AUSTRALIAN
RESEARCH
INDEPENDENT INVESTMENT RESEARCH

Australian Vanadium Limited (AVL)

November 2016

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November 2016

Note: This report is based on information as at November 2016

Investment Profile	
Share Price ($) as at 11 November 2016	$0.014
Issued Capital:	
Ordinary Shares (M)	1,101m
Options (M)	410.0m
Incentive Rights	15.0m
Fully Diluted (M)	1,606m
Market Capitalisation (M)	$15.4m
12 month L/H ($)	$0.007/$0.027

Board and Management

Directors and Management:

Mr Brenton Evans: Non-Executive Chairman

Mr Vincent Algar: Managing Director

Mr Leslie Ingraham: Executive Director

Major Shareholders	
Mr Neale Parsons	2.92%
Sunarp Pty Ltd	2.63%
Jalein Pty Ltd	1.82%
Top 20	22.88%
Directors and Management	4.83%

Share Price Performance

The investment opinion in this report is current as at the date of publication. Investors and advisers should be aware that over time the circumstances of the issuer and/or product may change which may affect our investment opinion.

Senior Analyst – Mark Gordon

GOING WITH THE VRFB FLOW

Australian Vanadium's strategy is to become a vertically integrated vanadium flake and electrolyte producer and vanadium redox flow battery ("VRFB") supplier. To that end it is looking at developing its high grade Gabanintha Vanadium Project in Western Australia, is commencing pilot scale testwork on producing VRFB electrolyte, and has entered into VFRB distributorship and installation agreements, with the first battery already having been installed in Western Australia. The strategy is timely, given the strong forecast growth in demand for storage systems in Australia (up to 3,000MWh by 2030, of which 30% or 900MWh could be VRFB's) - Australian Vanadium's early entry into the VRFB sector gives them a head start into becoming a major player as the market grows.

KEY POINTS

Forecast growth in vanadium demand and storage applications: Forecast global growth in electrical storage systems, including grid scale storage, should help drive vanadium demand over coming years, with some forecasters seeing a need for an additional 300,000t of V_2O_5 over the next 10 to 15 years – this is expected to lead to supply deficits, and thus increased prices.

World class vanadium deposit: With the Gabanintha Vanadium Project ("Gabanintha"), Australian Vanadium Limited ("Australian Vanadium" or "the Company") has a world class project and one of the highest grade undeveloped vanadium deposits globally, with excellent metallurgical characteristics and the potential for a long life, low cost operation to produce V_2O_5 flake concentrate.

Positive "Engineering Concept Study": The recently completed update to this study has provided the impetus for the Board to decide to continue work at Gabanintha, and is now progressing component studies to feed into a future Feasibility Study.

Vertical integration strategy: The Company is an early mover in the VRFB sales, installation and maintenance field in Australia, and should the market grow as forecast, be in an ideal position to be a major player in what could be a + $1 billion industry over the next 10 to15 years – the Company is aiming for at least a 25% market share.

First VRFB installed: The Company, in association with GILDEMEISTER Gmbh ("GILDEMEISTER") and solar panel providers and system installers Sun Connect Pty Ltd ("Sun Connect") has installed its first CellCube unit, and is currently following up 70+ leads for potential new installations.

Electrolyte testwork: Australian Vanadium, in association with UK based C-Tech Innovation Limited ("C-Tech"), is commencing testwork on producing vanadium electrolyte using C-Tech's electrolysis technology to supply the VFRB market – 900MWh of storage capacity will require around 45 million litres of electrolyte, which at an estimated price of $2.00-$2.50/litre will be upwards of a $100 million industry, with the Company aiming to supply other VRFB manufacturers in addition to producing electrolyte for its own installations.

Entry into the lithium space: The Company has broadened its exposure to the battery resources market, with an option to acquire up to 74% of the Blesberg Lithium-Tantalum Project ("Blesberg") in South Africa – this is a historical producer of pegmatite associated minerals close to infrastructure in an established mining area in the Northern Cape Province.

Experienced Board and Management with skin in the game: The Company's personnel have extensive experience in the junior resources sector, as well as holding some 4.83% of the shares, thus aligning their interests with those of shareholders.

Valuation: **Our valuation range of $0.042-$0.086/share** is based on shares diluted for conversion of the $0.01471 options, which have an expiry date of December 31, 2017 - this does not include any value for the significant downstream sales potential we see.

SWOT ANALYSIS

Strengths

- **World class vanadium deposit:** Gabanintha is a quality project, which should have attractive economics once vanadium prices improve.
- **Mining friendly jurisdiction:** Australian Vanadium is largely concentrating its activities in Western Australia, a mining-friendly jurisdiction which in 2015 topped the Fraser Institute Survey of Mining Companies.
- **Early movers in a growing market:** Being early movers in the potentially lucrative VRFB market gives the Company a strong advantage as the market grows and starts to mature.
- **Cash in the bank:** With ~$3.5 million in the bank, and the potential for $2.5 million from option conversion and revenue from battery sales, the Company is well funded for the next 12-24 months.
- **Experienced people with significant shareholdings:** Company personnel and consultants have significant experience in the resources game, as well as significant shareholdings in the Company.

Weaknesses

- **Market capitalisation and major project funding:** This will be a key consideration when they look to fund development of Gabanintha – the expected capital expenditure will be in the order of $250 to $300 million, and at the current market capitalisation (which however should improve with advances in activities) would lead to significant dilution for shareholders – the Company will need to look at different strategies for funding development.
- **Short term funding:** Our view is that, should the Blesberg acqusition proceed, the Company will need to raise funds in the short to medium term to help meet the estimated A$4 million commitment at Blesberg, as well as to maintain progress at Gabanintha and on other activities.

Opportunities

- **Growing VRFB markets:** Taking advantage of the expected growth in this sector is the key opportunity for the Company – should the market grow as forecast and the Company get the targeted 25% share (as well as electrolyte sales) we can see significant net revenues growth.
- **Growing vanadium demand:** This is largely tied into the forecast growth in the storage market, and with Gabanintha, the Company has a project that is well placed to take advantage of improving markets.
- **Gabanintha development options:** There is the potential for different development options at Gabanintha, including a low capex concentrate-only start up to generate cash flow to help fund installation of a roaster to produce V_2O_5 concentrate, and the potential to value add by installing a ferro-vanadium plant.
- **Gabanintha co-products:** There is the opportunity to extract high quality titanium and iron products through additional processing of the Gabanintha mineralisation – TNG Limited (ASX: TNG) is planning such an operation at Mt Peake in the Northern Territory using the licenced TIVAN process.
- **Blesberg:** Blesberg provides a key opportunity to broaden exposure to the battery materials markets.

Threats

- **Markets and resources prices**: A key consideration at the present time is the low vanadium price – this precludes development of Gabanintha. Also, junior resource stocks are very susceptible to falls in the overall stock markets, which will affect the capacity to raise capital should the markets turn.
- **Vanadium and battery demand not being as forecast**: The battery market not growing as forecast is a key threat to the complete vertical integration strategy of Australian Vanadium – it will affect sales of the downstream products, and will also affect the potential development of Gabanintha with expected rises in vanadium prices not occurring.

OVERVIEW

STRATEGY

- The Company's strategy is to develop a vertically integrated VRFB battery business, built around its flagship Gabanintha project, battery distributorship, installation agreements and proposed battery electrolyte production business.
- With current vanadium prices precluding development of Gabanintha, the Company is concentrating activities on the downstream activities whilst still progressing development studies at Gabanintha – this will place the Company in a good position to develop Gabanintha once prices improve.
- The Company has broadened its activities in the battery materials sector by the recent signing of an option to acquire up to 74% of Blesberg Lithium-Tantalum Project in the Northern Cape Province of South Africa.

FINANCIAL POSITION

- As of September 30, 2016 the Company had $3.57 million in cash and no debt.
- Since June 30, 2015 the Company has raised $3.067 million through a 1 for 3 non-renounceable rights issue at $0.013/share, with each listed share having a free attaching listed option with an exercise price of $0.02 and an expiry date of December 31, 2018.
- Over the same period the Company has received $1.261 million from the exercise of 1.417 cent options – the Company still has 174.2 million of these options on issue which expire on December 31, 2017, and which if all are exercised will bring an additional $2.562 million into the Company.
- Over the same period the Company spent $0.467 million on exploration and evaluation and $2.135 million on administration and staff costs – this is fair and consistent with the nature of activities and development stage of Gabanintha.

