ROLEK RESOURCES LTD

Strategic and Base Metals

Developing the Barramine Manganese Project and Lithium, Beryl and Tantalum in Western Australia

February 2019

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Competent Person's Statement

The information in this presentation that relates to geological and exploration matters is based on information compiled by Dr Joseph Drake-Brockman, a Competent Person who is a Fellow of the AusIMM. Dr Joseph Drake-Brockman is employed by Drake-Brockman Geoinfo Pty Ltd. Dr Joseph Drake-Brockman has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'. Dr Joseph Drake-Brockman consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

INVESTMENT HIGHLIGHTS

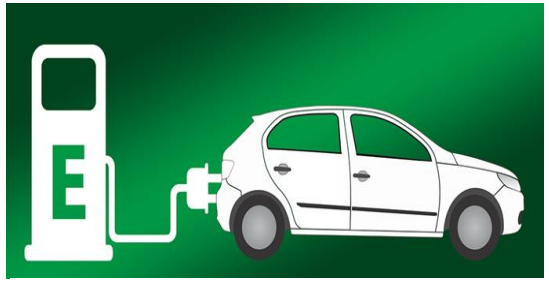
Exposure to base and strategic minerals in a world-class mineral province

- Barramine Manganese Project database includes 27,000m drilling, geophysics and metallurgical studies
- Limited number of ASX companies with manganese and near-term production capability
- Exploration projects include lithium/tantalum, nickel and cobalt
- Experienced management team

MANGANESE OVERVIEW

- Sustained increase in price with strong steel demand – there is no substitute for manganese in steel production
- Supply currently in deficit
- New demand from high-tech applications such as electric car batteries, energy storage batteries and solar panels
- A critical link in the lithium-ion battery supply chain
- **Added to the US Strategic Minerals stockpile list with cobalt, chrome and molybdenum – there is no manganese production in the US**

MANGANESE: A CRITICAL METAL



Steel production manganese enhances tensile strength, stiffness, hardness, toughness, hardenability, wear resistance as well as forging and rolling qualities. In ore production, about 30% of the manganese is used to refine ore and about 70% is used as an alloy in the final product. Currently, around 90% of manganese production is used by the steel industry, with demand growing about 2% per annum.

Battery production manganese is used as a depolarizer in dry cell batteries and required to make cathodes in the most common lithium-ion battery chemistry Nickel–Manganese-Cobalt (NMC) and Lithium Manganese-Oxide (LMO). High-purity Electrolytic Manganese (EMM) and Electrolytic Manganese Dioxide (EMD) are increasing in demand for the emerging electric vehicle market. Total demand for manganese from lithium-ion batteries was 21MT in 2017[1] and growth is estimated to be ~7% per annum.

Manganese is one of nine essential nutrients that **plants** require for growth. Many processes are dependent on this nutrient, including chloroplast formation, photosynthesis, nitrogen metabolism and synthesis of some enzymes. This role of **manganese** in **plants** is extremely crucial.

Manganese has other uses in chemical applications and is a vital component of a healthy diet. Small amounts of manganese are consumed in producing micronutrients for fertiliser and animal feed, water treatment chemicals and other chemicals such as those used as a colourant for car undercoat paint, bricks, glass, textiles and tiles.

1: Refer ASX release Shaw River Manganese, 20 August 2018

PROPOSED ACQUISITION

The Company has entered into a conditional binding agreement to acquire 100% of the issued shares in Rolhold Pty Ltd (**Acquisition**). In connection with the Acquisition[1].

- Rolhold has entered into an option deed to acquire all the shares in Rolek Pty Ltd which holds five granted mineral exploration licences and two applications for mineral exploration licences in Western Australia which are prospective for beryllium, lithium, tantalum, nickel and cobalt; and
- Rolbar Pty Ltd (a wholly-owned subsidiary of Rolhold) has entered into a deed of novation, termination and release under which it will acquire the exclusive exploration and mining rights in respect to iron and manganese within mineral exploration licence E45/4368 located in the Pilbara region of Western Australia (**FeMn Rights**).

Completion of the agreements above will occur simultaneously.

Following completion of the Acquisition, Rolek will be a natural resources company with a portfolio of strategic and base metals projects located in the Kimberley, Pilbara, Gascoyne and Murchison regions of Western Australia.

The Company's focus and vision will be to maximise shareholder value through the expansion of its resource base, development of its advanced Barramine Manganese Project and targeted exploration of its other strategic mineral projects.

Rolek will also seek to acquire other high-quality projects to complement and diversify its current portfolio of projects both in its geographical and commodity focus.

[1]Refer ASX release Shaw River Manganese, 20 August 2018

Our Plan on Listing

Creating *shareholder value short term* by:

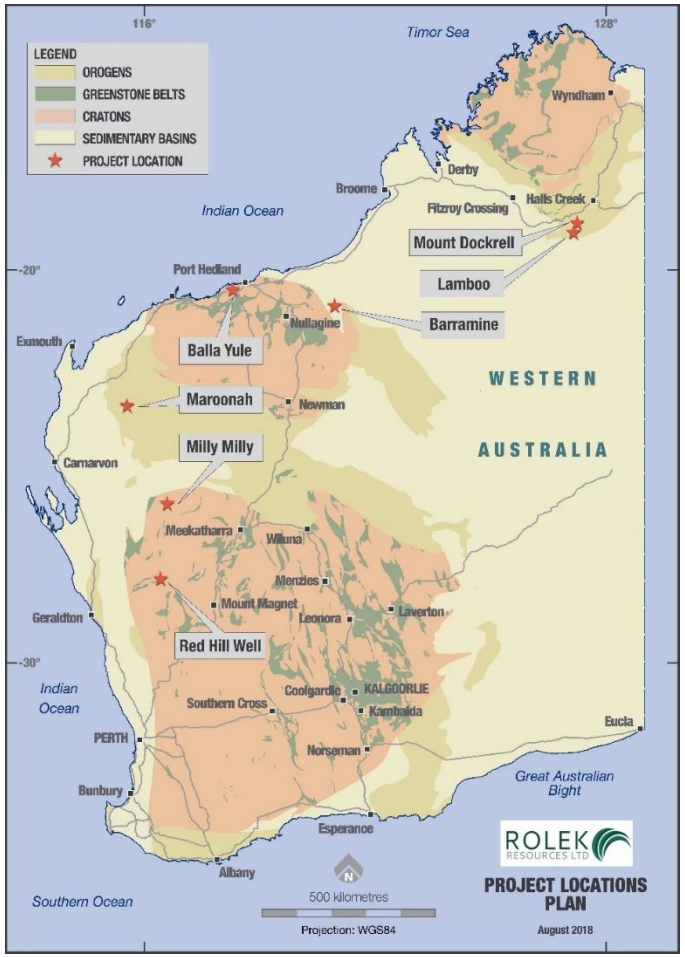
- Completing a maiden Inferred Resource for upgradable manganese product for the steel industry
- Commencing the application for a mining licence on the Barramine Manganese Project
- Completing a scoping study to produce manganese products for the steel industry
- Assessing the potential for direct battery grade manganese products through leaching of manganese oxides
- Strategic partnerships to fast track to production
- Capitalising on the $7.2 million spent historically

Creating *shareholder value long term* by:

- Exploration drilling to define further resource upgrades
- Successfully proving the economic outcomes to start construction
- Submitting a mine plan to convert areas to a mining licence
- Producing manganese products in various markets from steel to manganese battery products

BARRAMINE MANGANESE PROJECT

- Sustained increase in price with strong steel demand **– there is no substitute for manganese in steel production**
- Supply currently in deficit
- New demand from high-tech applications such as **electric car batteries, energy storage batteries** and solar panels
- A critical link in the lithium-ion battery supply chain
- Added to the US Strategic Minerals stockpile with cobalt, chrome and molybdenum – there is no manganese production in the US



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- Limited number of ASX companies with manganese and near-term production capability
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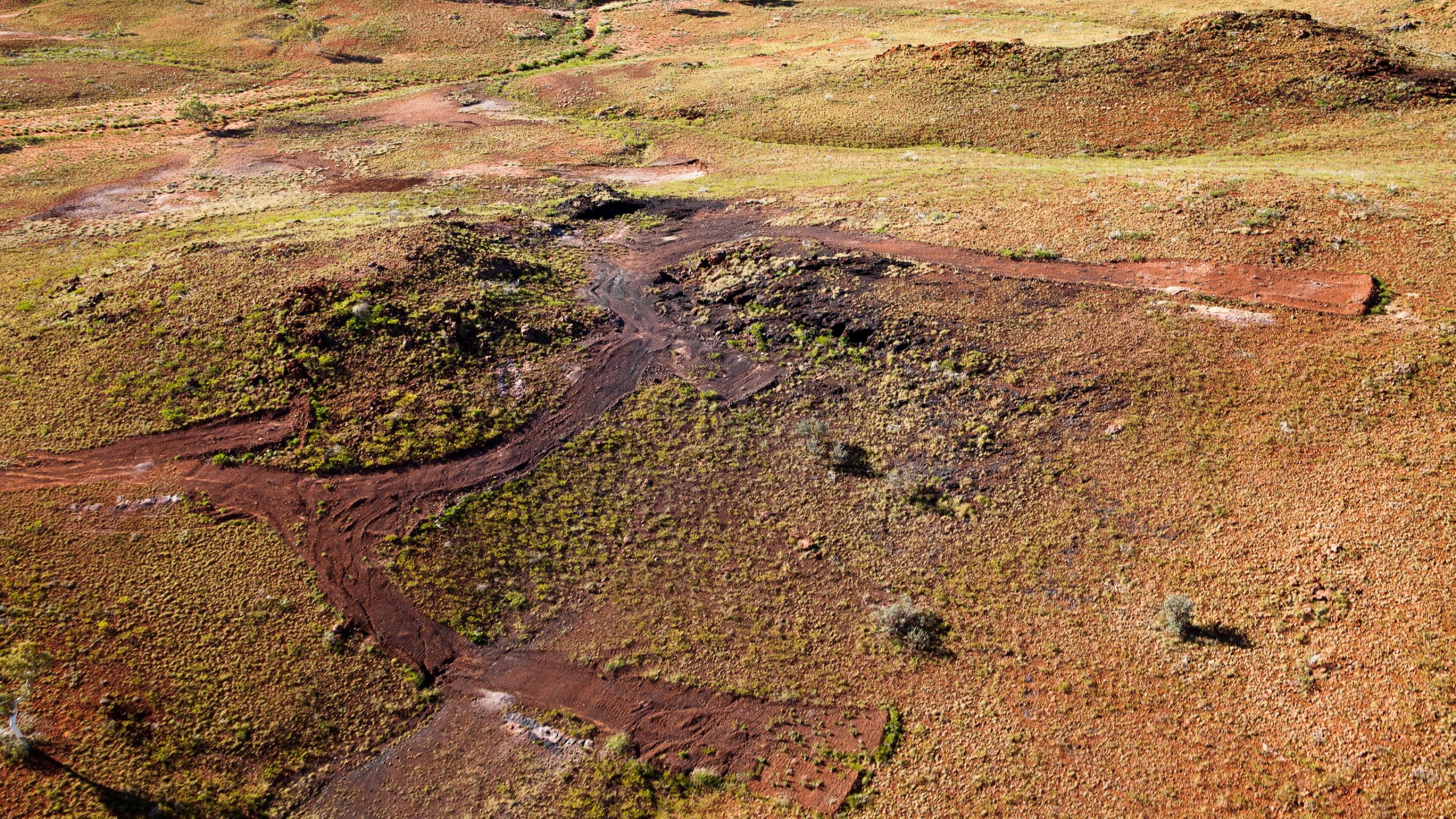
- Experienced management team



ROLEK RESOURCES LIMITED

Proposed Board and Management

Mr Luke Innes (Chairman)

Mr Innes is currently involved in the energy industry and has had 27 years' experience in the mining, minerals processing and power generation industry both in Australia and overseas. Within Australia he has held technical and managerial roles within the resources sector including gold, nickel and iron ore mining and mineral processing operations. These included Australia's largest iron ore and nickel operations. He has previously held a non-executive position within a public unlisted company as well as being a Non-executive Director and Non-executive Chairman of ASX listed Greater Pacific Gold.

