, so the heat flow varies substantially from area to area. The oceans have a higher average heat flow of just over 100 mW/m^2 compared to continents with about 65 mW/m^2 (Beardsmore and Cull 2001). These averages however mask local highs and lows within those areas; some units of ocean floor crust have heat flows less than 60 mW/m^2 whilst some geological regions of continental crust have surface heat flows approaching 100 mW/m^2 and small areas can have heat flows very much in excess of that.

Another way of considering the thermal distribution of the earth is in terms of thermal gradient, or how the temperature rises or falls over a certain distance.

As the core of the earth is about 6,000°C, an overall rise in average temperature with depth is apparent (a positive thermal gradient towards the centre of the earth). However, due to the aforementioned differences in geology within both the continents and oceanic crust, there are differences in the thermal gradient both laterally and with depth.

It is fundamental to the search and exploitation of geothermal energy in Australia that there are local variations in geology (such as intrusions of high heat producing granitoids) which can produce areas of elevated surface heat flow, and higher temperatures at shallower depths than usual. These produce conditions suitable for mankind to be able to tap the geothermal energy to produce electricity and useful heat energy at the surface.

Uses of geothermal energy

Mankind has made use of geothermal energy for millennia. Hot springs have been used for cooking and to ward off the cold since the earliest times. In the early industrial age, they were used in a number of chemical manufacturing processes requiring heating or drying. Today, geothermal resources are used for two main areas of application: producing electricity and direct use for heating and drying. 'Geothermal heat pumps' are not usually included as a use in the same way and these are not considered here.

Production of electricity

Electricity has been produced from geothermal sources since the early 1900s (Bertini *et al* 2006). In its simplest concept, steam and/or water at high temperatures and pressures are brought to the surface via a drill hole and either the natural steam (or steam 'flashed' from hot water after a drop in pressure) is directed through a set of blades which in turn drive an electrical turbine. If the fluid is hot water and the temperature makes flashing to steam unattractive or not possible, then the heat can be transferred or 'exchanged' to another fluid with a lower boiling point, such as isopentane. This more energetically boiling fluid then drives the turbine and the system is known as a 'binary' one.

Direct Use

The term 'Direct Use' of geothermal energy usually includes the use of hot geothermal fluids for any application other than electricity. This mainly encompasses space heating, agricultural and industrial drying but can include the heating of swimming pools and use in adsorption chillers (e.g. for air conditioning) and so on.

Classes of geothermal energy systems exploitable for electricity

There are three major classes of systems where mankind can exploit the geothermal energy of the earth for producing electricity. The discussion below is an over-view of the fundamentals only and does not discuss or consider the merits or risks of the various classes.

'Conventional' Geothermal Energy

In this class, natural ground waters (sometimes supplemented by re-injected spent geothermal fluids or waters from other sources) circulate against or close to a geologically recently emplaced magma system and are heated to high temperatures. They may vent to the surface (boiling hot springs, geysers, fumaroles) and/or circulate beneath the surface. The shallow hot fluids are readily accessible by drilling and can be directed to a steam turbine. The keys to this class are the shallow, magmatic nature of the heat source, high temperatures (well above 200°C) and the natural permeability of the host rocks.

The readily-accessible nature of this type geothermal resource and its high temperatures means that this class has been exploited for electricity for many decades. The class does not occur in Australia, but can be found in countries such as New Zealand, Iceland, the Philippines and Japan – countries with active or recent volcanism on or close to plate boundaries.

Enhanced Geothermal Systems (EGS)

EGS is a relatively new class and has yet to be deployed on a sustainable commercial basis anywhere in the world. In this class, a package of hot rock is located and its permeability artificially enhanced (e.g. by hydraulic fracturing or 'fraccing') to allow the transmission of fluids through the reservoir (MIT 2006). These fluids are introduced via a bore hole, pick up heat in the reservoir and are transported to the surface via another bore hole, to drive a steam turbine. The local heat source is usually a radiogenic granitoid which has been heated to (say) 180°C to 250°C by virtue of the heat being trapped by an overlying insulating blanket of sedimentary rock three to five km thick. The enhanced geothermal reservoir itself may be within the granitoid, or within the rocks immediately over-lying the granitoid.

The heat of the granitoid will be a function of the amount of radiogenic (heat producing) activity within it and the insulating qualities of the over-lying rocks, which in turn is a function of factors including their thickness and their own mineral composition. The amount of fluid that can be transmitted through the reservoir will be a function of how well pre-existing fractures can be opened up, their direction, inter-connectivity and propensity to stay open, amongst other things.

The EGS class is therefore characterised by temperatures typically lower than Conventional geothermal and at greater depths, and the requirement to have the reservoir's permeability artificially enhanced by 'fraccing'. In Australia, the company Geodynamics Limited have drilled a number of holes into a hot granitoid in the Cooper Basin in South Australia, have fracced it and produced hot fluids to the surface (Chen and Wyborn 2009). An independent firm has certified that EGS 'Proof of Concept' has been achieved, although this has taken a long time and considerable cost. A small electricity pilot plant has been installed but has yet to be commissioned. Another company, Petratherm Limited, has drilled a four km deep hole at its Paralana project, also in South Australia, targeting the sediments immediately above a hot granitoid as its geothermal reservoir. Fraccing here has yet to be attempted at the time of writing.

Hot Sedimentary Aquifers (HSA)

This is sometimes considered as a sub-set of the Conventional type, but in Australia especially it is recognised as a particular class on its own. Here, some porous sedimentary rocks may contain hot waters not directly relatable to a particular heat source. The temperatures and depths can be very variable, but in the Australian setting, source reservoirs might vary from between two to four km deep and the *in-situ* temperatures less than 200°C, frequently less than 150°C and even below 100°C (Bryson *et al* 2009), thus lower than both Conventional and EGS classes. The host rocks are of the type that typically host oil and gas reservoirs and indeed hot waters are frequently encountered in oil and gas wells. The sedimentary unit, being permeable and perhaps connected by faults or folds to deeper levels, allows waters to migrate from hot sources laterally and from depth, to a level where it is accessible by drilling and still hot enough to be useful. The natural permeability of the reservoir theoretically makes for a substantial volume of fluid to be able to be delivered to the surface without the need for any 'fraccing'.

