

# **LEGEND INTERNATIONAL INVESTMENTS PTY LTD**

**Annual Report on EL 25794**

**from 11 June 2011 to 10 June 2012**

**Central Australia, Northern Territory**

**Tenement Holder: Legend International Investments Pty Ltd**

**Distribution:**

- **Department of Resources Darwin, NT**
- **Legend International Investments Pty Ltd, Darwin**

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## SUMMARY

Exploration Licence (EL) 25794 is located about 1280 km south of Darwin, and 120 km north of Alice Springs Australia. It covers 450 sub blocks (1215 km<sup>2</sup>) on the Hermannsburg (1:250 000) sheet. EL was granted to Legend International Investment Pty Ltd on 11 June 2008 for a period of six years, and will expire on 10 June 2014.

Geology of EL 25794 is dominated by Palaeoproterozoic rocks of the Arunta Block along with possibility of Amadeus Basin stratigraphy, now covered by Quaternary sediments. These rocks are represented by Narwietooma Metamorphics, Mount Hay Granulite, Mount Chapple Metamorphics, Bunghara Metamorphics and Forty Five Augen gneiss, probably intruded by granites at depth.

In the reporting year, a stream sediment sampling program was undertaken in the eastern and western part of the tenement. For this purpose, a total of 80 stream/soil sediments and rock chip samples were taken. These samples were assayed for REE and trace element concentrations. In some samples significantly anomalous values of REE were returned which points towards the prospectivity of the project area. In addition, a number of reconnaissance field visits were undertaken Geological and geophysical data were reviewed in order to assess the mineral potential of the project area, which will help to define targets for drilling. Negotiations were held with land owner, particularly in the central part of EL 25794 to commence on-ground exploration activity and also with some companies to explore the project area under a JV agreement.

Geochemical sampling program points towards significant potential for REE mineralisation of the project area. In the next reporting period, after securing access in the central part of the tenement, geochemical sampling program will be extended to that part of the project area. This program will lead to target selections for further perusal and will ultimately lead to RC/RAB drilling.

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## **1.0 INTRODUCTION**

EL 25794 is located in central Australia, about 1280 km south of Darwin and approximately 120 km northwest of Alice Springs. Legend International Pty Ltd is exploring the project area for REE, Cu, Ni and gold mineralisation. This report covers the exploration activities undertaken during the reporting period year ending on 10 June 2012.

## **2.0 TENEMENT STATUS**

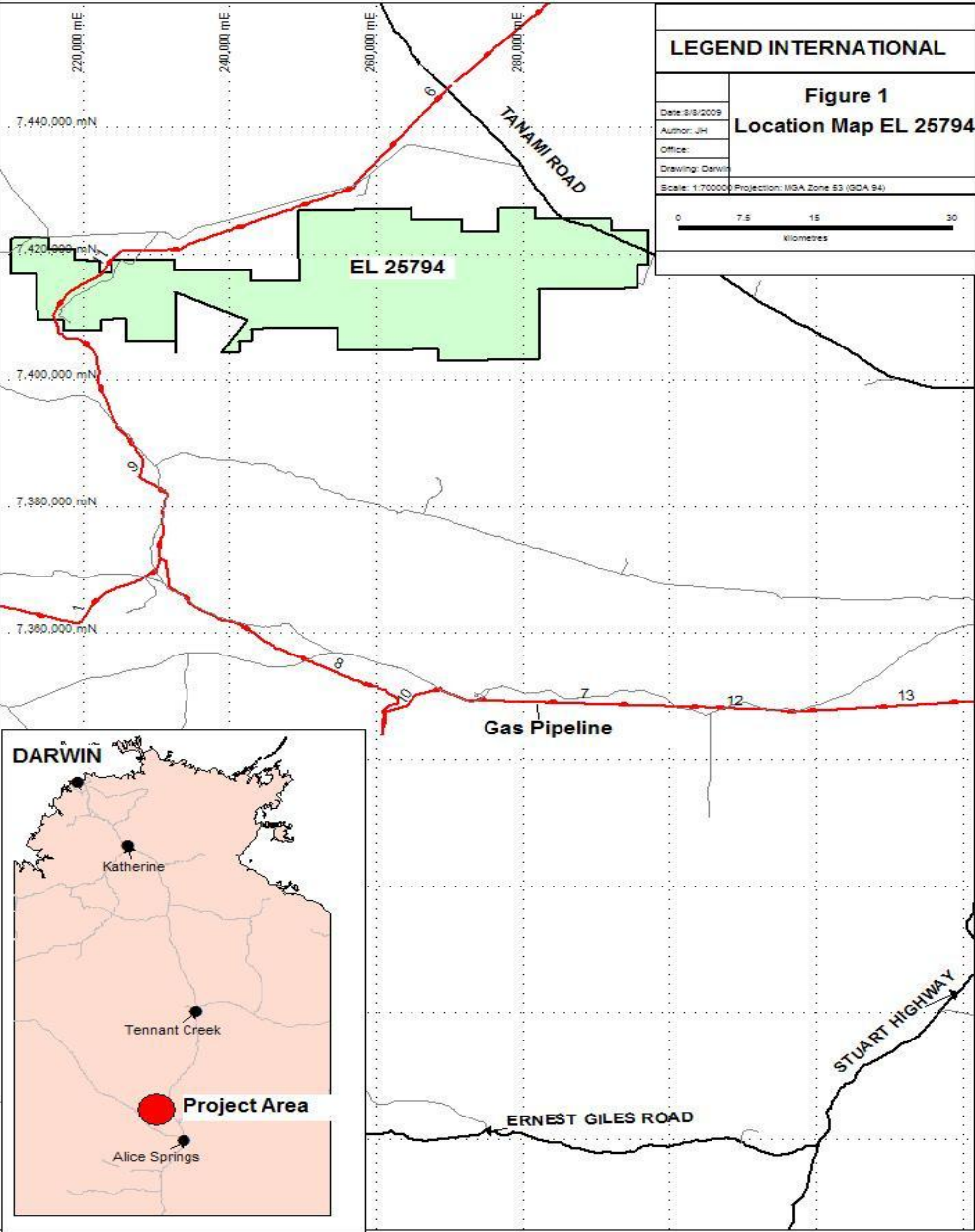
The EL was applied for on 7 December 2006 by Legend International Investments Pty Ltd and was granted on 11 June 2008 for a period of 6 years. Originally, it had 450 blocks (1215 km<sup>2</sup>) and in 2012 sixty blocks were surrendered in order to meet the NT Mining Act requirement.

