Terra Estus Resources Pty Limited

Data Review of

the Geothermal Potential of EPG 34, Normanton Area, Queensland

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Executive Summary

The data review was conducted over the geothermal exploration licence EPG 34 located in northwest Queensland. Tenement EPG 34 is considered to have a moderate to high potential for EGS and HSA geothermal energy targets.

The study review area of EPG 34 situated in a remote area which is proximal to the mining regions of Mt Isa – Cloncurry and Weipa. These are regions where industry and development is heavily centred and the supplement or supply of stable electricity supply would be beneficial to local industry.

Publically available data is generally sparse across this region of EPG 34. All public reports on the topic have used data from outside of the area and extrapolated that data over the region.

Only one stratigraphic hole has been drilled to the west of EPG 34. This hole intersected granite at 635m. This granite was age dated at 328+/2 Ma., Late Carboniferous. There is a distinct lack of surface outcrop with the dominant cover consisting of Pliocene alluvial sediments. EPG 34 is considered to be underlain by metamorphic units of Proterozoic to middle Phanerozoic age with minor small intrusive granite plutons.

Projected depth to basement estimations indicate that there is a deep trough which runs north/northeast from the south of EPG 34 through to the north east corner of EPG 34. Depth estimates to basement in this trough range from 1400m to >3000m. This trough may potentially be an early to middle Phanerozoic basin and offer potential elevated insulating properties.

Heat flow data is dominated by regional results with an average of 77^{o}C. Drill hole GSQ Normanton 1 had at temperature of 65^{o}C at 713m. Interpolation of this data suggests that the temperature at 5km depth could be in the vicinity of 170^{o}C to 200^{o}C. Further work is urgently needed to improve the data and define the temperature and heat flow properties. However the regional indication is promising.

Regional airborne magnetic and gravity data provide the best data sets available. Interpretations of these data sets indicate that there are a number of coincident magnetic and gravity anomalies which are potential granite intrusive targets at depth.

Two targets of moderate potential were generated within EPG 34 from combined magnetic weak anomalies with gravity features and projected depth to basement in the order of 1000m to 2000m. One target is in the south of EPG 34 whilst the other is on the northern boundary. A third target is considered to be the deepest part of the projected basin trough in the north east of EPG 34 which is coincident with an intense gravity high anomaly.

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INTRODUCTION

The data review was conducted over geothermal exploration licence EPG 34 located in northwest Queensland, to the east of the township of Normanton (Figure 1).

The aim of the review is to:

1. Assess the potential for power to be generated from the heat energy in the buried granitic rocks (geothermal energy) which are believed to underlie the EPGs from the available public geological and geophysical data;
2. Recommend what type of further geophysical remote sensing work (gravity, magnetic, other) could be conducted;
3. Recommend areas within the EPG where further geophysical work could be conducted.

In addition to reviewing the available published geological studies over the areas, an interpretation of the available gravity and magnetic data defining the subsurface configuration of any underlying granitic bodies as well as structural features (faults, fracture systems, etc) was also required.

The study review area of EPG 34is situated in a remote area which is proximal to the mining regions of Mt Isa – Cloncurry and Weipa.   These are regions where industry and development is heavily centred and the supplement or supply of stable electricity supply would be beneficial to local industry.

Geothermal Energy Synopsis

Any assessment of the geothermal energy potential for an area must consider which type of geothermal energy system(s) is being considered. There are four classic types of geothermal energy which are discussed and used worldwide. In Australia, three types of projects are under development, they are Enhanced Geothermal Systems (EGS or “hot rocks”); Hot Sedimentary Aquifers (HSA); and direct use for heating and cooling; in industry and agriculture, and domestically.

From the statement in point one of the aims listed above it could be concluded that the main target within the EPGs is for direct heat from the buried host granite rocks, that is an Enhanced (or Engineered) Geothermal System (EGS). However given the thick cover of the overlying sedimentary sequence there may be potential for Hot Sedimentary Aquifer (HSA) System(s) to also be considered.

The salient points for these two systems are listed below.

Enhanced Geothermal Systems (EGS) or Hot Fractured Rocks

Hot rocks allow for Enhanced Geothermal Systems (EGS), whereby developers artificially create a reservoir for water to flow through on deep hot granite rocks (Figure 2). In Australia known suitable sites are located in South Australia and Queensland. Typical factors considered for EGS are:

- Targeted high heat generating granites
- Are typically focused from ~3.5-5km depth
- Are considered to have an economic temperature lower limit of 180 degrees Celsius

Figure 1: Location of tenement EPG 34 in NW Queensland.

- Insulating units (low thermal conductivity sediments) above the granite
- Are considered to be a 'closed' system once operational
- Temperatures in excess of 200 degrees Celsius are considered positive.

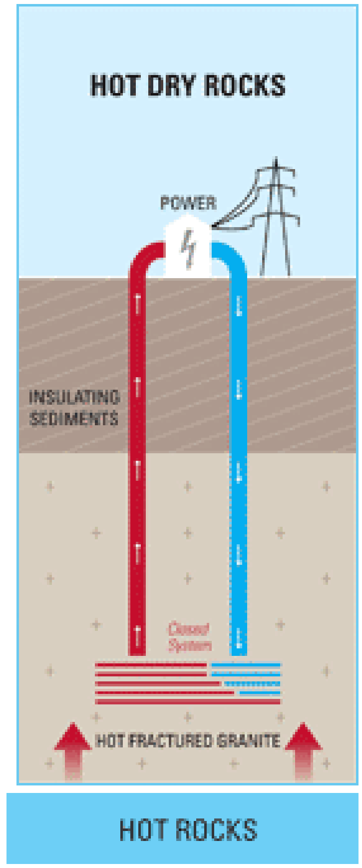

Figure 2: Simplified diagram of Enhanced Geothermal System

Hot Sedimentary Aquifer (HSA)

HSA systems are typically developed in naturally occurring porous sandstones or limestone rocks containing water that is heated by either crustal heat flow or proximate hot rocks. Fracturing techniques may still be used to enhance water flow between wells. HSA systems have been successfully operating in Australia and internationally for decades. Well known examples in Australia are the Otway and Gippsland basins in Victoria and the Great Artesian Basin in Queensland and South Australia. Characteristic factors considered for HSA are:

- Thick sedimentary basins which contain heat
- Basin composed of thermally resistive units trapping heat (low thermal conductivity)
- Sedimentary basin or part thereof contains an aquifer
- Aquifer may be fractured granite
- Typically shallower focused from ~1.5-2km depth
- Are considered to have an economic temperature lower limit of 150 degrees Celsius
- Heat source unknown or fractured granite.

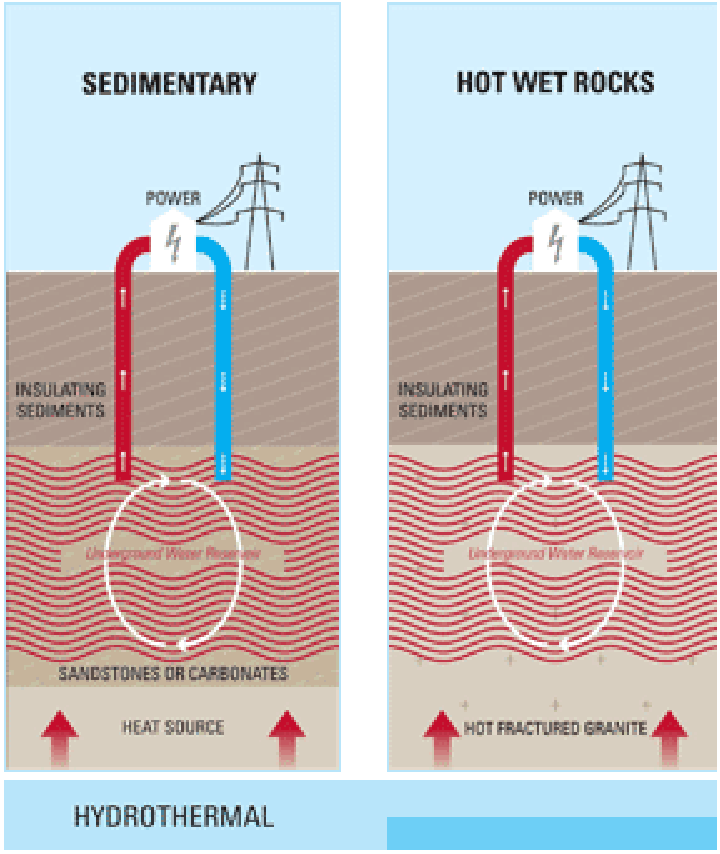

Figure 3: Simplified diagram of Hot Sedimentary Rock systems

Water Use

Water that is used in the geothermal energy production must be retained within a maintained high pressure. Hence geothermal projects that are a closed loop system are considered to require very little water to function and to have less impact on natural groundwater systems.

Desktop Study Focus

- Determine data available from open source
  - Is more data needed to be acquired via surveys (geophysical or geological)
- Regional geology
  - Sedimentary basins
  - Crustal Province
  - Geophysical data interpretation
  - Heat sources, flow and temperature
- Determine geothermal potential of EPG 34
  - geothermal gradient
    - Elevated heat flows/temperatures
    - Surface manifestations i.e. springs (either hot or cold)
      - Drill hole data
    - Lithology logs
    - Down hole temperatures

    - Geophysical logs
- Recommendations
  - Geophysical surveys to be undertaken
  - Exploration targets / focus areas

TENEMENT

Tenement EPG 34 is located in the Carpentaria Basin of Northern Queensland (Figure 1) and lies within the 1:250,000 scale Normanton mapping sheet (Table 1).

EPG 34was granted to Terra Estus 100% and expires on 26/09/2015 (Table 2).

Table 1: 1:250,000 Geological and 1:100,000 Topographic map sheets that cover EPG 34.

EPG No	1:250,000 MAP SHEETS		1:100,000 MAP SHEETS	
	NUMBER	**NAME**	**NUMBER**	**NAME**
34	SE54-7	NORMANTON	7162	NORMANTON

Table 2: Details of Tenement.

EPG#	Status	Sub Blocks	Area (km^2)	Date of Grant	Date of Expiry
34	Granted	200	683	27/09/2010	26/9/2015

LOCATION /CLIMATE/ACCESS/INFRASTRUCTURE

LOCATION

EPG 34 is located in northwest Queensland within the Gulf Savannah region of the Gulf of Carpentaria. EPG 34 lies east of Normanton (Figure 1) which has a latitude of 17.6°S, longitude 141.0° E and is 70 Km south of Karumba, 493 Km northeast from Mt Isa, 707 Km west of Cairns, and 2,500 kilometres northwest of Brisbane. Normanton is the capital of the 68,111 Km^2 Carpentaria Shire and part of the only sealed access to the Gulf of Carpentaria.

This region of Australia is largely unexplored by mining, petroleum/gas or energy companies.

The Gulf Savannah region extends from the Great Dividing Range in the east to the Northern Territory border in the west. The Gulf Savannah region is grassland dominated lowland with abundant wildlife.

CLIMATE

There are two seasons in the Carpentaria Shire region; The 'Dry' season and the 'Wet' season. The 'Dry' season occurs between the months of April to September and is characterised by little to no rainfall with mild to warm conditions. Average temperatures range from a maximum of 29°C to a minimum of 15°C. Humidity levels are lower during the 'Dry' season with averages of 45% to 55%.

The 'Wet' season occurs between the months of October to March and is characterised by heavy rainfall, particularly from January onwards with an average monthly rainfall of 250mm in January. Intense storms and cyclones are known to occur. Average temperatures range from a maximum of 36°C to a minimum of 25°C. Humidity Levels average between 55% and 65%.

A peculiar cloud formation, 'The Morning Glory', can be seen in the 'Wet' season, late in September to early November. The Morning Glory is a series of long cigar shaped cloud formations that roll out of the Gulf in lines of three or four, usually in the early hours of the morning before daylight. These multiple formations follow behind each other, and are accompanied by an intense wind called a 'shock wave'. The cloud itself does not travel much further than 60km inland but the wind has been registered as far south as Alice Springs. The emergence of these cloud formations is a powerful proclamation of the unstable and variable weather of the build-up to the 'Wet'.

ACCESS

Primary access to Normanton is from Cloncurry via the Matilda Highway (Burke Developmental Road) and from Cairns via the Savannah Way (Gulf Developmental Road). These major roads are now sealed but may have sections that have been subject to flooding and flood damage. Distances between towns are substantial (and hence also between sources of fuel, food and water supplies) and travel along these routes must be well planned. Other sealed roads in the district are of limited extent and mainly confined to around Normanton and the Normanton to Karumba Road.

All other roads in the region are gravel and black soil pavement roads. These require careful negotiation whilst driving. Seasonal thunder storms in the area can close the roads without notice, it is important to check with the local authority before travelling these outback roads. All such trips require good planning and application of best practice travelling procedures. Other access is via property tracks and may only be suitable for 4WD vehicles.

The historical Gulflander Railway is mostly a tourist operation which operates to Croydon one day a week, Wednesday, with the return journey to Normanton the following day. A bus service connects to Mt. Isa three times a week.

As of March 2011 Skytrans Airlines provides scheduled service flights to a number of North Queensland destinations and operates charter flights throughout Australia, Papua New Guinea and the southwest Pacific. The airline also provides fly-in fly-out charter services to many large companies within the mining sector. Scheduled flights operate from Cairns to Normanton Monday through to Friday, weather permitting.

GEOLOGY

SURFACE GEOLOGY

Surface mapped geological units in EPG 34 include alluvial silt, clay, clayey quartzose sand and gravel of Pliocene age cover the tenement. Minor Quaternary alluvial sand, gravel, silt, clay and soil are deposited along an east west drainage channel, Wills Creek, in the north of EPG 34.

Regional Geology

The regional geology of the Normanton area is described in detail in the report North Queensland Geology by Bain and Draper, 1997. Further public information is available on sedimentary basins in the region from Geoscience Australia downloadable information sheets.

Basement rocks throughout the area of study are interpreted to be variably deformed and intruded Proterozoic sedimentary and metasedimentry rocks with potentially some minor thin Phanerozoic age sedimentary sub-basin deposits (Draper, 1997). These Proterozoic rocks of the Kowanyama Province and Mt Isa Province are entirely concealed beneath the Carpentaria and Karumba Basins.

Palaeoproterozoic to Mesoproterozoic

The oldest rocks in North Queensland are probably those of the unexposed Kowanyama and Claraville Provinces which were cratonised during the Barramundi Orogeny between 1880 Ma and 1850 Ma. The resultant craton was rifted several times between 1880 Ma and 1520 Ma, forming the Mount Isa and Keer Weer Provinces. Geophysical properties indicate that the Kowanyama Province is probably dominated by metamorphosed sedimentary rocks and non-magnetic granites. The Mount Isa and Keer Weer Provinces have a higher proportion of volcanic rocks and magnetic granites.

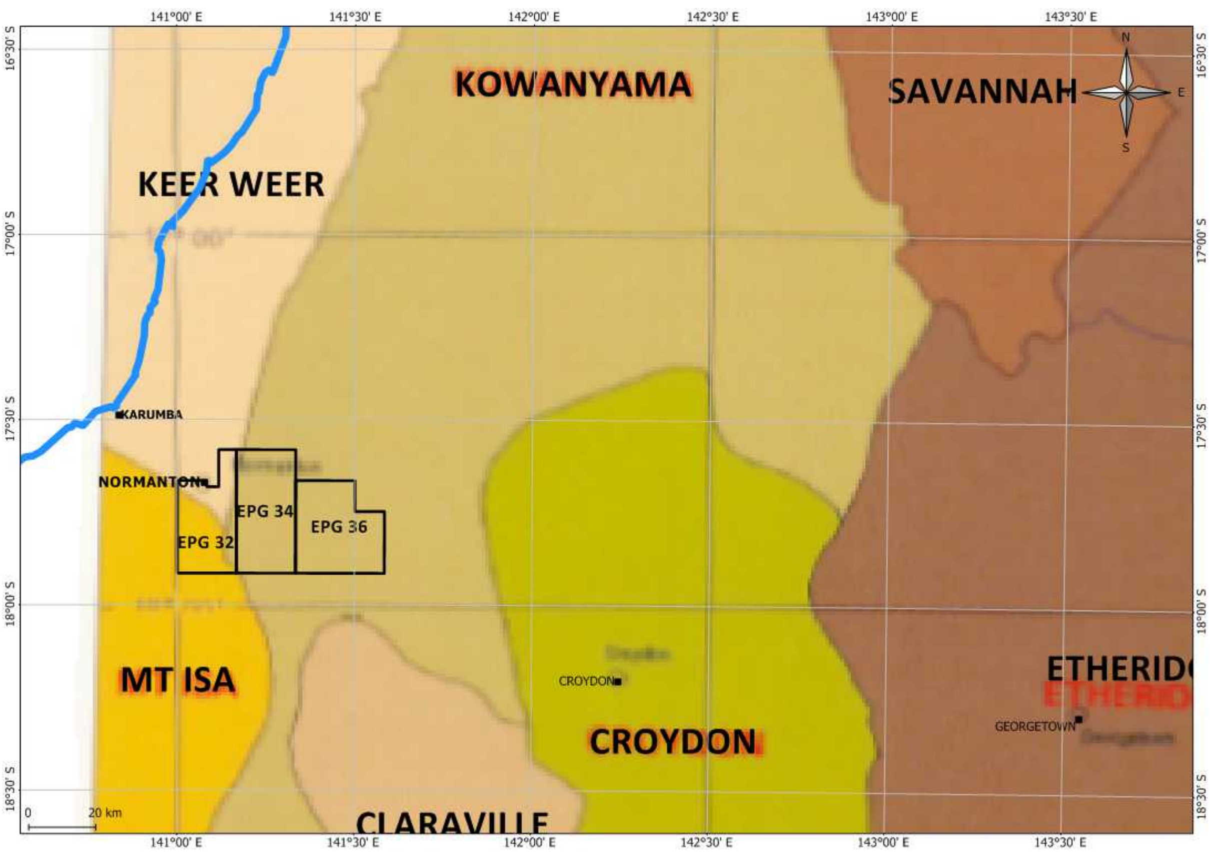

Figure 4: Basement Provinces underlying EPG 34.