PROJECT OVERVIEW

Gabanintha Vanadium Project

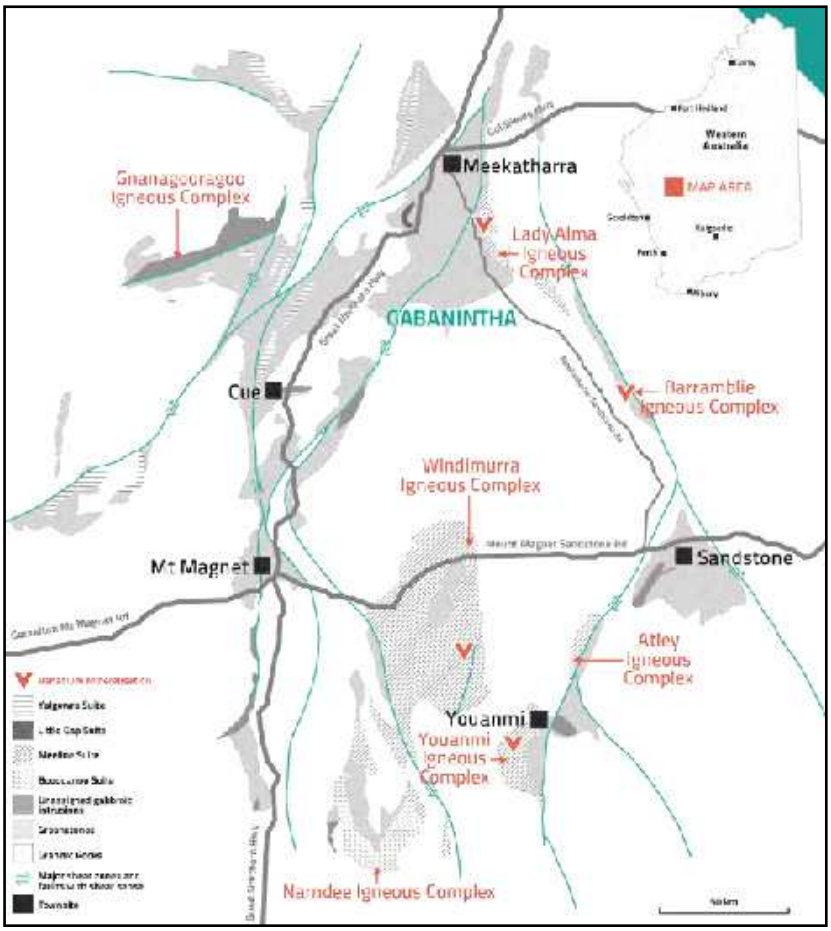
Introduction

- Gabanintha, located 50km southeast of Meekatharra in the mid-west of Western Australia is one of the highest grade undeveloped vanadium projects globally.
- The Company has recently completed an updated Engineering Concept Study which looked at an operation up to 10,000tpa of high quality V_2O_5 flake that would be trucked to Geraldton for shipping.
- Given the positive results of the study, Australian Vanadium is now progressing additional studies that will feed into a planned Feasibility Study.

Tenure and Permitting

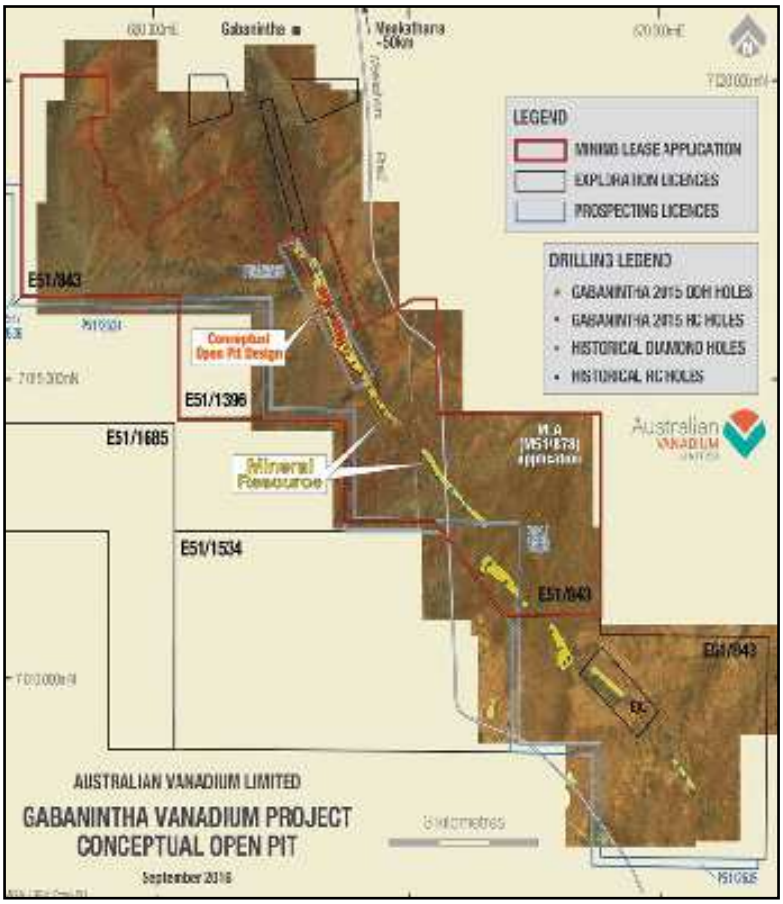
- The Project is situated within a 100% held package of five contiguous exploration licences and five associated prospecting licences for ~120km^2. The Company has recently submitted MLA51/878 of 3,563ha, covering the complete strike length of the Gabanintha intrusion, as well as areas expected to be required for proposed future operations.
- The Project is located approximately 50km southeast, along the gazetted all-weather Meekatharra-Sandstone Road, from the mining and pastoral town of Meekatharra. The nearest port is Geraldton, some 600km away.
- In April 2015 the Company announced that it had signed a Heritage Agreement with the Yamatji Marlpa Aboriginal Corporation, the representatives of the Traditional Owners, the Yugunga Nya People. The Company has now commenced discussions regarding an agreement on the development and mining of Gabanintha.
- Also, as part of the permitting process, the Company has recently commenced the last phase of the baseline flora and fauna studies, which will be included in the Environmental Impact Study ("EIS") for Gabanintha.

Figure 1: Gabanintha location plan



Source: Australian Vanadium

Figure 2: Gabanintha Vanadium Project tenements

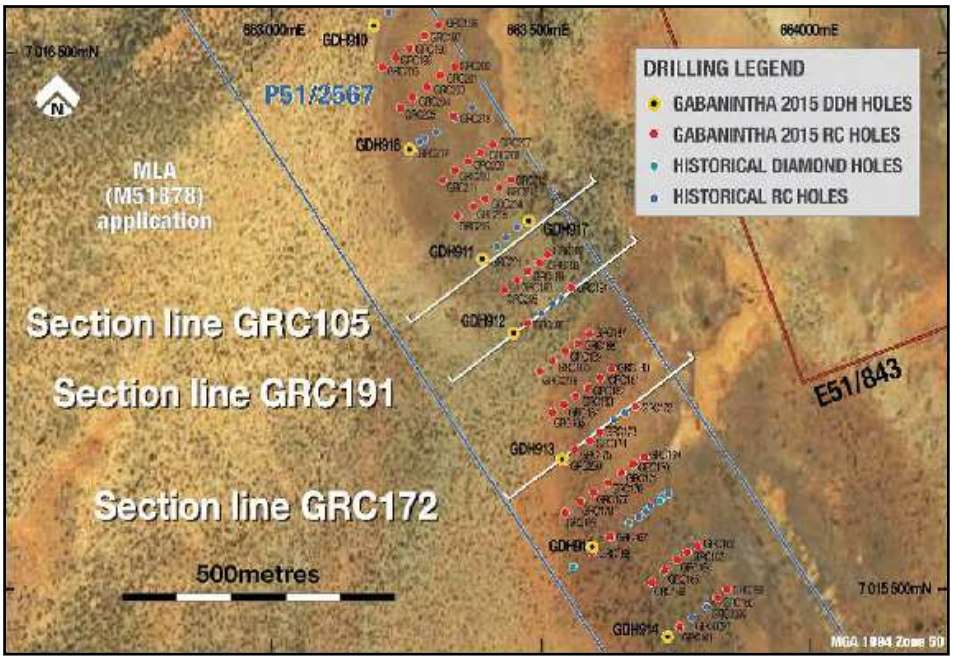


Source: Australian Vanadium

Geology and Mineralisation

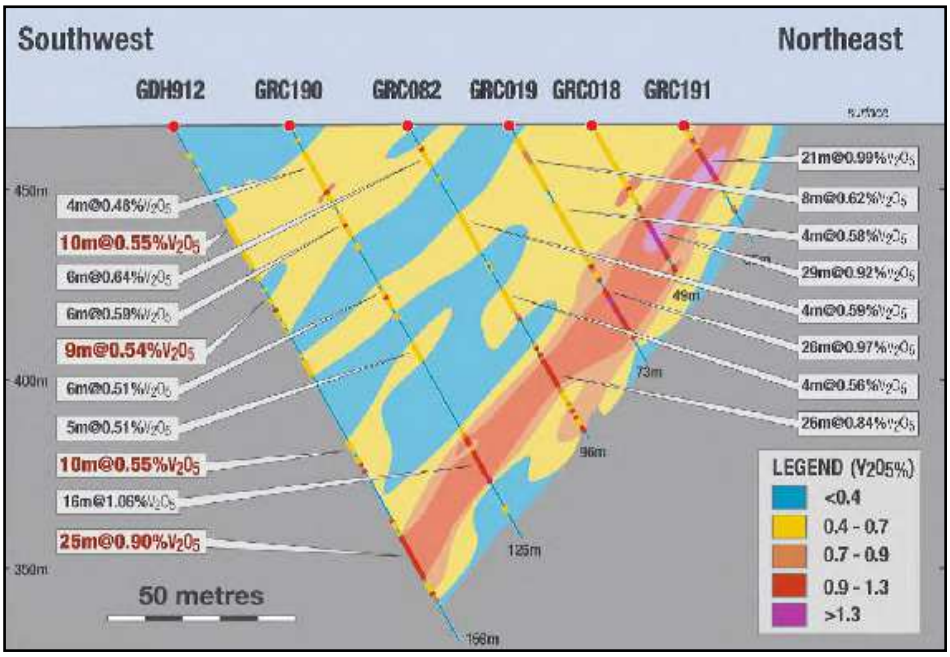
- The Project is located over units of the Archaean Yilgarn Craton, a key mineralised terrane in Western Australia.
- More specifically, it is located over the Archaean Gabanintha Gabbro, one of a number of mafic/ultramafic intrusive complexes in the region as shown in the figure above. Other significant complexes include Windimurra, site of the now closed Windimurra Vanadium Mine and Barrambie, the site of Neometals' Barrambie Titanium Project.
- The Gabanintha Gabbro, which has a strike length of some 12.2km and a consistent 45-55° south-westerly dip, has been dated at around 2,861Ma, the oldest such intrusive in the region and the basal body in the Norie Group, which is within the Northern Murchison Domain of the Murchison Supergroup. This and other similar intrusive bodies in the region are related to ancient volcanism.
- Gabanintha is a layered intrusive, with a total true thickness of up to 150m, with the basal, high grade mineralisation being associated with a titano-magnetite cumulate phase. This basal unit has a true thickness of between 10-30m, and the Company has stated that it is consistent along the entire strike length of the intrusion. This unit is comprised almost entirely of titano-magnetite, with accessory ilmenite and silicate minerals.
- Drilling in 2015 by Australian Vanadium over the northern 2.2km strike length has confirmed and reinforced this continuity in the drilled area, with a plan and cross section shown below.
- Upper units within the intrusive are dominated by gabbro-norites and anorthosites - gabbroic rocks which contain appreciable plagioclase and pyroxene. These units also contain appreciable disseminated vanadium bearing titano-magnetite in parallel zones, albeit of lower overall grade than the basal cumulate, however potentially economically recoverable (discussed later).
- The project area has been strongly weathered to a depth of around 50m; however the vanadium is not removed by weathering.