Underlying cadastre is covered by a number of pastoral properties such as PPL 1150, PPL 1145, PPL 1019 and PPL 1128.

## **3.0 LOCATION AND ACCESS**

EL 25794 is situated in central Australia and is located about 1280 km south of Darwin and 120 km NW of Alice Springs (Figure 1). Part of the tenement is intersected by Tanami Road in the east and Gas Pipeline in the west. Stuart Highway and Darwin to Adelaide Railway line are located about 100 km east of the project area. Three topographic high points Mt Chappell, Mt Zeil and Redbank are located within the licence area. Tenement is situated in the central part of Hermannsburg (1:250 000) sheet. It also covers area in Narwietooma, Hermannsburg, Glen Helen and Gosses Bluff (1:100 000) sheets. Access to the project area is gained by Stuart Highway then by Tanami Highway. Four wheels drive station tracks provide access to various parts of the tenement. The project area is mainly covered by red sandy plans with occasional sand dunes in the north whereas rocky ridges are present towards south. The area experiences a continental desert climate with annual rain of about 100 millimetres. Summers are dry and hot with maximum temperature over 50°C whilst winters are relatively cooling (maximum 30°C). Winter season is the most suitable for exploration.

Figure 1: Location of Project Area



## 4.0 GEOLOGICAL SETTING

The project area is situated within northern part of the Arunta Block which is overlain by rocks of Amadeus Basin. It is a Palaeoproterozoic fault-bounded sequence of igneous and metamorphic rocks that forms a deep depocentre within the Northern Australian Craton. The oldest rocks of the northern part of the Arunta Block comprises mafic and felsic granulites of the Strangways and Narwietooma Metamorphic complexes, which are partly underlain by Madderns Yard Metamorphic Complex (Warren and Shaw, 1995). During Strangways Orogeny (1760-1750 Ma), these rocks were down-wrapped to depths in excess of 20 km, and as a result of that deformed and metamorphosed.

