A new “spice” metal to enhance industry & life

Scandium is a rare earth element that most people would never have heard of. It’s a technology metal which can be used in very small amounts like a spice to considerably enhance aluminium alloys, fuel cells and lighting.

Brisbane-based mineral resource development company Metallica Minerals (ASX: MLM) owns a high-grade scandium and cobalt-nickel project, called SCONI, in North Queensland that is potentially the World’s first commercially-exploitable scandium deposit. Scandium has several valuable cleaner, greener and more efficient applications lying in wait.

While scandium is widely distributed through the earth’s crust, it is found in only trace amounts and is very rarely concentrated to exploitable levels. As a result, no primary supply exists and no scandium ore is mined anywhere in the world …… yet!

Scandium is a rare, silvery-white metal in its pure metallic form and has been known to the scientific community for 75 years as “Element 21”, symbol Sc, on the periodic table. It is most commonly used as scandium oxide $\text{Sc}_2\text{O}_3$ (called scandia). Outside research laboratories its commercial application has been limited to high performance aluminium alloys in the Soviet era aerospace industry and high-end sporting equipment such as bicycle frames, baseball bats, golf clubs, etc.

This is because scandium has always been in short supply, very difficult to source, and no one has found enough of the substance at exploitable concentrations to be economically viable to extract.

The exception was Soviet Union aerospace engineers who knew just how useful and strategic scandium was for creating stronger and lighter aluminium alloys for their aerospace programs. At that time, the cost of development and extraction was not a key consideration given scandium’s enhancing properties to their high performance alloys.

In addition, scandium is used in highly-efficient fuel cells and specialised lighting. In each case, the quantities required are small. For example, in aluminium alloys the scandium content is typically only a fraction of a per cent by weight (commonly 0.2 to 0.5% Sc) to achieve the desired exceptional grain refinement.

For this reason, scandium is referred to as a “Spice Metal” where small additions can significantly enhance the performance of the end product, similar to the effect spices and herbs have in cooking.

Like many other rare metals, scandium carries a high value – in recent years typically over US$2,000 per kilogram in its oxide form depending on purity and quantity. Metallica has used an average scandium oxide price of US$2,000/kg (>99.9% purity) for its SCONI feasibility studies. It is fortunate for the suppliers and consumers that these new age alloys, fuel cells and lighting products only require small amounts of scandium, meaning the overall cost to manufacture the product is relatively low, especially given the high value of these end products or components that it partly constitutes. This is a big insulator to the scandium price. Where performance is essential, second-best or cost considerations are of less significance.

The current total world supply of scandia is estimated to be approximately ten tonnes per annum. It is sourced and processed mainly as a minor by-product of other metal processing operations. This scarcity and consequent lack of reliable supply have severely restricted scandium’s commercial use. However, interest and demand has recently increased sharply, particularly from the aerospace and the fuel cell sectors.

Metallica discovered two large, high-grade shallow scandium deposits while evaluating its nickel-cobalt laterite deposits in North Queensland. This discovery
is a potential game-changer for scandium on the World stage. The company’s scandium-bearing nickel-cobalt resources along with very good metallurgical characteristics (ie extraction & recovery) and it’s proprietary scandium technologies, make SCONI ideally placed to provide the World with its first long-term, reliable supply of scandium.

Scandium is now a key driver for Metallica’s original nickel-cobalt project and therefore a major opportunity for the company. Due to the increasing emphasis towards scandium the project is now named SCONI – an acronym for ScAndium-POrtlandite Nickel.

The SCONI project is in an excellent location, centred on the large historic Greenvale Nickel Mine site, where high-grade nickel ore was mined from 1974 to 1992, close to the purpose built Greenvale township. Greenvale with adjacent fresh water and infrastructure is ideally located less than three hours’ drive on sealed roads from the Port of Townsville.

Initially, Metallica plans to produce around 50-65,000kg of scandium oxide per annum from the SCONI project, which is over five times the current World supply, as Metallica believes scandium demand for fuel cells and alloys will increase dramatically and therefore plans to be the world’s leading producer to match the expected growth in scandium demand.

