Eden Energy Ltd

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First and Final Report

Mungeranie Project
GEL 177

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CONTENTS

1 INTRODUCTION 3
1.1 BACKGROUND 3
1.2 LICENCE DATA 3
1.3 PERIOD 3
2 WORK REQUIREMENTS 5
3 WORK CONDUCTED 5
3.1 GEOLOGICAL REVIEW 5
3.2 MODELLING & INTERPRETATION OF GEOPHYSICAL DATA 6
3.3 THERMAL DATA REVIEW 8
3.3.1 Geothermal Constraints 8
3.3.2 Model Data 9
3.3.3 Recommendations from Data Review 9
3.4 FINANCIAL ANALYSIS 11
4 YEAR 1 EXPENDITURE 11
5 YEAR 2 WORK PROGRAMME 11
6 COMPLIANCE WITH THE PETROLEUM ACT (REG. 33) 12
6.1 SUMMARY OF THE REGULATED ACTIVITIES CONDUCTED UNDER THE LICENCE DURING THE YEAR 12
6.2 REPORT FOR THE YEAR ON COMPLIANCE WITH THE ACT, THESE REGULATIONS, THE LICENCE AND ANY RELEVANT STATEMENT OF ENVIRONMENTAL OBJECTIVES 12
6.3 STATEMENT CONCERNING ANY ACTION TO RECTIFY NON-COMPLIANCE WITH OBLIGATIONS IMPOSED BY THE ACT, THESE REGULATIONS OR THE LICENCE, AND TO MINIMISE THE LIKELIHOOD OF THE RECURRENCE OF ANY SUCH NON-COMPLIANCE 12
6.4 SUMMARY OF ANY MANAGEMENT SYSTEM AUDITS UNDERTAKEN DURING THE RELEVANT LICENCE YEAR, INCLUDING INFORMATION ON ANY FAILURE OR DEFICIENCY IDENTIFIED BY THE AUDIT AND ANY CORRECTIVE ACTION THAT HAS, OR WILL BE, TAKEN 12
6.5 LIST OF ALL REPORTS AND DATA RELEVANT TO THE OPERATION OF THE ACT GENERATED BY THE LICENSEE DURING THE RELEVANT LICENCE YEAR 12
6.6 REPORT ON ANY INCIDENTS REPORTABLE TO THE MINISTER UNDER THE ACT AND REGULATIONS DURING THE RELEVANT LICENCE YEAR 12
6.7 REPORT ON ANY REASONABLY FORESEEABLE THREATS (OTHER THAN THREATS PREVIOUSLY REPORTED ON) THAT REASONABLY PRESENT, OR MAY PRESENT, A HAZARD TO FACILITIES OR ACTIVITIES UNDER THE LICENCE, AND A REPORT ON ANY CORRECTIVE ACTION THAT HAS, OR WILL BE, TAKEN 13
6.8 STATEMENT OUTLINING OPERATIONS PROPOSED FOR THE ENSUING YEAR 13
7 KEY REFERENCES 13

List of Figures

FIGURE 1: LOCATION OF GELS 177 MUNGERANIE PROJECT 4
FIGURE 2: MUNGERANIE PROJECT AREA ON REGIONAL MAGNETICS (TMI). 7
FIGURE 3: MUNGERANIE PROJECT ON REGIONAL GRAVITY IMAGE AND CONTOURS (BOUGUER) 7
FIGURE 4: GEL177 BLOCK DATA, SEISMIC PROFILES AND OIL WELL LOCATIONS 9
FIGURE 5: SEEBASE IMAGE AND DEPTH CONTOURS FOR THE MUNGERANIE AREA (DEPTHS IN METRES) 10
FIGURE 6: ESTIMATES OF TEMPERATURE FOR GEL177 BASED ON REPRESENTATIVE THERMAL CONDUCTIVITIES FROM MULKARRA WEST STRATIGRAPHY AND REGIONAL HEATFLOW TRENDS. 11

1 Introduction

1.1 Background

The Mungeranie Project area is located in the Eromanga Basin west of the Moomba/Geodynamics project. The licence area is located on The Birdsville Track (see Figure 1). There is extensive cover and the area is relatively poorly explored.

The Mungeranie area was identified in Somerville et al. (1994) as an area with good Hot Dry Rock geothermal potential. In essence the area comprises the Mulkarra West 1 well, with an elevated thermal gradient, and large gravity low, interpreted to be a granite.

The Mulkarra West 1 well was completed in metasandstone at 1287m depth, with a gradient of 58°C per kilometre. The well was drilled above the large Mungeranie gravity low (see Figure ??) an area suspected to contain a buried granite of large dimensions. The sedimentary basin cover is about 1.5km thick and no granite has been intersected in drilling.

There are no specific measurements of heatflow in the area and regional trends must be extrapolated for predictions of geothermal gradient. However there are some indications for high temperatures from the Geoscience Australia's GEOTHERM database.

Temperatures >200ºC are predicted at depths of 5000m from the AUSTHERM03 database.

Two main components are required for a heat reservoir within the earth's crust to achieve the required temperature for commercial power generation:

(a) Primary heat production within the reservoir

The primary heat production from within a buried body results largely from radioactive decay of minerals within the body. Hence, large bodies which are relatively rich in such minerals will have the ability to generate anomalously large amounts of heat. In particular large, late stage granite plutons or large mineralised systems rich in radioactive minerals are potential targets. In addition, the temperature of such reservoirs would be enhanced if they are located in an area of anomalous heat flow within the crust, such as the fairly well defined area occupying a large portion of northeastern South Australia.