Figure 3: 2015 Gabanintha infill drilling



Source: Australian Vanadium

Figure 4: Cross-section GDH912 showing drill intersections



Source: Australian Vanadium

Drilling and Resources

- In November 2015 the Company announced a resource upgrade as presented in the table below, following on from the 2015 RC and diamond drilling programme. This drilling, which included 63 RC holes for 5,957m and eight large diameter diamond holes for 932m, tested the northern part of the intrusion and was designed to upgrade sufficient resources to Indicated and Measured to enable reserves to be defined in the planned Feasibility Study to provide feed for the initial 10 years of a 20 year operation – the 24.8Mt defined in the resource should achieve this.

Table 1: Gabanintha JORC-2012 Compliant Mineral Resources

Gabanintha JORC-2012 Compliant Mineral Resources

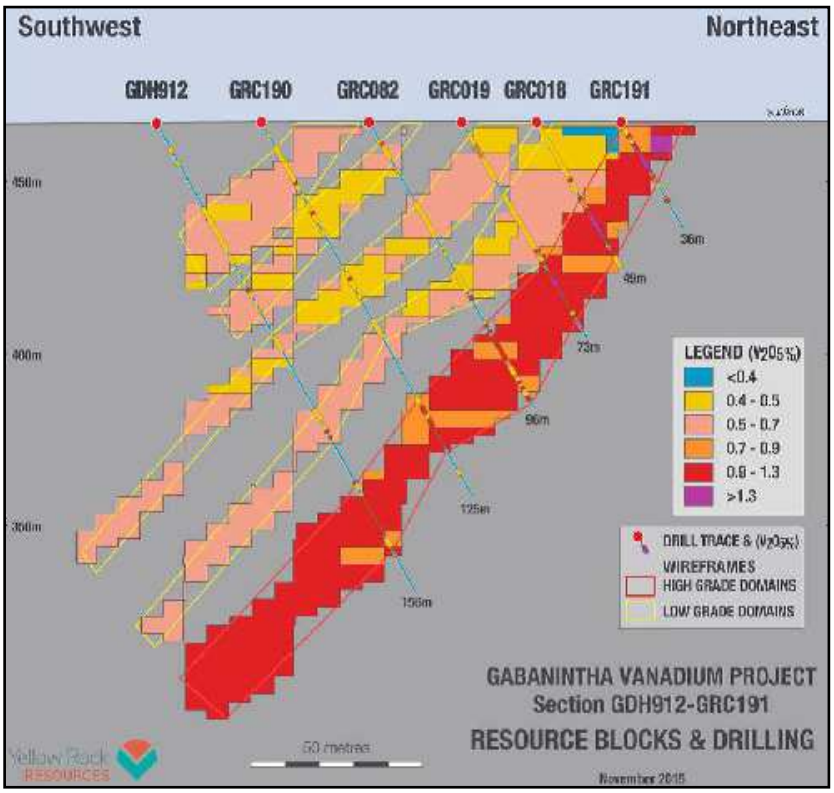
Material	JORC Resource Class	Million Tonnes	In situ bulk density	V_2O_5 %	Fe %	TiO2 %	SiO2 %	Al2O3 %	LOI %
High grade	Measured	7.0	3.73	1.09	43	12	10	8	3.4
	Indicated	4.3	3.29	1.07	41	12	12	9	4.6
	Inferred	45.5	3.67	0.97	42	11	12	8	2.8
Subtotal		56.8	3.65	1.00	42	11	12	8	3.0
Low grade	Indicated	13.4	2.39	0.55	24	7	27	19	8.7
	Inferred	21.1	2.48	0.53	25	7	27	17	7
Subtotal		34.6	2.45	0.53	25	7	27	18	7.6
Subtotal	Measured	7.0	3.73	1.09	43	12	10	8	3.4
	Indicated	17.8	2.61	0.68	28	8	23	16	7.7
	Inferred	66.7	3.29	0.83	37	10	17	11	4.1
	TOTAL	91.4	3.19	0.82	35	10	18	11	4.8

Source: Australian Vanadium

- Our view is that only limited drilling would be required to upgrade further resources to the Measured and Indicated category – in addition the resource report indicates that additional core bulk density measurements will also allow the upgrading in the confidence of some areas of mineralisation.
- The drilling returned very strong results, including a number of broad, high grade intersections in the basal magnetite zone, with some shown in the section above. The diamond drilling also intersected the full thickness of the intrusion, allowing for detailed geological interpretations.

- The updated estimate resulted in higher grades but lower overall tonnages than the maiden resource, however the latter is due to tighter geological control of the wireframing and block modelling, and a lower measured bulk density than was originally assumed. The resource contains more than ample tonnes for a long term operation.
- The high grade domain is related to the basal magnetite cumulate and has been calculated at a nominal lower cut-off grade of 1.00% V_2O_5; whereas the lower grade, upper disseminated zone also uses a nominal lower cut-off grade of 0.40% V_2O_5. In reality cut offs are determined by both grade and geology, which correlate very closely.
- Resources have also been calculated by oxidation state, which will have an impact on metallurgy. The high grade zone includes 7.0Mt @ 1.00% V_2O_5 oxide, with the low grade zone containing 15.8Mt @ 0.53% V_2O_5 in the oxide, for a total oxide resource of 23.2Mt @ 0.68% V_2O_5.
- The estimation also assessed the distribution of potentially deleterious elements with the Company believing the results are generally favourable. Key contaminants include silica and aluminium as clays (which can have an adverse effect in the roasting process), which should be able to be removed during concentration.

Figure 5: Cross section GDH912 showing resource blocks and drilling



Source: Australian Vanadium

Mining

- Any future mining will be via conventional low strip ratio open cut. The high grade ore will be mined by conventional drill and blast; however it may be possible to mine the waste and low grade material by free dig down to the base of oxidation at around 50m depth, following on from which drill and blast will be required.
- Given the thickness of mineralised zones there should be only minimal dilution, and the Company has also stated that the different zones are visually distinctive, again a positive for any future operation.
- As part of the updated Engineering Concept Study (discussed below) Australian Vanadium completed pit optimisation studies with the results as shown in the table below - the resultant pit is some 4,300m long, up to 350m wide and up to 160km deep with a strip ratio of 1.92:1.

Table 2: Pit optimisation modelling – pit shell 9

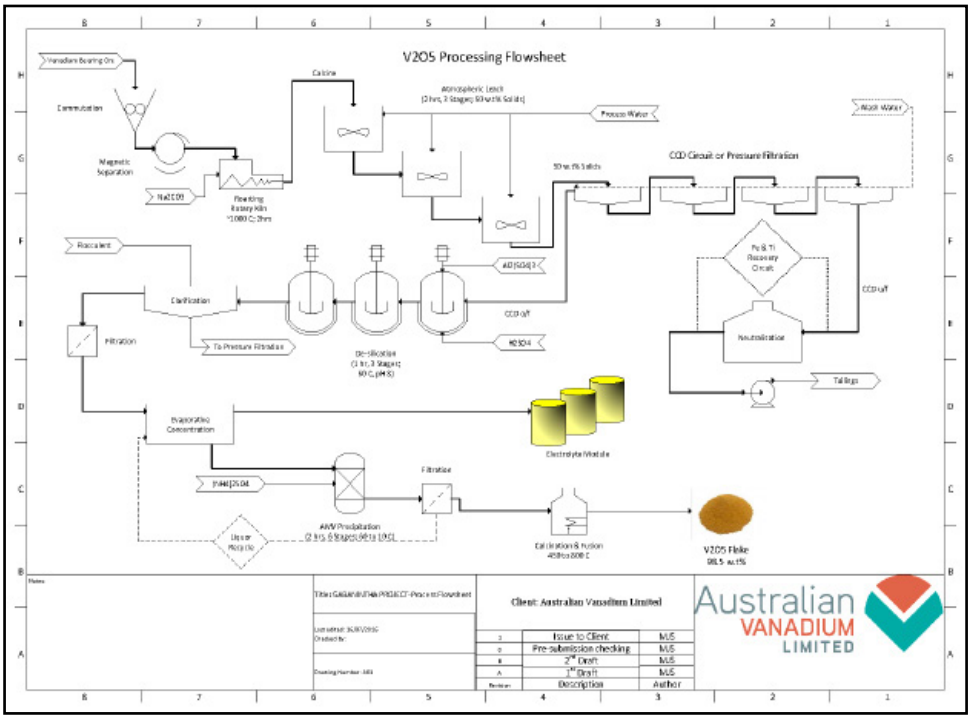
Pit Optimisation Modelling - Pit 9								
	High Grade		Low Grade		Total		Proportion %	
Category	Tonnage (Mt)	V_2O_5 (%)	Tonnage (Mt)	V_2O_5 (%)	Tonnage (Mt)	V_2O_5 (%)	Of shell	Of 2015 res.
Measured	7.0	1.09	-	-	7.0	1.09	15%	100%
Indicated	4.2	1.07	13.4	0.55	17.6	0.67	39%	99%
Inferred	12.2	1.00	8.5	0.53	20.7	0.81	46%	31%
TOTAL	23.4	1.04	21.9	0.54	45.3	0.80	100%	49.6%