Metallica has drill defined over 5 million kilograms of potentially recoverable scandium oxide along with substantial nickel-cobalt resources, sufficient to justify a mine life for its SCONI project of well over 20 years. During this period, it expects to acquire additional scandium deposits to develop, using its experience, technology and increased capability, to match further expected market growth over time.

Such a supply would give developers of scandium-bearing applications the ability to confidently increase commercial production, a position they could not previously consider because there was never a sufficient and reliable supply of scandium available – a real “chicken and egg” situation. Metallica sees itself creating the market for scandium usage by providing essential reliable supply, with its ability to easily match production to growth in demand. Critics might say that Metallica will flood the market with scandium, however, the company sees it as a market waiting to happen. Besides, the project will not proceed until it has a sufficient portion of its initial scandia production underwritten in off-take agreements with end users.

So what new applications for scandium can we expect to see should Metallica’s vision become a reality?

Scandium-strengthened aluminium alloys produce lighter-weight, higher-strength components and structures with superior weldability, better thermal and corrosion resistance, plus greater durability. This has been proved by a multitude of research papers and registered patents by large multi-national corporations regarding scandium-aluminium alloys, and also by the former Soviet Union aerospace industry through the use of scandium-aluminium alloy in their MiG jet fighters. The benefits of scandium addition are well understood by alloy specialists around the World – scandium is a proven enhancer of aluminium alloys.

While currently used in high-end bicycle frames, baseball bats, golf clubs etc, the opportunities to enhance the performance of aerospace, motor vehicles and marine craft are very significant, once a large and reliable supply of scandium becomes available.

Aluminium-scandium alloy powders also show great potential for use in Additive Layer Manufacturing (ALM) or Laser Additive Manufacturing (LAM) of light-weight aerospace and sophisticated transport system components, they will likely play a key role in what some commentators refer to as ‘the next industrial revolution’ (also known as 3-D printing, of “Near Net Shape Manufacture”).

For this reason, Europe’s leading producer of master alloys, KBM Affilips, has entered into a strategic alliance with Metallica in relation to the SCONI scandium project. KBM Affilips believes there will be significant demand for aluminium-scandium alloys in the aerospace industry, as well as other transport sectors, when sufficient scandia supply can be made available.

Following our strategic alliance agreement, KBM Affilips took the first practical step towards marketing SCONI scandium alloys when it produced an aluminium/scandium master alloy “waffle” ingot using scandium from Metallica’s SCONI pilot plant.

Scandium is also used in lighting, producing a white light that more closely resembles natural sunlight and uses less energy per lumen than conventional lighting.
Scandium lighting is better for reading and colour definition as it mimics the natural light for which our eyes have evolved. This has potential health benefits for people spending long periods under artificial light, including those in communities having long dark winters.

Perhaps even more exciting is scandium’s application in fuel cells used to generate electricity and heat through an electro-chemical process that converts fuel (typically natural gas, methane or biogas) and air (oxygen 20%) into electricity and heat without combustion, noise or moving parts. Technically known as “solid oxide fuel cells” or “SOFC’s”, the incorporation of scandium makes these fuel cells significantly more efficient, producing more electrical and thermal energy from the same amount of fuel. Scandium stabilised zirconia electrolyte provides very high ionic conductivity and efficiency.

Fuel cells have been used in space applications dating back to the Apollo program and continue to be used on the International Space Station today. Several companies in the USA and Europe have developed high-efficiency commercial fuel cells incorporating the benefits of scandium; however their larger scale product manufacturing is partly constrained by scandium supply. For this reason, one of the leaders in the field of SOFC’s, California-based Bloom Energy, has signed a binding Heads of Agreement offtake with Metallica Minerals to acquire a substantial proportion of the planned future production of scandium oxide from the SCONI project.