(b) Insulation of the heat reservoir

It is essential that the heat generated within the reservoir be trapped effectively, and the most efficient natural insulators are fine grained sediments, in particular carbonaceous shales and coal seams. Modelling by others indicates that around four to five kilometres of sedimentary cover would be required to blanket a granitic heat reservoir to ensure sufficient heat was retained. Large mineralised systems rich in radioactive minerals may require less sedimentary cover, possibly as little as 2-3 km.

On first analysis, the Mungeranie area appears to contain these components.

1.2 Licence Data

Geothermal Exploration Licence 177 (GEL177) was granted on 9th January 2005 with an initial term of five years over an area of 497km^2.

Figure 1 shows the licence location.

1.3 Period

In accordance with Section 33 of the Petroleum Regulations 2000, this report details work conducted during the first permit year of GEL177 as well as the work completed in the second year.

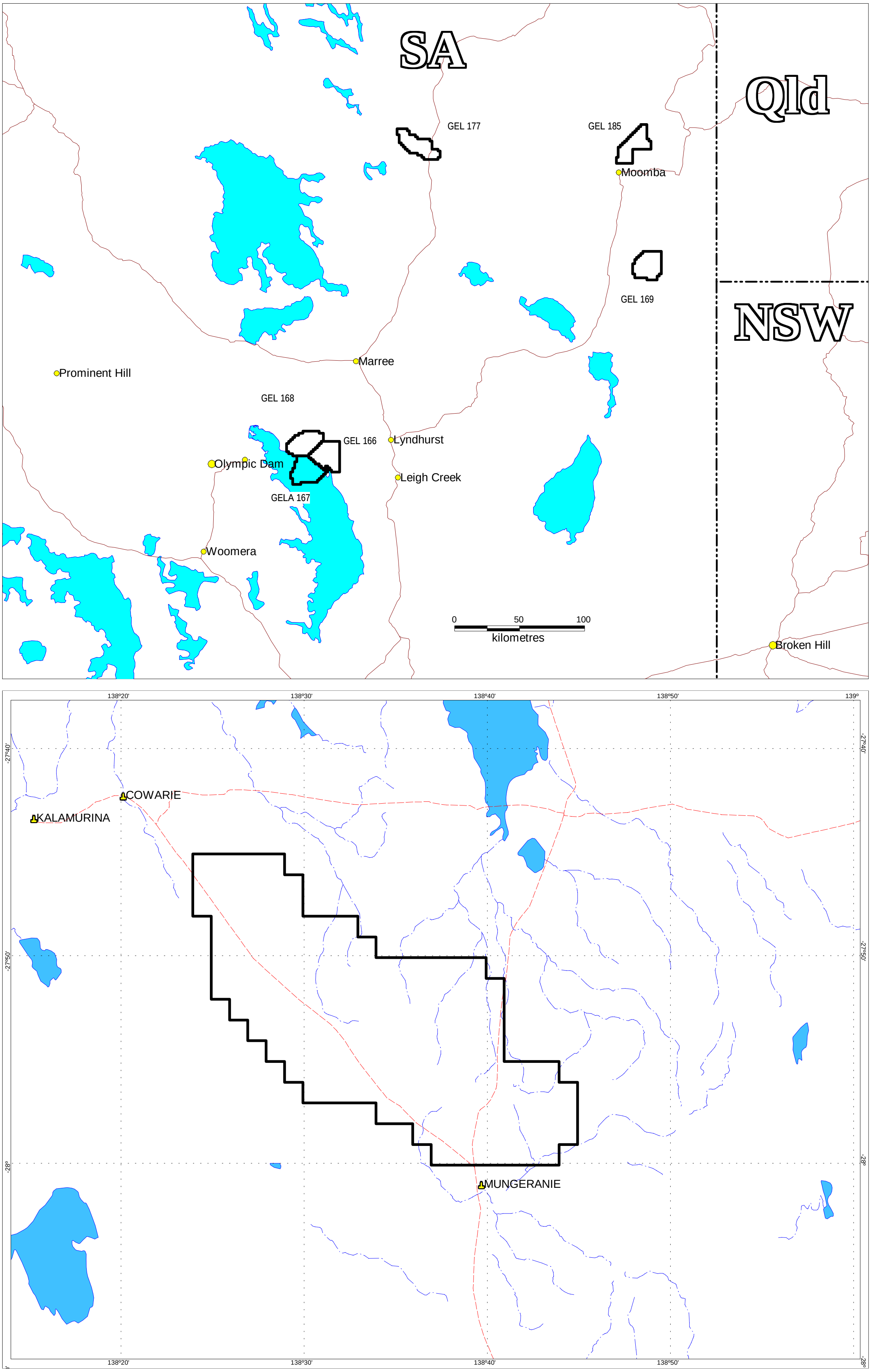

Figure 1: Location of GELs 177 Mungeranie Project

2 Work Requirements

The work programme agreed by Eden with PIRSA for the first two years of GEL 177 comprised completing geological and geophysical reviews.

