**15a Tate St, Albion, QLD 4010**
**Telephone: 07 3613 8800**
**Facsimilie: 07 3036 6273**
**ACN 152 286 774**

**Project Name**: Rakula West

**Titleholder**: Top End Energy Pty Ltd

**Title**: EL 29065 Combined first annual and final report for the period 28/5/2012 to 27/5/2013

**Author**: Global Ore Discovery Consulting

**Date**: 30th June 2013

**Target Commodity**: Coal

**Mapsheet: 1:100 000** Anson 4971

**Mapsheet: 1:250 000** Cape Scott SD5207

**Technical Approval**: Daryl Nunn

**Keywords**: Bonaparte Basin, Coal, Landsat, Permian, Remote Sensing

15a Tate St
Albion, QLD 4010
07 3613 8800
07 3036 6273
dgnunn@globalorediscovery.com

*As required under Regulation 126, I Daryl Nunn, as the relevant person for this report authorise the Minister to publish information in this report including the copying and distribution of the report and associated data (Regulation 126(3)(a).*

# 1. Abstract

This first annual and final surrender report describes the work undertaken by Top End Energy Pty Ltd in evaluating EL 29065 for coal deposits, which covers an area of 204 km$^2$. Top End Energy was granted EL 29065 for a period of 6 years commencing 28$^{th}$ May 2012. The tenure is located approximately 110km southwest of port facilities at Darwin. EL 29065 covers northeastern parts of the Paleozoic Bonaparte Basin and regional scale mapping shows Permian sedimentary rocks at surface. There are no named coal prospects within the tenement. No previous explorers have held the ground for coal exploration.

Top End Energy applied for the licence to explore for coal occurrences within the Permian stratigraphy. Exploration involved preliminary photogeology interpretation using LANDSAT remote sensing products and compilation of waterbore drilling. In total 191 km$^2$ of satellite imagery was processed and interpreted by Global Ore Discovery Consulting. Historic logging of waterbores is of uncertain reliability and the bores are typically drilled less than 65m deep. The majority of the waterbores record sediments that are interpreted to be the Permian Kulshlll Group.

No field-based exploration was completed on this tenement.

The title has been surrendered due to an inability to raise funds to support further exploration in the current market where commodity prices and investor support for coal exploration are substantially reduced.

# 2. Surrender

This combined first annual and final surrender report is submitted as required under the provisions of section 94(2)(e) of the Mineral Titles Act and regulation 86(3).

# 3. Location and Access

EL 29065 is situated approximately 110km southwest of Darwin, Northern Territory, Australia on the Cape Scott SD52-07 1:250,000 geological mapsheet and Anson (4971) 1:100,000 topographic mapsheet. The majority of the tenure overlaps land within Perpetual Pastoral Lease PPL 1086, “Labelle Downs” Station.

EL29065 is accessed from Darwin via the sealed Litchfield Park road and well graded Channel Point Road. Channel Point Road runs along the northern boundary of EL29065 to the coast. Access within the tenement along station tracks is only possible during the mid-late dry season due to swampy conditions.

Alternative access to Labelle Station is along 4WD gravel road which turns off Cox Peninsula Road past Berry Springs. This road is only accessible during the dry season. Although a shorter distance from Darwin, it is more difficult and time consuming (Hou, 2010).

# 4. Licence Details

EL29065 consists of 61 blocks (approximately 198 km$^2$) and was granted to Top End Energy Pty Ltd for a period of 6 years commencing 28th May 2012. Blocks along the coast are reduced in size to less

than the full block. There are no other mining leases or mineral claims shown within the Licence boundaries.

The Exploration Licence was surrendered on 19 June 2013. The licence details for EL29065 are outlined in Table 1 below. The expenditure covenant set for the first year was $12,050. No corporate dealings have been transacted.

*Table 1: Licence details for EL29065*

| ***Name*** | ***Status*** | ***Effective Date*** | ***Grant Date*** | ***Expiry Date*** | ***Blocks*** | ***Holder*** | ***Percentage*** |
|---|---|---|---|---|---|---|---|
| EL29065 | Grant | 28/5/2012 | 28/5/2012 | 27/5/2018 | 61 | Top End Energy | 100 |

*Table 2 Block description for EL 29065*

| Map Sheet 1:1,000,000 | Blocks* | Sub-Blocks |
|---|---|---|
| Darwin | 986 | j k n o p s t u x y z |
| Darwin | 987 | f g h j k l m n o p q r s t u v w x |
| Darwin | 988 | f g h j k l m n o p q r s t u |
| Darwin | 989 | f g l m q r |
| Darwin | 1058 | d e |
| Darwin | 1059 | a b c f g h m n s |

* Blocks overlapping the Channel Point Coastal Reserve National Park are excised.

# 5. Physiography

Topography for most of the tenement is low relief, with some floodplains. Along the Channel Point Road on the northern boundary of EL29065 relief reaches ~40m above sea level. Towards the coast, the area is very low lying and swampy. The dominant vegetation of the area is Oryza tall closed tussock grasslands which overlie dark grey/black cracking clays (Hou, 2010). The average annual temperature is 31.2 degrees Celsius and average annual rainfall is around 1850mm (Bureau of Meterology Channel Point Station IDCJAC0001 Reference: 13231782, Station ID 014253).

