RELINQUISHMENT REPORT ON EXPLORATION ACTIVITIES FOR AREA CEASED 11 AUGUST 2013, EL 28498 (FREELING).

By

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REPORTING DETAILS

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<td>Rare Earth Elements</td>
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SUMMARY

EL 28498 (Freeling) is part of Arafura’s Aileron-Reynolds project area. Arafura Resources holds the non-uranium rights and NuPower Resources (now Central Australian Phosphate Limited) hold the uranium rights to EL 28498. The tenement predominantly lies within the Aileron Province of the Arunta Region and is situated on the Napperby and Alcoota 1:250,000 map sheets. The northern parts of EL 28498 extend into the Tertiary Ti-Tree Basin.

The Aileron-Reynolds project area is centred on the Nolans Bore REE-P-U deposit and Arafura’s exploration activities are predominantly focussed on identifying additional REE resources within the Proterozoic basement rocks of the Aileron Region. Most of the tenement is either outcropping basement rocks or basement rocks with shallow transported cover overlying them. Interpretations indicate a greater thickness of Tertiary-Recent sediments in the northern part of EL 28498 which corresponds to the relinquished area and is the subject of this report.

NuPower Resources acquired regional-scale airborne EM (Tempest) survey data over a large area flanking the Aileron-Reynolds project area in 2007-08 to aid uranium exploration of the region’s Tertiary Basins. These AEM surveys were used to interpret basin geometries and to target exploration drilling. NuPower’s AEM survey covered the relinquished parts of EL 28498 but no drilling was conducted within this area.

No on-ground exploration activities were conducted by Arafura Resources within the relinquished area. The multi-tenement Aileron East airborne magnetic and radiometric survey which was acquired by Arafura in early 2013 just encroaches on to the southern part of the relinquished area. In 2013, Arafura Resources modelled the depth to magnetic basement across the project area using its detailed airborne magnetic survey data. Arafura also reviewed and reprocessed NuPower’s open file AEM data across the greater project area, using new processing algorithms and a revised 5 Layered Earth Inversion (LEI) model. These combined geophysical interpretations plus Nupower’s nearby exploration/stratigraphic drilling indicate there is a substantial thickness of Tertiary sediments within the relinquished areas. Consequently these areas were deemed to be of low exploration interest and the area relinquished.
INTRODUCTION

BACKGROUND

The known mineral occurrences in the Proterozoic rocks of the Aileron-Reynolds Range area include REE, U, Au, As, Sb, Ag, Fe, Sn, Ta, W, Mo, Cu, Pb, Zn, Ni, P, Th and talc. Of these, Arafura Resources is principally interested in exploring for REE mineralisation to complement the Nolans Bore deposit [total resource of 47Mt @ 2.6% REO, 11% P₂O₅ and 0.41 lb/t U₃O₈ (ASX:ARU 8th June 2012)] within the project area.

Arafura’s JV partner, NuPower Resources (now Central Australian Phosphate) also explored the region for uranium mineralisation. The uranium content of the Proterozoic basement rocks in the Aileron-Reynolds Region are significantly elevated compared to average crust and this region is prominent and anomalous on Territory-wide radiometric images. Hence this region was identified as a promising uranium source for sediment-hosted uranium deposits and the potential of the Tertiary Basins that overlie and flank the Proterozoic basement rocks was deemed worthy of significant exploration effort. The presence of lignite and carbonaceous units within the basin stratigraphy was also seen as a positive factor.

LOCATION AND ACCESS

The nearest area of occupation is the Aileron Roadhouse and the adjacent homestead for Aileron Station (beef cattle). These are located together on the Stuart Highway, 13 kilometres east-southeast of Nolans Bore and 133 kilometres along the Highway from Alice Springs (Figure 1). The area remaining as EL 28498 and the relinquished parts are shown on Figure 2.

About two-thirds of Aileron-Reynolds project area is located on Aileron Station. A substantial part of project area extends on to Pine Hill Station, and a small amount on to Napperby Station, in the north and northwest, respectively. The Stuart Highway and the three well-formed gravel/dirt public access routes pass through the project area. Access to most of areas within the tenements can be achieved by local station tracks and fence lines or by 4WD drive across relatively open country. Access is also available by permit along the NT Gas corridor which passes through the project area. There is limited vehicular access to areas within the ranges or within the dense Mulga stands on the open plains.

The Nolans Bore REE-P-U deposit is located in the Reynolds Range, 135 kilometres north-northwest of Alice Springs and 1,160 kilometres south-southeast of Darwin in the Northern Territory of Australia. The prospect is centred on Nolans Bore which is positioned at 133° 14' 24" E longitude, 22° 34' 54" S latitude (MGA94).

CLIMATE AND VEGETATION

This description is drawn from Stewart (1982) and Thevissen (1995).