Mr Ian Stuart (Executive Director)

Mr Stuart is a geologist by profession with experience in both the finance and mining industries. He holds an Honours degree in Geology, is a Fellow of the Financial Services Institute of Australasia and a member of the Australian Institute of Company Directors. Ian has extensive experience in capital markets and is conversant with public company governance and management across international jurisdictions. Mr Stuart is Non-executive Chairman of ASX listed Bryah Resources Ltd.

Mr Vincent Algar, B.Sc. (Hons), MAusIMM (Non-executive Director)

Mr Algar has 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. Mr Algar has worked on a wide range of commodities including base metals and uranium in Southern Africa. Mr Algar has held previous roles as Managing Director and Non-executive Director of ASX listed companies. Mr Algar is the current Managing Director of Australian Vanadium Ltd (since 2015) and is responsible for advancing the company's high grade Gabanintha deposit in Western Australia and developing a vertical integration strategy to incorporate energy storage markets. Mr Algar is a member of the Australasian Institute of Mining and Metallurgy.

Details of the Offer

The Company is seeking to raise $5 million through the issue of 250 million shares at an issue price of 2c per share, together with 1 free attaching option (4c, 3 years) for every 5 shares issued. The proforma capital structure on completion of the Offer and the Acquisition is set out below:

	Shares	Performance Shares	Options
Existing Securities	34,524,911	-	-
Options to be issued under seed raising (4c, 3 years)	-	-	30,000,000
Securities to be issued to vendors under Acquisition	122,500,000	50,000,000[1]	-
Public Offer	250,000,000	-	50,000,000
Securities to be issued on conversion of Convertible Notes[2]	20,000,000		20,000,000
Great Sandy Shares[3]	7,500,000	-	-
Promoter Shares	10,000,000		
Facilitator Options	-	-	15,000,000
Total	**444,524,911**	**50,000,000**	**115,000,000**

Post transaction	Value
Cash	~$4.5M
Market capitalisation	$8.9M
Enterprise value	$4.4M

1 *Performance shares will convert into fully paid ordinary shares if specified performance milestones are met.*

2 *Securities to be issued on completion of Acquisition to convert convertible notes on issue in Rolhold.*

3 *Shares to be issued in connection with acquisition of FeMn Rights.*

Use of Funds

Allocation of funds	$5,000,000 raised	
	First year	Second year
Exploration costs		
- Barramine Project	$1,320,000	$1,134,000
- Mt Dockrell and Lamboo Project	$90,000	$100,000
- Maroonah Project	$30,000	$30,000
- Red Hill Well Project	$40,000	$40,000
- Milly Milly Project	$70,000	$100,000
- Balla Yule Project	$30,000	$50,000
Working capital	$1,399,084	
Costs associated with the Public Offer and Acquisition	$646,916	
TOTAL	**$5,080,000**	

BARRAMINE MANGANESE PROJECT

Overview

- Historically, over $7.2M spent on exploration
- Initial metallurgical tests show a 20% head-feed produces a 43% Mn, 10% Fe product

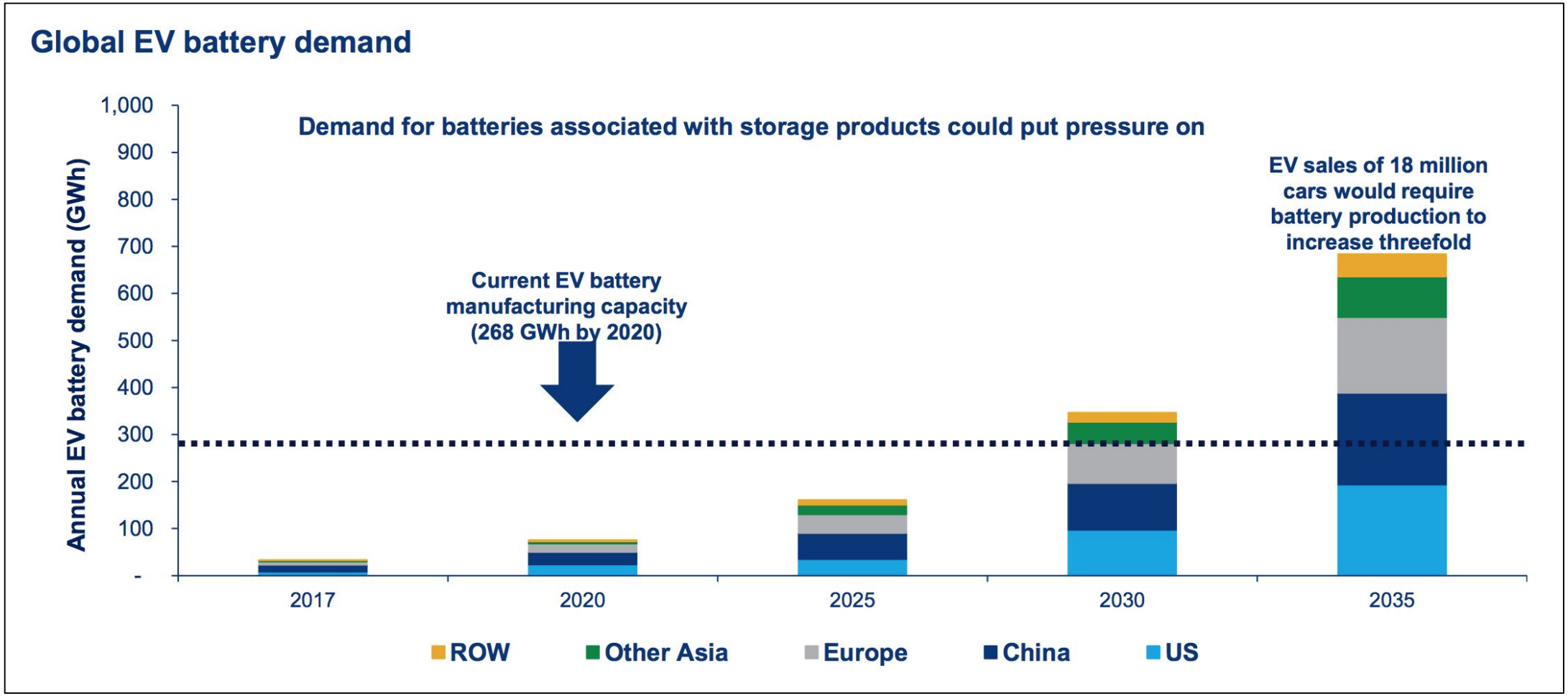
- Located in world-class Pilbara manganese province 255km ESE of Port Hedland
- Identical geological setting to the nearby Woodie Woodie Manganese Operations – 80km south. Shows significant potential for bulk mining operations
- Historical expenditure of over $7.2M on drilling and exploration with >27,000m of drilling, geophysics (incl. magnetics, EM and IP) sampling and metallurgical testwork
- Main target zone length ~2,500m with a total of 33 mineralised holes grading better than 5m at 10% Mn
- Initial JORC resources achievable in Areas 3 and 4 with targeted infill drilling
- Staged earn-in to an advanced manganese project in a world-class manganese province
- Strong demand and new end uses in solar, electric vehicles and batteries

POTENTIAL HIGH-GRADE MANGANESE FOR BATTERY INDUSTRY

- Oxide potential occurs as coating and in oxide zones near structures
- **Surface staining of Mn shows mobile Mn**
- Supergene enrichment zones
- Mn Oxide process metallurgy not investigated by previous explorers!

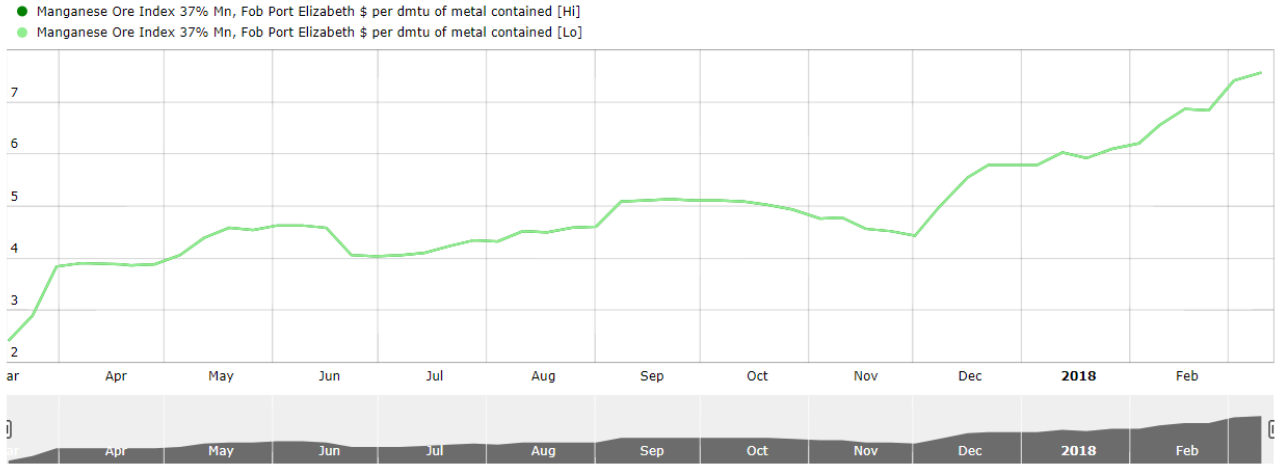
Products may be possible via leaching or beneficiation of Mn mineralisation to produce **Electrolytic Manganese Oxide/Dioxide (EMD)**

MANGANESE: THE THIRD BATTERY MINERAL



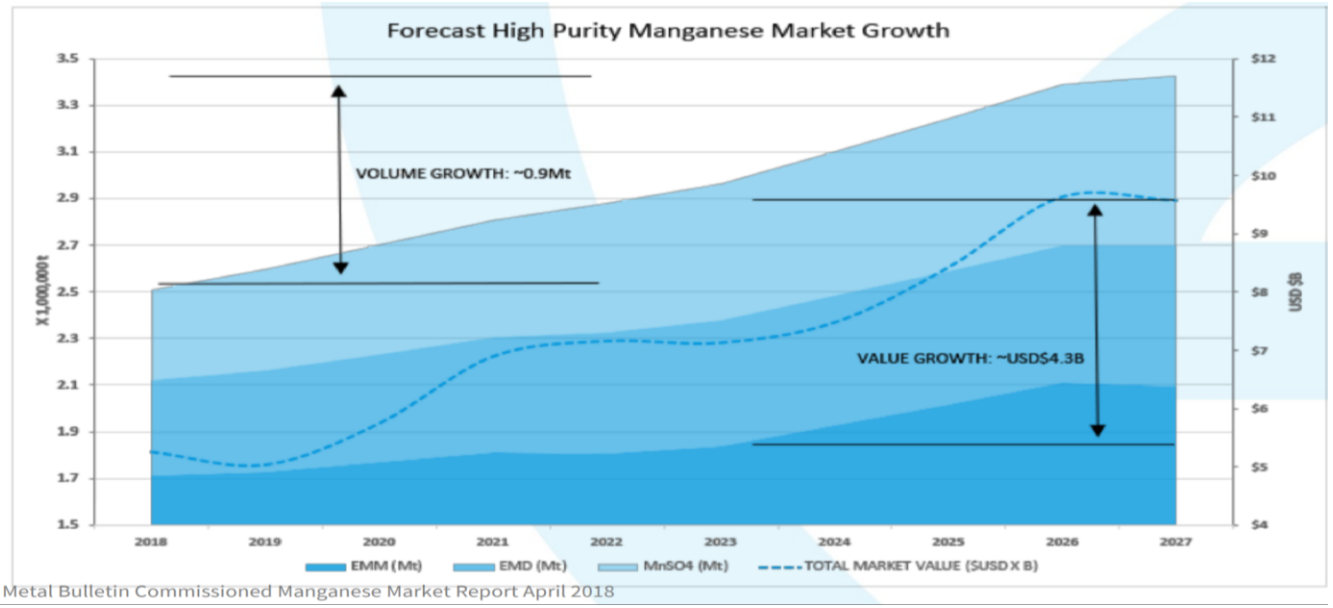
Source: Wood Mackenzie

All Manganese Markets Increasing



Mn Steel Market

Steady growth ~2%



Reference: Metal Bulletin Commissioned Manganese Market Report April 2018

Mn Battery Market (EMD)