Kowanyama Province (Wellman, 1997)

The Kowanyama Province consists of a band of low magnetisation crust about 1200 km long and 100-200 km wide, with a northerly strike. It is thought to have cratonised during the Barramundi Orogeny 1880-1850 Ma. This province is proposed to, completely underlie EPG 34 (Figure 4).

The Province is thought to be the oldest crust within North Queensland. It is crosscut by the Mount Isa and Keer Weer Provinces' crustal rifts in the south west and west. The province is inferred to be mainly nonmagnetic granites and metamorphic units; there are only a few areas where anomalies can be attributed to magnetic granites, or magnetic volcanics. The degree of deformation and metamorphic grade can only be inferred from the magnetic anomalies. In the northwest of the province, the magnetic anomalies reflect primary variations in rock magnetisation, so these areas are possibly little deformed, and of greenschist grade. Elsewhere there are few magnetic anomalies attributed to local structure, so the rocks are likely to be strongly deformed and of amphibolite grade.

A 20-40 km wide band along the western margin of the Kowanyama Province, through EPG 34 (Figure 4), has been deformed and metamorphosed by ~1880-1520 Ma events of the Mount Isa and Keer Weer Provinces. This potentially includes emplacement of fractionated granites.

Mount Isa Province

The Mount Isa Province is a complex multi-stage crustal rift, 800 km long and 150-250 km wide, with a north trend. The oldest rocks forming basement to the rift, and its rift margins, were metamorphosed during the Barramundi Orogeny (1880-1850 Ma). There were three periods of crustal rifting, at 1870, 1790 and 1678.Ma, resulting in volcanism, sedimentation and some granite intrusion. This was followed by the major deformation and metamorphic event, the 1620-1540 Ma Isan Orogeny, and by emplacement of fractionated granites along the eastern margin of the province about 1500 Ma ago.

Keer Weer Province

The Keer Weer Province is a band of strong gravity and magnetic anomalies along the eastern margin of the Gulf of Carpentaria. The band is 650 km long, 200 km wide, trending north, and co-linear with the Mount Isa Province. This province is considered to be basement to the north-west of EPG 34 (Figure 4). The province is interpreted as a major, multistage crustal rift, of similar type and probably similar age to the Mount Isa Province. The wide range of type of magnetic anomalies, and range in relations between gravity and magnetic anomalies, is consistent with there being a wide range of rock types in the province, including non-magnetic granites, folded sedimentary rocks, and volcanics. Subdivisions within the province, and structures within the subdivisions, trend northerly. The south eastern margin of the province has relatively high amplitude gravity and magnetic anomalies that are more elongate north-south, stronger boundary anomalies, and stronger metamorphic effects in the adjacent band of the Kowanyama Province. These features are consistent with this part of the Keer Weer Province being of higher metamorphic grade possibly amphibolite facies, more deformed, and thrust eastwards over the Kowanyama Province. Elsewhere, magnetic high anomalies show no obvious evidence of deformation or heating. The province is thought to be a rift crosscutting older Kowanyama Province crust to the west and east, to abut or grade into the Mount Isa Province to the south, and to be truncated to the north by a province under the Arafura Sea.

Neoproterozoic to Devonian

Events between 1550 Ma and the Devonian are not at all defined. However some intra-craton rifted basin with Palaeozoic infill sediments is postulated but not confirmed.

Late Devonian to Mid Permian

Bodies interpreted to be of igneous rocks similar in age and type to those of the Townsville-Mornington Island Igneous Belt (TMIB) and Badu-Weymouth Belt are scattered sporadically beneath rocks of the

Carpentaria and Karumba Basins throughout Cape York Peninsula and into the Gulf of Carpentaria. Further these Kennedy Igneous Province units are interpreted to also intrude up to 130 km northwest, west and southwest of Croydon. This regional distribution includes EPG 34. GSQ Normanton No. 1 drill hole, about 60 km south of the TMIB and west of EPG 34, bottomed in granite which when aged dated gave a resultant Rb/Sr age date of 328+/-2Ma., Late Carboniferous (Wellman et al. 1994; AGSO GEOCHRON database). This correlates with ages obtained for intrusives of the Kennedy Igneous Province.

The Kennedy Igneous Province is dominated by granites and ignimbrites that range in age from 330 Ma to 260 Ma. Documented intrusive compositions are mainly felsic to intermediate I-types, with lesser A-types, minor felsic S-types and rare mafic rocks. Some highly fractionated granite has been recorded in the province. These igneous rocks are considered to have been generated dominantly by partial melting of evolved Proterozoic crust (Kowanyama Province) in an extensional or transtensional, possibly back-arc, tectonic environment.

The Kennedy Igneous Province is also a main metallogenic terrane of North Queensland in terms of variety and quantity of minerals. Gold, tin, tungsten, molybdenum, bismuth, base metals and uranium have all been discovered. Gold is found in plutonic/mesothermal vein, breccia, porphyry, and skarn deposits. Tin occurs in plutonic vein, disseminated sheet, breccia vein, pipe, stockwork, skarn and greisen deposits and is known to be associated with fractionated, reduced granites. Tungsten is present as sub-volcanic deposits or skarn. Base metals are generally present as skarn or porphyry deposits. Uranium is associated with volcanic rocks within this province.

Jurassic and Cretaceous

A depositional hiatus is believed to have occurred between the Middle Triassic and the Middle Jurassic in North Queensland, but the Early Jurassic to mid Cretaceous was a period of widespread fluvial and marine sedimentation in the large intracratonic basin, the Great Artesian Basin. Breakup of the Coral Sea began in the Cretaceous and is marked by the influx of volcanic detritus into the Great Artesian Basin and the development of rifts and associated infill sediments.

The Great Artesian Basin includes the Eromanga, Carpentaria, Surat, Laura, Mulgildie, Nambour, Maryborough and Clarence-Moreton Basins. An onshore Gulf of Carpentaria region sub-basin within the broader Great Artesian Basin is the Staaten Sub-basin and includes the current onshore portion of the Carpentaria Basin (Figure 5) in which EPG 34 lies. The lowest unit is Gilbert River Formation sandstone which unconformably overlies the Kowanyama Province basement. Jurassic to Cretaceous lithostratigraphy, ages and correlations for the Carpentaria Basin are shown in Figure 6.

Fluvial deposition began in the Early Jurassic in fault-controlled basins. In the southern Carpentaria Basin Middle Jurassic deposition was restricted to isolated fault basins. Marine deposition occurred in the western Carpentaria Basin. In the Late Jurassic and earliest Cretaceous, deposition of transgressive shoreline and near shore sediments dominated. Sediments deposited in fluviatile environments during the Jurassic and Early Cretaceous times include alternating sandstones, clayey sandstones and siltstones and an influx of volcanic detritus. Subsidence rates in the Cretaceous were much higher than in the Jurassic. Deposition ceased at the end of the Early Cretaceous, and was followed by uplift, folding and erosion. Deformation is characteristically mild with the stratigraphy largely flat lying with slight inclination to the west. Thickness of the Carpentaria Basin sequence ranges from approximately 550 m in GSQ Normanton 1 stratigraphic hole to a projected >1600 m offshore in the Gulf of Carpentaria. Structural trends are generally inherited from the basement rocks.

Jurassic and Cretaceous sandstone and glauconitic sandstone formations and members in the Carpentaria Basin contain important groundwater resources. Additionally significant oil shale and vanadium resources occur within the Toolebuc Formation of the Eromanga Basin and by extrapolation north, possibly also in the Toolebuc Formation which has been encountered in stratigraphic drilling in the southern Carpentaria Basin (GSQ Normanton 1).

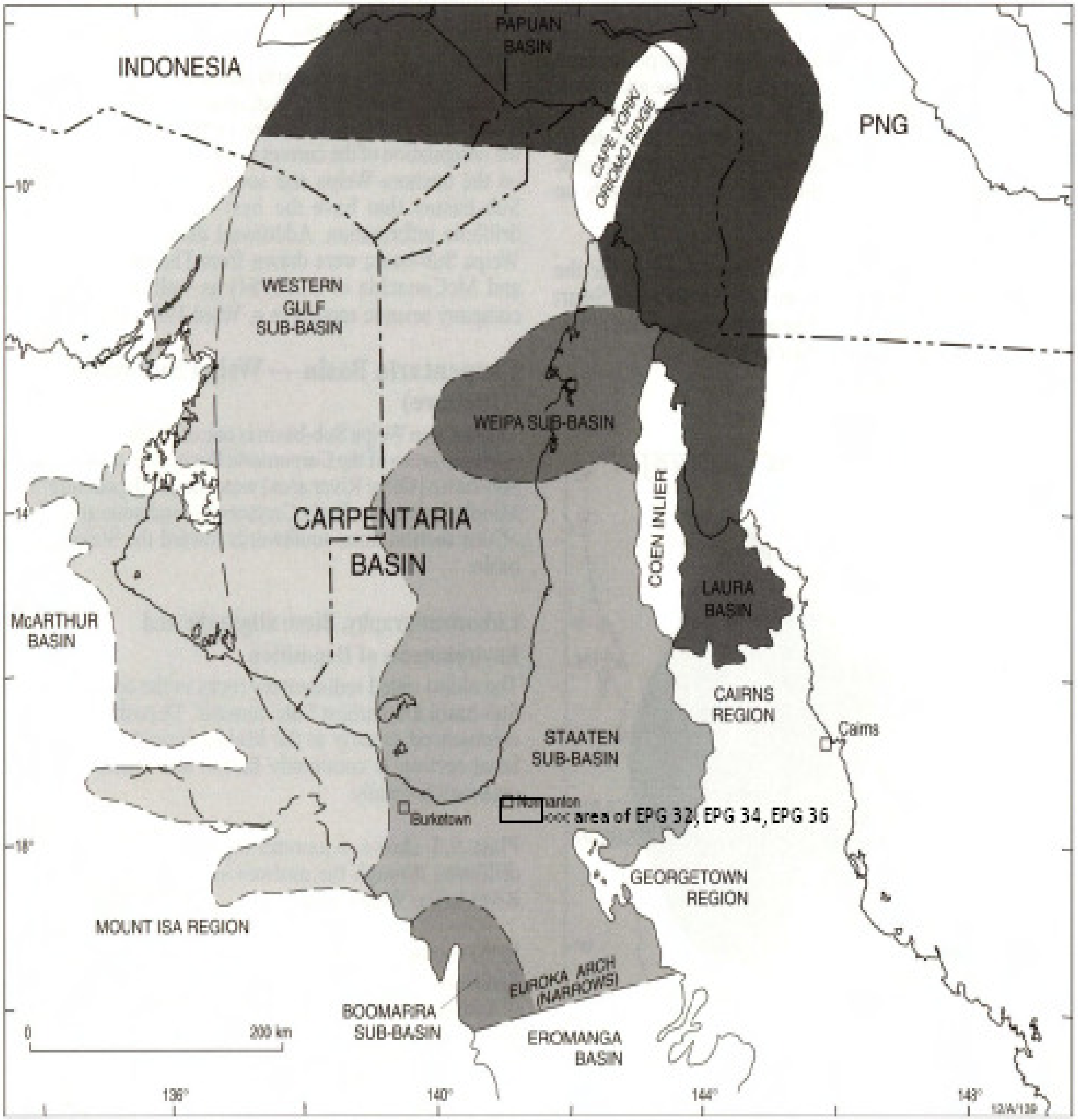

Figure 5: Extent of Carpentaria Basin (after Draper, 1997)

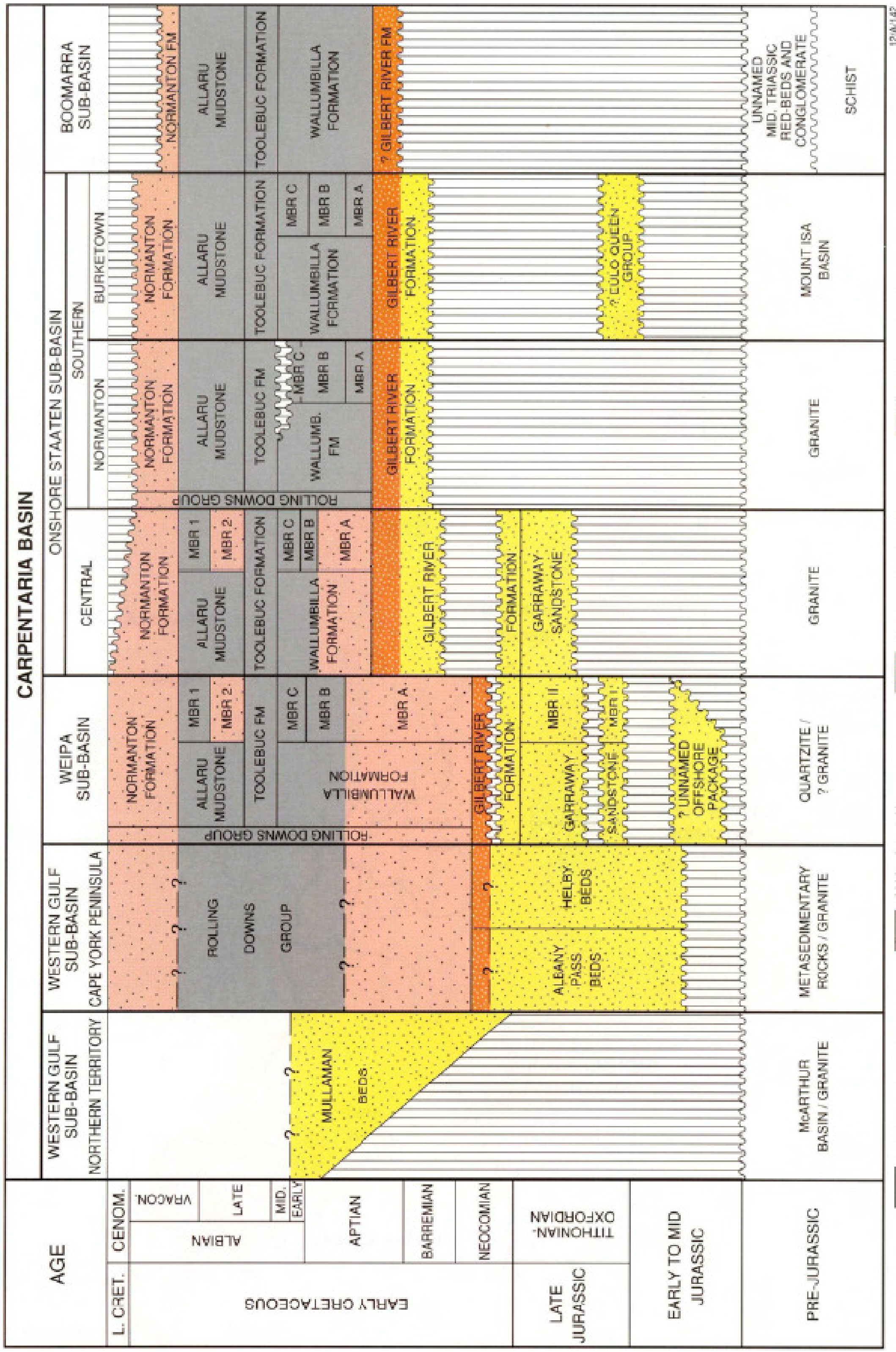

Figure 6: Lithostratigraphy, ages and correlations of the Carpentaria Basin(Draper, 1997)

Cainozoic

The Cainozoic in North Queensland is characterised by widespread fluvial sedimentation, intensive weathering and continental basalts. The Tertiary Karumba Basin (Figure 7) sequence unconformably overlies the Carpentaria Basin and comprises three cycles of sedimentation, erosion and weathering. The two earliest cycles, comprising the Bulimba Formation and Wyaaba Beds, contain artesian aquifers within interbedded sequences of sandstone, conglomerate and claystone. While the formations extend widely across the Karumba Basin, productive artesian aquifers are restricted to palaeochannels confined by surrounding clayey sediments between the Staaten and Holroyd rivers. The overall thickness of the Karumba Basin is relatively shallow with a maximum projected thickness onshore of approximately 247m. Karumba sediments were only penetrated to a depth of 18.5m in GSQ Normanton 1 stratigraphic hole, hence these sediments are not expected to be of any great depth over the area of EPG 34.

