ASX MEDIA RELEASE

Havilah Resources
A New Mining Force in South Australia

19 February 2020

Rare Earth Potential Confirmed by Expert

HIGHLIGHTS

- Rare earth element (**REE**) discovery potential in the Curnamona Craton highlighted by independent expert, Emeritus Professor Ken Collerson.
- Remarkable geochemical similarities noted with carbonatites from the largest REE deposit in the world at Bayan Obo in China.
- Based on Professor Collerson's recommendations, Havilah proposes to carry out REE mineralogical and metallurgical recovery studies on drill samples from the Kalkaroo copper-gold project and Croziers copper prospect over the next few months.
- Havilah's other project work and exploration drilling to be funded by the recent rights issue will continue as planned and will not be affected by the proposed REE studies.
- REE are of relevance and strategic importance given the Australian Government's recent efforts in promoting international investment in the development of critical minerals resources within Australia.

Havilah Resources Limited (**Havilah** or **Company**) has previously reported elevated levels of REE in drill samples from several of its Curnamona Craton mineral tenements (refer to ASX announcement of 7 January 2020). The REE data was subsequently provided to a recognised independent expert in this field, namely Emeritus Professor Ken Collerson, who concluded that **"The geochemical evidence clearly shows that the prospectivity of the area is very high for alkaline generated REE-copper-gold-cobalt-nickel-platinum group element systems. Discovery success will have positive commercial benefits for Havilah given the projected increased demand for REE in a variety of modern age applications. This provides a compelling scientific case for concerted REE exploration in the Curnamona Craton.**" (refer to Professor Collerson's 'Technical Review of Havilah Resources Rare Earth Element Data from the Curnamona Craton, South Australia' summary report in Appendix 1 of this ASX Media Release).

Professor Collerson noted that "**many Havilah samples exhibit levels of REE enrichment that are within the observed range of ore-grade hard rock REE deposits." and "In particular, there is remarkable geochemical similarity to carbonatites from Bayan Obo in China, the world's largest REE deposit. This has very positive implications for Havilah's future exploration outcomes."**

He also observed that because the REE may be recovered as a by-product of the copper-gold concentration process at Kalkaroo **"This could potentially provide an economic advantage for the Kalkaroo project, compared to those projects that are solely REE based."**

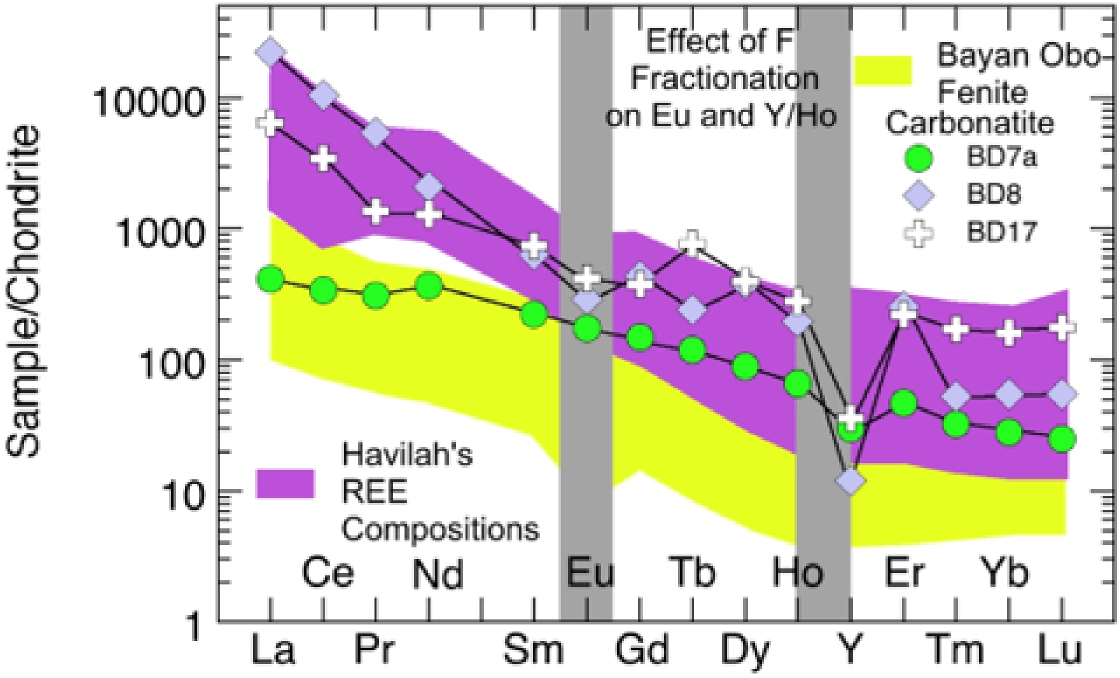


Figure 1 Havilah REE field superimposed on the REE patterns for Bayan Obo carbonatites (BD7a, BD8 and BD17) and fenites from Bayan Obo, the largest REE deposit in the world (data from Wang et al., 2018). Note the similarity in shape of the Bayan Obo and Havilah REE patterns and similar normalised REE levels.

Professor Collerson recommended initiation of **"detailed studies into the REE hosting minerals and the ability to recover these minerals by trialing various separation techniques on suitable samples. It is highly recommended that such studies should commence on samples from the advanced Kalkaroo project. Project economics will be positively impacted if Havilah can demonstrate successful recovery of a REE mineral concentrate from run of mine Kalkaroo oxide and sulphide ore. Additionally, this study shows that Kalkaroo is advantaged in having the highest proportion of the more valuable heavy-REEs."**

Havilah proposes to investigate the REE recovery options, with the following key tasks planned:

1. Complete shallow drillholes at the Kalkaroo project and Croziers prospect areas to obtain samples that are suitable for metallurgical recovery studies.
2. Mineralogical studies to determine the identities and physical properties (such as size, shape and density) of the REE-bearing mineral phases**.**
3. Metallurgical tests designed to establish recoveries of REE minerals from the drill samples.

Havilah has recently been advised by the South Australian Department for Energy and Mining (**DEM**) that its Expression of Interest for an Accelerated Development Initiative application entitled "**Investigation of REE Mineralisation in the Benagerie Dome**" has advanced to the next stage. Havilah has been invited by DEM to submit a detailed proposal, which it is now in the process of preparing. The proposal will include the three key tasks listed above, with the metallurgical study being carried out in collaboration with well renowned academic experts in this field at the University of South Australia.

Any results from the REE studies will not be incorporated into the ongoing updated Kalkaroo pre-feasibility study (**PFS**) program of work at this stage, which is being managed separately by Mr Richard Buckley, Havilah's Senior Mine Planning Engineer.

Commenting on the REE studies Havilah's Technical Director, Dr Chris Giles, said:

"The value upside for Havilah is that if REE can be economically recovered in a mineral concentrate as a by-product of the standard copper and gold recovery processes it could provide a further revenue stream for the Kalkaroo copper-gold project.

"As Professor Collerson has observed, this potentially puts Kalkaroo at an economic advantage compared with stand-alone REE producers.

"The critical questions for Havilah are what mineral(s) host the REE and can the REE be recovered and concentrated to produce a saleable, direct shipping by-product along with copper concentrates?

"Without detracting from our other work, these are the questions that we propose to address with experimental work over the next few months in collaboration with local well credentialed academic experts." he said.

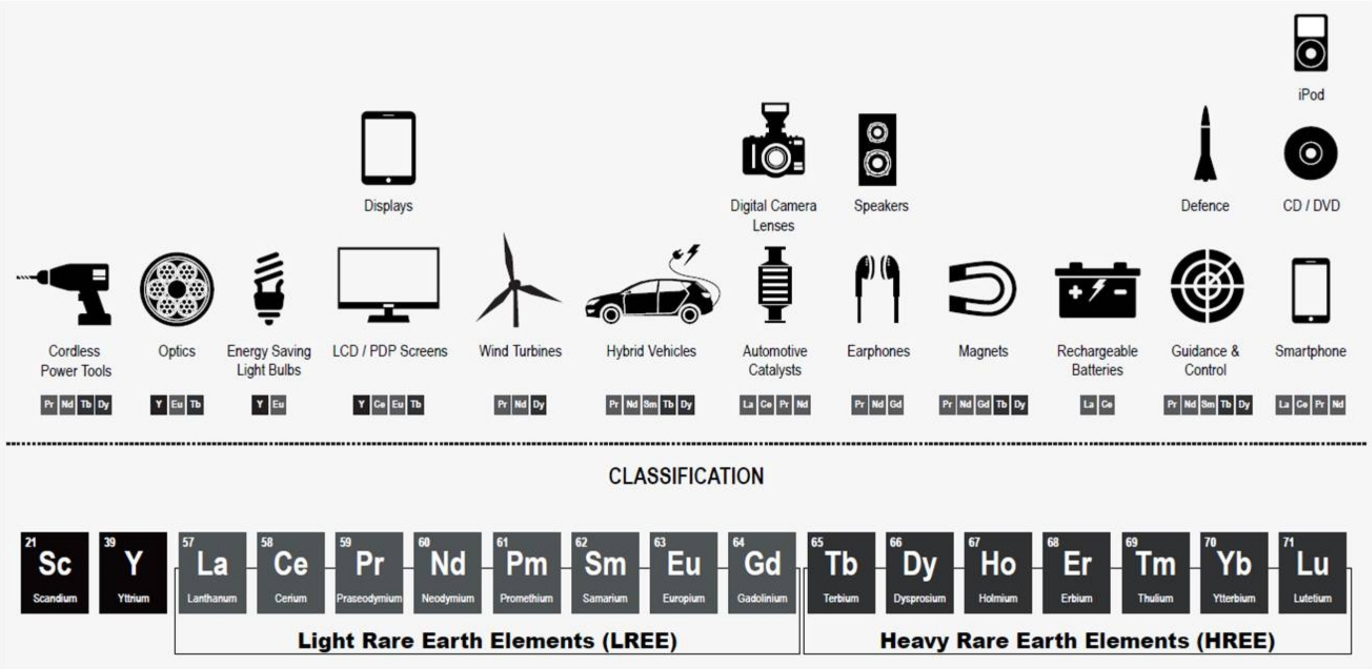
About Rare Earth Elements

REE are a related group of 16 elements (lanthanides plus Yttrium) that are not particularly rare and are typically widely dispersed in the earth's crust. However, there are limited minerals containing appreciable levels of REE and they tend to only form economic concentrations under rather uncommon geological conditions. For this reason, REEs are currently strategic and critical minerals for industry.

The lanthanide series of elements can be further subdivided into light-REE and heavy-REE. Light-REE are generally more abundant, and less valuable than the heavy-REE.

REE have a wide variety of important and often energy saving modern age usages because of their spectrum of slightly varying chemical behaviours. For example, modern brushless electric motors as used in power tools and many electric vehicles rely on powerful new generation magnets that use Neodymium (**Nd**), Dysprosium (**Dy**), Praseodymium (**Pr**), Terbium (**Tb**) compounds as vital components. Some of the many other uses of REE are summarised in the diagram below.

This release has been authorised on behalf of the Havilah Resources Limited Board by Dr Chris Giles.



Acknowledgement of source for the above diagram: China Water Risk report *“Rare Earths: Shades of Grey-Can China continue to fuel our clean and smart future?”* (published June 2016).

Cautionary Statement

This announcement contains certain statements which may constitute ‘forward-looking statements’. Such statements are only predictions and are subject to inherent risks and uncertainties which could cause actual values, performance or achievements to differ materially from those expressed, implied or projected in any forward-looking statements. Investors are cautioned that forward-looking statements are not guarantees of future performance and investors are cautioned not to put undue reliance on forward-looking statements due to the inherent uncertainty therein.

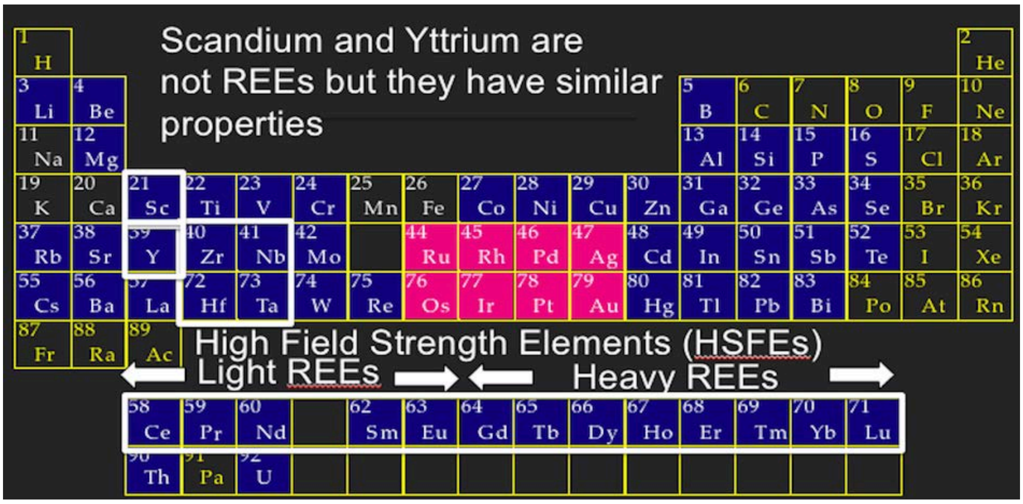
Competent Person’s Statements

The information in this announcement that relates to Exploration Results and Mineral Resources is based on data and information compiled by geologist, Dr Chris Giles, a Competent Person who is a member of The Australian Institute of Geoscientists. Dr Giles is Technical Director of the Company, is employed by the Company on a consulting contract and is a substantial shareholder. Dr Giles has sufficient experience, which is relevant to the style of mineralisation and type of deposit under consideration and to the activities being undertaken to qualify as a Competent Person as defined in the 2012 Edition of ‘Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves’. Dr Giles consents to the inclusion in the announcement of the matters based on his information in the form and context in which it appears.