In year one, work will focus on a thorough review of all available geological and geophysical data to ensure the technical robustness of the Mungeranie site. This will include detailed geophysical modelling designed to confirm the suitable nature of the reservoir and the thickness and nature of sedimentary cover rocks above it. Review of all relevant drilling data from both within the area and surrounds will be conducted. Any available thermal data from existing boreholes will be reviewed in an attempt to determine likely temperature gradients and confirm that the key parameters are present. Also in year one, modelling and investigation designed to confirm thermal and stress regimes will commence.

Stage one will ideally reduce the relative technical risk, and confirm that the initial assumptions about Mungeranie as a suitable site are still valid, and lay the groundwork for the next stages of the work programme.

Activities scheduled for year two are designed to secure funds for subsequent, higher cost aspects of the work programme, better define the target reservoirs by conducting specific, targeted geophysical surveys (if required) and selection of a suitable initial test drill site.

3 Work Conducted

During the first year of the licence Eden concentrated on reviewing all the available data for the area.

3.1 Geological Review

During the first year of the licences, Eden has focussed on acquiring and reviewing all the available open file data relevant to the project area.

A review of the published literature on the geology of the region was undertaken.

GEL177 is located in the Eromanga Basin on the southern margins of the Simpson Basin. Basement granites resemble those of the Moomba area in terms of heat production but surficial cover is much more limited. Consequently the thermal insulation is relatively poor and drilling conditions are less favourable for deep wells penetrating into basement at shallow depth. In addition there are no obvious focal points for groundwater circulation or creation of artificial fractures.

The Eromanga Basin has been extensively described in Alexander and Hibburtt (1996). They describe two main depocentres, one extending into the Northern Territory overlying the Pedirka/Simpson Basin and the other further southeast, overlying the Carboniferous to Triassic Cooper Basin in the South Australia Queensland border region. Commercial oil and gas fields have been found in the Eromanga Basin overlying and adjacent to the Cooper Basin. Good to excellent reservoir quality sandstones are found in the Jurassic to Early Cretaceous section and numerous oil shows have been found in wells drilled in the Northern Territory part of the basin. Abundant organically rich source beds have been identified in Jurassic, Triassic and Permian sediments. Cretaceous and Middle to Late Jurassic sequences are immature to marginally mature in many areas but Early Jurassic and Permo-Triassic sequences have reached the main oil generation window over large areas.

The Eromanga Basin is a sub basin of the Great Artesian Basin and consists of a number of thick sequences of non-marine and marine sedimentary units. The Toolebuc is part of the Rolling Downs Group of the Eromanga Basin that covers a wide but relatively shallow structural depression in eastern Australia, covering 1.5 million km^2. The Toolebuc Formation is a flat lying early Cretaceous (~100 My) sediment that consists predominantly of black carbonaceous and bituminous shale and minor siltstone, with limestone lenses and coquinites (mixed limestone and clays). It is composed of two distinct units representing two different facies: an upper coarse limestone-rich-clay-oil shale unit (coquina) and a lower fine grained carbonate-clay-oil shale unit. These units provide significant levels of thermal insulation which may enhance local geothermal energy prospects.

The region developed as a major downwarp on a basement of Proterozoic to Palaeozoic metamorphic and igneous rocks during the Jurassic to Cretaceous. Exon and Senior (1976) have proposed an evolutionary history of the basin. Sedimentation commenced in the early Jurassic period, with the deposition of fluvial sandstones of the Hutton Formation as a consequence of downwarping of the basement. These non-marine Jurassic sandstones are the main aquifers of the Great Artesian basin. Further fluviatile, lacustrine, and possibly deltaic sedimentation, continued at the close of the Jurassic. A worldwide marine transgression during the Cretaceous period was marked in the Eromanga Basin by the deposition of shallow marine and paralic sediments, including the Toolebuc Formation. Following final withdrawal of the sea, lithic sediments were deposited above the Toolebuc Formation. The stratigraphy of the Eromanga Basin is described in detail by Exon and Senior (1976).

Alexander and Jensen-Schmidt (1966) provide a regional synthesis of structural and geological elements associated with the Eromanaga Basin. Factors related to the thermal evolution of GEL177 are extracted from that work. In particular Alexander and Jensen-Schmidt suggest that the structural grain of the region is a product of a series of deformations and epeirogenic movements since the Cambrian. Residual heat, groundwater movements, basement lithology, and regional stress provide an indication of potential prospectivity for geothermal energy projects.

The Delamerian Orogeny was a series of major tectonic events which affected the Adelaide Geosyncline and the Palaeozoic mobile belt to the east in the Late Cambrian. Compression produced thrusts and recumbent folds, granitiods and mafic magmas were intruded and regional metamorphism occurred in the southern Delamerian orogen (Preiss, 1995). In the eastern Officer Basin adjacent to the G2 structural corridor of O'Driscoll (1983), Delamerian uplift and erosion removed up to 2 km of section. However, the Warburton Basin was not severely deformed by these events (Gravestock and Flint, 1995).

The structural grain of the Cooper, Arckaringa and Pedirka regions has been profoundly influenced by northwest-southeast oriented compression and uplift associated with the Devonian– Carboniferous Alice Springs Orogeny (360–330 Ma). Crustal shortening of the order of 20 km and uplift and erosion of 3 km are indicated by compressional structures in the Marla overthrust zone. Roberts et al. (1990) described overthrusts in Cambrian rocks beneath the Cooper Basin from seismic sections and drillholes. Overthrusts form northeast-southwest arcuate domal trends (e.g. Gidgealpa–Merrimelia–Innamincka (GMI) Ridge and the Birdsville Track Ridge) in northeastern South Australia. Roberts et al. (1990) attributed compressional tectonism to an Ordovician micro-continent collision and interpreted deformation as a previously unrecognised final phase of the Delamerian Orogeny.