Source: Australian Vanadium

Mineralogy and Metallurgy

- The Company is now undertaking additional metallurgical testwork, largely concentrating on roast/leach testwork following on from very successful concentration testwork that has been utilised in the updated Engineering Concept Study.
- As mentioned earlier, the Company plans to initially produce V_2O_5 flake on-site for export and for use in electrolyte production – there is the possibility of producing higher value FeV product down the track as well as an early stage concentrate only operation. The proposed treatment route to produce flake is the well proven salt roast-leach extraction process, which utilises off the shelf technology.

Figure 6: Proposed initial process flowsheet



Source: Australian Vanadium

- Initial work in the concentration testwork programme included mineralogy and petrology studies, with the following results:
  - In the massive zone, titano-magnetite weathers to martite, which retains all of the vanadium. This material also retains relic titano-magnetite, which will make it conducive for initial upgrading by magnetic separation,
  - Magnetite grains in the low grade material appear to contain relatively high grade vanadium – magnetic separation (or the use of other upgrading techniques in the weathered zone) of this material may produce a high grade concentrate suitable as feed for the roaster and subsequent processing.
- The results of this were supported by the subsequent concentration testwork, which looked at oxide, transitional and fresh material from both high and low grade material.
- Results from this work included:

- Both low grade and high grade partly oxidised and fresh material can be effectively upgraded to concentrates of up to 1.5% V_2O_5,
- Magnetic separation testwork on low grade material recovered between 70% and 85% of the V_2O_5, with a mass recovery of between 32% and 62%,
- Magnetic separation testwork on high grade material recovered between 92% and 95% of the V_2O_5, with a mass recovery of between 75% and 82%, and,
- Wet high intensity magnetic separation ("WHIMS") of totally oxidised material results in a high quality V-Ti-Fe concentrate, with mass recoveries of between 30% and 80%, and V_2O_5 recoveries of between 30% and 90%,

- The ability to effectively treat low grade material (particularly the oxide) is very positive, and should significantly improve the financial returns through two main avenues:
  - The generation of additional revenue, and,
  - The lowering of the strip ratio, leading to lower mining costs (on a per tonne of ore basis).
- Overall the results of the work were very positive; indicating the potential to produce quality concentrates from all ore types that should provide feed amenable to roasting and leaching.

Services and Infrastructure

- Given that the site is served by excellent road access, key infrastructure considerations for any future operation will be water and power, with these being investigated as part of upcoming development studies.

Power

- Due to a lack of grid power or nearby gas pipelines, all electricity generation will need to be generated on site, with diesel and solar being alternatives. The Company is currently looking at the economics of generating at least part of the power requirements with a solar plant and associated VRFB storage (particularly for the camp) - this has the potential to decrease operating costs (albeit with increased capital costs) when compared with a diesel plant alone. It is estimated that using on-site diesel generated power comprises some 20-30% of total operating costs.

Water

- Water will need to be sourced from bore fields, with no surface water readily available. Hydrogeological studies are being carried out as part of the ongoing development studies, and the Company has stated that they are confident that process water will be able to be sourced within the Company's licences. There are a number of potential water sources, including palaeochannels.

Engineering Concept Study

- An Engineering Concept Study, carried out by Battery Limits Pty. Ltd., was initially completed in 2009, with an updated study released to the market on September 14, 2014, which envisaged an operation producing between 5,000 and 10,000t of V_2O_5 per year over a 20 year mine life.
- The 2014 update was based on a 2.1mtpa, 1% V_2O_5 mining operation, with ROM material being magnetically or gravity concentrated to produce ~715,000t of roaster feed at a grade of 2% V_2O_5 to produce 10,000tpa of vanadium pentoxide flake. Initial capex of $230 million and operating costs of $8.90/kg ($4.00/lb) were estimated. The study also investigated a 5,000tpa V_2O_5 case without beneficiation, with an upfront capital cost of $170 million.
- This has subsequently been updated, with this 2nd update being released to the market on October 10, 2016. This update incorporated the 2015 resource upgrade and metallurgical results, and the 2016 pit optimisation study as discussed earlier.
- Given the results of the metallurgical testwork, the roaster feed would be of a lower grade than anticipated in the 2014 update – our calculations, using midpoints of mass and vanadium recoveries, indicate ~2mtpa of combined low and high grade ROM at a head grade of 0.8% V_2O_5, concentrating to roaster feed of 1.2mtpa at a grade of 1.07% V_2O_5.
- The lower grade will also necessitate a larger roaster for the same V_2O_5 output, thus requiring a larger capex - in our view this would be in the order of $250-$300 million.

Blesberg Lithium-Tantalum Project, South Africa

Introduction

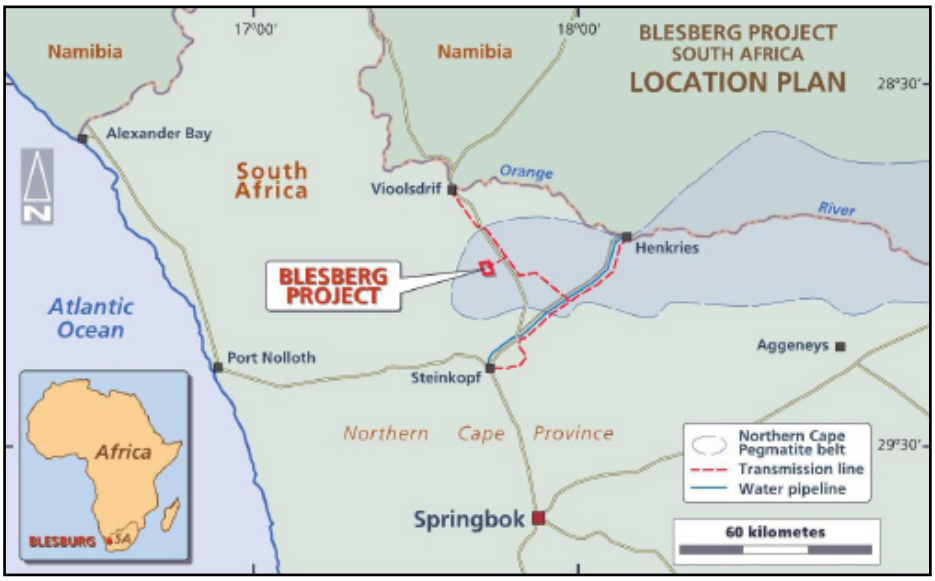
- On November 4, 2016 the Company announced that it had signed an option to acquire 100% of the South African registered company South African Lithium (Pty) Limited ("SAL"), which has the right to acquire up to 74% of South African Lithium and Tantalum (Pty) Ltd ("SALT") which owns 100% of the historically mined Blesberg Lithium-Tantalum Project, located in the Northern Cape Province of South Africa.
- SALT has an appropriate Broad-Based Black Economic Empowerment ("BEE") ownership structure in place.
- The Blesberg Prospecting Right ((NC) 940 PR) covers 887 hectares, including the entire historic mine and infrastructure, including a powerline to the base of the hill on which the operation was based.
- The property is located within 5km of the main N7 highway linking Capetown to the Namibian border, and is 80km north of the major town of Springbok, in a region with a strong history of mining.

Key terms of the acquisition include:

  - Non-refundable deposit of 7 million AVL shares within seven days of signing of the option agreement
  - Upon exercising of the option, the consideration for a 100% interest in SAL is 70 million AVL shares, two tranches of 40 million performance rights on meeting specified JORC-2012 compliant resources hurdles, and the vendor of SAL retaining a 1% Net Smelter Return Royalty on all production from Blesberg

- Australian Vanadium is to fully find SAL's acquisition of 50.03% of SALT through:
  - Payment of US$1,000,000 in three tranches, being US$250,000 on completion of due diligence and execution of further documentation, US$250,000 on commencement of a drilling programme and US$500,000 on announcement of a JORC-2012 compliant resource.
  - Funding an exploration earn-in phase of US$2,000,000 by June 2018.
- Following the earn-in phase any expenditure shall be pro-rata by all SALT shareholders – should the other shareholders decide not to contribute the Company has the potential to increase its holding in SALT to 74% through dilution of the other shareholders.

Figure 7: Blesberg location



Source: Australian Vanadium

Geology and Mineralisation

- Blesberg is located in the Northern Cape Pegmatite Belt, a Proterozoic aged belt that extends for ~450km eastward from near Blesberg.
- The belt hosts a number of lithium-caesium-tantalum ("LCT") type pegmatites, with a number being historically mined for a number of commodities, including beryl, bismuth, tantalite-columbite, spodumene, feldspar and mica.

