Hot Dry Rocks Pty Ltd
Geothermal Energy Consultants

HEAD OFFICE
PO Box 251
South Yarra, Vic 3141
Australia
T +61 3 9867 4078
F +61 3 9279 3955
E info@hotdryrocks.com
W www.hotdryrocks.com

ABN: 12 114 617 622

SERVICES
Exploration
Rock Property Measurements
Project Development
Portfolio Management
Grant Applications

Heat flow modelling of selected wells in SEL26/2005, Tasmania

Prepared for KUTh Energy Ltd (KEN)

Date 21 APR 2008 Draft 1.1

Gareth Cooper & Ben Waining

Executive summary

Four (4) shallow wells in SEL26/2005 (Tasmania) were measured by Hot Dry Rocks Pty Ltd (HDRPL) for equilibrated downhole temperature. The same wells were sampled and core samples measured for rock thermal conductivity. These data have been combined using HDRPLs 1D Heat Flow Modelling Software to produce modelled surface heat flow values for each well.

The resulting surface heat flows for each well are summarised in the table below:-

Well	Snow-1	Lake Leake-1	Elizabeth-1	Tooms-1
Modelled Heat Flow (mW/m^2)	92.0 ± 2.3	92.0 ± 2.9	94.0 ± 2.4	96.0 ± 2.5* 63.3 ± 1.3*

All four wells have consistent heat flow values (ranging from 92-96 mW/m^2) although Tooms-1 has an unusual temperature profile suggesting possible convection at the base of the well. This has the influence of reducing heat flow at the base of Tooms-1 to 63 mW/m^2, although the overall modelled surface heat flow of the well is approximately 96 mW/m^2.

The range of heat flow values modelled for these four Tasmanian wells is within the range of heat flow values reported for parts of the Cooper Basin and the Adelaide Fold and Thrust Belt (South Australia) and fall within the upper 17% of heat flow values recorded for Australia in the *Global Heat Flow Database*.

Table of Contents

1.0 Introduction

Hot Dry Rocks Pty Ltd (HDRPL) has been commissioned by KUTh Energy Ltd (KEN) to undertake heat flow modelling of selected wells in their tenement (SEL26/2005).

SEL26/2005 is located in eastern Tasmania and extends from George Town in the north of the state to Hobart in the south. As part of its work program, KEN is undertaking a shallow drilling program to define heat flows within their tenement. This report provided modelled heat flow values for the following shallow wells:-

- Elizabeth-1
- Tooms-1
- Snow-1
- Lake Leake-1

Heat flow models described in this report incorporate rock thermal conductivity measurements and calibrated precision temperature logs recently undertaken by HDRPL for the same wells.

2.0 Introduction to heat flow

Heat flow is a power unit expressed at surface (mW/m^2) and is a function of heat generated within the crust plus heat conducted from the mantle.

The principle aim of geothermal exploration is to locate anomalously high temperatures at an economically and technically viable drilling depth. Temperatures are usually expressed at the surface in the form of heat flow units (mW/m^2) and it is generally assumed that heat is transported to the surface by conductive means.

In a conductive heat regime the temperature **T**, at depth **z** is equal to the surface temperature $\mathbf{T_0}$ plus the product of heat flow **Q** and thermal resistance **R**, such that:

$\mathbf{T=T_0+QR}$, where **R**=**z**/(average thermal conductivity between the surface and **z**).

Consequently the most highly prospective regions for geothermal exploration are those that have geological units of sufficiently low conductivity (high thermal resistance) in the cover sequence combined with high heat flow.

Heat flow is a product of temperature gradient and rock thermal conductivity and is therefore a modelled value (not directly measured). Consequently, the modelling of heat flow is a precision skill that requires a detailed understanding of physical conditions in the bore and the physical properties of the rocks; including advective processes that may influence bore temperature (such as ground water flow) and the temperature dependence of conductivity.

