

Power down under

Annual Report 2010

**SEL 57/2008 (First Annual Report)
13th May 2009 - 13th April 2010**

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KUTh
E N E R G Y

Summary

KUTh Exploration Pty Ltd (KUTh) holds three Special Exploration Licences in Tasmania for Category 6 minerals (geothermal substances). The principle target of KUTh's work on these tenements is the location of high-temperature Hot Rock geothermal resources suitable for development as Enhanced Geothermal System (EGS) power generators. This annual report covers work completed in the year 13/5/2009 – 13/4/2010 on tenement SEL 57/2008. This is the first Annual Report lodged for SEL57/2008, which was granted on 13/5/2009. SEL 57/2008 is located in central Tasmania and incorporates a total area of 3980km².

Work commenced and/or completed on the tenements in this period includes:

- A comprehensive geological review incorporating compilation of existing surface geology, borehole and geophysical data together with data acquired by KUTh on its neighbouring tenement SEL 26/2005.
- Re-interpretation of open-file seismic reflection data, previously generated by Great South Land Minerals Pty Ltd in 2001, by Hot Dry Rocks Pty Ltd.
- A magnetotelluric (MT) survey across both SEL 57/2008 & neighbouring SEL 26/2005, extending the results produced from a previous survey on SEL 26/2005 in October 2008. Modelling of data derived from this survey confirmed a southern extension of the electrically conductive anomaly known as the Tamar Conductivity Zone (TCZ) into SEL 26/2005 but not west into SEL 57/2008. Analysis of results produced by 3D modelling of these data suggest that an anomalous heat flow value observed at Macquarie, (adjacent to SEL 57/2008) may be the product of fluid advection along an adjacent east-dipping fracture system.

The combined results of work completed to date indicate that the potential for geothermal resource development within the tenement area is most likely limited to the upper NE quadrant adjacent to the Macquarie heat flow anomaly (103mWm⁻²) previously observed by KUTh in tenement SEL 26/2005. Whilst insulating sequences are present across the tenement, the area is interpreted to be underlain by Pre-Cambrian or Cambrian formations that are unlikely act as heat sources. There are no indications of granite at depth. This being the case, a recommendation for partial surrender of those areas of SEL 57/2008 which are considered unlikely to be prospective for economic geothermal resources has been made.

Future work planned for the retained portion of SEL 57/2008 includes:

- Commissioning of an honours project (or equivalent) to collect new magnetic and gravity profile data across gaps in the local coverage (\$5000)
- Commissioning of a detailed linked gravity/magnetic/seismic interpretation along existing GSLM lines in the NE of the tenement area (to match existing work completed on behalf of GSLM on lines to the south and west) (\$10,000)
- Investigate the possibility of Heat Flow measurement in existing HEC boreholes in the west of the retained area (\$5000)
- Thermal modelling of the Macquarie heat flow anomaly (\$10,000)

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1 Introduction

KUTh Exploration Pty Ltd (KUTh) is a geothermal explorer based in Hobart, Tasmania and is the holder of three current geothermal exploration licences in that State. The principle target of KUTh's work is the location of high-temperature Hot Rock geothermal resources suitable for development as Enhanced Geothermal Systems (EGS) power generators. Whilst the primary goal of this work is to produce electrical energy, the company also maintains an interest in both cascading and direct-use applications for geothermal energy.

This annual report covers work completed in the period 13/5/2009 – 13/4/2010 on KUTh's tenement SEL 57/2008. This is the first Annual Report lodged for this tenement.

1.1 Tenement Status

KUTh Exploration Pty Ltd (KUTh) is a subsidiary of KUTh Energy Ltd and is the sole holder and operator of SEL 26/2005, SEL 45/2007 and SEL 57/2008 (Figure 1). All three tenements were granted for periods of five years to search for geothermal substances (Category Type 6). Tenure details of SEL 57/2008, granted in May 2009, are included in Table 1.

Tenement Type	SEL
Number	57/2008
Commodity	Geothermal
Licensee	KUTh Exploration P/L
Operator	KUTh Exploration P/L
Area	3980km ²
Date Granted	13/05/2009
Renewal	07/08/2011

Table 1: Tenure details for SEL 57/2008.

1.2 Location and access

SEL 57/2008 is located across the Central Highlands and Lakes area of Tasmania incorporating the northern boundary of the Great Western Tiers from Poatina south to Bothwell and east to Miena (Figure 1). Access is primarily via the Lakes Highway which bisects the tenement diagonally from Bothwell to Miena and the Lyell Highway which passes through the south-western corner of the tenement. A number of minor roads connect various localities to the highways and, together with farm, and powerline tracks, provide reasonable access to the majority of the tenement. A small number of areas are excluded from SEL 57/2008, these consist of nature and game reserves, a gas pipeline easement and various other features.

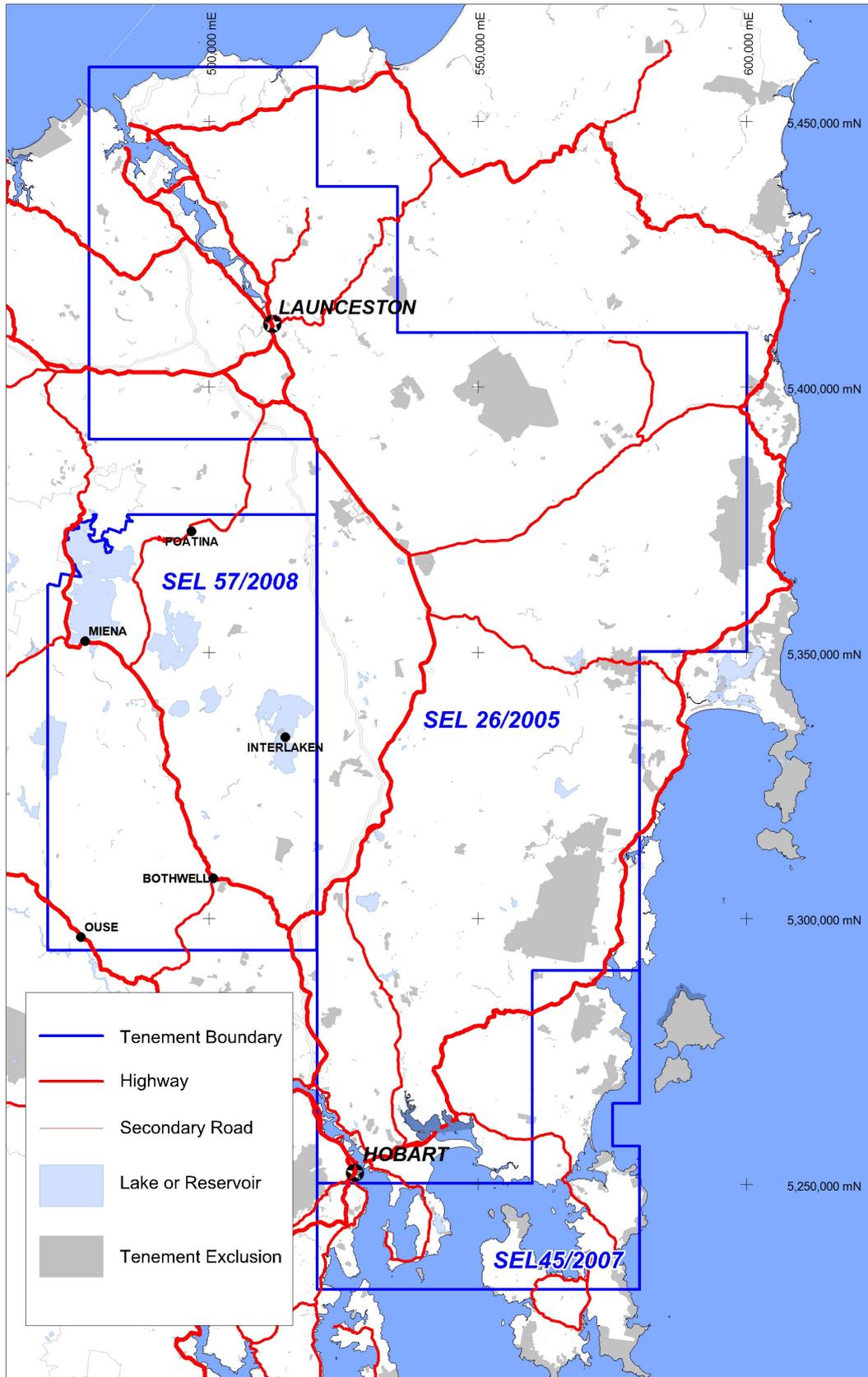


Figure 1: KUTh Energy tenement boundaries including restricted areas (exclusions within tenement boundaries). SEL 57/2008 was granted on the 13th May 2009. Total combined tenement area is 18,151km².

1.3 Topography and vegetation

Topographically, SEL 57/2008 is dominated by a broad dolerite plateau which extends across most of the licence area. Elevations are greatest in the north-west where the Great Western Tiers rise over 1000m above the low-lying country to the north. Elevations generally decrease southwards across the tenement area. Atop the plateau various engineering projects have resulted in the creation of a number of large lakes and reservoirs for water storage and hydro-electricity generation. Vegetation is controlled primarily by topography with dry eucalypt forest dominant across much of the tenement giving way to alpine heath and moorland in highland areas and native grasslands and developed pasture in lower lying valleys and plains.

1.4 Geological setting

Tasmania is divided into two basement terrains located in the west and east of the State (Figure 2). Distinguished by age, lithology and deformation these two regions are 'believed to have been juxtaposed at a NNW trending dislocation' inferred to coincide with the Tamar Valley region in central Tasmania (Burrett & Martin, 1989). The Western Terrain comprises variably deformed and metamorphosed Pre-Cambrian basement, the now-deformed Cambrian volcanics and sediments of the Dundas Trough and Mt Read Volcanic Belt and the Ordovician-Silurian shelf sediments of the Wurrawina Supergroup. In the East, deformed low-grade meta-sediments of the Ordovician – Devonian Mathinna Supergroup comprise deep water turbidite deposits that are analogous to the ubiquitous Tasmanide flysch of mainland eastern Australia. Similarities in the deformation and depositional style of the Mathinna Supergroup and mainland Tasmanide units have led to numerous attempts to correlate the two, the Mathinna being compared variably to the Melbourne Trough and the Tabberabbera Zone of central and eastern Victoria (Powell & Baillie, 1992; Reed, 2001).