The climate is characterised by long hot summers when temperatures regularly exceed 40°C, and short mild winters. The average rainfall is about 280 mm, most of which falls between October and March, but both frequency and amount are erratic. (Stewart, 1982)

Vegetation is predominantly Mulga (Acacia aneura) scrub (3-5 metres) in rocky areas but very dense Mulga in areas of sand plain making vehicular access difficult. Major drainages contain good stands of Bloodwood eucalypts (4-8 metres) and lesser Beantree. The south slope of most rocky ridges have characteristic stands of native Pines, although the main ranges are largely devoid of significant vegetation with only small species of Hakea and Melaleuca (2-4 metres) (Thevissen, 1995).
The variability of the rainfall in the region is demonstrated by the fact that 350 millimetres fell in the Aileron area in the 2-3 week period in February, 2000, immediately following the completion of the costeaning programme, and heavy falls of rain were recorded both in early April and also in early May, 2004, on either side of the drilling program. In 2005 drilling activities were interrupted by heavy rain in mid-June (60 millimetres) and early-July (90 millimetres) and rehabilitation activities were delayed by very heavy rain in mid-October (125 millimetres). In contrast to 2007-2008, the 2009-2012 period was well above average annual rainfall.

TOPOGRAPHY

The Reynolds Range is a relatively narrow (5-10 kilometre wide, 90 kilometres long), WNW trending belt of steep hills and mountains, and deeply incised drainages which flatten rapidly to both the north and south. The highest peaks in the range reach over 1000 metres above sea level (eg. Mt Freeling, 1005 metres; Mt Thomas, 1116 metres) whereas the adjacent lowlands, such as occurs around Nolan’s Bore, are at about 650 metres above sea level. Mount Boothby to the east of Nolan’s Bore is 866 metres.

The Nolan’s Bore prospect is situated on a flat plain area which straddles Kerosene Camp Creek to the west, north, south and northeast of Nolan’s Bore. The Nolan’s Bore cattle yards cover the eastern portion of the deposit. A wide expanse of alluvial sand and silt and calcrete separates the fluorapatite outcrops around the Bore and in the associated holding yards from those adjacent to Kerosene Camp Creek 500 metres to the NW and 800 metres to the SW of the Bore.

The southern part of the project area is relatively flat and gently slopes to the south with the Hann Range forming a prominent east-west strike ridge through the northern part of EL 27337. The northeastern part of the project area is a gently sloping sand plain.

LOGISTICS

Alice Springs (pop. 27,000) is serviced daily by jet aircraft from several Australian capital cities. Because of its location mid-way between Adelaide in South Australia and Darwin the town is also well serviced by road transport and interstate bus services.

A standard gauge railway line joins Alice Springs to Port Augusta and Adelaide to the south and Darwin in the north. The line to Darwin passes approximately 60 kilometres east of Nolan’s Bore. An existing natural gas pipeline from the Amadeus Basin (west of Alice Springs) to Darwin passes 5 kilometres east of the prospect.

A small community of Aborigines resides a few kilometres south of the Aileron Roadhouse (Alyuen Aboriginal Corporation, Figure 1). A larger community resides at Ti Tree Town Area, 59 kilometres north of Aileron. Ti Tree also hosts a medical centre, school and police station.
Figure 1: Location of Aileron-Reynolds project area tenements and the Nolans Bore REE-P-U Deposit, Aileron Region, NT.
Figure 2: Location of EL 28498 (Freeling) highlighting the relinquished area.
TENURE

In Year 3, commencing 12/8/2013, EL 28498 was partially reduced from 158 to 144 blocks.

Exploration Licences 27337, 28473 and 28498 were approved for group reporting, GR 261/12, by NT Department of Mines and Energy on 5 October 2012. The Aileron-Reynolds project has amalgamated technical reporting status but each exploration title remains a separate entity under the Minerals Titles Act. In order to synchronise and align the current technical and expenditure reporting a revised reporting schedule has been accepted.

- EL 27337 – Year 3: 11/01/2012 to 04/10/2012
- EL 28473 – Year 1: 05/10/2011 to 04/10/2012
- EL 28498 – Year 1: 12/08/2011 to 04/10/2012

The statutory timeframes and anniversary dates remain unchanged for the individual licences in this group for matters such as:
- payment of rent
- reductions of licence area
- relinquishment reports

Exploration Licence 27337 (Sheppard) was granted 100% to Arafura Resources Limited (ACN 080 933 455) as 81 blocks on 11 January 2010 for a period of six years, expiring on 10 January 2016. A waiver of reduction was sort and approved in 2012, and the title remains at 81 blocks for years 3 and 4.

EL 28473 (Boothby) and EL 28498 (Freeling) were granted to Arafura Resources Limited (ACN 080 933 455) as 99 and 158 blocks, respectively. The partial surrender of SEL 23671 and subsequent obtainment of EL 28498 was the result of an exercise agreed between Arafura and the then Department of Resources in order to eliminate a slither of ground left vacant as a result of the GDA datum shift in 2000. EL 28498 was granted on 12 August 2011 for a period of six years. Also in November 2010, Arafura lodged an application for EL 28473, covering that part of SEL 23671 (and part of EL 23571) not occupied by EL 28498, in order to extend the exploration lifespan of these areas. EL 28473 includes the Nolans Bore REE deposit, and was granted to Arafura on 5 October 2011 for a period of 4 years. This triggered the cancellation of the two underlying titles (EL 23571 and SEL23671). NuPower Resources had uranium rights to the previous titles.

The NT Department of Mines and Energy may allow exploration titles to be added or removed from the project area but depending on grant dates, bridging reports may be requested.