The information in this announcement that relates to REE is based on data and information compiled by geologist, Emeritus Professor Ken Collerson, who is a Fellow of the Australasian Institute of Mining and Metallurgy (FAusIMM). Professor Collerson is an independent consultant to the Company. Professor Collerson has sufficient experience, which is relevant to the style of mineralisation and type of deposits being reported on to qualify as a Competent Person as defined in the 2012 Edition of ‘Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves’. Professor Collerson consents to the inclusion in the announcement of the matters based on his information in the form and context in which it appears.

Appendix 1 Summary Version of Professor Collerson's Report

Technical Review of Havilah Resources Rare Earth Element Data from the Curnamona Craton, South Australia



Professor Ken Collerson
PhD., FAusIMM
KDC Consulting
Brisbane, Queensland

February 7th 2020

Contents

Executive Summary

Rare earth element data reviewed in this study indicates the significant and hitherto largely unrecognised REE potential of Havilah's tenements in the South Australian portion of the Curnamona Craton.

Maximum calculated TREY oxide concentrations occur in samples from Croziers and Benagerie Dome up to 2.6 wt.% and 1.57 wt.% respectively. However, TREY oxide concentrations in samples from the other locations, i.e., Birksgate (6460 ppm), Eurinilla (8425 ppm), Mulyungarie (9076 ppm) and Kalkaroo (8482 ppm) are still quite elevated.

It is apparent that many Havilah samples exhibit levels of REE enrichment that are within the observed range of ore-grade hard rock REE deposits namely, LREE (La to Eu) abundances ranging from >1000x to 10000x chondritic levels, and the HREE (Gd to Lu) abundances > 1000 times chondrites.

Scandium (Sc) concentrations in samples from Havilah's tenements are clearly significantly anomalous with many containing > 50 ppm Sc, compared with the crustal abundance of 12 ppm. Assuming that the REEs could all be separated during processing, Sc may also be recoverable and so contribute to the basket value of the metals recovered.

Sample data from different locations provided by Havilah exhibit significant variation in REE abundance and LREE to HREE fractionation shown by the large variation in La (LREE) to Yb (HREE) ratios. Kalkaroo with a mean La/Yb ratio of 49.7 has the highest concentration of HREEs (mean HREE = 319 ± 134 ppm).

As the HREEs are rarer and significantly higher priced than the LREEs, further investigation of the REE potential at Kalkaroo is definitely warranted as a high priority.

Total REE concentrations and La/Yb ratios (a measure of the ratio of light to heavy REEs) of the Havilah data are broadly comparable with data from other Australian REE deposits, such as the LREE enriched carbonatite at Mt Weld and the HREE rich carbo-fluoro-thermal deposits in Browns Range.

A key conclusion from detailed analysis of the geochemical data is that the REE enrichment and the shapes of chondrite normalised REE fractionation patterns in samples from Kalkaroo, Benagerie Dome, Eurinilla, Birksgate and Croziers are almost identical to those associated with the major global carbonatite REE deposits and their associated carbo-halo-hydrothermal fluid generated fenite haloes. In particular, there is remarkable geochemical similarity to carbonatites from Bayan Obo in China, the world's largest REE deposit (Smith et al., 2007, 2015), This has very positive implications for Havilah's future exploration outcomes.

Results of the study indicate that the REEs, the HFSEs and precious metals like Au and presumably also PGEs (cf. Impact Resources) in the Curnamona Craton were derived from Neoproterozoic plume generated mafic to ultramafic alkaline intrusions, some of which are associated with carbonatites. It is significant that many of the REE-rich sample locations are coincident with magnetic highs or lows and large elliptical zoned structures up to 5 x 4 km in size (e.g., Kalkaroo). They are remarkably similar to the magnetic signatures reported from differentiated and zoned alkaline intrusions by Thomas et al., (2016). The alkali metasomatism (or fenitisation) that is commonly associated with carbonatitic alkaline magmatism is crucial to the transport of REE and HFSE elements during late-stage magmatic hydrothermal mineralising activity. Thus an understanding of the fluid regimes and transport of REE in and around alkaline complexes is important to improve mineral system models in order to target the higher value REE and thus to identify potentially economic REE resources.

The geochemical evidence clearly shows that the prospectivity of the area is very high for alkaline generated REE-Cu-Au-Co-Ni-PGE systems. Discovery success will have positive commercial benefits for Havilah given the projected increased demand for REE in a variety of modern age applications. This provides a compelling scientific case for concerted REE exploration in the Curnamona Craton. Although the mineral system is still poorly understood, current exploration models employed by Havilah should be expanded to explore for buried alkaline intrusive complexes and the frequently associated carbonatite rocks.

Furthermore, given the style of copper-gold deposits in the Curnamona Craton there could be significant economic benefit to Havilah derived from producing a REE concentrate as a by-product of the copper-gold concentration process. This could potentially provide an economic advantage for the Kalkaroo project, compared to those projects that are solely REE based.

Several important recommendations for further work are provided in the report, including routine analysis for REE during future exploration programs. In my opinion, the immediate priority is to initiate detailed studies into the REE hosting minerals and the ability to recover these minerals by trialing various separation techniques on suitable samples. **It is highly recommended that such studies should commence on samples from the advanced Kalkaroo project. Project economics will be positively impacted if Havilah can demonstrate successful recovery of a REE mineral concentrate from run of mine Kalkaroo sulphide and oxide ore. Additionally, this study shows that Kalkaroo is advantaged in having the highest proportion of the more valuable HREE.**

Table of key abbreviations

ICPMS	Inductively Coupled Plasma Mass Spectrometer	
REE	rare earth elements	
HREE	heavy rare earth elements	
LREE	light rare earth elements	
REO	rare earth oxides	
TREO	total rare earth oxides	
REY	rare earth elements and yttrium	
REYO	rare earth element oxides and yttrium	
TREY	total rare earth elements and yttrium	
TREYO	total rare earth element oxides and yttrium	
La	Lanthanum	LREE
Ce	Cerium	LREE
Pr	Praseodymium	LREE
Nd	Neodymium	LREE
Sm	Samarium	LREE
Eu	Europium	LREE
Gd	Gadolinium	HREE
Tb	Terbium	HREE
Dy	Dysprosium	HREE
Ho	Holmium	HREE
Er	Erbium	HREE
Tm	Thulium	HREE
Yb	Ytterbium	HREE
Lu	Lutetium	HREE
Y	Yttrium	REE
Sc	Scandium	RARE METAL
Co	Cobalt	TECHNOLOGY METAL
W	Tungsten	TECHNOLOGY METAL
U	Uranium	
Th	Thorium	
IOCG	iron oxide copper gold	
PGE	Platinum Group Element	

1. Introduction and Scope

This report is an abridged summary of a comprehensive report that was commissioned by Havilah Resources Limited (**'Havilah'** or **'the Company'**) to provide a technical and commercial framework to assess the significance and development potential of elevated rare earth elements (REEs) in re-assayed drill core samples from the Kalkaroo copper-gold-cobalt deposit and the Croziers copper prospect (ASX announcement of 18 December 2019). Re-assays of samples were undertaken, because analytical techniques used in many historical data sets were not appropriate for dissolution of refractory minerals. These refractory minerals typically host the REEs as well as the high field strength elements (HFSEs) e.g., Ti, Nb, Ta, Zr and Hf. The results reported by Havilah clearly demonstrated the importance of acquiring multi-element assay data by fusion dissolution ICPMs.

This report reviews the REE potential of Havilah's tenements in the Curnamona Craton, South Australia (ASX Announcement January 7, 2020). Data reviewed include a large trace element assay data base from MMG Exploration, Havilah's former joint venture partner, as well as Havilah's re-assayed samples.

The review addresses the following:

- The significance of the REE concentration data.
- Are the levels of LREE and HREE potentially of economic significance?
- Comparison of these data with other Australian and global deposits?
- What do the REEs and other trace element systematics indicate about the source of the REE and thus the mineral system?
- Do the REE and other trace element systematics indicate local or regional scale mineralisation?
- What do the data indicate about the geodynamic controls on mineralisation?
- What are the implications of these interpretations for exploration and discovery potential?
- Recommendations for further work.

2. Drivers for REE Exploration

In recent years, there has been high growth in the use of rare earth metals. REEs are now widely used in electronic manufacturing, communications, military defence systems, medicine, medical devices and in emerging clean energy technologies (e.g. Eliseeva and Bünzli 2011; Chakhmouradian and Wall, 2012; Grandell et al., 2016).

In fact, the REEs, along with the platinum group elements (PGEs), Li, Mg, V, Cr, Co, Mn, Ni, Ga, Nb, Mo, In, Sb, Te, Ta and W, are essential ingredients for modern technologies. In view of their importance, they are regarded as "critical elements" (e.g. European Commission, 2017; Lee et al., 2018). REEs with short- and long-term supply risk (Dy, Tb, Y, Nd , Y and Eu) are depicted in Figure 1. All are important for clean energy applications.

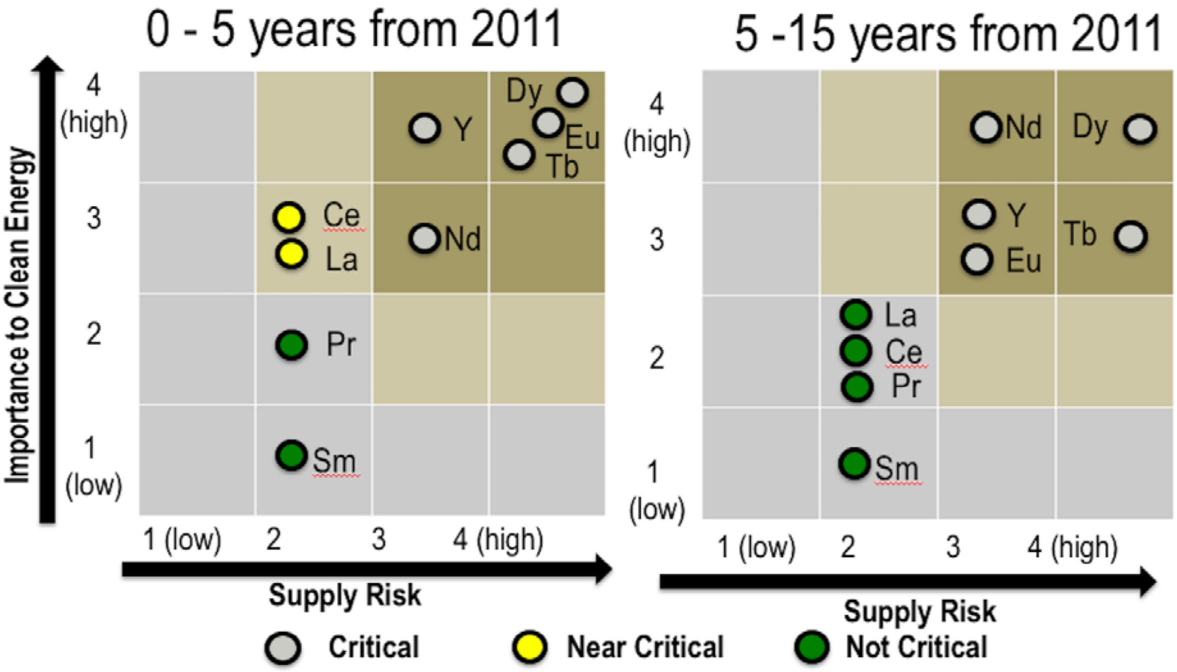


Figure 1: Matrix showing REE supply risk and importance used to define "critical materials". From DOE Strategic Materials Strategy Dec. 2011

In view of rapid growth in the green energy sector, it is anticipated that global demand for REEs will increase continuously in the next decade. This growth will put pressure on the current REE supply from China (84% in 2016; Zhou et al., 2017), who produce light REEs from carbonatite-hosted deposits and heavy REEs from low-grade ionic clay deposits.