Growth CAGR ~7%

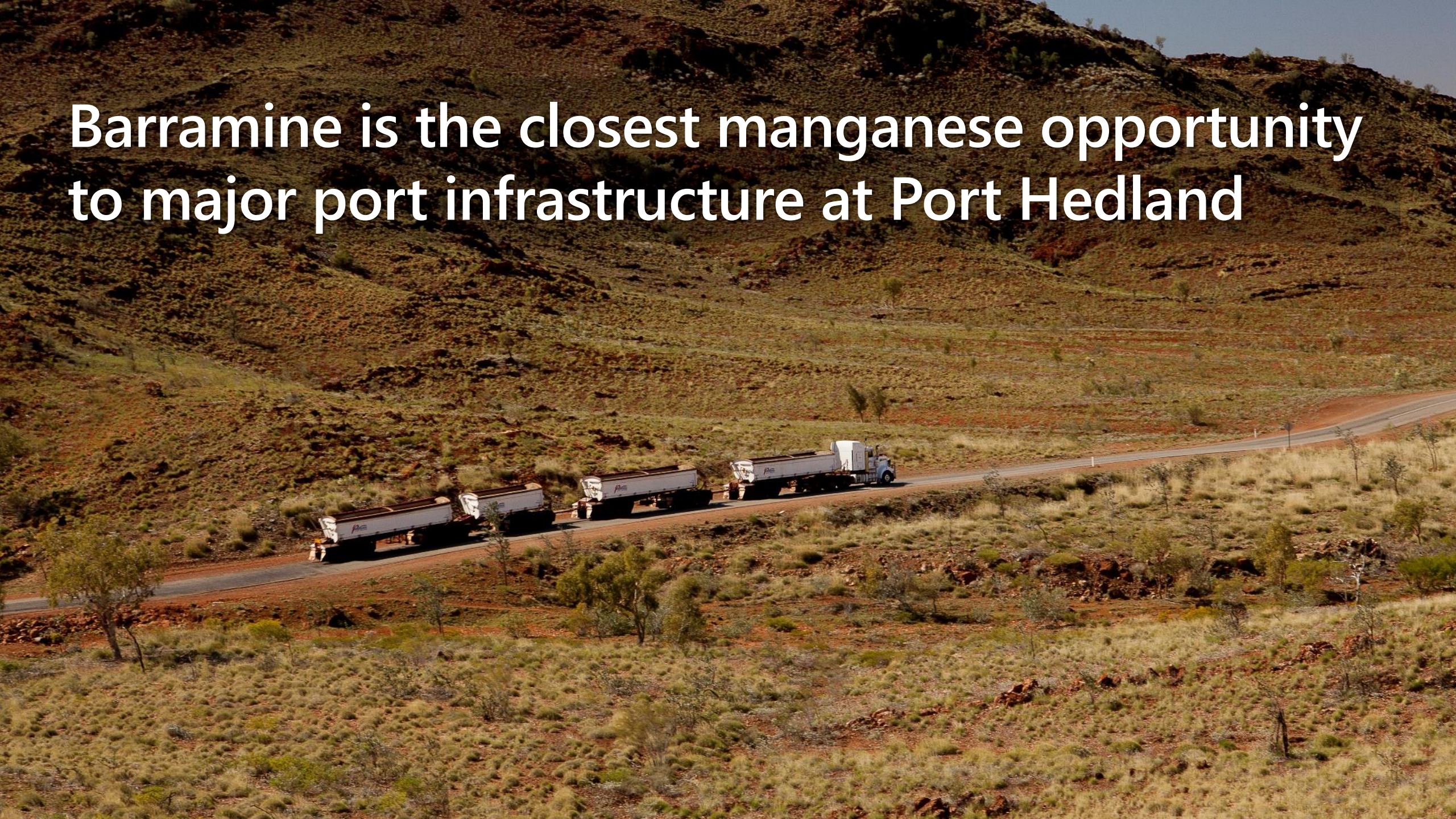
Source: Imnl 2018

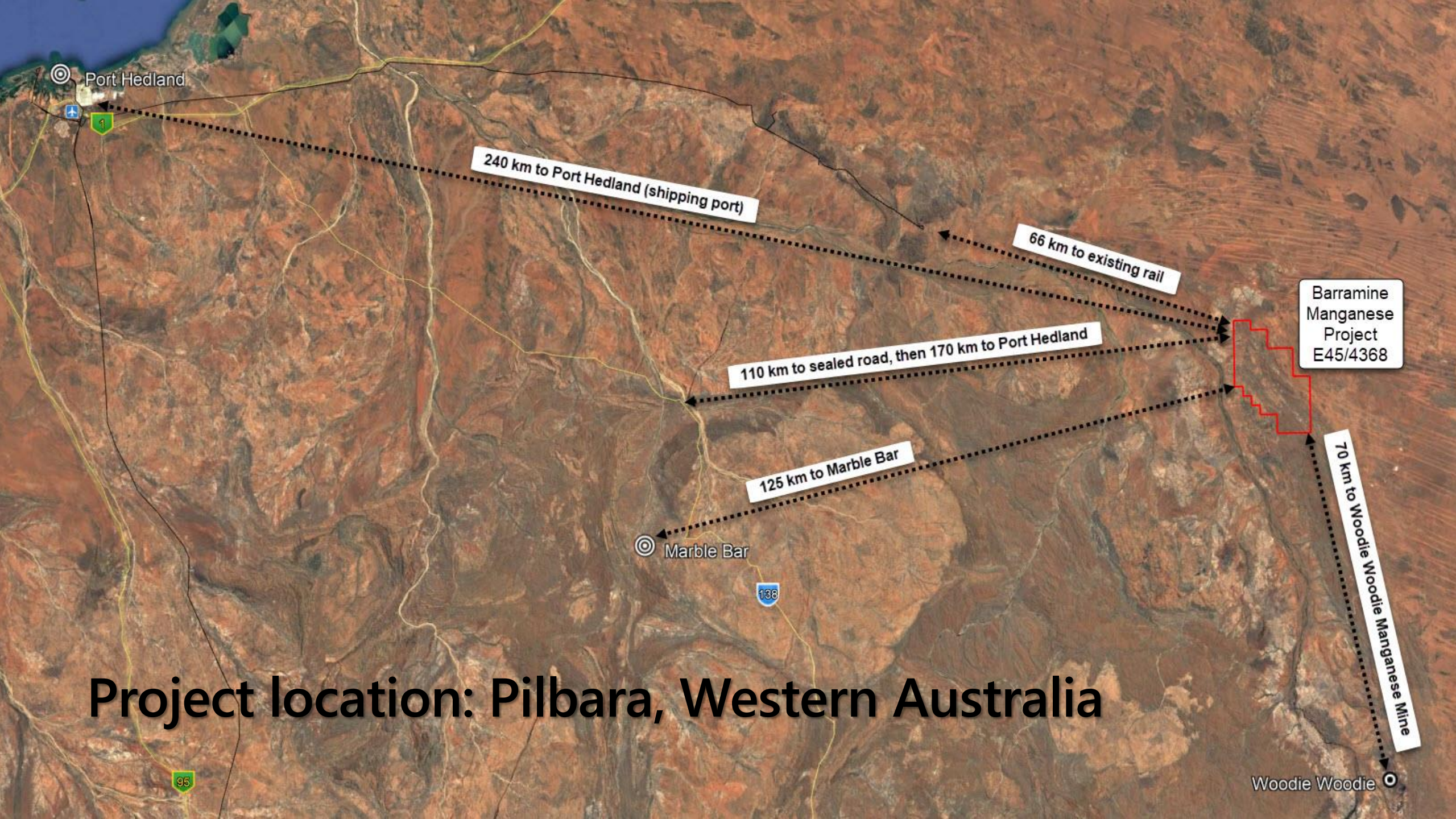
Significant Intersections

- Best drill-hole assays 36–46% Mn
- Average intersection of 10m at 16% Mn from a total of 46 intersections in 39 mineralised holes
- Thresholds; >10% Mn and >5m intersection

- **27m @ 20.3% Mn from 37m (BRC 290)**
  including 10m @ 31% Mn from 37m and
  6m @ 28.8% Mn from 67m
- **18m @ 21.4% Mn from 73m (BRC 241)**
  including 3m @ 36.1% from 86m
- **8m @ 22.4% Mn from 34m (BRC 169)**
  including 2m @ 36.2% from 36m
- **7m @ 22.3% Mn from 37m (BRC 332)**
  including 1m @ 29.3% Mn from 40m
- **10m @ 19.3% Mn from 91m (BRC 266)**
  including 2m @ 35.3% from 93m
- **10m @ 19.4% Mn from 10m (BRC 318)**
  including 6m @ 23.6% from 12m

Barramine is the closest manganese opportunity to major port infrastructure at Port Hedland