This class of geothermal system is exploited already in Australia. At Birdsville, the town's water supply is sourced by drill holes into the Great Artesian Basin, a very large sedimentary aquifer. The waters are delivered to the surface at approximately 98°C and a binary power plant produces a small amount of electricity (QDERM 2005). There are many sedimentary aquifers in Australia and these are being targeted by geothermal companies at the present to produce fluids in greater volumes but at lower temperatures than the EGS type (although temperatures should be greater than at Birdsville), for the production of both electricity and for 'Direct Use'.

Geothermal Prospectivity of SEL37/2007

In determining the prospectivity of an area for geothermal energy, the proposed model for production is important. Clearly no area on continental Australia is prospective for the Conventional geothermal class. Geopower has informed the author that within SEL37/2007 it is targeting relatively shallow 'low temperature' thermal reservoirs in sediments at or above the contact of buried radiogenic granitoids, with the objective being to produce electricity using technologies which can efficiently exploit temperatures in the range 150-180°C. This is a subset of the EGS class of geothermal which will require certain geological circumstances to be present, in particular granitoid rocks of good heat producing capacity and good to high quality insulating rocks above them, but other features are also relevant. The following section will review these geological characteristics with a view to see how they suit the model.

The Geology of North-Eastern Tasmania

The geology of north-eastern Tasmania and SEL 37/2009 is dominated by two broad geological units – the 'Mathinna Super Group' sedimentary rocks of Ordovician to early Devonian age and a suite of granitoid intrusives of broadly Devonian age (Burrett and Martin 1989).

Figure 1 shows SEL37/2009 in the context of the simplified geology of all of Tasmania, whilst Figure 2 focuses on the area of the Geopower tenement. Besides the above mentioned units, a number of later geological units and formations are present, including Jurassic age dolerite intrusives, Permo-Triassic sediments, Tertiary basaltic extrusives, and more recent unconsolidated sand, clay and talus deposits. None of these have any material impact on the geothermal prospectivity of the Geopower tenement and will not be considered further, except to note further the Tertiary extrusives.

Figure 1
Simplified Geology of Tasmania

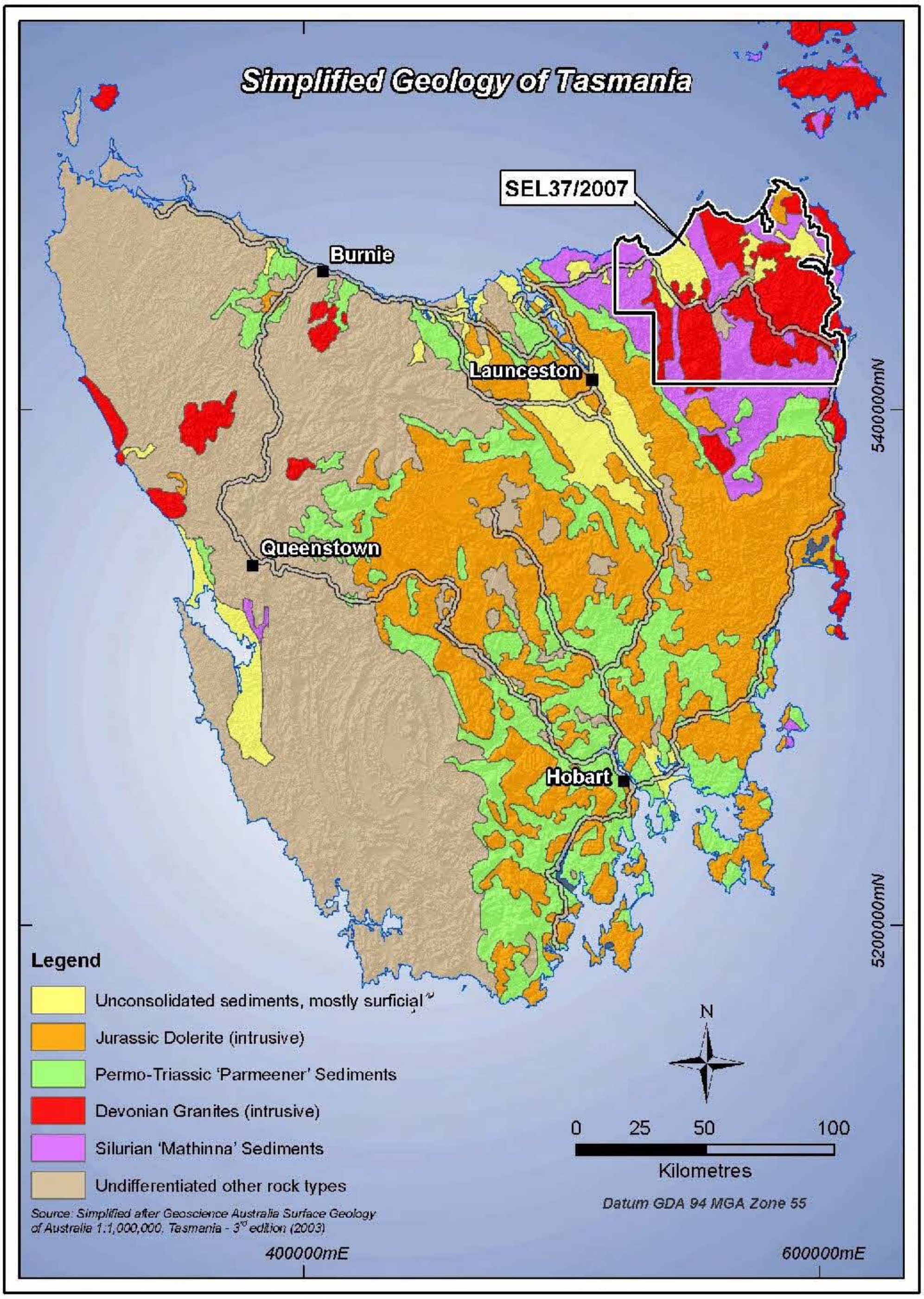
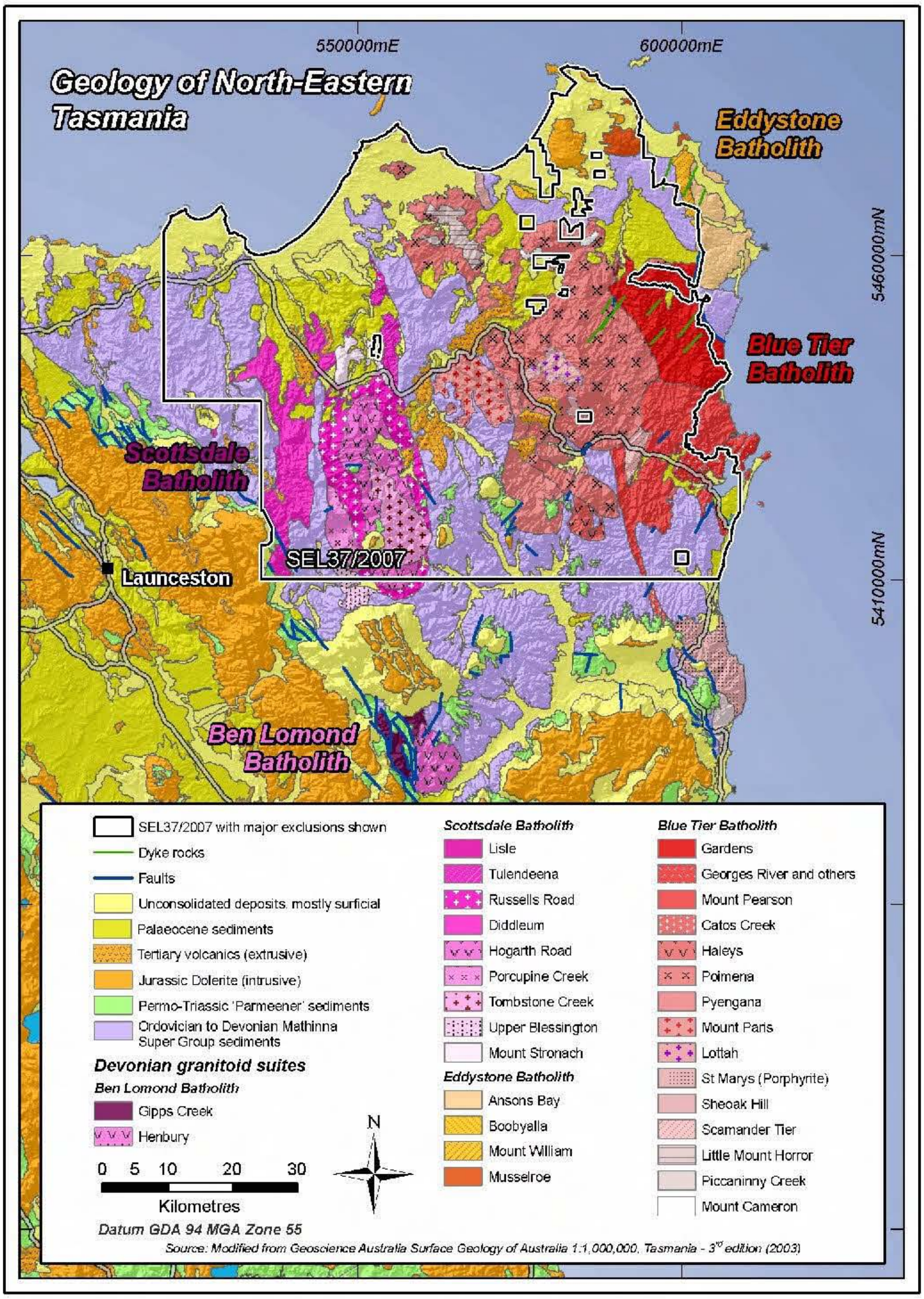