Like many of the critical elements, supplies of REEs are dominated by a single producer, China. Thus, pricing and supply of REEs, and the myriad of industries that rely on them, may be affected by supply restrictions. For example, the decision by China to impose rare earth export quotas, caused a significant spike in REE prices (Hatch, 2012a).

Although a ruling by the World Trade Organisation (WTO) removed quotas causing prices to return to pre-quota levels (Weng et al., 2015), this event nevertheless demonstrated the need to identify new, globally distributed and abundant resources of the REEs.

Increasing global demand for these critical elements and concerns regarding the security of supply, due to political, technological, spatial, economic, geological, social or environmental risks, has therefore stimulated a global effort to identify new sources of supply (e.g., Wall et al., 2017).

This pressure on supply was again threatened when China considered limiting exports of REEs to the USA during the 2019-2020 trade war.

3. REEs - the Vitamins of New Technologies

The shift from traditional energy sources towards green energy alternatives, such as solar cells, electric vehicles, and wind turbines, is becoming a global movement. The transition has led to a rapid surge in demand for a critical commodity: the REEs. They are crucial for manufacturing a broad array of high-tech products, devices, and technologies that have widespread application in the medical, defence, aerospace, and automobile industries.

The global market of REE-based products is estimated to be worth 1.5 – 2 trillion US dollars, based on trade information and REE contents of manufactured goods (Dutta et al., 2016). According to the United States Geological Survey (USGS) 2016 report, the annual growth rate of global REE demand is expected to increase by 5% by 2020. It is therefore essential for REE-consuming states to create or align supply chains for REEs, to maintain current technologies and to enable development of new advanced technologies.

REE demand is divided into five major segments: permanent magnet materials, catalytic materials, luminescent materials, polishing materials and hydrogen storage materials (Table 1). With the rapid development of global high-tech industries, REEs will be more extensively used in these technology fields and consumption of new materials containing REEs will grow rapidly. Wind power, new-energy vehicles, smart phones, wearable electronics and other industries related to REEs will place growing demand on REE supply chains.

Table 1: Uses of Rare Earth Elements

Applications	Examples	Rare Earth Element
Light Weight Powerful Magnets	Automobiles Electronics Speakers Wind Turbines	Nd, Pr, Sm, Dy, Tb
Military Applications	Night Vision Goggles Laser range-finders, guidance systems, communications Fluorescents and phosphors in lamps and monitors Amplifiers in fibre-optical data transmission Precision-guided weapons, “white noise” production in stealth technology	La Nd Eu Er Sm
Nuclear Reactors	Control rods Shielding	Eu, Sm. Lu Gd
Solar Cells		Tb
Fuel Cells		Sc, Tb
Lasers		Ce, Nd, Pr, Ho, Yb
Catalysts	Automotive Catalyst Clean diesel Oil Refining	Lu La, Ce, Nd, Pr, Sc Lu
Hybrid Vehicles	Electric motors and generators Storage batteries	La, Nd, Pr, Dy, Tb Nd, Ce
Energy efficient lights	Light bulbs	Eu, Tb, Y, Sc
Polishing powders	TV and Computer Screens LCD, Plasma, CRT Optical lenses Precision optical and electronic components	Ce, La, Pr, Sc
Medical Applications	Contrast agent for NMR Cancer treatment Genetic screening tests	Gd Sm, Y Eu
Glass additives	Phosphors Small optical lenses TV and computer screens CRT screens to stabilise glass from cathode rays	Nd, Yb, Sc, Y Ce, La, Gd, Er, Tb
Alloys	Aerospace frames Stainless steel	Sc Yb, Ce
Ceramics		Ce, La, Pr, Dy, Er, Gd, Ho

4. Rare Earth Element Chemistry

The REEs, comprise the bulk of the so-called "critical elements". They are a group of seventeen elements that include the fifteen lanthanide elements (lanthanum to lutetium), as well as scandium (Sc), and yttrium (Y), which have chemically similar properties (IUPAC, 2005). They are grouped according to atomic number (Figure 2) into the light rare earth elements (LREEs: La – Eu) and the heavy rare earth elements (HREEs: Gd to Lu).

The fifteen lanthanide elements are subdivided into the LREEs - lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), samarium (Sm), and europium (Eu); and the HREEs - gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu).

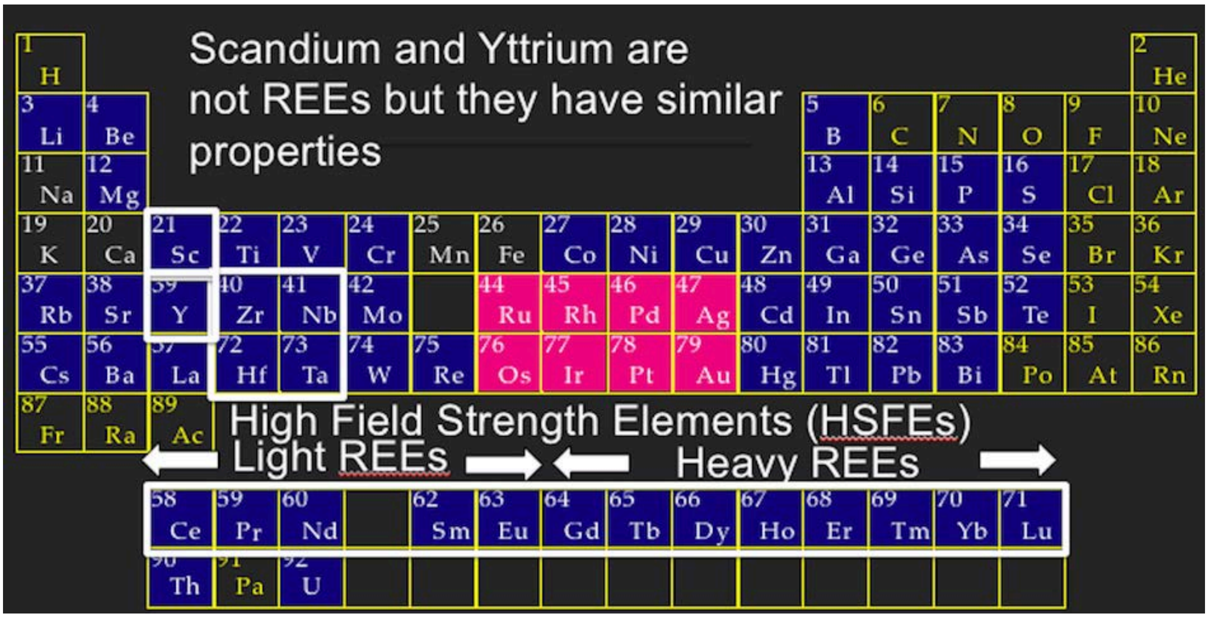


Figure 2: Position of the REEs (lanthanides) in the Periodic Table ranging in atomic number from La (n = 57) to Lu (n = 71)

Despite their low atomic number, yttrium (n = 39) and scandium (n = 21) are included with the HREE lanthanides because their ionic radii and behavioural properties are closer to the HREE than to the LREE. Yttrium is an excellent pathfinder for the presence of HREEs in rock samples. Furthermore, in exploration, Ce, La, Nd and Y can all be determined in the field by handheld x-ray fluorescence spectroscopy (p-XRF). This provides a real time opportunity to locate LREE-rich and HREE-rich in rock chips and soils during field work, or when logging drillcore.

Although scandium is classified as a REE, it behaves very differently from the rest of the lanthanides. This is because Sc has an ionic radius similar to iron and magnesium, and thus it substitutes in major ferromagnesian rock-forming minerals, in particular clinopyroxene.

The LREE are generally more abundant, and less valuable than the HREE. Furthermore, REEs with even atomic number are more abundant than their neighbours with odd atomic numbers, because of their greater relative stabilities of atomic nuclei. This is known as the Oddo-Harkins Rule. This is discussed further below.

4.1 How Rare are the Rare Earths?

Many of the rare earth elements are not particularly rare. For example, Ce and Y are the 25th and 30th most abundant elements by mass, significantly exceeding the abundance of Sn, Hg and Mo and most of the precious metals (Rudnick and Gao, 2003). However, the crustal abundances of many of the other REEs, particularly the valuable HREEs are very small. For example, the atomic concentration of terbium (Tb) and thulium (Tm) are 2 and 5 times less abundant in the continental crust than Mo and 5 times less abundant in the continental crust than Cu. Furthermore, the solar abundances of lanthanides with odd atomic numbers are in fact lower than 94% of the remaining elements, including Au, Pt and the other PGEs (Anders and Grevesse, 1989).

4.2 Portraying REE Chemical Variations

In terrestrial rocks and meteorites, the REEs with even atomic numbers are more abundant than the adjacent REE with odd atomic numbers. This reflects the Oddo-Harkins Rule and is caused by differences in binding energies and thus relative stabilities of nuclei with paired and unpaired nucleons. To overcome this pattern, REE abundances are normalised to the measured REE abundances in chondritic meteorites, such as C1 chondrites - the composition of the solar nebular (Anders and Grevesse, 1989). The normalised REE data are then arranged in order of increasing atomic numbers from La to Lu and plotted on a logarithmic scale. ***Ore-grade hard rock deposits must have LREE (La to Eu) abundances that >1,000 to 10,000 chondritic levels and the HREE (Gd to Lu) abundances >1,000 times chondrites.*** Chondrite normalised plots showing the REE fractionation patterns in Australian REE deposits are given in Figure 3.

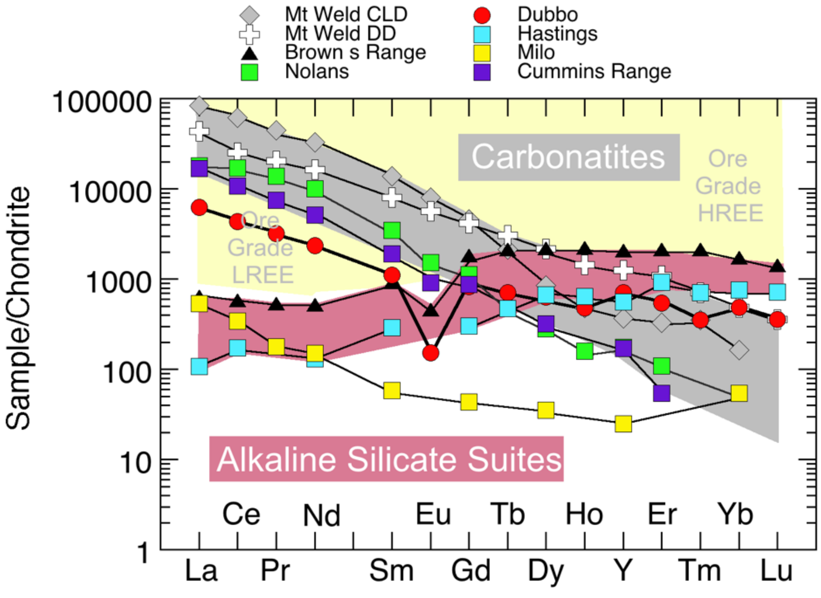


Figure 3: Chondrite normalized REE plot comparing LREE dominated Mount Weld, Nolans Bore and Dubbo (Toongi) mineralization with HREE enriched Browns Range mineralization.

A second projection to portray REE fractionation (La/Yb) against REE concentration, developed by Loubet et al., (1972), also shows the compositional range for a number of REE-bearing igneous systems (e.g. basalts, kimberlites and carbonatites). I have now amended this projection to also show the REE systematics in differentiated alkaline intrusions, A-type granites and in systems affected by fluoro-carbo-thermal fluids and volatiles liberated from REE-bearing alkaline intrusions. Importantly, for companies targeting HREE mineralisation, fluoro-carbothermal systems are commonly characterised by very low La/Yb ratios and high concentrations of HREEs (>5,000 ppm). An example of such a deposit, is Browns Range in Western Australia being developed by Northern Minerals to become the first significant non-China based producer of dysprosium (http://northernminerals.com.au/browns-range/overview/).

The REE-rich, LREE dominated carbonatite-hosted deposits shown in Figure 4 have elevated La/Yb ratios greater than 80 (e.g., Mount Weld, Mrima Hill and Mountain Pass). These deposits are distinct from deposits rich in HREE's hosted by agpaitic alkaline igneous suites with La/Yb ratios between ~2 and ~80.