HDRPL utilises its own 1D Heat Flow Modelling Software for the modelling of both advective influences and temperature dependence. The results of 1D heat flow modelling should be treated with caution when extrapolating data spatially over considerable distance.

3.0 Results of heat flow models

3.1 Summary of modelled surface heat flows

A summary of modelled surface heat flow results is shown in table 1. Sections below describe detailed information about each model.

Table 1. Summary of modelled surface heat flows for shallow wells in SEL26/2005

Well	Snow-1	Lake Leake-1	Elizabeth-1	Tooms-1
Modelled Heat Flow (mW/m^2)	92.0 ± 2.3	92.0 ± 2.9	94.0 ± 2.4	96.0 ± 2.5* 63.3 ± 1.3*

* Tooms-1 heat flow appears to be influenced by heat entering the bore via an extensive fracture and fault network at about 170-180 m. This has perturbed the modelled heat flow which is more likely to be around 96 mW/m^2 based on modelled results.

3.2 Snow-1 modelled surface heat flow

The heat flow model for Snow-1 (Fig. 1) illustrates a very good fit between measured conductivity and calibrated precision temperature data. Upper conductivities values (not measured) have been assumed at 2.4 W/mK being the upper end of the measured distribution. The modelled surface heat flow is **92.0 ±2.3 mW/m^2** over the conductivity-constrained interval.