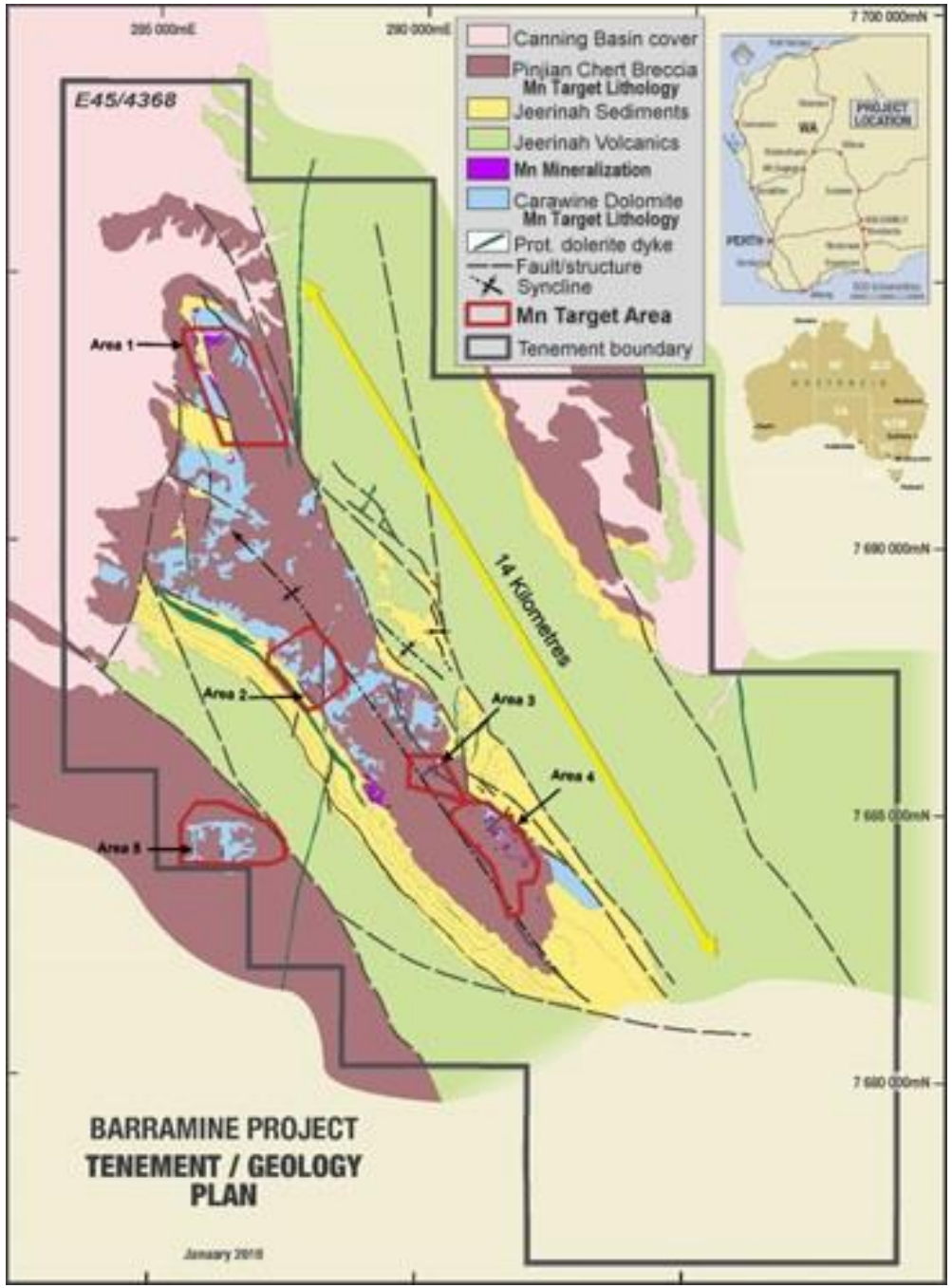




Project location: Pilbara, Western Australia

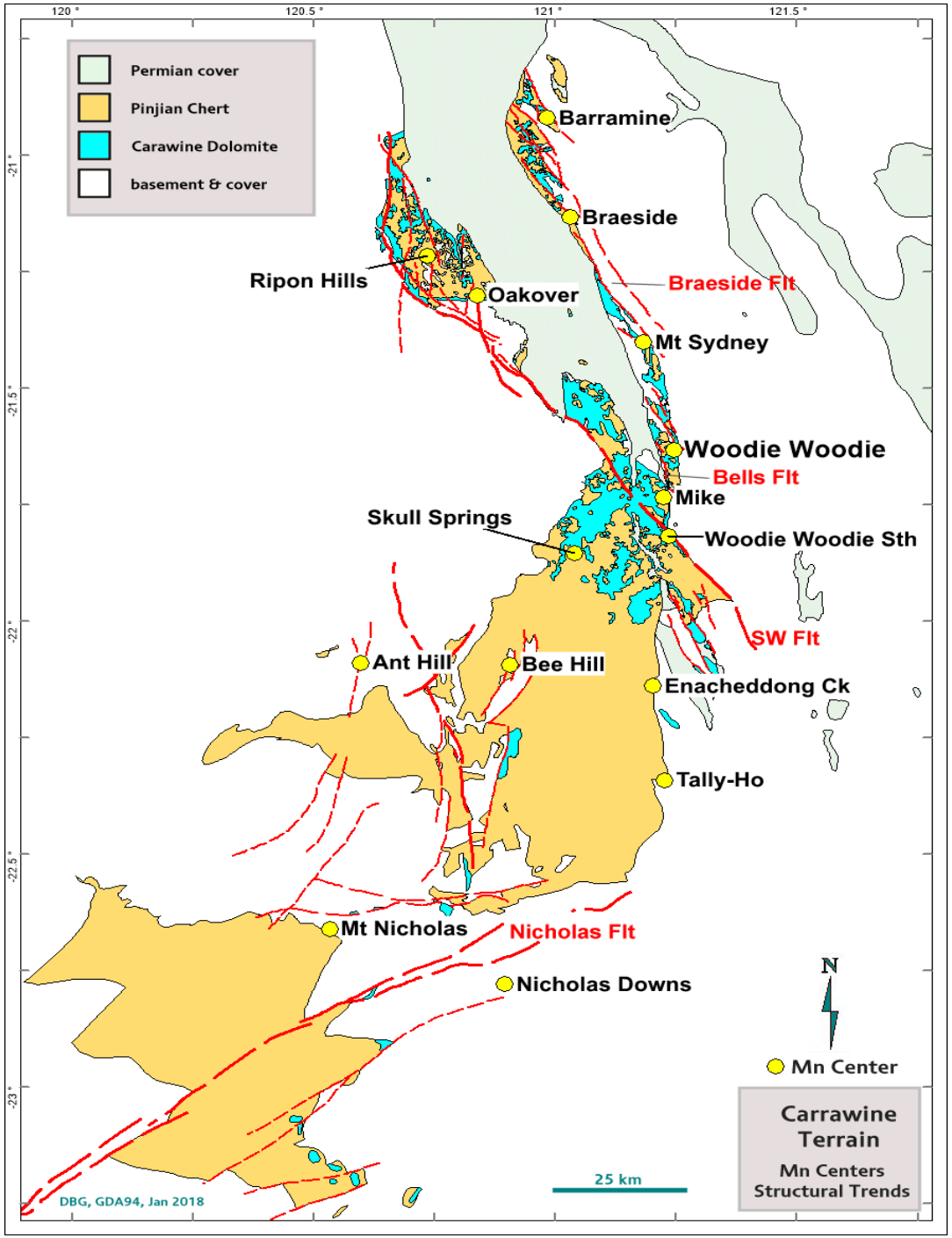
Project Geology

- 14km of prospective ground
- Priority 2.5km-long mineralised zone (Area 3 & 4) identified
- Strong soil anomalies correlate with major structures



Regional Overview

- Eastern Pilbara Manganese Field
- World-class manganese province

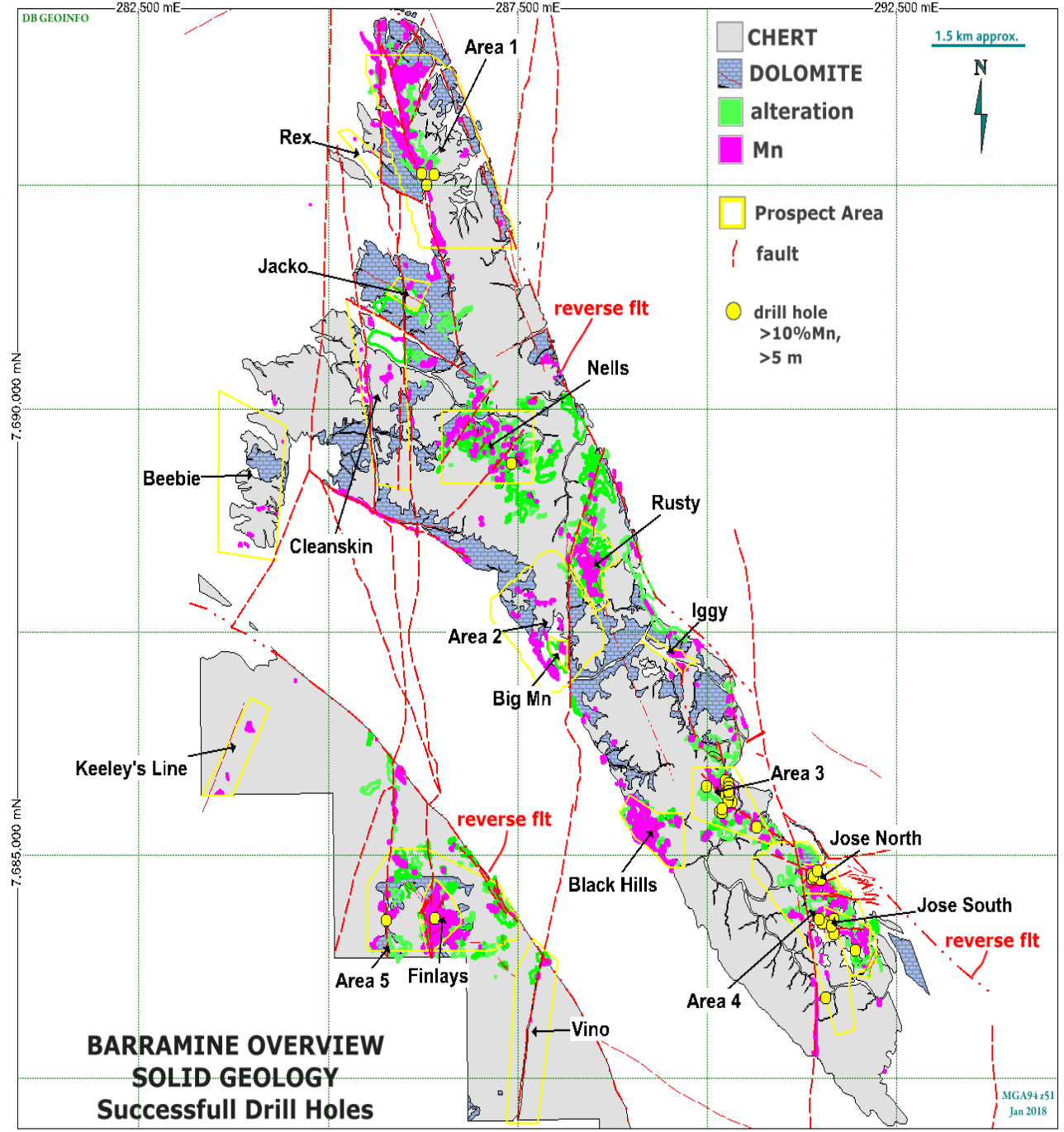


Note: Series of similarly orientated faults north of the SW Fault – extending from Woodie Woodie to Barramine and the increase fault intensity between Braeside and Barramine

BARRAMINE MANGANESE

Drill-hole distribution

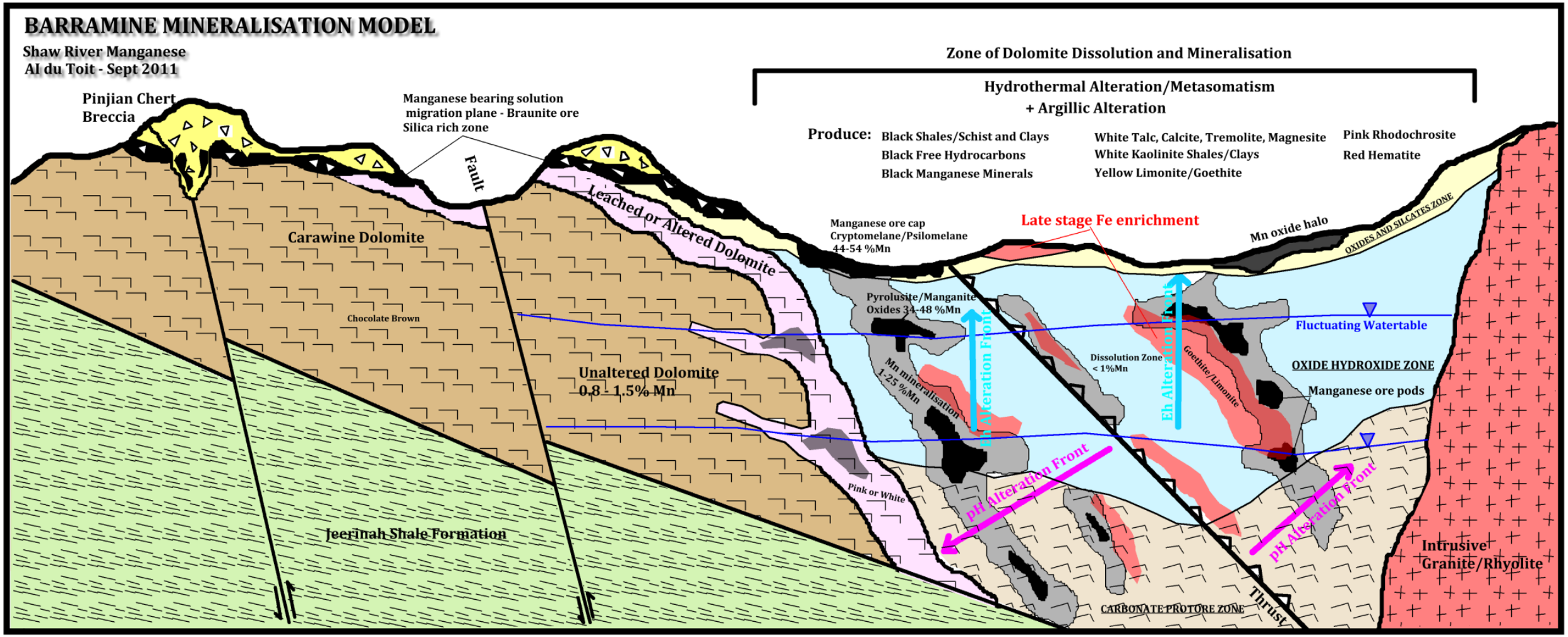
- Mn >10%
- Thickness >5m



Barramine successful drilling, solid geology and manganese signature

Geological setting of Barramine is identical to world-class Woodie Woodie Manganese Mine 70km to the south

