Geophysics and Drilling Collaborations
Final Report - Drilling

‘Bringing Forward Discovery’

Collaborations Application
Round 7

Spectrum Rare Earths Ltd.
ABN# 94 115 770 226
ASX: (SPX)

Confidential Commercial Information:
Final Report for Drilling Collaborations

Skyfall Prospect ‘Targeting a new type of Rare Earth Deposit’
EL27151

Diamond Drilling Final Report

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November 2014
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1 SUMMARY

1.1 Objective
The purpose of the proposed collaborations diamond drill program is to:

- Test for a deep seated magmatic body and primary mineralisation source associated with known rare earth anomaly at Skyfall.
- Test Spectrum’s structural model at Skyfall – the uplift of Lower-Proterozoic basement rocks through the younger sequence (Mid-Proterozoic, Cambrian and Cretaceous) by a positive flower structure associated with the Dorisvale Fault.
- Understand the full stratigraphic sequence from cover to basement rocks including unconformable surfaces and their potential influence for mineralisation across the District.
- To gain a better knowledge of rare earth mineralogy and concentration processes to apply across the Skyfall Rare Earth District through analysis of quality samples.

1.2 Commencement and completion dates
Spectrum started to planned the drilling of this hole in May 2014 however the drilling started in September 2014 and was completed by the end of this same month. Half core samples on zones of interest were sent for analysis and results were received in November 2014.

1.3 Program Overview
The program included the drilling of one 306m HQ/NQ stratigraphic diamond hole. The orientated core was subject to normal assay of mineralised zones with mineralogical test work planned on zones of interest.

1.4 Main Results and Conclusions
SKDH05 failed to intersect any significant rare earth numbers expect for the already known flat lying surface mineralisation. SKDH05 did not intersect the magmatic body interpreted to be the source of the rare earth mineralisation. Cover sequence above the Carpentarian seems to be thicker than what Spectrum expected.

SKDH05 provided Spectrum with new information on the regional stratigraphy and unit thicknesses. Spectrum observed the presence of crude oil trapped in Antrim Plateau basalt’s vesicles and fractures.

Scanning electron microscopy analysis of the deeper flat lying rock showed the presence of sedimentary/detrital monazites. However, in the zone at 297m evidence of secondary mobilisation by basinal brines within the rocks exists.

Spectrum hypothesises that the more economically important types of rare earth minerals such as those found in the Skyfall surface mineralised zone (xenotime and crandallite group minerals) or at Stromberg (xenotime), are formed where these primary zones hit the surface and weather. Some secondary mobilisation and concentration mechanisms are active within the basin particularly around fault zones.
2 INTRODUCTION

2.1 Location
EL27151 (Skyfall Prospect) is located approximately 93km South-West of Pine Creek, Northern Territory on the Fergusson River (SD 52-12) 1:250,000 and Jinduckin 1:100,000 topographic map sheets.

2.2 Topography
Surface land types in and around the prospect consist mainly of plateaus, cliff faces, alluvial floodplains, with open grassland or woodland. Other land types include gentle, undulating crests and slopes as well as flat or gently undulating areas. Rainforest exists in areas surrounding the creeks. The Prospect location and topography is illustrated in Figure 1.

![Figure 1: Topography over the Skyfall Prospect.](image)

2.3 Access Infrastructure
Access to EL27151 from Darwin is via the Stuart Highway onto Dorat Road to Oolloo Crossing, and then a track to Fish River transects the northern and western portion of the Licence, Figure 2.
Alternate access is from Tipperary Station along the Fisher Tracks to Beeboom Crossing and onto Indigenous Land Corporation (ILC) land, Figure 2.
Spectrum has established good communication with both the ILC and the Tipperary land owners and has contributed for the tracks used over a 7 year period. The road between Oolloo Crossing and Skyfall is a Government gazetted road therefore no access permission is required on this route.
At a work program meeting, held on 17/09/2013, the Northern Land Corporation (NLC) and Traditional Aboriginal Land Owners gave Spectrum permission to use the roads within non-consent areas depicted on Figure 1 as EL30***.
Figure 2: Project Area and Prospect Location with Underlying Cadastre– EL27151 (Skyfall) (coordinates in GDA94 z52)
2.4 Basic Tenement Details

Full access to the Skyfall Tenement (EL27151) was granted to Spectrum on 8/11/2013 after due processes. (Table 1).

Table 1: Spectrum Tenement Details

<table>
<thead>
<tr>
<th>Tenement</th>
<th>Owner</th>
<th>Grant Date</th>
<th>Expiry Date</th>
<th>Blocks</th>
<th>Area (Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL27151</td>
<td>Spectrum Rare Earths Limited (100%)</td>
<td>8/11/2013</td>
<td>7/11/2019</td>
<td>148</td>
<td>404.61</td>
</tr>
</tbody>
</table>

2.5 Land Owner Consultation - Cadastre

At Skyfall (EL27151) the underlying cadastre is Aboriginal Freehold Land and is owned by the Upper Daly River Land Trust under the care of the Wagaman People. There are also Pastoral lease holders within the Aboriginal Freehold Land, detailed in Table 2 below.

Spectrum has established an Aboriginal Land Use Agreement with the Land Trust through the NLC. A Mine Management Plan (MMP 0773-01) was approved on 15/11/2013 (Appendix A). A work program was approved for the MMP area by the Traditional Land Owners on 17/09/2013. Pastoral Lease holders are made aware of spectrum’s activities and work, on an ongoing basis, as programs develop. No formal agreements are required with the Pastoralists.

Spectrum has worked with the Wagaman People on the adjoining tenement EL25222 at its Stromberg Rare Earth Prospect since 2008 and a strong working relationship exists. Spectrum has recently interviewed a number of the Wagaman community for field assistant positions and one person has been selected for a job offer which is expected to be made in mid-May 2014.

Spectrum has contacted the appropriate land owners prior to any work commencing as per Spectrum’s land owner consultation procedure.

The underlying cadastre and land ownership details for Spectrum’s Skyfall Tenement are outlined Figure 2 and Table 2.