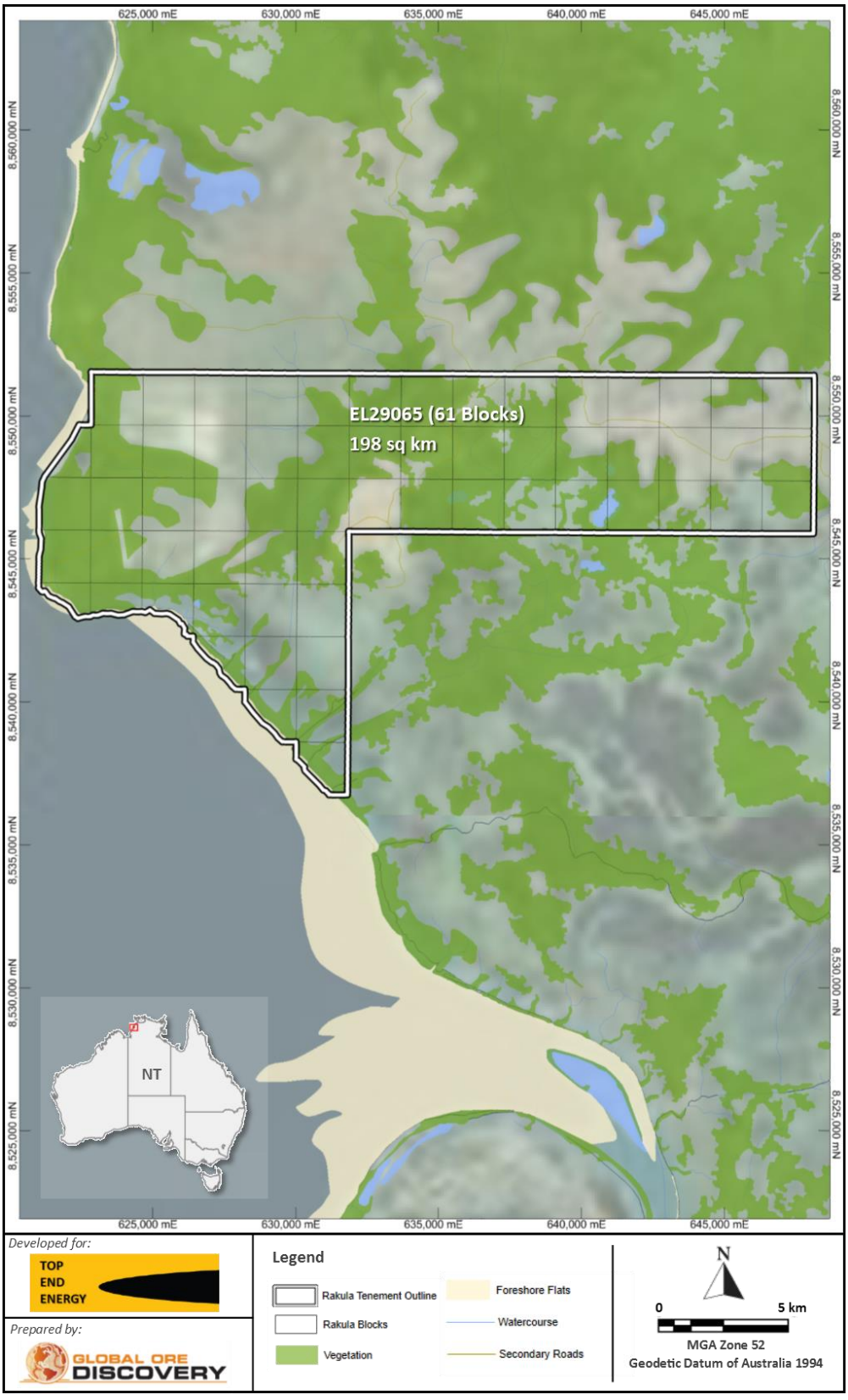


*Figure 1 Location Map EL 29065*

# 6. Geological setting

## Regional Geological Setting

EL29065 is located within the Petrel Sub-basin of the Bonaparte Basin. The Bonaparte Basin is a Cambrian to Recent fan-shaped, hydrocarbon-bearing basin extending over 270,000 km$^2$ offshore and onshore. It is comprised of southern Palaeozoic and northern Mesozoic depocentres and hosts known remaining reserves of 33.42 GL of oil and 668.55 BCM of gas. Coal and petroleum explorers have reported coal in drilling records, however no mineable coal reserves have been defined to date. Extensive reference lists are provided in RET and GA publications, (http://www.ga.gov.au, 2012 and http://www.ret.gov.au, 2009)

As summarised by Geoscience Australia, the Petrel Sub-basin is an asymmetric, northwest-trending Paleozoic rift that contains a succession of thick Paleozoic and thinner Mesozoic sediments. The eastern and western faulted margins of the sub-basin converge onshore to form a southern termination. Extensive basement shelves overlain by a thin cover of Phanerozoic sediments lie on the eastern, western and southern margins of the Petrel Sub-basin. To the east, the Kulshill Terrace and Moyle Platform extend to the north-northeast into the Darwin Shelf (Geoscience Australia, 2013a).

Sediments within the Petrel Sub-basin dip regionally to the northwest about a northwest-plunging synclinal axis, resulting in exposure of Early Paleozoic sediments in the southern onshore area, and in the progressive subcropping of Late Paleozoic, Mesozoic and Cenozoic sediments offshore.