BARRAMINE MANGANESE MINERALISATION MODEL



METALLURGICAL TESTWORK

Beneficiation testing indicates recovery of manganese similar to Woodie Woodie product

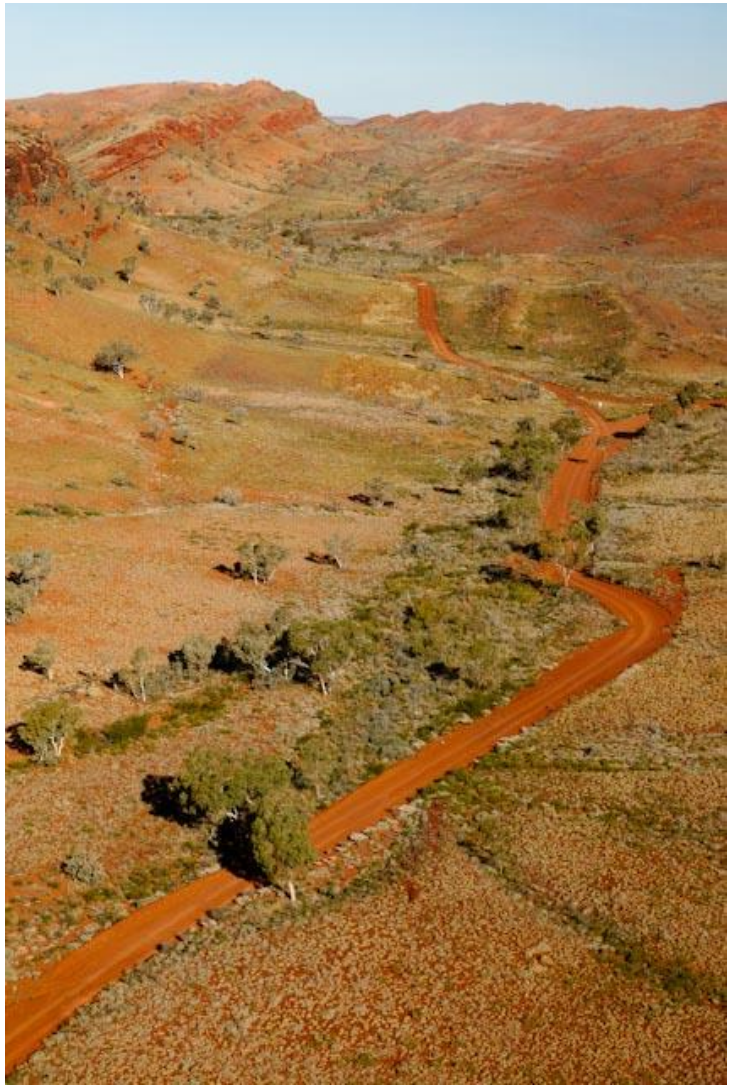
- DMS testwork indicates 20% Mn head-feed can produce 43% Mn, 10% Fe product
- Metallurgical testwork was completed on 11 composite samples during 2010 by NAGROM Laboratories. The aim of the testwork was to determine the potential for upgrading the material from Barramine
- The beneficiation test work was conducted on composite RC drill samples from seven drillholes spread over five prospects, these being representative of the current mineralisation identified so far at Barramine
- Based on the preliminary testwork done, the following observations have been made (Vincent Algar, 2011):

  "DMS and gravity separation tests show manganese can be upgraded from approximately 20% feed to 43% product, pointing to a highly saleable product. 76% of the manganese metal was recovered from 35% of the mass in the DMS, pointing to extremely favourable mining and processing economics" (SRR ASX Release, January 2011)

RESOURCE POTENTIAL OVER 2.5KM STRIKE LENGTH

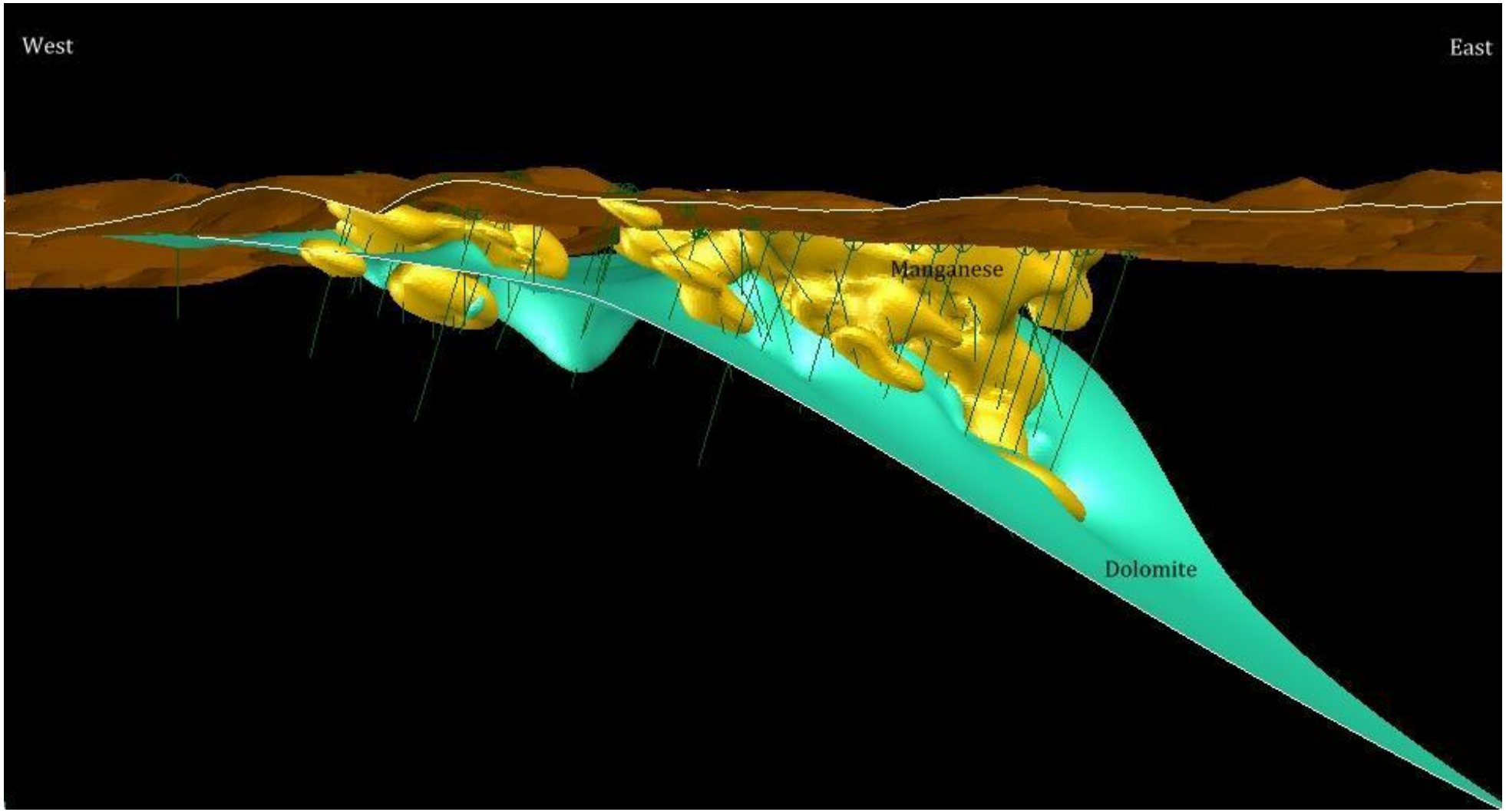
Mineralised zone (Areas 3 and 4) identified; further drilling between these zones and along strike a priority

- Visible manganese alteration and argillic dissolution over target strike length ~2,500m
- Partly drilled ~600m (Area 3 and 4 south); only 24% strike tested to date
- Scattered outcrop of high grade cryptomelane/nsutite cap over 400m
- Targeting the remaining 1,900m with a conceptualised mineralised zone 50m wide, from 30–100m depths over possibly 50% of the area
- Area 5 is also recommended for further investigation – BRC250 intersected 15m @ 20% Mn (composite)

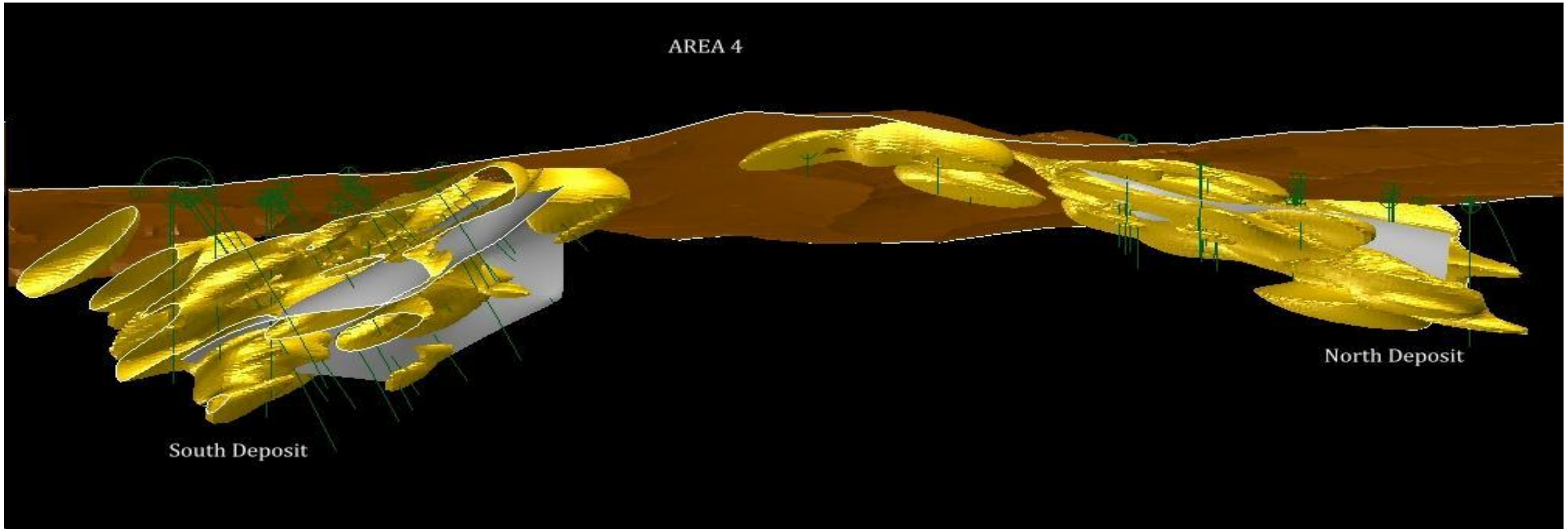


Note: Mt = million metric tonnes

LEAPFROG MODELLING – AREA 3



LEAPFROG MODELLING – AREA 4



INITIAL WORK PROGRAM UNDERWAY

- Complete public offer to raise $5M and seek re-admission of the Company on ASX
- Assets to be acquired under Acquisition also include lithium and copper-nickel-cobalt greenfield tenements in Western Australia
- Following completion of the Acquisition and re-admission to the official list of ASX:
  - complete data collation and finalise JORC compliant resource on Area 3 and Area 4 deposit areas
  - conduct Scoping Study for small-scale operation and commence environmental, mining licence application and native title engagement
  - conduct further exploration drilling between Area 3 and Area 4 as well as resource drilling around previous intersections across the licence