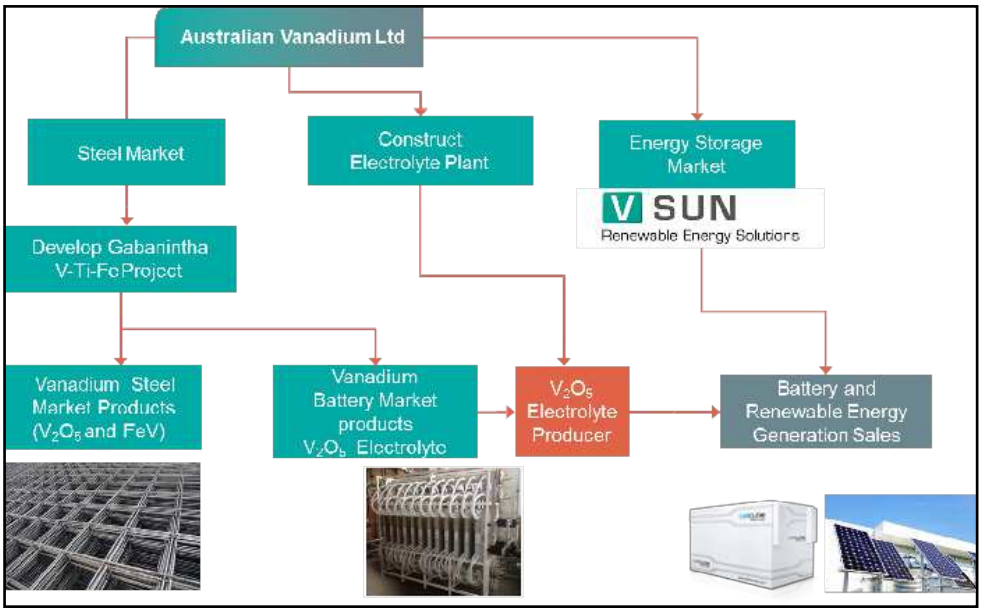
- The main pegmatite at Blesberg, which strikes northwest and dips at 50°-80° to the southwest outcrops for some 700m over the entire length of Blesberg Hill, and has a width of between 9 and 42m in two main pegmatite dykes.
- The two main dykes are part of a number of pegmatite bodies outcropping in the area.
- At its north-western extend the pegmatites disappear under sand cover.
- The presence of large spodumene crystals, as well as other lithium bearing minerals including lepidolite and cleavelandite has been noted; as well samples collected in 2013 reportedly contained grades of between 2.19% and 6.51% Li_2O.

Vertical Integration Strategy

Introduction

- Given the growing interest in energy storage markets the Company has developed a vertical integration strategy and, as announced to the market on September 9, 2015, has incorporated VSUN Energy Pty. Ltd. ("VSUN") to advance the strategy.
- As part of this Australian Vanadium, through VSUN, has secured distribution rights with GILDEMEISTER, a German-based VRFB manufacturer, partnered with Perth-based commercial solar installer Sun Connect on the installation of integrated solar/VRFB facilities and has signed an MoU with C-Tech, a UK research and technology company in developing vanadium electrolyte production facilities to support VRFB installations.
- As part of the latter the Company is about to start pilot scale testwork to develop a commercial plant, and will look at integrating a vanadium electrolyte plant at Gabanintha, with the plant using a proprietary electrolytic process to produce electrolyte from V_2O_5 and sulphuric acid.
- A structure for this strategy is presented below.

Figure 8: Vertical integration structure



Source: Australian Vanadium

GILDEMEISTER and Sun Connect Partnerships

- Gildemeister has developed the CellCube VRFB, for which there are now over 100 installations worldwide and which is based on 15 years of development. The Company offers individual units in a number of sizes, ranging from outputs of 10-250kW and 40-2,000kWh in capacity – larger capacities can be obtained through the use of multiple units.
- VSUN recently installed the first facility under the partnership, also in collaboration with Sun Connect. This includes a 15kW solar array connected to a 10kW-100kWh CellCube unit on a rural property near Busselton in Western Australia, which was the first system of its type to be installed in the state. The cost of the combined system although appearing high at ~$164,000 was reportedly competitive with the alternate grid connection.

C-Tech Partnership

- Australian Vanadium has partnered with C-Tech on the development of electrolyte processing facilities. C-Tech has developed an electrolytic process that mixes sulphuric acid and V_2O_5 to produce VRFB electrolyte. As part of the partnership a pilot plant is in the process of being installed in Western Australia – the results of testwork will be used to develop commercial scale electrolyte facilities in Australia and the Asia-Pacific region.

CURRENT AND UPCOMING ACTIVITIES

Vanadium Operations

- The Company is progressing activities on a number of fronts, generally associated with the planned Feasibility Study and legislative requirements relating to the potential development of Gabanintha - this will generate significant news flow over coming months.
- Planned and ongoing activities at Gabanintha, due to be completed by mid-2017, include:
  - A resource upgrade using the latest density and weathering profile information,
  - Detailed mine design and scheduling,
  - Metallurgical testwork, concentrating on roast and leach metallurgy which will be used to finalise process design inputs,
  - Water supply assessment,
  - Environmental risk assessment including additional baseline studies,
  - Assessment of permitting and approvals requirements and timeframes.

Figure 9: Proposed activities - Gabanintha

Source: Australian Vanadium

- This work will be used to determine a project Feasibility Study and development timeline that will be dependent upon market conditions. Much of the work in the Concept Study is of a standard to be incorporated into any future Feasibility Study.
- In parallel the Company will continue marketing of the GILDEMEISTER battery systems (with the Sun Connect integrated solar systems where required) and progress the development of the electrolyte production process.

Blesberg

- Work on Blesberg will concentrate on finalising the due diligence, with the option due to expire on December 6, 2016.
- Dependent upon exercise of the option, the Company will complete 3D geological modelling and drill hole design for an initial reverse circulation/diamond drilling programme, as well as map and sample other pegmatites within the licence area.

VALUATION AND DOWNSTREAM SALES POTENTIAL

Current Valuation

- We have completed a valuation for Australian Vanadium as presented in the table below.
- We have not included any value as yet for Blesberg given that the option is yet to be exercised

- We have not ascribed any value for the downstream businesses, however we do see potential future value as discussed further below.

Table 3: Australian Vanadium valuation summary

VALUATION SUMMARY - AUSTRALIAN VANADIUM						
Asset	**Low Value**	**High Value**	**Mid Value**	**Per Share Low**	**Per Share High**	**Mid Value**
Gabanintha Vanadium Project	$48.0m	$104.0m	$76.0m	$0.038	$0.082	$0.060
Cash - September 30, 2016	$3.6m	$3.6m	$3.6m	$0.003	$0.003	$0.003
Cash on Option Conversion	$2.6m	$2.6m	$2.6m	$0.002	$0.002	$0.002
Total	$54.1m	$110.1m	$82.1m	$0.042	$0.086	$0.064

Source: IIR Analysis

- The per share valuation assumes conversion of the $0.01471 options, with the per share valuations based on the diluted shares of 1,275 million.
- The Gabanintha valuation is based on an in-ground value calculation, using total resources, the current V_2O_5 price of US$4.00/lb and an AUD: USD exchange rate of 0.75 – these calculations are detailed below.
- We have used IGV multiples between 0.72% and 1.56% - these are calculated from typical yardstick values weighted for the resource category mix of Gabanintha.
- There are no direct vanadium project sales we can use as a yardstick – the only recent Australian transaction was the sale of Windimurra by the Administrators of Atlantic for $250,000 to the new owners of Atlantic.
- In-house DCF modelling indicates that the project is not commercially viable at current vanadium prices, however should the price increase to a forecast US$5.50 to $6.00/lb it does become viable - the forecast price is in the ballpark of the past 10 year average price of US$6.50/lb.

Table 4: Gabanintha IGV calculations

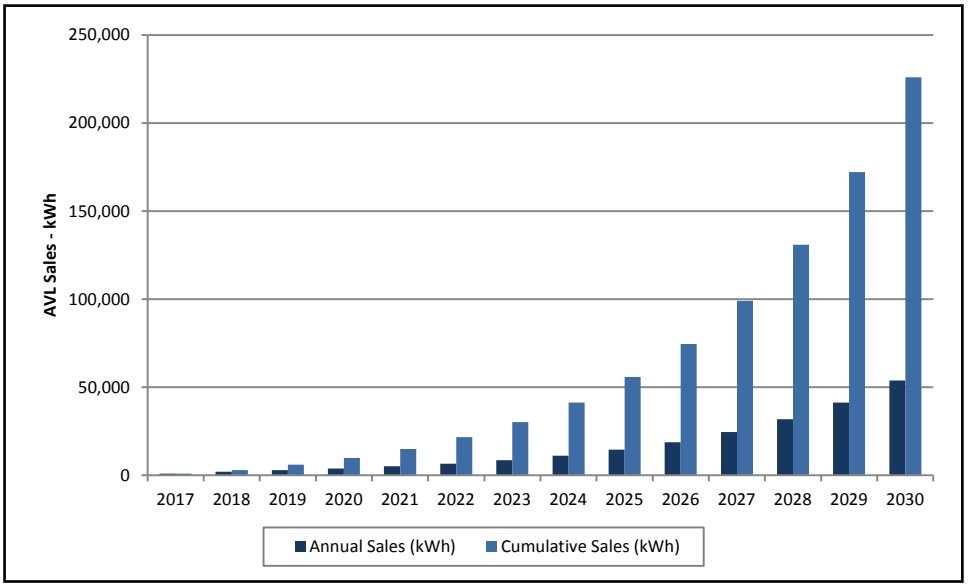
GABANINTHA IGV CALCULATIONS - US$4/lb V_2O_5					
	V_2O_5	**Price**	**IGV**	**Multiplier**	**Value**
Gabanintha lower value	568,000 t	A$11.73/kg	$6,665m	0.72%	$48m
Gabanintha upper value	568,000 t	A$11.73/kg	$6,665 m	1.56%	$104m
Notes:					
Multiplier weighted by different categories in Gabanintha resource					
Yardstick value/IGV multiplier for inferred resources in 0.5-1.0%					
Yardstick value/IGV multiplier for indicated resources in 1.0-2.0%					
Yardstick value/IGV multiplier for measured resources in 2.0-5.0%					