The Jurassic depocentres contain thick marine mudstones flanked by fan delta sandstones with potential for Permian coastal plain sub-bituminous coals.

## Local geological setting

EL29065 is located on the western margin of the Pine Creek Orogen and regional geological mapping indicates the underlying geology of EL29065 is broadly divided into Permian sediments of the Bonaparte basin in the western half of the tenement, and the Proterozoic Litchfield Granite Complex in the east (Morgan et al. 1970). Locally the Proterozoic basement is termed the Wagait Granite (Hou, 2010), which consists of granite and granodiorite type rocks, and presents in outcrop as low ridges and hills. The Wagait Granite is considered to be the basement to the younger basin sediments that overlie it, and 'granite' has been intercepted in two water boreholes within EL29065: at 63m and 6m depth (Boreholes RN-030292, -030678).

In EL29065 the Wagait Granite is interpreted to be unconformably overlain by undifferentiated Permian sedimentary rocks of the Bonaparte Basin. The generalised Permian units of the Bonaparte Basin include (from base to top): the dominant Kulshill Group, Fossil Head Formation and Hyland Bay Formation (Geoscience Australia, 2013a). Some outcropping Permian units are mapped along the coast within EL29065. These are interpreted as part of the Kulshill group, consisting of feldspathic sandstone, siltstone, claystone, coal; and minor diamictite and conglomerate (Geoscience Australia, 2013b). Hou (2010) reports that stratigraphic drilling on the western coast of EL24984 (within EL29065) intersected Permian Kulshill Formation sediments.

The 1:250,000 scale geological mapping (Morgan et al. 1970) reports Permian units. Later Cenozoic laterite and ferruginous rubble, and recent swamp muds now cover the sequence within EL29065.

# 7. Historical mining and exploration

There has been no coal mining conducted previously within EL29065.

No record of drilling targeting coal in the Permian Kulshil Group sediments within EL29065 was identified during the reporting period. Local water borehole records within EL29065 show intercepts of shallowest lithified units (sandstones) at between 3m and 45m depth (Boreholes RN-030488, -030676, -022024, -030291). Coal potential is inferred from exploration elsewhere in the Bonaparte Basin.

In the mid 1960's Lower Permian coals were intersected 130km to the South of EL 29065 in the Kulshill 1, and Kulshill 2 petroleum exploration wells, drilled by Australian Aquitaine Petroleum Pty Ltd (Duchemin and Creevey, 1966) under Authority to Prospect OP2 granted in 1968. These wells were collared in Upper Permian Kulshill Group sediments.

Kulshill 1 and Kulshill 2 recorded approximately 2.5 metres of net coal at 186m depth, in the Fossil Head Formation. These intersections spurred a phase of coal exploration in the Upper Kulshill Group, outcropping in the Port Keats area and undertaken by Theiss Brothers Pty Ltd, Coal Licence 172. Theiss concluded the coals are thin, discontinuous and of no appreciable areal extent (Lalor, 1967). The coal are hosted by unconsolidated sediments and, with equipment available at the time, could not be mined by either open cut or underground methods.

Coal exploration continued in the Port Keats area with drilling by Utah Development Company in 1972 and maceral analysis by Western Mining Corporation Limited (WMC) in 1982. WMC's literature review of Utah's drilling and their own coal quality analysis of historic petroleum well cuttings led them to conclude that the coal potential of the Port Keats area is limited as the Lower Permian coal seams are thin and discontinuous. They concluded that neither open cut mining nor underground mining would be economic in that area in 1982 (Meyer, 1982).

Historic exploration within EL29065 is reported in recent company reports. Hou 2010 (CR2010-0600) reports on previous exploration for minerals conducted in the area covered by and surrounding EL 29065. Previous minerals exploration has focused mostly on geophysical and photogeological analysis, geochemical sampling and shallow drilling. The report by Hou 2010 included a review of company reports shown in Exploration Rationale

Top End Energy was exploring for thicker, pod-like accumulations of the Permian coal seams at mineable depths. Regional scale geological mapping suggests Permian "Kulshill Group" sediments may occur within the application area however there are no known coal intersections and the thickness, quality and lateral continuity of any seams that may occur was completely unknown.

Top End Energy planned to proceed with exploration on the premise that the permissive stratigraphy

a) occurs from shallow depths (accessible by truck mounted drill rigs),
b) has the potential to host seams greater than half a metre thick proximal to infrastructure and
c) are in areas where community & environmental impact are likely to be minimal.

Initial work focussed on understanding the surficial stratigraphy using processed LandSat satellite imagery. Current economic conditions have prevented the company securing the necessary investment to pursue conceptual targets. No further work is planned on the tenement and a request for complete surrender has been made to the Minister.

Table 3.