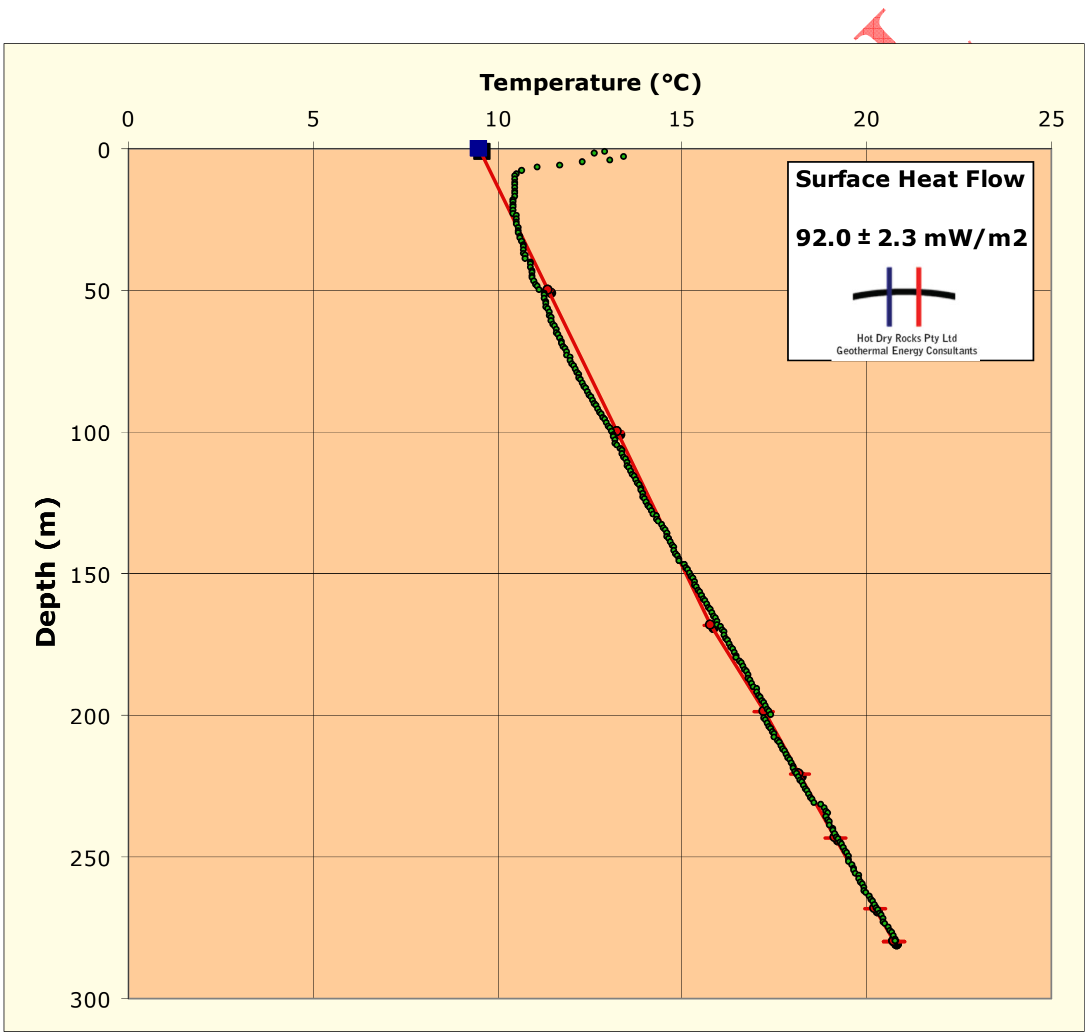

Figure 1. Snow-1 – modelled surface heat flow based on rock thermal conductivity data (red points) and precision temperature logs (green line). Upper divergence in temperatures is due to air and cooled water at the top of the bore.

3.3 Lake Leake-1 modelled surface heat flow

The heat flow model for Lake Leake-1 (Fig.2) illustrates an excellent fit between measured conductivity and calibrated precision temperature data. Upper conductivities values (not measured) have been assumed at 2.4 W/mK being the upper end of the measured distribution. The modelled surface heat flow is **92.0±2.9 mW/m^2** over the conductivity-constrained interval.