Figure 2

Geology of north-eastern Tasmania



Mathinna Super Group

The 'Mathinna Super Group' is a package of fining-up Bouma sequences comprising variable quantities of sand to silt-sized, quartz-dominated, detritus, up to about seven km thick in total, deposited in Ordovician through to early Devonian times (Tahiri and Bottrill 2005, Seymour *et al* 2007). This assemblage will need to form both the 'insulating blanket' above any heat source and also form the geothermal reservoir, so its composition and structural characteristics are an important consideration.

The base of the succession isn't known. The lowermost known unit is Ordovician and has been identified mainly from areas to the immediate west of the Geopower SEL and may be present below other members within the tenement. It is described by Powell *et al* (1993) as quartzose turbiditic mudstone approximately one km thick and named the Stony Head Sandstone. (Mathinna Super Group litho-stratigraphy is under review with current Mineral Resources Tasmania mapping but no gross changes to lithologic succession is expected – M. McClenaghan *pers comm.*) This unit is over-lain by up to two kilometres of a black pelite, the Turquoise Bluff Slate, which has thin beds of siltstone and fine sandstone in its upper reaches.

The above units are thought to be unconformably overlain by a further two kilometres of sublithic feldspathic turbidites (Bellingham Formation) followed by a further two kilometres of feldspathic turbidites (Sidling Sandstone), with the proportion of sand increasing in the latter.

The above lithologic units are best distinguished by mapping in the west of the Geopower tenement area, and areas west of that. In the east, the Mathinna Super Group is largely undifferentiated in respect of named units in published works. Recent geophysical surveys by Mineral Resources Tasmania, especially radiometrics, has apparently allowed some structure of the Mathinna to be traced (Mitre Geophysics Pty Ltd 2008) but that study has yet to be fully integrated into mapping.

The Mathinna rocks were deformed in orogenesis during the Devonian. In general, there was more than one compressional deformation events, producing north-westerly trending fold axes and prominent slaty cleavage(s). The nature of the metamorphism and structure is important, as both can affect the thermal conductivity of the rocks and hence their insulating properties. Broad scale and smaller parasitic folding is common in the Mathinna. In general, a given package of Mathinna rocks might be expected to have components of slaty cleavage both steeper and shallower in dip and exhibit a variety of fold amplitudes and wavelengths. That said, mapping by government geologists (Mineral Resources Tasmania 1993) in the area of Mathinna rocks between the Scottsdale and Blue Tier Batholiths, in the central south portion of the Geopower tenement, shows a predominance of steep (>80°), north-westerly strikes to both bedding and primary cleavage.