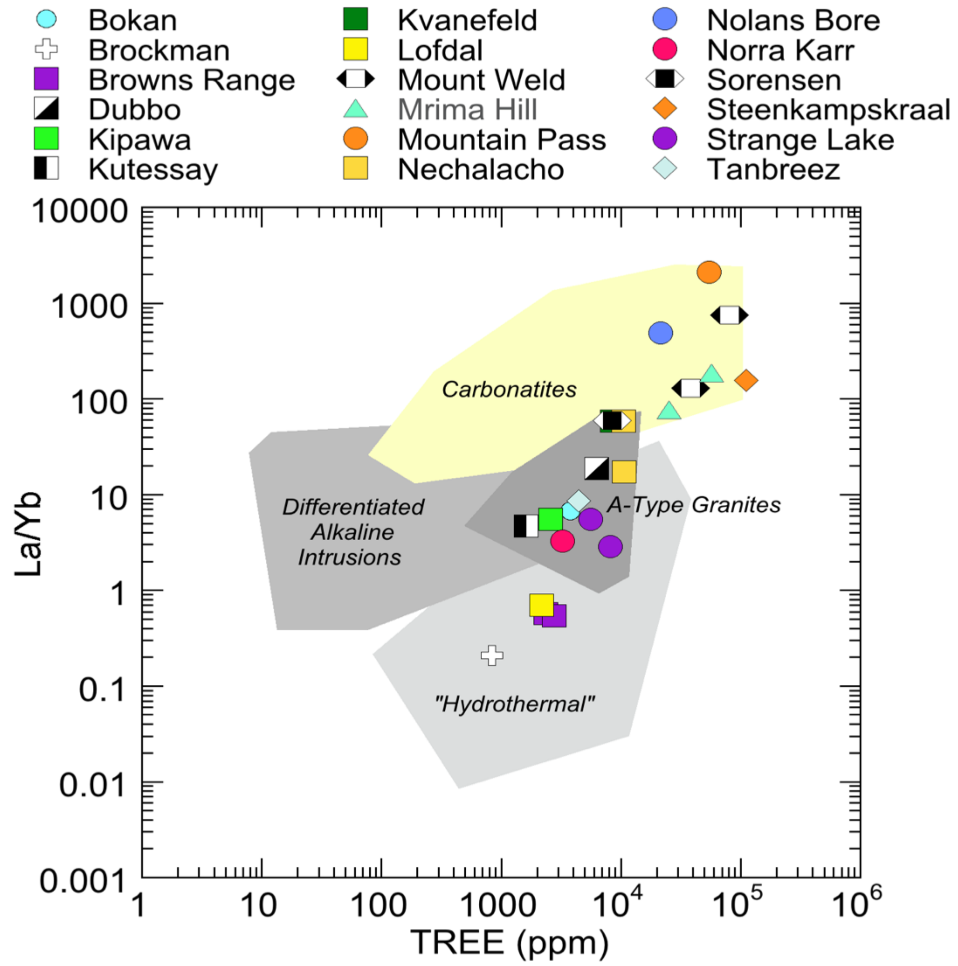


Figure 4: Comparison between total REE content and ratio of light REEs to heavy REE in current and development deposits. Data from Hatch (2012b)

REE deposits with the lowest La/Yb ratios, and the most HREE enrichment, generally form by precipitation of REEs that are mobilised and transported in hydrothermal (carbo-fluoro thermal) fluids. These deposits contain HREE-rich minerals, like xenotime, that are precipitated in metasomatic "fenite" aureoles that surround alkaline intrusions due to reaction between carbo-fluoro thermal fluids and adjacent country rocks (Elliott et al., 2018). These reactive acidic fluids also migrate along faults that act as plumbing systems for fluid transfer. Examples include

Browns Range in Western Australia (Cook et al. 2013), the HREE enriched systems at the Lofdal carbonatite in Namibia (Bodeving et al., 2017) and the Songwe Hill carbonatite in Malawi (Broom-Fendley et al., 2017).

As shown in this report, the REE systematics of cores from Havilah's tenements in the Curnamona Craton, appear to have been strongly influenced by hydrothermal processes.

5. Rare Earth Mineral Systems

REE-bearing minerals systems are classified according to host rock or host environment. First, deposits where the REEs are the principal commodity extracted. These include:

- Carbonatite and carbonatite-related deposits;
- Laterite deposits above carbonatites, where REE concentrations are enhanced by weathering processes;
- Carbo-fluoro thermal replacement deposits;
- Peralkaline hosted deposits;
- Ion adsorption clay deposits; and
- Placer deposits.

The second category comprises deposits that contributed to historical production of REE, such as:

- monazite ± apatite veins
- REE-bearing uranium deposits
- phosphate rocks

A third category includes future HREE-enriched deposits that have recently been discovered in deep sea pelagic muds in the Pacific and Indian Oceans.

Principal REE deposits are shown in Figure 5. Australian REE deposits are shown in Figure 6.

Figure 5: Map showing the global examples of different REE mineral systems

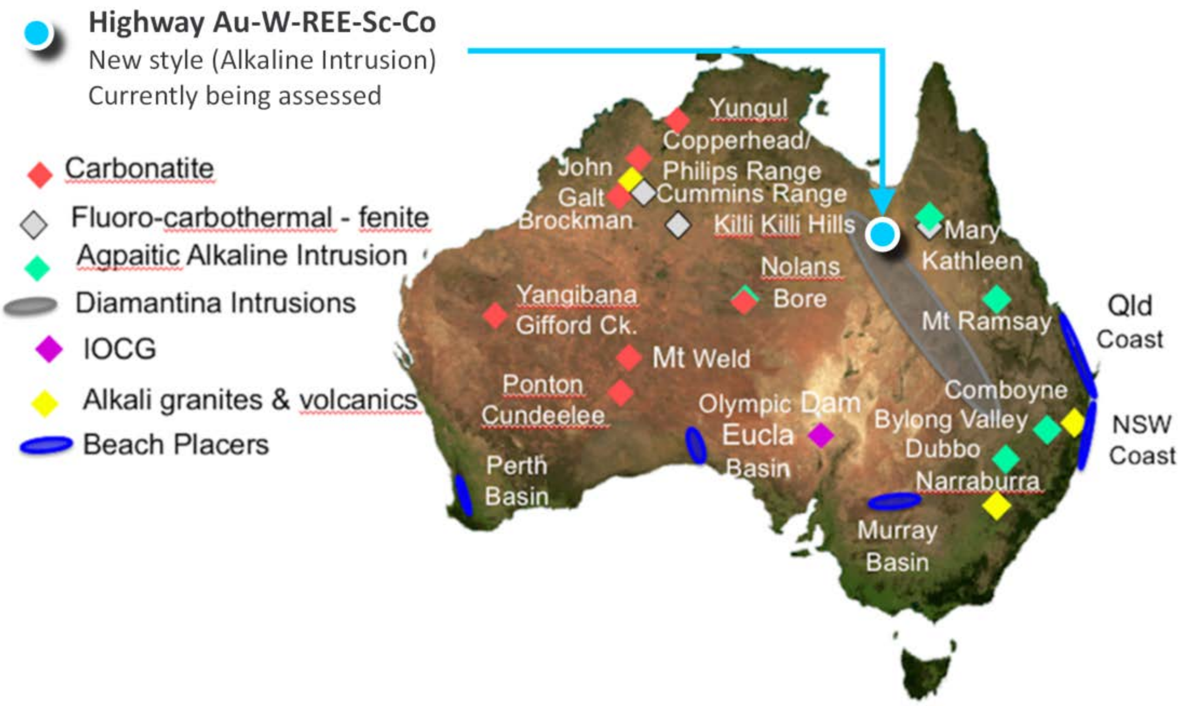


Figure 6: Locations of REE deposits and potential host rocks in Australia

6. Sample Localities in Havilah's Tenements in the Curnamona Craton

Localities of MMG and Havilah samples reviewed in this study are shown in Figure 7. A number of sample locations occur over magnetic highs or lows. On closer inspection some appear to be large elliptical zoned structures up to 5 x 4 km in size (e.g., Kalkaroo; Figure 8). They are remarkably similar to the magnetic signatures reported from zoned alkaline intrusions (e.g., Thomas et al., 2016).

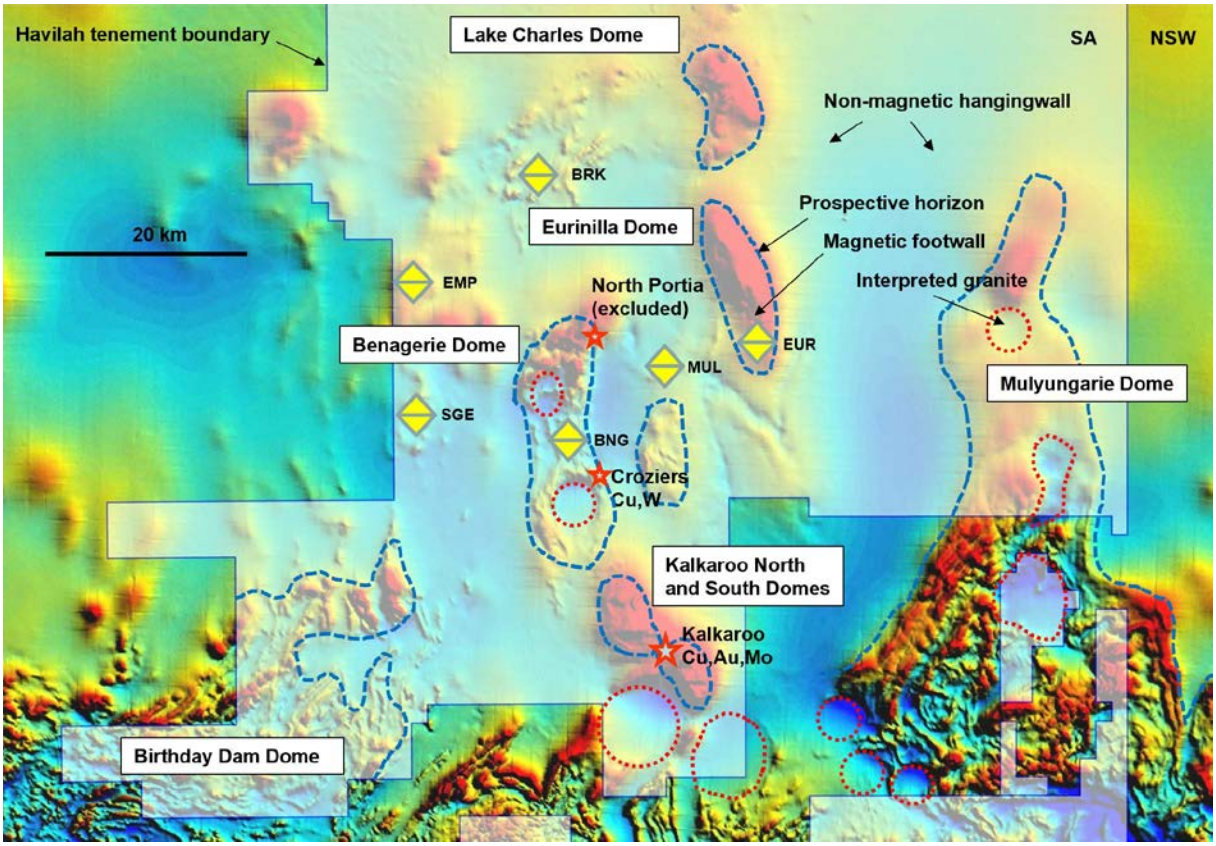


Figure 7: High resolution magnetic image of Havilah's tenure in the central Curnamona Craton showing sample locations.

