

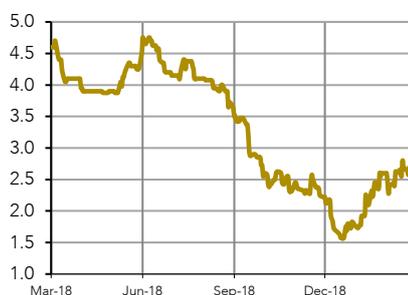
# Jangada Mines plc (JAN AIM)

11 March 2019

## Stock Data

Share Price:	2.75p
Market Cap (M):	£6.5
EV (M):	£5.9

## Price Chart



## 52 Week Range

4.95p	2.75p
1.56p	

## Company Summary

Jangada Mining is developing an open surface PGM + Nickel project at Pedra Branca, Brazil which is currently concluding the BFS stage.

MAIN SHAREHOLDERS	HOLDING
Brian Mc Master	20.3%
Matthew Wood	20.3%
Luis Azevedo	19.8%
Mark Summer	6.4%

Source: Jangada Mines & Bloomberg

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## Jangada Announces Vanadium Drilling Update

### Event

Jangada Mines plc ("Jangada") has announced drilling results for the Pitombeiras West vanadium project which is in close proximity to, but distinct from the PGM and nickel deposits within Pedra Branca.

### Highlights

The key points relating to Jangada's RNS are:

- Drill results confirm the presence of a high-grade deposit with potential for significant resource delineation
- High-grade zone contains an average of 0.83% V<sub>2</sub>O<sub>5</sub>, 11.6% TiO<sub>2</sub> and 48.4% Fe over a 12.8 m average downhole width
- Total mineralised intersections range from 26m to 46m wide with average grades of 0.57% V<sub>2</sub>O<sub>5</sub>; 8.1% TiO<sub>2</sub> and 37% Fe
- High grade mineralisation commences at surface and remains open at depth and along strike
- Preliminary metallurgical tests demonstrate that the material can be processed by conventional methods currently used for the ore type globally

### Comment

This is really positive news for Jangada, coming on the back of the recent upgrade to its PGM resources at Pedra Branca.

The vanadium exploration at Pitombeiras is at a very early stage, with only 4 holes drilled for a total of 300m of diamond drilling. The key aspects of this new find is that it outcrops, so one assumes the strip ratio will commence at a low figure and the high grade core is approximately 10m wide. Currently the samples have only been analysed by x-ray fluorescence although laboratory samples have been submitted with the results expected before the end of the first half of 2019.

One of the key parameters with upgrading vanadium is the grade in the magnetite after magnetic separation, a process that is currently used at around 90% of existing vanadium operations. Previous metallurgical test results by Jangada demonstrated that the mineral responds well to magnetic separation and produced fractions rich in vanadium and iron; with titanium being enriched in the non-magnetic fraction but, no results been published to date.

The resource is currently open along strike and at depth. The current presentation indicates that the deposit dimensions are 2,000m long, 1,000m wide and a depth of 200m. This suggests an orebody of around 400Mt which has been indicated through geophysical 3D modelling. However, the key advantage in developing this vanadium asset will be its location. Being located in close vicinity to the Pedra Branca PGM project it will benefit from the infrastructure having already been developed. These advantages include roads, power, water supplies and assay laboratory including the sample preparation facility.

## Vanadium Deposits

BHC has reviewed a number of vanadium operations, both in production and prospective. The V<sub>2</sub>O<sub>5</sub> grades at these operations are:

Company	Mkt Cap (€M)	Resource (Mt)	Grade (%)	Country
Jangada (AIM)	6.4	na	0.83	Brazil
Bushveld (LSE)	411.3	285	0.68	South Africa
Largo (TSX)	630.7	19.01	1.15	Brazil
Australian Vanadium (ASX)	21.1	183.6	0.76	Australia
Golden Deeps (ASX)	3.0	2.8	0.66	Namibia
Tando Resources (ASX)	10.4	588	0.78	South Africa
Technology Metals Australia (ASX)	10.6	16.7	0.96	Australia
First Vanadium Corp (TSX)	15.9	28	0.515	USA

The above table refers to reserves where possible and resources where no reserve grades are available. The vanadium grade refers to the grade of the vanadium pentoxide in the resource and NOT the vanadium pentoxide grade of the magnetite concentrate.