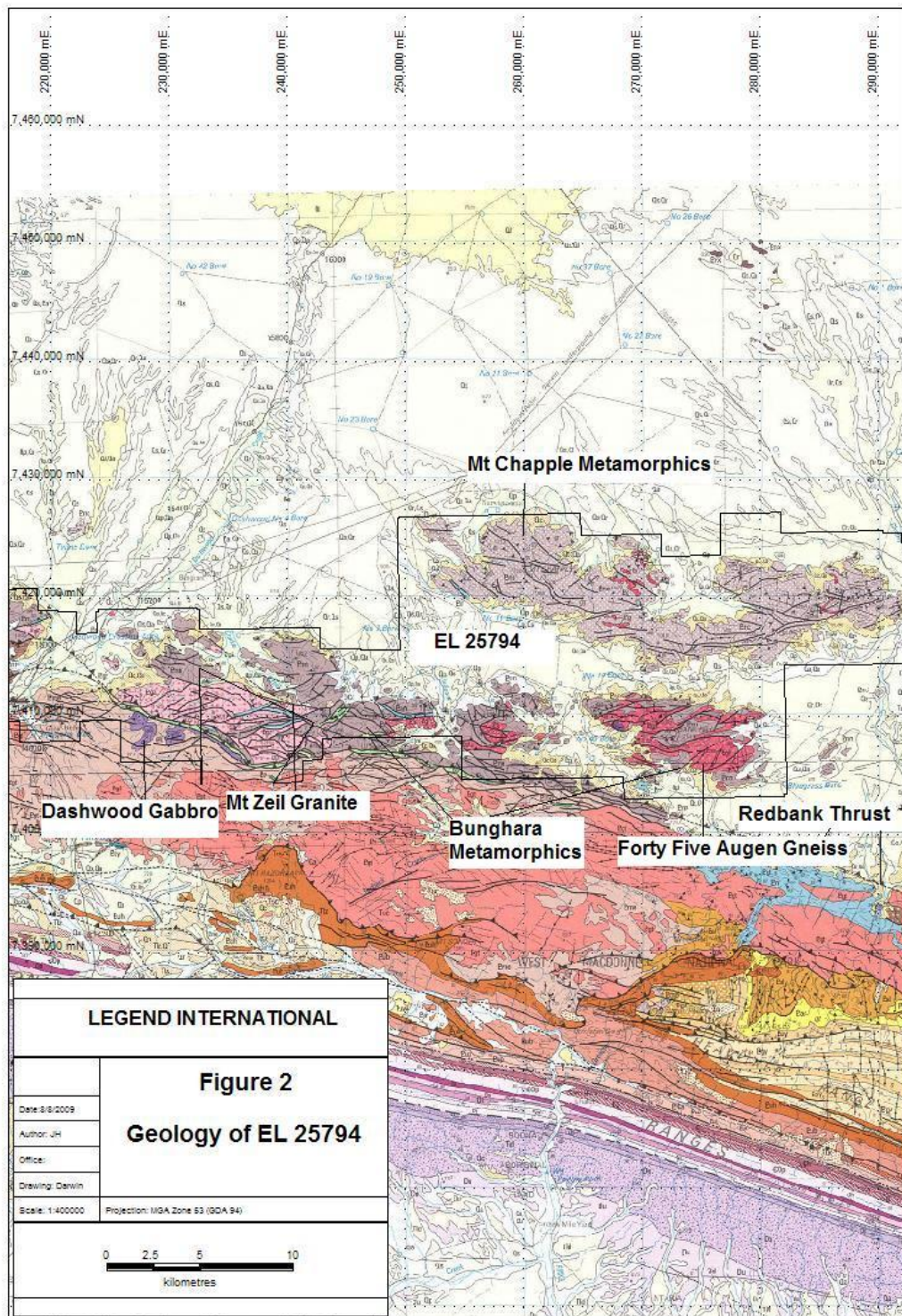
The Strangways Complex forms part of the southern Arunta Block which consists of Palaeoproterozoic volcanics and sedimentary rocks, which were strongly deformed and metamorphosed to granulite and amphibolite facies and intruded by granites (Warren and Shaw, 1995). An episode of migmatization occurred during Neo-Palaeoproterozoic followed by wide spread thrust-faulting and associated retrogressive metamorphism occurred in Neoproterozoic (Alice Springs Orogeny).

The geological mapping done so far indicate that the Strangways Complex consists essentially of high-grade metamorphics – granulite of mafic and felsic and pelitic compositions, including pyroxene granulite, cordierite granulites, charnockites, anorthosite and migmatites. The metamorphics comprised of amphibolites, gneisses, schists, marbles, pegmatites and meta-dolerites. Common mineral assemblages are quartz-hypersthene-cordierite-biotite and garnet.

In the project area mainly rocks of the Narwietooma Metamorphic Complex (Figure 2) are present which, in turn, are overlain by Cainozoic lithologies. The Mt Chappell Metamorphics is the most common unit and forms the Mt Chappell massif and low hills to the east. It is predominantly mafic to intermediate granulite and gneiss along with minor metasediments. In places, felsic granulite and orthopyroxene-bearing gneissic granites are also present. Another formation in the Narwietooma Metamorphic Complex is Bungahra Metamorphics. Main outcrops are around Mt Heughlin where it forms low rounded massifs and series of small hills further east. The unit consists of meta-igneous rocks and very minor sediments. Mafic to intermediate granulites, dark toned on aerial photographs predominate



Figure 2: Geological Setting of the Project Area



(Warren and Shaw, 1995). More basic rocks appear to be migmatic. Metamorphic facies range from granulite to upper amphibolite. Retrogressive garnet occurs in mafic to intermediate meta-igneous rocks.

The Mt Hay Granulite forms most of the Mt Hay Massifs and Ceilidh Hill to the east. It consists of fine-grained mafic granulite and minor interlayered metamorphosed felsic gabbro-anorthosite granulite and minor calc-silicate rocks. Felsic granulite is also present which may form up to 10% of the unit. Quartzose metasediments occur as thin recessive bands within migmatic layers containing garnet and biotite-sillimanite intergrowths. Calc-silicate rock forms a small lens west of Ceilidh Hill. The Mt Hay Granulite passes gradationally into the Mt Chappell Metamorphics, and encloses the main part of the Anburla Anorthosite.

Metamorphosed igneous rocks within the Narwietooma Metamorphic Complex are represented by the Anburla Anorthosite and that forms three separate bodies in the Hermannsburg (1:250 000) sheet area. The unit ranges in composition from essentially monomineralic plagioclase-rock to a lithology containing plagioclase and approximately 40% ferromagnesian minerals. Many outcrops have dark bands a few mm thick comprising of hornblende, enclosing pyroxene.

The forty five Augen Gneiss forms the southern part of the Redbank Hill. It consists mainly of quartzo-feldspathic gneiss with large augen of K-feldspar and aggregates of unfoliated granite inclusion in a foliated matrix. Dyke-like tongues of non-foliated microgranite dated at  $1760 \pm 11$  Ma, cut gneiss which is dated at  $1754 \pm 9$  Ma (Warren and Shaw, 1995). The augen gneiss contains a variety of country rock xenoliths and minor rafts and pods of mafic rocks, and is cut by Redbank Shear Zone, formed during Alice Springs Orogeny.