Background land tenure to EL 27337, EL 28473 and EL 28498 is several pastoral leases (Figure 1). The Nolans Bore prospect lies within Perpetual Pastoral Lease (PPL) 1097 “Aileron” held by Waite River Holdings Pty Ltd.

Arafura Resources has negotiated and executed an Exploration Agreement with the Central Land Council (on behalf of registered Native Title Claimants). SEL 23671 and EL 23571 were subject to this agreement, where there were no Native Title impediments to continued exploration other than holding appropriate consultations, avoiding activity on identified sacred sites and paying agreed amounts of financial compensation. The superseding titles are in the process of being brought into this agreement via an annexure.
Arafura’s historic tenure in the project area

Exploration title over the Nolans Bore prospect was previously held under Substitute Exploration Licence 23671 (Aileron) which was relinquished to 113 graticular blocks (approximately 357 square kilometres) on 5 October 2011. This licence, originally of 500 blocks was granted to Arafura Resources NL (ACN 009 627 132) on 8 December 2003 for a period of 4 years in substitution of existing licences EL 9762 and EL 22384.

The licence was subject to a 50% reduction at the end of each year of its term and was reduced to 250 blocks in December 2004. The proposed reductions for December 2005, December 2006, December 2007 and December 2008 were waived.

A renewal for a 2 year period was applied for in 2009 and granted with a new expiry date of 7 December 2011. A reduction in this area was not required during the renewal period; however in November 2010, SEL 23671 was reduced to 113 blocks. The area surrendered from SEL 23671 is now covered by EL 28498, which was granted to Arafura Resources Ltd on 12 August 2011.
GEOLOGY

REGIONAL SETTING

The regional geology of the project area is illustrated in Figure 3. Geological details in this diagram are drawn from digital copies of the Napperby (SF 53-9) and Alcotta (SF 53-10) 1:250,000 Geological Series published by the Bureau of Mineral Resources, BMR (now Geoscience Australia). Lithological units and labelling is derived from the published maps and the reader is referred to the published map legends and explanatory notes for additional details. The Reynolds Range Region 1:100,000 Geology Map is also available and is again published by the BMR.

Nolans Bore is located in the eastern Reynolds Range. According to the web-site of the NT Geological Survey (December, 2004) basement rocks in this range comprise part of:

“... the Arunta Region, a complex basement inlier in central Australia that has undergone a prolonged history of sedimentation, magmatism and tectonism extending from the Palaeoproterozoic to the Palaeozoic. The Arunta Region can be subdivided into the three, largely fault bounded terranes with distinct geological histories: the Aileron, Warumpi and Irindina Provinces.

The Aileron Province comprises greenschist to granulite facies metamorphic rocks with protolith ages in the range 1865-1710 Ma. It forms part of the North Australian Craton and is geologically continuous with the gold-bearing Tanami and Tennant Regions to the north.

In contrast, the Warumpi Province comprises amphibolite to granulite facies rocks with protolith ages in the range 1690-1600 Ma, and is interpreted to be an exotic terrane that accreted to the southern margin of the North Australian Craton at 1640 Ma.

The Irindina Province in the Harts Range region comprises Neoproterozoic to Cambrian metasediments that formed in a major depocentre within the Centralian Superbasin. It underwent high-grade metamorphism and deformation during Ordovician (480 - 450 Ma)

Palaeoproterozoic metamorphic rocks and intrusive granites in the Reynolds Range belong to the Aileron Province. In Figure 3 these units are differentiated only in the broadest sense with the metasedimentary units coloured light brown, quartzites are bright yellow, and the granites and granitic gneisses coloured in various shades of pinks and red. Distinct marble and calc-silicate rich units are coloured bright light blue.

Because of the high grade of metamorphism which has affected the basement rocks and the relative paucity of continuous outcrop and geological constraints across the Arunta Province, a reliable stratigraphy has not yet been constructed for the metasedimentary sequences. Instead, the Northern Territory Geological Survey recently proposed a series of temporal metasedimentary packages and number of discrete tectonothermal events to assist with the development of a regional stratigraphic framework in the Arunta Region (Scrimgeour, 2003). While the details are yet to be fully resolved, ongoing U-Pb dating of representative rocks suggests most of the mapped metasedimentary units in the Nolans’s Bore area can be assigned to either the 1865-1820 Ma Lander package or the ~1780 Ma Reynolds package (e.g. Claoué-Long et al., 2008). There is also a possibility that some metasedimentary units in the Nolans Bore area could be related to the 1810-1790 Ma Ongeva package (cf. Claoué-Long et al., 2008) but this is yet to be fully resolved as it probably requires substantial remapping and the subdivision of the existing geological map units.

The Lander Rock beds (Pll) which crop out in the vicinity of Nolans Bore, and the Aileron Metamorphics (Pna) to the southeast of Nolans Bore, are currently included as part of the Lander package. The Mount Thomas Quartzite (Prt), Pine Hill Formation (Prp/r) and Woodforde River beds (Po) unconformably overlie the Lander package and were all originally mapped as Reynolds Range Group, and is the type area for Reynolds package. The Wickstead Creek beds (Pl), and the Mt Freeling (Pf) and Mt Dunkin (Pd) Schists have also been included in the Reynolds package.
According to published maps (Figure 3), the Lander Rock beds include schist, phyllite, andalusite hornfels, garnet-cordierite-biotite-quartz granofels, sillimanite-biotite-cordierite-orthoclase granofels, tourmaline metaquartzite and tourmaline-quartz pods. These units are variably migmatitic and have been metamorphosed to amphibolite and granulite facies at Nolans Bore (Hussey, 2008).