# 8. Exploration Rationale

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*Table 3 Company reports detailing mineral exploration within and around EL 29065 reported by Hou, 2010.*

| Company Report | **Tenure** | Licence Holder | Commodity |
|---|---|---|---|
| CR19169-0048 | **AP 1873** | Tipperary Land Corporation | Bauxite, phosphate and "other minerals" |
| CR1972-0068 | **AP 3333** | Devex | Heavy mineral sands |
| CR1973-0156, CR1973-0251, CR1975-0035, CR1975-0143, CR1976-0069, CR1982-0333, | **EL 71** | Dampier Mining Co (BHP) | Massive sulphide mineralisation |
| CR1974-0066 | **EL 878** | Esso | Uranium, Copper, Zinc, Nickel and Cobalt |
| CR1978-0034, CR1978-0171, CR1979-0193, CR1980-0227, CR1981-0292, CR1983-0090, | **EL 1408** | AOG Minerals | Uranium |
| CR1981-0313, CR1983-0089, | **EL 2407** | Australian Diamond JV | Diamonds |
| CR1983-0071 | **EL 3188** | Australian Diamond JV | Diamonds |
| CR2007-0383 | **EL 3405** | Rio Tinto Exploration | Bauxite, diamonds |
| CR1991-0438, CR1992-0539 | **EL 6652** | Stockdale Prospecting | Diamonds |
| CR1995-0006 CR1996-0291 | **EL 8258** | Normandy Exploration | "Bedrock mineralization" |
| CR2003-0426, CR2004-0203 | **EL 23110** | De Beers Australia Exploration | Diamonds |
| CR2004-0358, CR2005-0228, | **EL 23146** | BHP Billiton | Copper-nickel |

| | | | |
|---|---|---|---|
| CR2007-0326, CR2008-0346, CR2010-0599, CR2010-0600, CR2011-0457, CR2011-0691, CR2012-0577, | **EL24984** | Territory Uranium | Uranium |

# 9. Remote sensing

## Intention

Landsat 8 imagery was acquired to obtain coverage of the tenure with moderate resolution imagery for relatively low cost. This imagery also provides multispectral data for use in land surface analysis including; spectral variation, composition, lithological discrimination to attempt to highlight coal bearing horizons.

## History & Specifications

Landsat 8 was launched on February 11, 2013 to carry on from Landsat earth observing satellites which commenced back in the 1970's. Landsat 8 ensures the continued acquisition and availability of Landsat data utilising a two-sensor payload configuration, the Operational Land Imager (OLI) and the Thermal InfraRed Sensor (TIRS). The new OLI sensor was developed utilising refined, heritage band assignments with the addition of 2 new bands designed specifically to focus on coastal and aerosol (cloud/atmosphere).reflectance wavelengths. Figure 2 and Table 4 illustrate the comparison between Landsat 7 ETM+ and Landsat 8 OLI/TIRS band assignments.

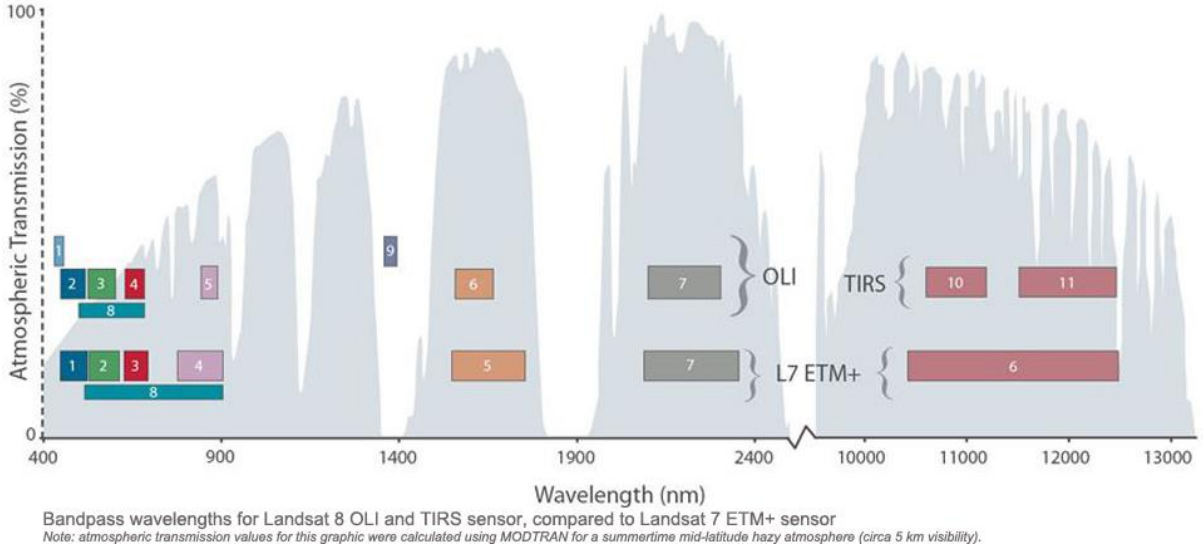



*Figure 2 Comparison of Landsat 7 and Landsat 8 band allocations - From USGS Landsat Missions Page* http://landsat.usgs.gov/L8_band_combos.php