Table 2: Land Owners Details

<table>
<thead>
<tr>
<th>Land Owner</th>
<th>Location Address</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Daly Aboriginal Land Trust</td>
<td>Northern Land Council, P.O. Box 42921, Casuarina NT 0811</td>
<td>Via the NLC</td>
</tr>
<tr>
<td>NT Portion: 4059</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lease Holders in EL27151:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tony Harrower</td>
<td>Dorisvale Station</td>
<td>89767007 (Pell Airstrip)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8975 4735 (Dorisvale)</td>
</tr>
<tr>
<td>Alan Fisher</td>
<td>Wombunji Station</td>
<td>0889 754 148</td>
</tr>
<tr>
<td>Keith Phelps</td>
<td>Oolloo block</td>
<td>0419 612 476</td>
</tr>
<tr>
<td>Nick Krebs</td>
<td>Benung block</td>
<td>8975 0589</td>
</tr>
</tbody>
</table>
2.6 Historical, Aboriginal, Heritage Sites

Aboriginal Areas Protection Act (AAPA) certificates have been issued for the Skyfall area. As part of land access negotiations on EL27151 the NLC and Traditional Aboriginal Land Owners surveyed the area. A number of non-consent areas and sites were identified in this process.
3 REGIONAL CONTEXT

The project area sits within the Fergusson River (1:250000) and within the Jinduckin (1:100000) geological maps (Figure 3).

3.1 Summary of Regional Geology

The Fergusson River geological map is cut in its centre by a major structure: the Dorisvale Fault trending NW-SE, (Figure 3). The fault divides the geology into two main areas: the eastern part is mainly covered by the Daly River Basin sediments estimated as Cambrian to Ordovician age. The western part is largely covered by the Victoria basin with Carpentarian intrusive bodies. These formations are partially covered by flat-lying Mesozoic and Cainozoic cover.

EL27151 contains both Daly River Basin sediments in its eastern part and Victoria Basin sediment in its western part. These two major groups are separated by the Dorisvale Fault located in the middle of EL27151. The Skyfall prospect sits on this fault.

Figure 4 describes Spectrum’s interpretation of the geology, structure, tectonic history and mineralising events in relation to the Skyfall area.

Folded Lower-Proterozoic Finniss River Group rocks (greenschist to amphibolite facies) rest on an Achaean granitic-gneissic complex. Lower-Proterozoic granites were intruded into this sequence. In Spectrum’s tenements these include: the Soldiers Creek Granite, the Allia Creek Granite, and further away the Cullen Granite. This intrusion episode is displayed in Figure 4 and is considered to be the first event supplying rare earths into the system. These granites will be discussed further in 5.1 Regional Conceptual Model as they are important in Spectrum’s exploration model.

Lower-, Mid-Proterozoic sedimentary rock including the Tolmer Group lie unconformably on the Lower-Proterozoic unit described above and were laid down in shallow seas. One unit known to outcrop in the area is the Hinde Dolomite. Both these units are weakly folded.

The previously described Lower-, Mid-Proterozoic rocks are unconformably overlaid locally by the Lower-Cambrian Antrim Plateau Volcanics. Uplift and erosion preceded the regional extrusion of these volcanics. They consist of massive and vesicular tholeiitic basalt. In places, medium grained feldspathic sandstone is interbedded with the basalt.

Unconformable to the Volcanics is the Daly River Group consisting of a gently dipping sequence of limestone, sandstone, and siltstone laid down during an extensive marine transgression in the Mid-Cambrian. These sediments are confined to the Daly Basin, the western margin of which is defined by the Dorisvale Fault. This unit is carrying the base metal mineralisation implying a fluid circulation and mineralisation event at that time as illustrated in Figure 4. The Palaeozoic Daly Basin is believed to have resulted from Tertiary movements. Other work has suggested that a basin existed in Precambrian times since a thickening of the Precambrian sequence is implied beneath the basin.

Unconformably overlying the Daly River Group are Mesozoic Mullaman Sedimentary Beds. The Mullaman Beds have been extensively laterised; in places the laterite profile has been silicified and forms a tough cap rock on hilltops.

Superficial deposits overlying the above strata are the Cainozoic sediments. These are widespread across the district and consist of pisolitic laterite, ferruginous rubble and alluvium. Spectrum believes that these sequences host a third phase mineralisation event where rare earths were re-concentrated due to weathering, (Figure 4).
Figure 3: Ferguson River Geocological Map (1:250000) over Spectrum Tenements.
3.2 Summary of Project Area Geology

The Skyfall Prospect is cut by numerous NW-SE faults forming a positive flower structure that uplifted older, folded Lower-Proterozoic rock units. These structures are associated with hydrothermal brecciation and smaller E-W trending tension (riedel) faults mapped by Spectrum. The larger faults are showing a closing pattern towards the South of the prospect, therefore Skyfall is interpreted to sit on the closing edge of the positive flower structure. The Dorisvale Fault would then be a strike-slip fault with its north-east side moving southward and its south-west side moving northward.

The Lower-Proterozoic units are covered by flat lying Cambrian rock mainly constituted of sandstone, siltstone and nodular siltstones cut by coarse conglomeratic channels potentially from an estuarine environment.

The latter rock units are covered by more recent lateritic plateaus.

The Project area geology will be discussed further in 5 Spectrum’s Exploration Concept.
4 PREVIOUS EXPLORATION

4.1 Historical Exploration on EL27151

Spectrum completed a data compilation of previous companies’ exploration efforts in the area through the Mineral Exploration Reports provided by NTGS. Useful results and reports are summarised in Tables in Appendix B. Tables include company name, report number, exploration license number, commodity and important information extracted from the reports.

Most of the exploration work undertaken over EL27151 was from 1967 to 1995. Different companies have been successively looking for diamonds, base metals and gold. Diamond was the most targeted commodity over the exploration licences; the most advanced exploration was for base metals. No rare earth exploration has ever been undertaken in this area.

A number of geophysical surveys have been conducted over EL27151.