Across much of the state, basement is concealed by up to 1km of flat-lying Permian-Triassic sediments of the Tasmania Basin and the extensive thick (>300m) Jurassic dolerite sills which intruded these during Gondwana break-up. Mesozoic and Tertiary cover, including extensive dolerite, shale, silt and some coal formations, totally obscure the contact between the Pre-Cambrian Western and Palaeozoic Eastern terrains, which is inferred lie to the east of the tenement area.

Both Western and Eastern Terrains host Devonian granite, the most extensive intrusions being the slightly older batholiths in the East (Burrett & Martin, 1989). Exposures of Devonian-aged granite in the far north-east of the state are known to include highly-fractionated high-heat-producing (HHP) granites as part of three major suites (Figure 2; Burrett & Martin 1989). To the south and west of this area, the exposed granite plunges beneath cover which potentially provides the insulation necessary for a classic Hot Dry Rock or Enhanced Geothermal System (EGS) target. Complicating this picture is the presence of a known electrical conductivity anomaly observed in the northern Tamar Valley area and referred to as the Tamar Conductivity Zone (TCZ) (Figure 2; Hermanto, 1992). Coinciding broadly with the boundary of the East and West terrains, the TCZ has been interpreted an indicator of fluid in fractured permeable zones (Hermanto, 1992). Intersection between the TCZ and buried HHP granites may thus imply the presence of an existing fracture-permeable geothermal system in Eastern Tasmania.

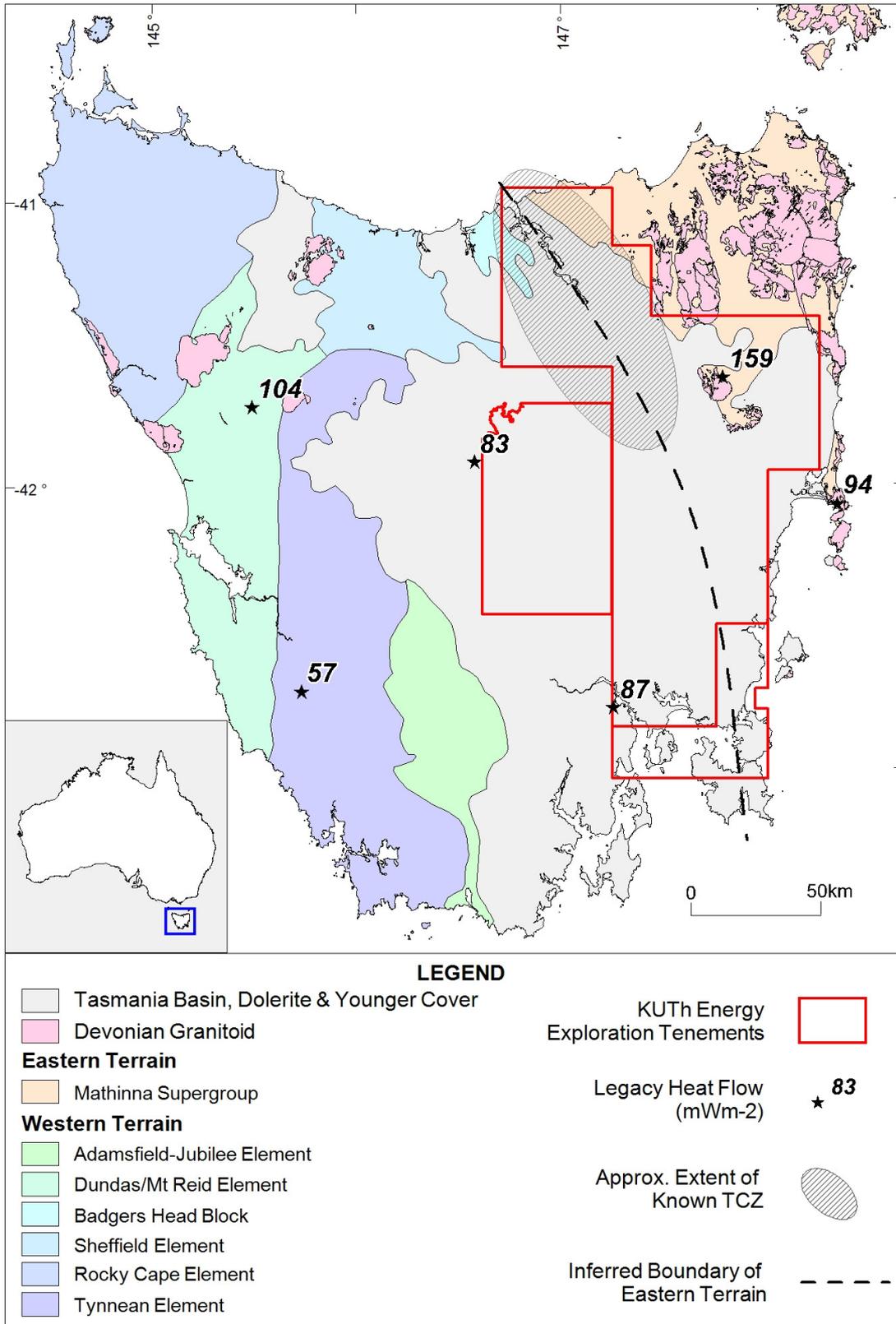


Figure 2: Regional geology of Tasmania showing the major crustal elements. Legacy heat flow data are as summarised by Cull (1991). Also shown is the approximate extent of the known TCZ prior to recent MT survey work.

2 Previous Exploration

Extensive, thick dolerite cover combined with significant topographic relief imply that much of the area beneath SEL 57/2008 remains under-explored. No previous systematic geothermal exploration has been attempted across this area.

Hot Rock or EGS geothermal play models require a number of elements to coincide within a given area in order to produce the conditions necessary for the existence of an exploitable crustal temperature anomaly. Key amongst these elements are the presence of a heat source (most commonly radiogenic or HHP granites) combined with an overlying insulating sequence. For commercial development a suitable reservoir unit must be present within drillable depth (above 5km). For a Hot Rock EGS this unit must be a significant body of relatively hard, uniform rock suitable for fracture stimulation. Alternative reservoir units may comprise porous aquifer sequences or rocks which host permeable structures such as fractures.

Information regarding the *in situ* geological relationships at surface and depth are thus relevant to geothermal explorers and, even in the absence of specific thermal data, may be sufficient to determine the geothermal prospectivity of an area. To this end, a summary of available relevant geological data on SEL 57/2008 is presented.

2.1 Surface Geology & Stratigraphic Drilling

SEL 57/2008 is overlain by six 1:50,000 geological map sheets (clockwise from NW corner): Great Lake, Lake River, Interlaken, Oatlands, Ouse and Lake Echo. A simplified stratigraphic column derived from surface mapping is provided in Figure 3.

The basement geology within SEL 57/2008 is almost entirely obscured by younger sequences with the exception of a number of small inliers located along the north-west trending margin of the Great Western Tiers (Figure 4). Where exposed, basement comprises metabasalt, volcanogenic metasediment, pelitic metasediment and minor dolomite and is interpreted to be of Proterozoic – Cambrian age (Matthews *et al.*, 1996). Strong NE-E facing cleavage is evident in outcrop, although the exposure is not sufficient to characterise folding or other structures (Matthews *et al.*, 1996). Basement units are also encountered in deep stratigraphic drilling (RG145) located near Tunbridge to the east of SEL 57/2008 (Figure 4). Metasediments observed between 908 - 914.5m in this hole display multiple deformations with folding, foliation and multiple episodes of quartz-carbonate veining. Petrological analyses of these rocks have concluded that they are analogous to Pre-Cambrian units of the northern Badger Head Group (Western Tasmanian Terrane), although no quantitative age determinations are yet available to confirm this (Forsyth, 1989).

Cover rocks within the tenement area are dominated by the sediment of the Permo-Triassic Tasmania Basin (Parmeener Group) and the younger Jurassic Dolerite which intrudes them. Parmeener Group sediments are generally divided into two sub-groups, the older (Permian), dominantly marine, Lower Parmeener and the younger (Triassic), fluvial/lacustrine, Upper Parmeener. Basal sequences typically comprise a distinctive glacial

till which unconformably overlies basement and which displays significant lateral thickness variations. These are in turn overlain by sequences dominated by fossiliferous marine mudstone and siltstone with minor sands. Intercalated with these rocks is a freshwater horizon associated with the formation of Permian coal beds (Mersey Coal Measures and equivalents). The stratigraphy of the Upper Parmeener sub-group has not been formally described but it is generally considered to comprise basal feldspar and quartz sand units overlain by lithic and volcanic-lithic sand and silt. Coal measures are recorded at two stratigraphic levels with Late Permian seams (Cygnet Coal Measures) commonly observed in basal sequences and widespread Late Triassic seams associated with lithic sandstone units.