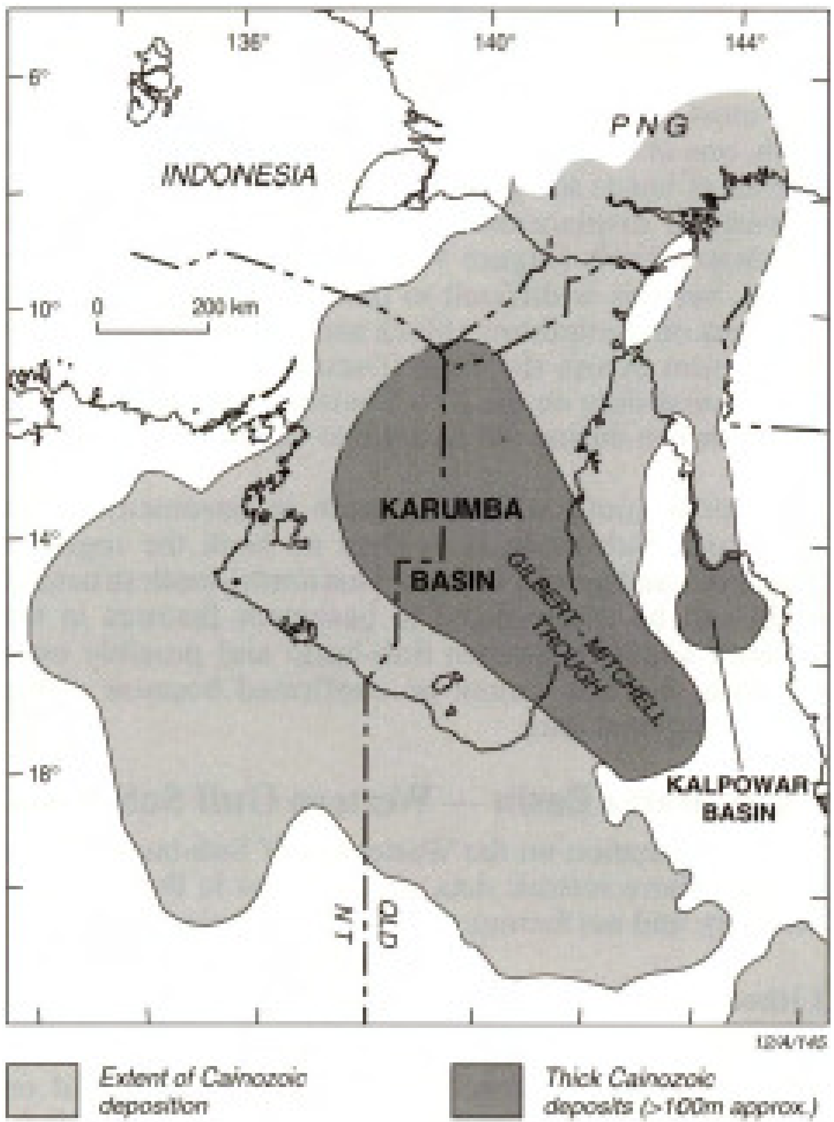

Figure 7: Extent of Karumba Basin (Draper, 1997).

Exploratory Drilling

Drilling is sparse in this region, with 6 deep wells and 25 shallow wells (< 45m deep) recorded which predominantly lie west of EPG 34. Only one drill hole is relatively close to EPG 34, GSQ Normanton 1 which is a stratigraphic bore drilled by the Geological Survey of Queensland. Exploration for minerals has not been extensively conducted throughout the area of EPG 34 due to the considerable depth to basement, in excess of 600m. Petroleum exploration in the general region has been sparse and unsuccessful.

Stratigraphic Holes

Two stratigraphic drill holes are located within the region (Table 3, Figure 8). These are Normanton 1 (GSQ), located west of EPG 34, and another hole located southeast of EPG 34 which appears to have no data available.

Table 3: Stratigraphic drill hole details.

Well ID	Company	Depth (m)	Date drilled	CRN	Publication Ref.
Normanton 1	GSQ	712.9	25/3/1988		QDM Record 1988/13 (CR 41038)
N/A	BMR	N/A	01/06/1964	N/A	BMR Record 1971/142

Petroleum Wells

Only four holes are located within the region, none of which are in EPG 34 (Table 4, Figure 8). These holes may be too far away from the area of study to provide any useful geological control.

Table 4: Petroleum well details.

Well ID	Company	Depth (m)	Date drilled	CRN	Publication Ref.
Karumba 8	Zinc Corporation Ltd (AAO)	720.5	03/03/1958	428	
Normanton Scout 2	MWE?	464.2	01/06/1964	N/A	GSQ Pub 299
Normanton Scout 1	MWE?	243.2	02/12/1963	N/A	GSQ Pub 299
Silverleaf 1	Comalco Aluminium Ltd	681	26/10/1988	20581	

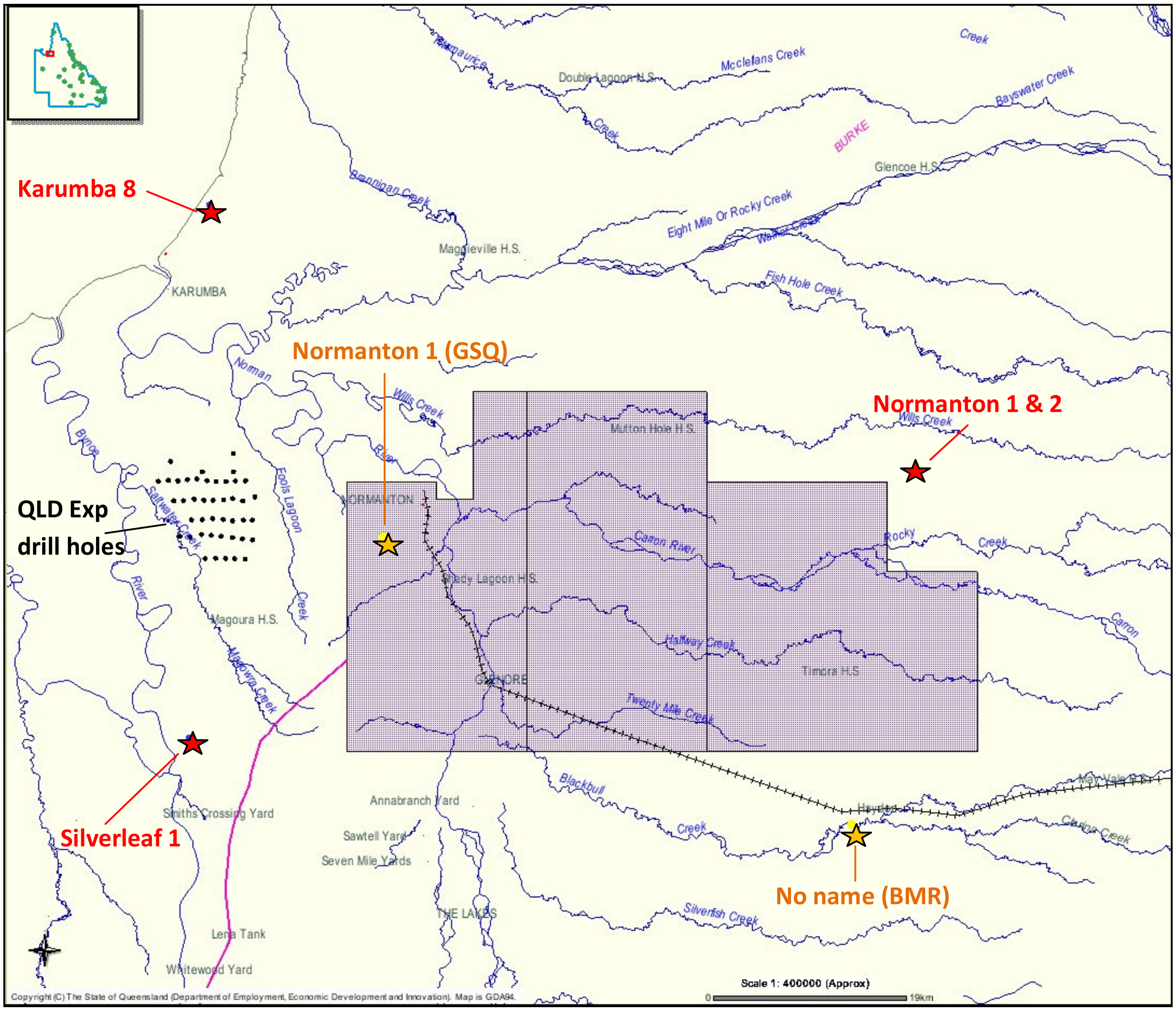

Figure 8: Location of stratigraphic (yellow stars) and petroleum (red stars) drill holes in region.

Depth to Basement Estimations

Depth to basement estimations produced by the Queensland Geological Survey are based on depth within drill hole logs, seismic interpretation estimations and estimations based on magnetic survey data. The data largely reflects the depth of first intersect within exploration drill holes, as the seismic data estimation and the magnetic survey data interpretations both gave apparent overestimation of the depth to basement and hence were either removed from the interpolation process or down weighted to limit their influence. The relevant portion of the resultant estimated depth to basement image is shown in Figure 9. Within EPG 34 the imaged depth to basement ranges from approx. 900m in the northwest corner to approx. 3000m in the southeast corner. The deep estimate in the southeast corner is part of what appears to be a basement low "trough" which runs northeast through EPG 34 and into the adjacent area (Figure 9).

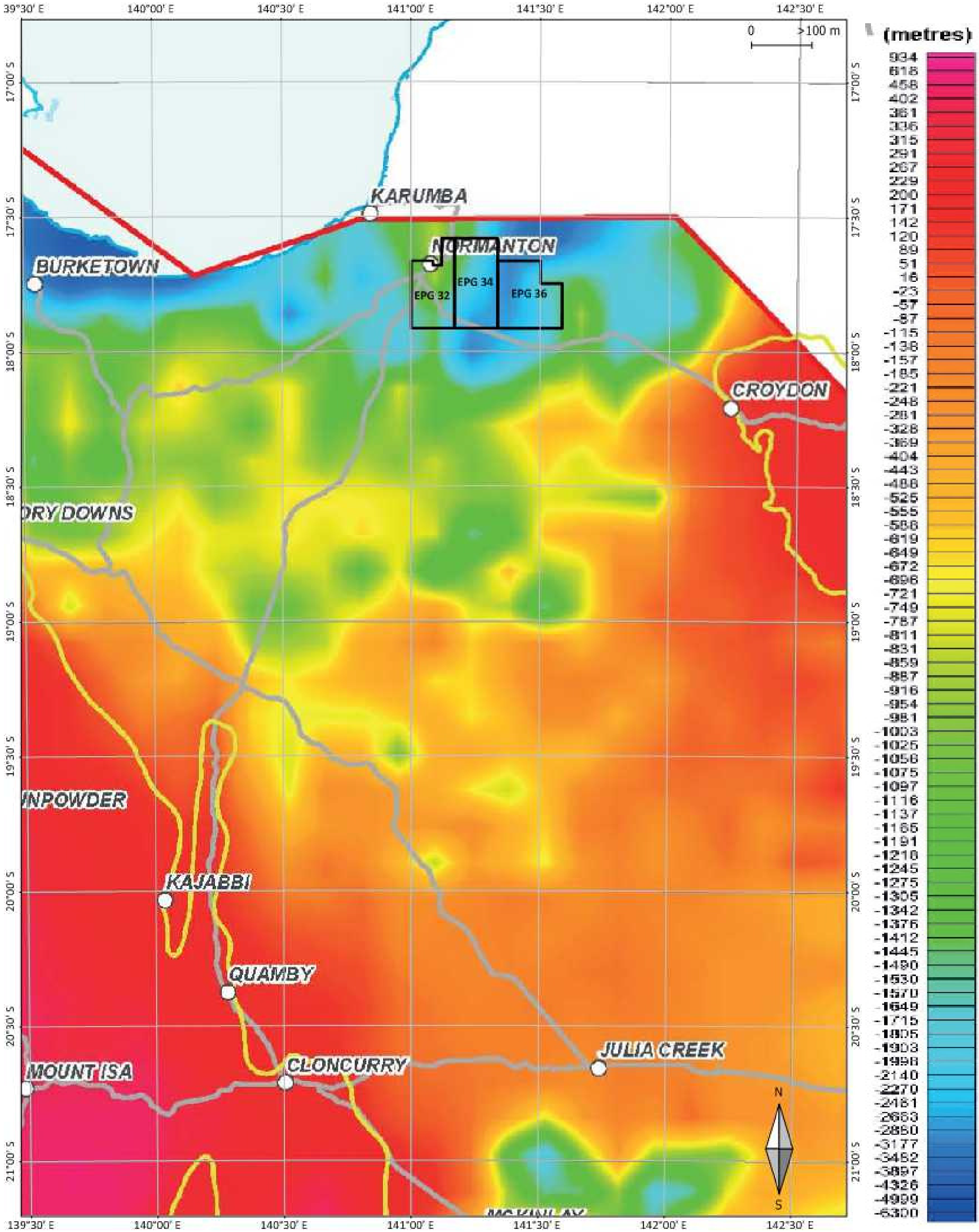

Figure 9: Estimated depth to basement image

Recorded minimum basement depth in drill hole GSQ Normanton 1 west of EPG 34 is 635 m,. Geological logs show that the basement intersected at this depth is a coarse grained granite which is commonly fractured and sheared. The shears and fractures are infilled with chlorite. The total depth of GSQ Normanton 1 was 713m.

Potential Economic Mineralisation

Carpentaria and Karumba Basins

The Carpentaria and Karumba Basins may contain sandstone-hosted uranium deposits. This conclusion is based on the presence of favourable host lithologies, an appropriate depositional environment for the host rocks and the presence of eroding felsic igneous rocks to the east which could have acted as a source for uranium. Mesozoic units in the Carpentaria Basin that are thick, have a high permeability and/or contain carbonaceous horizons are probably most prospective. Some selective exploration occurred in the 1970s but without success. Any outcropping Mesozoic stratigraphy is generally oxidised and has been flushed by meteoric water, which would tend to obscure the presence of such deposits. Therefore units under cover are more favourable, though difficult to explore. Sandstone-hosted lead-zinc mineralisation may also occur within the Carpentaria Basin. Host lithologies, their depositional environment (continental to shallow marine) and the tectonic setting are all favourable. The presence of extensive granitic basement beneath the basin has been confirmed from drilling and geophysical interpretation and may also be an important component to this type of mineralisation. All these factors occur in EPG 34.

Sedimentary manganese deposits could be concealed within the Carpentaria Basin given the large Groote Eylandt manganese deposit on the western margin of the Gulf of Carpentaria. Groote Eylandt occurs in Early to mid Cretaceous Mullaman Beds. These have been correlated with the Normanton Formation to the southeast. Manganese nodules (averaging 49% MnO) have been identified as surface float on Normanton Formation. The Normanton Formation is considered to be the upper unit to the Carpentaria Basin throughout EPG 34. Sedimentary manganese deposits are favoured by a shallow marine environment along a stable cratonic margin and appear to occur at an oxidation-reduction interface associated with sea level changes in enclosed basins with restricted access to the sea. Such deposits are commonly hosted by glauconitic sandstone, which is common throughout the stratigraphy of the Carpentaria Basin. Sedimentary phosphorites can be associated with sedimentary manganese deposits and form in a similar depositional environment and tectonic setting. However there is no indication from the stratigraphy that phosphate accumulations have occurred, and geochemical anomalies have not been reported.

The Toolebuc Formation contains bituminous shale and is a potential source of oil shale, although the thickness and grade are variable. It occurs as a 5- 20 m thick unit in the southern part of the Carpentaria Basin as far north as latitude 16°S and at depths of up to 500 m. Toolebuc Formation was encountered in the GSQ Normanton 1 drill hole. The Toolebuc Formation is projected to continue throughout EPG 34.

No significant hydrocarbons have been intersected in drilling of the onshore portions of the Carpentaria Basin. This reflects the absence of suitable source rocks and the dearth of suitable structures within the Carpentaria Basin for petroleum accumulation, even though argillaceous units in the Rolling Downs Group provide an extensive regional seal over most of the basin. The Karumba Basin is too thin and shallow for petroleum accumulation.

Geophysical evidence indicates that the Croydon Province in the Georgetown Region extends beneath the Carpentaria Lowlands and could host mesothermal gold and vein tin deposits. However where the cover sequence is projected to be more than 400 m thick, metallic deposits hosted by the basement will be difficult to detect and unlikely to be economic.

Groundwater

Important groundwater resources, including artesian groundwater occur in the Carpentaria Basin and shallow groundwater in coastal sedimentary aquifers. Important aquifers also occur in the Karumba Basin. Groundwater in the fractured rocks of the Palaeozoic and Proterozoic metamorphic and igneous basement rocks is limited in quantity and variable in quality (Draper, 1997).