Bloom has signed up offtake for up to 30,000 to 60,000 kg’s of scandium oxide per annum of from the SCONI Project, underpinning Metallica’s belief that a much larger potential scandium market exists if a reliable long-term supply is offered.

Bloom Energy’s commitment to become a base load customer has underpinned the commercial rationale to develop the SCONI project, allowing Metallica to proceed with confidence through Feasibility Studies and accelerate towards project development.

SOFCs can contribute to the new trend of ‘Virtual Power Plants’ (VPPs) by the installation of new energy servers at the point of power use, wherever there is gas supply. VPPs mean there will be less need for new power stations and expensive transmission equipment as the emerging middle class in developing countries demand and receive more power, and also as environmentally aware citizens in all countries demand more greenhouse gas-friendly power supply.

SOFC’s containing scandium oxide (using natural gas or methane as the fuel source) are a more efficient, cleaner energy supply, with applications at both commercial and domestic levels. Imagine homes with delivered gas to their own mini power station the size of a dishwasher or refrigerator producing their own more efficient electricity supplies as well as by-product heating for general heating, hot showers, warm pools (for which heating is predominately provided by burning fossil fuels). This could be the next big transformation in domestic appliances like the massive growth in dishwashers and air conditioners in the 70’s and 80’s - now nearly every house has one or more.

SOFC’s convert up to 85% of the energy contained in natural gas to usable energy in the form of electricity and heat. This conversion efficiency to useable energy is much higher than conventional coal-fired power stations and considerably better than conventional gas combustion-generated electricity since from both of these the generated heat is largely wasted. There are also transmission losses getting the electricity from these conventional power stations to the consumer.

Fuel cells using natural gas are like mini power stations and can be sized for any purpose, be it a house, office building or baseload power for a town. Google, Yahoo, Wal-Mart and others are already using scandium-bearing SOFC’s to reliably power and heat some of their operations. In addition, Apple recently announced a 4.8 megawatt solid oxide fuel cell farm to help power its critical North Carolina data centre, making it sustainable and non-reliant on grid power. Homes could soon have scandium-bearing fuel cells that cleanly and efficiently convert natural gas energy to electricity and useable heat.

The importance of scandium to the world market cannot be overestimated, especially with the massive worldwide expansion of natural gas usage and distribution infrastructure - natural gas and fuel cells are the future. Metallica believes its SCONI project will play a part in that future by getting the most amount of electrical and thermal energy from the least amount of fuel – where efficient cleaner energy is the gateway to a more sustainable society.

Metallica predicts scandium demand will increase rapidly as the world increasingly recognises the part this very strategic “spice metal” can play in moving towards a greener economy.

Scandium is a green-tech metal, and is playing its part in
providing new products that are more efficient, cleaner and cost effective. In today’s world of heightened environmental responsibility, everybody will want to use or own these new generation more efficient products.

Metallica’s confidence in the market potential for scandium is demonstrated by its commitment of many millions of dollars to define its own exploitable deposit for this “spice metal” (along with co-products nickel and cobalt) through detailed metallurgical, mining, engineering, environmental, community and feasibility studies. Furthermore, in July 2012, Metallica produced high-purity scandia (>99.9%) from its purpose built pilot plant in Brisbane from it’s own SCONI ores and its proprietary technology.

These scandium enhanced products will be more efficient, they will be cost effective and, in today’s World of environmental and sustainably-conscious branding, everybody will prefer to use or own these new products.

Metallica aims to be producing commercial scale scandium starting late 2015. With the capability of producing high-purity scandia now established, upcoming milestones for Metallica include signing further scandium offtake agreements with current and emerging end-users, permitting, feasibility studies, financing and ultimately construction of the SCONI project.

The company’s unique deposits of high-grade scandium resources are of World significance. Scandium the “spice metal” will play a small but critical component in potentially revolutionising global energy supply from fuel cells, improving the economies, manufacturing and performance of using aluminium based frames for aeroplane, automobile and other transportation applications, and more efficient lighting.

**The future looks bright for scandium and Metallica.**