Source: IIR Analysis

Downstream Sales Potential

- We see significant potential, should sales forecasts prove correct, for considerable value in the future sales and installations of VRFB's and electrolyte.
- However it needs to be noted that the discussion below is hypothetical – it is based on a number of broad assumptions and forecasts, which by their nature are inherently imprecise given the current small size and immaturity of the market.
- As mentioned earlier, some forecasters see total installed storage capacity in Australia of 3,000MWh by 2030, with potentially 30% of that, or 900MWh being for VRFB's.
- With a capital intensity of upwards of $1,000/kWh, this gives a potential market in the order of $900 million through to 2030.
- The Company has stated that they will be looking to capture at least 25% of the market, which would generate sales and installation revenue of ~$225 million over the period.
- The graph below shows a hypothetic sales growth profile for Australian Vanadium, based on 25% of 900MWh installed by 2030 – this requires an installation CAGR of around 30%, not only for Australian Vanadium but for the Australian market as a whole.

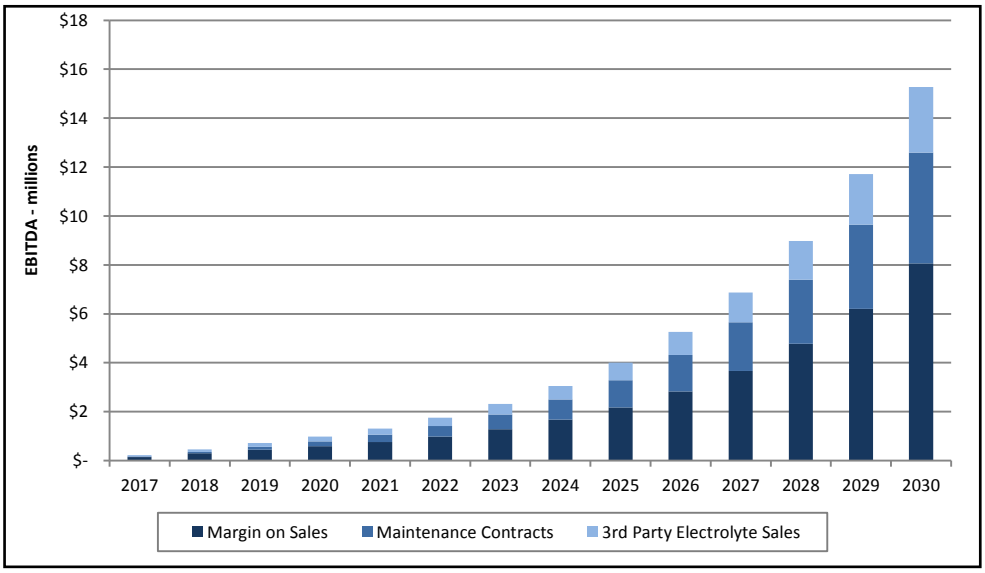
Figure 10: Hypothetical annual and cumulative sales by kWh



Source: IRR analysis

- In addition sales would include maintenance contracts of 2% of the installation cost per annum, as well as the potential for electrolyte sales to other battery providers – we have assumed electrolyte sales to cover a further 25% of the market in addition to the Company's own battery sales.
- The graph below shows a hypothetical EBITDA profile for the period through to 2030 – this is based on an "EBITDA"/sales margin of 15%, and a margin of $1.00/litre for 3rd party electrolyte sales.
- Using an EV/EBITDA multiple of 10, this would imply a valuation of $150 million by 2030 – our research indicates that this is a reasonable multiple for this type of business.
- Even should sales be half of what is forecast, there is still significant potential value in the downstream business.
- Such valuations would appear to be not unrealistic – as discussed in our peer group section later, ASX listed flow battery producer Redflow (ASX: RFX) has a market capitalisation in the order of $150 million, and UK listed entity redT has a market capitalisation in the order of A$100 million – both are yet to achieve significant sales revenue.

Figure 11: Hypothetical EBITDA profile



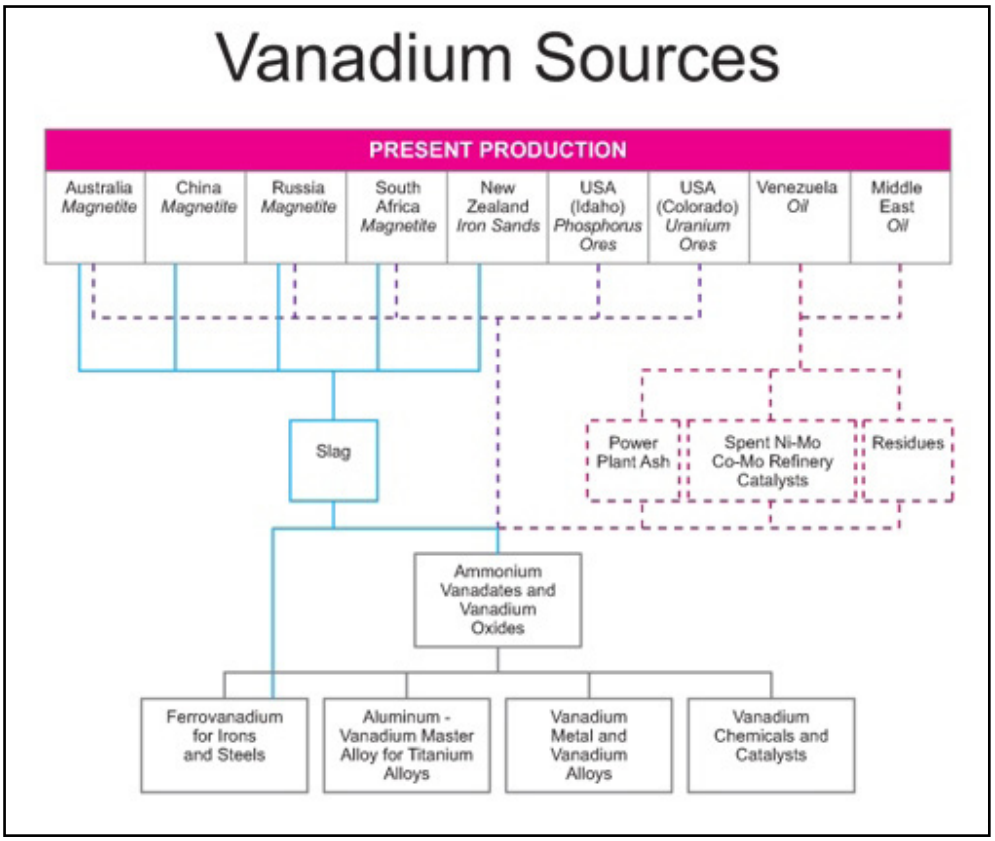
Source: IRR analysis

BACKGROUND – VANADIUM AND VRFB'S

Introduction

- The main use of vanadium is as a steel additive in high-strength steel, which accounts for about 92% of the current global demand of ~100,000t of contained vanadium (~180,000t V_2O_5 equivalent). Other uses include chemicals, catalysts and in batteries. Vanadium is produced as two main products – FeV for steel-making and V_2O_5 for chemical and battery applications.
- The largest source for vanadium is as a by-product from slag produced from the smelting of titaniferous magnetite ores for steelmaking – it is estimated that this accounts for ~60% of total supply, with 20% being derived from mining as a primary product and the remainder from secondary sources, including oil residues and fly ash.
- Supply is concentrated, with over 90% of vanadium products produced in South Africa, China and Russia. In addition non-Chinese production is limited to only a few companies, including Glencore, Evraz, Largo, Vanchem and BlueScope Steel (New Zealand iron sand operations).
- We have recently seen some supply shocks. One such event involves South African producer Evraz Highveld which is now in the process of being wound down, following the failure of a proposed aquisition by Hong Kong based International Resources. This has also led to a production halt by Vanchem, given that Evraz's Vametco operations (in which Vanchem has a 35% non-economic interest, and which has a capacity to supply some 2,750tpa of vanadium as vanadium nitride and oxide) supplies the raw material for Vanchem's vanadium chemical production business, as well as to other customers. LSE listed Bushveld Minerals is currently negotiating the acquisition of Evraz's Vametco mining and processing operations.
- On the other hand new developments include Largo Resources Maracas Project in Brazil, which is now in full production, and exceeding the planned output of 6,500t of V_2O_5 per year, with a planned FeV plant to be added at a later date.