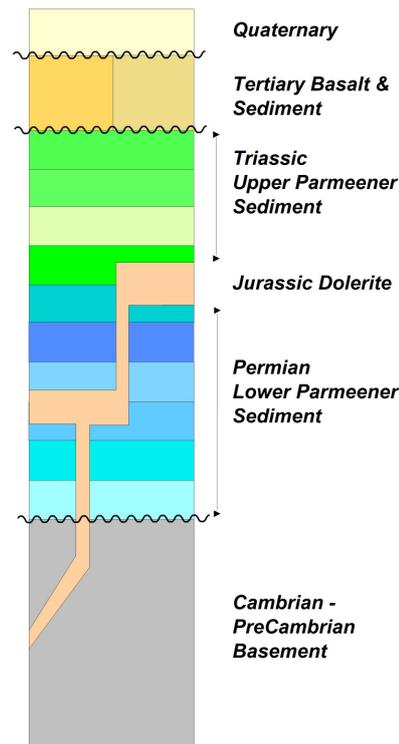


Figure 3: Simplified stratigraphic column for SEL 57/2008

Parmeener sediments are generally observed to be flat-lying with bedding dips of $<10^\circ$ (Forsyth, 1984). Block faulting has led to offsets and tilting but there is little to no evidence of folding in the region of SEL 57/2008 (Matthews *et al.*, 1996; Forsyth, 1989; Forsyth, 1984). Sediment thicknesses of up to 1700m are predicted within or adjacent to the tenement although considerable lateral variation is apparent due both to basin geometry and later faulting (Forsyth, 1989). Stratigraphic drilling at Tunbridge (RG145) intersected a near-complete Lower Parmeener sequence ~900m thick. A borehole at Mount Vernon (MTV-1) in the south-east of the tenement (Figure 4) intersected a significant Upper Parmeener sequence, including a 2.3m thick Triassic coal seam at 205m (Bacon, 1983). Data compiled from regional water bore drilling indicates that Parmeener rocks may be host to fracture permeable aquifer systems, although their prospectivity is expected to be reduced in the highland areas (Bacon & Latinovic, 2003).

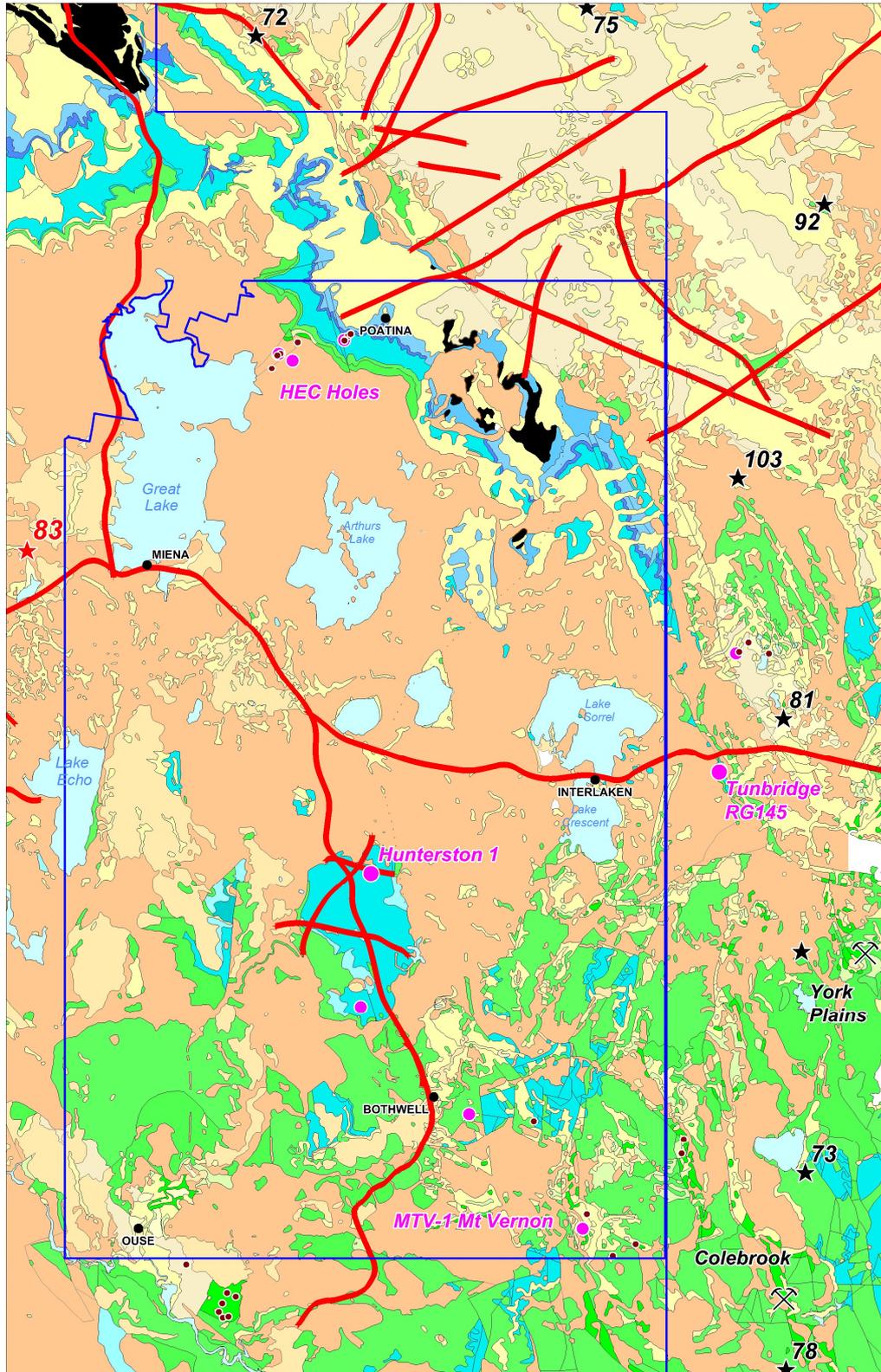


Figure 4: Surface geology and legacy data beneath SEL 57/2008. Geology legend is as per Table 2 except for Cambrian-PreCambrian units which have been highlighted in black. Small purple dots are legacy drill holes <300m deep; larger pink dots, holes >300m deep. Significant hole names referred to in the text are labelled. Black stars indicate KUTh Energy surface heat flow data; red, legacy heat flow data. All heat flows are reported in mWm^{-2} . Red lines indicate the location of GSLM seismic lines from survey TB01. At the time of reporting GIS were not available to indicate the location of TB02 lines, which are predominantly located in the SW quadrant of this image. The location of legacy coal mines at York Plains and Colebrook are as shown.

Intrusion of tholeiitic Jurassic Dolerite into the Parmeener sequences is extensive and typically manifests as flat-lying sills 300-400m thick along sedimentary bedding layers. Dolerite has variably intruded at all levels within the Parmeener sediments and is also recorded within the Pre-Cambrian basement (Forsyth, 1984; Matthews *et al.*, 1996). Intrusion mechanisms are inferred to be along sub-vertical feeder systems (dykes and pipes) and dolerite thickness may increase (up to 600m) within the vicinity of these features (Forsyth, 1984). Accommodation faults associated with dolerite emplacement are often characterised by coeval intrusion of minor dykes (Matthews *et al.*, 1996) and variations in the intrusive geometry such as dykes and split sheets are commonly observed (Forsyth, 1984).

The resistive nature of the intrusive dolerite has resulted in it forming the most extensive surface outcrop across the tenement area (Figure 4). Within the boundaries of SEL 57/2008 dolerite is overlain only by relatively minor occurrences of Tertiary basalt and sedimentary sequences and younger Quaternary alluvium and colluvial deposits. Tertiary basalts are alkali - tholeiite in composition and are typically preserved in palaeo-drainage channels (Matthews *et al.*, 1996; Forsyth, 1989; Forsyth, 1984). Tertiary sediments are most significant to the north-east of the tenement where they form basin fill within the interpreted Tamar rift valley.

General structural trends vary across the tenement from NW in the Lake River sheet to ESE in the south Interlaken sheet to NS in the Oatlands Sheet. The majority of observed and inferred faults within the tenement area are considered to post-date dolerite intrusion with no clear evidence for the presence of significant older structures. As stated in Forsyth (1984):

'The major dolerite sheets and their host strata have been broken by steeply-dipping normal faults with throws ranging from <1m to several hundred metres. The faults are linear for distances of a few hundred metres to several kilometres but with notable changes of trend between segments.'

Extensional in style, the tectonic environment in which these features developed was most likely a Tertiary-aged rifting event which led to the formation of a series of half-grabens along the axis of what is now the modern-day Tamar Valley (Forsyth, 1984).

2.2 Hydro-Electric Commission Drilling

Development of extensive hydro-electric resources across the Central Highlands area in the 1950-60's necessitated the drilling of a number of deep (>300m) diamond boreholes for engineering purposes. Within SEL 57/2008 a number of these Hydro boreholes are located in the NW corner of the tenement, between Great Lake and Poatina (Figure 4). These holes are found to penetrate between 50 to 240m of dolerite before intersecting Parmeener sediments. No holes penetrate through the Parmeener to identify the underlying basement. Whilst no significant coal intersections are recorded in these holes, carbonaceous shales and minor coal bands and seams appear to be common within the Parmeener section.

Immediately to the west of SEL 57/2008 a heat flow value of 83mWm^{-2} was recorded in dolerite intersected by a 320m deep vertical Hydro borehole, HEC-5001 Great Lake (Newstead & Beck, 1953; Figure 4). This value implies a comparatively moderate heat flow and, until recent work by KUTh to the east in SEL 26/2005 (see section below), remained the only direct indicator of crustal thermal conditions in this area.

2.3 Coal Exploration

The existence of Triassic coal measures in the Midlands region to the south and east of SEL 57/2008 has been known since the early nineteenth century. Today, named coal 'fields' include areas between Bagdad and Kempton to the south of SEL 57/2008, around Colebrook, York Plains and Woodbury to the east of the tenement and at Mike Howes Marsh near Melton Mowbray within the south-east corner of SEL 57/2008 (Bacon, 1991). Both York Plains and Colebrook were actively mined from the mid-nineteenth to mid twentieth century. Where observed today, remaining coal seams are generally thin (typically <1m) and are often discontinuous amounting to relatively small *in situ* reserve estimates (<100Mt; Bacon, 1991).