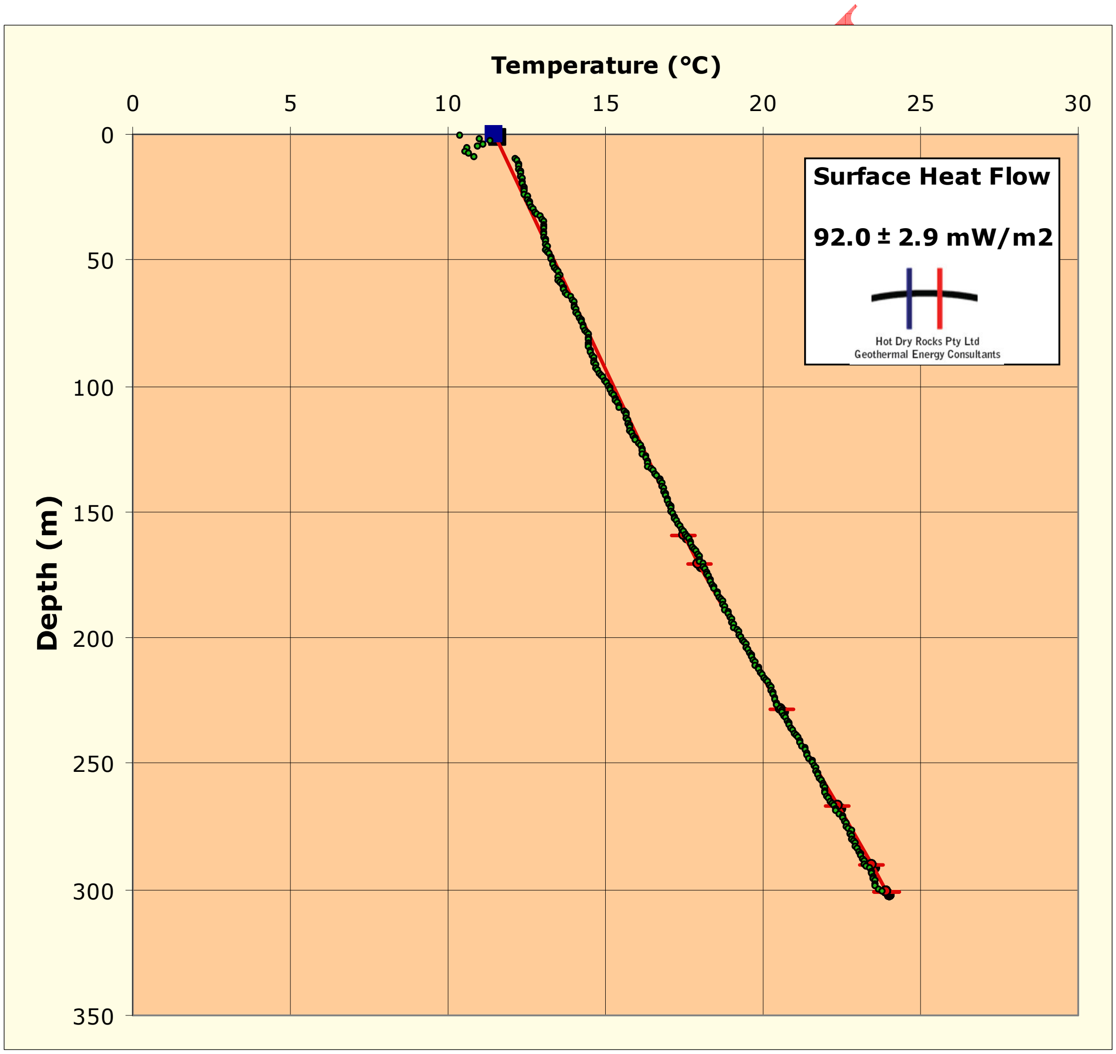

Figure 2. Lake Leake-1 – modelled surface heat flow based on rock thermal conductivity data (red points) and precision temperature logs (green line). Upper divergence in temperatures is due to air and cooled water at the top of the bore.

3.4 Elizabeth-1 modelled surface heat flow

The heat flow model for Elizabeth-1 (Fig.3) illustrates an excellent fit between measured conductivity and calibrated precision temperature data. Upper conductivities values (not measured) have been assumed at 2.4 W/mK being the upper end of the measured distribution. The modelled surface heat flow is **94±2.4 mW/m^2** over the conductivity-constrained interval.