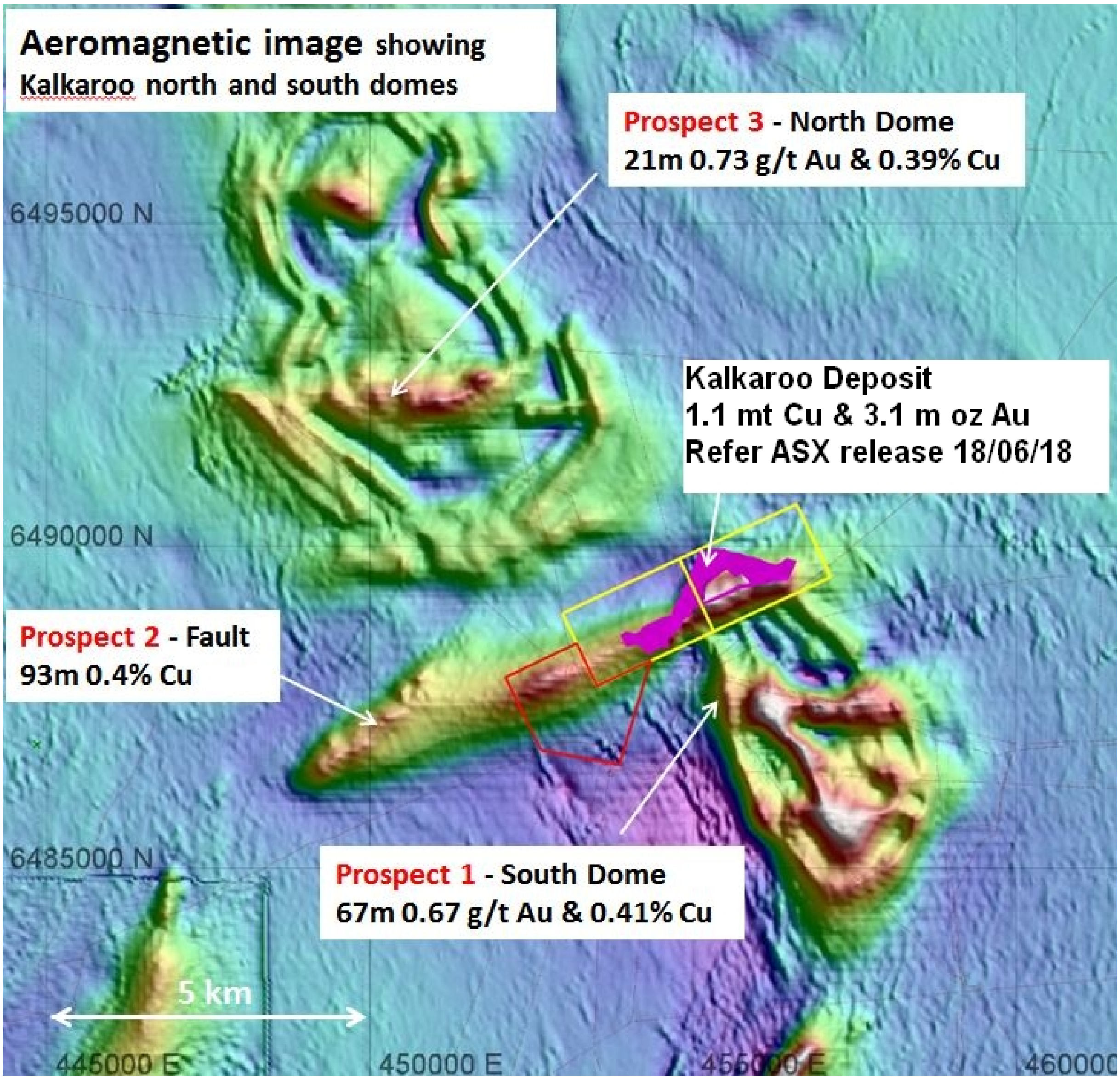


Figure 8: Concentrically zoned magnetic features at Kalkaroo.

7. Study Results

Multi-element data supplied by Havilah for samples from locations shown in Figure 7 was carefully analysed in order to answer several key question as summarised in the following discussion. A summary REE oxide concentrations is given in Table 2.

Table 2 Maximum Sc, Y and REE abundances (ppm) and total REYO and HREYO values (ppm) in samples from Havilah's Tenements

	Benagerie Dome	Birksgate	Eurinilla	MUL	Kalkaroo	Croziers
Sc	95	78	20.9	36.9		
La	5410	2490	1890	500	2150	9600
Ce	5960	1250	551	6760	2030	9900
Pr	426	537	1001	90	366	735
Nd	1075	1585	3190	317	1355	1700
Sm	88.5	193	347	52	236	117
Eu	16	25	42.3	8.88	51.2	16.3
Gd	76.8	101	118	32.4	186	35.5
Tb	11.2	12.3	15.4	4.6	21	3.82
Dy	65.6	59.6	65.9	24.1	103.5	19.5
Ho	13	10.1	10.5	4.47	18	3.01
Y	384	254	219	118	572	86.4
Er	40.4	29.3	24.5	11.5	51.3	6.77
Tm	5.9	4.1	2.98	1.57	6.85	0.46
Yb	36	26.4	18.1	9.11	41.9	4.58
Lu	5	3.9	3.03	1.41	6.58	0.78
Total REYO	1.57 wt.%	6460	8425	9076	8482	2.60 wt.%
Total HREYO	733	512	542	238	1232	207

As shown below, many of the Havilah samples exhibit ore grade levels of REE enrichment and thus the area is clearly highly prospective. But the mineral system is poorly understood.

7.1 Chondrite Normalised REE Plots

Chondrite normalized REE plots for representative analyses from Kalkaroo, Benagerie Dome, Eurinilla, Birksgate and Croziers are shown Figure 9. These chondrite normalised REE data were produced using normalizing data from McDonough and Sun 1995. The data define smoothly fractionated trends from LREE enriched to HREE depleted patterns. Some patterns have slightly negative Eu anomalies and negative Y/Ho ratios that reflect the influence of fluorite crystallisation and fluorine fractionation respectively (Buhn, 2008). Some samples e.g., Birksgate, Kalkaroo and Eurinilla, exhibit negative Ce anomalies similar to those reported from carbonatites (Loubet et al., 1972; Moller et al., 1980; Hornig-Kjarsgaard, 1998).

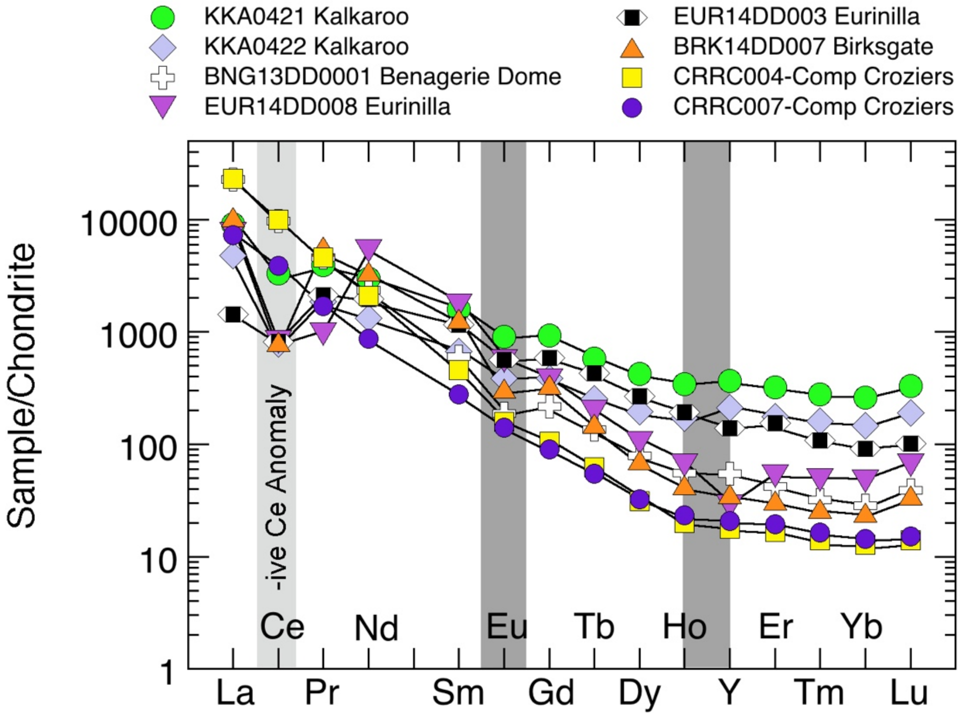


Figure 9 Chondrite normalised plot showing representative patterns from Havilah's projects. Some patterns show negative Ce anomalies. Others show slightly negative Eu anomalies due to fluorite removal and negative Y/Ho ratios that reflect the influence if fluorine fractionation.

The REE patterns from Kalkaroo, Benagerie Dome, Eurinilla, Birksgate and Croziers are compared with the typical chondrite normalised fields seen in carbonatites, agpaitic undersaturated alkaline suites and carbothermal secondary deposits in Figure 10. It is clear that the smoothly fractionated shape of the Havilah samples is remarkably similar to that exhibited by carbonatites.

This REE compositional field for samples from Kalkaroo, Benagerie Dome, Eurinilla, Birksgate and Croziers exhibit almost identical abundance levels and chondrite-normalised REE fractionation patterns to carbonatites from Bayan Obo (Figure 11). Bayan Obo mine in China (Inner Mongolia Province), is the world's largest REE deposit and is interpreted to be a highly altered carbonatite system (Smith et al., 2007, 2015).

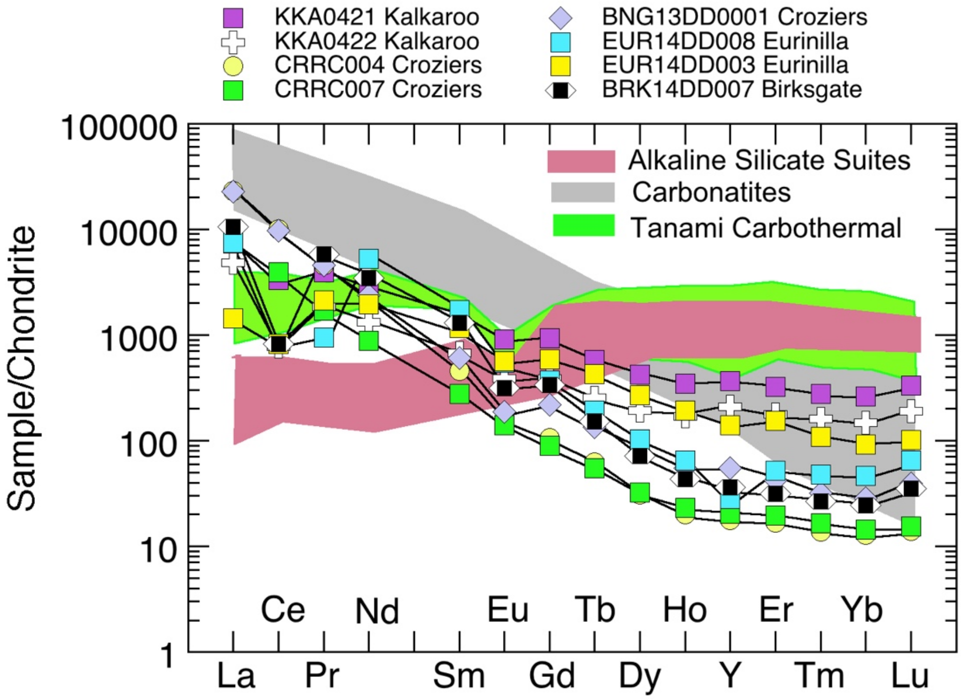


Figure 10: Havilah REE patterns superimposed on typical field exhibited by carbonatites, agpaitic undersaturated alkaline suites and carbothermal secondary deposits. The smoothly fractionated shape of the Havilah data is remarklably similar to that shown by carbonatites.

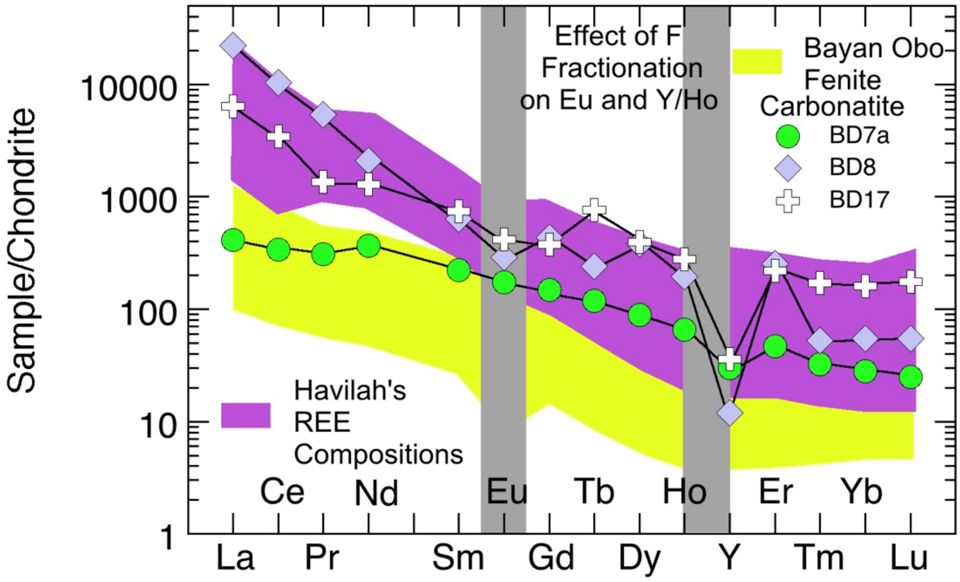


Figure 11: Havilah REE field superimposed on the REE patterns for Bayan Obo carbonatites and fenites (data from Wang et al., 2018. Note the similarity in shape of the Bayan Obo and Havilah REE patterns.

7.2 La/Yb versus Total Rare Earth Projection

The La/Yb ratio (a proxy for LREE/HREE ratio) versus total REE diagram is an extremely valuable projection to show REE sources. Figure 12 (modified after Loubet et al.,1972) shows variation in REEs and La/Yb ratios in MMG samples. Samples from Benagerie Dome, Birksgate, Eurinilla, Mulyungarie and SGE plot within the field of enrichment shown by carbonatites, in which increasing TREE content is positively correlated with an increase in La/Yb ratio (i.e., LREE/HREE ratio). This enrichment is most likely due to igneous fractionation. A second trend at a TREE content of 0.1 wt.% is also present, but this is associated with a large variation in La/Yb, extending from ~100 to ~6. This enrichment in HREEs is believed to be caused by fractionation in carbo-halo-hydrothermal fluid. These >1000 ppm HREE rich domains are potential economic targets.