Exploration within the vicinity of SEL 57/2008 was undertaken by Capricorn Mining and CRA Exploration in the late 1970's to early 1980's and is summarised in Bacon (1991). Whilst this work failed to identify significant economic coal seams within or adjacent to the tenement area, interest in the region continued due to the 2.3m coal intersection observed in stratigraphic hole MTV-1 at Mt Vernon. In the early 1990's the Cornwall Coal Company undertook a shallow drilling program (<200m) to further explore the Mount Vernon area. The results of this program revealed a locally complex geology with coal seams disrupted by faulting, sections missing due to uplift and erosion, dipping too steeply to mine or over-heated by local dolerite intrusion (Bryan 1992, 1993).

For geothermal exploration the presence of even sub-economic coal in SEL 57/2008 is significant as the thermal insulating properties of carbonaceous material are known to be considerable. The occurrence of coal and carbonaceous sequences within the Parmeener appears to be widespread with observations recorded in Hydro holes in the north-west and coal drilling in the south-east of the tenement area. Despite local disruptions related to faulting and dolerite intrusion, this widespread presence of carbonaceous material implies that the net thermal effect of the Parmeener sediment across SEL 57/2008 should be that of an insulating 'blanket' atop basement rock.

2.4 Petroleum Exploration

The Central Highlands area, including SEL 57/2008, has been subject to petroleum exploration by Great South Land Minerals Limited (GSLM) since the late 1990's. Notable work completed by GSLM during this time includes the drilling of a single well (Hunterston 1) to 1324m, the acquisition of deep seismic reflection data along established roadways and the commissioning of integrated geophysical interpretation using available seismic, magnetic and gravity data.

Information available regarding the stratigraphy encountered by well Hunterston 1 (located in central SEL 57/2008; Figure 4), is available from Stacey & Roach (2003). Spudded in Lower Parmeener mudstone, dolerite was intersected at 134m and continued to 784m

where it was again bounded by Lower Parmeener sediments. These continue until 980m where they terminate at an unconformable contact atop basement dolomite. Glacial till is noticeably absent from the base of Parmeener section in this area, the group instead terminating in stratigraphically younger mudstone sequences. Basement dolomite is interpreted to be Pre-Cambrian in age and is currently the only drilled intersection of these strata observed within SEL 57/2008. No log or lithological data describing the dolomite are available from GSLM, although descriptions contained in Leaman (2007) are of 'massive dolerite' suggesting little to no *in situ* porosity.

Seismic data were collected by GSLM from two major surveys, TB01 (2001) and TB02 (2006-2007). Of these, the most relevant to SEL 57/2008 is TB01 which comprises 662km of data acquired along 23 regional lines, several of which effectively bisect the tenement area (Figure 4). The quality of data derived from TB01 is variable with the effects of curved survey lines, seismic attenuation through high velocity dolerite and poorly constrained stratigraphic control (particularly of basement sequences) combining to reduce the resolution and decipherability of the resulting images (Leaman 2007). Regional interpretation of TB01 is provided in Stacey (2007).

Seismic interpretation confirms the presence of Parmeener sediments across the Central Highlands area as broadly flat-lying layers. Disruptions are due mainly to faulting and dolerite intrusion although occasional very gentle upright folds are interpreted. When corrected for the effects of faulting and disruption, a reasonably constant regional thickness (~400-500m) is observed for Lower Parmeener sediments (Stacey, 2007).

Dolerite intrusions are confirmed to be generally flat-lying sills, conformable with the bedding horizons of their host sediments and generally located in the interval between Base Lower Parmeener and mid-Upper Parmeener sections. Sill thicknesses are typically between 300-500m but may increase to 800m in areas where intrusions remain undercover. Significant lateral variations are observed in sill thickness; these may be abrupt and step-like structures from one stratigraphic level to another are common.

The total thickness of cover sequences (dolerite plus Parmeener) across SEL 57/2008 is typically found to be <1000m. Whilst Stacey (2007) does not attempt to distinguish specific basement lithologies, a number of interesting observations are made regarding regional structural relationships. The majority of structures observed at surface are considered to be related to Tertiary-aged rifting along the Tamar Valley. Extension appears to have been greatest in the Longford Basin to the north of SEL 57/2008 where shallow NW-striking structures are almost exclusively the product of the Tertiary event. In the Midlands area to the east of the tenement, extension appears to have been less intense with the development of steeper NNW-trending faults which display both extensional and strike-slip geometry. Fewer structures are observed within the Central Highlands although those that are display a greater variety in age and fault mechanism and include older Jurassic features. Typical fault strike directions within the Highlands area range from WNW-N.

Throughout the region, younger surface structures are often observed to be reactivations of older basement features. The structural style observed in basement units appears to vary from east to west with inferred Devonian-aged NE-dipping thrust stacks beneath the

Tamar Valley and Midlands areas in the east becoming mixed fold/thrust sequences beneath the Central Highlands area and finally fold-dominated in the west (Stacey, 2007).

Despite the success of seismic interpretation in indicating basement structures, determining the nature of the basement geology beneath the Central Highlands area remains problematic. Leaman (2007) undertook to integrate local gravity and magnetic data with seismic data from both TB01 and TB02 surveys to better predict the nature of the basement at depth. The results of this work, whilst untested, are consistent with a complex overthrust terrane in which thrusts are both east and west facing and basement is comprised of juxtaposed slices of Pre-Cambrian and Palaeozoic material. Significantly for geothermal exploration, Leaman did not predict any granite or granite-like bodies in the area beneath SEL 57/2008.

2.5 KUTh Energy Geothermal Exploration SEL 26/2005

In 2007 KUTh Exploration commenced work on its tenement SEL 26/2005 which now lies adjacent to the east of SEL 57/2008. Work completed to date includes a gravity survey, shallow heat flow drilling, magnetotelluric (MT) surveys and airborne magnetics and is detailed in Ward (2008) and Goh & Holgate (2009).

A significant amount of rock property data has been acquired through KUTh's own heat flow program and via sponsored academic studies (Goh & Holgate, 2009). These data confirm that both the Parmeener sediments and the Jurassic dolerite are excellent thermal insulators. Older Ordovician-Devonian rocks of the Mathinna beds are found to be thermally anisotropic (where heat is more easily conducted along planar structures than across them) relative to the orientation of deformation fabrics, although the effects of this variability on the bulk properties of the section remain uncertain. To date, no empirical data are available on the thermal insulating properties of Pre-Cambrian strata.

Key amongst the results of KUTh's work on SEL 26/2005 is the recognition of a close spatial relationship between the location of known and predicted Devonian granite bodies and anomalously high heat flow (Figure 5). This result supports the hypothesis that local heat anomalies are sourced from concentrations of "hot" radiogenic elements in granite. Only one anomalous heat flow ($>90\text{mWm}^{-2}$) is observed to be a significant distance from predicted granite bodies. This is the westernmost anomaly (103mWm^{-2}) located at the Macquarie heat flow hole. The presence of this unexplained value close to the western boundary of SEL 26/2005 was the prime motivation for the acquisition of licence SEL 57/2008. To the south and north-west of Macquarie, available heat flow data on SEL 26/2005 are somewhat reduced ($72\text{-}81\text{mWm}^{-2}$) consistent with surrounding regional legacy data at Great Lake and Glenorchy to the south (Figure 5).

At the time of application of SEL 57/2008, the origin of the Macquarie heat flow anomaly was poorly understood. Since application, the return of results from an initial MT survey in SEL 26/2005 has indicated the presence in the area of a deep, east-dipping electrically conductive anomaly (Figure 6). This feature, which has been linked with the previously identified Tamar Conductivity Zone in the north of the state, has been attributed to the presence of fluid, clay or graphite along a fractured zone (Hermanto, 1991). Significant 3D effects were noted in data along the southern MT line; to resolve these issues and to test

the potential for further extension of the anomaly to the west (near Macquarie hole) a second, larger, 3D MT survey was commissioned across SEL 26/2005, extending into SEL 57/2008, in 2009. Results of this survey work and its implications for SEL 57/2008 are included in following sections.