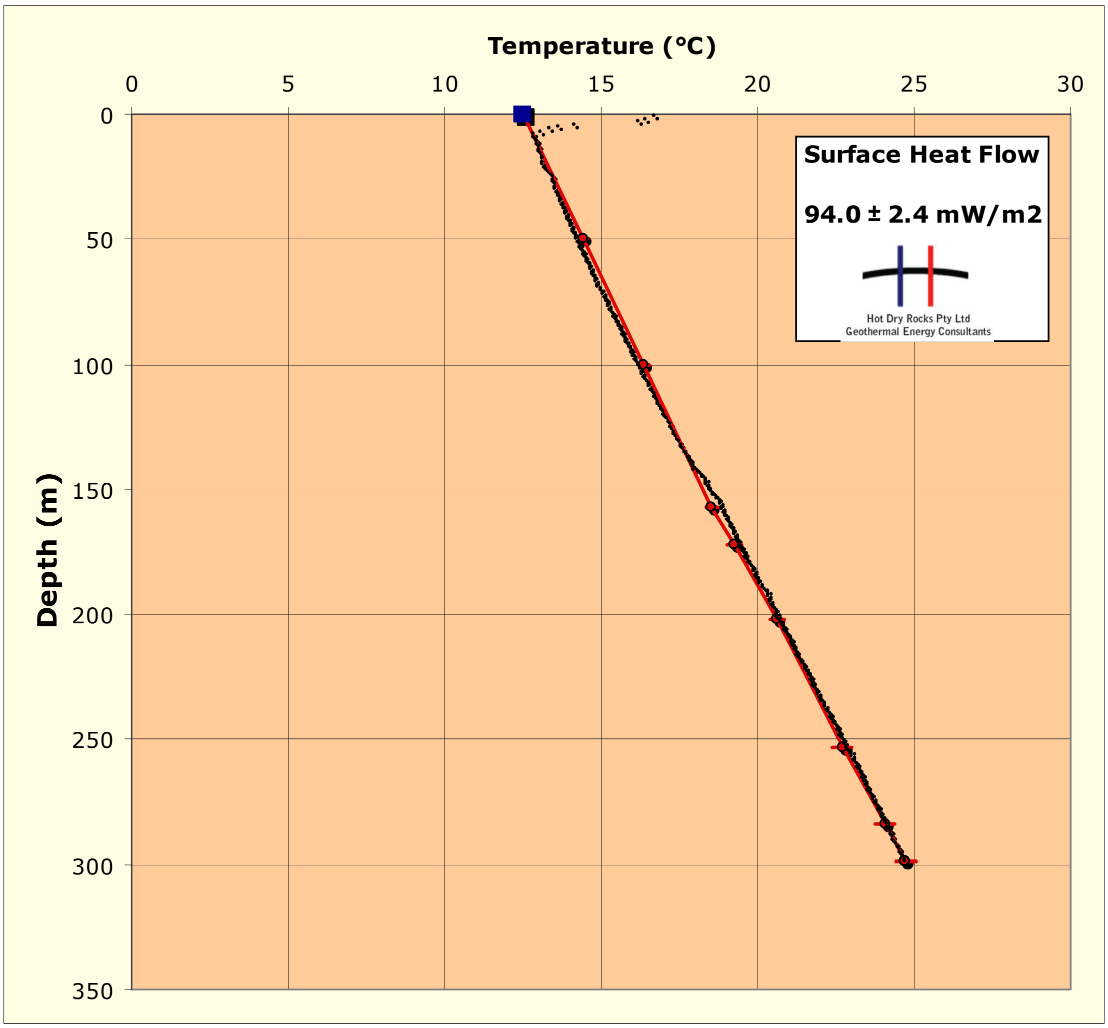

Figure 3. Elizabeth-1 – modelled surface heat flow based on rock thermal conductivity data (red points) and precision temperature logs (green line). Upper divergence in temperatures is due to air and cooled water at the top of the bore.

3.5 Tooms-1 modelled surface heat flow

The heat flow model for Tooms-1 (Fig.4) illustrates a good fit between measured conductivity and calibrated precision temperature data. Upper conductivities values (not measured) have been assumed at 2.4 W/mK being the upper end of the measured distribution.

Modelling for Tooms-1 is however complicated by the strongly sygmoidal geometry of the temperature profile, indicating probable convection within the deepest part of the bore. Modelling suggests that a significant amount of heating may be added between 154 and 204m depth with the addition of approximately 62 mW/m^2. This may suggest shallow warm waters are entering the bore at this level via a fracture network within dolerite.

This has the overall influence of reducing the modelled heat flow iin the base of the well to **63.3±1.6 mW/m^2**. This value is inconsistent with regional trends and given the complexities of heating processes within this bore, it is recommended that lowest conductivity values should only be considered when expressing surface heat flow. This would estimate surface heat flow at **96.0±2.5 mW/m^2**, consistent with other wells modelled in this report.

This zone of significant heat addition coincides with an area of extreme fracturing and faulting within the core where upto three (?reverse) faults were noted during inspection. The location of fractures and faults is shown as pink polygons on figure 4.