*Table 4 Spectral Bands from NASA, 2012. Landsat Data Continuity Mission*

**ETM+ and OLI/TIRS Spectral Bands**

| L7 ETM+ Bands | | LDCM OLI/TIRS Band Requirements | |
|---|---|---|---|
| | | 30 m, Coastal/Aerosol, 0.433–0.453 µm (*A) | Band 1 |
| Band 1 | 30 m, Blue, 0.450–0.515 µm | 30 m, Blue, 0.450–0.515 µm | Band 2 |
| Band 2 | 30 m, Green, 0.525–0.605 µm | 30 m, Green, 0.525–0.600 µm | Band 3 |
| Band 3 | 30 m, Red, 0.630–0.690 µm | 30 m, Red, 0.630–0.680 µm (*B) | Band 4 |
| Band 4 | 30 m, Near-IR, 0.775–0.900 µm | 30 m, Near-IR, 0.845–0.885 µm (*B) | Band 5 |
| Band 5 | 30 m, SWIR-1, 1.550–1.750 µm | 30 m, SWIR-1, 1.560–1.660 µm (*B) | Band 6 |
| Band 7 | 30 m, SWIR-2, 2.090–2.350 µm | 30 m, SWIR-2, 2.100–2.300 µm (*B) | Band 7 |
| Band 8 | 15 m, Pan, 0.520–0.900 µm | 15 m, Pan 0.500–0.680 µm (*B) | Band 8 |
| | | 30 m, Cirrus, 1.360–1.390 µm (*C) | Band 9 |
| Band 6 | 60 m, LWIR, 10.00–12.50 µm | 100 m, LWIR-1, 10.30–11.30 µm (*D) | Band 10 |
| | | 100 m, LWIR-2, 11.50–12.50 µm (*D) | Band 11 |

***Explanation of Differences**

A. Coastal Band added at request of ocean color investigators requiring higher resolution of coastal waters relative to MODIS and SeaWiFS.

B. Bandwidth refinements made to avoid atmospheric absorption features (enabled by the higher signal-to-noise ratio inherent in push-broom architecture).

C. Cirrus Band added to detect cirrus contamination in other channels.

D. TIRS will acquire the data for these two thermal bands.

Landsat 8 data, when purchased is delivered with the following parameters;
Processing Level: Level 1 T- Terrain Corrected

| | |
|---|---|
| Pixel Size: | OLI multispectral bands 1-7, 9: 30-meters<br>OLI panchromatic band 8: 15-meters<br>TIRS bands 10-11: collected at 100 meters but resampled to 30 meters to match OLI multispectral bands |
| Data Characteristics: | GeoTIFF data format, 16-bit pixel values<br>Cubic Convolution (CC) resampling, North Up (MAP) orientation<br>Universal Transverse Mercator (UTM) map projection, World Geodetic System (WGS) 84 datum<br>12 meter circular error, 90% confidence global accuracy for OLI, 41 meter circular error, 90% confidence global accuracy for TIRS |
| Data Delivery: | tar.gz compressed file via HTTP Download |
| File size: | Approximately 1 GB (compressed), approximately 2 GB (uncompressed) |

## Processing

The RAW Landsat 8 data was acquired by utilising the USGS "GLOVIS" Viewer. The data is delivered as 11 bands in GeoTIFF format which can be loaded into image processing software.

EXCELIS's ENVI (Version 5 Service Pack 3) software package was used to load the RAW Landsat 8 data. The individual bands were first stacked into a single file, resampled to 30m pixels and reprojected into MGA zone 52, GDA94 datum and projection.

The stacked Landsat 8 data were then atmospherically corrected using a "dark body subtraction" calculation, which is a simple technique that determines the pixel in the image with the lowest brightness value. This pixel is assumed to have a zero ground reflectance such that its radiometric value represents the additive effect of the atmosphere (Crane 1971, Piech and Schott 1975, Crippen 1987). That value is then removed from all remaining pixels to correct for atmospheric effects.

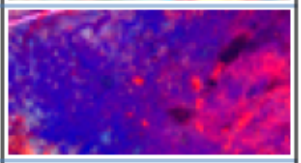
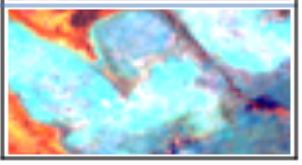
The dark pixel corrected data was then used in the creation of a suite of false colour imagery, band ratios and image classification.

False colour imagery created include;

- A natural colour stretch (bands 4, 3, 2 in RGB), this image uses the bands covering the VNIR, and produces an image that simulates natural colour as observed by the eye.
- A traditional Landsat false colour stretch (bands 7, 5, 3 in RGB), this is the standard Landsat false colour image, it is useful for lithological and structural determination.
- Abrams Ratio (bands 6/7, 4/2, 5/4 in RGB), (Abrams 1983), this image of ratios represents clays in Red, ferric iron in Green and vegetation in Blue.
- Crippen's Ratio (bands 6/7, 6/5, 4/2 in RGB), (Crippen 1990), this image of ratios represents clays in Red, ferrous iron in Green and ferric iron in Blue.
- Regolith ratio (bands 6/7, 5/7, 5/3 in RGB), (Dauth 1997), this image of ratios represents clays in Red, earthy soils in Green and potential outcropping rocks in Blue.
- Clay iron & silica ratio (bands 6/7, 6/5, 7+2 in RGB), (Fraser & Green 1987), this image of ratios represents clays in red, iron oxides in green and silica in blue.

Image Classification involved utilising the clay iron and silica ratios to "train" the software by using small regions of clay/iron/silica pixels, to create a classified vector map of the three band image. The classification method used was Maximum Likelihood. This classification algorithm assumes that the statistics for each class (i.e. Clay/iron/silica, see Table 5 for examples) in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. Each pixel is assigned to the class that has the highest probability (that is, the maximum likelihood).