The Mt Zeil Granite forms a large body of intrusive complex on the northern side of the Redbank Thrust Zone (Figure 2). It also crops out on the north-eastern side of the Mt Heughlin massif. It consists of homogeneous to migmatitic medium-grained granodiorite and granite along with medium-grained granitic gneiss and augen gneiss. Thin layers of mafic granulite parallel to the gneissic foliation contain high level of Nb, LHREE and Zr (Warren and Shaw 1995). It is cut by Redbank type mylonite zones and pegmatites (Black and Shaw, 1992). The Dashwood Gabbro is present in the south-western part of project area. It comprises altered gabbro, dolerite, and ultramafic rocks.



In the project area, unconsolidated Quaternary sediments form a surficial covers. These are ferruginised alluvium and sand along with drainage channel deposits. During drier periods, aeolian reworking spread sheet and dune sands. Close to hills there are coarse sand and gravel and, as they spread out, they contain more silt and sand. Fans are currently spreading over the clayey units. Some calcrete and Silcrete outcrops may also be present.

## **5.0 PREVIOUS EXPLORATION ACTIVITY**

Project area is situated in the centre of Australia continent which has seen little exploration since today. Part of the project area has been explored under historical ELs (EL 519, EL9566, EL 1323, EL 754, EL 755).

Earliest record of uranium exploration is covered under EL 754 which involved geological mapping, radiometric survey and water sampling for sedimentary uranium deposits (Hughes and O'Sullivan, 1973). Historical EL 754 covers eastern part of the project area. Overall results were disappointing and eventually EL 754 was dropped.

Western part of the project area was explored under EL 755 which involved drilling of 74 augers holes to determine the presence of calcrete development, which might host uranium mineralisation. However, all sample retrieved showed low concentration of uranium. The average value was 1 ppm to 2 ppm of uranium (Scott, 1973).

CRE conducted exploration for uranium under EL 519 which covered western part of the current tenement area. During this campaign geological mapping, review of sedimentation processes and gamma-logging of open water bores (Hughes and O'Sullivan, 1973) were undertaken. Results of this investigation were not encouraging and tenement was surrendered.

First phase of geological mapping was conducted by Bureau of Mineral Resource, Geology and Geophysics during 1960's (Quinlan and Forman, 1968). Second phase of geological mapping of the area was undertaken by Bureau of Mineral Resources, Geology and Geophysics in 1995 (Shaw and Warren, 1995). During this exercise, geology of the project area was revised as part of Hermannsburg (1:250 000) project. This led to sub-division of main geological stratigraphy which forms the basis of our geological understanding of the area today.

Large part of the tenement was explored under EL 1323 by Esso Australia in 1977. A detailed photogeological assessment was undertaken and spectrophotometer survey of the area was conducted. During geophysical survey, a number of radiometric anomalies were identified; however, none of these were investigated. Granites in the area appear to be radioactive and host radioactive anomalies.

In 1978, exploration program further pursued EL 1323 for the presence of uranium mineralisation. Two airborne radiometric surveys were flown which identified additional uranium anomalies which were checked during ground-truthing. However, geochemical and petrological studies showed that uranium mineralisation has little economic significance (Fraser, 1978) and eventually tenement was surrendered.

Part of EL 25794 was explored under Mt Hay/Sixteen Mile project by Rio Tinto Exploration Pty Ltd (Home et al., 1998). This project was investigated for Ni-Cu-PGE mineralisation. Exploration program included geological mapping, rock sampling/assaying, airborne magnetic, radiometric and EM survey,

downhole conductivity and magnetic susceptibility logging and drilling. No sign of significant mineralisation was encountered and area was surrendered.

## **6.0 EXPLORATION ACTIVITY YEAR ENDING 10 JUNE 2012**

During the reporting period, a soil and rock chip sampling program was undertaken and a total of 80 samples collected, which were assayed for REE concentrations. In addition, a number of reconnaissance field visits were undertaken along with review of geological/geophysical data in order to assess mineral potential of the project area.

Negotiations were held with a land owner to commence on-ground exploration activity in the central part of the tenement, and also with some companies to explore the project area under a JV agreement.

### **Geochemical Survey**

Approximately 60% of the project area is covered by Quaternary unconsolidated sediments which could be 10's meter thick in places. Some exploration for sedimentary type uranium mineralisation has taken place without success, but this surficial cover needs thorough testing because further south, a number of uranium deposits have been identified in similar geological setting. In addition, recent

exploration by Crossland Mines Limited has made an important discovery of alluvial REEs mineralisation towards SE of EL 25794 (ASX Announcement, 13 July 2011). Heavy Minerals containing significant quantities of REEs are wide spread in the alluvial cover at various stratigraphic horizons. These Minerals are xenotime, monazite, zircon and others which have assayed >10% (REO + Y<sub>2</sub>O<sub>3</sub>). It may be noted that this type of recent sediments are wide spread within EL 25794, owned by Legend International, and planning is underway to explore these sediments. It is expected that these heavy minerals have been derived from the felsic to mafic-ultramafic rocks of the Arunta Complex.