Groundwater is important for pastoral, agricultural, domestic, homestead, town and industrial uses throughout North Queensland. In the southern part of North Queensland where EPG 34 lies, surface water is often available during summer, but it is unreliable and unevenly distributed. Groundwater is the only reliable source of water in the region.

The hydrogeology of the Great Artesian Basin as a whole was summarised by Habermehl (1996) and groundwater resources of the northern Carpentaria Basin were described by Horn et al. (1995).

Hydrogeology

Aquifers in the Carpentaria Basin are present in the Gilbert River Formation and some minor aquifers are present within the lower parts of the Rolling Downs Group. The main confining sequence is the Rolling Downs Group, Wallumbilla and Toolebuc Formations, and the Allaru Mudstone. Aquifers in the Eromanga Basin to the south are connected to the aquifers in the Carpentaria Basin across the Euroka Arch, and groundwater movement is directed northwards across the Euroka Arch into the Carpentaria Basin.

Isotope hydrology studies in the northern Eromanga Basin and in the northern part of the Carpentaria Basin show similar meteorological patterns of continuing recharge from geological to modem times, and groundwater movement away from the intake beds towards the centre of the basin. In North Queensland, most groundwater in the Eromanga and Carpentaria Basin moves in a westwards direction. Sparse potentiometric data indicate that the groundwater flow through the area of EPG 34 is from east to west/northwest. Only regional GAB estimations are available for transmissivity and flow rates, which are considered to be low. The majority of the data that this information is based on comes from the southern areas of the GAB, not from the northern Carpentaria Basin component. Recorded water temperatures throughout the Carpentaria Basin vary from 20^{o}C to 80^{o}C with the lower temperatures in water bores close to the edge of the basin and the higher temperatures towards the basin deeper sections.

Recharge is considered to occur in areas to the east along the Great Dividing Range where the aquifer units are exposed, Figure 10. Calculated recharge rates for the Carpentaria Basin are given in Table 5.

Table 5 Carpentaria Basin calculated recharge rates (Great Artesian Basin Coordinating Committee, 2010)

Aquifer	Area (km2)	Average rainfall (mm)	Effective rainfall (%)	Tambo recharge (mm/year)	Calculated recharge rate (mm/year)	Total recharge (ML/year)
Carpentaria Basin	31,358	1,600	50	0.00725	0.00967	303,127

Natural discharge from the Great Artesian Basin (GAB) occurs as concentrated outflow from springs (Figure 10), vertical leakage through confining beds towards the regional watertable, and subsurface outflow into neighbouring basins. Diffuse discharge from the artesian aquifers through the confining beds towards the surface occurs in the areas where the confining beds are relatively thin, pressures are high, and the watertable is shallow, such as the Euroka Arch. No known springs or discharge zones are recognised in the area of EPG 34.

Artificial discharge occurs by means of free or controlled artesian flow and pumped abstraction from water bores drilled into the aquifers. Flowing and non-flowing artesian water bores that tap the aquifers are important for the water supply of Cape York Peninsula because of their shallow depths and the good quantities and quality of the groundwater.

Aquifers in the Karumba Basin occur in the Bulimba Formation and in the Wyabba Beds, though they are limited in their thickness and extent. The Karumba Basin is the most important source of water on the Western Cape York Peninsula. Confining beds consist of the fine grained Cainozoic sediments overlying most of the aquifers in the Karumba Basin. The hydraulic characteristics of the Karumba Basin aquifers are poorly known, except in the Weipa area where the water is used for the town supply and in the mine.

WATER QUALITY

Groundwater from the major aquifers (Gilbert River Formation) in the Carpentaria Basin is generally good in unconfined aquifers and suitable for most purposes. In confined aquifers, water quality deteriorates, probably due to mixing with saline waters from the Rolling Downs Group. Fluoride values are often too high for human consumption. This occurs in the recognised Carpentaria Basin anomaly which is about30 km south of EPG 34, where fluoride values of up to 37.5 mg/L have been recorded in the sandstones that overlie granitic basement . High groundwater fluoride values are considered to be due to the dissolution of fluorine bearing minerals in granitic basement directly underlying the sandstone aquifers (Great Artesian Basin Coordinating Committee, 2010). Fluoride concentration is complicated in that geochemical changes in groundwater and the solubility of calcium fluoride will determine the fluoride carrying capacity of the groundwater. Low calcium concentrations provide scope for dissolution of fluorine bearing minerals. Average groundwater analyses for the Carpentaria Basin are given in Table 6.

Figure 10: Major spring groups for GAB dotted outlines, general flow direction green arrow, recharge zones gold. (Great Artesian Basin Coordinating Committee, 2010)

Groundwater quality in the Karumba Basin is generally good, with the Bulimba Formation water suitable for all purposes, but the Wyabba beds contain some saline waters. An average water analysis for the Karumba Basin is given in Table 6.

Table 6 Average water analyses, Carpentaria Basin (after Draper, 1997).

Unit	n	Cond	Hard	SAR	Alk	Na	Ca	Mg	Cl	HCO3	SO4	NO3	F
Bulimba Formation/ Wyabba beds	214	801*	154*	7.41	158	128*	26	22	158*	190	38*	0.8	0.7
Rolling Downs Group	8	3800*	566*	20	277	667*	119*	65*	975*	335	336*	0.07*	2.6*
Gilbert River Formation	26	1340	87*	17	223	258	23*	7.68	276*	267	36*	1.0*	2.6*

* .. indicates data with a skewed distribution with significant variance; n = number of analyses; cond = conductivity; hard = hardness; SAR = Sodium Absorption Ratio; alk = alkalinity; elements and ions in mglL.

Seismic Data

In 1986 Comalco Aluminium Ltd conducted 14 seismic line surveys in the Burketown- Normanton area to determine the extent and structure of the Mesozoic sedimentary sequences (Beahan, P.L. & Senapati N., 1986). Information previously available to Comalco indicated that the sedimentary sequences could be ‘marginally mature for petroleum’ and petroleum trap-like structures may occur. Basement was hypothesised to be a range of igneous and metamorphic rocks of predominantly Pre-Cambrian age. After completion of the survey Comalco concluded that although there were potential drilling targets, more information was needed to map the structures in the Mesozoic sequence. No further work, drilling or otherwise, was conducted by Comalco in this area.

For Terra Estus 4 seismic lines may provide some structural information west of tenement EPG 34 butno lines cross EPG 34. Lines 86BN13 and 86BN14 run NE to the west of the tenement and lines 86BN16 and 86BN15 run NW-SE. Refer to Table 7 and Figure 11.

Table 7: Comalco seismic lines near EPG34.

Line ID	Company	Length (km)	Date completed	CRN	Survey name
86BN15	Comalco Exploration Ltd	14.03	31/12/1986	16168	Burketown-Normanton 86
86BN16	Comalco Exploration Ltd	14.86	31/12/1986	16168	Burketown-Normanton 86
86BN14	Comalco Exploration Ltd	25.73	31/12/1986	16168	Burketown-Normanton 86
86BN13	Comalco Exploration Ltd	33.32	31/12/1986	16168	Burketown-Normanton 86

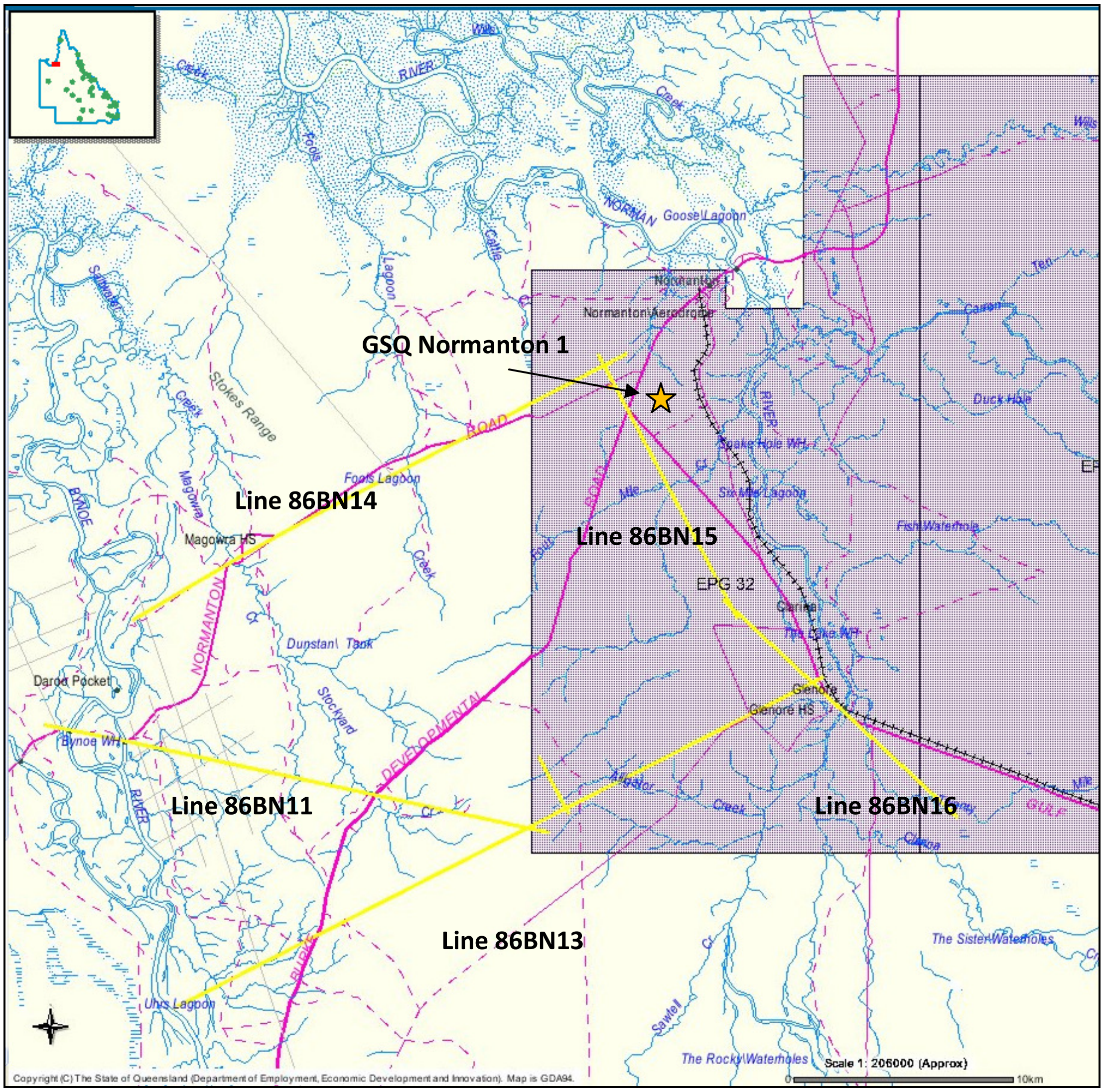

Figure 11: Seismic lines which provide some structural information. IRTM.

Seismic profile plots, Figure 12 and Figure 13, were coloured by Comalco to indicate the interpreted depths of the Carpentaria sequences. Their primary focus was the Carpentaria and Karumba Basins and little interpretation is provided for the sequences below the Mesozoic boundary. Re-interpretation of the raw data may be required as only images of the seismic lines are available publically.

From the seismic profile of line 86BN11 it appears that the volume of the Karumba is insubstantial compared to the Carpentaria, possibly less than 200m thick. Across lines 86BN13, 14, 15 and 16 the Carpentaria Basin appears to be ~500m thick and relatively flat lying with lineaments visible in the middle to deeper sequences. Magnetic and gravity analysis suggests the Carpentaria Basin deepens to the south east and that the Mesozoic boundary should become steeper in line 86BN16.

In Figure 12 and Figure 13 the Mesozoic boundary shows only a gradual change in depth, ~70m over 25km, becoming slightly shallower towards the south east. The highlighted light blue line equates to the base of the Allaru Mudstone. The light green highlighted is equated with the base of the Wallumbilla Formation, and the dark blue highlight line is equated with the base of Mesozoic. Weak mounding upward features appear to exist just below the Mesozoic boundary and are possible granites. However these features are faint and at this stage it is difficult to determine if these are true features or merely artefacts of the data processing.

The black vertical line indicates possible position of GSQ Normanton 1. (Beahan, P.L. & Senapati N., 1986). Based on the stratigraphic well information for GSQ Normanton 1, the hole appears to be located next to the northern end of Line 86BN15 (Figure 12). Granite was intersected at a depth of 635.6m. In Figure 12 a mounding upward feature (of 0.63 twt) can be seen on the left hand side of the image just under the interpreted Mesozoic boundary. If 0.1 two-way-time is equivalent to 100m, then the depth of this feature appears to be at the correct depth of ~630m. This then correlates with the granite intersected by GSQ Normanton 1.

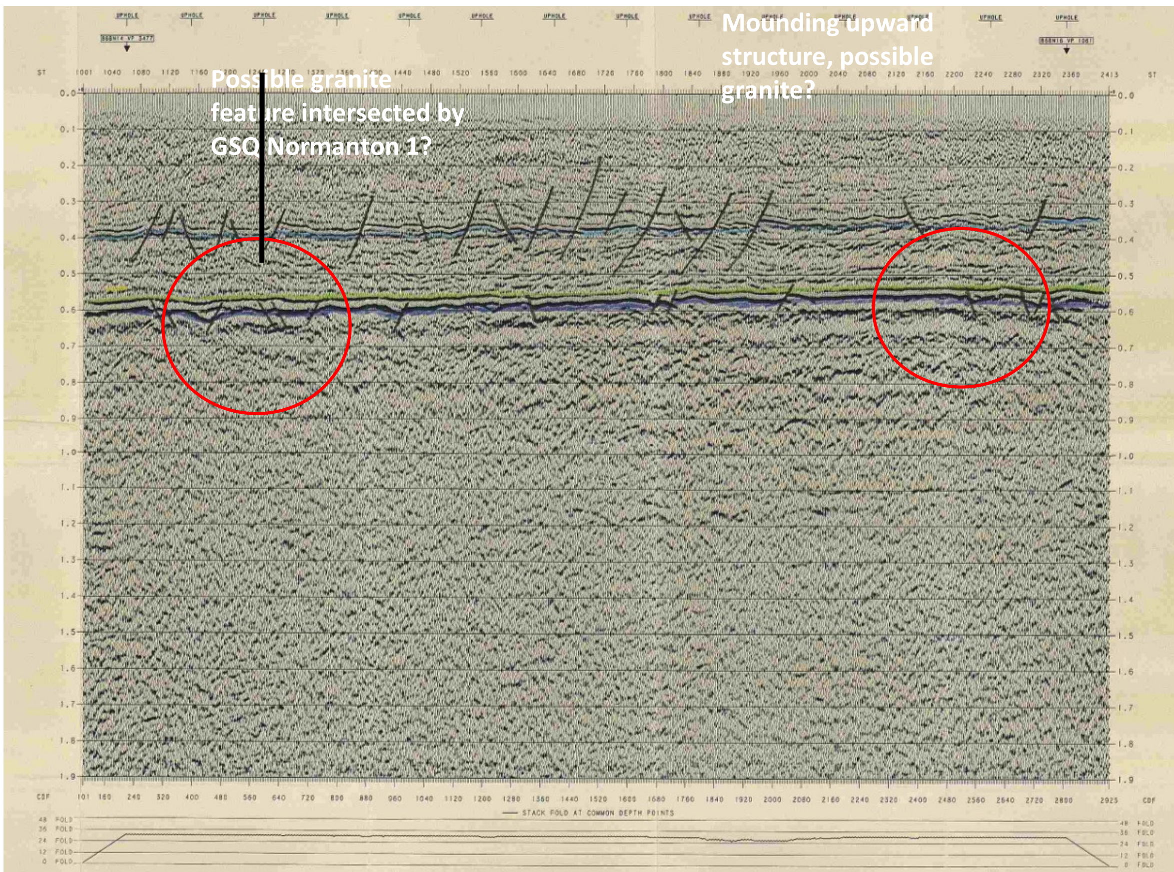

Figure 12: Line 86BN15 with Comalco interpretation.

The red arrow drawn on Figure 13 indicates direction of deepening basin, from ~550m to 600m to the north. The mounding feature highlighted here on line 86BN16 also occurs on line 86BN15 where both seismic lines overlap. (Beahan, P.L. & Senapati N., 1986).