The metamorphic rocks in the Nolans Bore area are extensively intruded by igneous suites related to the 1810-1800 Ma Stafford and 1780-1770 Ma Yambah Events, both of which are dominated by large bodies of fractionated granitoids. Igneous rocks related to the Stafford Event crop out almost continuously for about 100 kilometres between the Reynolds and Anmatjira Ranges. Granitic rocks (Pg) which intrude the Lander Rock beds include the Granites (Pg) which transgress all field relationships (Collins et al. (1995)).

Hussey (2008) indicates that all of the above units were metamorphosed to granulite facies at 1560-1600 Ma in what has been termed the Chewings Event. The Chewings Event was relatively strain-free producing variable amounts of fine- to coarse-grained leucocratic melts in most country rocks, annealing earlier structural fabrics and overprinting the localised contact metamorphic effects of the Stafford- and Yambah-aged intrusions.

Dykes and irregular masses of very coarse grained pegmatite intrude the above units and transgress all observed metamorphic foliations. According to Hussey (2008) similar moderate- to very coarse-grained pegmatitic units occur throughout the Anmatjira-Reynolds Range region and he adds that:

Collins et al. (1995) report Rb-Sr muscovite ages of 1401-1619 Ma from a number of pegmatites in the Anmatjira-Reynolds Range region. They found that half of these muscovite samples gave Rb-Sr ages clustering around 1500 Ma (1540-1490 Ma). These ages are consistent with field relationships indicating that the pegmatites post-date high-grade metamorphism and the pervasive regional tectonic fabric in this region. The younger muscovite ages are attributed to subsequent deformation and partial resetting of the Rb-Sr system, probably during the Alice Springs Orogeny. The oldest two Rb-Sr muscovite ages (1619 and 1608 Ma) reported by Collins et al (1995) are clear outliers. They occur within or adjacent to the Napperby Gneiss to the west of Nolan’s Bore and may be related to this gneiss and suggest that a number of pegmatite suites may occur.

To the south of Reynolds Range the Arunta Inlier is stratigraphically unconformably overlain, though, because of thrusting, structurally underlain by Neoproterozoic and early Palaeozoic sediments (Pav, Pat) of the Ngalia Basin.

As can be seen in Figure 3, unconsolidated Quaternary red soils, alluvial sands and gravels and aeolian sand, (Qr, Qa, Qt) along with minor Quaternary calcrete (Qc), blanket much of the lower lying areas along the northern and southern margins of the Reynolds Range including the area of the Kerosene Camp Creek drainage basin immediately surrounding the Nolan’s Bore prospect. Tertiary saprolite (Tla) and ferricrete (Tlf) is also developed in some parts of the range.

Structurally, the Reynolds Range has been affected by several orogenies. The area is now dominated by numerous major west-northwest trending faults and shear zones (some up to several hundred metres wide) which parallel the regional fabric evident in imagery produced from aeromagnetic data. There have been suggestions that the Reynolds Range occupies a position on a trans-continental basement shear zone which includes the Granites-Tanami Shear further to the west (Stewart, 1997). It may also form part of the Woolanga Lineament, a major west-northwest trending gravity structure commented on by Black and Gulson (1978).
At a local scale the metasediments and metavolcanics have been intensely folded, which, in conjunction with the effects of faulting and granite intrusion and lack of detailed local mapping, results in relatively complicated litho-distributions on existing published geological maps (Figure 3).

Recent investigations suggest that the major west-northwest trending shear zones in the south-eastern Reynolds Range date from the 400-300 Ma Alice Springs Orogeny and not from the ca. 1.6 Ga regional metamorphic event (Cartwright, et al., 1999).

In regard to the regional shear zones Hussey (2008) comments:

All units in the vicinity of Nolan’s Bore are truncated by localised retrogressive high-strain zones. These high-strain zones are part of the mapped east-west or northwest-southeast trending mylonite zones in NAPPERBY (cf Stewart et al., 1981). These high-strain zones are usually steeply dipping to the northeast or subvertical and commonly have down-dip lineations with a north over south (reverse) sense of movement. Micas from a mylonitised (retrogressed) granitic gneiss to the northwest of Nolan’s Bore in Sandy Creek have been recently dated at 334 Ma by Ar-Ar step-heating methods (Cartwright et al., 1999). Micas from the Aileron gold prospect, in a mylonite zone several kilometres to the southeast give a similar Ar-Ar plateau age of 327 ± 3 Ma (Wygralak, pers comm. 2005). Both of these ages are consistent with localised high-strain deformation in the Alice Springs Orogeny

In an attempt to better constrain the timing of mylonitisation at Nolans Bore, Fraser et al., (2010) separated micas from two adjacent drill core samples and dated them using the 40Ar/39Ar step-heating method. They found that muscovite grew only in the mylonite band at ~345 Ma and its growth occurred below ~300°C. The muscovite age of ~345 Ma is, therefore, interpreted as the best estimate for the timing of mylonitic deformation at Nolans Bore which is broadly consistent with the other localised high-strain zones noted above and attributed to the Alice Springs Orogeny. The age of the pre-mineralisation mylonite about one kilometres to the west of Nolan’s Bore has not yet been determined however recent mapping by Dr Martin Hand (University of Adelaide; pers. comm. 2010) indicates there are a number of post-Chewings Event mylonite zones in the Boothby hills that are cut by later Alice Springs aged mylonite zones, consistent with the observations around Nolan’s Bore. Drill core relationships suggest there are additional pre-mineralisation mylonites at Nolans Bore as well as the late overprinting mylonites.