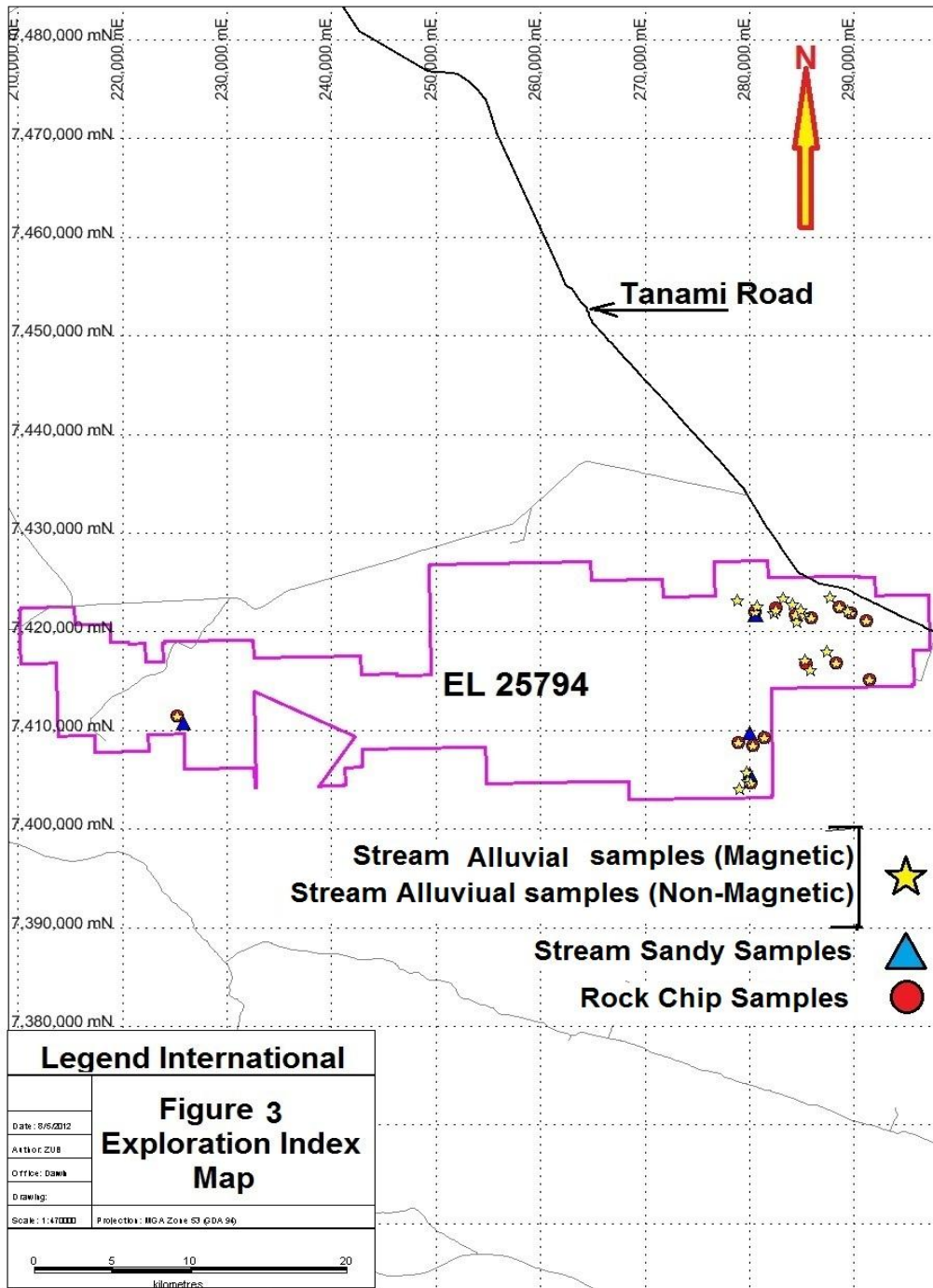
Having considered the above mentioned information, company designed an exploration program to test the mineral potential of Quaternary sand and alluvium in the project area. Access to only eastern and western part of the project area was available. For this purpose, a total of 80 samples were collected ranging from stream sediments, alluvial and rock chips. After processing, these samples were assayed for REEs, trace elements and major elements concentrations by ICP-MS. All assay data along with processing and analytical techniques are provided in Appendix 1.

Of 80 samples collected, 30 were collected from stream beds and mainly comprised of sandy loam (~25 kg), sand with soil component and termed as Mount Zeal Sandy Alluvium (MZSA). These samples were passed through Wilfley Table to produce Heavy Mineral concentrates for REE and Sn, Ta, W, U and Th assay. These concentrates were put through magnetic separator (flow sheet, Appendix 1) to produce two concentrates 1) magnetic concentrate and 2) non-magnetic concentrate. Both fractions (300 grams per sample) were assayed for REE concentrations by ICP-MS (Method Code: ME-ICP61) and details of analytical methods are given in Appendix 1. Data are reported as Table1\_MZSA\_MagSep (30 samples) and Table2\_MZSA\_NonMagSep (30 samples) in Appendix 1.

A consignment of 15 stream sediment samples (Table3\_MZSS) were directly assayed for REE concentrations by ICP-MS (Method Code: ME-ICP61). Results and analytical methods are given in Appendix 1. Another consignment of 5 rock chip samples (300 g per sample) was also processed to assay for trace element concentration by ICP (Method Code: ME-ICP61). It is reported as Table4\_RockChip in Appendix 1 along with processing and analytical methods.

Spatial distribution of all sampling data is shown in Figure 3. It may be noted that central part of project area is devoid of any sample location mainly due to access problem.