Figure 5 displays the different surveys conducted in the area. Four types of surveys cover the Skyfall Prospect (aeromagnetic, radiometric, electromagnetic and IP surveys), however, line spacing is generally wide (Figure 6); 1km for electromagnetic survey and 400m for the radiometric survey. Despite the broad line spacing radiometric data pointed out radiometric anomalies over EL27151.

Figure 5: Historic Geophysics Surveys over Spectrum’s Skyfall Prospect
Greenfield exploration including stream sediment, soil and rock chip sampling was conducted by previous companies. Best results highlighted base metals and uranium anomalies along the Dorisvale Fault mostly concentrated on the now named Skyfall radiometric anomaly. Results obtained from the previous companies are summarised in tables in Appendix B and displayed in Figure 7 and Figure 8. A general base metal anomaly was noted. The mineralisation has been interpreted to be a carbonate-hosted base metal type. Notable values included up to 320ppm uranium, 800ppm copper, 19.3% lead and 1.65% zinc.
Figure 7: Historic Surface Geochemistry Thematically Mapped by Lead across the District

Figure 8: Historic Surface Geochemistry Thematically Mapped by Uranium across the District
Subsequently drilling was completed over the Skyfall area first by Euralba Mining and then by Esso Australia, summarised in Figure 9 and Appendix B. Euralba Mining drilled 10 percussion/diamond holes and found values up to 47 ppm uranium, 20,000 ppm zinc and 48,000 ppm lead. Following this, Esso Australia drilled 3 holes identifying sulphides associated with sediment breccia interpreted as a carbonate-hosted epigenetic type deposit. The best values were up to 1,000 ppm lead, 220 ppm copper and 7,500 ppm zinc. Importantly these holes were not tested for rare earths.

Spectrum has digitally compiled the geological logs from these holes and plotted them on cross sections. However, recorded geological descriptions have been of limited use in developing Spectrum’s exploration model. Attempts have been made to correlate the described drilling to recently mapped geology but have been unsuccessful. Spectrum has made every attempt to locate the core from these holes but to no avail. No core photography has been located despite a significant search.
4.2 Known Mineralisation around the Prospects Area

More recently Spectrum’s Greenfields exploration efforts have led to the drill discovery of two Heavy Rare Earth Prospects; Stromberg and Scaramanga (Figure 10) and the trial pit discovery of the Skyfall Magnetic End-Use Rare Earth (MEU REO) Prospect and the geochemical discovery of the Largo, Knightfall and Severine Rare Earth Prospects.

Geological modelling at Stromberg defined a robust mineral inventory, next stage JORC Inferred Resource Conversion, of ~1.5Mt @ 0.46% TREO from 85 drill holes within a mineralised envelope at a 0.1% TREO cut off and 0.05% mineralised envelope.

Stromberg consists of multiple at surface flat lying zones in a sedimentary setting. Mineralisation is seen to be thicker closer to faults which are believed to be feeder or concentration structures for the mineralisation (Figure 11).
The intersections at Stromberg contain high proportions of Heavy Rare Earth (HREE) with an approximate average of 85% HREE from all drilling to date above a cut-off of 0.2% TREO. Of this HREE content, the critical and valuable metal distributions are on average:

- Dysprosium (Dy) 7.5%/TREO;
- Yttrium (Y) 64.9%/TREO;
- Erbium (Er) 4.8%/TREO;
- Terbium (Tb) ~1%/TREO.

Mineralogy by XRD (X-Ray Diffraction) and optical methods has confirmed Xenotime-(Y) mineralogy as the rare earth element (REE) host (Young and Prince, 2013). Xenotime is arguably the second most efficient minerals for rare earth extraction.

Approximately 5 km from Stromberg; drilling successfully defined additional mineralisation at the Scaramanga Prospect highlighting the broader district potential. Significant intersections include:

- SCRC07 - 2m @ 0.12% TREO (81.2% HREO/TREO) from 10m;
- SCRC02 - 5m @ 0.1% TREO (70% HREO/TREO) from 10m.

Mineralisation at Scaramanga is interpreted to be in the same geological setting as Stromberg.

### 4.3 Spectrum Exploration Summary at Skyfall on EL27151

Spectrum commenced on-ground exploration on Skyfall in early 2013.

In the early stages of exploration geophysical interpretation was very important. Spectrum used Government pre-competitive data to understand the regional geology and develop confidence in the Prospect. Gravity and magnetic surveys established the importance of Skyfall’s location along a major deep crustal fault corridor and within close proximity to an interpreted intrusive granite body. The latter could act as a feeder of rare earth mineralisation, Figure 12. Spectrum geologists believe that this major crustal fault corresponds to the Dorisvale Fault previously mapped by Pontifex, I.R and Mendum, J.R., (1972).
Figure 12: Regional Geophysics Interpretation Highlighting Skyfall’s Close Proximity to a Major Intrusive and its Favourable Position along a Major Deep Crustal Fault.

In early October 2013 Spectrum organised an aerial imagery and detailed topography survey, flown by Aerometrex, over the main rare earth prospects (Skyfall, Largo and Knightfall). This survey provided an excellent basis for accurately interpreting faults and stratigraphy, Figure 13. The structural and stratigraphic interpretation made from the remote sensing was crucial in conducting follow up on-ground geological mapping of geochemical sampling. Geological mapping across the tenement has shown a consistent North-West to South-East trend of the major structures (also regional structures).

Figure 13: Aerial imagery from the remote sensing survey used to defined faults (blue lines) and stratigraphy (black lines). The red lines represent tracks and the light blue lines are rivers.
Over 550 soil samples and 123 rock samples, taken in conjunction with the geological mapping, now define the prospect. The sampling lines were oriented 50°N, perpendicular to the main structures identified with geophysics and aerial imagery. Figure 14 shows the kriged soil grid for Total Rare Earth Oxide (TREO) and highlights zones of interests in pink. The latter described pink zones are strongly associated with geological structures and more concentrated towards the South of the prospect where the structures seem to intersect.
Figure 14: Geochemical Sampling Results Map, including a soil geochemistry grid by TREO and all soil and rock chip results to date coloured by TREO’s abundance.
In February 2014 Spectrum commenced hand digging trial pits at Skyfall, locations shown on Figure 14.