Although EGS geothermal systems rely mostly on buried granitoids to produce the heating, it is relevant to note that the sedimentary package can also generate heat via its own content of sedimentary radiogenic minerals. Goh (2008) measured the uranium, thorium and potassium contents of a range of Mathinna Super Group lithologies and calculated the resultant heat production. Shales, siltstones and mudstones were the highest, at 1.9 $\mu W/m^3$ (quoted to one significant figure) with sandstone 1.2 $\mu W/m^3$. Although considerably lower than the heat produced by granitoids measured in the study (see below) and less than 'average' sedimentary heat generation of 2.1 $\mu W/m^3$ reported by Beardsmore and Cull (2001), the sediments' own contribution will impact overall surface heat flow.

Devonian granitoid suite

Large scale granitoid intrusions at high crustal levels with narrow contact aureoles occurred in Tasmania in the Devonian period (McClenaghan 2006). In eastern Tasmania, emplacement occurred prior, during and following the Devonian orogenic episode (Seymour *et al* 2007). The eastern intrusives have traditionally been grouped into the Scottsdale, Blue Tier, Eddystone and Ben Lomond Batholiths (Figure 2). Mapping and analysis by Mineral Resources Tasmania have identified about 30 granitic bodies in or close to the Geopower SEL (Everard 2005) and mapping and study continues. It is not intended to describe all these granitoids and their characteristics here, but to look at the features which may impact geothermal potential.

The heat-producing characteristics of granitoids can be judged by proxy via their content of radiometrically active isotopes of Potassium (K), Thorium (Th) and Uranium (U). Their radioactive emissions can be measured directly by ground and air surveys or in laboratory studies. The total percentage of uranium and thorium can also be measured directly, and is usually expressed as a percentage of the element's oxide compound; potassium can also be measured this way but its radioactive isotope is only a proportion of the total.

Uranium and thorium are 'heavy' elements with large atomic radii. Classically, as granitic magmas cool and crystallise, such elements will be tend to be concentrated in the remaining magma liquid as they are more difficult to accommodate in the lattices of common rock-forming minerals. Thus the 'residual' liquid will be continually enriched in these elements, together with other large ion metallic elements such as tin and tungsten. Eventually these residual magma liquids will crystallise and they tend to form small bodies or 'cupolas' toward the top of an intrusive suite but need not be restricted to that position.

Collins *et al* (1981) conducted a gamma ray spectroscope study on outcropping granitoids throughout NE Tasmania and converted the radiometric readings into amounts of U, Th and K_2O with a mathematical treatment. In general, alkali granitoid bodies associated with tin or tungsten mineralisation were found to have higher radioactive (U, Th) content than those lacking tin/tungsten mineralisation. The Mt Paris and Lottah granitoids of the Blue Tier Batholith and portions of the Ben Lomond Batholith (Figure 2) were identified as particularly rich in the radiogenic elements. The Mt Stronach granitoid was identified as partially anomalous.

Goh (2008) measured the heat generation capacity of a small number of eastern Tasmanian granitoids. They were from Royal George and Gipps Creek (Ben Lomond Batholith), Poimena (Blue Tier Batholith, and within the Geopower SEL) and Coles Bay. Overall, the Royal George granitoid had the highest heat generation of 10.5 $\mu W/m^3$ followed by Gipps Creek at 8.3 $\mu W/m^3$, Coles Bay 7.3 $\mu W/m^3$ and Poimena 7.2 $\mu W/m^3$. Goh (2008) noted that these values were high compared to the published range for the global average for granitoids of 2.5-5.5 $\mu W/m^3$ and lay within the range of values from South Australia (where geothermal projects are widespread) of 4.5-61.6 $\mu W/m^3$.

Mapping and analyses by Mineral Resources Tasmania (Everard 2005, McClenaghan 2006) have broadly catagorised the granitoids of NE Tasmania and elsewhere into 'S' or 'I type' and within a spectrum of fractionation. Again, the most highly fractionated (and therefore most likely to contain elevated uranium and thorium and higher potassium if rich in 'alkali' feldspar minerals) bodies were found to be the Mt Paris, Lottah, Gipps Creek and Mt William 'S' type bodies and the Mt Cameron, Henbury and Mt Stronach 'I' type granitoids (see Figure 2). Most of these have been described as 'alkali feldspar' intrusives.

The recent aerial radiometric survey of NE Tasmania by Mineral Resources Tasmania (Mitre Geophysics Pty Ltd 2008) cannot be used directly as a tool for identifying highly radiometric granitoids, as soil, vegetation and other effects can mask the radiometric emissions from the aerial probe. However prima facie much of the above information was confirmed in this survey, with the Mt Cameron, Henbury, Gipps Creek, Mt Paris, Mt Stronach, Tombstone, Musselroe, Mt Pearson and some others being mapped as high to very high radiometric 'total count'.

The point of the above is that relatively highly radiometric granitoid bodies are well known in outcrop from within and near the Geopower SEL 37/2007. These outcropping bodies are not directly beneficial to geothermal energy production as they lack the insulating blanket to trap the heat. However there is no inherent geological reason which would preclude granitoids of similar composition existing at depth beneath, say, outcropping sequences of Mathinna Super Group rocks, although the tendency of such bodies to be higher, rather than lower in the crust and overall intrusive suite needs to be born in mind.

Possible volcanic plugs

The presence of Tertiary aged basalt in north-eastern Tasmania is well known (e.g. Burrett and Martin 1989). An aerial magnetic survey conducted in 2007 was interpreted in part by Leaman (2008) who noted that although many 'point anomalies' could be ascribed to Tertiary basalt or other known features, a number could not and raised the possibility that some may be volcanic plugs of unstated age. A number are within the Geopower tenement.

The presence of volcanic plugs is uncertain and their likely age would mean that the volcanic systems are cold, however their presence adds some remote possibility of local remnant elevated temperatures at depth.