*Table 5 Examples of defined classes and training areas*

| Class Name | Defining Signatures | Resultant Colour in RGB: (6/7, 6/5, 7+2) | Examples of Defined Training Areas |
|---|---|---|---|
| **Clay** | Strong clay signature only | Red |  |
| **Iron** | Strong iron signature only | Green |  |
| **Silica** | Strong silica only, low iron, low clay | Blue |  |
| **Clayey Iron** | Strong clay + iron signature, low silica | Yellow/Orange |  |
| **Clayey Silica** | Strong silica + clay signature, low iron | Purpley/Blue |  |
| **Iron rich Silica** | Strong silica + iron signature, low clay | Cyan/Greeny-Blue |  |

## Results

Geological interpretations were based on the following processed Landsat satellite imagery products, which are provided with this report:

- A natural colour stretch (bands 4, 3, 2 in RGB)
- A traditional Landsat false colour stretch (bands 7, 5, 3 in RGB),
- Abrams Ratio (bands 6/7, 4/2, 5/4 in RGB)
- Crippen's Ratio (bands 6/7, 6/5, 4/2 in RGB)
- Regolith ratio (bands 6/7, 5/7, 5/3 in RGB)
- Clay iron & silica ratio (bands 6/7, 6/5, 7+2 in RGB)

The texture and colour of the clay, iron, silica response was grouped into regions, and then attributed a rock/sediment type while also considering the topography and geomorphology of the area. A classification of spectral response from the clay-iron-silica and Crippen Ratio processed imagery is summarized in Table 6.

Figure 4 shows the clay, iron and silica processed image to produce a classified vector map. Figure 5 shows an interpretation of the surface geology within the tenement area based on the processed Landsat imagery and compiled waterbore drilling.

No outcropping coal was interpreted from the Landsat images.