Figure 3: Exploration index map of EL 25794 for 2011 – 12



A cursory examination of assay data shows that samples derived from stream sediments have produced some positive results. Both magnetic and non-magnetic fractions of stream samples (Table1\_MZSA\_MagSep, Table2\_MZSA\_NonMagSep) have returned encouraging results particularly Non-magnetic separates (Table1\_MZSA\_NonMagSep). Both types of samples have the same location point and composition but were divided into two fractions by Wilfley Table and magnetic separator into magnetic and non-magnetic separates. A comparison of both fraction assays indicates that non-magnetic separates have returned considerably higher concentrations of some REEs and zircon ((Table 5).

**Table5: A comparison of elemental concentrations in magnetic and non-magnetic separates from EL 25794**

Sample Types	Ce ppm	La ppm	Nd ppm	Pr ppm	Y ppm	Th ppm	Zr ppm
<b>Non-Magnetic Separate</b>							
Minimum	70	33	30	8	46	51	2500
Maximum	9940	6550	2180	817	1160	1310	41200
Average	1365	801	404	130	289	446	16427
<b>Magnetic Separate</b>							
Minimum	66	30	31	7	41	17	550
Maximum	1620	861	616	172	467	503	3990
Average	314	162	110	31	117	89	1415

In magnetic fraction (Table1\_MZSA\_MagSep) REE such as Ce, La, Nb, Nd, Y and Th, and Zr are high and the elements have the highest concentrations from non-magnetic fractions (Table2\_MZSA\_NonMagSep). In magnetic fraction Ce varies from 66 ppm to 1620 ppm with an average of 314 ppm. Whereas in non-magnetic fractions, Ce ranges from 70 ppm to 9940 ppm with an average of 1364 ppm. The highest concentrations of enrichment in sandy alluvium is shown by zircon in non-magnetic fraction where it ranges from 2500 ppm to 41200 ppm with an average of

16427 ppm, which is over 11 times the average of Zr in magnetic fraction (Table 5). La is another element of noteworthy which ranges 33 ppm to 6550 ppm with an average of 801 ppm in non-magnetic fraction. On the other hand, magnetic fraction shows much lower concentrations (30 – 861 ppm, average= 162 ppm). Nd, Pr and Y also recorded higher concentrations in non-magnetic fractions than the magnetic fractions. Thorium has shown interesting behaviour due to its significant concentrations in sandy alluvium samples of non-magnetic character, where it ranges from 51 to 1310 ppm with an average of 446 ppm. In sandy alluvium this enrichment behaviour is not known at present and mineralogical studies are required to find which mineral is hosting thorium.

A total of 15 sandy samples were assayed for REE and other elements reported above and given in Table 3\_MZSS (Appendix 1). These sandy samples have returned considerably lower concentration of REEs. Ce ranges from 33 ppm to 303 ppm with an average of 101 ppm. La, Nd and Pr are also low with an average of 53 ppm, 30 ppm and 9 ppm respectively. However, zircon maintains its comparatively higher values (120 – 940 ppm, average= 391 ppm). Five rock chip samples were assayed for some major and trace elements (Table4\_Rockchip, Appendix 1) which did not record any significant concentration of elements except Ba. It ranges from 700 ppm to 1210 with an average of 918 ppm.

### **Geological and Geophysical Interpretation**

Project area dominantly contains Palaeoproterozoic mafic and felsic gneiss, variable metamorphic lithologies, migmatites and granites. Within the area, these rock formations occur as EW-trending ridges (Figure 4) with peaks like Mt Chapple, Mt Hay and Mt Zeil, however, northern part of the project area is mainly covered by surficial recent sediments. These rocks have been deformed and metamorphosed during Alice Spring Orogeny. Red Bank Shear Zone is the most important structural feature of the project area (Figure 2), which separates granulite-facies rocks of the central province from amphibolite-facies rocks of the southern province.



**Figure 4: EW-trending rock formations in the project area**



It is an anastomosing network of shears which roughly run east-west and probably are significant exploration targets in the project area.

Approximately 60% of the project area is covered by Quaternary unconsolidated sediments which could be 10's meter thick in places. Some exploration for sedimentary type uranium mineralisation has taken place without success, but this surficial cover needs thorough testing because further south, a number of uranium deposits have been identified in similar geological setting. In addition, recent exploration by Crossland Mines Limited has made an important discovery of alluvial REEs mineralisation towards SE of EL 25794 (ASX Announcement, 13 July 2011). Heavy Minerals containing significant quantities of REEs are wide spread in the alluvial cover at various stratigraphic horizons. These Minerals are xenotime, monazite, zircon and others which have assayed >10% (REO + Y<sub>2</sub>O<sub>3</sub>). It may be noted that this type of recent sediments are wide spread within EL 25794, owned by Legend International, and planning is underway to explore these sediments. A recent geochemical survey by Legend International (reported above) has confirmed the presence of REEs within Quaternary cover of the project area. It appears that these heavy minerals have been derived from the felsic to mafic-ultramafic rocks of the Arunta Complex.

On the TMI image of the project area (Figure 5), alluvial sediments are characterised by magnetically recessive valleys in contrast to exposed bed rock geology. These

sediments also show relatively higher radioactivity as displayed on the Uranium image of the project area (Figure 5).