The ~345 Ma age of some mylonite development at Nolans Bore is significantly younger than the best estimate for the age of the primary mineralisation at Nolans Bore. Unweathered uraniferous fluorapatite separates produced a well-defined upper intercept U-Pb age of 1244 ± 10 Ma age (Maas et al., 2009).

Cainozoic Regional Geology

The southern NT forms a ‘basin and range’ province with Proterozoic and Palaeozoic rocks forming prominent ranges separated by broad valleys. Cainozoic sedimentary basins are widespread and well-developed within these intervening topographic depressions with at least twenty major basins known (Senior et al., 1995). The Woodforde tenement covers portions of the eastern half of the Ti-Tree Basin (Figure ).

The stratigraphy of the intermontane Cainozoic basins of the southern NT region is generally poorly known. This is attributed to a lack of outcrop, strong weathering overprints, the paucity of drillholes and a lack of attention paid to the ‘cover’ overlying crystalline basement. Knowledge of the distribution and extent of the Cainozoic has been largely gained through accidental intersections in water bores or in drillholes seeking mineralisation under cover.

Water bores throughout the Alice Springs region provide only limited stratigraphic information on the upper parts of the Cainozoic as they rarely exceed 100m in depth and are typically <50m deep. Limited
stratigraphic drilling was undertaken in the southern NT region by both the BMR (now Geoscience Australia) and the NTGS during the 1960’s and 1970’s. These programs were summarised in Senior et al., (1994) from which a single paper (Senior et al., 1995) was published. These sources provide almost all of the stratigraphic information on the Cainozoic Basins.

Historical exploration drillholes in the vicinity of the Woodforde tenement are shown in Error! Reference source not found.. In 1972, CRA Exploration completed a traverse of six drillholes in the western part of the Ti-Tree Basin, one of which (TT6) was located on Woodforde (EL24741). CRA’s work indicated that, in places, the Ti-Tree Basin is in excess of 300m deep. In 1983, BHP also drilled a single hole (OG1) to investigate an anomaly in the Proterozoic basement rocks and drilled through 94m of Tertiary sediments before intersecting crystalline basement. OG1 is situated just to the north of relinquished area.

During the late 1970’s and early 1980’s the relatively small Hale Basin (Figure ) was explored extensively for coal (lignite) and sedimentary uranium and can therefore be considered to be the best known Cainozoic basin in the NT. The stratigraphy of the Hale Basin is summarised in Figure and although the succession in the Hale Basin is relatively thin (<100m), it can considered to represent a generalised Tertiary stratigraphy for the southern NT. These Hale Basin stratigraphic names and units were used by NuPower for all Tertiary Basins but are more correctly stratigraphic equivalents when found in the nearby Basins.

Based upon drilling in the Hale Basin, Senior et al. (1994) defined a broad two-fold stratigraphic subdivision that corresponds well with the observed pattern of Cainozoic sedimentation elsewhere in southern Australia. It comprises a restricted, fluvial palaeochannel dominated Palaeogene succession (Hale Formation) overlain by a more widespread, dominantly lacustrine Neogene succession (Waite Formation). An additional stratigraphic unit, the Napperby Formation (Higgins, 2009) has since been recognised as overlying the Waite Formation and represents the development of prograding alluvial fans shed from the ranges flanking the Cainozoic Basins.

Strong affinities with Eocene palaeochannel sediments in southern Australia (Higgins, 2009) suggest that the Hale Formation should be further subdivided into a Upper subdivision (Late Eocene), comprising the Tug Sandstone Member and representing development of a widespread ‘sand sheet’; and a Lower subdivision (Early-Middle Eocene) recording a fining upwards trend from the fluvial Ambalindum Sandstone Member to the paludal Claraville Mudstone and Ulgnamba Lignite Members.

Whilst Senior et al.’s (1994) Cainozoic stratigraphic units were initially defined in separate, small and isolated Tertiary Basins, these units are now recognised as components of a much larger Tertiary palaeodrainage system, the extent and size of which has until now been vastly underappreciated (Higgins, 2009).