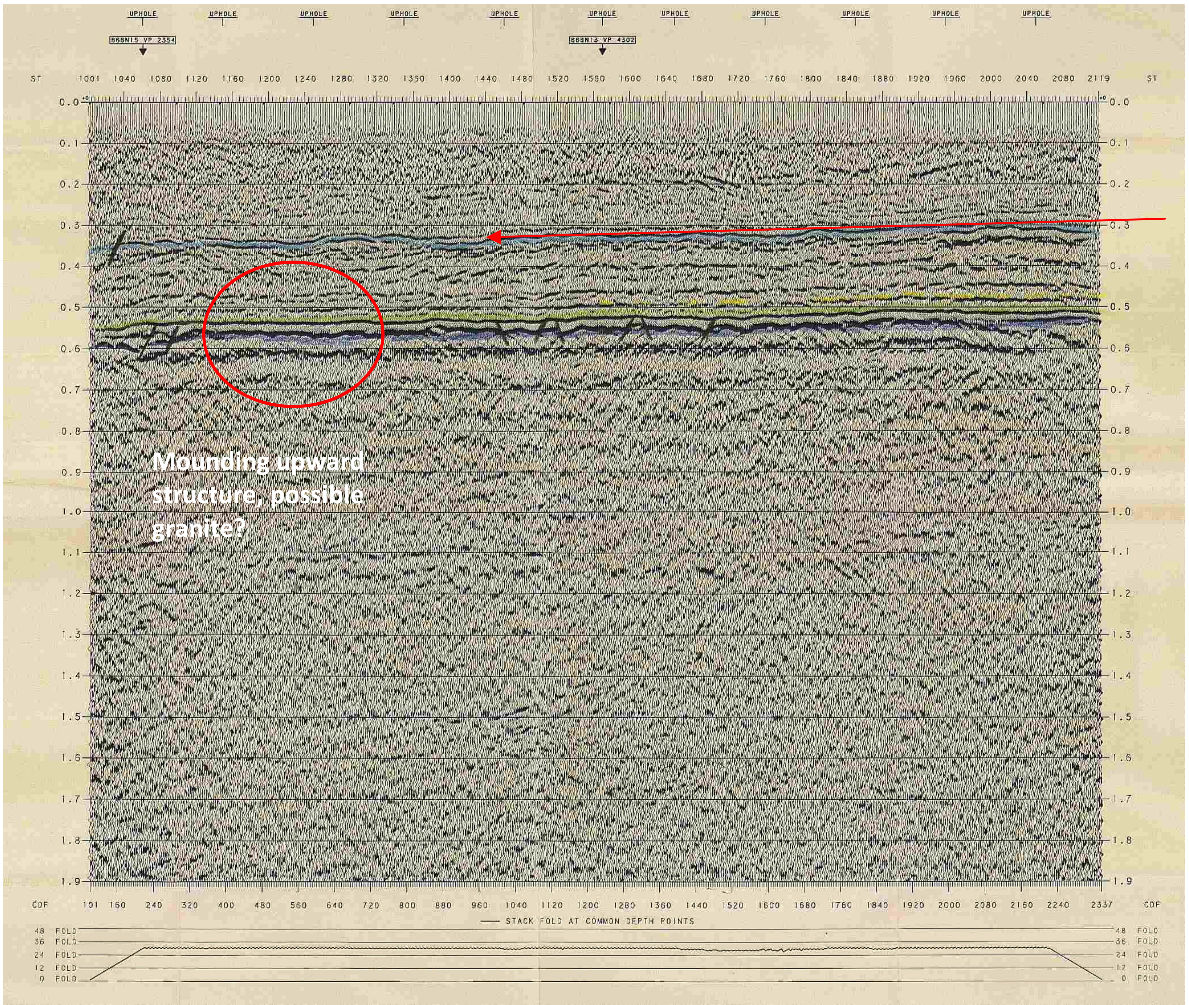

Figure 13: Line 86BN16 with Comalco interpretation.

Magnetic, Gravity and Other Geophysics

The Normanton region, which includes tenement EPG 34, is covered only by regional airborne magnetic and regional gravity data. Airborne magnetic and gravity surveys were conducted by Queensland Geologic Survey as part of their Smart Exploration and/or Smart Mining programmes between 2006 and 2010. Spacing of the regional magnetic data is 400m line spacing and for the gravity data the spacing is 4 km between stations. Both are hence very broad data sets.

No company magnetic and gravity data appear to have been conducted within the area of EPG 34.

The area of EPG 34 has low average magnetisation (Figure 14), mostly low density and low seismic velocity which is similar in character to 'sedimentary basin type' regions with predominantly sediment infill and intruded non magnetic granites.

The low density and low seismic velocity (< 6.1 kms^{-1}) for 70-80% of the North Queensland upper crust is consistent with an upper crust of mainly sedimentary rock and granite (S-type)(Bain, 2002). The low-amplitude of short-wavelength magnetic anomalies is consistent with the relative absence of highly magnetic rocks (volcanic rocks, magnetic granites, mafic granulites) in the upper crust (Draper, 1997).

It is possible that abnormally low magnetism adjacent to the margins of provinces could be a resultant reflection of interference and thickened crust from one province being thrust over the older crust. Hence the low magnetisation may likely be due to a poorly understood consequence of over thrusting.

An interpreted gravity “worm” boundary runs along the western edge of EPG 34 (Figure 14) and is correlated with the change in overprinted geophysical domain to a more substantially quiescent zone in EPG 34.

EPG 34 has a predominantly low magnetic and density character indicative of low magnetisation crust, inferred to be mainly metamorphosed sedimentary units and non-magnetic granites below thick sedimentary basin sequence. The northwest section of EPG 34 appears to have a higher magnetic (Figure 14) and density character and hence potentially be an overprint band. An anomalous magnetic feature in the southeast of EPG 34 corresponds to a relative density anomaly as seen by the gravity “worm” boundary surrounding this area (Figure 14). This is considered to be probable magnetic granite below considerable depth of basin sediment, as the modelled magnetic depths are overestimates the possible depth to this granite is in the order of 3000m from the NW Queensland imaged data (Figure 9).

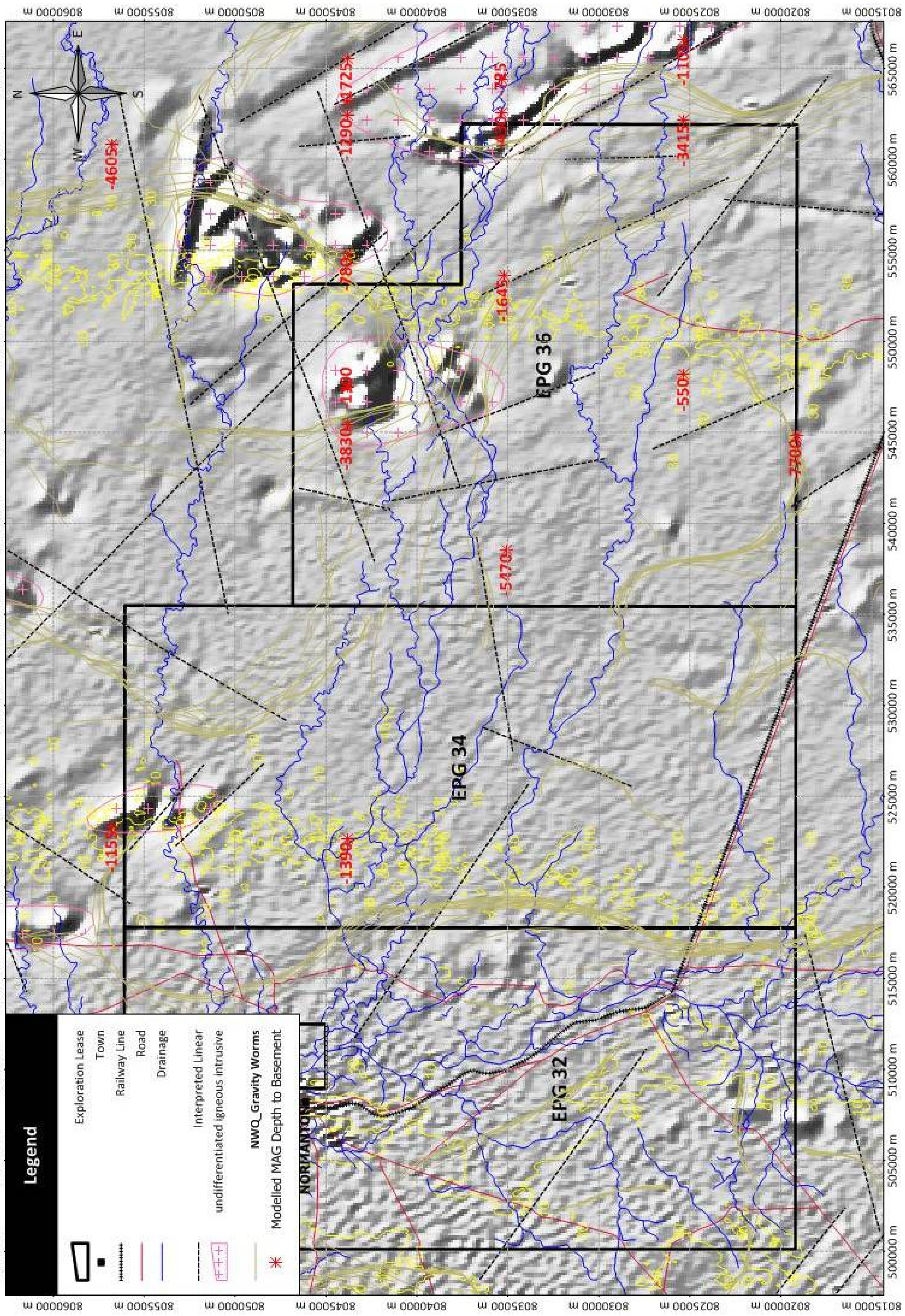

Figure 14: First vertical derivative total magnetic image, EPG 34 showing interpreted granite intrusions, linears, spot modelled magnetic depth to basement, and gravity "worm" boundaries defining higher density areas.

Coincident magnetic and gravity high anomalies are potential buried granite bodies and hence likely targets for geothermal exploration.

A regional gravity high zone runs southeast through the northern portion of EPG 34 and through the north eastern portion of the adjacent area to the east of EPG 34 (Figure 15). This gravity high zone is coincident with interpreted granite intrusions. Gravity high anomalies within EPG 34 are interpreted to indicate a denser basement of probable granite intrusion; these 6 anomalies are outlined by white circles on Figure 15.

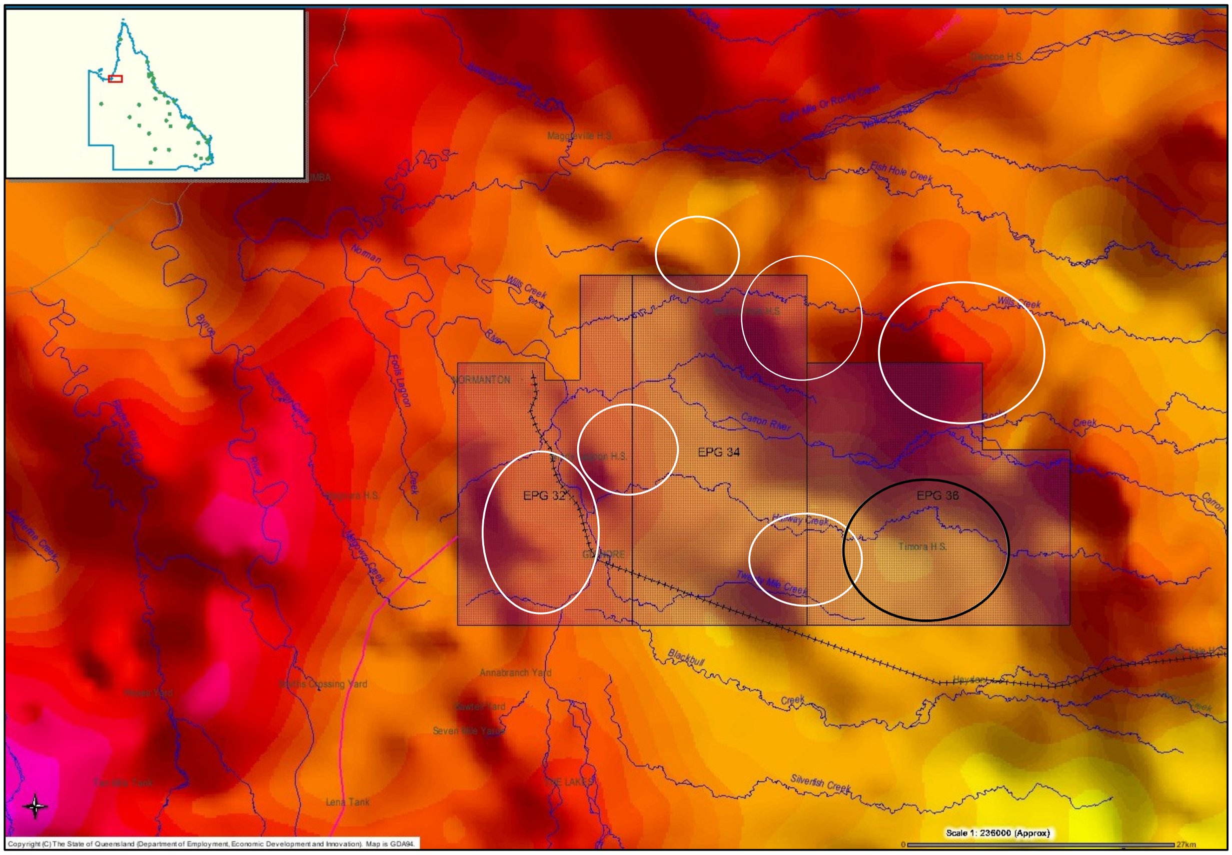

Figure 15: Regional gravity image. IRTM.

The north-western gravity high of EPG 34 lies just outside the north boundary. This is coincident with a magnetic high anomaly which extends into the north of EPG 34 (Figure 16). The larger area of magnetic high anomalism in northeast EPG 34 does not have any coincident magnetic anomaly (Figure 14). This anomaly is situated in the projected deepest portion of the overlying basin sediments, which may be up to 4000m thick (Figure 9). A gravity high anomaly in the southeast of EPG 34 is coincident with a weak magnetic feature in this area and is projected to be beneath 3400m of sediment. Both of the deeper gravity anomalies warrant further investigation for both EGS and HSA style geothermal operations.

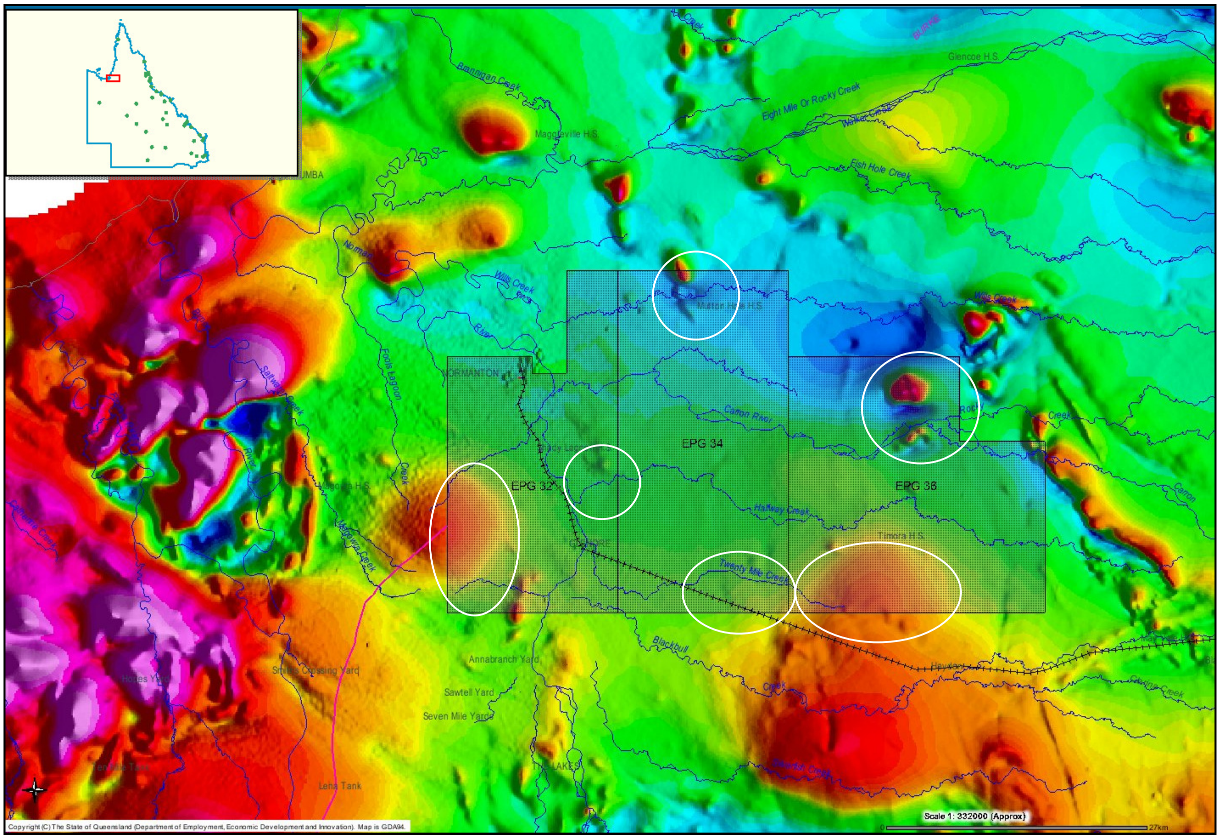

Figure 16: Regional magnetic interpretation, magnetic high anomalies outlined. IRTM.

OTHER DATA

There is no available magnetotelluric survey data covering tenement EPG 34. Magnetotelluric would be beneficial in defining the deeper intense crustal features, faults, crystalline basement to sedimentary sequence disconformity and similar features.