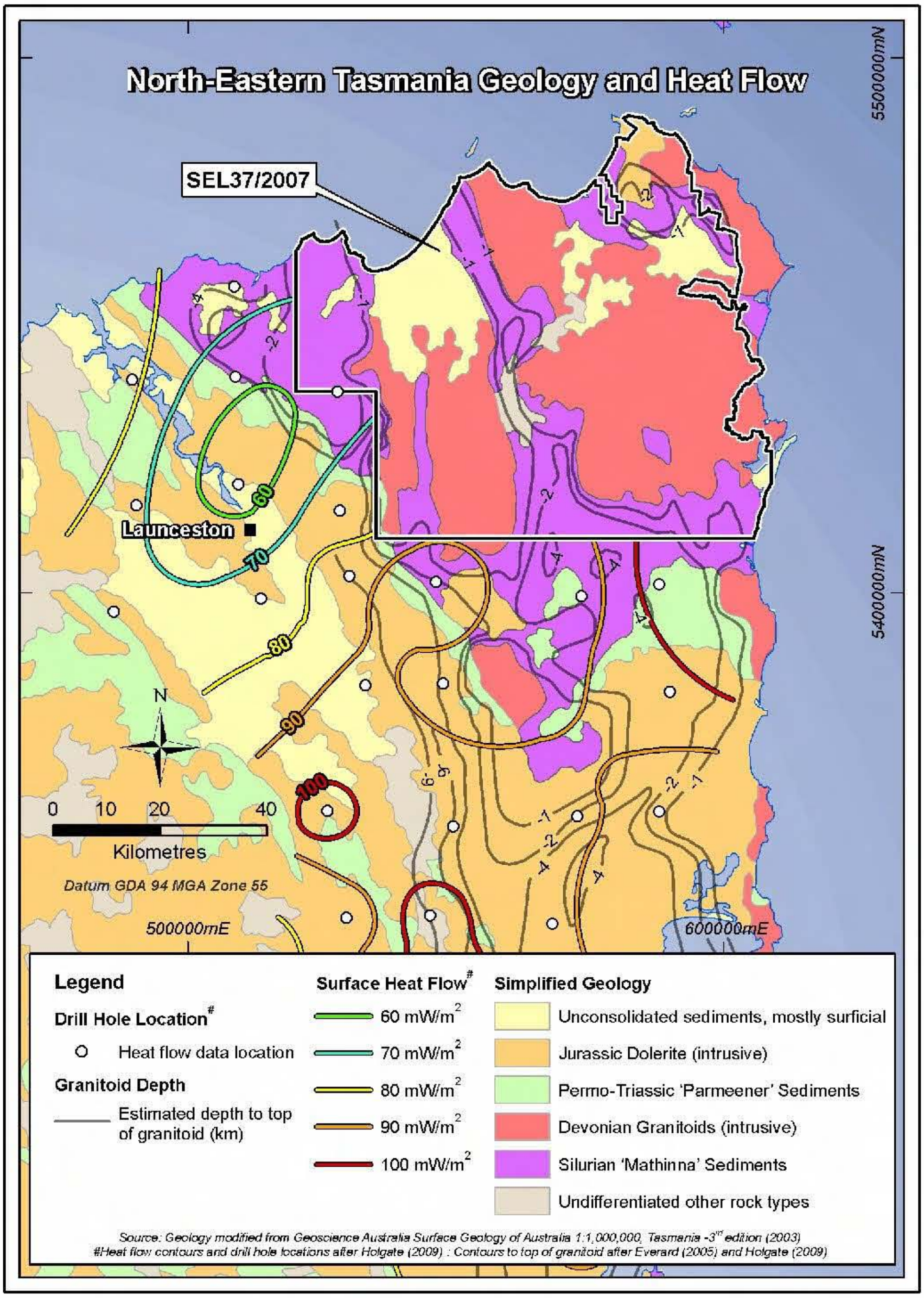
Thickness of the cover sequence on top of the granitoids

A further part of the Mineral Resources Tasmania studies over a number of years has been to model regional and sub-regional aerial magnetic and ground gravity survey results as a way to determine the sub-surface distribution of major rock groups and types. Rocks have different concentrations of magnetic minerals, and their signature can be read with accuracy using a magnetometer. Different rock types tend to also have different densities – for instance, granitoid rocks tend to have lower densities than many sedimentary rocks and so a concealed granitoid hosted within sediments may be detected as a 'gravity low' compared to the surrounding area. After a gravity and/or a magnetic survey over an area, a geophysicist may produce a model on computer, where rocks with certain characteristics and extents (eg depth below surface) are created in the model, to see if the resulting calculated surface response profile matches the field measurements. If it does, and the model is consistent with the known geology of the area, then it can be a reasonable (albeit non-unique) interpretation of the sub-surface.

Such work has undertaken such modelling over many parts of Tasmania (eg Leaman and Richardson 2003) and more recently over several areas within and adjacent to SEL37/2007 (Leaman 2008, Steve Webster Pty Ltd 2008).

The compilation of Everard (2005) (see Figure 3) indicates that within SEL37/2007, the deepest the top of granitoids is likely to be is about four km at the edge of the middle part of the southern boundary of the tenement, south-east of the Scottsdale Batholith outcrop. The top to granitoid in the wide area between the Scottsdale and Blue Tier Batholiths was modelled to be generally between two and four km deep. In the north-east, mid north and north-west of the tenement, the compilation suggests depths to granitoid of between one and two km.

FIGURE 3
North east Tasmania geology and heat flow



In the more recent work of Leaman (2008), areas such as north of the outcropping Scottsdale Batholith (Lyndhurst gold field) and between the Scottsdale Batholith and the Blue Tier Batholith at their south-east and south-west points respectively, models point to concealed granitoid bodies beneath Mathinna sediments at depths between two and four km. Interestingly, some of the deeper burials were within Geopower tenement boundary, for example line 5,423,000N.

Overall within the Geopower tenement, on present information the Mathinna Super Group rocks will probably rarely exceed four km in thickness, and large tracts of the formation appear to be only between one and three kilometres thick. A four kilometre package of 'average' Mathinna lithology and mixed foliation directions lying over a suitable radiometric granitoid would probably constitute sufficient thickness of insulation to produce at their base temperatures in the order of the target sought by Geopower. However on present knowledge there areas are neither large nor widespread, and are determined by geophysical modelling rather than drill hole intercepts.