Trial Pit 1 (TP1) showed a rare earth distribution rich in Heavy Rare Earth Oxides (HREO) and geochemistry assays returned rare earth amount up to 0.33% TREO. TP2 assays returned results up to 1.58% TREO with exceptionally high proportion (41%) of the combined Magnetic End Use Rare Earths (MEU REO) dysprosium, terbium, neodymium, praseodymium, gadolinium and samarium.

Figure 15 highlights the best results in Trial Pit 2 associated with a purple brown clay fault gouge. This fault direction is oblique to the main NW-SE trending faults illustrated in Figure 13 and Figure 14 and is interpreted to be a Riedel fault important in controlling mineralisation across the prospect. It is likely that these fault branches are abundant across the Skyfall Prospect and represent the main weakness along which regional stress has been concentrated. The rock at the base of Trial Pit 2 (Figure 14) is interpreted to be weathered rhyolitic tuff due to its quartz and kaolinite mineralogy.

Samples from both trial pits were sent to ANSTO Minerals in Sydney for mineralogical analysis. XRF, QEMSCAN and Scanning Electron Microscopy identified small amounts of more typical secondary rare earth minerals with a very strong association with clay and iron oxide/hydroxide. Typical rare earth minerals identified included xenotime-(Y), crandallite, florencite, a rare iron-, yttrium-phosphate and other general rare earth species. However, the amount of these minerals does not seem to fully account for the amount of rare earth elements present in the samples and further tests have been scheduled to test for adsorbed or ionic rare earth species. This mineralogy could provide Spectrum with a number of very low cost mineral processing options.

Diamond drilling already in progress at Skyfall is targeting the MEU REO mineralisation around Trial Pit 2 in the shallow cover rocks and clays. This Collaborations proposal seeks funding to aid in the investigation of the deeper stratigraphic profile and the potential for a buried mineralised intrusive stock and fault system.

Further details of geology are presented under Section 5 ‘Exploration Concept’ in this report.
5 SPECTRUM’S EXPLORATION CONCEPT

Spectrum is applying two conceptual models for the Skyfall District. The first is at a regional scale and includes the Skyfall, Largo and Knightfall Prospects, the second model is localised to Skyfall. Both model scales will be explained in Sections 5.1 and 5.2 respectively.

5.1 Regional Conceptual Model

5.1.1 Tectonic Framework

The first tectonic event recorded in the area is a Late-Archean to Early-Proterozoic extension event responsible for the formation of an early basinal environment which deposited the Lower-Proterozoic Finiss River Group sediments.

Following this basin formation the region was affected by the Top End Orogeny (Figure 4). The subsequent erosion and isostatic equilibration of the Orogen led to an extensional environment forming a continental rift or aborted-rift setting. The latter event produced deep crustal faults, thinning of the crust, rising of a convecting evolved mantle and magma formation. Spectrum has modelled gravity gradient data (sourced from Geoscience Australia pre-competitive datasets) and identified a number of these structures and magmatic intrusions. As seen in Figure 16 these deep basement tapping faults dip in opposite directions on each side of the Skyfall Prospect area forming a rift-like pattern.

Later reactivation of these faults in the Mesoproterozoic and the Cambrian/Ordovician continued basin development and deposited the Mesoproterozoic Tolmer Group and Cambrian to Ordovician Daly River Group sediments. Further fault reactivation has occurred and formed shallow basin sediments in the Cretaceous.
5.1.2 Intrusives

Intrusive igneous rocks in the tectonic setting interpreted at Skyfall are of extreme importance in Spectrum’s Rare Earth District as they represent a potential rare earth source. Spectrum has identified intrusives from both the NTGS mapping and from the gravity data noted above in Figure 12 and Figure 16. Some of these are located directly to the West of both the Stromberg and Skyfall Prospects. These granites are believed to be Post-Orogenic resulting from the thinning of the crust and the rising of the mantle associated with rift emplacement. Such an event will create interactions between the mantle and the lower crust such as melting of the base of the crust, metasomatism from the mantle affecting the lower crust, or even mantle contamination of the re-melted lower crust. Mantle metasomatism is believed to be responsible for anomalous rare earth element enrichment in magmatic bodies as demonstrated by Martin, R., F. (2006). Therefore the evidence of mantle metasomatism, explained below, is crucial for Spectrum’s exploration model.

All of the granites illustrated in Figure 16 and Figure 17 are believed to be from the same origin and period as the Cullen Batholith (3,000km²). The Cullen Batholith is only partially exposed to the North-East and is located approximately 40km East of Skyfall. It was emplaced at the culminating stages of the Top End Orogeny (around 1780 Ma). The majority of this batholith’s area is believed to be concealed beneath the Daly River Group sediments and the satellite plutons noted in the Stromberg and Skyfall area.

Bajwah (1994) noted that the Cullen Batholith was enriched in K, Rb, Ba, Zr and light rare earths from complex metasomatism and re-melting of the lower crust. The author interpreted the phenomenon of metasomatism was caused by alkaline carbonate fluids derived from the mantle. Bajwah’s
recognition of metasomatism in the District is key in supporting Spectrums rift and granite rare earth source exploration model. Another distinctive feature of the Cullen Batholith is its accessory phases which include the rare earth bearing minerals apatite, zircon and allanite.

5.1.3 Tectonic and Intrusives; Implication for Rare Earth Exploration

The type of tectonic and intrusive setting described above hosts several world class rare earth deposits as discussed in section 5.3 Similar Geological Context. Moreover knowing that the Cullen Batholith is unusually enriched in incompatible elements/rare earth, it could be inferred that the plutons identified by Spectrum are thus enriched in incompatible elements/rare earth as well. These bodies would represent a source for the known rare earth mineralisation at Skyfall. The series of faults interpreted and observed in the area could act as fluid conduits from the deep seated rare earth enriched granites.