A study by Australia Geological Organisation/NT Geological Survey (Hoatson, 2001) recognises metallogenic potential of the project for PGE and Ni-Cu-Co mineralisation, particularly rocks of Mt Hay Metamorphics and Mt Chapple Metamorphics (Figure 2). Mapping by the Northern Territory Geological Survey suggest that project area together with regional scale has been intruded by a number of mafic to felsic intrusions dated at  $\sim 1635 \pm 9$  (Edgoose et al, 2001). These are medium to large homogeneous mafic-felsic bodies emplaced prior to main granulite facies metamorphic events dated at 1780 -1760 Ma and 1730 – 1720 Ma.

Within mafic granulites, Hoatson (2001) observed locally contained well-preserved medium-grained inter-granular textures, rare compositional layering, and mafic pillows associated hybrid felsic rocks that indicate that the protoliths were probably homogenous sequences of gabbros that comingled with felsic magmas.

It has been argued that timing of S-saturation in evolving mafic-ultramafic is related to the type of mineralisation in layered intrusions. PGE-bearing stratabound layers such as Merensky Reef and Bushveld Complex are considered PGE-enriched index of fractionation (Hoatson, 2001). According to this investigation, Mt Chapple and Mt Hay intrusion could host Ni-Cu-Co mineralisation.

Presence of Glen Helen base metal prospect located at Latitude 23.4224, Long 132.3238 supports this contention. Therefore, it is recommended that mafic and felsic granulites should be mapped in details and a detail geochemical sampling program along with modelling of data will fully assess the potential of the project area.

Deformed and metamorphosed Palaeoproterozoic lithologies are also host to a wide variety of mineralisation throughout the world and Northern Territory is no exception. Granulites of Arunta block are an important host to REE-Uranium mineralisation in the Alice Springs region. Nolan Bore deposit is a significant discovery in recent times where REE-Uranium mineralisation is associated with carbonatite present within granulite complex

Similar lithologies are also present in the project area and possibility of carbonatite related REE-Uranium also exists, particularly deformed zones associated with the Red Bank Shear Zone. Discovery of REEs mineralisation (Crossland Uranium Mines Ltd, 2011) in the SW of EL 25794 further attest to this contention, and the presence of