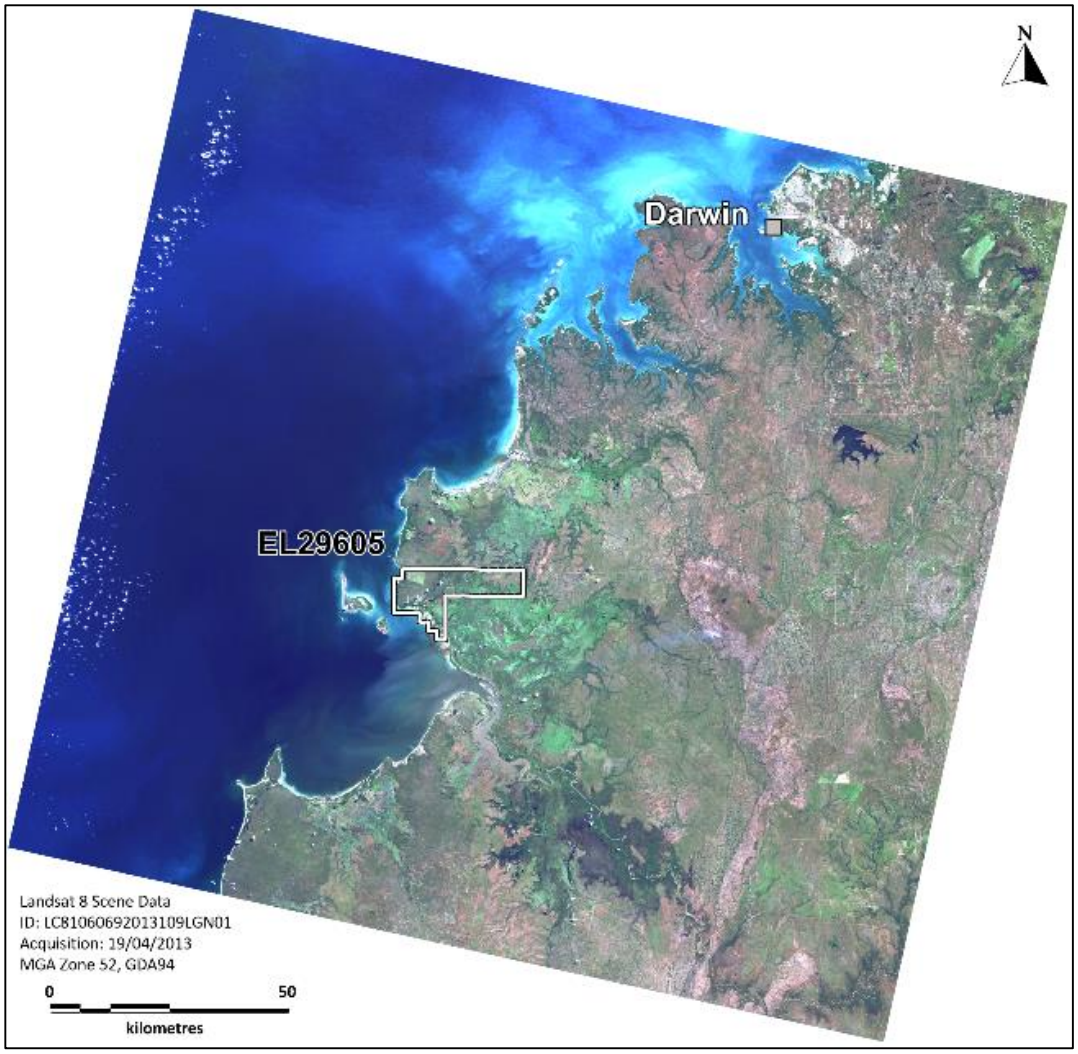



*Figure 3 Processed Landsat imagery (Bands 432 RGB)*

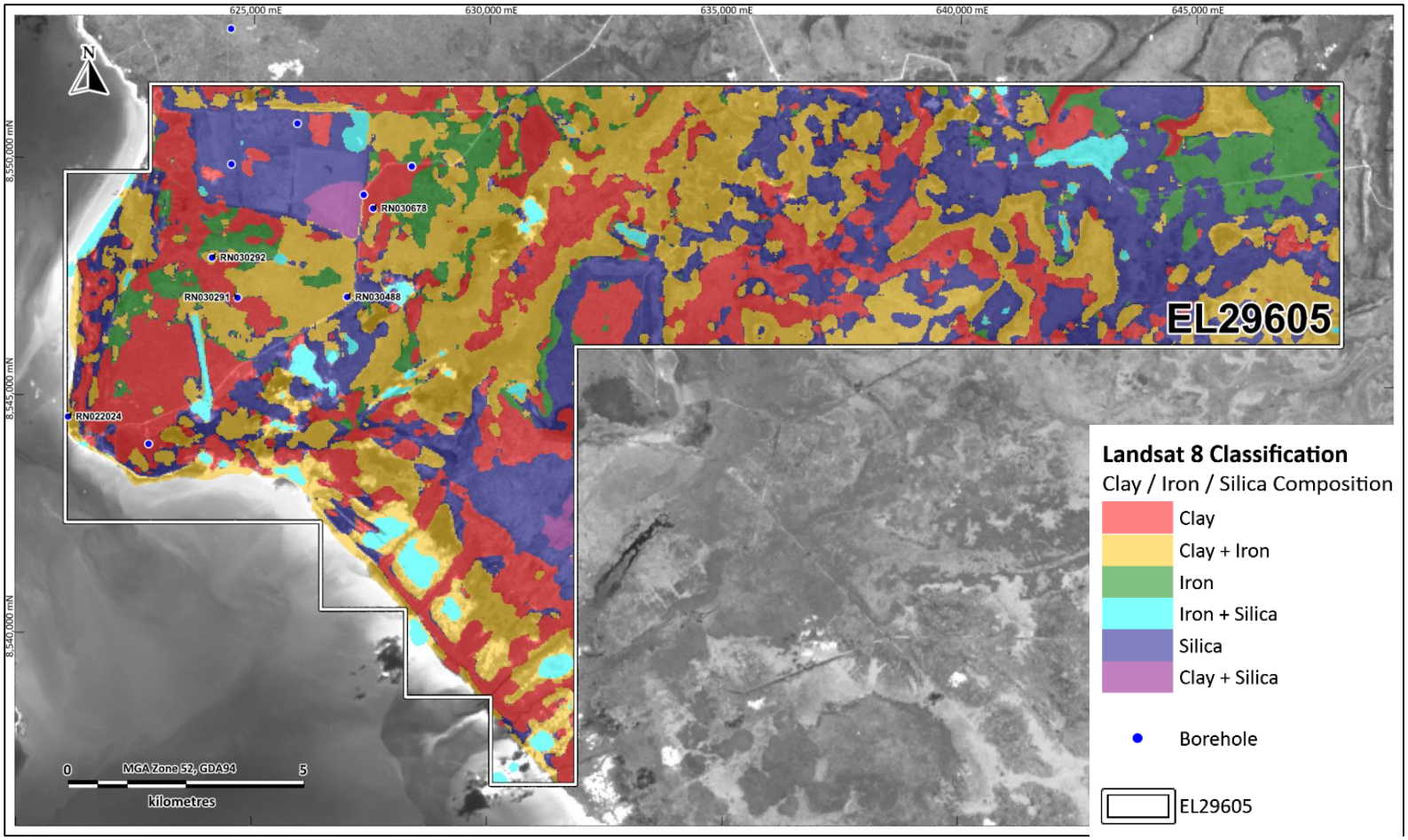



*Figure 4 Interpretation of processed Landsat imagery (Bands 432 RGB greyscaled) to determine clay, Iron and Silica composition*