Gatehouse (1986) considered the Late Ordovician – Silurian Benambran Orogeny of southeastern Australia to have affected the Warburton Basin; Apak et al. (1995) regarded the mid-Carboniferous Kanimblan Orogeny as the main compressional deformation. However, Gravestock and Flint (1995) linked this compressional event to the Alice Springs Orogeny, as Cambrian and Ordovician sediments are structurally concordant in cores. Highlands produced by compressional tectonism (e.g. Musgrave Block, Sturt–Taloola–Tantanna high) were glaciated during the Late Carboniferous and remained as topographical features during Early Permian deposition. Evidence of localised thermal effects associated with the Alice Springs Orogeny has been described in the Cooper region and Eringa Trough (Gatehouse et al., 1995, Alexander et al., 1996).

Big Lake Suite granites in the Moomba area and Nappamerri Trough have been dated as 298±4 and 323±5 Ma (early–mid Carboniferous) using SHRIMP analyses (Gatehouse et al., 1995). The ages correspond to the Alice Springs Orogeny and Kanimblan Orogeny. Apatite Fission Track Analysis from several wells in the Eringa Trough area indicate the early Palaeozoic section and crystalline basement experienced temperatures over 100°C prior to cooling between 400 to 300 Ma. This cooling is interpreted as a result of uplift and erosion during final stages of the Alice Springs Orogeny (Alexander et al., 1996).

3.2 Modelling & Interpretation of Geophysical Data

Public domain magnetic and gravity data were compiled and re-processed (see Figure 2 and Figure 3)

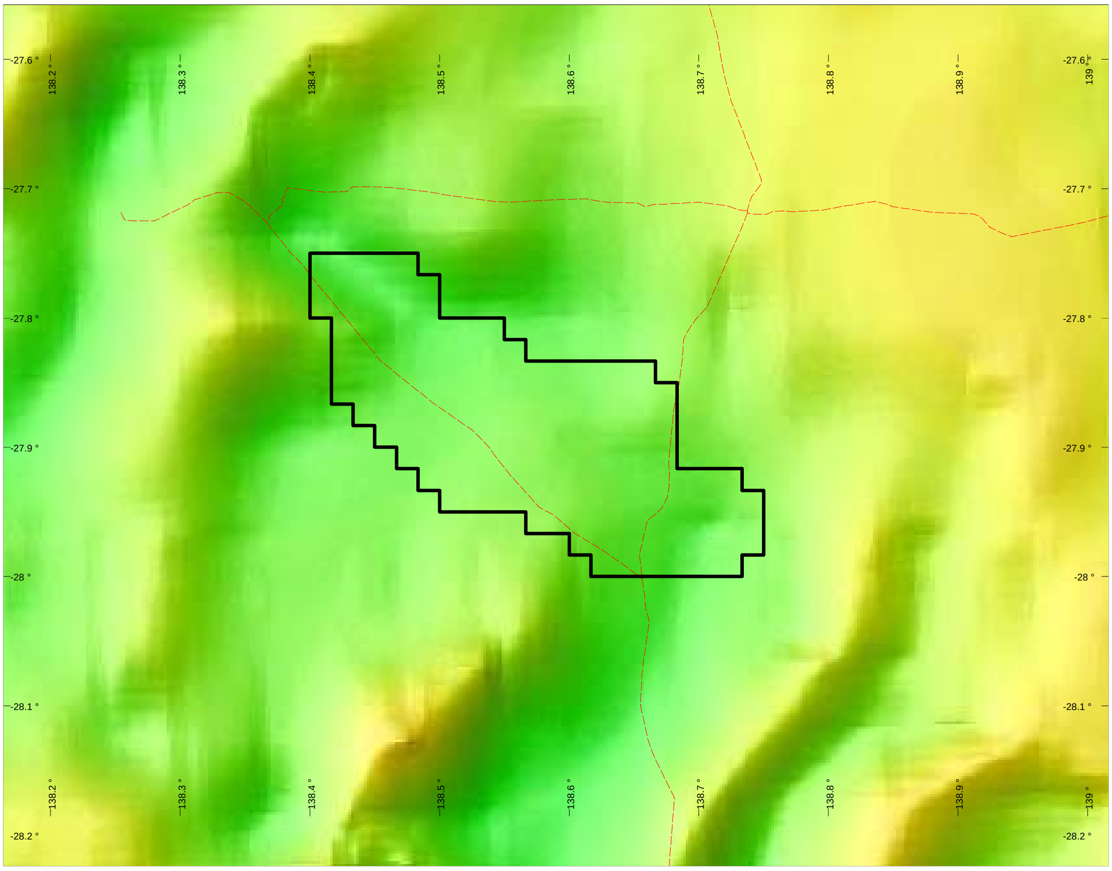

Figure 2: Mungeranie Project area on Regional Magnetics (TMI).