5.2 Local Conceptual Model

The comprehensive geochemical sampling program undertaken across Skyfall has successfully defined a primary drilling target illustrated in pink Figure 18. Spectrum interprets the sub-circular MEU REO (magnetic end-use rare-earth oxide) target to be a surface expression of a covered fault controlled intrusive stock.
The exploration model cross section in Figure 19 illustrates an interpreted positive flower structure associated with deep basement tapping faults (The Dorisvale Fault). These faults have allowed deep basement rock (Lower-Proterozoic) units to be uplifted closer to the surface. These uplifted, strongly folded rocks are overlain by younger flat lying and unconformable Tolmer Group and Daly Basin sediments. The cross section in Figure 19 also illustrates the interpreted stock discussed above. Spectrum interprets that this stock has been intruded within the Dorisvale Fault Zone as per Spectrum’s regional model. This exploration target is interpreted to be derived from rare earth enriched metasomatised igneous bodies associated with the Cullen Batholith Suite and rift emplacement.
Primary mineralisation targets illustrated in Figure 19 are interpreted to be within three distinct settings:

- An intrusive stock hypothesised to be derived from a metasomatised igneous body;
- Fault controlled hydrothermal mineralisation;
- Stratigraphic and fold controlled mineralisation associated with the crests of anticlinal structures.

Secondary mineralisation is interpreted to be within two distinct settings:

- Near surface tabular clay rich bodies in younger flat lying sediments, concentrated by meteoric water circulation in more porous rocks and weathering.
- Clay weathering and alteration products above the interpreted mineralised stock.

The mineralisation type targeted in this Collaborations Proposal is primary REE’s associated with the interpreted fault controlled intrusive stock. Proof of concept for this exploration model will have important implications for exploration across the District (Largo Knightfall, Severine) and the Northern Territory as similar geological settings could be recognised.
5.3 Similar Geological Context

5.3.1 Regional Geological Model

The regional geological context described in 5.1 Regional Conceptual Model is similar to the geological context of most of the known rare-earth deposits, e.g., Mountain Pass, United States (Castor, 2008), Bayan Obo Fe-Nb-REE, China (Yang et al., 2009), Maoniuping, China (Xie et al., 2009), Strange Lake, Canada (Salvi and Williams-Jones, 1996) and Nechalacho, Canada (Sheard et al., 2012). The latter deposits are hosted by or genetically related to carbonatites and peralkaline intrusions which are usually members of plutonic suites formed in zones undergoing extension. The rare earth enrichment present in these magmas are also interpreted to be produced from a convecting evolved mantle that has reacted with the lower crust or are directly mantle derived magmas.

5.3.2 Local Geological Model

Primary geology and mineralisation at the Skyfall Prospect can be compared to two World Class Rare Earth deposits; namely, Mt Weld deposit (Australia) and the Nechalacho deposit (Canada).

Mount Weld, Australia (secondary mineralogy in the weathering profile)

The Mt Weld deposit, ‘the richest known deposit of rare earths in the World’, is located 250 km North-East of Kalgoorlie, Western Australia, and is the product of an intrusive carbonatite and its associated weathering profile. Decomposing primary igneous carbonatite minerals have led to rare earth concentration (Lottermoser, 1990). A combination of water table movement associated with palaeodrainage, and pH and oxygen fugacity changes over a long weathering period have led to rare earth enrichment in the laterite profile at Mt Weld, (Lottermoser, 1990). Observations of weathering in mapping and mineralogy from trial pit samples at Skyfall show that the prospect has been subjected to the same concentration mechanisms as the Mt Weld Ore Body. The geochemical pattern at Mt Weld shows fractionation of rare earths within the weathering profile, this has also been noted at Skyfall, Figure 18 illustrates how MEU REO’s have fractionated within a larger 6km long TREO anomaly.

Geochemical data obtained at Skyfall also supports a feeder source (perhaps similar to Mount Weld) below the area of strongest geochemical results (Figure 18).

Mt Weld is also known for a large amount of hydrothermal fluid flow associated with its intrusive source. Mapping at Skyfall has identified fluid controlled hydrothermal breccia associated with the main REE anomalies (Figure 20); assays pending.

![Figure 20: Hydrothermal Breccia Observed in a Fault Zone, Skyfall South.](image)
Nechalacho, Canada (similar rare earth chondrite normalised pattern)

Skyfall mineralogy results from a trial pit dug into the MEU REO circular anomaly were compared to other rare earth deposits in the world on a chondrite normalised diagram. Skyfall shows a strong similarity with the Nechalacho Deposit, Canada (Figure 21). Nechalacho Deposit is hosted by peralkaline syenite. Both Prospects display the same REE curve and Y enrichment, Figure 21. A possible economic advantage for Skyfall mineralisation is its depletion in the less valuable La and Ce elements and its greater enrichment in MEU REO compared to Nechalacho’s mineralisation.

Figure 21: Trial Pit 2 Sample - Chondrite Normalised Plot Comparing Skyfall’s MEU REO Mineralisation Style to some Major Rare Earth Deposits.

In summary, Skyfall shows strong similarities with some World Class Rare Earth Deposits but also shows some unique features and advantages.
5.4 Innovation

Spectrum’s Collaboration Proposal innovations include:

- The development of a regional conceptual exploration model that includes the interpretation of a feeder stock in a rift setting under the Skyfall Prospect; as defined by pre-competitive gravity and magnetic data sets. No similar models have previously been recognised in the region.

- The interpretation of a positive flower structure uplifting deep basement rocks through younger sequences at Skyfall. This interpretation is significantly different to existing geological maps and previous interpretations.

- Spectrum has advanced its methods of testing by investing in its own man-portable diamond drill rig allowing flexibility in drill programs. This reduces Spectrum’s costs and environmental footprint since no access tracks are required. Innovation has come from scaling down equipment, using marine engines to provide suitable light weight power, and the transference of oil field drive technology to the minerals industry. Spectrum has worked with the manufacturer to design a drill rig and logistical system which has allowed the scaling down of helicopter support and mobilisation by two factors (Long Ranger to R44 to R22). Spectrum plans to use this drill rig when carrying out the proposed drilling for this Collaborations Program.