Perhaps the best comparison is with Largo Resources, also located in Brazil. The company operates the Maracás Menchen Mine in the province of Bahia. The mine commenced commercial production of vanadium flake in Q3 2014 and has a contracted take-or-pay off-take agreement with Glencore International Plc. for 100% of its vanadium material which expires in Q2 2020. The mine is projected to produce between 10,000 and 11,000 tonnes of vanadium pentoxide in 2019 which is inclusive of high-purity flake and powder. The Company announced in April 2018 plans to expand production capacity by 25% at the mine with construction which began in June 2018. The enhanced production rate at the Maracás Menchen Mine is expected to result in an additional 200 tonnes of V<sub>2</sub>O<sub>5</sub> being produced per month totalling 1,000 tonnes per month beginning Q3 2019.

## What is Vanadium?

Vanadium is a chemical element with symbol V and atomic number 23. It is a hard, silvery-grey, ductile, malleable transition metal. It is harder than most metals and can exist in four oxidation states, V<sup>2+</sup>, V<sup>3+</sup>, V<sup>4+</sup> and V<sup>5+</sup>. In 2017 total world consumption of vanadium was 85,800t of which only ~9,000t went into the high purity market.

Vanadium occurs naturally in about 65 different minerals and in fossil fuel deposits. It is produced in China, South Africa and Russia from steel smelter slag; other countries produce it either from the flue dust of heavy oil, or as a by-product of uranium mining. World resources of vanadium exceed 63Mt and reserves are 15Mt. However, because vanadium is typically recovered as a by-product or co-product, demonstrated world resources of the element are not fully indicative of available supplies.

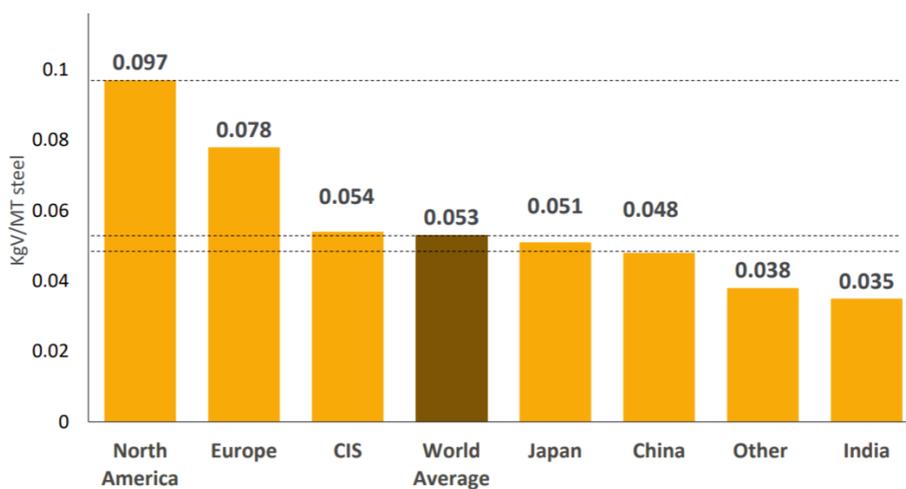
Vanadium's major use is as an alloy to strengthen steel and titanium. The high purity vanadium is used in aerospace alloys, as a chemical catalyst, especially in the production of sulphuric acid and a fast developing new use in vanadium flow batteries.

## Why is the vanadium price so high?

64% of vanadium production has historically been derived as a by-product from the production of steel, producing vanadium as a slag. These plants typically produced steel using a titano-magnetite feed stock. This technology cannot currently compete due to the low iron ore prices and higher costs of production. The major casualty was the Highveld Steel plant in South Africa which produced 11% of total vanadium supply (around 66kt of vanadium slag and 8kt of ferrovanadium). This caused the vanadium price to bounce by 25% and further closures are anticipated which are expected to push the vanadium price higher.