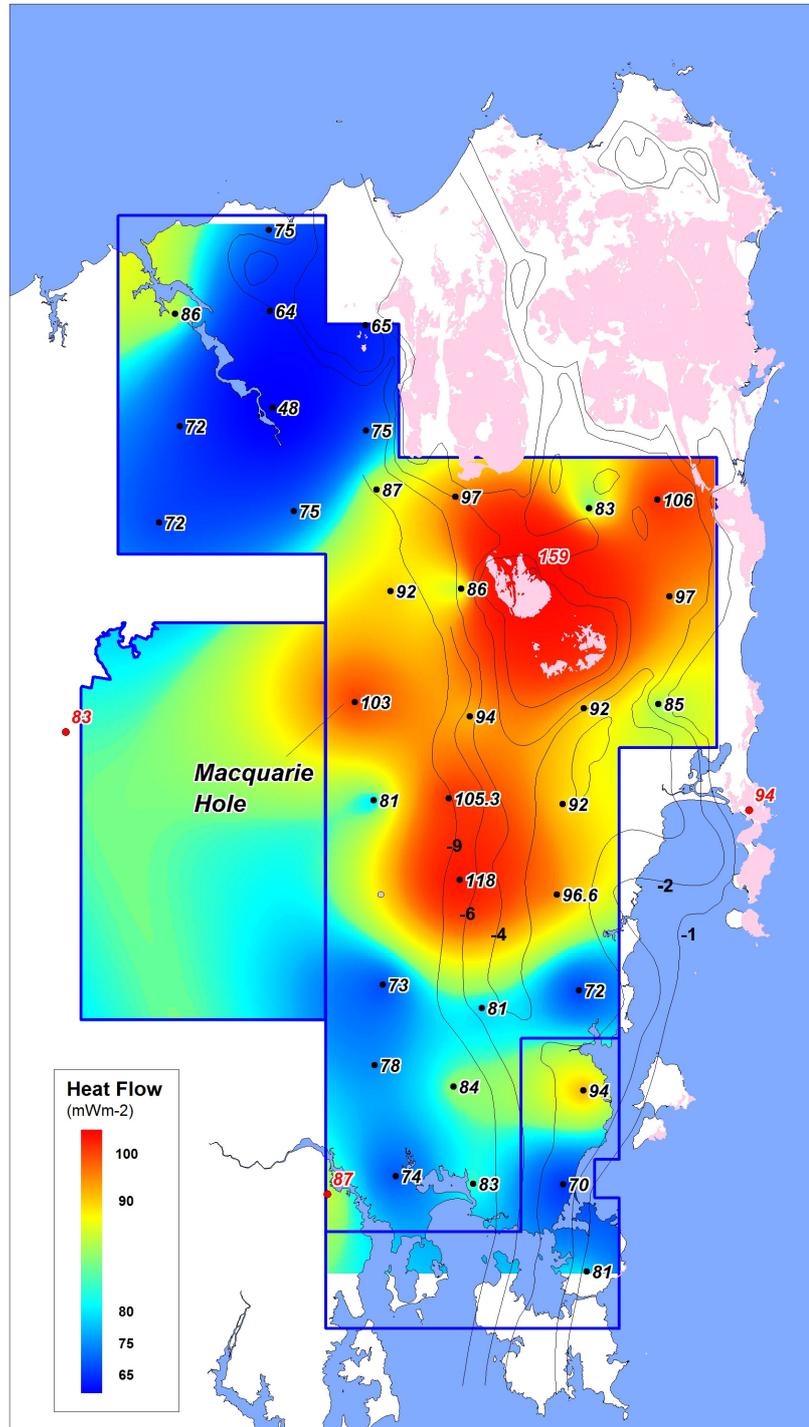


Figure 5: Results of geothermal exploration 2007-2009 by KUTh on adjacent tenement SEL 26/2005. Interpolation of the heat flow field produced from both KUTh (black dots) and existing legacy (red dots) heat flow data illustrates a strong spatial association between areas of high heat flow ($>90\text{mWm}^{-2}$) and areas of known (pink) and predicted (contour lines) granite occurrence. Depth to granite contours are in kilometres ASL and are based on gravity models generated by Leaman (2008).

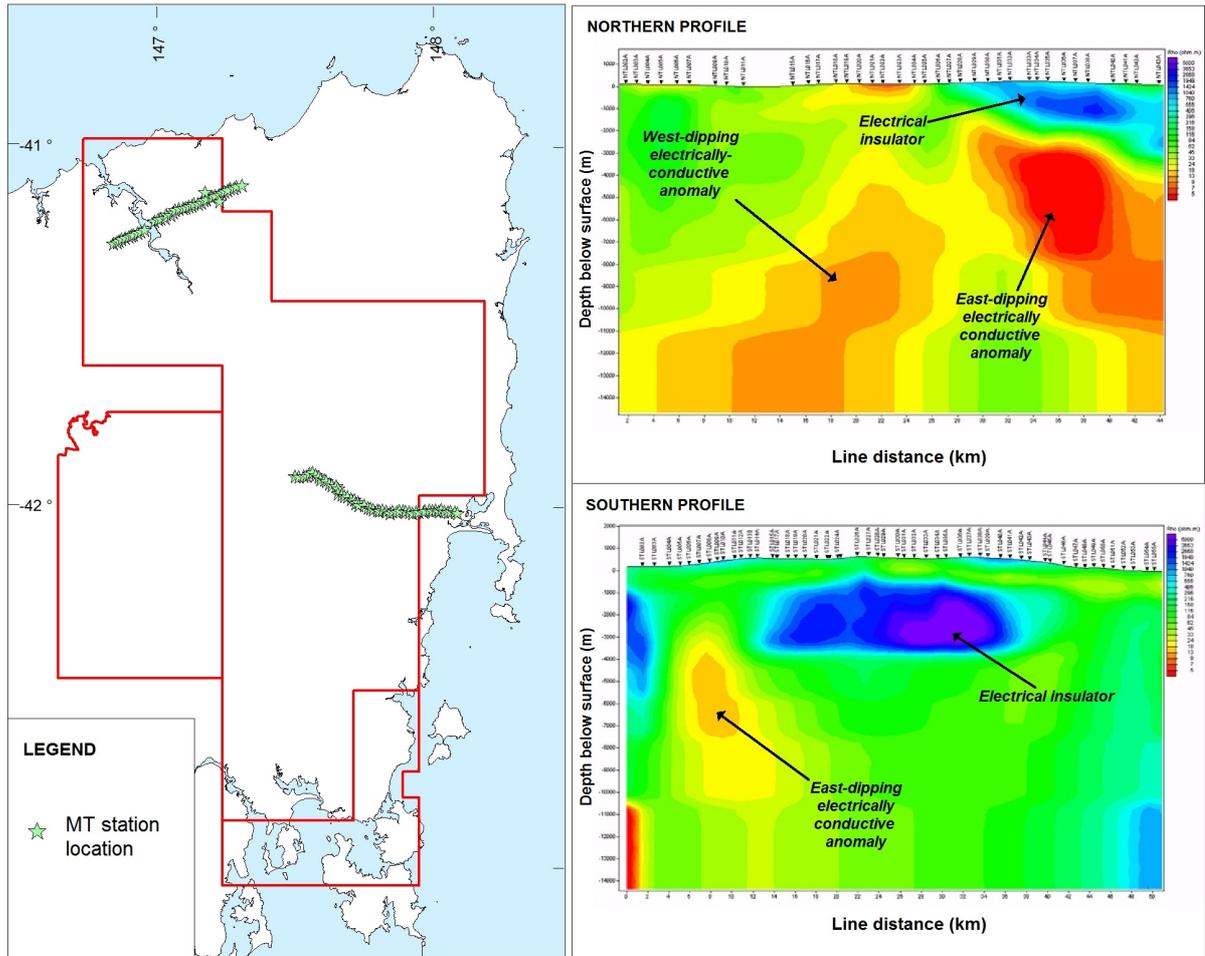


Figure 6: 2008 MT survey location and 2D modelled profile results for two lines across SEL 26/2005. Models are inversions of TM and TE shifted data. Resistivity range 50ohm.m (red) to 6000ohm.m (purple), maximum depth below surface is 14km, line distance northern line = 44km, southern line = 50km. Details of modelling processes are included in Goh & Holgate (2009).

3 Work Completed

Work detailed in this section was undertaken between May 2009 and April 2010.

3.1 *Re-interpretation of GSLM Seismic Data*

As part of a program of legacy data assessment KUTh commissioned Hot Dry Rocks PL (HDRPL) to undertake a re-interpretation of selected open-file 2D reflection seismic data previously acquired over Central Tasmania by Great South Land Minerals PL (GSLM) and by Geoscience Australia (GA). The GSLM lines, which were acquired in 2001 as part of a petroleum exploration program, bisect SEL 57/2008 and extend into SEL 26/2005 (Figure 7). Two further onshore lines, which were shot by GA in 1995 as part of a broader investigation into the Tasmanian crust, are located within SEL 26/2005 near Tunbridge in the west and Mathinna in the north-east. In all, four GSLM lines (TB01-PF, TB01-PG, TB01-PT and TB01-ST) and two GA lines (95AGST4 and 95AGST3) were reinterpreted. The goal of this work was to gain a greater understanding of the regional structural style and to provide information on the nature of local basement sequences.

When viewed by HDRPL the GSLM seismic data were found to be adequate for interpretation, although they were of relatively poor quality due to noise attenuation and line curvature. Issues were also encountered with the GSLM header file data which were incomplete, requiring assumptions to be made regarding the datum for depth conversion. Data from the GA survey lines were generally of poor quality although stacking velocities derived from these lines were used to interpret the GSLM data.

Results of the re-interpretation, provided in detail in Appendix 1, indicate a regional structural style that is dominated by NE-dipping, NNW-trending faults which sole into a major detachment interpreted between 7 - 8km depth and are thus consistent with existing interpretations by Stacey (2007) and Leaman (2007). A major bounding fault in the west, visible on line TB01-ST, is interpreted to mark the western extent of interpreted Mathinna-equivalent units (Figure 8). Evidence again suggests the reactivation of faults over time, with inversion of the tectonic regime from early extension to later compression marked by thrust-faulting. Younger Permian-aged faults commonly sole into older structures and are observed to display similar NNW trends within the Midlands area.

Thicknesses of Mathinna and/or Mathinna-equivalent sediments were interpreted to range between 4 – 5km along the eastern margin of the GSLM lines. The Parmeener Supergroup appeared to thin to <1km toward the east from a maximum of 2 - 3km beneath Tertiary sub-basins along the Tamar Valley axis. Jurassic Dolerite is interpreted as a blanket layer between 200 – 320m thick and is observed to be offset by minor Tertiary and ?Cretaceous faulting. No evidence of Devonian granitoid was observed which is again consistent with existing interpretations which place these rocks further to the east (Leaman, 2007; 2008).