- In addition, Spectrum has worked with Traditional Owners in the region which opened up access to the Skyfall tenure. Work has resulted in the overturning of a moratorium period prior to its natural termination. Spectrum understands that this is a first time that this has been achieved in Australia on Aboriginal Freehold Land. Spectrum’s fresh approach to dealings with the Traditional Owners and the Land Council helped with land access matters. Innovations included:
  
  - The frequency and consistency in communication in exploration matters irrespective of land access matters or progress;
  - The personal involvement of all Spectrums Staff with the Traditional Owners even in periods of lower on ground activity;
  - A long term multi-media and experiential approach to education on matters relating to uranium and uranium mining was trialed. Tools used included: an Australian Uranium Associations Video on the uranium industry, Web Research with Traditional Owners and regular visits for Traditional Owners to site to develop an understanding of the exploration process. These visits were undertaken from early stage geological mapping and rock chipping to drill programs;
  - The Employment Traditional Owners in the early stages of exploration under another first for the Northern Territory, a ‘Preliminary Exploration Permit’.
Figure 22: Man-portable Diamond Drill Rig –Skyfall May 2014.

Figure 23: Traditional Owners, Spectrum Staff and the NLC on Cultural Training October 2013
6 DETAILS OF PROPOSED COLLABORATIVE PROGRAM

6.1 Method

The purpose of the proposed collaborations diamond drill program is to:

- Test for a deep seated magmatic body and a primary rare earth mineralisation source;
- Test Spectrum’s structural model at Skyfall – the uplift of lower Proterozoic basement rocks through the younger sequence (mid Proterozoic, Cambrian and Cretaceous) by a positive flower structure associated with the Dorisvale Fault.
- Understand the full stratigraphic sequence from younger cover rocks to basement rocks including unconformable surfaces (two unconformities) and their potential influence for mineralisation across the District and Daly Pine Creek regions.

6.2 Drilling Proposal

Spectrum plans to drill a single NQ orientated diamond hole. Table 3 details the planned drill hole. Figure 19 shows the planned drill hole in cross section relative to the main drill target. The drill hole plan in Figure 18 shows the drill hole trace.

Table 3: Spectrum Diamond Drill Hole details

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>Easting (GDA94 z52)</th>
<th>Northing (GDA94 z52)</th>
<th>Elevation</th>
<th>Dip</th>
<th>Grid Azimuth</th>
<th>Depth (m)</th>
<th>HQ</th>
<th>NQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKDH05</td>
<td>731722</td>
<td>8408383</td>
<td>204</td>
<td>-60</td>
<td>050</td>
<td>210</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

This hole design is covered by Spectrum’s approved MMP0773-01. The approval letter for this MMP is provided in Appendix A.
### 6.3 Sampling, Analysis and Measurements

Table 4 details the drilling, sampling, analysis and measurement protocols for the proposed drill program.

#### Table 4: Drilling Sampling and Measurement Protocol

<table>
<thead>
<tr>
<th>Drilling Method</th>
<th>Drilling will be undertaken with conventional NQ wireline coring tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Orientation</td>
<td>Core will be orientated on every run with an in core barrel ezi-mark tool.</td>
</tr>
<tr>
<td>Downhole Survey</td>
<td>Downhole survey information will be taken at collar to ensure correct hole set up and at intervals not exceeding 50m, but more typically 30m. Magnetic influence is not expected. An electronic multi shot tool will be used.</td>
</tr>
<tr>
<td>Core Mark Up</td>
<td>All core will be marked at 1m intervals. Orientation and sample lines will also be marked.</td>
</tr>
<tr>
<td>Core Photography</td>
<td>All core will be photographed prior to sampling using a high quality Nixon Digital SLR camera on a fixed mounted tripod and lighting set.</td>
</tr>
<tr>
<td>Sample Quality</td>
<td>HQ Triple tube equipment will be available on site in the event that core loss or core recovery issues are encountered. This selective triple tube coring process will help keep costs to a minimum and preserve meterage for penetrating to basement.</td>
</tr>
<tr>
<td>Logging</td>
<td>Core will be logged digitally [Tables include Lithology, Weathering and Regolith, Water Intersections, Structure, Veining, Alteration, Mineralisation, Geotechnical including RQD data, and Magnetic Susceptibility and Specific Gravity (1 sample per 10m)].</td>
</tr>
<tr>
<td>Data Storage</td>
<td>Digital recording and storage of all geological, assay and downhole geophysical data using Spectrums Datashed database. Logging will be coded using Spectrum’s comprehensive geological legend.</td>
</tr>
<tr>
<td>Sampling Procedure</td>
<td>Sampling commences once all core photography logging and geophysical analysis has been completed. Samples of ½ core will be taken to geological intervals generally at 1m intervals (maximum 1.4m, minimum 0.4m) for normal metal analysis. Core will be sampled in areas of geological interest, to geological boundaries or to provide a multi element geochemical signature of specific units. It is estimated that a minimum of 60% of the core will be sampled. Spectrum intends to leave a minimum of quarter core as a record of sample. All drilling will preferentially sample the right hand side of the core facing downhole or to the right of any orientation mark facing downhole.</td>
</tr>
<tr>
<td>Sampling QAQC</td>
<td>Blanks will be inserted at 5% or in areas of expected mineralisation using barren granite rock from previous Spectrum drilling. ¼ core samples will be taken as an addition to original ½ core samples by way of duplicate analysis at 5% or in areas of expected mineralised intersection. Blanks and duplicates will not be scheduled for holes targeting diamonds and indicator minerals.</td>
</tr>
<tr>
<td>Downhole Analysis</td>
<td>No downhole geophysical or petrophysical analysis is planned.</td>
</tr>
<tr>
<td>Sample Dispatch</td>
<td>Sample dispatch will be via Spectrums Batchelor core-shed where dispatch checks are run. Spectrum will deliver samples to Bureau Veritas’s Darwin facility on its own truck.</td>
</tr>
<tr>
<td>Analysis</td>
<td>Samples are assayed for Rare Earths generally with ICP Mass Spectrometry and Lithium Meta Borate Fusion Finish to at least 1 ppm detection levels to ensure a fuller and more accurate analysis is obtained. In addition, the samples are assayed for a number of indicator, rare earth associated elements and base metals to at least 0.5 ppm levels (not reported or significant in this announcement) with ICP Mass Spectrometry and ICP Atomic Emission Spectrometry. All samples are assayed for precious metals using Fire Assay Analysis to ppb detection limits. Samples are assayed by Bureau Veritas in Adelaide. Appropriately graded mineralised and geochemical standards are run by the laboratory on all elements at 5% of a sample batch. Blanks are run on sample batches by the laboratory randomly at a rate of approximately 5%.</td>
</tr>
<tr>
<td>Analysis QAQC</td>
<td>Appropriately graded mineralised and geochemical standards are run by the laboratory on all elements at 5% of a sample batch. Blanks are run on sample batches by the laboratory randomly at a rate of approximately 5%. A nominal one in twenty (5%) of all samples are analysed in duplicate. Samples returning anomalous results will be re-assayed by techniques considered appropriate for the level of analysis encountered. Bureau Veritas complies with AS9001 Quality Systems standards and partakes in round robin check analysis with other laboratories. Spectrums post assay result QAQC will include plots of actual values against expected blank values and correlation plots for duplicate core analysis.</td>
</tr>
<tr>
<td>Mineralogical Sampling and Analysis</td>
<td>Mineralogy Analysis – Mineralogical samples will be taken in areas of interesting mineralisation and alteration if intersected. In the first instance samples will be analysed by ANSTO Minerals in Sydney using XRF, QEMSCAN and SEM analysis to define rare earth or other mineralogy types.</td>
</tr>
</tbody>
</table>
7 RESULTS AND INTERPRETATION