Insulating characteristics of the cover sequence

In general, the thermal conductivity of a rock's constituent minerals strongly influences the overall thermal conductivity of the formation and hence it's insulating properties; other factors include the rock's anisotropy, porosity and density (Beardsmore and Cull 2001, Matthews and Beardsmore 2007). For instance, the 'average' thermal conductivity of quartz has been reported as 7.69 W/mK (Watts per metre degree Kelvin) which is more thermally conductive (less insulating) than the feldspar anorthite with 1.68 W/mK (figures tabulated in Beardsmore and Cull 2001). A sandstone may have a thermal conductivity of up to 7 W/mK, a mudstone about 3 W/mK, and coal (an excellent thermal insulator) 0.3 W/mK.

Holgate *et al* (2009) published values of eastern Tasmanian rocks, including those determined by Goh (2008). An average value for Mathinna Super Group sandstone was 4.4 W/mK whilst an average value for Mathinna shale was 2.7 W/mK. The latter value can be regards as being quite favourable for the purposes of an insulating blanket, although the proportion of shale to sandstone in complete vertical profiles of Mathinna Super Group rocks is largely guess work.

Rocks which have a well defined cleavage such as slates and schists have been found to have varying thermal conductivites, depending on whether the measurement was taken perpendicular (lower conductivity) or parallel (higher conductivity) to the cleavage. Antriasian (2009) and also Holgate *et al* (2009) published analyses of the effect of foliation on Mathinna rocks' thermal conductivities. For mudstones, thermal conductivities ranged from about 5 W/mK to about 1.5 W/mK as the measurement changed from parallel to foliation to perpendicular to it. The latter type of value would indicate good insulating characteristics but the foliation angle in any particular vertical package of Mathinna Super group rocks can be expected to vary considerably.

Due to the relative lack of knowledge about the overall structural attitude of Mathinna Super Group rocks, and uncertainty of the overall vertical composition of the sequence in the areas of interest, it is not possible to be definitive as to whether the Mathinna Super Group is a 'good' or 'bad' thermal insulator. Overall however, as long as there is a reasonable mix of foliation attitudes and not an over-abundance of sandy rock types in the cover sequence in question, the Mathinna Super Group can be expected to provide a reasonable insulating blanket for trapping heat.

Heat flow

The existence of a buried 'hot granitoid' may be indicated by the presence of anomalously high heat flow at or near the surface, although a number of factors can come into play which blur the relationship between a buried heat source and the surface heat flow above it, such as the presence of aquifers. Heat flow at the surface can be estimated from measuring a temperature profile down a borehole, together with thermal conductivities of the rock profile, then applying a mathematical treatment to derive the heat flow value, measured in mW/m^2 (1D thermal modelling – e.g. Beardsmore 2009).

Tasmania appears to lie within a broad domain of elevated heat flow in eastern Australia. Figure 4 is an image produced by Hot Dry Rocks Pty Ltd ('HDRPL') in 2009 where published surface heat flow values have been gridded to produce an Australia wide map. Details of the gridding routine nor the location of data points have not been published, so care should be exercised in interpreting this image and HDRPL note that it not intended for exploration purposes and no investment decision should be made based on it.

FIGURE 4.
Surface heat flow map of Australia.

The HDRPL map is probably more comprehensive than that published by Geoscience Australia (2009) but the form of the eastern Australian anomaly is essentially the same, and the latter has data points plotted, highlighting that data points are not distributed smoothly.

There are no known published heat flow values from within the Geopower tenement. A very high value of 159 mW/m^2 was published by Jaeger and Sass (1963) from a borehole in the Ben Lomond Batholith to the immediate south of the Geopower tenement, which supports the view derived from evidence of radiometric data (Collins *et al* 1981) and the differentiated/tin mineralised nature of the intrusives, that this is a 'hot' granitoid. Green (1989) published a value of 102 mW/m^2 from the Coles Bay granitoid to the south-east of the Geopower SEL; again, this granitoid body contains (uneconomic) tin mineralisation.

KUTh Energy Limited have conducted a systematic heat flow estimation program through most of their tenement SEL26/2005, which lies to the west and south of SEL37/2007 and have published maps showing point and contoured surface heat flow values (eg Holgate 2009). Figure 3 reproduces the heat flow contours and data collection points from that source. Heat flow contours published by

Holgate *et al* (2009) extend well into the Geopower tenement but do not appear to be geologically constrained in the latter, so will be disregarded.

The KUTh heat flows appear to fall into two broad domains as they relate to the Geopower tenement. To the west is a consistent low heat flow zone with values <80mW/m^2 centred on the Tamar Valley. The Tamar Valley is the most northerly expression of the postulated 'Tamar Conductivity Zone' (Hermanto 1992, Holgate 2009), thought to be a fluid rich, large-scale fracture zone. One of KUTh's holes, near Lisle very close to the Geopower tenement boundary returned a heat flow value of only 65 mW/m^2, in spite of the presence locally of small outcrops of the Lisle granitoid, part of the Scottsdale Batholith. KUTh Energy's contouring implies that the NW area of the Geopower tenement – that is, much of the Mathinna Super Group outcrop north-west of the Scottsdale Batholith outcrop – will also be relatively low in heat flow. Although highly radiogenic granitoids might be present beneath the Mathinna sediments within the Geopower area and able to create a more localised heat-flow high, the low-heat flow interpretation in the north-west area is supported by the gravity and magnetic modelling of Roach (1994) and Steve Webster Pty Ltd (2008). Their models suggest that a slice of ultramafic rock (a rock type unlikely to be significantly radiogenic) has been emplaced at between five and eight km depth through a broad area roughly co-incident with the extent of outcropping Mathinna Super Group in the western part of SEL37/2007. This would imply a lack of a significant body of granitoid to those depths and likely relatively low heat flow.

The second domain of KUTh Energy heat flow is along the southern boundary of SEL 37/2007 (Figure 3). The four bore-holes along and within 10 km of that boundary returned values of 87, 97, 83 and 106 mW/m^2, all generally anomalously high, with the 97 mW/m^2 and 106 mW/m^2 values especially so. The coarseness of the data points entitles one to regard the contouring at the tenement edge with some scepticism, and local features within the Geopower tenement will determine the heat flow there, but there does appear to be a trend to anomalously high heat flows through the Mathinna Super Group sediments in the southern portion of the Geopower tenement.