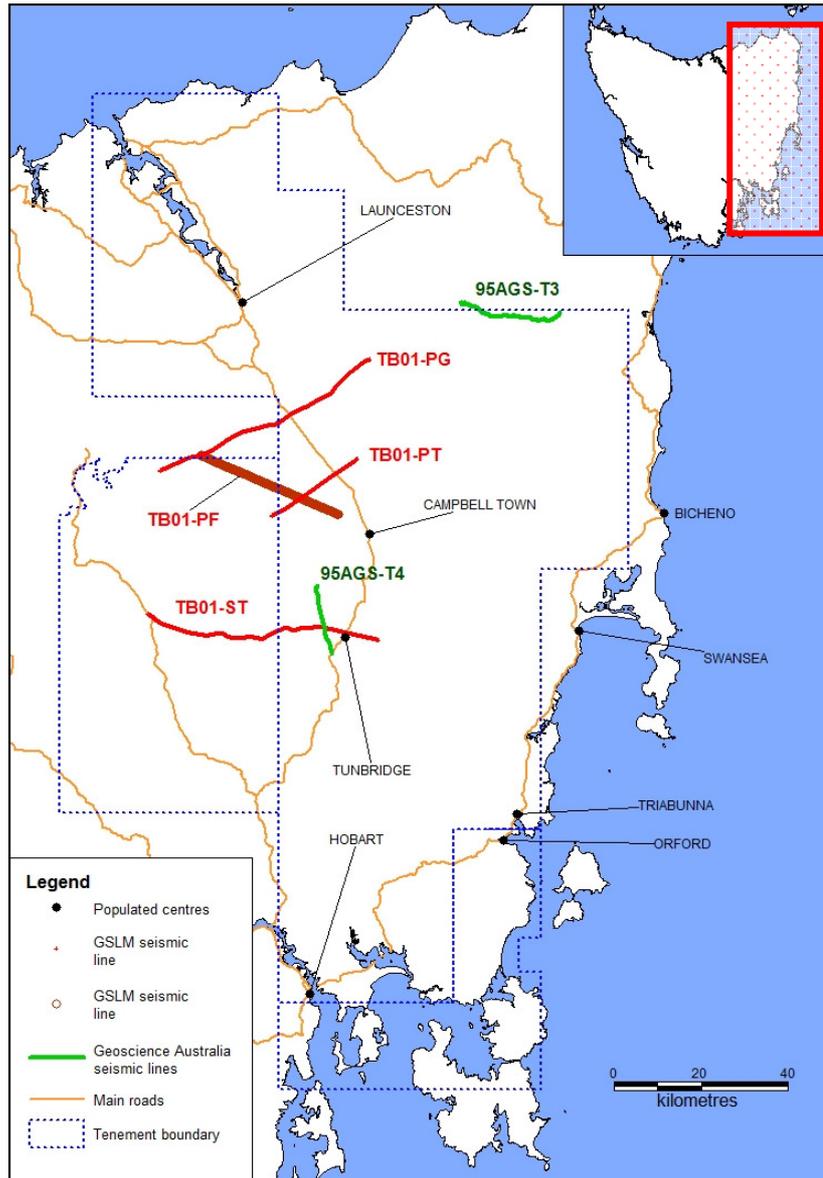


Figure 7: Location of seismic lines re-interpreted for KUTh by Hot Dry Rocks PL. Red lines/points are seismic lines sourced from the GSLM TB01 survey and green lines/points are sourced from Geoscience Australia (previously AGSO).

3.2 MT 2009

Following the successful application of MT survey techniques on SEL 26/2005 in 2008 a second, more detailed, 3D survey was planned to test the apparent extension of the electrically conductive anomaly known as the Tamar Conductivity Zone (TCZ) southwards and westwards towards central-eastern Tasmania. The presence of the TCZ in this region created potential for intersection with areas of anomalously high surface heat flow at Macquarie (103mWm^{-2}) and Charlton/Lemont (105 & 118mWm^{-2}). Where present, the TCZ may imply the existence of fracture permeability and naturally occurring fluids at depth and hence would represent a significant target for future geothermal development should it be found to coincide with areas of high heat flow.

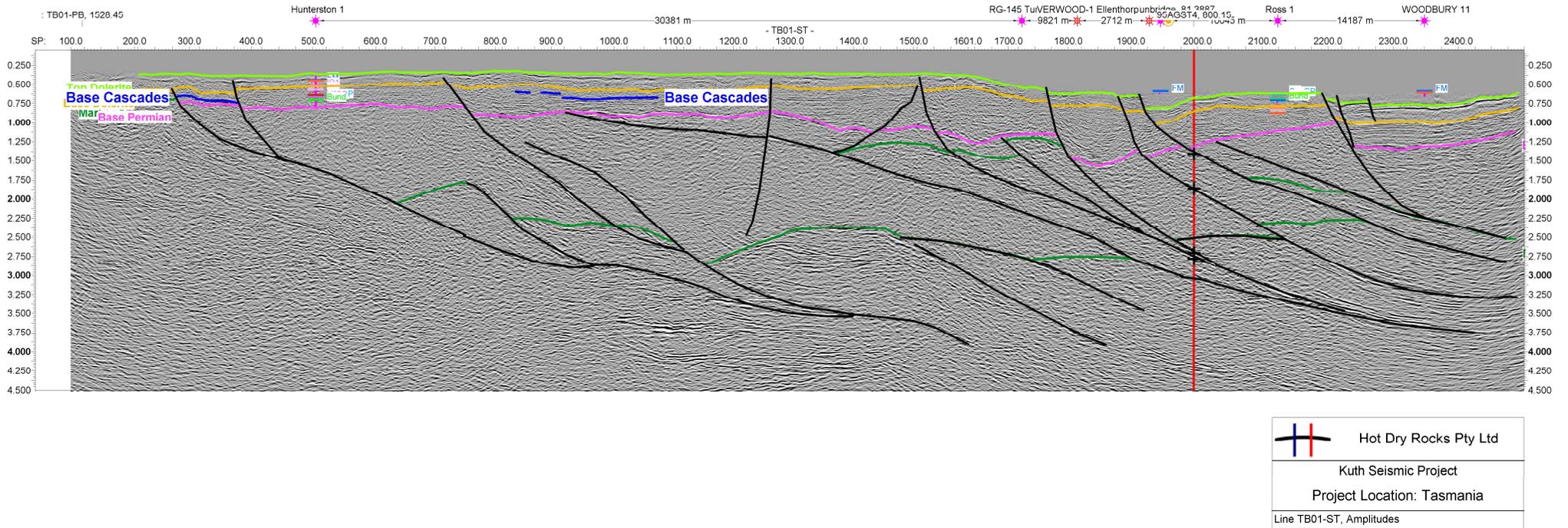


Figure 8: Great South Land Mineral seismic line TB01-ST reinterpreted by HDR PL. The interpreted major bounding fault is visible on the left of this image.

The observation of apparent 3D effects along the southern line of the 2008 MT survey (Goh & Holgate, 2009) implied that, to investigate this area further, and to correctly delineate the extension of the TCZ, a more detailed 3D MT array was required. In addition to MT data, it was decided to collect Time Domain Electro-Magnetic data (TDEM) at each station location. The purpose of the TDEM data would be to assure accuracy in the MT model by providing a reliable static shift correction for near-surface conductivity.

3.2.1 Location and Planning

An array of stations was deployed across SEL57/2008 and SEL 26/2005 building upon the 2008 southern MT line with the aim of supporting a 3D MT model of the area across the central Midlands (Figure 9). On SEL 26/2005 two NNE trending profiles, NSA and NSB, extend south ~50km orthogonal to the southern line. A third profile line, EWA, runs WNW extending the western end of the original southern line by around 34km. The western end of this line runs onto SEL 57/2008. Station spacing along the profiles is ~1km with a wider spaced array of ~5km located around the main lines and to the north of the original southern line. A total of 16 MT/TDEM stations were located on SEL 57/2008.

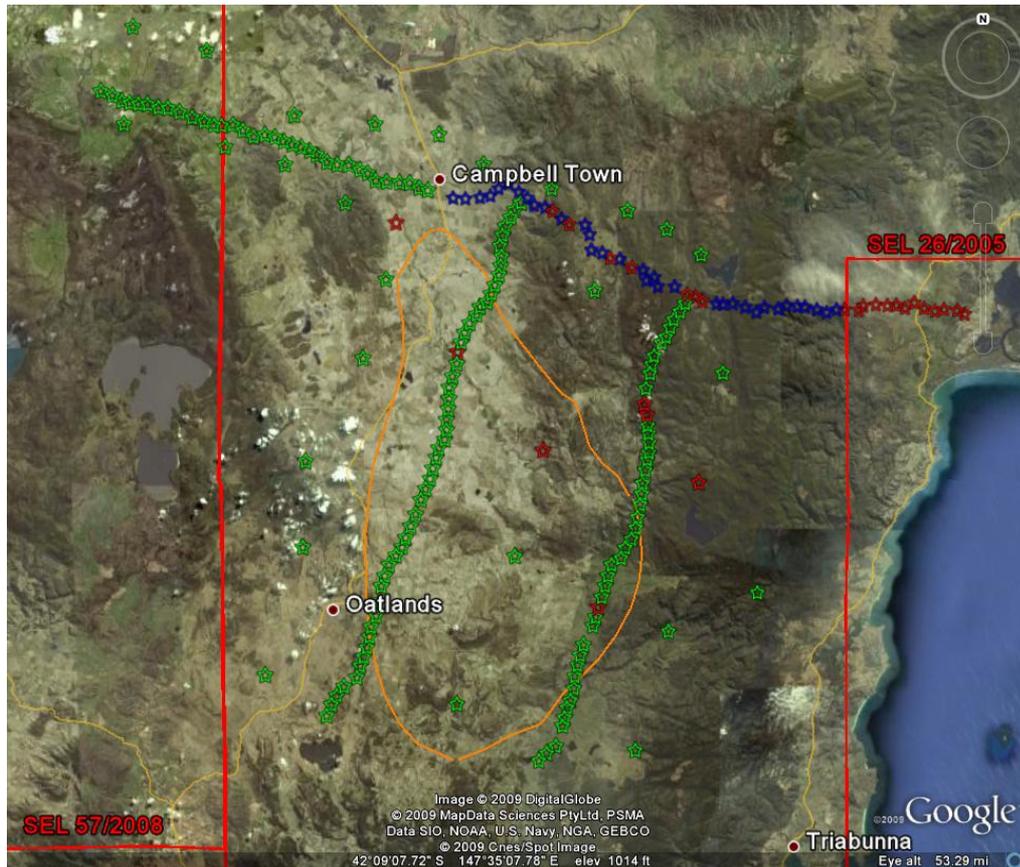


Figure 9: Location map of the 2009 3D MT/TDEM survey array across KUTh Energy’s Tasmanian tenements. Green stars represent new (2009) MT and TDEM stations, blue existing (2008) MT stations for which TDEM data has now been collected and red all MT stations (2008 & 2009) for which TDEM data were not collected. The orange outline in the central tenement area indicates the surface extent of the Charlton-Lemont Inferred Geothermal Resource on SEL 26/2005 (Goh & Holgate, 2009). Background Image ©Google Earth.