Both historic and recent drilling results indicate that the apparently isolated Tertiary Basins contain very thick sedimentary packages. The Cainozoic fill of the Burt Basin exceeds 200m and the Sixteen-Mile Basin contains at least 180m of sediment. Similarly, the Whitcherry Basin and Waite Basins are known to exceed 250m in thickness in some locations, whilst minor tributaries feeding the Ti-Tree basin contain up to 140m of sediments. The maximum thickness of the Cainozoic sediments in the Ti-Tree Basin is not currently known as exploration drillholes to date in the centre of the basin, after drilling through a minimum of 320m of sediment, have failed to penetrate to basement.
Figure 3: Regional Geology
Figure 4 - Tertiary Basins in The Woodforde – Alice Springs Area.
Figure 5 - Hale Basin Composite Stratigraphic Column (Senior et al., 1994).
Deposition and Weathering

Deposition of Cainozoic sediments was episodic and punctuated by hiatuses during which prolonged periods of weathering resulted in the formation of well-developed weathered profiles (palaeosols and duricrusts). Deep weathering was an ongoing process during the Tertiary but was enhanced at particular times during the time by the combination of periods of warm, humid climates, non-deposition and surface exposure. Senior et al. (1995) defined three Palaeogene weathering events which affected Arunta igneous and metamorphic basement rocks and the overlying Tertiary succession. An additional two weathering events have been recognised from the overlying Neogene succession and appear to correlate with similar periods of weathering and exposure evident in southern Australia.

Weathering Event A (Senior et al. 1994, 1995) occurred during the Late Cretaceous to Early Tertiary (Palaeocene). Trizonal weathering profiles were developed in basement rocks over a widespread area of the Arunta Region and at the base of surrounding Tertiary basins. The trizonal profile consists of a basal kaolinitic zone (up to 10 meters thick) that grades into a multicoloured mottled zone (up to 10 meters thick) and is then capped by a ferruginous or (laterite/ferricrete) zone up to 8 meters thick.

Following uplift and partial truncation of the deeply weathered basement rocks, sedimentation in the surrounding Tertiary basins began in the Palaeocene with deposition of thick colluvium including fanglomerates flanking the ranges. This was followed by deposition of fluvo-lacustrine sand, silt and clay (locally carbonaceous) and lignite of the Lower Hale Formation in the Ti-Tree and Burt Basins during the Early to Middle Eocene. Locally this includes a basal lacustrine green and grey pyritic mudstone, white mudstone and siltstone, and red iron oxide stained siltstone and siltstone. Fluvial sands of the Ambalindum Sandstone Member fine upwards into the paludal Claraville Mudstone and Ulgnamba Lignite Members.

Weathering Event B, recorded in the Hale Basin, occurred prior to the Middle Eocene, although there is little evidence elsewhere for this weathering event (Senior et al., 1995). This resulted in lithification and formation of a second ferricrete profile.

Deposition of sandstones of the Upper Hale Formation took place during the Late Eocene and these sediments were subsequently overprinted by Weathering Event C marking widespread exposure and surficial weathering in response to a prolonged period of non-deposition during the Oligocene.

Climatic amelioration during the Early Miocene rejuvenated the palaeodrainage systems and led to the deposition of fluvial sands at the base of the Waite Formation. A change from fluvial to lacustrine sedimentation then followed during the Middle to Late Miocene and resulted in the accumulation of over 300 meters of fluviatile and lacustrine limestone, sands, muds, and sandy conglomerate in localised depocentres.

The upper portions of the Waite Formation are regionally extensive and consist largely of clay and dolomitic clays that reflect the widespread development of broad, shallow evaporitic lakes throughout southern Australia as the continent drifted further northwards and became progressively more arid and seasonal. Two gradational upwards cycles from clays to dolomitic clays to dolomitic limestones (often capped by chalcedonic limestones and silcretes) are commonly observed, suggesting that deposition of the Waite Formation occurred in at least two phases. Weathering Event D was responsible for the formation of the inter-Waite Formation silcrete (possibly in the Middle Miocene).

Outcrops of the Waite Formation are frequently capped by calcritised limestones and distinctive chalcedonic silcretes that form regionally widespread stratigraphic markers. Development of these more variable duricrusts occurred in response to Weathering Event E.

In proximal locations, the Waite Formation interfingers with, and is conformably overlain by a moderately thick (<60m) succession of oxidised colluvial material shed off the Woodforde and Reynolds Ranges in response to neotectonism during the (?Late) Pliocene. This material can be recognised throughout the region and represents a broadly coarsening upwards alluvial fan which can be subdivided into an Upper, Middle and Lower Members. This unit is informally referred to as the Napperby Formation and comprises a succession of oxidised and haematitic, clayey sands, sandy
clays and minor conglomerates. Ferruginised, haematitic alluvial palaeosols (bearing a strong resemblance to modern soils) are a characteristic feature of the Middle Member with palaeosol development potentially corresponding to Weathering Event E (or recording another period of enhanced weathering).

Overlying these sediments are unconsolidated Quaternary sediments including quartz sands, silts, red earths and clayey and sandy soils that record a complex history of deposition, erosion and redeposition due to climate changes and gentle tilting. Large outwash fans from the northern side of the MacDonnell Ranges have formed alluvial plains and overbank deposits alongside sandy drainage channels. In more distal locations, the development of aeolian sand plains was widespread. The formation of calcretes, particularly within drainage channels and atop the Waite Formation, was widespread during the Quaternary (Weathering Event E).
PREVIOUS INVESTIGATIONS

REGIONAL

Pre-1994

Records of systematic exploration in the Reynolds Range date back as early as 1948 (Thevissen, 1995) but most investigations date from about 1965 (Stewart, 1982). Base metals, tin and tungsten were mainly targeted prior to 1973 when uranium exploration gathered momentum. This commodity dominated the exploration in the area for the next 15 years, both in the metamorphic and granitic rocks of Reynolds Range and also in the sandstones of the Ngalia Basin to the south. After 1990, with the advent of the BLEG geochemical technique more attention was directed towards gold exploration though some uranium exploration activity still persisted.