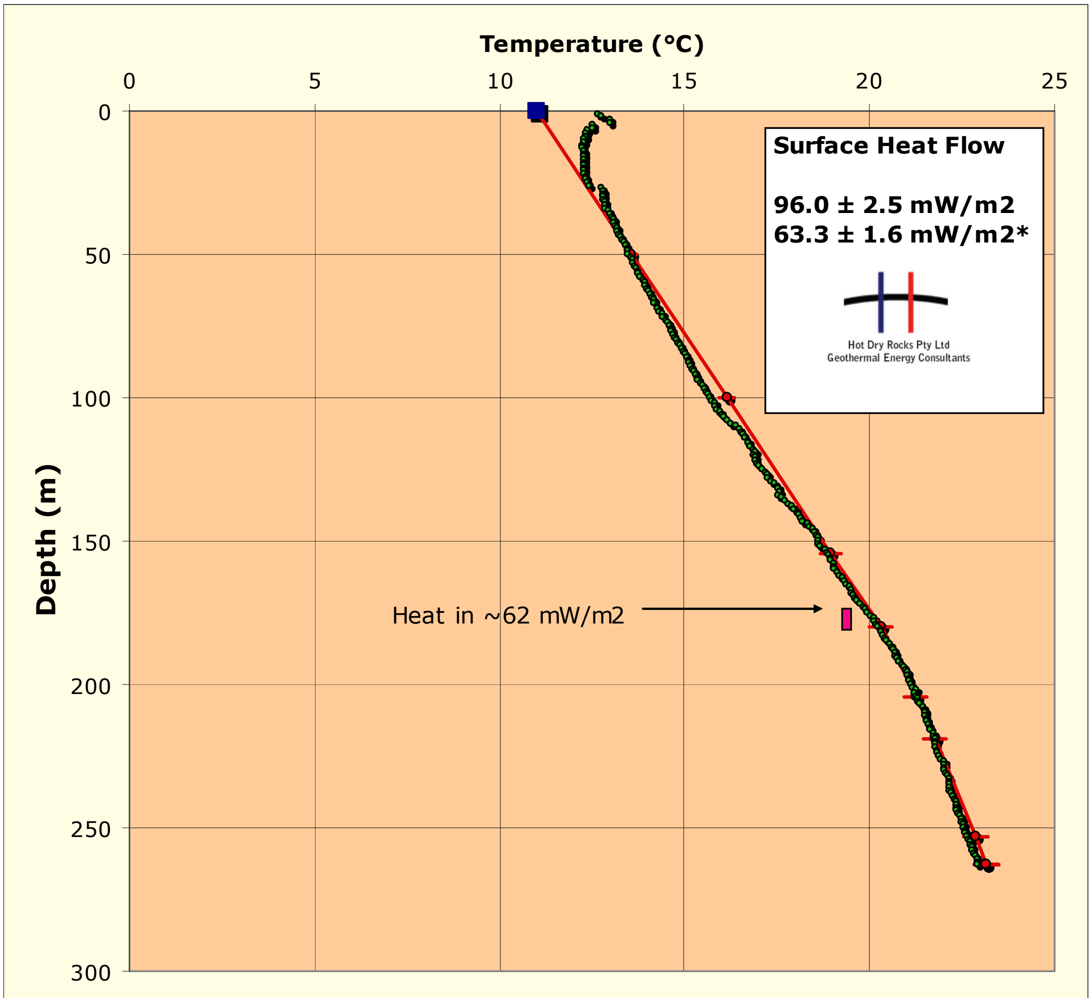

Figure 4. Tooms-1 – modelled surface heat flow based on rock thermal conductivity data (red points) and precision temperature logs (green line). Upper divergence in temperatures is due to air and cooled water at the top of the bore. A significant amount of heat ~62 mW/m2 may be added to the bore between 154-204m depth, possibly due to the flow of warm water through a fracture network. *This possible convective heat flow has perturbed the modelled heat flow in the base of the well (63 mW/m2). However the real surface heat flow is probably about 96 mW/m2 based on the deepest conductivity data. Pink polygons denote zones of extensive fracturing and faulting noted in core.

4.0 Comparative interpretation of heat flow data

Modelled surface heat flow values for SEL26/2005 range between 92 and 96mW/m^2. These Tasmanian data are within the range of values commonly reported in many parts of the Cooper Basin, South Australia (Beardsmore, 2005 & McLaren et al, 2003)[1] and recently reported for the Adelaide Fold and Thrust Belt (South Australia).