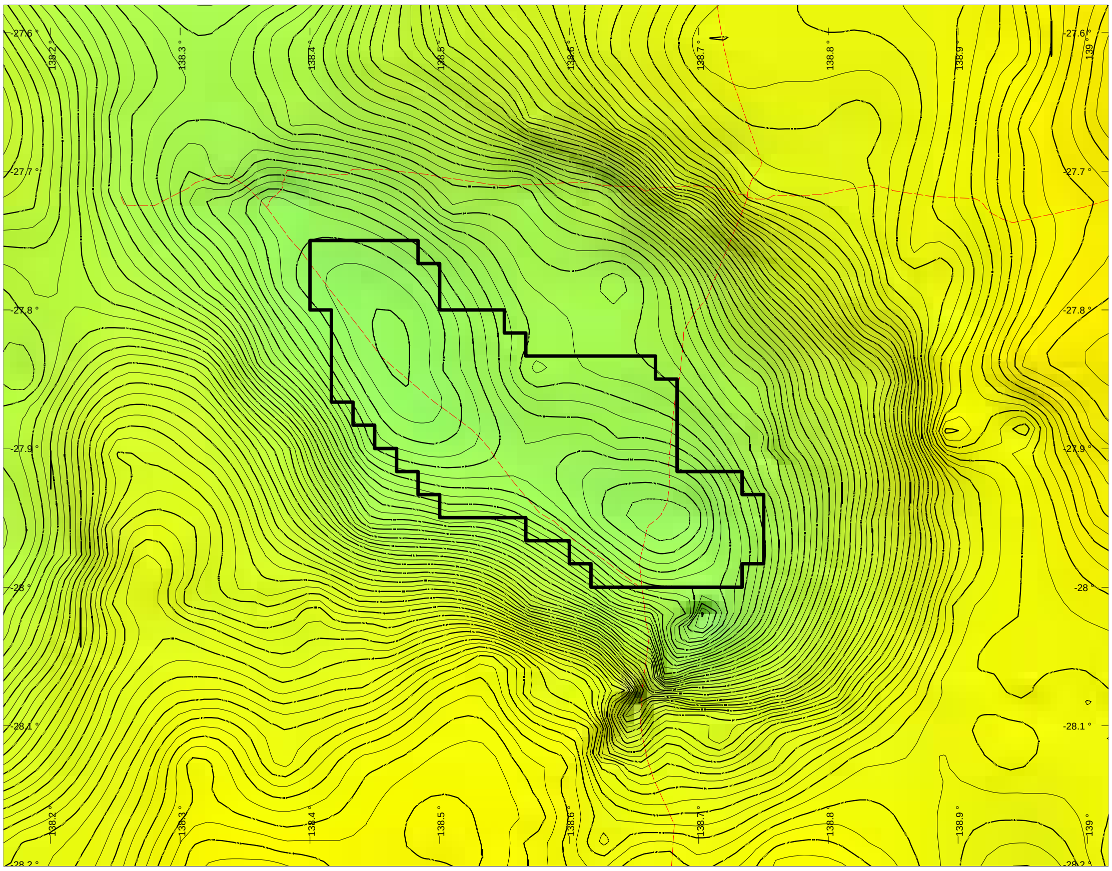

Figure 3: Mungeranie Project on regional Gravity image and contours (Bouguer)

3.3 Thermal Data Review

Professor James Cull from Monash University reviewed geothermal constraints for the area and undertook preliminary modelling of thermal parameters.

3.3.1 Geothermal Constraints

Tingate and Duddy (1966) provide an extensive review of fission track data related to thermal evolution in the Western Eromanga Basin. Several of the wells used in their study are in close proximity to GEL177 and allow some extrapolation of the resulting thermal models. Tingay and Duddy report that there is widespread evidence for a recent increase (<5 Ma) in geothermal gradient has been found across the South Australian part of the Eromanga Basin. This recent heating has not had sufficient time to increase the thermal maturity of most of the formations sampled but has probably caused recent petroleum generation in deeper parts of the Cooper Basin.

- ***Koonchera 1***

Five samples were taken from Koonchera 1. The uppermost sample from the Winton Formation (GC582-6) is currently at a maximum temperature of 48°C and probably experienced palaeotemperatures of ~35°C until the last 5Ma. Sample GC582-7 from the Namur Sandstone has experienced higher palaeotemperatures than present. It appears to have cooled from ~100°C between 40 Ma and present. The AFTA parameters from the deeper Hutton Sandstone suggest that it is currently close to maximum temperature (98°C). The sample is also consistent with having experienced temperatures of ~100°C between 40Ma and present, cooling to lower temperatures, and then recently heating back to ~100°C.

Sample GC582-9 (Poolowanna Formation) has probably only recently reached its current temperature of 110°C. The lowest sample, GC582-10, consists of data from two grains. The age and length data suggest that the grains may be from cavings from higher up the drillhole since the age and length do not display enough annealing to be consistent with the present temperature, even taking into account a recent increase in geothermal gradient. The thermal effects observed in Koonchera 1 do not appear to be consistent with uplift and erosion in the past under a lower geothermal gradient, followed by a recent increase in geothermal gradient.

Tingay and Duddy state that it is more likely that the data represent localised heating below the Winton Formation that is unrelated to increased depth of burial. Some form of heated water flow in the Namur and Hutton Sandstones and the Poolowanna Formation, that ceased in the mid–late Tertiary (40–15 Ma), is a likely cause. Vitrinite data (Geotrack, 1995b) from Koonchera 1 support a recent rise in geothermal gradient within the drillhole.