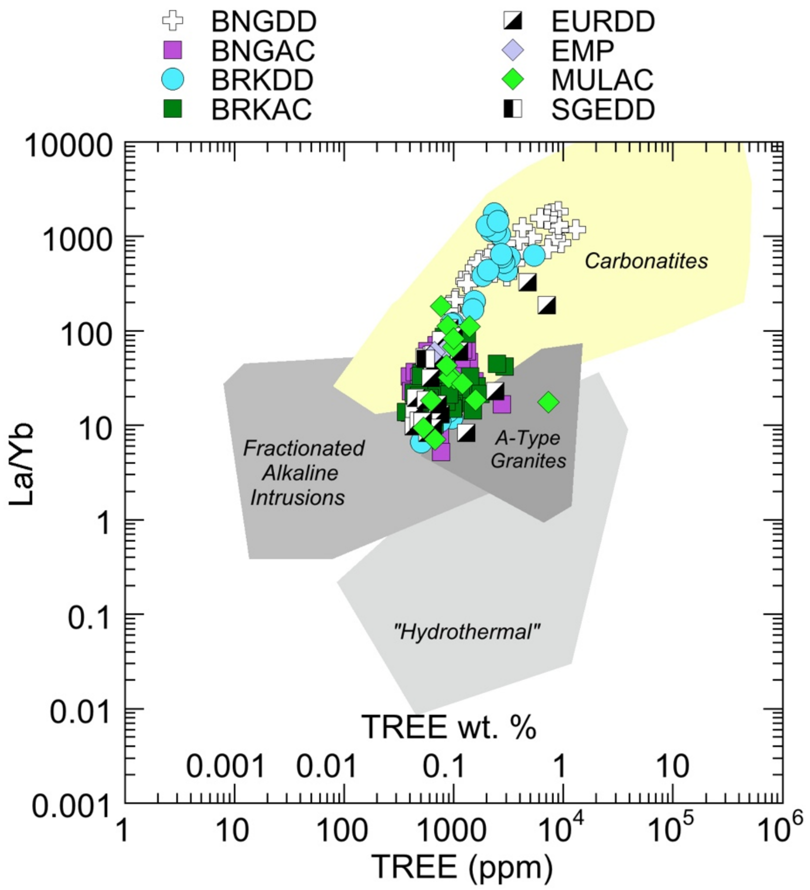


Figure 12: Variation in REEs and La/Yb ratios (modified after Loubet et al., 1972) in MMG samples. Samples from Benagerie Dome, Birksgate, Eurinilla, MUL and SGE plot within the field of enrichment shown by carbonatites with progressive increase in TREE content correlating with an increase in La/Yb ratio (i.e., LREE/HREE ratio). This most likely reflects enrichment due to igneous fractionation . A second trend is also present at a TREE content of 0.1 wt.% but with a large variation in La/Yb that extends from ~100 to ~6. This shows the presence HREE rich domains with containing ~1000 ppm REEs. This enrichment in HREEs is believed to be caused by fractionation in carbo-halo-hydrothermal fluid.

Samples from Croziers, and Birksgate (Figure 13) also plot within the field of enrichment shown by carbonatites, with progressive increase in TREE content correlating with an increase in La/Yb ratio (i.e., LREE/HREE ratio). Samples from Croziers exhibit the most extreme LREE enrichment with some containing ~2 wt. % TREE. By contrast Kalkaroo and Eurinilla samples fall on the trend caused by carbo-halo-hydrothermal fluid fractionation, with more HREE enrichment La/Yb ratios <40 and total REEs up to 0.6 wt%.

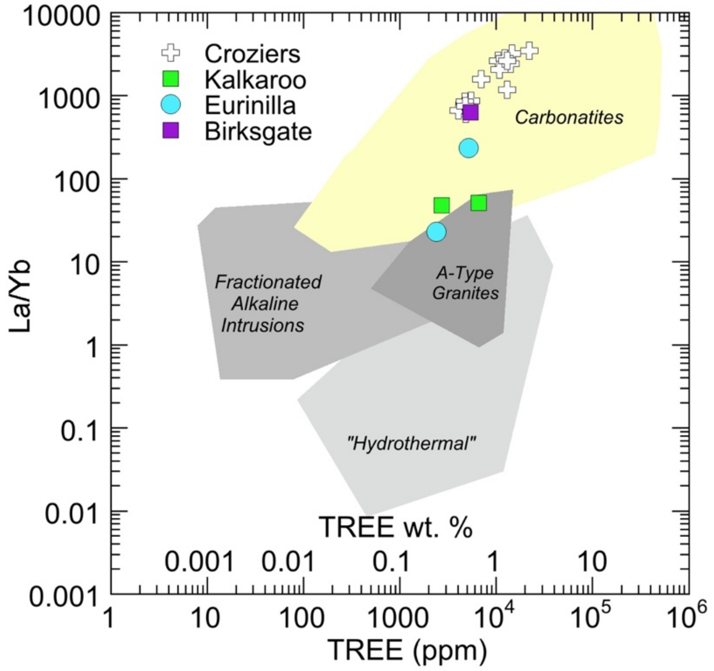


Figure 13: Variation in REEs and La/Yb ratios (modified after Loubet et al., 1972) in Havilah samples. Samples from Croziers, Kalkaroo, Eurinilla and Birksgate plot within the field of enrichment shown by carbonatites with progressive increase in TREE content correlating with an increase in La/Yb ratio (i.e., LREE/HREE ratio). Samples from Croziers show the most extreme LREE enrichment. A second trend is also present at a TREE content of 0.1 wt.% but with a large variation in La/Yb that extends from ~100 to ~6. This shows the presence HREE rich domains with containing ~1000 ppm REEs. This enrichment in HREEs is believed to be caused by fractionation in carbo-halo-hydrothermal fluid.

8. Summary and Recommendations

8.1 The significance of the REE concentration data

Rare earth element concentrations reviewed in this study indicate the significant and hitherto largely unrecognised REE potential of Havilah's tenements in the Benagerie Ridge portion of the Curnamona Craton.

Samples from different locations exhibit considerable variation in REE abundance and LREE to HREE fractionation shown by the large variation in La (LREE) to Yb (HREE) ratios e.g., Croziers 10,282 ± 5379 ppm (La/Yb = 1896±1035); Kalkaroo 4671± 2255 (La/Yb = 49.7± 1.9); Benagerie Dome 1975 ± 2466 ppm (La/Yb = 292±447); MUL 1411 ± 1799 (La/Yb = 54.4 ± 53.1) ; Birksgate 1168 ± 878 ppm (La/Yb = 203±409) and Eurinilla 1172± 1485 (La/Yb = 56.9±69.1). Kalkaroo with a mean La/Yb ratio of 49.7 has the highest concentration of HREEs (mean HREE = 319 ± 134).

As the HREEs are rare and significantly higher priced than the LREEs, further exploration at Kalkaroo is warranted.

Maximum calculated TREY oxide concentrations occur in samples from Croziers and Benagerie Dome up to 2.6 wt.% and 1.57 wt.% respectively. However TREY oxide concentrations in samples from the other locations, i.e., Birksgate (6460 ppm), Eurinilla (8425 ppm), MUL (9076 ppm) and Kalkaroo (8482 ppm) are still quite elevated.

Scandium concentrations in samples from Havilah's tenements are clearly significantly anomalous with many containing > 50 ppm Sc, cf., the crustal undanced of 12 ppm. Assuming that the REEs could all be separated into a liquid phase during processing, Sc could easily be recovered and contribute to the basket value of the metals recovered.

8.2 Are levels of light REES and heavy REES potentially of economic significance?

Ore-grade hard rock REE deposits must have LREE (La to Eu) abundances ranging from >1000x to 10000x chondritic levels, and the HREE (Gd to Lu) abundances > 1000 times chondrites.

As many of the Havilah samples exhibit such levels of REE enrichment, the area is clearly very highly prospective for economic REE deposits.

However, the mineral system is still poorly understood and the exploration model should be broadened to explore for buried alkaline intrusive complexes and associated carbonatites.

8.3 Comparison of these data with other Australian and Global deposits?

Total REE concentrations and La/Yb rations (ratio of light to heavy REEs) of the Havilah data are broadly comparable with data from other Australian REE deposits, such as the LREE enriched carbonatite at Mt Weld and the HREE rich carbo-fluoro-thermal deposits in Brown Range.

Total REE concentrations and La/Yb rations (ratio of light to heavy REEs) of the Havilah data are almost identical to some of the major global REE resources, in particular Bayan Obo in China.

8.4 What do the REEs and other trace element systematics indicate about the source of the REEs and thus the mineral system?

Many of the REE-rich sample locations are from magnetic highs or lows, possibly large elliptical zoned structures up to 5 x 4 km in size (e.g., Kalkaroo). They are remarkably similar to the magnetic signatures reported from differentiated and zoned alkaline intrusions by Thomas et al., (2016).

Trace element covariations of transition elements confirm the strong influence of ultramafic to mafic fractionation. For example Cu and Ni samples from Benagerie Dome ranges up to ~9000 ppm and ~ 600 ppm respectively. Ni and Co are also positively correlated with the highest Co values, ~650 ppm, in samples from Birksgate, Eurinilla and MUL. Ni and Cr up to ~100 ppm and 200 ppm respectively display a weak positive correlation in samples from Birksgate. This positive correlation is additional evidence for fractionation of a mafic magma, possibly with the crystallisation of ultramafic cumulates.

Samples from Croziers, and Birksgate also plot within the field of enrichment shown by carbonatites, with progressive increase in TREE content correlating with an increase in La/Yb ratio (i.e., LREE/HREE ratio). Samples from Croziers exhibit the most extreme LREE enrichment with some containing ~2 wt. % TREE. By contrast Kalkaroo and Eurinilla samples fall on the trend caused by carbo-halo-hydrothermal fluid fractionation, with more HREE enrichment La/Yb ratios <40 and total REEs up to 0.6 wt%.

Covariation plots for P, TREE (ppm), Y (ppm), HREEY/TREEY ratio and HREYO in MMG analyses from Benagerie Dome, Birksgate, Eurinilla and Mulyungarie shows that P and TREE are broadly positively correlated which suggests the substitution of REEs into a phosphate, possibly LREE-rich fluorapatite. The highest Y bearing samples from Benagerie Dome, Birksgate and Eurinilla with ~1000 ppm P, might reflect the presence of xenotime. The negative correlation between P and HREEY/ TREEY suggests the presence of other HREE bearing minerals in addition to phosphates.

8.5 Do the REEs and other trace element systematics indicate local or regional scale mineralisation?

Kalkaroo, Benagerie Dome, Eurinilla, Birksgate and Croziers have chondrite normalized REE patterns that are almost identical to abundance levels and fractionation patterns in carbonatites from Bayan Obo, the world's largest REE deposit that is interpreted to be a highly altered carbonatite system (Smith et al., 2007, 2015). The Havilah REE data also yield similar shaped chondrite normalised REE fields to that of fenites from Bayan Obo.

Alkali metasomatism (or fenitisation) is commonly associated with carbonatitic alkaline magmatism and plays an important role in the transport of REE and HFSE elements during late-stage magmatic hydrothermal mineralising activity. Thus an understanding of the fluid regimes and transport of REE in and around alkaline complexes is important to improve mineral system models in order to target the higher value REE and thus to identify potential economic REE resources.

8.6 What do the data indicate about the geodynamic controls on mineralisation?

Results of the study indicate that the REEs, the HFSEs and precious metals like Au and presumably also PGEs (cf. Impact Resources) in the Curnamona Craton were derived from Neoproterozoic plume generated mafic to ultramafic alkaline intrusions, some of which are associated with carbonatites.

This plume model is confirmed in plots of Ta/U_{PMN} versus Nb/Th_{PMN} Benagerie Dome (BNG), Birksgate (BRK), EMP, MUL and SGE samples all lie in the plume field. Samples from Eurinilla are crustally contaminated and thus extend from the plume field towards lower crustal Ta/U_{PMN} and Nb/Th_{PMN} ratios.

Notably, alkaline plume generated felsic, mafic and ultramafic alkaline lithologies have already been discovered at several locations in the Curnamona Craton in support of this concept.

8.7 What are the implications of these interpretations for exploration and discovery potential?

Importantly, the current study has provided a scientific rationale to broaden the exploration model to include REE for the entire Curnamona Craton, specifically to explore for buried alkaline intrusive complexes.

The prospectivity of the area is clearly very high for alkaline generated REE-Cu-Au-Co-Ni-PGE systems and thus a high level of commercial potential from discovery success. Although beyond the scope of this study, the Cu/Au ratios also clearly indicate an alkaline source for these elements.