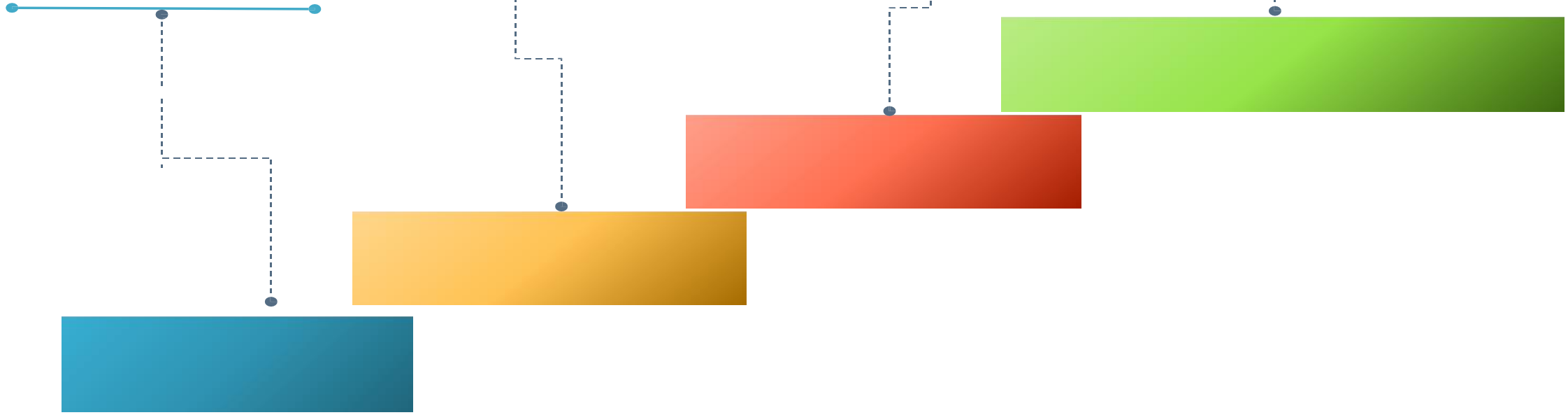
Proposed Programs and Timelines

- Initial resource estimates
- Metallurgical studies including
- Environment impact studies
- 4,000m drilling program
- Mining licence application

- Process report
- Plant design
- Mine design
- Offtake partners

- Exploration drilling
- Further resource definition
- Plant costing

- Mine plan
- Environmental permitting
- Mining licence
- Production



WHY MANGANESE?

Steel

Solar PV
EV batteries
Energy storage

- Sustained increase in price with strong steel demand **– there is no substitute for manganese in steel production**
- Supply currently in deficit
- New demand from high-tech applications such as electric car batteries, energy storage batteries and solar panels
- A critical link in the lithium-ion battery supply chain
- Added to the US Strategic Minerals stockpile with cobalt, chrome and molybdenum **– there is no manganese production in the US**

RECENT EXPLORATION

Shaw River Manganese (2009–2012)

- Shaw River's drilling in 2011 at the prospects Area 3 and Area 4, identified manganese mineralisation in high grade (>25% Mn) plunging shoots within a more coherent zone of +10% Mn, which is very similar in nature to many of the deposits at the nearby Woodie Woodie mine (56 deposits, average tonnage 500,000 tonnes and an average grade 40% Mn)
- Metallurgical testwork carried out on samples from these prospects showed a consistent positive response to beneficiation using DMS (dense media separation) techniques with concentrate grades ranging from 31.6% Mn to 43% Mn and manganese yields from 60% to almost 92%
- Globally within both areas, the drilling density is sufficient to define an Inferred Resource at a 0% cut-off, but at the cut-offs of economic interest, the uncertainty in both tonnage and grade is much higher and the corresponding resources are considered as "Unclassified", in accordance with the JORC Code

Historical Exploration

Sentinel Mining Co. (1967–1968)

Sentinel explored for iron and manganese over an area known as the Warrawagine Basin – Mount Cecilia Project.

Longreach Metals NL (1971–1972)

Longreach Metals' Ripon Hills project area was located southwest of the Barramine tenement and exploration identified 11 distinct ore deposits (A to K).

Valiant Consolidated Ltd and Consolidated Minerals Ltd (1993–1999)

Valiant's Gingarrigan Well Project tenement E45/1337 overlapping the portion of E45/4368 covering Shaw's Area 5 and Vino prospect areas.

Pilbara Manganese Pty Ltd (2005–2009)

Pilbara Manganese's Parson's Creek Project tenement E45/2733 was located immediately south of tenement E45/4368.

Shaw River Manganese Ltd and Laconia Resources Ltd (2009–2012)

Between 2009 and 2012, the project area was jointly explored by Shaw River Manganese and Laconia Resources. A summary of Shaw River's exploration can be found in WAMEX report A102131.

Other Studies Completed

MINERALOGY

Roger Townend & Associates mineralogical analysis via polished thin section examination and XRD/SEM analysis found that the manganese minerals are predominantly not liberated. The most common chip type is composed of the manganese phases pyrolusite and cryptomelane, with goethite being commonly associated, with occasional quartz/chert inclusions.

NATIVE TITLE

Various heritage surveys were completed by Yamatji Marlpa Aboriginal Corporation. No identified registered aboriginal heritage sites are evident. No ethnographic sites were identified that constituted constraints to previous works programs; however, some material cultural objects were reported. No objections were raised in regards to exploration activities in the project area at planned RC drilling sites.

REHABILITATION

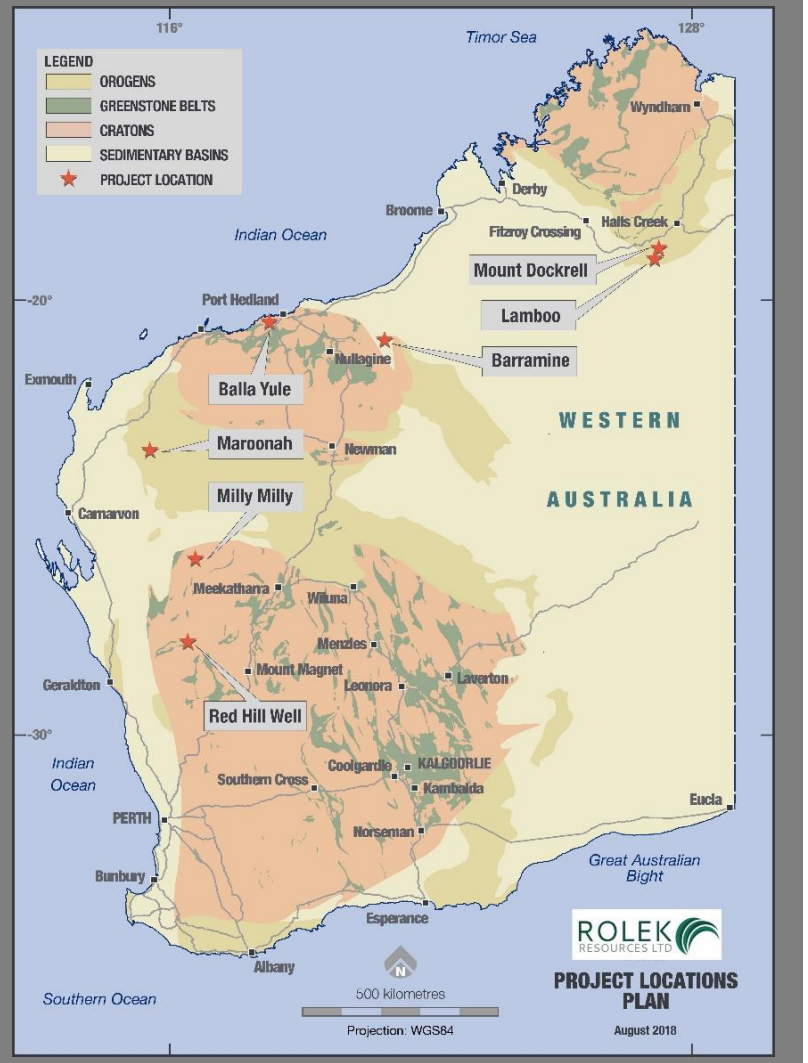
Peter Spitalny of Hanree Holdings Pty Ltd was commissioned and completed outstanding rehabilitation. Shaw River registered for the MRF (post-rehabilitation program).

Li-Ta-Ni & Co Exploration Projects

Interest driven by project demand for lithium tantalum nickel and cobalt, in particular the steadily increasing demand for EV, and battery storage

- Li-Ta mineralisation model:
  - Fertile peraluminous source granite
  - Proximity to causative granite body
  - Proximity to feeder structures
  - Open fracture systems
  - Generally mafic host rocks
  - Location 2–8km from the granite margin
- The Rolek tenements comprise five project areas in the Kimberley, Pilbara, Gascoyne and Murchison areas of Western Australia
- The project areas are prospective for strategic and base metals including beryllium, lithium, tantalum, nickel and cobalt
- Rolek will systematically assess the potential for commercially viable deposits of strategic and base metals with particular focus on lithium, tantalum, nickel and cobalt

LITHIUM-TANTALUM PEGMATITE PROJECTS



Mount Dockrell/Lamboo Project – Be, Ta, Li, Ni, Co (89 blocks)

- Located in the Kimberley, the Mount Dockrell/Lamboo Project neighbours a tin-tantalum mining field where alluvial tin was mined in the 1920s and 1930s
- Accessory spodumene and niobium minerals in pegmatites also recorded
- Interpreted pegmatite targets in project areas

Maroonah Beryl Project – Be (9 blocks)

- Known beryl occurrences near the Maroonah Homestead in the Gascoyne region

Red Hill Well Project – Li, Ta (6 blocks)

- Known beryl showing in the Murchison region
- Indicating the formation of volatile-rich fluids and potential for Li-Ta mineralisation
- Evidence of pegmatite development and an obvious granite source

Nickel-Cobalt Projects

Milly Milly Project – Ni, Co (27 blocks)

- Located in the Murchison; historical exploration in the 1960s included mapping, rock chip and soil sampling
- A layered sequence of gneiss, amphibolite, banded iron and serpentinite
- Surface sampling has shown Ni-Co anomalies in six localities over a 17km-long zone
- Recent exploration focused on uranium and iron ore with significant occurrences of banded iron formations in the area
- Sizable target areas with numerous potentially Ni-Co bearing serpentinites have been identified from satellite imagery

Bella Yule Project – Ni, Co (12 blocks)

- Located in the Pilbara close to Port Hedland, the project is prospective for Ni and Co in ultramafic bodies intruded along the Scholl Shear Zone
- Adjacent historical drilling identified Ni-Co mineralisation
- Scholl Shear Zone, a favourable regional geological structure defined over a length of >250km with known komatiite and ultramafic rock associations

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APPENDICES

Further background

ConsMin CEO Oleg Sheyko said the restart of Woodie Woodie is an important event for the Western Australian mining industry. Australia is the third largest manganese producer after China and South Africa, with yearly production of around 2.5Mt.

Most mined manganese goes toward steel production, as the metal improves the properties of other metals in alloys. But manganese also has a growing role in the development of dry-cell batteries, and its use in that sector may enhance its outlook in the near future. In fact, a recent report says manganese is one of several crucial metals headed for a tight supply crunch.