In 1973, CRAE conducted mapping of outcrops on EL 753 near Sheppard Bore (Hughes, 1973). Quartz-heamatite+/-pyrite veins were identified, however, the anomalous radioactivity is associated with the granitic gneiss, and not the veins. The reported U and Th contents are typically of granitic rocks in the area.

In 1979, minor phosphate inapatite-mica schist was reported from Quartz Hill, 17 kilometres northwest of Napperby Station towards the western end of the adjacent Yalyirimbi Range; and REEs (+20% REE) were reported from a small lens (2x0.5 metres) of garnet-monazite rock in biotite gneiss at Mt Finniss, 6 kilometres north of Pine Hill Station (Stewart, 1982).

CRA Exploration Pty Ltd EL752 (1972)

EL752 overlapped EL28498 and extended eastwards. Based on earlier work in the tenement area, six rotary cored holes were drilled at 5km intervals. The sediments intersected were not considered favourable for uranium deposition due to poor permeability, fine grain size and fair to good sorting. One hole, TT6, is within EL24741 and the other five are on a line bearing northeast at N42ºE from TT6. It was recognised that palaeochannels could exist and three seismic lines were run using the reflection method. The reflection seismic method appears to have successfully indicated basement topography and a subsurface valley structure has been indicated, but the tenement was subsequently relinquished in 1973.

BHP Minerals Ltd EL4188 (1983)

A combined aeromagnetic/radiometric survey was flown over the tenement in May 1983 and two gravity traverses were carried out. The resulting magnetic intensity contour map of the area revealed a “bull’s-eye” shaped anomaly, however, subsequent evaluation of the anomaly gave no significant values. One percussion hole, drilled 256m, passed through 94m of Tertiary sediments before intersecting crystalline basement. It was concluded that a unit within the Arunta Complex was the source of the anomaly and geochemical analyses of drill samples for base metals revealed no significant values.

Tidegate Pty Ltd, EL 8117, 1993-1994

EL 8177 covers the northeast corner of EL 27337 and extends on EL 28473 and 28498. Tidegate explored Native Gap (Ni, Cr), Harry’s yard amphibolites, Aileron shear zone and Aileron gold reefs (Fraser, 1994).

The Native Gap Ni-Cr prospect is located about 2.5km east of the Stuart Highway, approximately 20km south of Aileron. The prospect was discovered in the 1960’s and further explored by NTGS geologist Jim Morlock in 1973. Assays of rock chip samples collected by Morlock showed highly anomalous Ni and Cr values in a circular body of amphibolite (500m diameter) intruded by pegmatite (no gold assaying was done). Interpretation of AGSO (BMR) regional airborne magnetic data
speculates that the amphibolite is part of a large ultramafic intrusion on the southern side of the Hann Range. Tidegate collected nine loam BLEG samples, nine soil / sediment samples and five rock chip samples from the amphibolites and surrounding contacts. Gold values in BLEG ranged up to 1.05ppb Au with moderately anomalous Ni and Cr values. Tidegate dropped the ground after these disappointing results.

The Harry's Yard amphibolite body was found to be mainly sheared and altered meta-gabbro with possible komatite “Spinifex” textures, intruded by pegmatite and quartz veins on the perimeter. Nineteen loam BLEG, nineteen soil / sediment samples and three rock chip samples were collected on the intrusion, however, gold values were considered not to be anomalous and no further work was recommended.

The Aileron shear zone was discovered in 1939 and prospecting was abandoned in 1940 after the recovery of a single ounce from quartz-pyrite veins. Veins form lenticular bodies up to 30m long and 1.5m wide. McMahon Construction Pty Ltd and Lindsay Johannsen in 1990 briefly explored the prospect who sent a small consignment to Tennant Creek for processing (no data for gold grades or recovery). Tidegate collected four grab samples in January, 1994 from quartz vein and sheared granite with fresh sulphides, however, all gold results were below detection (0.008ppm Au) and no significant As, Ag or base metal values were detected (except Co, up to 104ppm). A reconnaissance BLEG loam and drainage survey was carried out along the shear zone westerly from Stuart Highway. Results were below level of interest in reasonably well-exposed country and the land was dropped.

**PNC Exploration (Australia) Pty Ltd, EL8411, 1994-1995**

PNC Exploration explored the Reynolds Range for Mary Kathleen-style uranium occurrences hosted by metasomatised calc-silicate gneiss under EL8411 in 1994 and 1995 (Thevissen, 1995). Using detailed airborne radiometrics, PNC located the Nolans Bore REE/P/U prospect and explored in some detail, three significant U prospects - at Mt Dunkin, 22 kilometres west-northwest of Nolans Bore; at Napperby Creek, 50 kilometres west-northwest of Nolans Bore; and at Mt Freeling, 15 kilometres west of Nolans Bore (Figure 1). They withdrew from the area in early 1996.