- ***Poonarunna 1***

Three samples were analysed from Poonarunna 1. The shallowest sample (GC582-14) is currently at maximum temperature and probably has experienced heating recently. The two deeper samples are consistent with cooling from higher temperatures (100–110°C) in the last 40 Ma (Table 8.2). The lengths from each sample suggest that the current temperatures are related to recent (<5 Ma) heating. Maximum palaeotemperatures in the Namur Sandstone and Birkhead Formation appear to be related to hot water flow that ceased in the mid–late Tertiary.

- ***Mulapula 1***

Three samples were analysed from Mulapula 1 on the Birdsville Track Ridge. Each sample has experienced higher palaeotemperatures than present. The three samples are consistent with palaeotemperatures ~20°C greater than present but have different ranges for the timing of cooling. All samples are consistent with cooling from maximum temperatures in the last 60 Ma. The data are also consistent with a recent increase

(<5Ma) in geothermal gradient. Vitrinite reflectance measurements also support higher palaeotemperatures than present (Geotrack, 1995b).

3.3.2 Model Data

Several seismic sections have been obtained close to the area but the subsurface structure near GEL177 is relatively unknown due to the poor petroleum prospectivity (see Figure 4). Only one deep well has been drilled within the boundaries of GEL177 (Mulkarra West) but general trends can be obtained from adjacent holes (particularly Koonchera, Poonarunna, and Mulapula as describe by Tingate and Duddy).

Geothermal models have been constructed from the stratigraphic data contained in the completion reports for Mulkarra West. Estimates of heatflow for this location are uncertain but values of 100-120 mW/m^2 can be assumed from regional trends. Similarly there are no specific values for thermal conductivity in the Mulkarra West well but representative values for the specific stratigraphy can be based on previous observations in the Eromanga basin and tables of typical values for similar basins elsewhere. The range of estimates is reflected in the resulting geotherms (see Figure 6) but temperatures of 200ºC are unlikely at depths less than 4000m.

Some additional information has been obtained from GIS spatial images of gravity and magnetic data also published by PIRSA. These confirm the major structural elements and there are some indications in the magnetic data of favourable lineaments which intersect the tenement (Fig 3). The nature of these lineaments remains obscure but they may indicate zones of faulting or stress in the centre of the tenement. Consequently they provide a focus for the selection of potential drill sites for any future development.

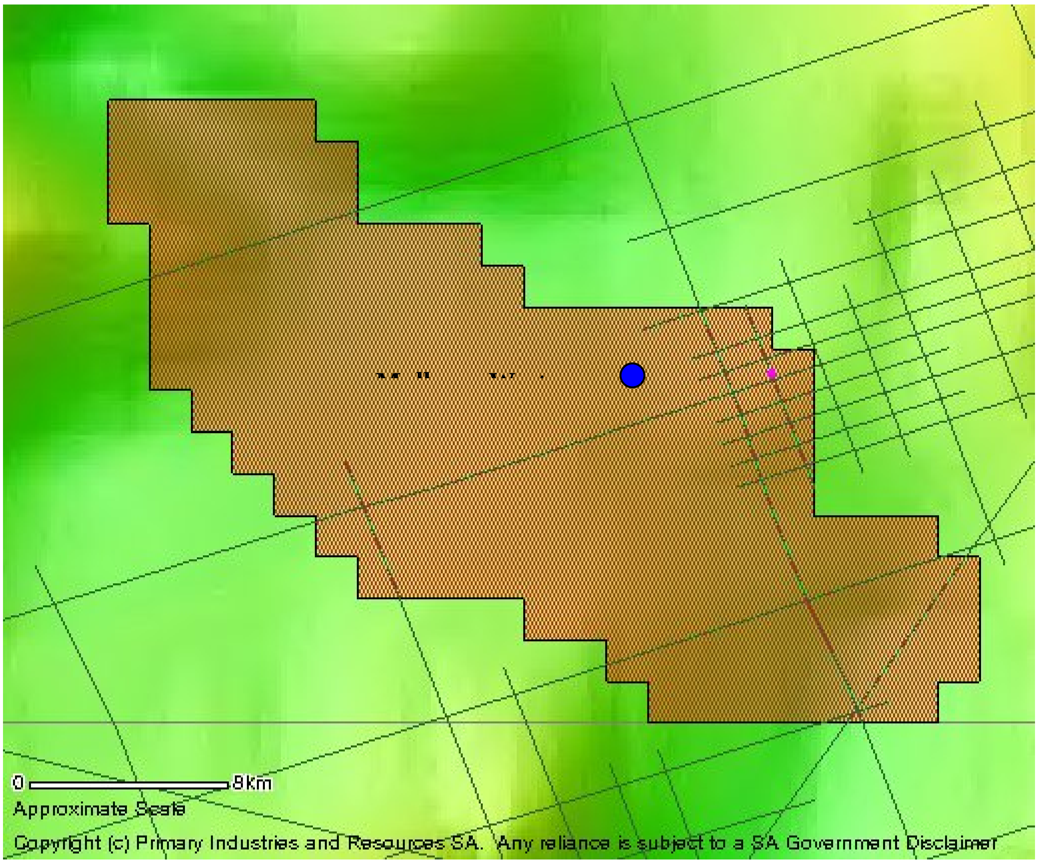

Figure 4: GEL177 block data, seismic profiles and oil well locations

3.3.3 Recommendations from Data Review

Cull (2005) concluded that in view of its proximity to the Birdsville Track Ridge (separating the Cooper and Simpson Basins) the sediment cover in GEL177 is relatively limited in depth (this conclusion is supported by the SeeBASE image for the area presented in Figure 5). Consequently geothermal gradients are likely to be more modest than observed in the Moomba/Habanero area. Furthermore additional drilling costs can be expected with basement intersected at more modest depths. As a result this prospect is not highly rated for geothermal energy projects.