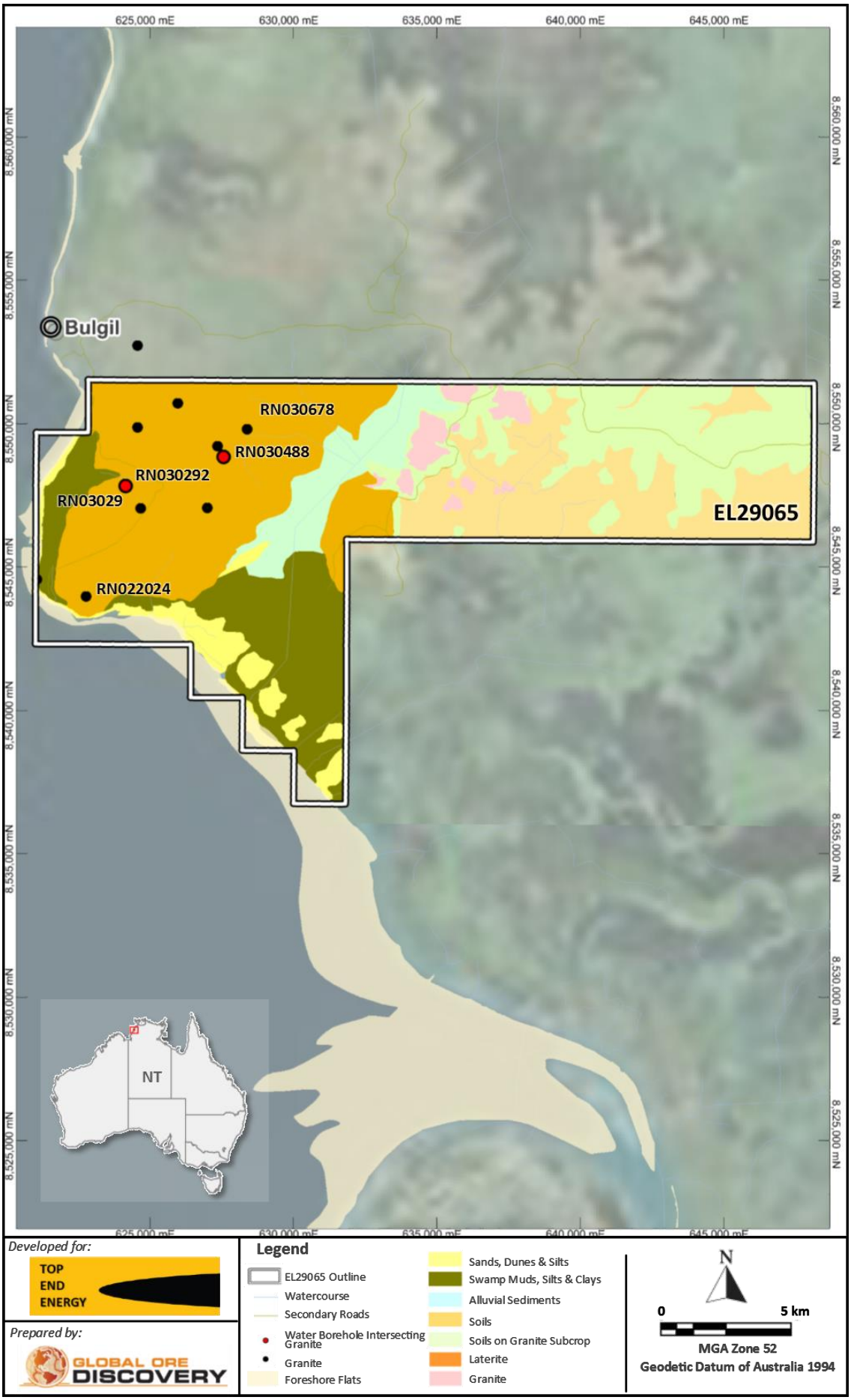



*Figure 5 Surficial lithology interpretation of EL29065*

*Table 6 Classification of responses and interpreted lithology for the clay-Iron-Silica and Crippen Ratio processed imagery*

| Lithology Type | Clay-Iron-Silica Classification | Crippen Ratio Classification |
|---|---|---|
| Coastal Sands, dunes, and silts |  Prominent aqua-blue, sometimes with yellow striations |  Prominent aqua-blue, sometimes with dark-blue striations |
| Coastal swamp muds, silts and clays |  Predominant dark yellow-orange |  Prominent dark blue areas with a striated texture |
| Alluvial sediments |  Mottled orange-yellow-brown, edges rimmed by dark brown. |  Electric blue with pale green wispy patches |
| Residual Soils |  Mottled bright and dull yellow. Much brighter than 'Alluvial seds' |  Strong dark blue with wisps of green-grey |
| Laterite |  Grey-green with an underlying pale aqua-blue |  Green and grey mottled with an overriding blue hue |
| Residual soils on granite subcrop |  Dull blue-grey with transparent green patches |  Bright aqua-blue slightly mottled with dull yellow |
| Granite outcrop |  Distinct, subrounded areas of dull orange-dark brown |  Distinct, subrounded areas of prominent dark blue, with navy blue patches |

## 10. Geophysical activities

No geophysical activities were completed during the reporting period.

## 11. Surface geochemistry

No surface geochemistry activities were completed during the reporting period.

## 12. Drilling

No drilling activities were completed during the reporting period.

## 13. Geotechnical studies

No geochemical or coal quality activities were completed during the reporting period.

## 14. Resources and reserve estimation/modelling

No resource or reserve estimation modelling activities were completed during the reporting period.

## 15. Environment and rehabilitiation

No ground disturbing activities were conducted during the reporting period.

## 16. Landowner relations

During the reporting period, preliminary communications were held with Labelle Station with regards to land access. Good progress was made and a working relationship established.

## 17. Conclusion and recommendations

The first year exploration program demonstrated processed Landsat imagery to be useful for stratigraphic mapping at Rakula West. Literature searches suggest the Permian coals within the Bonaparte Basin to be laterally discontinuous and thin. The potential for thicker or more substantial accumulations of coal in the part of the basin covered by EL 29065 has not been tested by drilling during the reporting period and the exploration target remains conceptual.

Current economic conditions have prevented the company securing the necessary investment to pursue conceptual targets. No further work is planned on the tenement and a request for complete surrender has been made to the Minister.

# 18. References

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# 19. Expenditure

Expenditure consisted of:

| | |
|---|---|
| C. Geophysical and Remote Sensing Activities | $2,000 |
| H. Office Studies | $8,888 |
| I. Overheads | $1,425 |
| **K. Total Expenditure** | $12,313 |