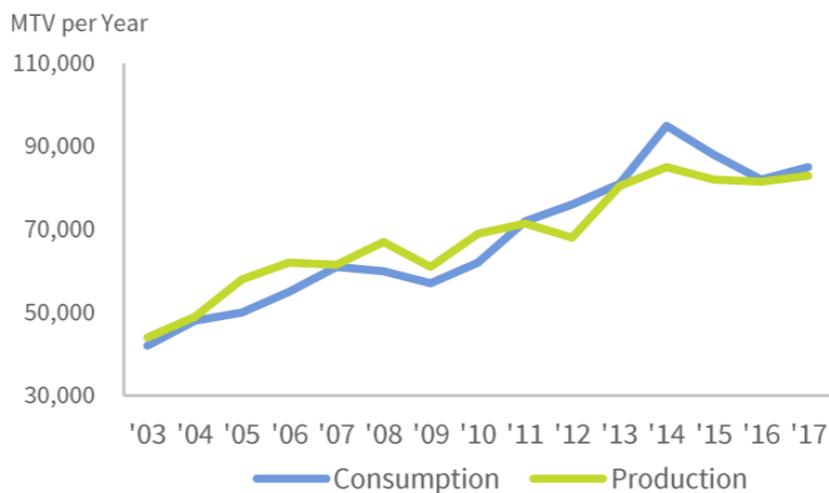
The downturn in the vanadium price was followed by an improving demand for vanadium steel from two sources, but both are related to improving the tensile strength of steel which currently consumes 91% of total vanadium production. Following the 2010 earthquake in China, the Chinese authorities tightened the building regulations resulting in the need for higher strength steel to be used for construction purposes. The other major growth area for vanadium steels is the automobile industry where stronger and lighter steel is one area where car makers can reduce the weight of vehicles, increasing fuel efficiency and lowering emissions. If the Chinese intensity of vanadium consumption were to match that of European steel producers, it would add 33,000t to annual world vanadium demand.

Exhibit 1: Vanadium use in Steel



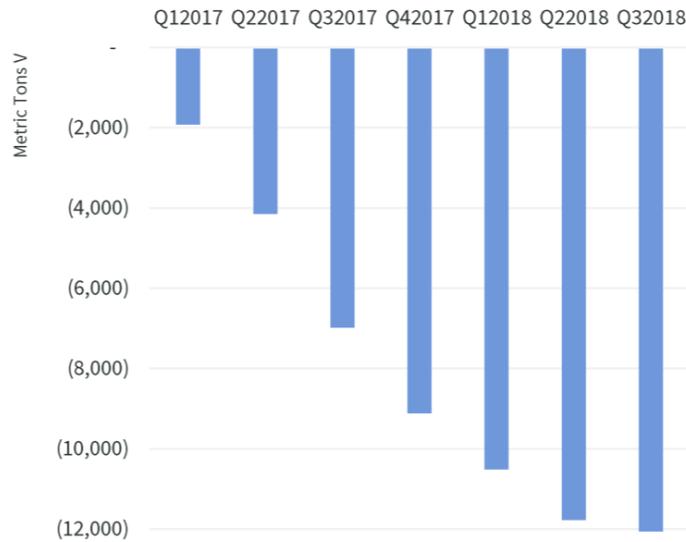
Source: Bushveld Minerals

Exhibit 2: Historical Global Vanadium Production & Consumption



Source: Largo Resources

**Exhibit 3: Cumulative Vanadium Inventory Change**



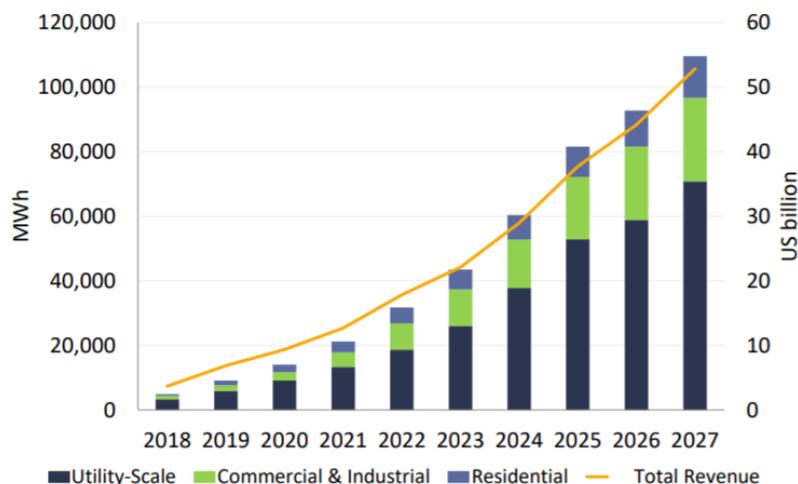
Source: Largo Resources

**Vanadium Redox Batteries**

This is seen as a substantial new market for vanadium as it is one of the few materials that can provide batteries of any significant size, with the latest battery being commissioned at 500MWhours. These large energy storage devices are seen as very important following the move to wind and solar power where it is particularly difficult to match supply and demand due to the vagaries of the elements. In countries such as those in Africa that do not have a grid, the use of large vanadium-redox batteries is seen as the future, complementing the intermittent sources of power such as wind and solar to provide consistent energy supply. The major advantages of vanadium flow batteries are that they are:

- Excellent for long duration energy applications of more than 4 hours per day
- They offer lower round trip efficiency with longer battery life and no degradation
- No risk of fire from thermal runaway
- Are yet to experience economies of scale
- Offer more nascent technology

**Exhibit 4: Forecast Annual Installed Stationary Energy Storage Capacity and Deployment Revenue by Market Segment**



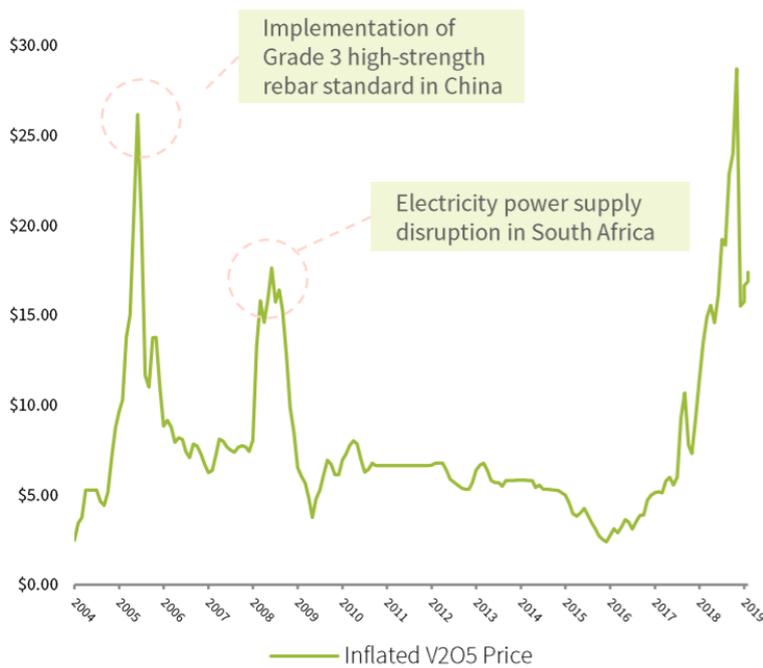
Source: Bushveld Minerals

### The vanadium price

There is a strong correlation between economic development and vanadium intensity of use, with the steel sector currently accounting for ~90% of vanadium consumption. The major industrialised economies such as North America and Europe typically use around twice as much vanadium per tonne of steel that the emerging economies such as India and China. As stated previously, we anticipate that this will change, with the emerging economies increasing their usage of vanadium.

In addition, vanadium flow batteries have the potential to double vanadium demand by 2027 where recent work by luxresearch has indicated that in large-scale renewable integration projects vanadium flow batteries are already cost competitive against not only lithium ion batteries but also against natural gas turbines. With the growing amount of electricity being produced by intermittent supplies such as wind and solar, there is a fast growing market for energy storage to even out the peaks and troughs of supply.

Exhibit 5: V2O5 Monthly Midpoint Price Average



Source: Largo Resources

Whilst there are a number of new projects in the pipeline, most of them are quite small, and the traditional source of vanadium slag from steelmaking using magnetite ore is not expected to return any time soon. Therefore, with demand booming, it is anticipated that the price will remain strong for the foreseeable future.

## Research Disclosures

### Peter Rose

Peter has 32 years' experience in equities as a resources analyst; he has been at Brandon Hill Capital for 11 years, after having spent 11 years with Deutsche Bank in Australia. Prior to this he spent 2 years with Prudential Bache and 6 years with James Capel. Peter's industry experience includes 16 years as a metallurgist, 3 years with De Beers in South Africa and 9 years in the uranium industry, six of which were spent at the Ranger Uranium mine. Peter holds a BSc degree in Applied Mineral Science from Leeds University UK and a Bachelor of Commerce from the University of South Africa. Peter is also a member of the Institute of Materials, Mining & Metallurgy and a chartered engineer.

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Research disclosure as of 11 March 2019

Company Name	Disclosure
Jangada Mines plc (JAN AIM)	1, 2, 7, 8, 9

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