Thanks to the collaboration program Spectrum was able to drill a deep stratigraphic hole at Skyfall: SKDH05. Location is shown on Figure 24.

Figure 24: SKDH05 location
7.1 Stratigraphy

The diamond drill hole SKDH05 drilled by Spectrum in September 2014 is interpreted to have intersected different layers of the Daly Basin from the Mid-Cambrian to the Adelaidean. Spectrum believes that the stratigraphic units intersected are as follows: Jinduckin Formation, Tindall Limestone, Antrim Plateau Volcanics and possibly the Hinde Limestone inter-bedded with irregular layers of K-Feldspar Tuffite. The drill hole and the associated section interpreted by Spectrum Rare Earths are displayed in Figure 25.

![Figure 25: Section including Hole SKDH05 drilled by Spectrum in September 2014.](image)

7.2 Structure

No major structure was intersected except from small calcite and epidote (sometime containing few pyrite grains) veins cutting the basalt sub-horizontally.

7.3 Petrography and Mineralogy

Rock units described below have been interpreted by Spectrum to be part of different sediment groups known in the region. The first six rock units are believed to be part of the Daly River Group. The Unit below corresponds to the Antrim Plateau Volcanics and the dolomite intersected may be part of the Tolmer Group. These rock units are displayed on the cross section in Figure 25.

Petrographic and mineralogical analyses of core samples presented below were done by Townend Mineralogy Laboratory.
7.3.1 Daly River Group

Siliceous Claystone

The sediment consists of very fine-grained partly goethite impregnated kaolin with a subordinate content of fine silt sized (<50 μm) quartz. The matrix shows variation in translucence due to apparent variation in this goethite content. On the margin of the section, there is a narrow band of sand size quartz vein.

This fine grained texture is host to occasional fine quartzite/chert fragments, the largest measuring 6 mm. Within this latter body there is a millimetre area of chert containing a concentration of curved probable organic palimpsests. Within the clay matrix, there are several other silica replaced/filled small structures that were interpreted as sponge spicules.

Numerous LREEs aluminium phosphates were located in the polished thin section, >2micron fraction and <2 micron fraction, that have complex chemical compositions somewhat approaching florencite composition. Ubiquitous calcium, and commonly detected barium, sulphur and strontium suggests intimate mixtures or solid solutions amongst the following APS (aluminium phosphate sulphate) end members: florencite, crandallite, goyazite, gorceixite, woodhouseite and/or svanbergite.

The LREEs present are cerium, neodymium, subordinate lanthanum and occasionally samarium and europium.

Clayey Siltstone (Goethite impregnated)

The sediment is mostly a uniformly fine brown coloured translucent rock with grainsizes below 50 μm and quartz only very sporadically visible. There is slight evidence of bedding due to an increase in goethite content.

There were several small quartz filled structures plus a porous structure, that were also interpreted as sponge spicules (see Figure 26).

![Sponge spicule fossil from clayey siltstone](image)

SEM analyses found several REE instances within the thin section and no examples within the >2 microns and the <2 microns fractions. These appear to be LREE (aluminium) phosphates that have complex chemistry somewhat approaching florencite composition. The presence commonly of calcium, sulphur, strontium and barium indicates these may be intimate mixtures or solid solutions amongst the following APS end members: florencite, crandallite, goyazite, gorceixite, woodhouseite and/or svanbergite. These LREE phosphates all appear to be sub 3 microns sized grains and/or aggregates.
The LREEs present are cerium, neodymium, and intermittent lanthanum, praseodymium and samarium. Additional phases found include biotite, quartz, titanium oxides and kaolinite.

Nodular Siltstone
The rock unit is dark brown to reddish siltstone forming of well-rounded nodules of regular siltstone layers, there size varies from few cm to 50 cm. This unit is very iron-rich and is the most outcropping at surface across the prospect.

Variegated Silty Claystone
Much of the sediment consists of a fine-grained claystone containing some silty quartz and showing a coarse patchy colour variation due to sporadic apparent goethite impregnation. The rock also contains coarse 1-5 mm areas essentially composed of very fine kaolin.

The analyses of the thin section, the >2 microns fraction and the <2 microns fraction predominantly found xenotime plus rare aluminium phosphates. Fine (sub 2 microns) xenotime grains and aggregates litter the thin section. The REEs detected in the xenotime were typically dysprosium and intermittently gadolinium, neodymium and samarium.