3.2.2 Data Acquisition

MT data acquisition was undertaken by Moombarriga Geosciences using Phoenix-made MTU-5A data recorders and MTC-50 induction coils. At the commencement of the survey all of the induction coils were calibrated to calculate the response of each coil to a known signal over a range of frequencies. The calibration files were then used for processing. Parallel tests were also performed to ensure all induction coils were measuring the same signal. Three components of the magnetic field (Hx, Hy and Hz) and 2 components of the electric field were recorded at ~50% of sites due to difficult digging conditions. Times series data were recorded for an average of ~16 hours at each site in an effort to resolve apparent resistivity and phase to a period of 100 seconds (300 – 0.01Hz).

At the majority of sites MT data were augmented by the addition of TDEM data recorded on an Alpha Geoscience TerraTEM system. It was originally planned to perform the TDEM soundings at the same time as the MT sounding but unfortunately because of instrument problems the TDEM sounding were done after the MT survey was completed.

The MT survey ran from May to end June 2009 with TDEM data collection continuing until mid-August. Adverse weather conditions (rain & flooding) impacted the survey severely, causing delays and stretching the time to completion considerably. At a small number of sites TDEM data were not able to be recorded as the location had become inaccessible due to rain.

Field data processing undertaken by Moombarriga Geosciences included the conversion of time series data to apparent resistivity and phase curves using Phoenix propriety software. Details of the data acquisition, field processing and results for stations on SEL 57/2008 are included in the MT Survey Report (Appendix 2) and as an electronic attachment to this report.

3.2.3 Data Quality

Data quality returned during the survey was quite variable. Poor data quality was due to two reasons: 1) low signal and 2) the presence of electrical noise. The main source of cultural noise was from electric fences. Atmospheric noise was coincident with rain periods and resulted in spiking in the time series although this was not a common occurrence. The signal that is utilized in MT at periods greater than 1 second comes from solar radiation and is roughly coincident with the number of sunspots (the greater the number of sunspots the better the signal). Sunspots generally vary through an 11 year solar cycle and at the time of survey were at a minimum implying that the signal was low, particularly in the period range 5-50 seconds. As was the case with the 2008 survey, this meant that signal strength during the 2009 survey was low which made acquire good quality data challenging.

The TDEM data generally displayed smooth decay curves to ~3msec which were sufficient to allow for overlap with the MT data. Poor data appeared to be associated with higher elevations around the Lake Leake area. This may be due to the outcropping electrically resistive dolerite in the area giving a very small secondary response in the TDEM receiver.

3.2.4 Modelling and Interpretation

Modelling of the 3D crustal resistivity was undertaken by WesternGeco EM (Geosystem) using proprietary software built upon the code described by Mackie and Madden (1993). Modelling was performed as an inversion process involving the initial computation of a forward (predicted) response followed by an iterative process of comparison and modification based upon the differences between the predicted and observed data.

Two sets of 3D inversion models were run, a fine mesh using all available MT stations and a coarser mesh using an approximately evenly-spaced subset of 62 sites. Parameters for the fine model (accepted as the final result) are summarised in Table 3. The consistency between major features identified in the fine and coarse spaced models was considered to be good.

Static shift factors were successfully accounted for by application of near surface topography and structure in the 3D inversion models implying that corrections using TDEM data were not required.

Cumulative Iterations	50
RMS	2.398
tau	3
InZ _{xy} amplitude, error floor	3%
InZ _{xy} phase, error floor	3%
Tipper error floor	0.02
Regularisation	Laplacian
Mesh orientation	-16°
Cell number (xyz)	121, 99, 112
Minimum cell dimension (xyz)	800,800,30
No. Sites	196
No. Frequencies	21
No. Frequencies/decade	4
Minimum Frequency	0.003

Table 2: Specifications of the reported 3D model array

Summarised results for the fine mesh model showing major sections lines and a 3000m model slice are presented in Figure 10. Electrically conductive anomalies are clearly visible on all three section lines and also appear in the plan section confirming the southward extension of the TCZ into SEL 26/2005. Visible as a strong electrically-conductive zone (red), the data indicate that the TCZ undergoes a major shift in orientation from NS to EW within the model area exhibiting an arcuate trend when displayed in horizontal or plan view. The vertical section along the E-W station line (Line A, Figure 10) indicates an east-dipping anomaly which projects to surface at the Macquarie heat flow anomaly (103mWm⁻²). No significant electrically conductive anomalies are observed in the line section beneath SEL 57/2008. A full set of model plans and sections are included in Appendix 3 along with a report from Geosystem detailing the 3D modelling process.

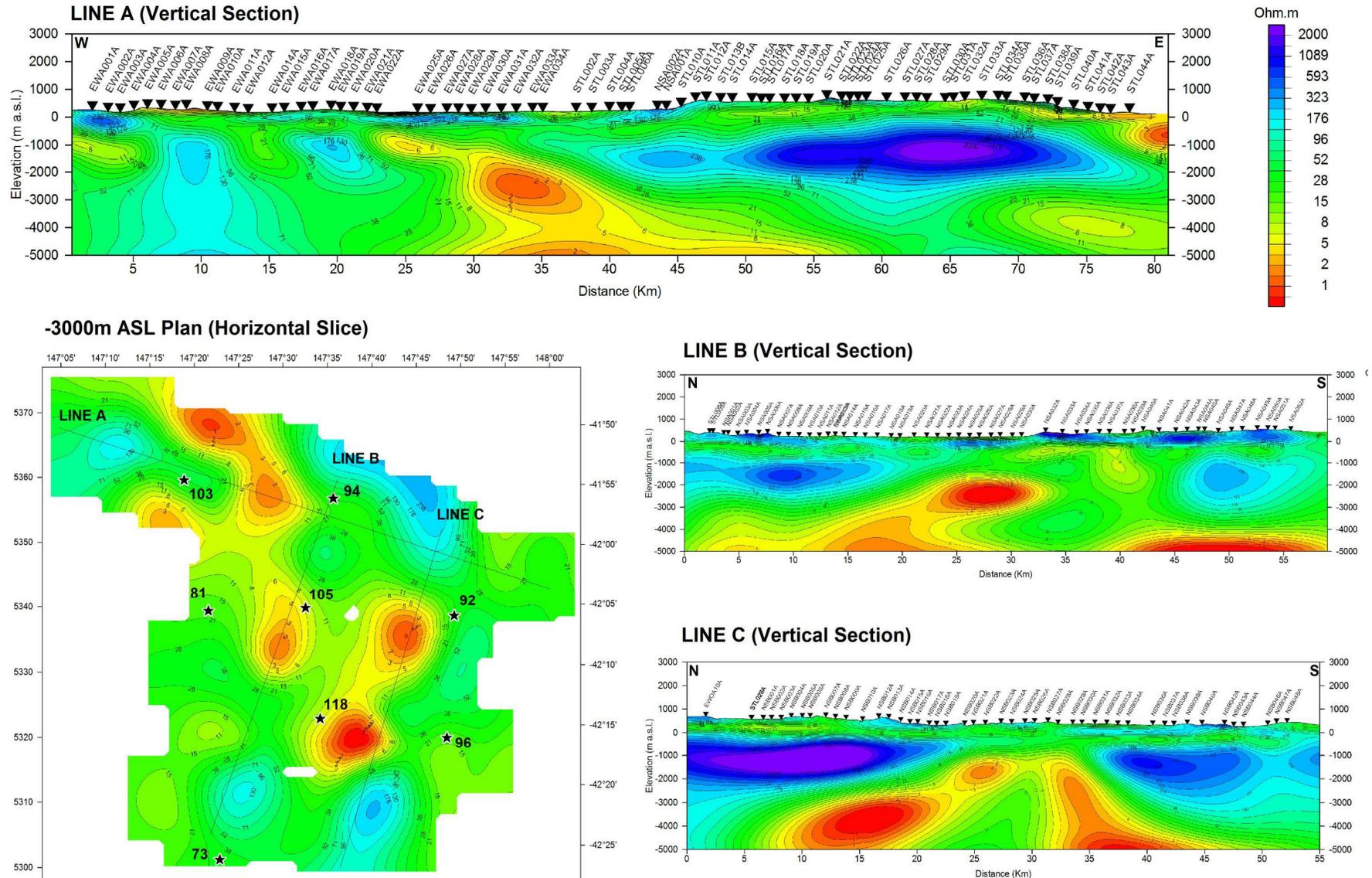


Figure 10: Results from the 2009 3D magnetotelluric survey presented as resistivity images. All images share the same scale (shown); warmer colours indicate increased electrical conductivity. Vertical section lines are as located in on the -3000m ASL Plan. Vertical exaggeration of these sections is 2:1. The location of surface heat flow values (mWm^{-2}) from KUTh's shallow heat flow program are shown on the plan as black stars. Details of the modelling process are provided in Appendix 3.

4 Research activities

Descriptions of research projects with KUTh support that were completed or underway during the reporting period are included within this section.

4.1 Earthquake Data Review

A review of available earthquake location and magnitude information for Tasmania was conducted as part of a company-sponsored student project at the University of Tasmania. The review targeted catalogues of instrumental recordings with the aim of maximising the utility of the data holding to improve data accessibility. The results of this review are expected to assist KUTh in undertaking studies of seismic risk across its tenement holdings. At the time of reporting the results of this review remained outstanding and will consequently be presented at a future date.