Radiometric data publically available is from the same surveys as that conducted for the gravity and magnetic data. The data imaging for the area of EPG 34 tends not to show any significant features other than to define the drainage channel system where there is elevated potassium and to a lesser extent uranium. The total count radiometric image is shown in Figure 17, highlighting the drainage channels and the Recent marine sediments northwest of EPG 34.

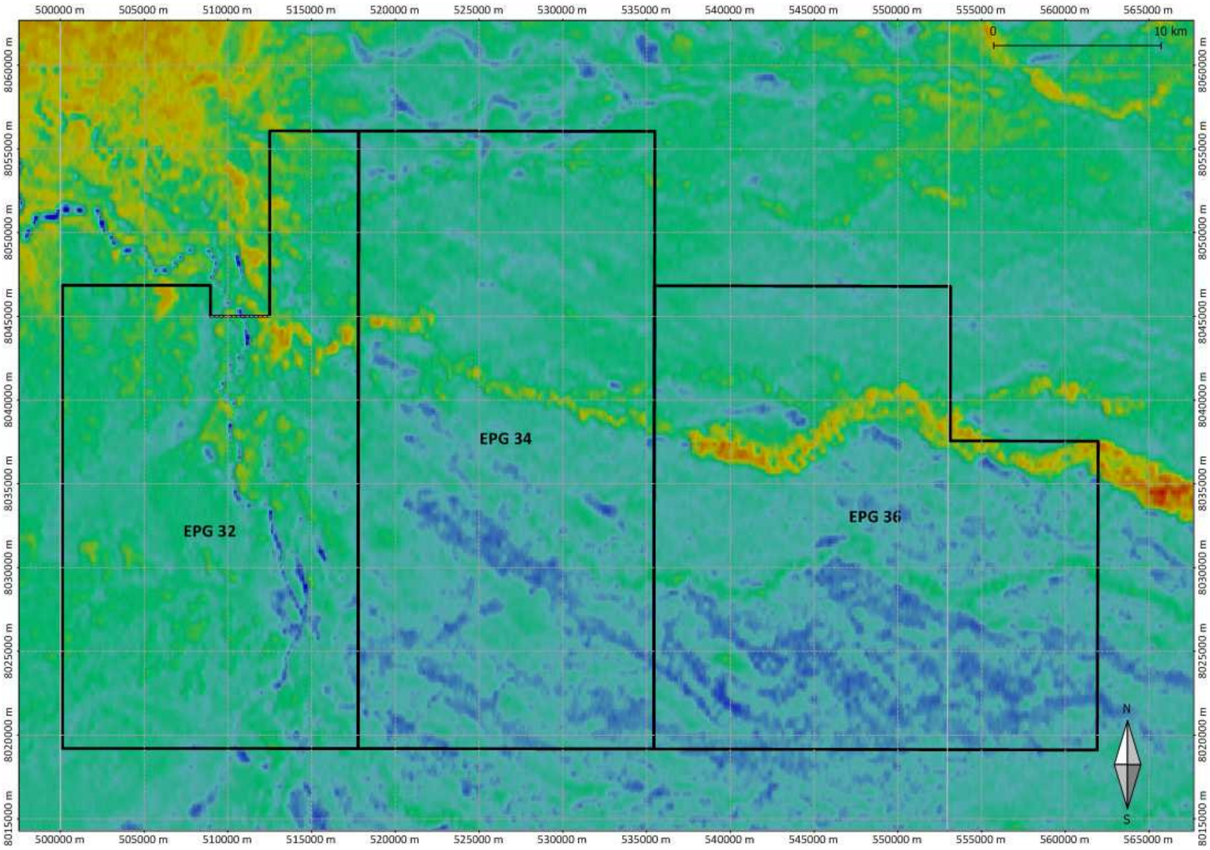

Figure 17: Total count radiometric image

SYNTHESIS

Incorporating the available raster data sets for the regional magnetic survey and the regional gravity survey into a GIS system has allowed these images to be overlayed with each other and other available data (e.g. projected depth to basement image). This has enabled a synthesis interpretation to be made and the following pseudo-section cartoon to be drawn along 804000mN. This was done in an attempt to determine major granite intrusions, structure of the underlying basement and any faulting in the section.

The area west of EPG34 displays a distinct magnetic character in the first vertical derivative imaging of the magnetic survey data. This area is considered to be underlain by a largely metamorphic domain of Proterozoic to early Phanerozoic age with accompanying granite intrusions, Figure 18. The magnetic character of this area is thought to result from the over thrusting of the Mt Isa and Keer Weer Provinces over the Kowanayama Province. This could be supported by the westward shallowing in the depth to basement and the intersection of granite in GSQ Normanton 1 stratigraphic drill hole. The contact zone (province boundary), is believed to be the coincident as a weak magnetic anomaly with a strong gravity feature which trends northeast across EPG 34.

EPG 34 is considered to be underlain by metamorphic units of Proterozoic to middle Phanerozoic age with minor small intrusive granite plutons. These are particularly notable in the southern and northern sectors. EPG 34 in characterised by general low magnetic intensity and gravity intensity. Further EPG 34 is also characterised by a wide deep palaeo-topographic trough to ~ 3000m depth which may be a Phanerozoic basin.

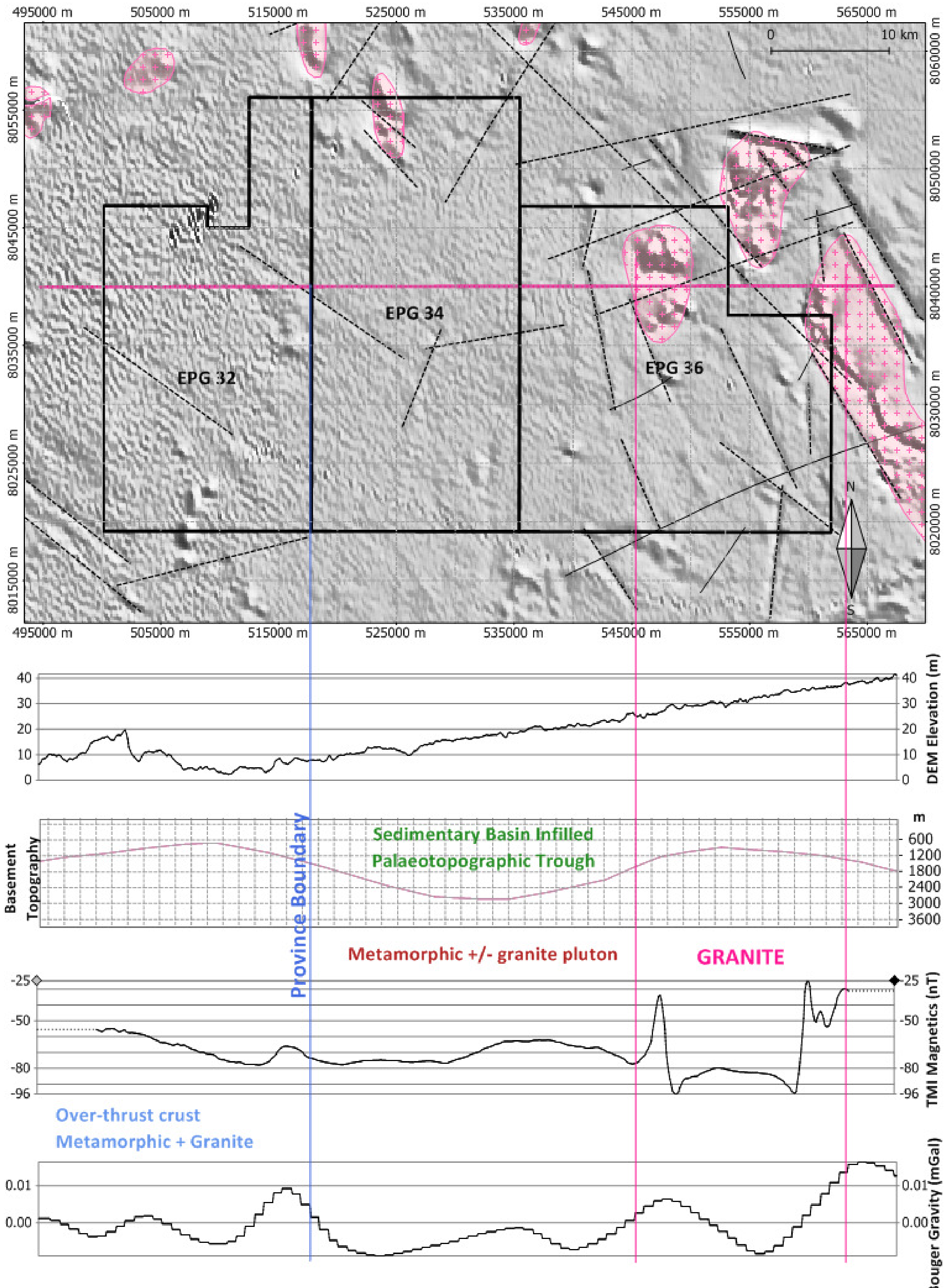

Figure 18: Pseudo-section drawing correlating magnetic, gravity and depth to basement regional features.

Again it must be stressed that although the magnetic and gravity datasets are reliable they have been acquired on a regional scale and so may not be true reflections of the actual occurrences. Also the depth to basement data is projected from very few drill holes and corrected magnetic calculated depth to top of magnetic feature, which may not be entirely reliable.

GEODYNAMICS

Thermal data is sparse across EPG 34. The only available data is in the form of regional interpolations of heat flow, regional estimated temperatures at depth and expected thermal conductivities from similar lithologies. Geoscience Australia has collated available regional data together to map potential geothermal resources for north Queensland, Figure 19 (Huston, D.L., 2010).

In the Normanton area the potential for HSA appears to be more favourable with moderate to high potential compared to a low to moderate potential for EGS (Huston, D.L., 2010). This in part is due to the Carpentaria Basin forming an insulating blanket across any heat sources and possible utilisation of aquifers in the Great Artesian Basin.

The most important thermal data to be obtained are down hole temperatures from several hundred meters deep. Apart from one stratigraphic well at Normanton 1 to the west, no drilling for any type of resource has taken place in tenement EPG 34. Hence no temperature or heat flow values have been collected or calculated for the specific region of EPG 34.

Typically petroleum wells have been the most useful for geothermal exploration as they are deeper than mineral holes and record bottom hole temperatures which can be incorporated into 1D temperature profiles to estimate temperatures at depth. Together with stratigraphic logs these are vital for building 3D thermal models and defining the type of potential geothermal resource that may exist. Bottom of hole temperature data will also enable calculation of surface heat flow values. Surface heat flow mapping may provide broad thermal anomalies which could be matched to other geophysical data to generate areas of interest.

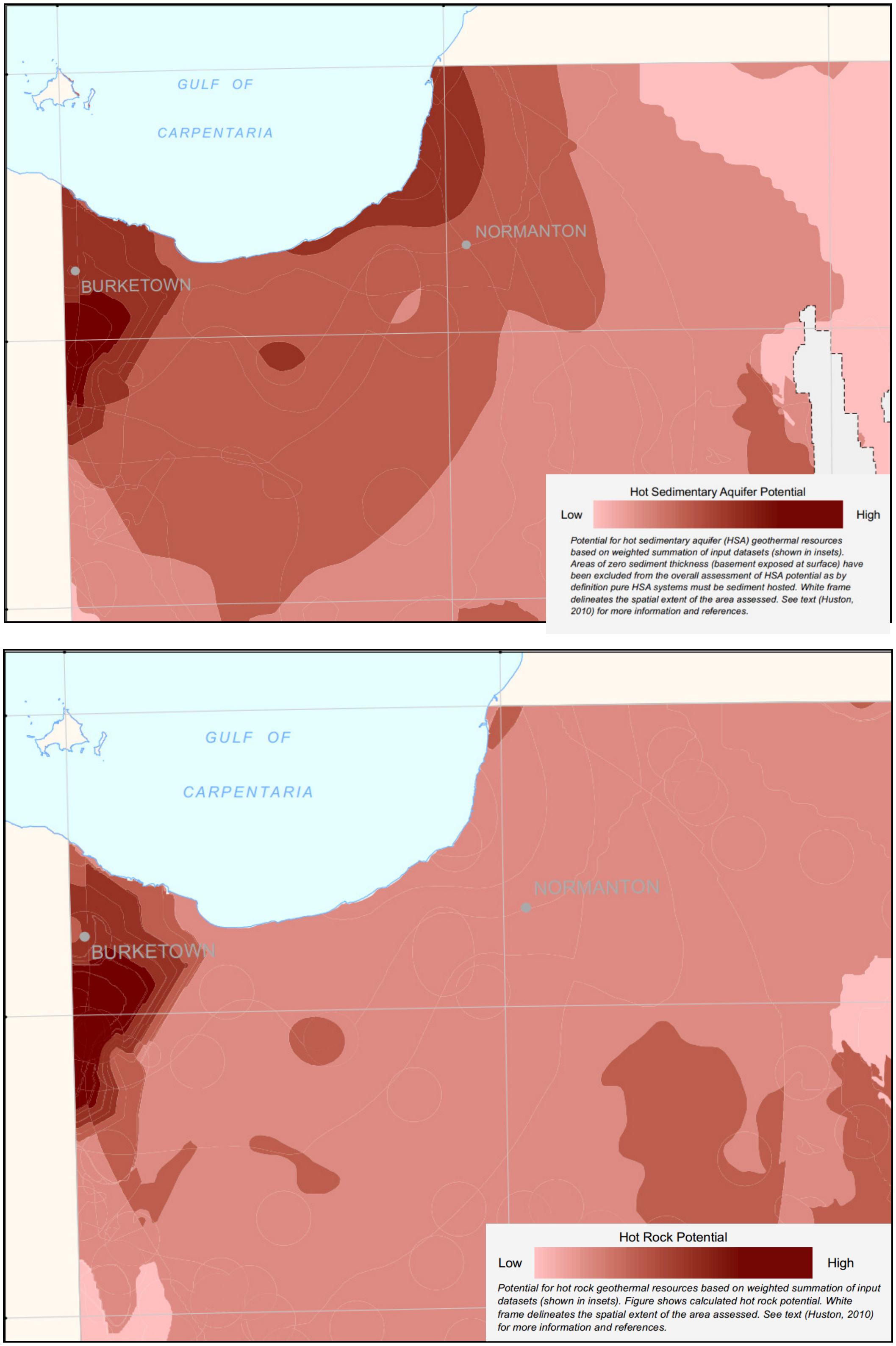

Figure 19: Mapped geothermal potential of north Queensland, after (Huston, D.L., 2010).

The upper map (previous page), Figure 19, displays the potential for HSA resources in the Normanton area. Note that the area of high potential mapped to the north west of EPG 34 coincides with the deeper Carpentaria Basin portion. The lower map in Figure 19 displays the EGS/Hot Rock potential and shows that there are currently no known high potential resources in the vicinity of EPG 34. This data is based on regional well data that is located well away from the review area.

Temperature

From Austherm07 data the temperature at 5 km depth is predicted to be between 168°C and 180°C in the Normanton area (Huston, D.L., 2010). It should be noted that the Austherm07 database may contain only one data point west of EPG 34 and no data points from within EPG 34. Extrapolation over a large area has taken place to calculate the predicted temperatures at depth, Figure 20.

One down hole temperature value is available from drill hole GSQ Normanton 1, 65°C at 713m (Derrington, E.A. & Williams, L.J., 1988). It is unclear if corrections have been applied to this data to take into account the heat generated from drilling. In general a few weeks are allowed to pass before temperature measurements are taken to enable the well to equilibrate to ambient temperature.