8.8 Recommendations for further work.

To improve understanding of the mineral system in order to enhance exploration success, it is recommended that the following activities should be undertaken:

- All multi-element assay data should be obtained using fusion digestion and not 4 acid dissolution techniques.
- As there is clearly an ultramafic connection in the mineral system, all fire assays should include measurement of Pt and Pd (cf., Impact Resources discoveries at Broken Hill).
- A high resolution ground gravity survey or an airborne gradiometry survey should be undertaken to improve geophysical knowledge of the metal sources and improve interpretation of the magnetic data sets.
- In areas of thin cover, consideration should be given to undertaking a multi-element ultra-fine soil geochemical survey to improve identification of regional geochemical anomalism.
- A modern pXRF should be used routinely in the field to identify LHREE (La and Ce) and HREE (Y) samples.
- Litho-geochemical studies should be undertaken on selected cores specifically to identify REE-bearing mineral phases and to document evidence of fenitisation using cathodolumiescence. Samples should be selected following inspection of core intervals with highest total REEY and Sc contents. Polished thin sections should be prepared for petrographic description as well as EPMA or SEM characterisation.
- A geochronological study of U-Th bearing phases (e.g. titanite, zirconolite, xenotime etc.) that on post-date metamorphic fabrics, should be undertaken, either by LA-ICPMA or SHRIMP techniques, to resolve the age of alkaline magmatism and hence the establish the timing of mineralisation.
- There could be significant economic benefit from producing the REE concentrate as a by-product of the copper-gold processing. This could potentially provide an advantage for the Kalkaroo project, compared to those projects that are solely REE based.
- Detailed studies of the REE hosting minerals and the ability to recover these by trialing various separation techniques on suitable samples. It is recommended that such studies should commence on samples from the advanced Kalkaroo project in order to determine whether successful recovery of a REE mineral concentrate from run of mine ore is feasible.

Certificate of Qualified Person

I, **Emeritus Professor Kenneth D. Collerson**, am the Principal of KDC Consulting (KDC^2) at 33 Cramond St, Wilston, 4051 Queensland, Australia.

This certificate applies to this technical report titled:
" Technical Review of Havilah Resources Rare Earth Element Data from the Curnamona Craton, South Australia " that has an effective date of 7th February 2020.

I am a Fellow of the Australasian Institute of Mining and Metallurgy (#100125). I graduated in 1993 as Doctor of Philosophy (Geology) from the University of Adelaide, South Australia and also have a Bachelor of Science degree with 1st Class Honors from University of New England, N.S.W., Australia (awarded in 1997). Emeritus Professorial status at the University of Queensland acknowledges of my contribution to research, management and teaching in the University sector.

I have practiced my profession as a Principal Consultant with Salva Resources, HDR Salva and Caracle Creek (Toronto) and as a self-employed consultant for more than 35 years. As a Principal Consultant in mineral exploration I have an excellent record of discovery. I have worked on a variety of multi-commodity metals exploration projects through high-level consulting activities in more than 15 countries.

In a consultancy for Geological Survey of Queensland (2014-2016) using spinifex grass as a biogeochemical exploration medium in the Simpson Desert, in 2014 I discovered a Devonian age alkaline metallogenic province, (Diamantina Province). Importantly, I showed that the Diamantina Province is part of a much larger belt (a plume track) of ~ 440 Ma to 365 Ma igneous activity that extends more than 2000 km from central NSW to the Northern Territory. The entire belt is prospective for a range of metals including scandium, cobalt, PGEs, copper, and gold, as well as for diamond.

Recent industry and Government consultancies include:
- Transition Resources 2019 to present Targeting Cu-Co-Au-HREE-Sc mineral systems in the Cloncurry area.
- AusMex Ltd February 2020 - Target Vectoring in the Burra Mineral System, South Australia.
- Chinova Resources February 2020 - Targeting New Economy Minerals in the Sc-REE-Cu-Co-Ni-Au PGE Bearing Mount Cobalt - New Hope Mineral System
- Mayur Resources January 2020 - Prospectivity Assessment PNG Basilaki
- Chinova Resources December 2019 Lithochemical Characterisation and Exploration Vectoring - Mt Hope/Mt Cobalt Mineral System, south Cloncurry region, Northern Queensland
- Mayur Resources Sept. 2019 Prospectivity assessment of porphyry and epithermal Feni Konos, Rambutyo, Basilaki and Sidea Projects, PNG
- Mayur Resources July to August. 2019 Prospectivity assessment of Hardie Pacific assets in PNG viz., (1) Epithermal (Au) Gameta (EL2546) and Oredi Creek (EL2572) - Fergusson Island
- Qld. DNRM December 2018 - Cobalt and HREE Mineral Systems in the Mount Isa Block
- AusMex Ltd September 2018 - Rare Earth Element - Cobalt-Copper-Gold Mineral System at Burra, S.A: Significance of the AusLAMP Magnetotelluric Anomaly

- Hammer Metals August 2018 - U-Pb Titanite Geochronological Constraints on Origin and Age of the Mount Philip Breccia
- Northern Cobalt June 2018 - Review of Wollogorang Project Chemistry: Mineral System and Exploration Vectors.
- Longford Resources Feb. 2018 - present. Targeting Co and PGE mineralisation in the Goodsprings area, Nevada.
- Hammer Metals Feb. 2018 - present. Identification of key mineralisation geochemical vectors, as well as mineralisation and alteration styles in the Mary Kathleen Belt
- Encounter Resources May 2017 - present. Spinifex biogeochemistry proof of concept survey over gold and Co anomalies in the Telfer area, WA
- Laconia Resources Ltd May 2017 - present. Au-Ni-PGE target generation in the Kraaipan Greenstone Belt, Botswana
- Caracle Creek International 2016 - present. Associate Pegmatite Specialist Providing field geological, petrological and geochemical advice for international clients on exploration for LCT pegmatites
- Tyranna Resources June 2016 - present. Improved understanding of calcrete gold geochemistry in the western Gawler Craton that allowed discrimination between true and false calcrete Au anomalies with great success.
- Macarthur Lithium 2016. Provided field geological, petrological and geochemical advice to the MD on lithium exploration in the Pilbara and Yilgarn Cratons. Developed a technique using trace elements in K-feldspar to identify the Li content of the source pegmatite. This IP has global application.
- Impact Minerals Ltd 2015 - present. Petrology and geochemistry of outcrop and drill core samples from Red Hill and Mulga Springs-Moorkaie Intrusions at Broken Hill. Decoded the geochemistry and petrology of PGE-Au-Cu-Ni-Zn mineralisation at Broken Hill, resulting in enhanced understanding of the entire mineral system at Broken Hill, one of Earth's largest accumulations of metals.
- Providence Natural Resources 2012 - present. LCT pegmatite exploration for lithium at Järkvissle in Central Sweden. Currently contracted to find a JV Partner for a JORC Li resource.
- Exco/Copper Chem 2014. Preparation of a geological briefing paper for the Mary Kathleen rare earth Government tender bid.
- Exco 2014. Preparation of a prospectivity assessment for the White Dam area, South Australia, specifically identifying geochemical vectors that allowed improved understanding of the style of mineralisation.
- Chinalco Yunnan Copper Resources Limited 2013 - April 2014.Reviewed and reinterpreted drill core at Elaine and Blue Caesar and developed new model for Cu-Au-Co-REE-U mineralisation in the Mary Kathleen Belt, NW Queensland. I identified the alkaline igneous source of metals in the terrane and demonstrated that these ~1526 Ma alkaline intrusions were emplaced at a shallow crustal depth and produced epithermal mineralisation. As well as improving knowledge of Mary Kathleen Belt mineral systems, this discovery also explains Cloncurry Belt IOCG mineralisation.
- Viti Mining Pty Ltd. 2013 April - Present. Confirmed the existence of world-class very high-grade Mn mineralisation (DSO) at a number of locations on Viti Levu, Fiji. Showed that mineralisation was hydrothermal and occurred as part of an epithermal alteration system above Au-Ag-Cu bearing shoshonite intrusions
- Golden Island Resources Pty Ltd. 2013 April - Present. Undertook a literature review and discovered “lost” reports showing very widely distributed high grade Au and Ag assays (up to 35 g/t) on Waya and Wayasewa. Showed that these islands formed an extension of the

shoshonite – gold trend west of Viti Levu and following recovery of excellent panned concentrate results the islands are now being investigated using soil geochemistry to delineate drill targets.

- Golden Island Resources Pty Ltd. 2013 April - Present. I reprocessed magnetic and gravity data for Viti Levu and discovered a previously unknown ~40 km diameter Au-bearing shoshonite caldera south of Tavua caldera that has never been drilled. The Tavua caldera is host for the >1MOz epithermal Au-Ag Emperor goldmine on Viti Levu.
- Waratah Resources 2012 December. Prospectivity assessment of Gabon and the Republic of the Congo. Reviewed the geochemistry of BIFs in Waratah Resources tenements in Gabon and the Republic of the Congo to facilitate regional exploration and resource estimation.
- ASERA Iron Project 2012. December Geochemical evaluation of Lake Vättern orthomagmatic Fe-Ti-V project, Southern Sweden. Concluded that mineralisation is hosted by an anorogenic anorthosite intrusion not IOCG as previously believed.
- Triton Gold 2012 – August to December. Geochemical interpretation, Au and Mn target assessment on Viti Levu.
- Pacific Wildcat Resources 2011 – July to October. Fieldwork in Kenya and interpretation of DD core from Mrima Hill carbonatite and outcrops of nepheline syenite in a nearby intrusion. Showed that carbonatites and syenites were genetically related forming part of a >10 km diameter intrusion. Discovered an untested mineral system and identified zones of rare earth mineralisation for a subsequent RC and DD drilling program.

I am responsible for all sections of this draft report and am independent of the Department of Natural Resources and Mines as is described by Section 1.5 of NI 43-101.

I am confident that this report has been prepared in compliance with the JORC 2012 Code and with the instrument NI 43-101.

As of the effective date of the technical report, to the best of my knowledge, information and interpretation in the report contains all scientific and technical details that are required to be disclosed.

Dated 7th February 2020

Professor Kenneth D. Collerson
Ph.D., FAusIMM

Appendix 2

Sections 1 and 2 below provide a description of the sampling and assaying techniques in accordance with Table 1 of The Australasian Code for the Reporting of Exploration Results. Havilah confirms that it is not aware of any new information or data and that all material assumptions and technical parameters underpinning results published in the earlier market announcements continue to apply and have not materially changed.

Details for drillholes from which REE sample data was obtained

Hole Number	Easting m	Northing m	RL m	Grid azimuth	Dip degrees	EOH depth metres
KKAC0421 (Havilah)	454564	6488751	120	154	-70	122
CRRC004 (Havilah)	447391	6507209	96	251	-60	112
CRRC007 (Havilah)	447454	6506802	99	251	-60	82
BNG13DD001 (MMG)	447678	6507337	99	236	-70	284
BNGAC103 (MMG)	441573	6508214	100	0	-90	73
BNGAC105 (MMG)	442377	6508224	99	0	-90	95
BNGAC107 (MMG)	443183	6508214	100	0	-90	79
BNGAC108 (MMG)	443581	6508224	100	0	-98	66
BNGAC109 (MMG)	443982	6508224	99	0	-90	62
BNGAC110 (MMG)	444394	6508201	100	0	-90	64
BNGAC111 (MMG)	444775	6508221	99	0	-90	58
BNGAC113 (MMG)	445578	6508222	97	0	-90	62
BNGAC114 (MMG)	445980	6508220	97	0	-90	75
BNGAC115 (MMG)	446379	6508222	97	0	-90	103
BNGAC116 (MMG)	441276	6507624	102	0	-90	82
BNGAC120 (MMG)	442878	6507622	101	0	-90	82
BNGAC121 (MMG)	443285	6507623	100	0	-90	72
BNGAC122 (MMG)	443678	6507621	101	0	-90	80
BNGAC123 (MMG)	444079	6507622	102	0	-90	74
BNGAC124 (MMG)	444478	6507621	101	0	-90	87
BNGAC125 (MMG)	444877	6507619	100	0	-90	75
BNGAC126 (MMG)	445276	6507622	99	0	-90	53
EUR14DD001 (MMG)	461221	6524821	65	135	-70	223
EUR14DD002 (MMG)	461408	6524314	66	53.5	-80	312
EUR14DD003 (MMG)	461587	6524116	66	45	-70	239
EUR14DD004 (MMG)	463675	6523100	68	290	-70	306
EUR14DD005 (MMG)	463543	6524455	66	270	-70	262
EUR14DD006 (MMG)	463519	6525324	64	270	-70	263
EUR14DD007 (MMG)	463934	6525854	64	240	-70	279
EUR14DD008 (MMG)	463065	6526121	63	315	-70	222
EUR14DD009 (MMG)	462976	6526523	63	225	-70	233

BRK13DD001 (MMG)	432309	6537549	42	0	-90	561
BRK13DD002 (MMG)	435943	6537059	53	150.5	-70	465
BRK13DD004 (MMG)	444854	6544026	52	180	-80	319
BRK13DD011 (MMG)	463867	6558969	39	180	-75	501
BRK14DD001A (MMG)	439348	6535516	45	190	-70	296
BRK14DD003 (MMG)	438671	6537339	44	90	-80	375
BRK14DD007 (MMG)	438551	6535739	50	279	-70	318
BRK14DD010 (MMG)	439337	6535283	51	310	-80	273
BRK14DD011 (MMG)	439504	6535491	47	278	-70	333
MULAC005 (MMG)	452579	6517426	78	0	-90	104
MULAC008 (MMG)	454609	6515392	81	0	-90	130
MULAC010 (MMG)	454580	6516444	80	0	-90	56
MULAC012 (MMG)	454557	6517473	78	0	-90	94
MULAC016 (MMG)	456572	6516320	79	0	-90	106
MULAC021 (MMG)	456550	6518858	76	0	-90	21
MULAC027 (MMG)	458548	6518345	76	0	-90	82
MULAC028 (MMG)	458566	6518831	75	0	-90	84
Datum: AGD66 Zone 54						

Section 1 Sampling Techniques and Data

Criteria	JORC Code explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (eg cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report. In cases where 'industry standard' work has been done this would be relatively simple (eg 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (eg submarine nodules) may warrant disclosure of detailed information.*	• Sample data used by Professor Collerson were derived from a variety of earlier Havilah and MMG Limited ('MMG') aircore ('AC'), reverse circulation ('RC') and diamond drillholes, as documented in the table above. • RC and AC assay samples averaging 2-3kg were riffle split as 1-2m intervals. • Drillcore samples were mostly collected as half core over 1m intervals, unless the geological boundaries dictated otherwise. • All Havilah and MMG AC, RC and core samples were collected into pre-numbered calico bags and packed into polyweave bags by Havilah staff for shipment to the assay lab in Adelaide.