Figure 5 illustrates the distribution of heat flow data modelled in this report (orange polygon) with respect to those values presently available for all of Australia within the *Global Heat Flow Database*. Values modelled in this report for SEL26/2005 are all within the top 17% of heat flow values for Australia in the *Global Heat Flow Database*.

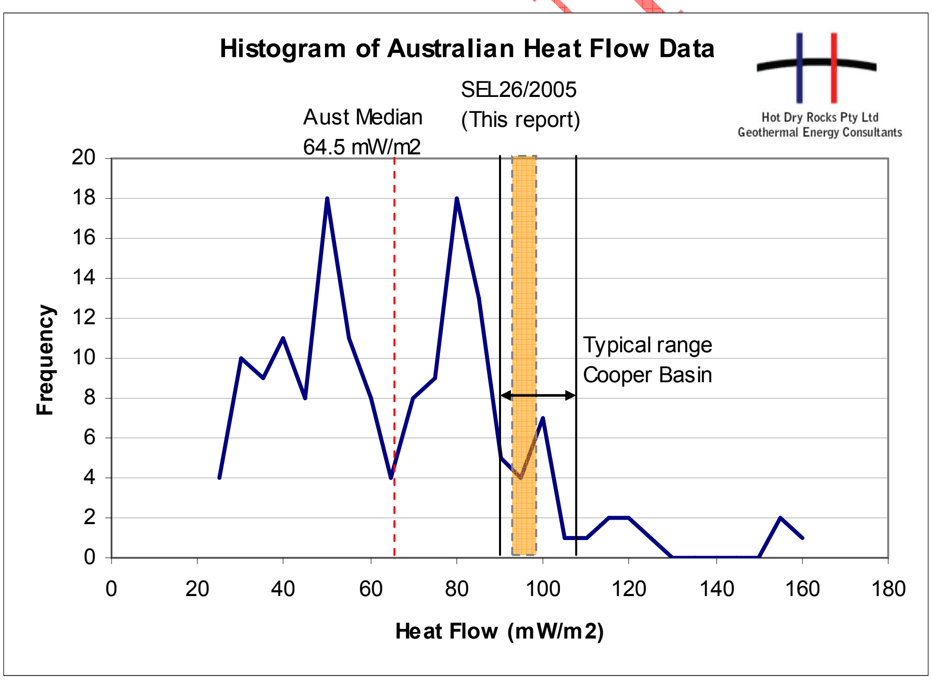

Figure 5. Distribution of Australian heat flow data from the Global Heat Flow Database showing relative position of values commonly reported for the Cooper Basin (South Australia) and values modelled for SEL26/2005 (Tasmania) in this study (orange polygon).

[1] **Beardsmore, G.R.** (2005). Thermal modeling of the hot dry rock geothermal resources beneath GE99 in the Cooper Basin, South Australia. Proceedings of the World Geothermal Congress 2005, Antalya, Turkey. CD-Rom.

[2]**McLaren S, Sandiford M, Hand M, Neumann N, Wyborn L and Bastrakova I** (2003). The hot southern continent: heat flow and heat production in Australian Proterozoic terranes. Geological Society of Australia Special Publication 22, pp 151-161.

5.0 Conclusions and recommendations

Modelled surface heat flow values for four shallow wells in SEL26/2005 are generally consistent and range between 92 and 96mW/m^2. These values are similar to those commonly reported for parts of the Cooper Basin and Adelaide Fold and Thrust Belt (South Australia).

The following recommendations are presented for the clients consideration:-

- Continued conductivity measurement, precision temperature logging and heat flow modelling for other parts of SEL26/2005 to increase the density of available quality heat flow data.
- Thermal conductivity measurement of selected wells in the 0-150m interval so as to better constrain conductivity-temperature relationships for the upper well section and define advective processes (if present).
- Deep 1D heat flow modelling of selected areas based on data available in this report and from deeper stratigraphy defined from regional reflection seismic data and/or regional cross-section and mapping data. This should provide preliminary estimates of projected temperature at depth.