Note: Mt = million metric tonnes

Source: https://investingnews.com/daily/resource-investing/critical-metals-investing/manganese-investing/surging-prices-australian-manganese-mine/

About Manganese – A Critical Metal

Manganese is a brittle, hard, grey-white to silvery metal with the chemical symbol Mn. It constitutes roughly 0.1% of the Earth's crust, making it the 12th most abundant element, and it is the 4th most used metal in tonnage behind iron, aluminium and copper.

Demand

The best-known use of manganese is as a critical and irreplaceable ingredient in the production of steel. It serves the important function of removing oxygen and sulphur when iron ore is converted into iron and is also used as an alloy that increases both the strength and flexibility of steel. Approximately 30% of the manganese used in steelmaking is consumed in the former process; 70% is consumed in the latter.

According to the International Manganese Institute, global steel consumption is expected to grow at a rate of about 2% a year to 2020[1], providing a steady source of demand. However, much like other "tech" metals such as lithium, graphite and cobalt, it is manganese's increasing use in clean energy applications that is expected to drive significant growth in the market going forward.

In a refined, high purity form known as electrolytic manganese dioxide, the commodity is a key cathode ingredient in rechargeable nickel-metal hydride and lithium-ion batteries used in electric vehicles and electricity storage solutions such as the Tesla Powerwall. It is even more critical in the production of lithiated manganese dioxide (LMD) batteries, a newer type of rechargeable battery that is increasingly finding favour with electric vehicle manufacturers. LMD batteries feature 61% manganese in their cathode mix compared to only 4% lithium and are said to provide numerous benefits over lithium-ion batteries including high power output, better thermal stability and improved safety. Nissan has adopted LMD battery technology for its Leaf electric vehicle, as has Chevy for its Bolt model.

Small amounts of manganese are consumed in producing micronutrients for fertiliser and animal feed, water treatment chemicals and other chemicals such as those used as a colourant for car undercoat paint, bricks, glass, textiles and tiles.

[1] *http://www.manganese.org/images/uploads/board-documents/14._2015_AC_-_Aloys_dHarambure.pdf*
minerals.usgs.gov/minerals/pubs/commodity/manganese/mcs-2018-manga.pdf

About Manganese – A Critical Metal (cont'd)

Supply

While global demand for manganese is forecast to reach 28.2 million tonnes by 2022, global production peaked in 2014 at 18 million tonnes and reserves are falling, highlighting a deepening imbalance that is already leading to price appreciation.

Indeed, the US Geological Survey noted the 8.6% year-on-year decline in global manganese production to 16 million tonnes in 2016 in declaring manganese a "critical mineral", which is defined as a mineral that is essential to the economy as well as being at significant risk of incurring supply interruptions.

Most of the world's manganese is produced by just a handful of countries: South Africa, China, Australia and Gabon. China is the world's second largest producer of manganese behind South Africa but is also one of the largest consumers of the commodity. Its reliance on imports has increased to the point where in 2016 almost two-thirds of manganese ore consumed came from foreign producers.

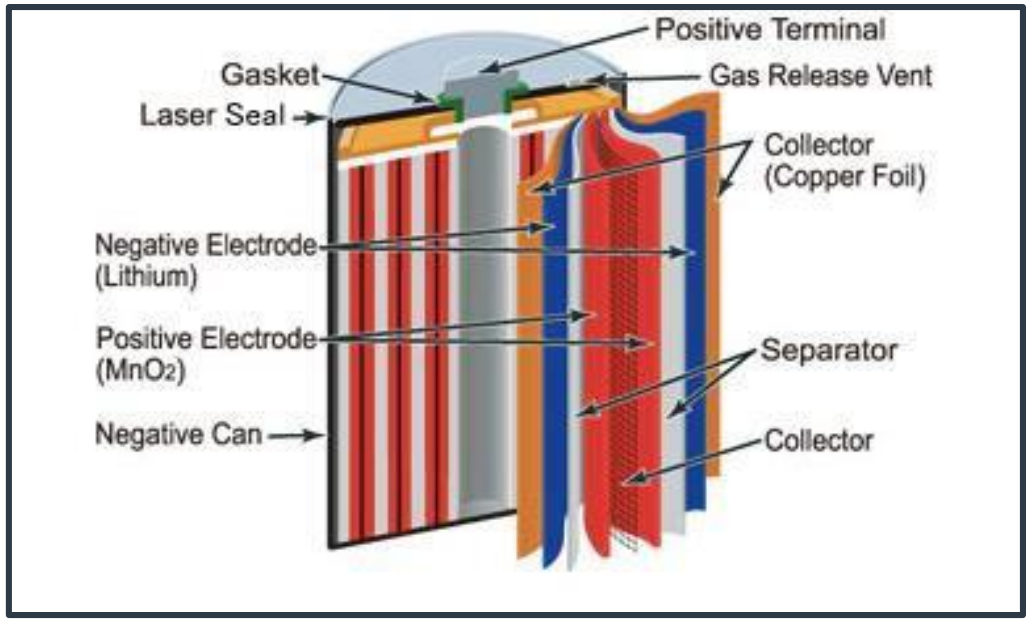
Types of Manganese Products

Approximately 90% of manganese ore consumed globally is upgraded into alloyed manganese and foundry products. High, medium and low carbon ferromanganese, along with silicomanganese, fall into this category. The remaining 10% of manganese ore is consumed in the production of metallurgical and chemical products including electrolytic manganese metal (EMM), electrolytic manganese dioxide (EMD), lithium manganese oxide, manganese sulphate and other chemicals.

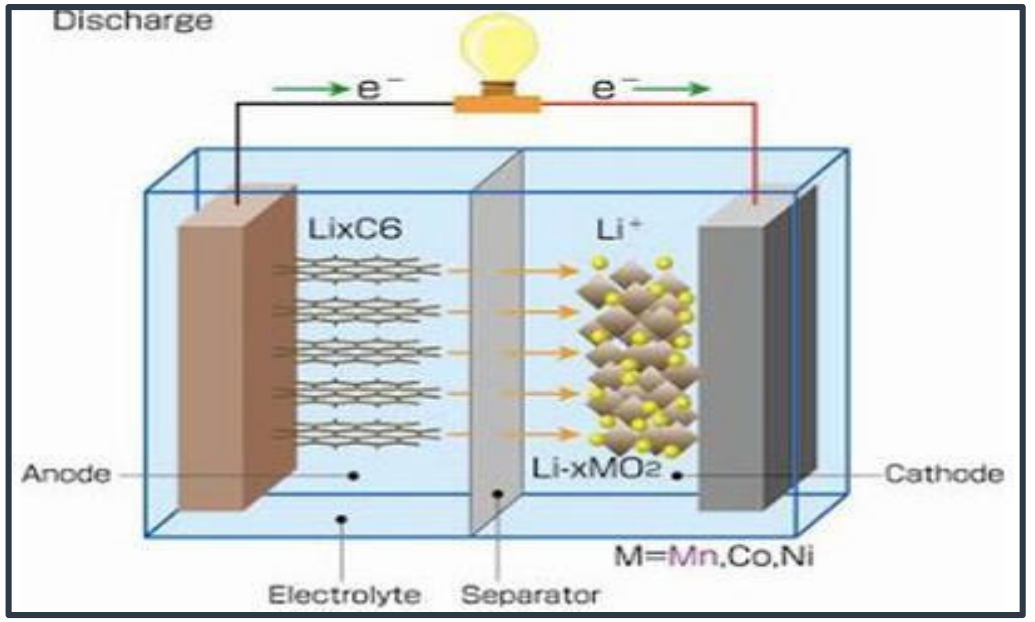
https://minerals.usgs.gov/minerals/pubs/commodity/manganese/mcs-2017-manga.pdf

Battery Chemistry and Manganese Use for Cathodes

Lithium Manganese Oxide $LiMn_2O_4$ (LMO)

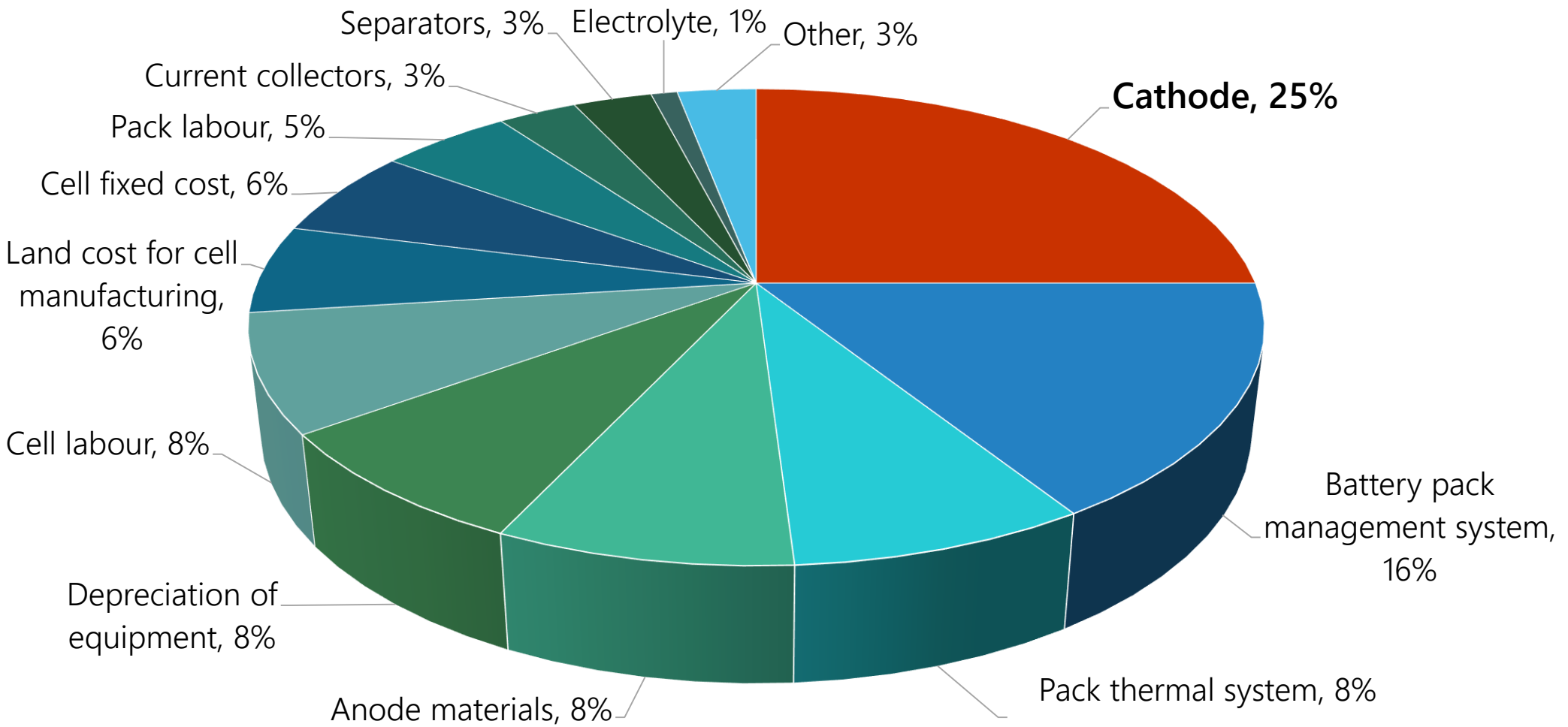


Lithium Nickel Manganese Cobalt Oxide (NMC)



The most important non-metallurgical use of manganese is to act as a depolarizer in a dry cell battery in the form of manganese dioxide. The working principle of manganese in the battery is very simple: the cathode and anode of the battery are basically wet, during the discharge, hydrogen will be generated in a certain electrode coating, and the electrode coating will produce a gas film to prevent further Infiltration, thus cutting off the generation of electricity. The role of manganese dioxide is to oxidize hydrogen to form water, the reaction rate of which depends on the reactivity of the dioxide.