Criteria	JORC Code explanation	Commentary
Drilling techniques	- *Drill type (eg core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc) and details (eg core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc).*	- All RC holes were drilled using a standard face-sampling bits, with bit size of 146mm. All samples were collected via riffle splitting directly from the cyclone. - All AC holes used a 121mm blade bit. - Diamond core sizes ranged from NQ (48mm) to HQ (64mm). - Triple tube methods were used where required to maximise core recoveries. - Drillcore was routinely orientated where ground conditions allowed, using a Reflex downhole orientation tool.
Drill sample recovery	- *Method of recording and assessing core and chip sample recoveries and results assessed.* - *Measures taken to maximise sample recovery and ensure representative nature of the samples.* - *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.*	- Overall, RC sample recoveries and diamond drillcore recoveries were considered to be quite acceptable for interpretation and modelling purposes. - Core recovery for MMG diamond drillholes was measured directly and averaged >95 %. - The sample yield and wetness of the RC and AC samples was routinely recorded in drill logs. Very few samples were too wet to split. No evidence of RC sample bias due to preferential concentration of fine or coarse material was observed. - Sample recoveries were continuously monitored by the geologist on site and adjustments to drilling methodology were made to optimise sample recovery and quality where necessary.
Logging	- *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* - *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc) photography.* - *The total length and percentage of the relevant intersections logged.*	- All RC and AC samples and drillcore was logged by experienced geologists directly into a digital logging system with data uploaded directly into an Excel spreadsheet and transferred to a laptop computer. - All drillcore and RC chip trays have been photographed. - All drillcore and RC chip sample trays and some back-up samples are stored on site at Kalkaroo. All RC and AC samples were logged in detail by experienced geologists directly into a digital logging system with data uploaded. - Logging is semi-quantitative and 100% of reported intersections have been logged. - Logging is of a sufficiently high standard to support any subsequent interpretations, resource estimations and mining and metallurgical studies.

Criteria	JORC Code explanation	Commentary
Sub-sampling techniques and sample preparation	- *If core, whether cut or sawn and whether quarter, half or all core taken.* - *If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.* - *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* - *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* - *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* - *Whether sample sizes are appropriate to the grain size of the material being sampled.*	- RC or AC drill chips were received directly from the drilling rig via a cyclone and were riffle split as 1-2m intervals to obtain 2-3kg samples. - Half core samples were collected at 1m intervals, unless otherwise dictated by the geology. - Sampling size is considered to be appropriate for the style of mineralisation observed. Assay repeatability for gold and other metals has not proven to be an issue. - All Havilah samples were collected in numbered calico bags that were sent to ALS assay lab in Adelaide. - At ALS assay lab the samples are crushed in a jaw crusher to a nominal 6mm (method CRU-21) from which a 3kg split is obtained using a riffle splitter. The split is pulverized in an LM5 to 85% passing 75 microns (method PUL-23). These pulps are stored in paper bags. - All samples are then analysed for a 33 element package using ALS's ME-ICP61 suite, whereby samples undergo a 4 acid digest and analysis by ICP-atomic emission spectrometry and ICP mass spectrometry. Over limit Cu, Pb and Zn are re-assayed using ME-OG62. - Gold is analysed by 50g fire assay, with AAS finish using ALS method Au-AA26. - The total assay methods are standard ALS procedure and are considered appropriate for the main economic elements sought (i.e. Cu and Au). - Pulps are retained by Havilah and for the CRRC004, CRRC007 and KKAC0421 drillholes, relevant samples were retrieved and submitted to ALS for selected elemental analysis by lithium borate fusion and ICP-MS (ALS method ME-MS85). The chosen elements included all REE plus Cs, Hf, Rb, Sn, Y and Zr. - MMG followed similar sampling and assaying procedures for the diamond core samples.
Quality of assay data and laboratory tests	- *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* - *For geophysical tools, spectrometers, handheld XRF instruments, etc, the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* - *Nature of quality control procedures adopted (eg*	- According to ALS analysis precision expectation is +/-5%. - Due to the small number of samples and the fact that the assays were not proposed to be used for resource estimations, Havilah did not run any of its internal standards, duplicates or blanks as would normally be the case. - Checking of the new REE data against previous La, and in some cases Ce analyses where

Criteria	JORC Code explanation	Commentary
	standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (ie lack of bias) and precision have been established.	available, indicates good correlation.
Verification of sampling and assaying	- *The verification of significant intersections by either independent or alternative company personnel.* *The use of twinned holes.* *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.* - *Discuss any adjustment to assay data.*	- Checking of the new REE data against previous La, and in some cases Ce analyses where available, indicated good correlation. - Rigorous internal QC procedures are followed to check all assay results. - All data entry is under control of the responsible geologist, who is responsible for data management, storage and security.
Location of data points	- *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* - *Specification of the grid system used.* - *Quality and adequacy of topographic control.*	- MMG diamond drillholes were surveyed at approximately 30m downhole intervals using a Reflex downhole digital survey camera. - The Croziers RC holes were surveyed in the rods at approximately 30m intervals with only dip measurements recorded. AC hole KKAC0421 was not surveyed. - Drillhole collar coordinates are surveyed in UTM coordinates using a differential GPS system with an x:y:z accuracy of 20cm:20cm:40cm and are quoted in AGD 66 Zone 54 datum.
Data spacing and distribution	- *Data spacing for reporting of Exploration Results.* - *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.* - *Whether sample compositing has been applied.*	- Havilah drilling was completed at 25m intervals on nominal 25m sections perpendicular to the strike of the primary copper mineralisation at West Kalkaroo. RC holes at Croziers were completed at 50m intervals on sections 200m to 400m apart. - MMG diamond drillholes were drilled at various oblique angles and directions to test specific targets. Hole BNG13DD001 was drilled perpendicular to strike. - Sample compositing was not used.
Orientation of data in relation to geological structure	- *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.* - *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have introduced a sampling bias, this should be assessed and reported if material.*	- The drillhole azimuth and dip was chosen to intersect the mineralised zones as nearly as possible to right angles and at the desired positions to maximise the value of the drilling data. - At this stage, no material sampling bias is known to have been introduced by the drilling direction.
Sample security	- *The measures taken to ensure sample security.*	- RC and AC chip samples are directly collected from the riffle splitter in numbered calico bags. - Several calico bags are placed in each

Criteria	JORC Code explanation	Commentary
		polyweave bag which are then sealed with cable ties. The samples are transported to the assay lab by Havilah personnel at the end of each field stint. • There is minimal opportunity for systematic tampering with the samples as they are not out of the control of Havilah personnel until they are delivered to the assay lab. • This is considered to be a secure and reasonable procedure and no known instances of tampering with samples occurred during the drilling programs. • MMG diamond core samples were collected using a very similar methodology.
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data.*	• Ongoing internal auditing of sampling techniques and assay data has not revealed any material issues. • Robert Dennis who is employed by consulting firm RPM Global Asia Limited ('RPM') visited Kalkaroo during November 2016 and found field procedures to be of acceptable industry standard. • RPM completed independent re-sampling and assaying for Kalkaroo and found results to be reliable.

Section 2 Reporting of Exploration Results

Criteria	JORC Code explanation	Commentary
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a license to operate in the area.*	• Security of tenure is via current mining leases over Kalkaroo and exploration licences covering the Croziers, Eurinilla, Birksgate and other prospects, are all owned 100% by Havilah.
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	• Kalkaroo was explored by a number of major mining groups in the past including Placer Pacific Limited, Newcrest Mining Limited and MIM Exploration Pty Ltd, who completed more than 45,000m of drilling in the region. • Croziers, Eurinilla, Birksgate and other prospects have been explored by Pasminco Limited and MMG in the past. • All previous exploration data has been integrated into Havilah's databases.
Geology	• *Deposit type, geological setting and style of mineralisation.*	• In general the mineralisation style is stratabound replacement and vein style copper-gold mineralisation within Willyama Supergroup rocks of the Curnamona Craton.

Criteria	JORC Code explanation	Commentary
		- At Kalkaroo, the stratabound mineralisation is uniformly distributed along more than 3 km of strike that follows an arc around the 35 degree dipping northern nose of the Kalkaroo south dome. It is hosted by an 80m-120m thick mineralised horizon that is sandwiched between psammitic footwall rocks and a thick pelitic hangingwall sequence. - In part, the mineralisation is associated with near-vertical, mineralised quartz vein breccia fracture/fault fillings, which probably formed channel ways for the mineralising fluids. Interference folding resulted in dome structures which probably acted as structural traps for the rising mineralising fluids carried by these vertical structures. - The mineralising events were associated with iron-rich and sodium-rich alteration fronts, which are manifest as widespread fine-grained magnetite in the lower sandy formations and as pervasive albite alteration, overprinted by later potassic veining and alteration. - Erosion in the Mesozoic and Tertiary period exposed the region to prolonged and deep weathering. Consequently, the original sulphide mineralisation shows typical supergene enrichment features in its upper part, caused by oxidation of the primary sulphides in the weathering zone, forming a soft clay rich rock called saprolite. This is manifest in a sub-horizontal stratification of the ore minerals from top to bottom: 1. Supergene free gold in saprolite, with generally minor copper, recoverable by gravity and cyanide leaching methods. 2. Native copper and gold in saprolite, largely recoverable by gravity methods. 3. Chalcocite dominant with gold, recoverable by conventional flotation. 4. Chalcopyrite dominant with gold and locally rich molybdenum, recoverable by conventional flotation.
Drill hole information	- *A summary of all information material to the under-standing of the exploration results including a tabulation of the following information for all Material drill holes:* o *easting and northing of the drill hole collar* o *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar*	- This information is provided in the accompanying table for the relevant drillholes.

Criteria	JORC Code explanation	Commentary
	o *dip and azimuth of the hole* o *down hole length and interception depth* o *hole length* - *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.*	
Data aggregation methods	- *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (e.g. cutting of high grades) and cut-off grades are usually Material and should be stated.* - *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* - *The assumptions used for any reporting of metal equivalent values should be clearly stated.*	- Not applicable as not reporting mineral resources.
Relationship between mineralisation widths and intercept lengths	- *These relationships are particularly important in the reporting of Exploration Results.* - *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.* - *If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (e.g. 'down hole length, true width not known').*	- Downhole lengths are reported. Drillholes are typically oriented with the objective of intersecting mineralisation as near as possible to right angles, and hence downhole intersections in general are as near as possible to true width. - For the purposes of the geological interpretations and resource calculations the true widths are always used.
Diagrams	- *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported. These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	- Not applicable as not reporting a mineral discovery.
Balanced Reporting	- *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* - *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	- Not applicable as not reporting mineral resources.
Other substantive exploration data	- *Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples - size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock*	- Relevant geological observations are reported.

Criteria	JORC Code explanation	Commentary
	characteristics; potential deleterious or contaminating substances.	
Further work	- *The nature and scale of planned further work (e.g. tests for lateral extensions or depth extensions or large- scale step-out drilling).* - *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	- Additional drilling may be carried out in the future to explore strike and depth extensions and for resource delineation.