Figure 5: TMI image of the project area

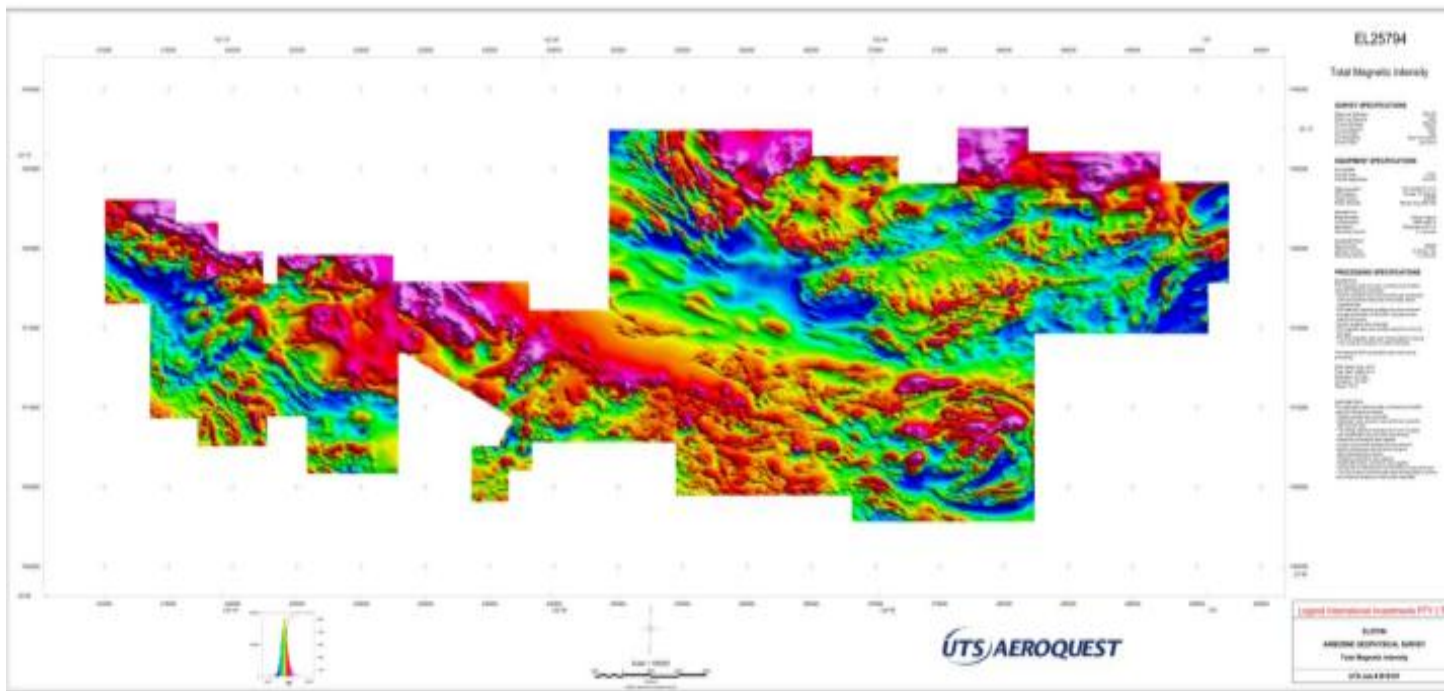
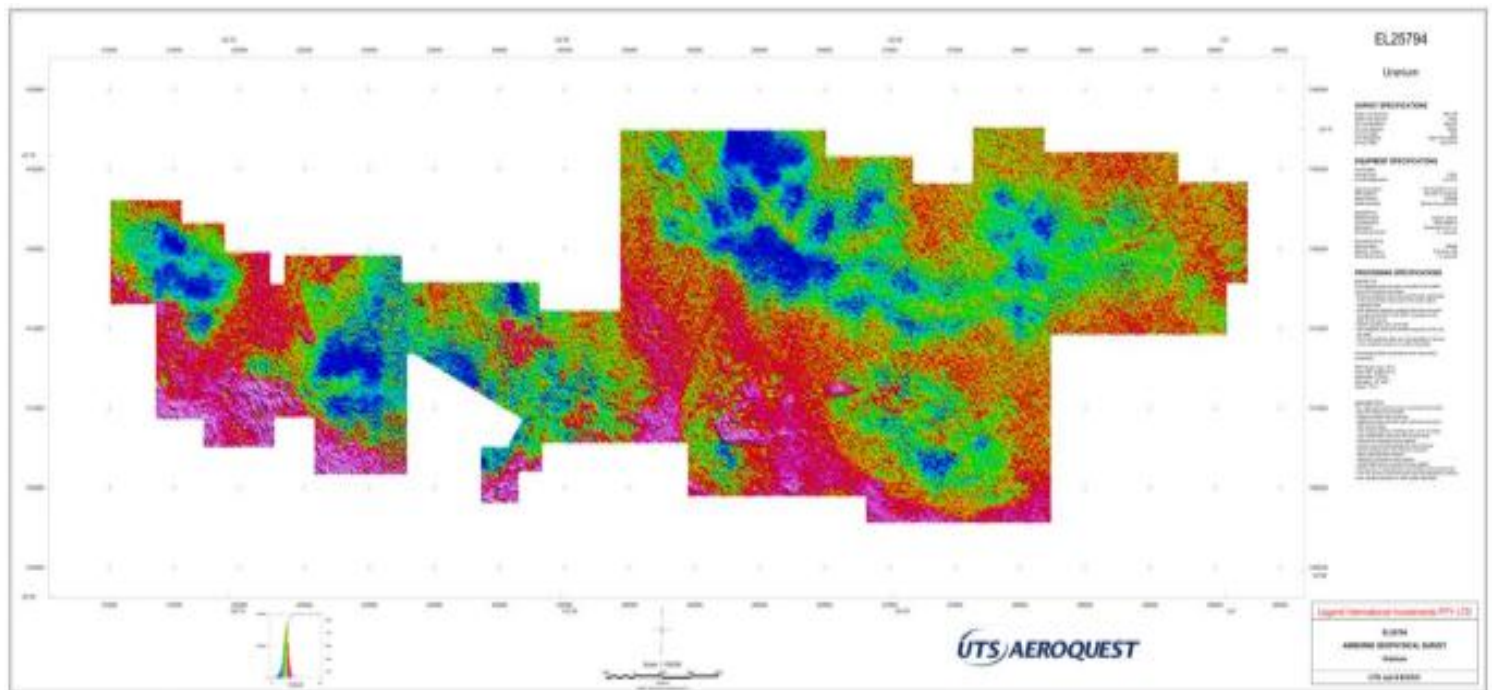


Figure 6: Uranium image of the project area



REEs heavy minerals within alluvial sediments of the project area are highly likely. These heavy minerals must have been derived from the surrounding mafic to felsic Palaeoproterozoic rocks during weathering process. This may also points towards the presence of carbonatite type REEs mineral deposit within these rocks. primitive magmas that were S-undersaturated which were emplaced in the magma chamber. Economic significance of these intrusions has been demonstrated by a study, which compares S concentrations with incompatible elements that provide an

Figure 5 shows TMI image of the project area where Palaeoproterozoic lithologies are characterised by pronounced magnetic ridges. These probably represent mafic gneiss, granulite and amphibolite which could have a variety of mineralisation.

Granite plutons present within the gneiss complexes are important for exploration point of view. Geochemistry of these plutons suggest that they are fractionated to some degree and that could lead development of hydrothermal system responsible for porphyry copper- gold mineralisation. It is suggested that these granites should be evaluated for mineralisation.

In the past, a number of exploration programs have targeted igneous, metamorphic and sedimentary rocks for uranium mineralisation. These programs met with little success, but never the less, they have highlighted uranium potential of the project area by identifying various radioactive anomalies in the area. In central Australia, a wide variety of uranium mineralisation has been discovered (Lally and Bajwah, 2006). Uranium image (Figure 6) of EL 25794 shows enhanced level of radioactive area, including recent sediments. Project area requires a thorough investigation for the presence of uranium mineralisation.

## **7.0 Proposed Exploration Activity**

Discovery of REEs mineralisation has provided encouragement to explore the project area with a dedicated exploration program. In addition, geological and geophysical review also indicated potential of the project area for Au, Cu, Ni and Co. In the next reporting year, further sampling of stream sediments will take place which will be assayed for REEs mineralisation. This program will lead to target selections for further perusal and will ultimately lead to RC/RAB drilling.

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