Figure 12: Vanadium sources



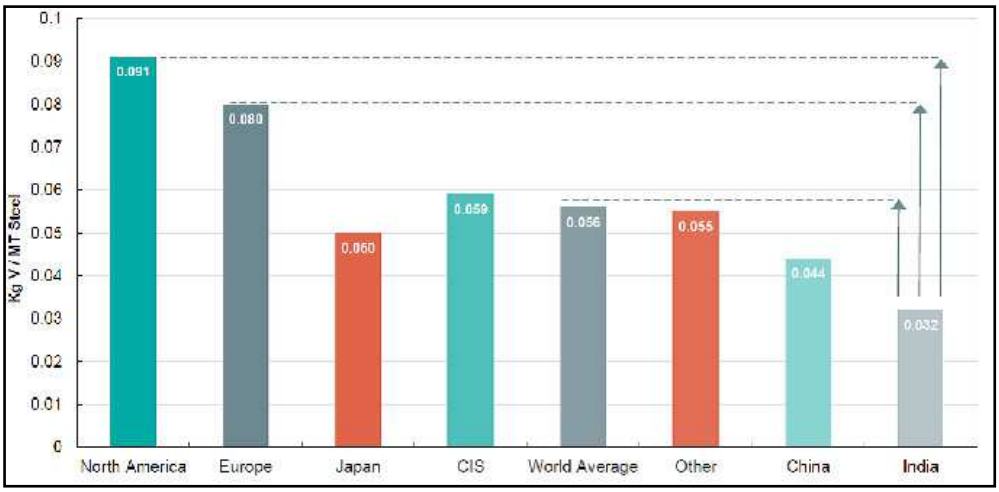
Source: Vanitec

Demand Drivers

Steelmaking

- The key demand driver at the current time is as an additive in steel – demand for vanadium closely follows the production of steel. This includes two factors – firstly the natural organic growth in steel production and secondly increasing vanadium intensity in steel with the move to lighter weight and higher strength steels – the addition of just 0.2% vanadium to steel increases steel potentially strength by up to 100% and reduces weight in relevant applications by up to 30%
- This second factor is particularly relevant in China, where there is increasing vanadium intensity in rebar due to changes in building standards, partly following on from the 2008 earthquake.
- Roskill estimate that, although steel production will only grow at 1% CAGR over coming years, the increasing intensity of vanadium in steel along with other end uses will result in a long term demand growth of 3.45% CAGR from ~100,000tpa V in 2015 to 140,000tpa contained V in 2025, with supply deficits from 2018.
- The graph below shows the relative vanadium intensities between various jurisdictions.

Figure 13: Vanadium steelmaking intensity

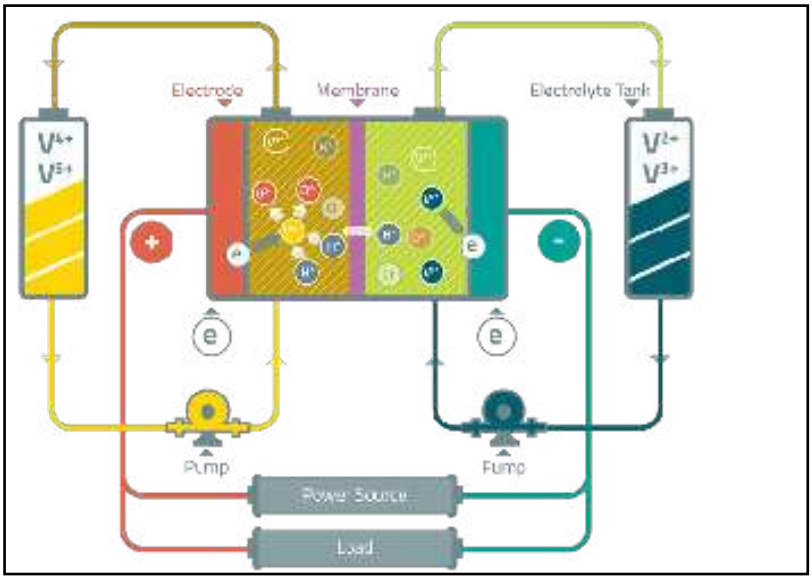


Source: Australian Vanadium

Energy Storage – VRFB's and Li-Ion Batteries

- The blue sky in demand is in grid scale battery usage. The key here will be the adoption of VRFB's that have the capacity for multi-megawatt scale storage - this makes them useful for grid scale applications, including grid balancing, and storing energy from variable output sources, including wind turbines and solar cells.
- The batteries are inherently simple, relying on the changing redox state of vanadium to store and then supply power.
- Other attributes of these batteries include:
  - Scalability
  - Long lifespan – up to 20 years
  - Up to a 1 year charge retention
  - 100% discharge without damage
  - Only one element – V in various oxidation states – in electrolyte.
- There are widely differing forecasts on the growth in VRFB's, however some commentators see the potential for VRFB's to provide up to 30% of the growing energy storage market, with some forecasting an additional demand of 300,000t of vanadium over coming years to meet this need.
- There are a number of active VRB developments globally at the moment, reportedly with the largest being the commissioning of a US$200 million, 15MW/60MWh facility by Sumitomo on the Japanese island of Hokkaido.

Figure 14: VRFB schematic



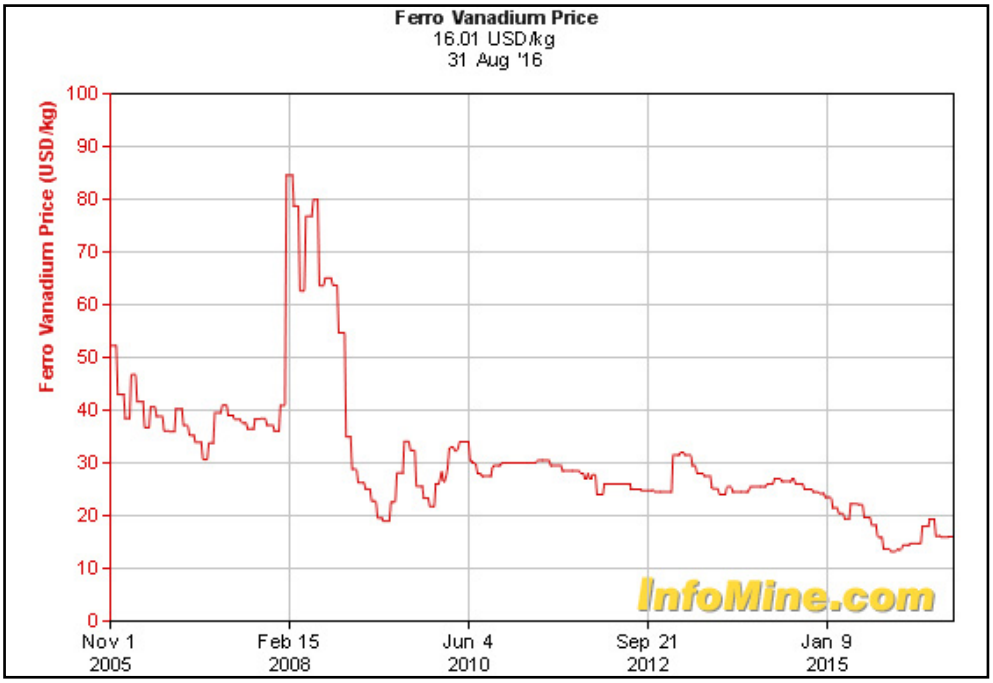
Source: Australian Vanadium

- Development of these has been partly hamstrung by the lack of a suitable battery grade V_2O_5 supply – batteries require a higher purity product than that used in steelmaking.
- As mentioned earlier some forecasts see the Australian energy storage market reaching 3,000MWh by 2030 – should the VRFB penetration reach an estimated 30% of the market this will result in the requirement of 900MWh of VRFB capacity over the same period (this capacity is equivalent to 9,000 Busselton CellCube units).
- Australia is an ideal market for fringe-of-grid and off-grid storage facilities given the extended power networks and large off-grid areas.
- Assuming a capital intensity of A$1,000,000/MWh, this equates to a A$900 million market.
- Given a usage intensity of 7.25t of V (12.94t of V_2O_5) per MWh of capacity, there is the potential for a total domestic market of over 11,000t of V_2O_5 in electrolyte over coming years if the above forecasts come to fruition.
- Electrolytes generally require a concentration of ~145g/l of V (260g/l of V_2O_5), with 5,000l of electrolyte required for a 100kWh unit – this equates to a potential demand for 90 million litres of electrolyte over the period to 2030.
- There is also significant forecast demand (~1/3 of that for VFRB's) for vanadium in Li-ion batteries.

Pricing

- We can see from the chart below that the FeV price has traded between $10 and $15/kg since the end of the GFC, however it has dropped recently due to demand/supply imbalances. Standard grade V_2O_5 (98% purity) tracks at about half the price of FeV. We would expect a premium for battery grade V_2O_5, however we have no data.
- The 30 year average price has been US$11.00/kg V_2O_5, with the 10 year average being US$14.23/kg V_2O_5.
- The market is not particularly transparent, and also prices do not correlate with steel production even though this is the key demand driver.