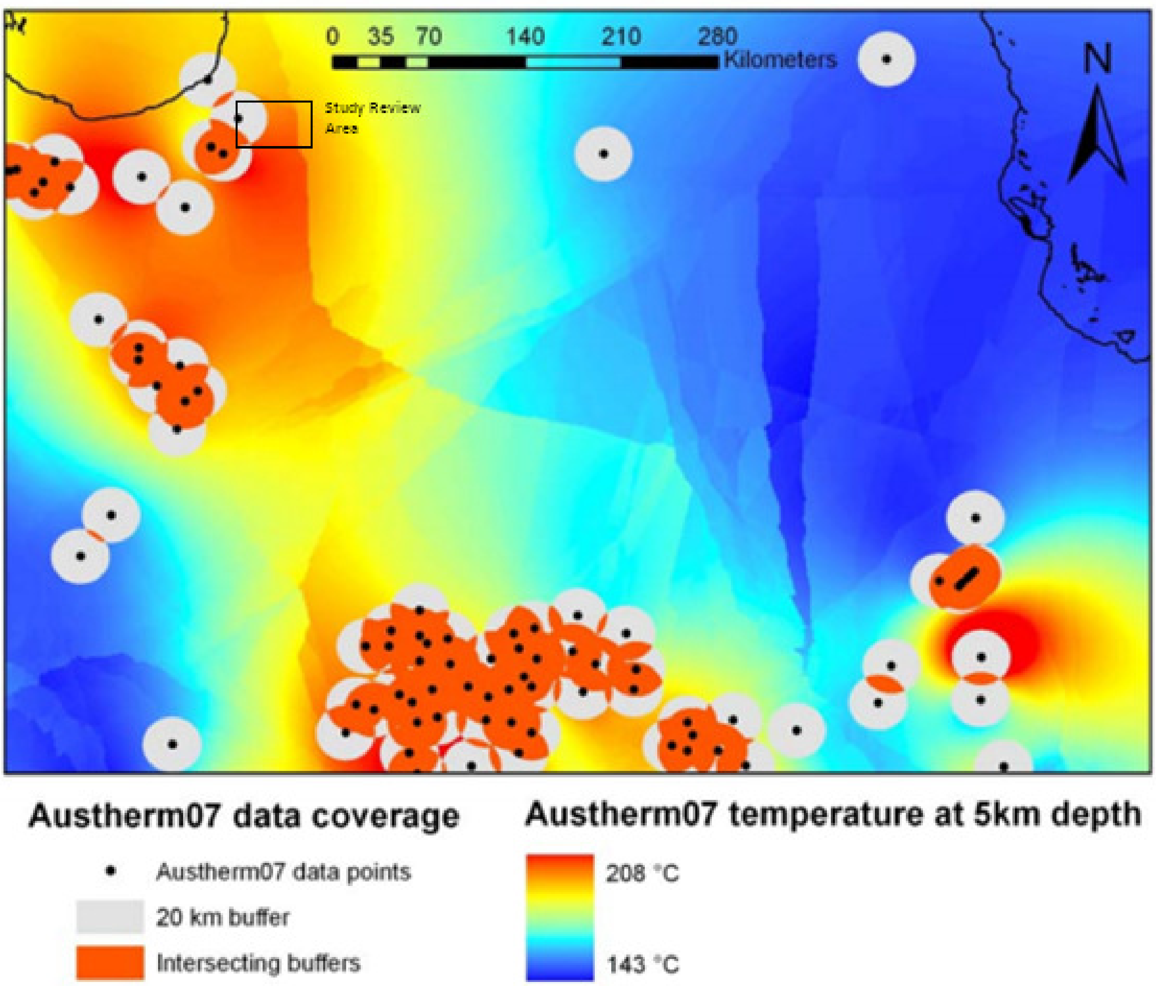

Figure 20: Distribution of Austherm07 data points in north Queensland (Huston, D.L., 2010).

Temperatures from the GAB study (Great Artesian Basin Coordinating Committee, 2010) were also recorded from shallow bores. Unfortunately none of these were drilled inside EPG 34. The recorded temperatures come from bores which are located outside of the tenure study review area and this decrease the confidence level for extrapolation of this bore water temperature data, Figure 21. Even should the data be extrapolated with confidence laterally, the shallowness of the bores may not provide enough information to create 1D temperature profiles to 5km depth.

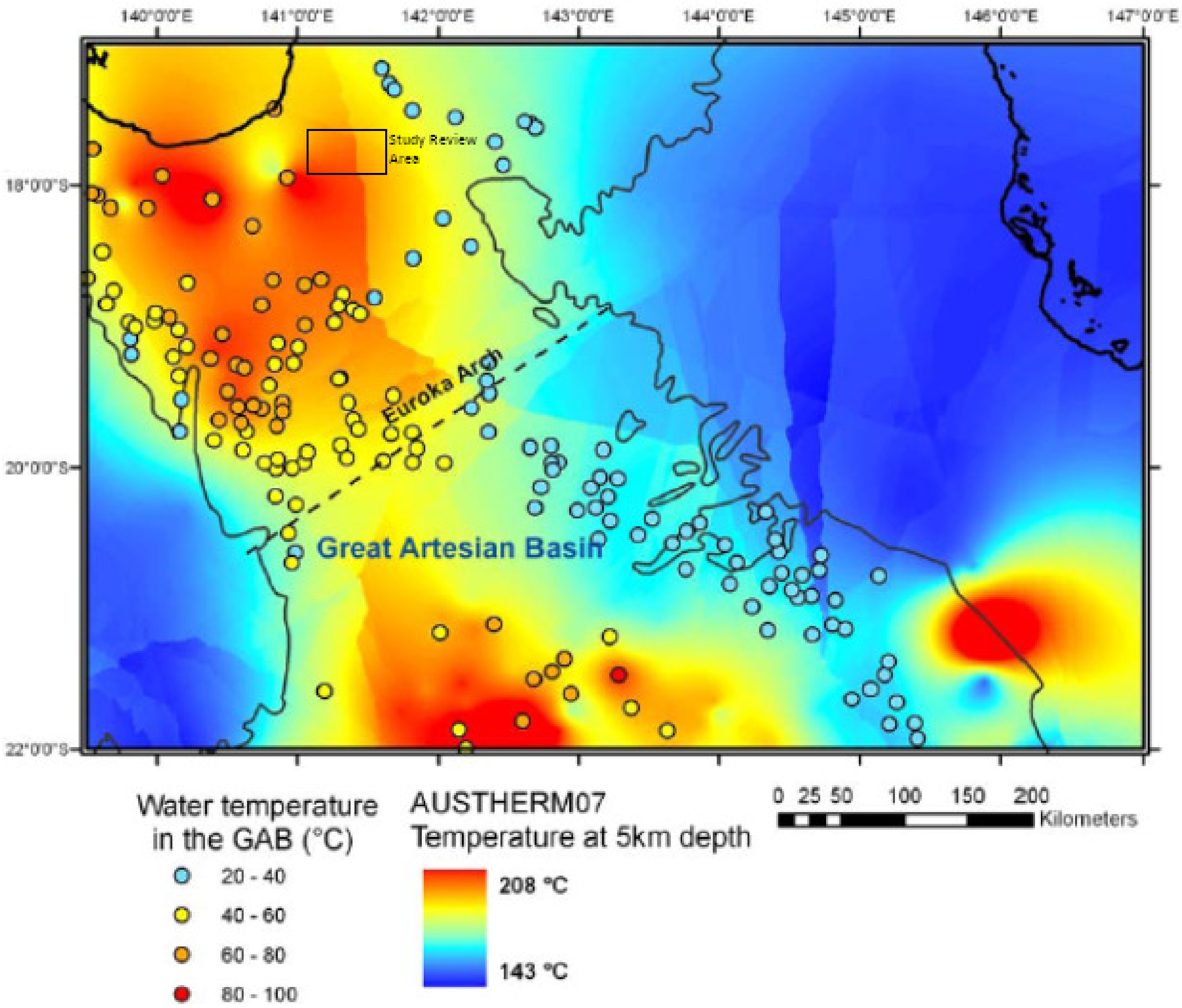

Figure 21: Distribution of water bores in north Queensland for the GAB study (Huston, D.L., 2010).

Heat Flow

Typically heat flow values for northern Queensland are expected to be in the range from 53 to 100m Wm^{-2} based on the literature (Huston, D.L., 2010). There are no heat flow values available within EPG 34. The closest heat flow data available is from bores located north of Georgetown, Figure 22. The highest heat flow values were observed in northern Cape York near Weipa and along the southern coast of the Gulf of Carpentaria.

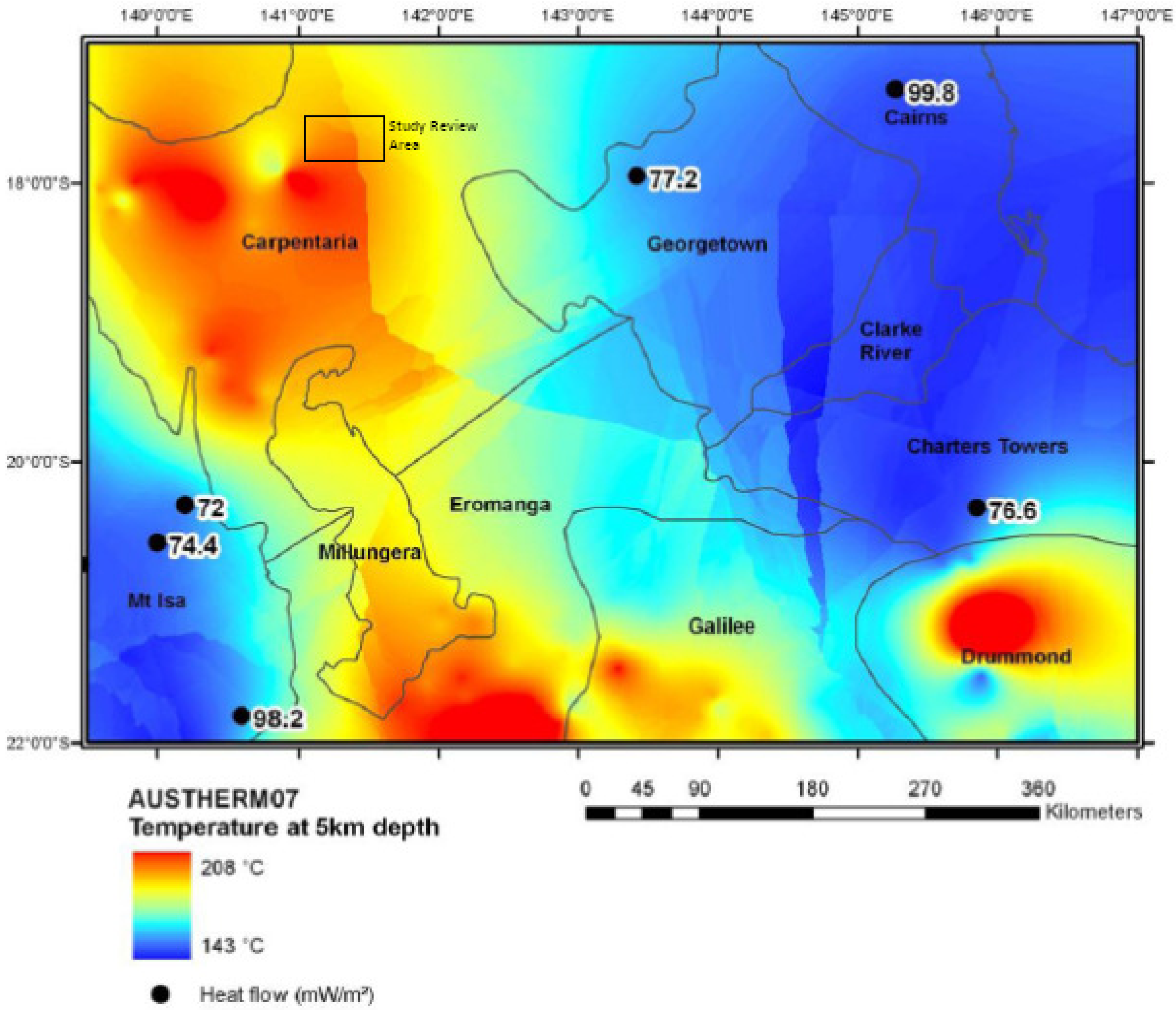

Figure 22: Heat flow data points overlain on the Austherm07 map (Huston, D.L., 2010).

From Figure 22 (Huston, D.L., 2010) typical surface heat flow values for the Normanton area could be in the range between 70-99m Wm^{-2} based on nearby surface heat flow data. It is difficult to propose any correlation between high heat flow and high temperatures at depth based on the sparse amount of data available. Areas of elevated heat flow, >100m Wm^{-2}, may indicate high temperatures at depth and a possible geothermal resource. However areas with this level of heat flow are not seen in Figure 22. In Figure 22 areas of high heat flow, ~98m Wm^{-2}, have low estimated temperatures at 5km depth, ~140°C.

Surface heat flow values in excess of 110m Wm^{-2} may be needed to indicate temperatures at depth greater than 180°C. Also complicating the picture are the projected high temperatures of up to 208°C as shown on Figure 22 from the GAB water bore study where there are no surface heat flow values. These high temperature bores are potentially too shallow to calculate surface heat flow values from. It is possible that once new data is added from deeper drilling these temperatures may not increase significantly down hole which will result in relatively low surface heat flow values of ~70m Wm^{-2}.

Thermal Conductivity / Resistivity

No thermal conductivities are available within the study review area or EPG 34, primarily due to the lack of drilling. Geoscience Australia has divided northern Queensland into 10 thermal conductivity regions with the Carpentaria region being the largest (Huston, D.L., 2010). These regions are based on current geological provinces and an average thermal conductivity as calculated for similar lithologies within each province. Based on Huston's report (2010) modelled thermal conductivities in the Normanton area could range between 1725 and -1800 m^2/KW which could be considered to have a low potential to insulate any heat sources present. The author considered thermal resistance a better indicator of insulation potential then sediment thickness as thermal conductivity/resistivity of the overlying lithology is very important to both HSA and EGS processes.

To enable a higher confidence in thermal modelling, thermal conductivities could be measured on any core available from GSQ Normanton 1 or from any new drilling on EPG 34.

Heat Generation

For EGS the potential heat source is expected to be a high heat generating felsic intrusive buried below an insulating sedimentary sequence. There is also a possibility that sandstone hosted uranium deposits could be potential heat sources for EGS projects in the future but more studies are needed on this topic.

In northern Queensland values range from 0.06-18.32 $\mu W/m^3$ with an average of 3.5 $\mu W/m^3$, Figure 24 (Huston, D.L., 2010). This average falls within the global range of 2.5-5.5 $\mu W/m^3$ but is slightly lower than the South Australian range between 4.5-61.6 $\mu W/m^3$ (Matthews, C & Beardsmore, G, 2007)(Neumann, N. Sandiford, M. & Foden, J., 2000). Felsic intrusives in the Normanton area with a heat production above 4 $\mu W/m^3$ would be considered high generators of heat and a more favourable target for drilling.

Currently no heat generation data is available in the vicinity of the study review area or EPG 34 (Huston, D.L., 2010). Heat generation data is also not available for a large area of granite between Normanton and Julie Creek, Figure 23 & Figure 24. There is a lack of granite outcrop in EPG 34, and therefore samples from drilling will need to be obtained to determine possible heat sources for geothermal targets.

Heat generation data could be obtained from GSQ Normanton 1 where granite was intersected at 635.6m. Gamma logs for this stratigraphic hole indicate that the radiometric background total count per second (cps) for this granite is between 200 and 250cps. Considering the logged content of large pink feldspar, biotite and muscovite, it could be assumed that the radioactivity is largely due to potassium within the alkali feldspar and from the mica minerals however both thorium and uranium would have an input into the total gamma count. No whole rock chemistry was located for this intersected granite. Analysis of water from 604m to 713m indicate that the uranium content of the water is less than the 0.005 mg/l (ppm) detection limit of the method, hence the granite is probably not uraniferous. However there was some indication in the logs that this water could be returned drill water rather than true groundwater.

Further analysis on the granite in this hole by XRF and ICP-MS methods may provide heat generation values which can be incorporated into 3D thermal models.

Note that the intrusives shaded dark blue in Figure 23 indicate no data is available in these granites. Several of these are southeast of EPG 34. The nearest known high heat generating intrusives are located in the south west near Cloncurry (Huston, D.L., 2010).

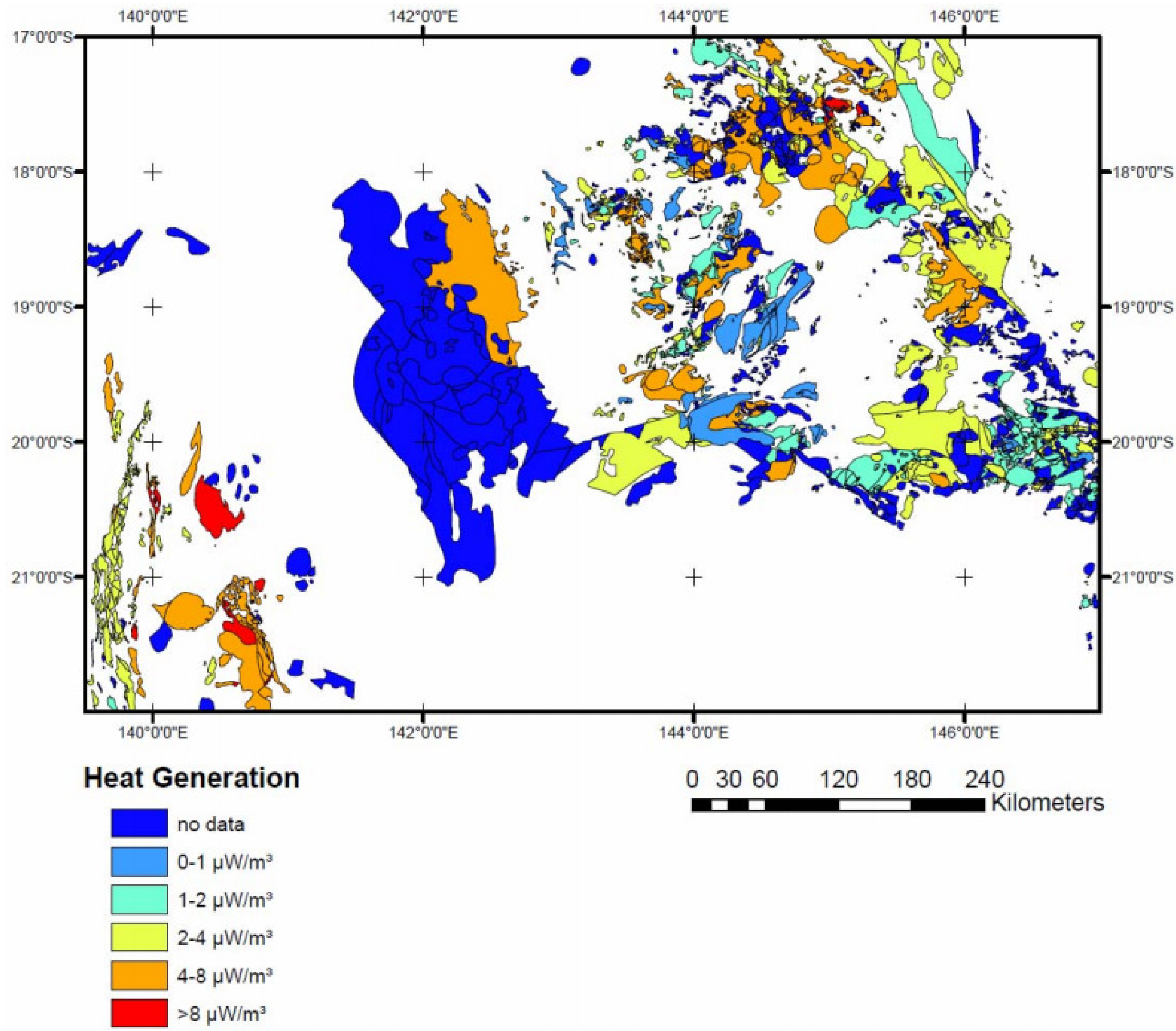

Figure 23: Heat generation data for felsic intrusive in northern Queensland.