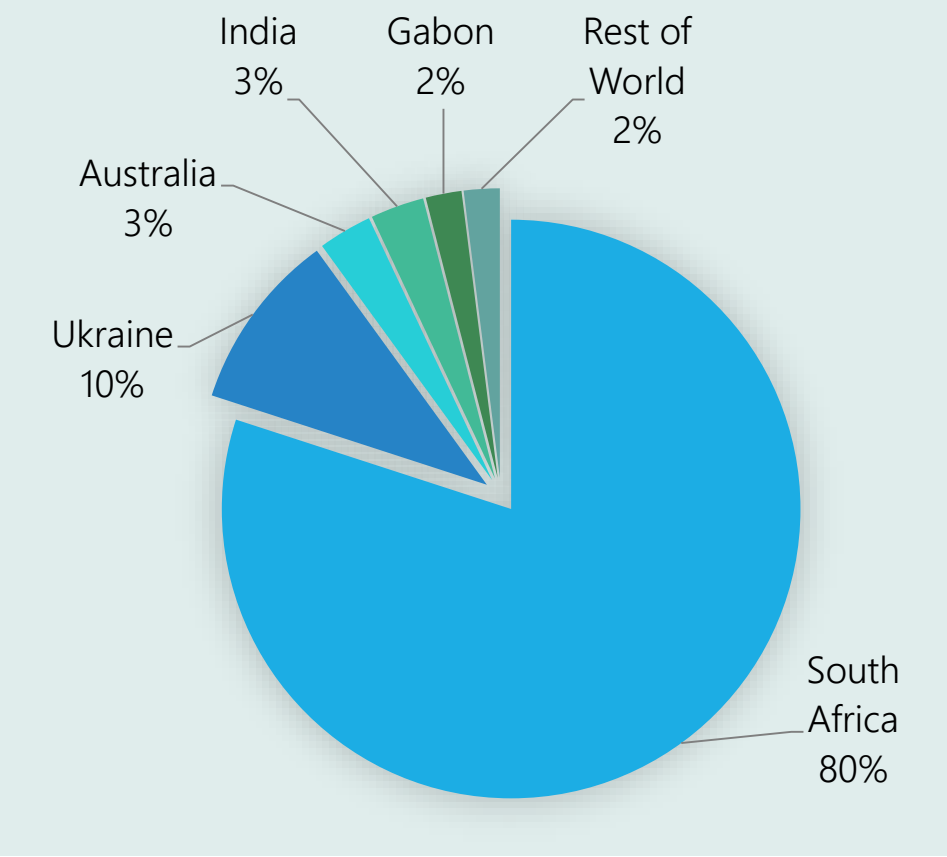
Cost Breakdown of Lithium-Ion Battery Pack



Source, adapted from: https://www.moorestephens.com.au/locations/western-australia/news-and-views/july-2018/manganese-is-it-the-forgotten-battery-mineral

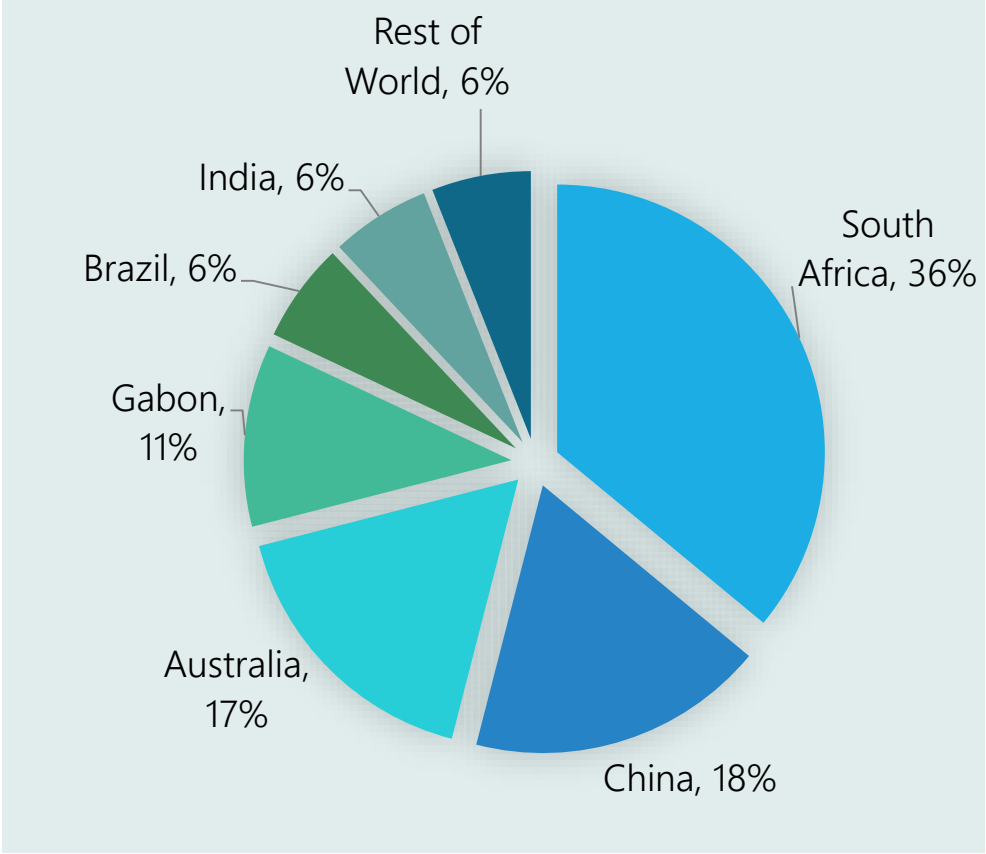
Global Manganese Production and Reserves

Global Manganese Reserves



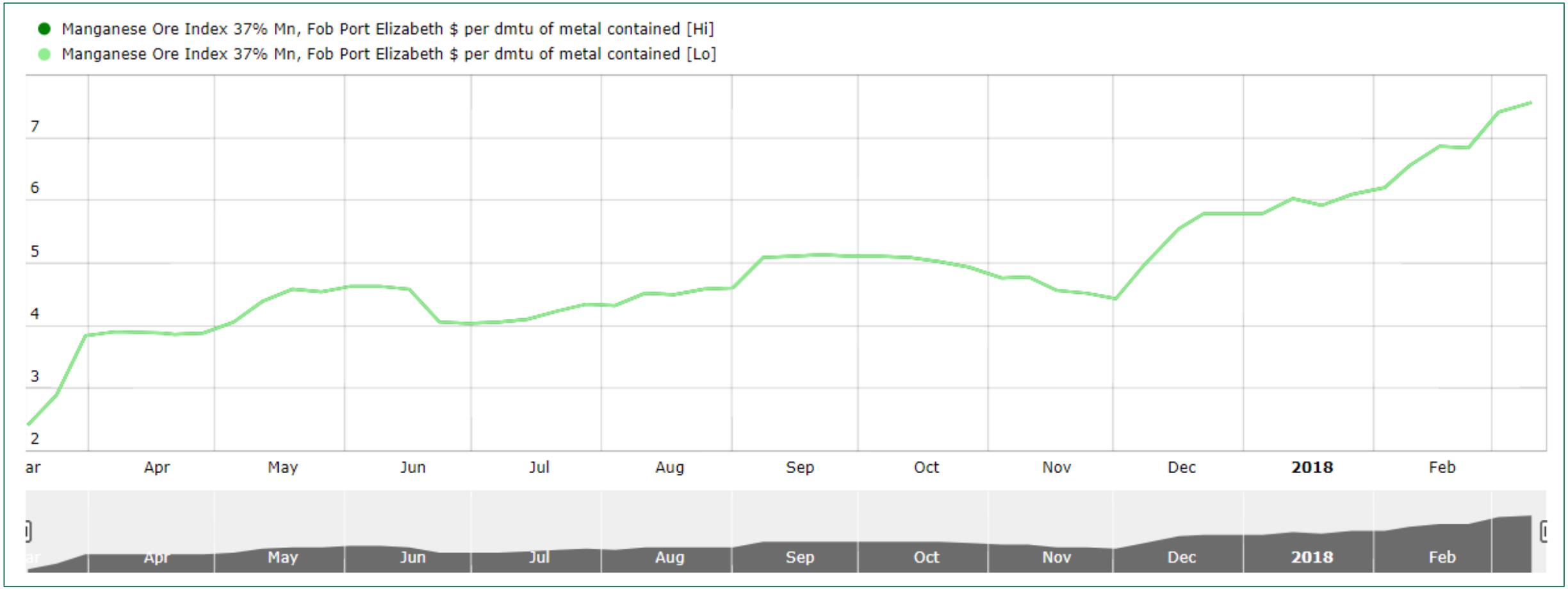
Source: US Geological Survey

Global Manganese Production



Source: Manganese Investing News

Manganese Ore Index 37% Mn
FOB Port Elizabeth $/dmtu of Metal Contained



Source: Metal Bulletin as at 10 March 2018

Manganese Uses and Market Background

- Manganese (Mn) is essential to iron and steel production steelmaking, including its ironmaking component, accounts for most domestic Mn demand, presently in the range of 85–90% of the total
- Mn ferroalloys, consisting of various grades of ferromanganese and silicomanganese, are used to provide most of this key ingredient to steelmaking
- Products for construction, machinery and transportation are leading end uses of Mn
- Mn is also a key component of certain widely used aluminium alloys and, in oxide form, dry-cell batteries
- As ore, additional quantities of Mn are used for such non-metallurgical purposes as plant fertilisers, animal feed, and colorants for brick

Manganese Reserves by Country

South Africa, Ukraine and Brazil have the highest manganese reserves, but many other countries also hold significant manganese reserves. This is where other nations stand:

4. Australia – 91 Mt
5. India – 52 Mt
6. China – 43 Mt
7. Gabon – 22 Mt
8. Ghana – 12 Mt
9. Kazakhstan – 5 Mt
10. Mexico – 5 Mt

Various other countries hold smaller amounts of manganese reserves, with the world total sitting at 690 Mt.

Note: Mt = million metric tonnes

MANGANESE USES AND MARKET BACKGROUND (CONT'D)

SOUTH AFRICA

Manganese reserves: 200 Mt

- At 200 Mt, South Africa holds the highest manganese reserves in the world by a long shot
- Unlike some countries with high manganese reserves, the nation is a major producer of the metal; in fact, it was the world's top producer of manganese in 2016 with output of 4.7 Mt
- Manganese-rich Kalahari Basin holds 80% of the world's known manganese ore resources

UKRAINE

Manganese reserves: 140 Mt

- Ukraine produces much less manganese than South Africa, but its reserves of the metal are nevertheless high – it put out 320,000 t of manganese in 2016, and its reserves stand at 140 Mt
- Russia Insider has said in the past that it is difficult for the country to harness its mineral resources due to a combination of corruption, war and mismanagement

BRAZIL

Manganese reserves: 116 Mt

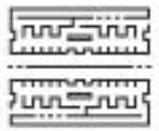
- Brazil's manganese reserves total 116 Mt
- Brazil produced 1.1 Mt of manganese in 2016

Note: Mt = million metric tonnes

Manganese Added to the US List of Critical Minerals (16 Feb 2018)

Energy

HAFNIUM
RHENIUM
TANTALUM
URANIUM

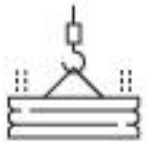


Technology

GERMANIUM
INDIUM
GALLIUM
RARE EARTHS

Industrial

BERYLLIUM
ZIRCONIUM
TUNGSTEN
ALUMINUM
PGMs
BARITE
FLUORSPAR
ARSENIC
SCANDIUM
STRONTIUM
TITANIUM
POTASH



Steel

MAGNESIUM
CHROMIUM
TIN
TELLURIUM
MANGANESE
VANADIUM
NIOBIUM

Batteries

LITHIUM
COBALT
ANTIMONY
GRAPHITE

Research

HELIUM
RUBIDIUM
CESIUM
BISMUTH

Source: Visualcapitalist.com http://www.visualcapitalist.com/35-minerals-critical-security-u-s/