Figure 15: FeV price chart



Source: Infomine

PEER GROUP ANALYSIS

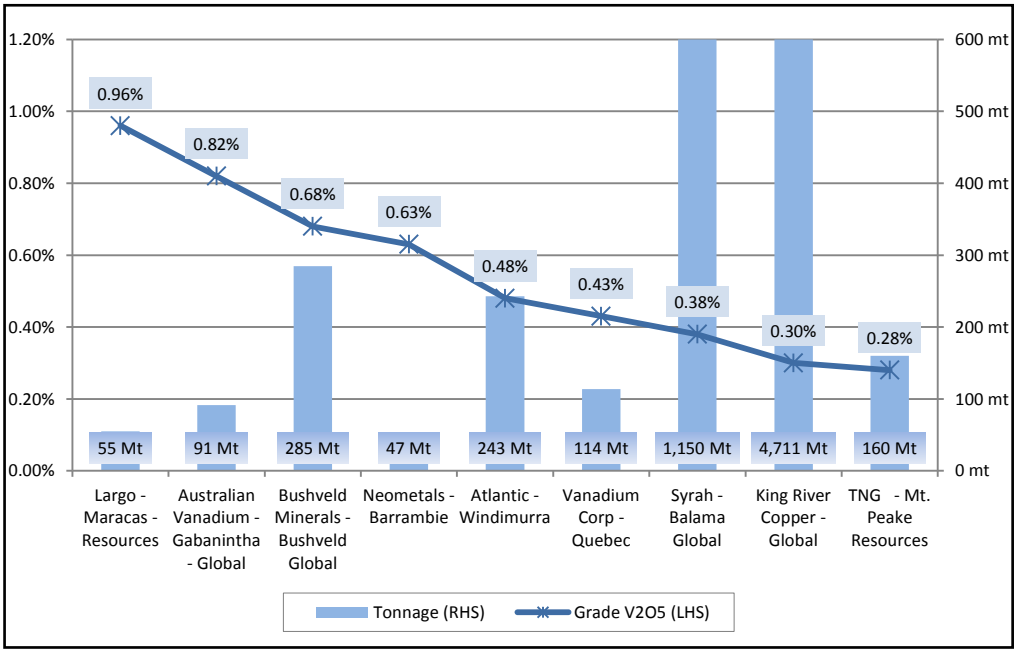
- Australian Vanadium has two main peer groups – firstly the vanadium developers and producers (of which the Company is only one of a few globally, let alone listed on the ASX), and secondly dedicated battery producers and suppliers, of which the peer group is significantly smaller.
- On the developers and producers front, in our view the closest analogy is Largo Resources (TSX-V: LGO), which commenced production in 2015 from its Maracas Project in Brazil, and is treating ~ 1mtpa of ore per annum to produce, depending on head grade up to 9,000tpa of V_2O_5 flake – this is of a similar quantum to production planned by Australian Vanadium at Gabanintha.
- Neometals Limited (ASX: NMT) is currently looking to produce Ti, V and Fe products from its Barrambie Project, which is located within 50km of Gabanintha, and hosted in a similar style of intrusion, however their main focus is on the producing Mt. Marion lithium mine.
- Also in Australia TNG Limited (ASX: TNG) is looking to develop their Mt. Peake V-Ti-Fe Project in the Northern Territory; the plans are to treat this using the proprietary TIVAN® process, to produce high quality vanadium, titanium and iron oxide products. TNG is currently talking to potential finance and development partners having recently completed a positive BFS.
- These companies are included in the table and graph below, which also includes the market capitalisation in Australian Dollars (this has been converted in the case of non-ASX listed companies). The table includes a breakdown of different projects and resource categories for each company.
- What the figures show is the relatively high grade of Australian Vanadium's resources, particularly the high grade, as well as the low market capitalisation - we would expect to see this rise as the activities progress.

Table 5: Australian Vanadium Peers

AUSTRALIAN VANADIUM PEERS						
Company and Project	**Tonnage**	**Grade V_2O_5**	**Contained V_2O_5 - Mt**	**Enterprise Value**	**Stage**	**Notes**
Largo - Maracas - Resources	55 mt	0.96%	0.53 mt	$436.96m	Production	September 2016 - 806t produced
Australian Vanadium - Gabanintha - Global	91 mt	0.82%	0.75 mt	$12.95m	Concept Study	
Bushveld Minerals - Bushveld Global	285 mt	0.68%	1.94 mt	$12.37m	PFS Completed	
Neometals - Barrambie	47 mt	0.63%	0.30 mt	$112.17m	PFS	Primary operations are at the Mt Marion lithium project, and Barrambie is primarily a titanium project
Atlantic - Windimurra	243 mt	0.48%	1.16 mt	N/A	Suspended	Taken over
Vanadium Corp - Quebec	114 mt	0.43%	0.49 mt	$9.73m	Resource	
Syrah - Balama Global	1,150 mt	0.38%	4.37 mt	$610.60m	Scoping	Graphite is main focus
King River Copper - Global	4,711 mt	0.30%	14.13 mt	$3.71m	Resource	Activities focussed on other assets
TNG - Mt. Peake Resources	160 mt	0.28%	0.45 mt	$111.74m	DFS Completed	Ti and Fe co-products in proposed TIVAN plant

Source: IRESS, IIR analysis

Figure 16: Australian Vanadium Peers



Source: IRESS, IIR analysis

- With regards to battery producers, the main ASX listed peer is Redflow Limited (ASX: RFX, "Redflow"), which outsources production of its zinc-bromine flow batteries, including the 10kWh ZCell, targeting household energy storage. Redflow, which has a market capitalisation of $150 million, also has other zinc-bromine flow battery products, targeting larger applications. 2016 sales were $1.1 million; however these are now expected to significantly pick up with preliminary issues solved through the outsourcing of production of the ZCell product.
- In the UK there is redT (RED:L), which is a VRFB focussed company currently concentrating activities in Europe and Africa, with a number of containerised units being installed as part of a "market seeding" programme – redT has also performed some commercial installations. RedT also operates a biogas management and a green energy investment advisory business, with 2016 revenue of £4,533k (~A$7,471k), and a current market capitalisation in the order of £65 million (~A$105 million).

CAPITAL STRUCTURE

- Australian Vanadium currently has 1,181 million shares (including 80 million partly paid) and 15 million performance rights on issue.
- The Company also has 235.9 listed options on issue, with an exercise price of $A0.2 and an expiry date of December 31, 2018, and 174.1 million unlisted options with an exercise price of $0.0147 and an expiry date of December 31, 2017.
- The top shareholder at 2.92% is Mr. Neale Parsons.
- The Board and Management hold 4.83%.
- The Company has 2,804 shareholders, with the top 20 holding 22.88%.

RISKS

- **Exploration and Resource** – Given the stage of the Project and the recent resource upgrade we do not see this as a major risk for Gabanintha. Work to date has defined a resource that appears to be able to support a long term operation. However this will be a risk for Blesberg – this has had no historic drilling.
- **Metallurgy** – Recent work has largely mitigated this risk, particularly with regards to the low grade and oxide material. Additional work is ongoing, largely on variability test work and roast/leach testwork of magnetite concentrates.
- **Funding** – In addition to the $3.57 million in the bank as of September 30, 2016, the Company has 175 million $0.0147 options on issue that are currently close to being in the money, and have the potential to bring in an additional $2.6 million – as such the Company is of the view that it will have sufficient funds to complete planned studies at Gabanintha, however will need to raise funds to meet the expected US$3 million required for Blesberg over the coming 18 months. In addition there is the potential for income from battery sales.
- **Metal Prices and Exchange Rates** – These are key for the success (and a decision to go ahead) of any potential resource project, and a factor in which the operators have no control. After seeing a nadir in late 2015, the last 12 months, and particularly the last 6 months have seen significant rises in vanadium prices, pointing towards a possible longer term recovery in the metal.
- **Permitting and Sovereign Risk** – Given that Western Australia is a relatively friendly mining jurisdiction, we do not see this as a key risk. This is also mitigated by Gabanintha being located in a historical mining district, and the progress made thus far on agreements with the traditional owners. South Africa is a different matter; however events over the past few years indicate that the situation is improving and we are seeing increasing investor interest in the country.
- **Sales and Market Acceptance** – On the battery side, the key risk now is to grow sales and gain market acceptance of the CellCube product – this acceptance will partly come through positive performance of the existing and subsequent installations.

BOARD AND MANAGEMENT

- **Mr Brenton Lewis – Non-Executive Chairman:** Mr Lewis was a Senior Academic having spent the past 20 years in the tertiary education sector. He has held management positions including Head of Department and Head of Post Graduate Studies and chaired Boards of Management in both academia and community organisations. He has taught, published and researched in areas including Ethics and Psychopathology.

  He has acted as a consultant to a number of agencies including the Hong Kong Hospital Authority and the Health Department, WA. He was the founding chairman of the James House Respite Centre and the Greg Nemer Foundation. He has and continues to serve on numerous Boards of Management including both academic and NGOs.

- **Mr Vincent Algar – Managing Director:** Mr Vincent Algar BSC (Hons) Geology, MAusIMM, is a geologist by profession with over 24 years' experience in the mining industry spanning underground and open cut mining operations, greenfields exploration, project development and mining services in Western Australia and Southern Africa. He has significant experience in the management of publicly listed companies, which includes the entire compliance, marketing and management process and encompasses

the development of internal geological and administrative systems, exploration planning and execution, plus project acquisition and deal completion.

Mr Algar helped float and was Managing Director of Shaw River Manganese Limited from December 2006 – March 2012 and was responsible for successful capital raisings, which raised more than $40 million for the Company's exploration and acquisition programs. He was instrumental in the $20 million acquisition of a 75.5% stake in the Otjo Manganese Project in Namibia, in 2011, which is currently being brought into production.

Mr Algar has worked on a wide range of commodities most recently in base metals, and uranium in Southern Africa as a consultant and analyst. Vincent is a member of the Australasian Institute of Mining and Metallurgy.

- **Mr Leslie Ingraham – Executive Director:** Mr Ingraham has been in private business for over 20 years and is an experienced mineral prospector and professional investor. He has successfully worked as a consultant for private companies as well as companies listed on the Australian Stock Exchange. Core competencies include capital raising, shareholder liaison and prospecting.

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