PNC also sampled a minor occurrence of ‘apatite’ (reportedly similar to the Nolans Bore apatite) hosted by orthogneiss at their MB05 anomaly, 7 kilometres north of Nolans Bore. The sample assayed 3.9% P, 1.9% Ba, 2.1% La, 4.6% Ce, and 1.8% Nd but only 1.0% Ca which suggests that monazite rather than apatite hosts the REE.

**Homestake Gold of Australia Limited, EL9672, 1996-1998**

Under a farm-in arrangement with McCleary Investments, Homestake explored EL9672 (which included much of the area relinquished from EL8411) for gold between 1996 and 1998. Their work comprised mainly regional BLEG stream sediment sampling with some limited geological reconnaissance to follow up one elevated gold value which was not replicated by later sampling. Results of Homestake’s programmes are detailed by Stewart (1997) and Lindsay-Park (1998).

**NTGS, Geophysical Surveys, 1997**

Detailed airborne magnetic and radiometric surveys were completed over the Reynolds Range area in 1997 as part of a more extensive survey which included all of the Napperby 1:250 000 Sheet area as well as the northern half of the adjacent Hermannsburg 1:250 000 Sheet to the south. All primary data and gridded data as well as some plotted products from this survey are available free of charge from the Northern Territory Geological Survey (NTGS). The survey over the Reynolds Range was flown at a line spacing of 400 metres and a mean terrain clearance of 60 metres. A total count radiometric anomaly over the Nolans Bore fluorapatite deposits is clearly evident in the data as is a discrete magnetic low over the western half of the deposit.
ARAFURA RESOURCES

Most of Arafura exploration activities within the Aileron-Reynolds project area have been focussed on the Nolan Bore deposit. Between 2005 and 2012, a number of regional exploration activities were also conducted. None of these on-ground regional exploration activities concentrated on the relinquished area.

In 2012 and 2013, processed SPOT5 imagery was acquired from Geoimage’s publically available catalogue to aid regional exploration and mapping activities. The combined satellite imagery covers Arafura’s entire project area and surrounds at 2.5m resolution. The imagery over the relinquished area is shown in Figure 6 below. Only cultural and vegetation features are evident within the relinquished area. This part of the tenement is an extensive sand plain with no visible outcrops.

In 2013, Arafura acquired a detailed, low-level airborne magnetic and radiometric geophysical survey over a number of tenements in the Aileron-Reynolds project area (EL 24741, EL 28473, EL 28498, and EL 29509). The Aileron East geophysical survey was a multi-tenement survey with a total of 8,915 line kilometres acquired. The specifications and details of this airborne survey are provided in Appendix 1. A total of about eight km² of this survey was over ground relinquished from EL 28498. A representative RTP magnetic image is shown in figure 7. The high frequency data in the southwest of the relinquished area on Figure 7 is part of the new Aileron East survey whilst the remainder is the regional NTGS data.

Southern Geoscience Consultants (SGC) modelled depths to magnetic features/basement over the entire Aileron-Reynolds project area using Arafura’s detailed aeromagnetic data. SGC’s report is attached as Appendix 2 and processed images showing depths to magnetic features using the Euler method over the relinquished areas are presented in Figures 8-10. A number of shallow depths are modelled in the southwestern most parts of the relinquished area. However, most of the modelled depths are greater than 50 metres. These data are more or less consistent with Arafura’s review of
NuPower’s AEM data and their nearby drilling which shows the depth to basement is significant (Figure 11).

Figure 7: RTP magnetic image of the relinquished area.

Figure 8: Thematic map showing modelled depths to Structural Index 0 (SI0); modelled depth ranges as follows: red 0-25m (none), orange 25-50m, yellow 50-75m, green 75-100m and blue greater than 100m.
Figure 9: Thematic map showing modelled depths to Structural Index 1 (SI1); modelled depth ranges as follows: red 0-25m (none), orange 25-50m (none), yellow 50-75m (none), green 75-100m and blue greater than 100m.

Figure 10: Thematic map showing modelled depths to Structural Index 0 (SI0); modelled depth ranges as follows: red 0-25m (none), orange 25-50m, yellow 50-75m, green 75-100m and blue greater than 100m.
Figure 11: Regional geology with the modelled depth to base of AEM conductor (blue is deeper) and actual logged depth to basement based on NuPower’s drill holes. The blue hues modelled from this AEM survey are therefore indicative of substantial thickness of Tertiary Basin sediments. Note shallow conductor depths have been masked out. This highlights the basin and associated channels.
The abundance of shallow Euler solutions, particularly in figures 8 and 10 appear to be at odds with the processed AEM data which suggests the Basin is slightly deeper in some areas.

It has therefore been interpreted that the AEM modelling is more reliable and the relinquished area has a relatively thick accumulation of Ti-Basin sediments overlying the prospective Proterozoic basement rocks. This is largely based on the hard data based on nearby drilling.

RECOMMENDATIONS

The remainder of EL 28498 is considered more prospective largely because it is mostly outcrop or subcrop with shallow cover. In relative terms, the relinquished area is therefore considered too deep to systematically explore at this stage of the project.
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