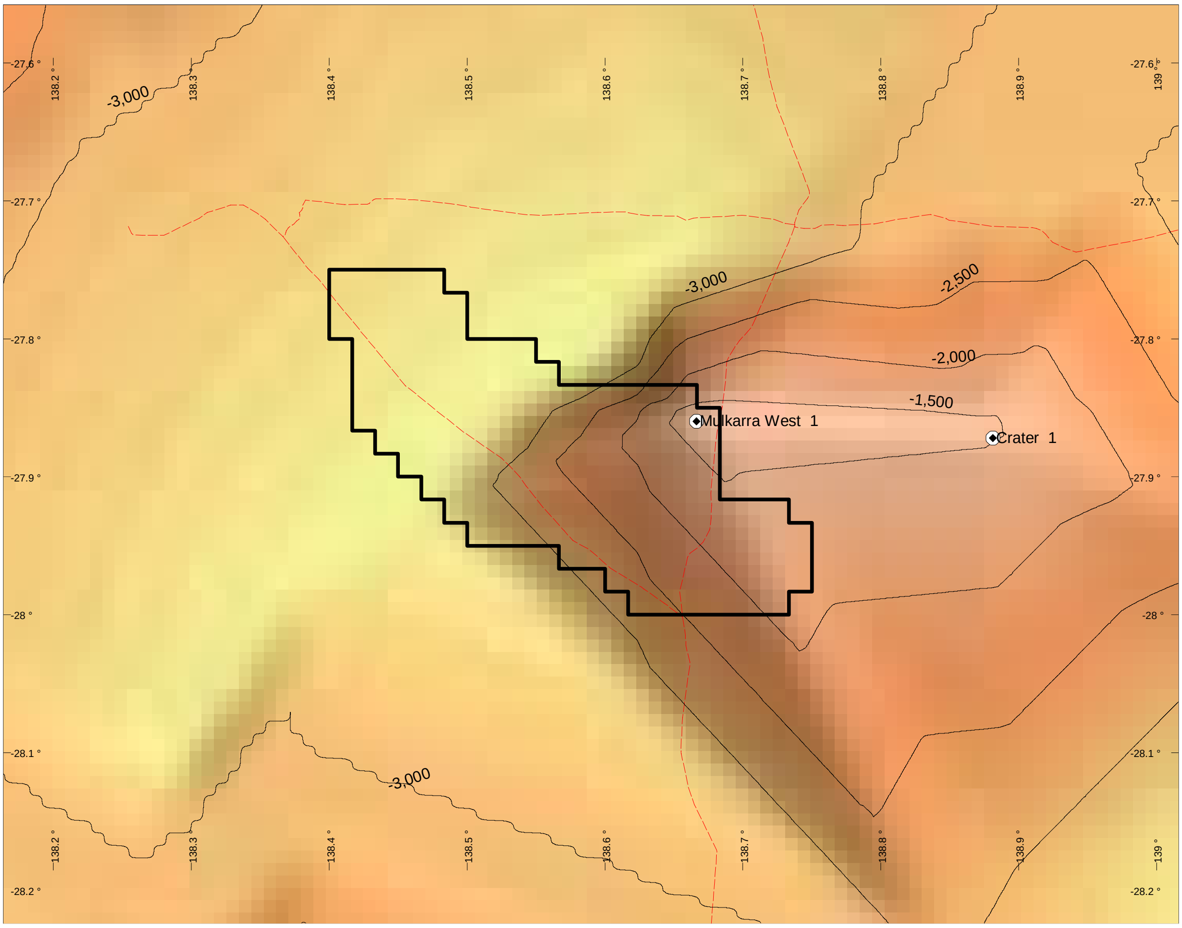

Figure 5: SeeBASE image and depth contours for the Mungeranie area (depths in metres)

The nature of the regional lineaments noted on the airborne magnetic image remains obscure. However it is possible that this structure provides a mechanism for deep circulation of groundwater along with relatively easy drilling in a complex fracture zone. This feature should be considered in any more direct geophysical survey (including MT) designed to locate zones of anomalous heating and possible basement fractures.