5 Discussion

Analysis of the available legacy data on SEL 57/2008 indicates that insulating cover sequences (comprising Parmeener sediment and Jurassic Dolerite) of up to 1km thick are present across much of the tenement area. The existence of insulating cover is a critical component of Hot Rock or EGS plays, however, in order to build temperature, cover sequences must be underlain by an appropriate heat source. At present, no such heat sources have been identified.

Geophysical analysis of data derived from SEL 57/2008 indicate that basement is comprised of juxtaposed slices of Pre-Cambrian and Palaeozoic material as part of a complex overthrust terrane in which thrusts are both east- and west-facing. Data available from field mapping and drillhole intersections indicate that the composition of basement material is most likely a mixture of (meta-)sediment and (meta-)volcanic material and is therefore unlikely to contain significant abundances of radiogenic elements. Regional heat flow values surrounding the tenement appear to reflect this with values typically between 70-85mWm⁻² at varying distances to the north, west, south and east of the licence area.

Whilst still anomalous on a global scale (continental average heat flow ~60mWm⁻²) values of 80mWm⁻² are unlikely to produce economically attractive temperatures at depths shallow enough to be exploitable using current technologies. This situation could be improved by addition of significant thicknesses of high-quality thermal insulator within basement. Mafic volcanic and pelitic metasediments such as those observed in outcrop in the north of SEL 57/2008 may have relatively low thermal conductivities, however, their insulating properties are likely to be impacted by the presence of pervasive deformation fabrics. Alternatively, dolomites, such as those observed in the Hunterston 1 well, are typically very poor insulators. Even with the addition of significant thickness of thermal insulators, the apparent absence of crystalline rock within the basement is problematic for Hot Rock or EGS development which, to date, has only been demonstrated in granitic reservoirs.

Given the apparent absence of predicted granitic heat sources at depth, the presence of a single anomalous heat flow value at Macquarie to the NE of the tenement area remains problematic. Data from recent MT surveys across SEL 57/2008 and SEL 26/2005 suggest that the Macquarie heat flow may be spatially associated with an east-dipping electrically conductive zone that has been interpreted as a potentially permeable fracture system. Were this interpretation to be correct, then it is possible that the elevated heat flow observed in this locality may be the result of localised fluid advection of heat. Based on the current MT data this is considered to be the most likely cause of this heat flow anomaly, however, in the absence of drilling to verify the nature of the MT anomaly this cannot be stated definitively. Other potential explanations for the Macquarie anomaly include heat refraction effects produced by juxtaposition of high and low thermal conductivity materials along adjacent fault zones (as observed by HDR PL in re-interpretations of the GSLM data) or the presence of an as-yet unidentified "heavy" granitoid (as has previously been suggested by Leaman & Richardson (2003) for areas to the west of the current granite "wall").

Given the current uncertainty surrounding the cause of the heat flow anomaly at Macquarie it is considered prudent to maintain that portion of licence SEL 57/2008 that lies within the vicinity of this value. It is recommended that work be undertaken to better understand the deep thermal and structural relationships in this area and to investigate the possibility of an as-yet unrecognised local crystalline heat source. This work should include gravity data interpretation and heat flow measurement. It is further recommended that attempts at heat flow measurement first rule out the possibility of using an existing Hydro borehole before committing to the drilling of any new holes in this area. Further investigation of the Macquarie heat flow anomaly by thermal modelling is also warranted. Retention of this portion of SEL 57/2008 is also considered advisable should the heat flow anomaly be linked directly to fluid advection along structures within this area due to the possibility of extension of these features into the licence area.

A 2930km² area outside the immediate vicinity of the Macquarie heat flow is considered to have a reduced prospectivity for geothermal exploitation and is thus recommended for surrender. A map detailing the proposed partial surrender of SEL 57/2008 is presented in Figure 11.

6 Conclusion and Recommendations

A detailed review of available legacy data and work completed to date has resulted in a recommendation for partial surrender of areas of SEL 57/2008 which are considered unlikely to be prospective for economic geothermal resources. Recommendations for future work on the retained portion of the tenement are:

- *Commissioning of an honours project (or equivalent) to collect new magnetic and gravity profile data across gaps in the local coverage (\$5000)*
- *Commissioning of a detailed linked gravity/magnetic/seismic interpretation along existing GSLM lines in the NE of the tenement area (to match existing work completed on behalf of GSLM on lines to the south and west) (\$10,000)*
- *Investigate the possibility of Heat Flow measurement in existing HEC boreholes in the west of the retained area (\$5000)*
- *Thermal modelling of the Macquarie heat flow anomaly (\$10,000)*

Total expenditure on the reduced tenement area for Year 2 is thus projected to be \$30,000.

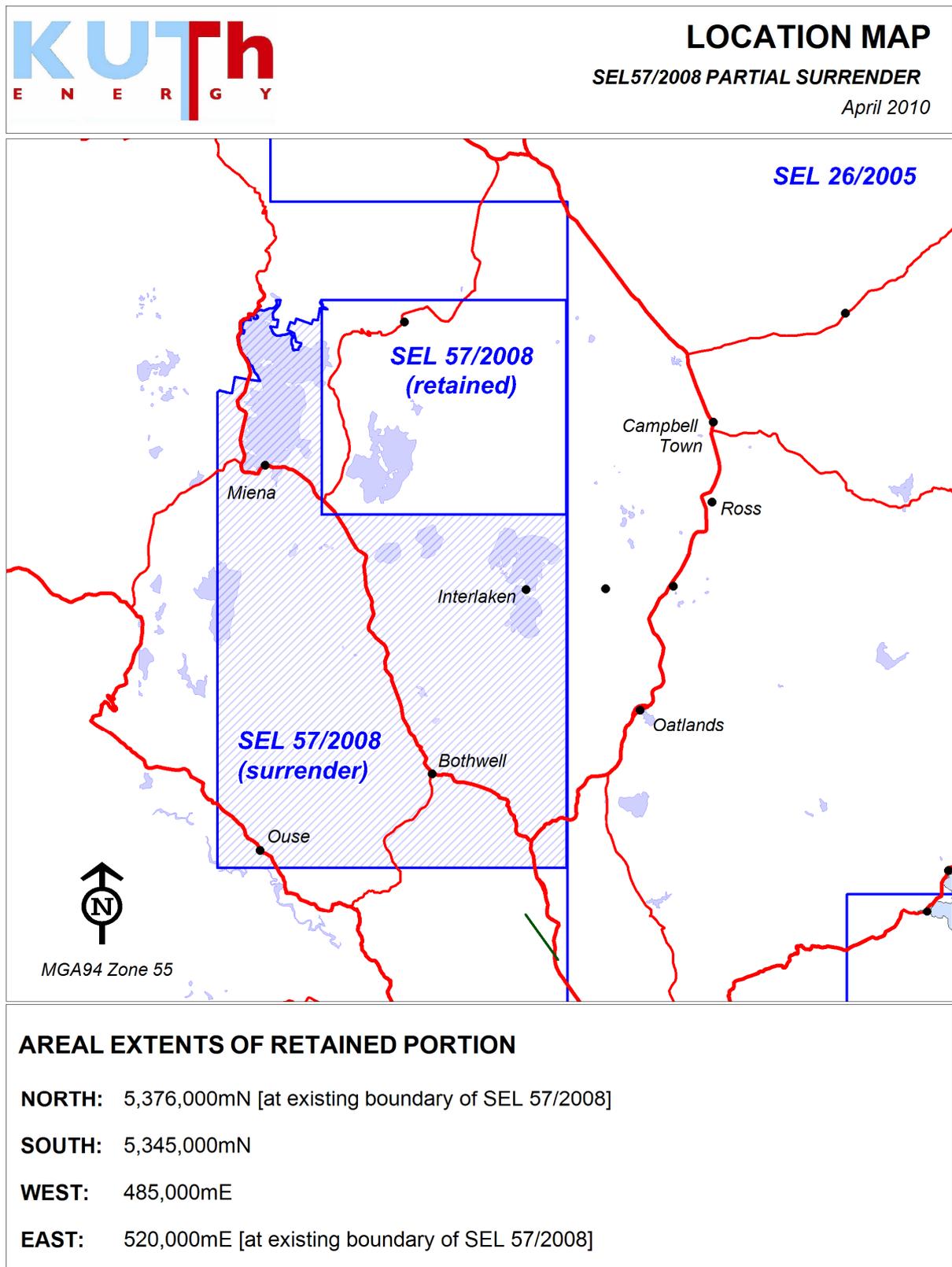


Figure 11: Map illustrating partial surrender area for SEL 57/2008.

7 Environment

7.1 MT station rehabilitation

Environmental disturbance due to the MT survey was minimal. In all cases MT station sites were assessed for the presence of rare or endangered plant species prior to digging. Digging of the vertical Hz component was carried out using a petrol powered post-hole digger. All other components were dug using suitable hand- tools. Care was taken at all sites to ensure that equipment was cleaned on completion of digging. Upon removal of equipment all trenches/holes were rehabilitated by replacement of the original soil and divots. Before and after shots of selected MT stations are included in Appendix 3.

8 Expenditure

Details of expenditure on SEL 57/2008 in the year 2009-2010 are captured in Table 11 below.

	SEL 57/2008
Geoscience Costs	\$
Geology	16961
Geochemistry	-
Geophysics	33504
Remote Sensing	-
Drilling & Gridding	
Gridding	-
Drilling	-
Land Access Costs	-
Rehabilitation Costs	-
Feasibility Study Costs	41
Other Costs	557
Administrative Costs	4924
TOTAL	55987

Table 3: Total expenditure on KUTh tenement SEL 57/2008 in the year 2009-2010.

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10 Keywords

Geothermal exploration

HDR (Hot Dry Rock)

HFR (Hot Fractured Rock)

EGS (Enhanced Geothermal System)

High Heat Producing (HHP) granite

Tamar Conductivity Zone (TCZ)

Magnetotelluric