Adjacent Inferred geothermal resource

In March 2010, KUTh Energy Limited announced an estimated Inferred geothermal resource in the north-eastern corner of its SEL 26/2005 (KUTh Energy Limited 2010). The estimation, made via a 3D numerical model using heat flows determined from KUTh's shallow drilling program and other data, was for stored heat in an EGS-type reservoir within buried granitoid between 3.2km and 5.0km depth. Temperatures within the reservoir were estimated to be between 150°C and 220°C.

The northernmost point of the surface projection of the reservoir is within approximately 5km of the southern boundary of Geopower's SEL 37/2007, however no inference can be made about the presence of a geothermal resource on the Geopower tenement merely because of the proximity of KUTh's Inferred geothermal resource. Amongst other differences, the KUTh resource is capped by coal-bearing Parmeener sediments and doleritic intrusives (both good to reasonable thermal insulators) and these are generally lacking within the Geopower tenement. However the KUTh resource report supports the model of radiogenic granitoid beneath the Mathinna Super Group sediments in the southern reaches of the Geopower tenement.

Thermal gradient and estimated temperatures at depth

The use of assumed or extrapolated thermal gradients (°C/km) to estimate temperatures at depth can result in misleading results, and the author is not in favour of their use in poorly constrained environments. This is the case in areas such as eastern Tasmania, where there are no deep boreholes to check the Mathinna lithological profile, no measured temperature profiles beyond perhaps 750 meters and a generally poor understanding of the roles of heat conduction, heat convection and fluid movement. At the Soultz-sous-Forêts EGS project in France, observed high thermal gradients from the upper kilometre or so were found in drilling not to be sustained at depth (Fritsch 2008). Genter *et al* (2009) noted that in the upper section at Soultz, heat transfer was predominantly conductive, giving way to a convection dominated system at depth, with much lower thermal gradients and consequently lower temperatures at depth than were originally extrapolated.

A map of Australian estimated crustal temperatures at five km depth was published by Chopra and Holgate (2005) and generally shows Tasmania as being cool – below 160°C. However, Chopra (2007) noted that this work neglected the thermal blanketing of the Mathinna Super Group. Consequently the temperatures at 5 km in eastern Tasmania at least would be expected to be higher but in general such estimations in a poorly constrained geological environment are not very instructive.

Goh (2008) undertook simple 1D modelling of a number of scenarios of rock columns in eastern Tasmania in order to test surface heat flow values estimated by KUTh Energy Limited and in particular the effect of different lithologies in the sedimentary package on the heat flow. Some thermal gradients were calculated, but these do not refer to 'real' situations and are not applicable here.

Stress field / fracture system

One of the components of the Geopower geothermal model is the ability to enhance a set of preferably horizontal or sub-horizontal fractures in rocks immediately above a buried granitoid, which will allow cool fluids introduced by a drill hole to travel through the rock, picking up heat for delivery back to the surface. An inclined fracture set might be able to be utilised, but ones nearer horizontal are preferred (Chen and Wong 2009).

The ability of engineers to enhance a pre-existing fracture set in rocks at depth in general by hydraulic stimulation is well known in the petroleum sector and has been demonstrated in a number of 'EGS' class geothermal projects, including Geodynamics' Habanero project in South Australia (eg Asanuma *et al* 2009, Chen and Wyborn 2009). At Habanero, the fractured rock was the radiogenic granitoid at depths greater than 4 km. A better analogue for the Geopower project is the Paralana Project of Petratherm Limited in South Australia (eg Goldstein *et al* 2009). Petratherm is hoping to demonstrate their 'Heat Exchanger Within Insulator' (HEWI) model, where sediments lying immediately above a radiogenic basement will be fractured rather than the basement itself (King *et al* 2009). Quoting from King *et al* (2009):

> One of the principal limiting factors in commercialising EGS has been the inability to manufacture a heat exchanger of sufficient size and fluid production rate. Existing technical difficulties in achieving a robust sub-surface heat exchanger in EGS applications generally relate to the practice of developing the sub-surface heat exchanger within the heat producing granite rock. Granite is by nature an impermeable and mechanically strong rock.

> As a result it is inherently difficult for fluid to flow through granite, or to mechanically fracture the rock to develop an effective reservoir artificially. By comparison, the rocks which make up the overlying insulating sediments tend to have greater naturally occurring porosity and permeability, are mechanically weaker, and more susceptible to induced chemical and mechanical stimulation if enhancement of the reservoir is required.
>
> The Heat Exchanger Within Insulator (HEWI) model aims to exploit naturally permeable and porous insulating sedimentary rocks above the granite heat source. Where intrinsic permeability is inadequate, the HEWI approach will deliver greater control over the reservoir development through the hydraulic stimulation of these units. This strategy more closely approximates the systems successfully used in petroleum reservoirs and conventional geothermal projects. This enables the application of techniques for stimulation and geochemical mitigation developed in these industries.

It should be noted that the Paralana target rocks are deeper, lithologically different and generally have a more flat lying attitude compared to the Geopower target rocks. At the time of writing, the first 'production' hole at Paralana has been completed but no stimulation to enhance fracturing has been attempted, or at least announced publically.

The ability of Geopower to successfully enhance fractures in the Mathinna Super Group sediments above a radiogenic granitoid will depend on many factors, but prominent amongst them will be the direction of the *in situ* stress field, the depth of the target and the types of lithology, fractures and cleavages of the Mathinna rocks.

The stress conditions of Tasmania are poorly covered in the published literature. Clark and Leonard (2003) did not consider any cases from Tasmania and there are no Tasmanian data in the Australasian Stress Map (Hillis and Reynolds 2000, Reynolds 2009). The nearest data to Tasmania in the latter are in mid Bass Strait, offshore Gippsland Basin and offshore Otway Basin in Victoria. In most cases the maximum horizontal stress is NW-SE as it is for most of south-eastern Australia but the overall stress regime is classified as 'unknown'.

In general, the Australian continental stress field is regarded as favourable for EGS fracture propagation, due to the horizontal attitude of the direction of least compressive stress resulting from the Australian continent's current collision with the neighbouring plate to the north. However whether that field propagates as far south as Tasmania remains to be seen.