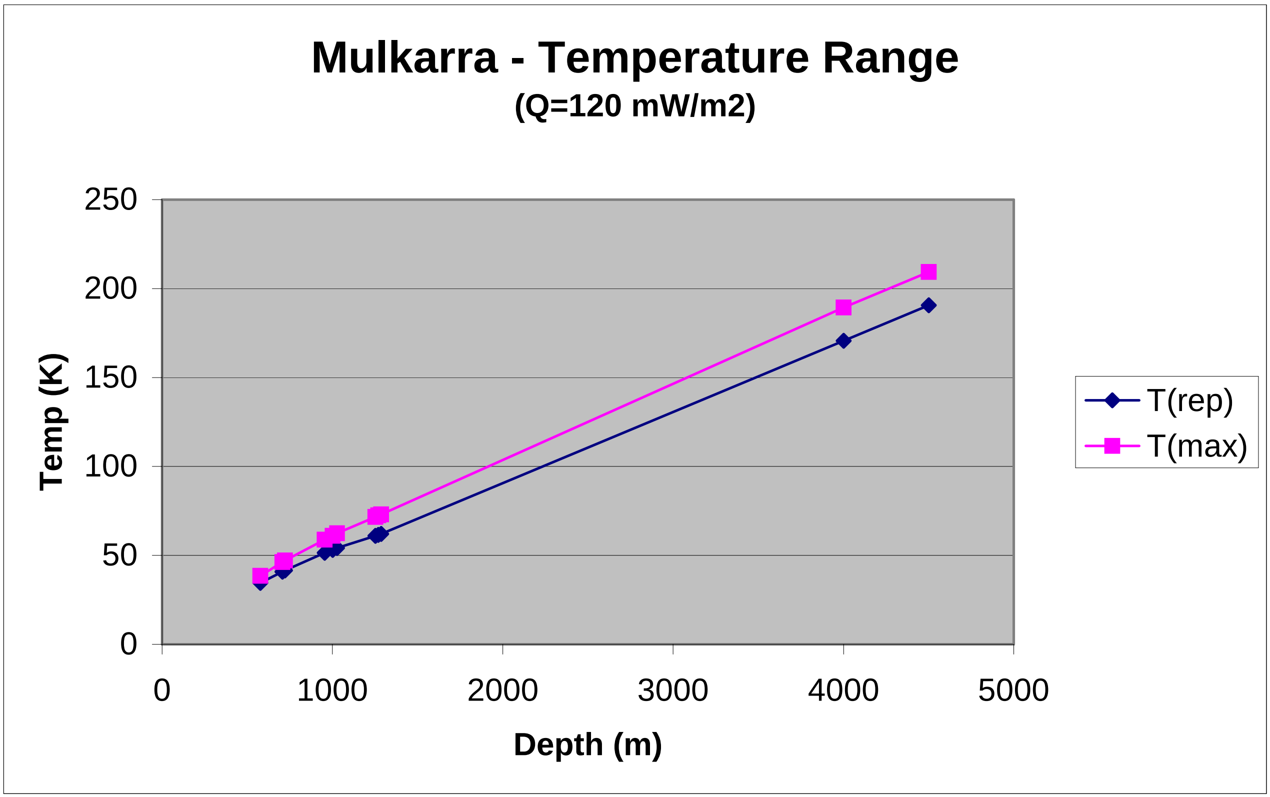

Figure 6: Estimates of temperature for GEL177 based on representative thermal conductivities from Mulkarra West stratigraphy and regional heatflow trends.

3.4 Financial Analysis

Eden undertook a preliminary in-house review of likely economic parameters affecting development of the Mungeranie Project. The predominant concern was the location of the project and the likely cost to deliver electricity to the State power grid. Eden concluded that this was likely to be a significant obstacle to the project development.

4 Year 1 & 2 Expenditure

Table 1: Mungeranie Project Years 1 & 2 Expenditure

Commercial in Confidence

5 Year 2 Work Programme

Eden was to undertake reviews of the geology and geophysics of the Mungeranie area in the first two years of the licence.

The aim of the work is to assess the depth of cover, and plan a location to drill a test hole to enable thermal data collection allowing an assessment of heatflow to be made.

Eden are examining the suitability of magnetotellurics to assist in this assessment.

6 Compliance with the Petroleum Act (Reg. 33)

6.1 Summary of the regulated activities conducted under the licence during the year

Eden has not undertaken any regulated activities as defined under the Petroleum Act in GEL 177 during the licence period to date.

6.2 Report for the year on compliance with the Act, these Regulations, the licence and any relevant Statement of Environmental Objectives

Given that no regulated activities were undertaken during the reporting period, many of the regulations are inapplicable at this stage and no non-compliances have been noted, with the exception of late submission of this report.

6.3 Statement concerning any action to rectify non-compliance with obligations imposed by the Act, these regulations or the licence, and to minimise the likelihood of the recurrence of any such non-compliance

Eden recognises the importance of achieving regulatory compliance and is committed to achieving appropriate practices in its management strategies, work practices and procedures. Eden is committed to operating in an environmentally and socially responsible manner.

6.4 Summary of any management system audits undertaken during the relevant licence year, including information on any failure or deficiency identified by the audit and any corrective action that has, or will be, taken

Eden is a new company and is developing appropriate systems and documentation to cover Field Operations, Environmental Management, Health and Safety issues and compliance checklists to ensure the requirements of relevant Acts and Regulations are met.

Eden’s activities have been essentially desktop studies at this stage and no management system audits have been undertaken as yet.

6.5 List of all reports and data relevant to the operation of the Act generated by the licensee during the relevant licence year

Most of the work conducted during the period of the licence comprised compilation of various public domain data and preparation of a number of memoranda by consultants. The contents of the memoranda have been incorporated into this report.

No new surveys or data relating to the tenement have been acquired.

6.6 Report on any Incidents reportable to the Minister under the Act and Regulations during the relevant Licence Year

No reportable incidents occurred.

6.7 Report on any reasonably foreseeable threats (other than threats previously reported on) that reasonably present, or may present, a hazard to facilities or activities under the licence, and a report on any corrective action that has, or will be, taken

No threats have been identified.

6.8 Statement outlining operations proposed for the ensuing year

See Section 0 above.

7 Key References

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