Rare LREE aluminium phosphates were located in the thin section and >2 microns fraction. These all appear to be somewhat approaching cerium-neodymium florencite composition. However these have complex chemical compositions, with the detection of barium, calcium and sulphur that may be a solid solution or intimate mixtures of APS minerals; namely gorceixite, florencite, crandallite and/or woodhouseite.

Within the clay fraction several aluminium phosphates were found; possibly wavellite or augelite.

Kaolinised Silty Shale containing extensive chalcedony vein structures
The sediment is fine-grained showing banding. However there is also a considerable disruption of these bands, possibly soft sediment structures. Part of the slide features quite extensive chalcedony vein material that in part is lining cavities.

Analyses of the polished thin section, >2 microns fraction and the <2 microns fractions, found both xenotime and calcium aluminium phosphates. The xenotime are typically very fine (sub 2 microns) grains and/or aggregates that typically contain dysprosium and intermittently detectable gadolinium, sometimes associated with zircon.

The calcium aluminium phosphates typically are approaching crandallite composition. Detection of barium, strontium and sulphur was intermittent whilst only one example contained cerium. This may suggest that these are solid solution or intimate mixtures of APS minerals; crandallite, florencite, gorceixite, goyazite, svenbergite and/or woodhouseite.

Carbonated Tuffite containing numerous euhedral quartz crystals.
The dominant matrix consists of fine-grained (30-50 μ) of carbonate (dolomite), potash feldspar, muscovite and quartz.

There are fine grained strips of more shaley material that are probably a combination of chlorite, and clays. This matrix texture is interrupted by occasional linear zones/veins of coarse-grained carbonate (probably calcite).

The sample is distinguished by quite common perfectly idiomorphic quartz crystals, with some examples exceeding 0.5 mm and some containing inclusions of carbonate. This euhedral quartz is clearly related to finer examples found in the 36.5 interval. Some examples are grouped.

Haematite is identified as common 20-30 μ rather angular grains, and may be also present as fines.
Rare earths are contained by detrital monazites. A field emission SEM examination found three examples of a thorium bearing cerium monazite. One was a discrete 40 μ length triangular fragment. The other two were poorly defined 4 and 6 μ examples. The very angular nature of this 40 μ monazite does suggest a clastic origin rather than in situ crystallisation (Figure 27).

**Figure 27: Very angular monazite found in Carbonated Tuffite**

### 7.3.2 Antrim Plateau Volcanic

This rock unit is a vesicular coarse-grained basalt with around 20% vesicles mainly filled in with calcite, quartz and chlorite and occasionally by crude oil as seen on Figure 28.

**Figure 28: Photograph of vesicular basalt in SKDH05. Some vesicles were filled with crude oil.**

### 7.3.3 Possible Tolmer Group

Fine-Grained Dolomite, containing irregular layers of K-feldspar tuff, crossed by veins of coarse grained dolomite.
The dominant lithology is a uniformly fine-grained micritic dolomite (30 μ). It is essentially monomineralic apart from low levels of fine quartz. Marginally it contains a zone of a very fine grained foliated matrix that is rich in K feldspar (staining/XRD). This is in contact with a similarly fine grained ferruginous dolomite that becomes paler towards the margin of the drill core. It contains a little K-feldspar. The micritic dolomite is irregularly veined by coarse-grained dolomite.

A field emission SEM scan failed to detect any rare earths. However the SEM detected a composite mass (30 μ) of a uranium silicate, maybe coffinite that enclosed pyrite, an adjacent 12 μ coffinite and a separate 5 μ scheelite (Figure 29).
7.4 Assay Result

No significant rare earth results have been intersected.

Assay results are displayed in Appendix C.

8 CONCLUSION

SKDH05 failed to intersect any significant rare earth numbers except for the already known flat lying surface mineralisation.

SKDH05 did not intersect the magmatic body interpreted to be the source of the rare earth mineralisation. Spectrum still believes that magmatic bodies are responsible for the presence of rare earths in the basin enriched at surface by weathering. However, these magmatic bodies are very likely sitting underneath the Adelaidean sediment sequence which seems to be thicker than what Spectrum expected.

SKDH05 provided Spectrum with new information on the regional stratigraphy and unit thicknesses. The Antrim Plateau basalt was first intersected at 62.8m deep and is 91.6m thick and the subjacent dolomite (possibly Hinde Dolomite) is over 100m thick.

Spectrum observed the presence of crude oil trapped in Antrim Plateau basalt’s vesicles and fractures. Also, SKDH05, gave information on what lay beneath the Antrim Plateau Volcanics which is a thick sequence of dolomite interpreted to be the Hinde Dolomite part of the Tolmer Group. This sequence is very thick (over 100m) and includes irregular beds of tuffite.

Scanning electron microscopy analysis of the deeper flat lying rock (36m down hole and deeper), showed more common primary rare earth mineralogy such as monazite (Figure 27). Closer examination of the mineralogy in the deeper zones suggests the monazites may be sedimentary/detrital in nature (similar to a placer deposit).

However, in the zone at 297m (see Figure 25) evidence of secondary mobilisation by basinal brines within the rocks exists. The photomicrograph in Figure 29 shows a coffinite halo around a pyrite grain within this zone.

Spectrum hypothesises that the more economically important types of rare earth minerals such as those found in the Skyfall surface mineralised zone (xenotime and crandallite group minerals) or at Stromberg (xenotime), are formed where these primary zones hit the surface and weather. Some secondary mobilisation and concentration mechanisms are active within the basin particularly around fault zones.

Mineralisation at surface might have been circulating towards the top layer using the outward faults located outside the Skyfall anomaly (east and west side) that remain untested.
9 REFERENCES

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Lottermoser, B. G. (1990). Rare-earth element mineralisation within the Mt. Weld carbonatite laterite, Western Australia. Department of Geology, University of Newcastle, Newcastle, N. S. W. 2308 (Australia).


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10 APPENDICES

Appendix A: 131119_27151, 28970 Dept MMP Authorisation 0773-01

Appendix B: Detailed description of previous work by other companies listed by previous tenure

Appendix C: Assay Results from SKDH05