Given that Geopower intend to exploit a lower temperature reservoir than has been generally targeted in Australia before, especially EGS types, it may be that reservoir stimulation will be at shallower depths than others are attempting. Mortimer (2009) considered the case of 'Finite but low permeability rocks at shallower depths (≤4km)', such as graben structures (although 'high temperatures' were contemplated) and noted that:

> Rocks in these locations generally have higher *in situ* permeabilities and may be more easily stimulated due to lower confining pressures and rock mass stiffness. Reservoir rock types may also include non-crystalline, weaker rock types, such as layered sediments, within the insulating horizon. Layered sedimentary units may contain higher *in situ* permeabilities due to relatively higher fracture densities including bedding planes.

... but also that:

> The potential disadvantages of [this type of] reservoir targets are that reservoir growth may be more difficult to constrain with an increased probability of fluid losses. Within a sedimentary basin setting additional complexities may arise from an increased probability of chemical alteration from basinal fluids and an increased probability of local stress field perturbations due to major basin structures or interbedded rock types with significant mechanical contrasts.

Significant influences on reservoir fracture propagation for Geopower will be the lithology, presence and orientation of fractures etc and structural attitude of the intended reservoir Mathinna sediments immediately above the granitoid. The Mathinna package in the south-eastern portion of the tenement appears to be thick enough and have the best potential for high heat flows from an intrusion of radiogenic granitoid at depth. The first thing to observe is that the position within the Mathinna sequence that the granitoid has intruded to is unknown. If the granitoid topped out near the base of the Mathinna, then the sediments would be relatively quartz rich (Powell *et al* 1993) and probably thermally metamorphosed into a quartzite or similar. Quartzite being a relatively brittle rock would be prospective for fracture propagation, although the direction would be largely determined by the existing fracture orientation. However if the granitoid intruded higher up the sequence, quartz would be less abundant and the rocks would likely be contact metamorphosed to pelitic hornfels type rocks.

Most of the Mathinna Super Group is deformed (folded) and has one or more slaty cleavages (Powell *et al* 1993). Any attempt to hydraulically fracture such rocks may see the fractures tend to propagate along pronounced cleavage and remnant bedding planes as well as existing fracture sets, and so the orientation and extent of the resultant fracture network will be less certain than in an undeformed sediment or even in a granitoid. Modelling would assist in predicting the outcome (e.g. Mortimer 2009).

A field visit to the Geopower tenement allowed the opportunity to examine a number of outcrops of Mathinna Super Group, and to follow mapping published by Mineral Resources Tasmania. In almost all Mathinna outcrops examined, at least one prominent slaty cleavage was present and generally these were steeply oriented. Mapping at 1: 50,000 by geologists of Mineral Resources Tasmania (Mineral Resources Tasmania 1993) shows that in the southern portion of the Geopower tenement between the Scottsdale and Blue Tier Batholiths, both bedding and primary cleavage in Mathinna sediments have orientations dominated by north-westerly strikes and 80° or steeper dips. In several good outcrops (including one outside, but close to the Geopower tenement) a number of fracture sets were observed in the Mathinna sediments (Figure 5) and these were often occupied by thin (<5mm) quartz veins. Whilst it was not always possible to obtain a true dip, it appeared that dips <30° were not uncommon in these fractures. If these fracture sets are typical of the Mathinna at depth, then they would be beneficial in countering any dominance of steep bedding and cleavage when it comes to fraccing.

Taking all the above into account, it can be stated that the ability to stimulate a geothermal reservoir in the Mathinna Super Group, which can be expected to be deformed, have considerable fabric anisotropies and uncertain fracture characteristics at depth, is uncertain and this adds a layer of uncertainty to the proposed project.

Figure 5

Road cutting of Mathinna Super Group sediments. Planar bedding dipping top left to bottom right; fracture sets generally left to right, but note these are apparent, not true dips.

This outcrop is not within the Geopower tenement, but approximately 2km south.

Limitations, indemnities and consents

This Independent Geologist's Report was prepared at the request of Geopower Limited in a letter dated 9 November 2009. In the preparation of this report I have relied on information provided to me by the Company who has asserted that they would not with-hold any relevant information, including confidential information. I made a field visit to the area in January 2010 but I note that most of the geological aspects pertinent to the report are not observable in surface outcrop. The report is presented in good faith and is an accurate summary of my opinion in relation to the geothermal prospectivity of the Company's geothermal exploration licence, given its particular model. I make no comment on the valuation of that tenement or of Geopower shares, nor express an opinion on land access or ownership impacts, including native title and heritage matters.

Draft copies of this report were reviewed for factual errors by the Directors of Geopower Limited but none were noted.

Geopower Limited has provided me with an indemnity against loss or damage resulting from the reliance by me on information provided by Geopower that is inaccurate or incomplete, except where the claim is as a result of proven negligence, misconduct or breach of the agreed mandate/scope of the engagement. Geopower has also agreed to make a daily payment in respect of any extensions of the work including questions, clarifications, public hearings or additional written reports.

Qualifications and Independence

I am an independent geoscience and management contractor and have worked in the minerals sector in Australia and offshore for approximately 30 years. I was involved in the management and technical planning and oversight of Tasmanian geothermal explorer KUTh Energy Limited 2007-2008 and hold shares in that company. Since leaving KUTh Energy I have consulted in the geothermal sector in Australia and overseas, servicing both Australian and offshore clients and have presented papers at Australian and international geothermal conferences.

I hold a Bachelor of Science degree with First Class Honours in geology from the University of Tasmania and a Master of Science degree from Queen's University, Ontario, Canada. I am a Member of the AusIMM and Geothermal Advisory Pty Ltd is a member of the Australian Geothermal Energy Association (AGEA) and the Australian Geothermal Energy Group (AGEG). At the time of writing I am the Chairman of the joint AGEA/AGEG Geothermal Reporting Code Committee and also serve on the Legislation Committee of AGEA.

I have not previously undertaken any work for Geopower, or its related entity Macquarie Harbour Mining Limited ('MHM'). Neither I, my family, Geothermal Advisory Pty Ltd or entities I control, (or their Directors) own or control shares or have any other material interest in Geopower or MHM or any of their tenements. My relationship with the Company is strictly as an independent consultant. I will receive a fee in line with prevailing commercial rates for the preparation of this Report, plus out-of-pocket expenses. The payment of the fee is payable irrespective of the conclusions in this Report.

<<Signed>>

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