The potential to generate heat was assigned to felsic intrusives from OZCHEM data where currently no data is available, Figure 24 (Huston, D.L., 2010). Notably a low value was assigned to the batholiths southeast of the study review area. This again reflects the lack of data available.

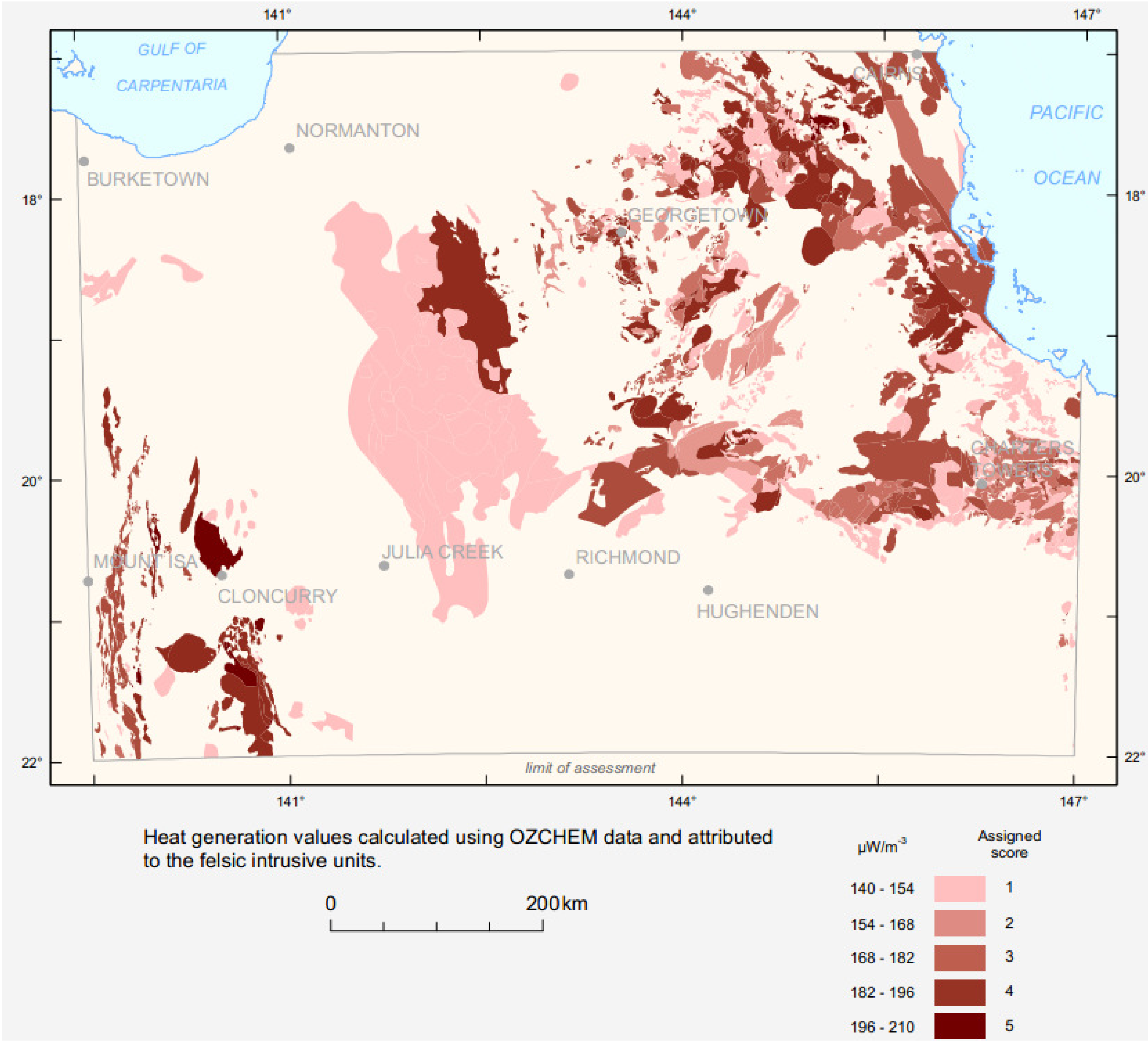

Figure 24: Calculated heat generation potential for felsic intrusives in northern Queensland (Huston, D.L., 2010)

CONCLUSIONS

Data is generally sparse across the region of EPG34. Only one stratigraphic hole has been drilled in the area, west of EPG 34. This hole intersected granite at 635m. This granite was age dated at 328+/2 Ma., Late Carboniferous.

Projected depth to basement estimations indicate that there is a deep trough which runs north/northeast from the south of EPG 34 through to the north east corner of EPG 34 (Figure 9). Depth estimates to basement in this trough range from 1400m to >3000m.

Sparse heat flow data ranges from 65°C in drill hole GSQ Normanton 1 (713m) to a regional 77°C. Interpolation of this data suggests that the temperature at 5km depth could be in the vicinity of 170°C to 200°C. However the sparsity of the data used for this interpolation in the region of EPG 34 (no hole data) tends to downgrade this interpolation. Further data are required to improve this. However the regional indication is promising.

Regional airborne magnetic and gravity data are the best data sets available. Interpretations of these data sets indicate that there are a number of coincident magnetic and gravity anomalies (Figure 15, Figure 16) which are potential granite intrusive targets at depth. Such targets to the east of EPG 34 have been interpreted by other workers as granite bodies.

Prioritised targets are shown on Figure 25 and Figure 17 below.

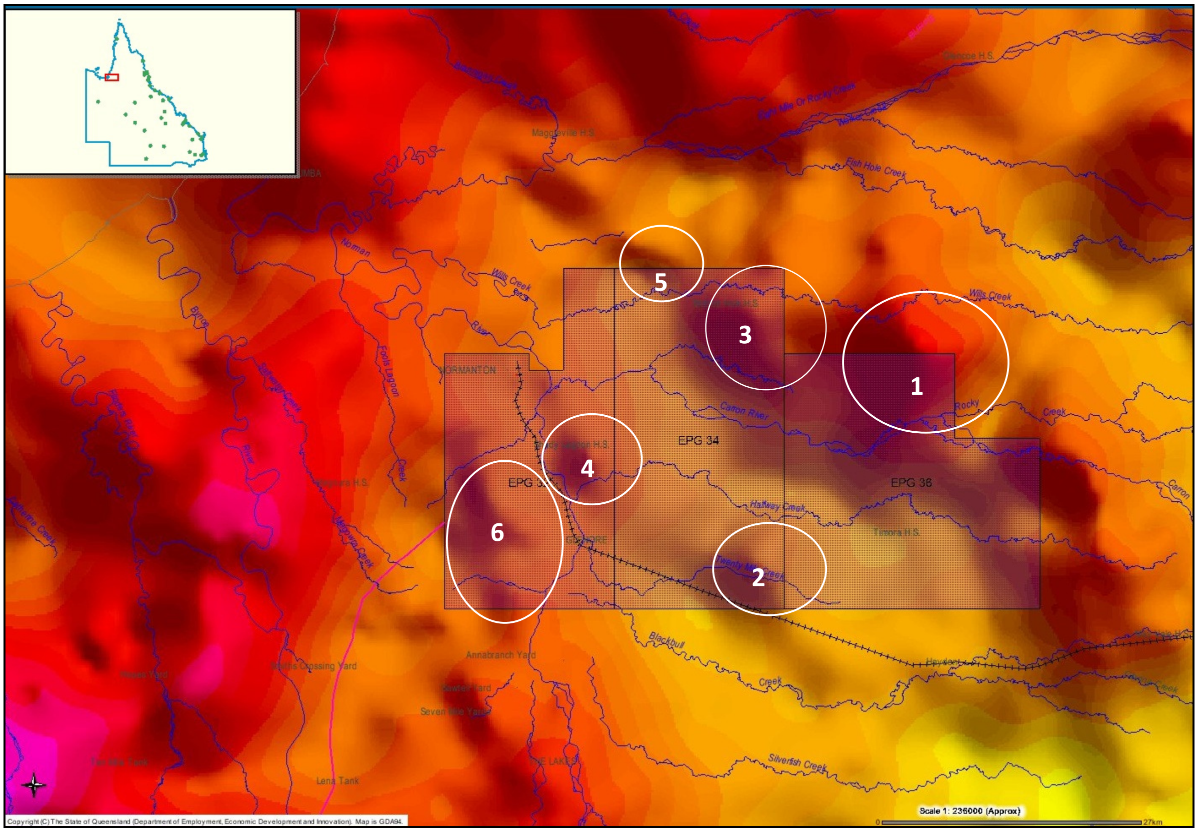

Figure 25: Prioritised targets on regional gravity image

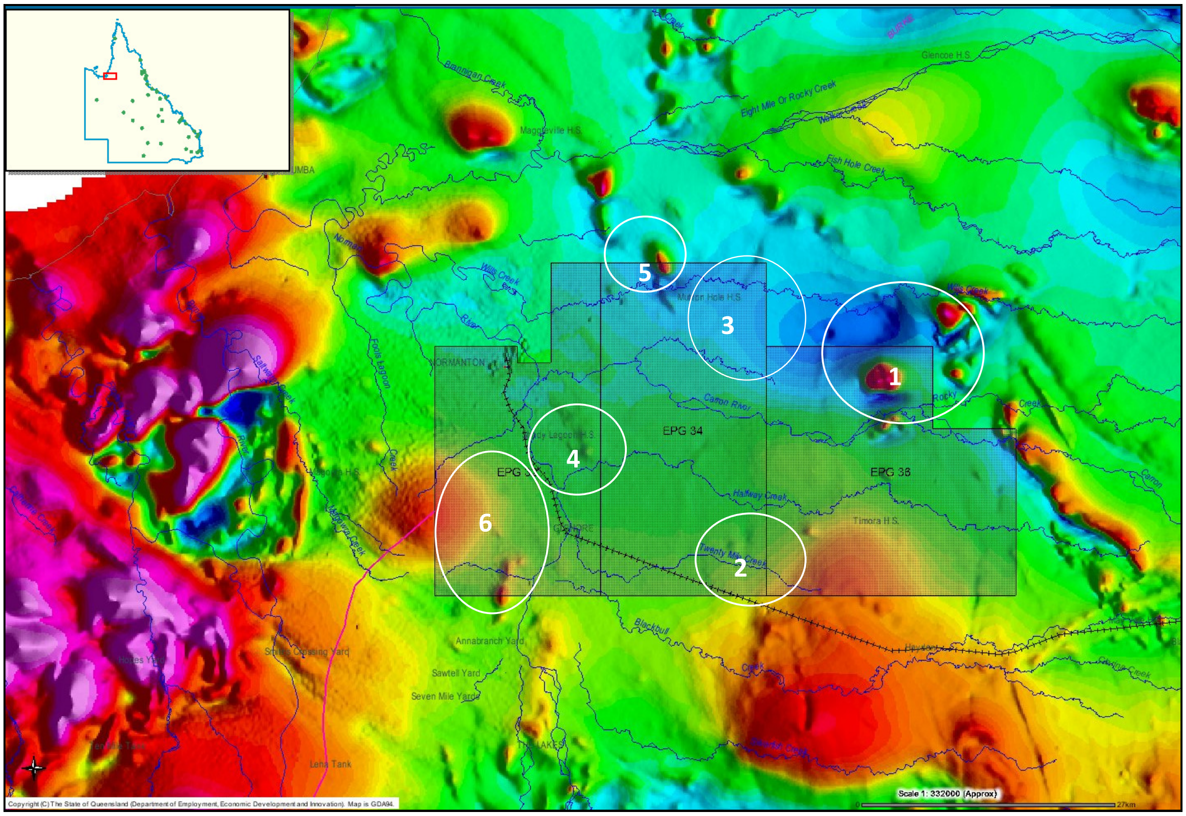

Figure 26: Prioritised targets on regional magnetic image TMI RTP

Exploration of geothermal projects would be best suited to be conducted on a phased programme basis. This can be as outlined below:

Phase 1:

- Acquire via surveys or purchase direct from supplier
  - relatively close spaced survey data over the tenure for
    - gravity
    - magnetic
    - radiometric
  - Extending to acquisition of VLF magnetotelluric data
- Any existing boreholes >300m depth should be temperature logged to determine geothermal gradients
  - Any available core should be measured for thermal conductivity and thermal diffusivity
  - The aim is to define areas of extra high temperature and heat flux associated with extra hot granites
- Conduct drilling of relative shallow holes, >300m depth, to fill any gaps in the data obtained above.

Phase 1 is considered to be relatively inexpensive compared with subsequent exploration activities.

Phase 2:

- Drill the first deep hole up to 5km or as required, in the best target
  - Average cost per 5 km hole ~$5-10 Million (estimated from various company reports)
  - This is likely to change the understanding of regional geology and will need very thorough revision of the data before proceeding further

- Testing and interpretation of the parameters
  - Temperatures,
  - Possible heat exchanger rocks
  - Permeabilities of the pre-fractured aquifer rock
  - Outline the absolute control of granite topography
  - General feasibility undertaken
- The first economic feasibility study generated.

Phase 3:

- Commence fracturing of the aquifer rock and permeability measurements
- Commit to a second or deflected hole and establish a rock heat exchange
  - Injection well and recovery well
  - From here on engineering becomes the dominant part of the project
- Pilot plant test work
  - Determine the characteristics of the heat exchange
  - Energy outcomes

Phase 4:

- A final economic assessment conducted
- Further capital will be required - bankable feasibility study
- Arrangements made for off the shelf or purpose built generating plant etc.
  - Provided the pilot investigation and economic assessment results are favourable
- Construct and commence operations of a full scale generating operation
  - Preference would be for the design to be as expandable modules.

EPG 34 is considered to have a moderate to high geothermal energy potential for EGS and HSA. The project is in the early stage of Phase 1 of the exploration model outlined above. In addition to the acquisition of relatively close spaced geophysical data another method for determining the depth and characteristics of the overlying sedimentary units is to conduct a series of seismic traverses across the tenements.

Recommendations

In view of the above conclusions and the sparse data available in this region the following recommendations are made:

- Conduct broad spaced seismic traverses across EPG 34 with interpretation
  - Determine structure and crystalline basement
- Conduct more detailed, closer spaced Gravity survey over the tenement
  - Consider using airborne system to get better coverage
  - Acquire regional gravity data and combine with new data
  - Reinterpret gravity data
- Conduct closer spaced detailed infill airborne magnetic survey over the tenement
  - Acquire regional airborne magnetic survey data and combine with new data
  - Reinterpret airborne magnetic data

- Conduct a regional water bore water temperature at depth survey
  - Baseline data acquisition
  - May assist with temperature / thermal modelling
  - Chemical analysis of water samples may indicate high U or F content
    - Indicate proximity to U/F source granite
- Undertake a magnetotelluric survey over several sections across the tenure
  - Through prioritised target areas
  - Structure and lithological boundary determination
- Undertake a regional relatively shallow drilling program
  - 500m deep 30 holes broadly spaced across tenements
    - Concentrating on prioritised target areas
  - Baseline data acquisition
  - Lithology/stratigraphy
  - Investigate thickness of insulating cover- is there enough sediment for a HSA target
  - Acquire thermal conductivity/ down hole temperatures
  - Create Surface Heat Flow (SHF) map
  - Explain elevated heat flow areas
  - Apply 1D thermal modelling extrapolations down to 5km
  - Serves to control geophysical and seismic interpretation across the tenement.
- At least one deep stratigraphic diamond core hole is needed
  - Drill magnetic high/gravity high anomalies to determine if they are coincident with granite bodies
  - Add further control definition to seismic / geophysical interpretations.

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