

# Zirconium and establishing a domestic rare earths supply chain

## A clear path forward required for reducing our reliance on China

Despite its relative obscurity, zirconium remains a critical material with significant supply risk. China controls most of the industrial production capacity to process zirconium mineral concentrates into the basic starting compounds needed for downstream zirconium products. In fact, **China controls 95% of the world's production of the key zirconium compound Zirconium Oxychloride ("ZOC")**, which is the starting material required for downstream manufacturing into various commercial products including nuclear-powered naval vessels. Currently, 100% of the ZOC used outside China must be purchased from producers in China. A second basic zirconium compound required by industry is Zirconium Basic Carbonate (ZBC). The ZBC is derived from ZOC. The current North American annual demand for ZOC is approximately 50,000 tonnes. Worldwide demand outside of China is approximately 150,000 tonnes per year.

To reduce reliance on China for a domestic supply of critical zirconium starting compounds such as ZOC, a North American production facility for zirconium compounds must be established. And, with zirconium minerals often found associated with rare earth minerals, developing a rare earth supply chain could create an opportunity to establish a new primary supply of zirconium minerals at the same time.

There are several examples in North America of primary rare earth resources that also contain zirconium minerals. This is commonly the case with rare earth deposits that occur in

alkaline igneous intrusive rocks. These rocks may contain resources of a number of critical minerals as well as some more familiar metallic commodities such as copper and iron ore. In some cases, where such resources were mined for base metals, the tailings may contain significant quantities of recoverable critical minerals. An appropriate rare earth / zirconium resource could supply the ZrO<sub>2</sub> compound for the zirconium production industry as well as the refined rare earth products to downstream users.



*Zirconium dioxide is a white crystalline oxide of zirconium. Its most naturally occurring form is the mineral baddeleyite.*

Zirconium is usually found in the silicate mineral zircon (ZrSiO<sub>4</sub>) which always contains another rare element, hafnium, averaging a low 2% concentration. Hafnium can be a valuable by-product of zirconium recovery from a zircon resource. One interesting application for hafnium is its addition to nickel-based superalloys used in gas turbines. The other zirconium ore mineral occasionally found in a type of alkaline intrusive rock called carbonatite is baddeleyite, a pure ZrO<sub>2</sub> mineral that offers a simpler processing solution to produce ZrO<sub>2</sub>, if it can be found in sufficient concentrations to justify recovery.

Unlike the rare earth industry's lack of domestic, downstream-refining and manufacturing capacity to make the needed derivative products such as magnet alloys, **the zirconium industry does have downstream manufacturers for all the current products needed in industry.** Because the downstream manufacturing capacity of zirconium products is available, it could be argued that an attractive development option for a combined rare earth / zirconium resource would be to start by selling ZrO<sub>2</sub> and stockpile the rare earths until downstream rare earth consumers can come on line. There is also a potential role for government to purchase the rare earths for

a government managed stockpile of critical minerals until the downstream components of the supply chain are established.

The critical importance of zirconium alone could be sufficient to justify the need for bringing a combined rare earth zirconia resource into production. Significantly, there are many applications that require both a rare earth and zirconium to develop the necessary properties for the application. One example is the use of yttria-stabilized zirconia in hydrogen fuel cell technology.

**Zirconium needs to be considered part of the solution for establishing a rare earths supply chain**, along with other critical minerals such as scandium, that often occur together with rare earths in the same resource. Developing these resources in alkaline igneous rocks, of which there are a number of examples in North America, offers a clear path forward for reducing our reliance on China for a basket of critical materials.

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## **2017 – The Year of Alkane Resources**

A little while ago, I wrote an article that claimed 2017 would be an incredible year for renowned Australian multi-commodity explorer, Alkane Resources Ltd. (ASX: ALK | OTCQX: ANLKY) (“Alkane”), and for those of you who remain unconvinced, the company recently published an outstanding quarterly activity report that goes beyond suggesting that their position is getting increasingly formidable by the week. Record quarterly gold production combined with rapidly improving market conditions are outstripping even my expectations, and looking

at Alkane's share price chart, I spy a recent trend reversal that could signify a serious boom period for the Aussie junior.

The company's Tomingley Gold Project has produced a staggering quantity of material this financial year, and furthermore, Alkane has managed to significantly reduce on-site operating costs. The company sold 31,107 ounces of gold generating revenues of A\$52.6 million at an average price of A\$1,690/ounce, and secured forward contracts (as of 30 June 2017) of 17,500 ounces at an average price of A\$1,716/ounce. Given that budgets for FY2018 are complete and production is expected to be 65,000 to 70,000 ounces of gold at an all-in sustaining cost (AISC) of A\$1,100 to A\$1,200 per ounce, those expanding margins are looking very healthy indeed.

Gold production was above forecast at 27,924 ounces and well above the previous quarter of 18,721 ounces. This has been largely attributed to surprisingly high-grade material emerging from one particular pit (Caloma Two), and mining for the coming budget period will be exclusively from this mine and one other (Wyoming One). Full year production for FY2017 was 68,836 ounces, meaning that Q4 production comprised over 40% of the annual total; with Caloma Two playing a more significant role in the coming year, FY2018, in my opinion, stands to be even more impressive.

On top of record gold activities, the highly anticipated Dubbo Project has made significant advances. Alkane signed a processing agreement with Vietnam Rare Earths (VTRE) in 2016, and this quarter signed a 12-month toll treatment agreement; subsequently, VTRE processed two shipments of light rare earth element (REE) concentrates totalling 80 tonnes acquired on market by Alkane, producing approximately 31 tonnes of separated rare earth oxides, including cerium, lanthanum, praseodymium, and neodymium oxides. Final processing is expected to be completed in July, with products then available for sale as pure oxides, or after conversion, as metal alloys.

The DP itself remains construction ready, with the mineral deposit and surrounding land wholly owned; all State and Federal approvals in place; an established flowsheet and a solid business case. Furthermore, amid China's increased restrictions on production and environmental compliance issues aimed at minimising environmental pollution, REE prices are undergoing some dramatic changes.

The crackdown by Chinese authorities is understood to be targeting all chemical industries, including rare earths, in order to tackle air pollution and the long term damage affecting waterways and soil degradation, and has resulted in REE prices hitting record highs. The sought-after magnetic materials, Neodymium and Praseodymium, have hit their highest value in two years, and Zirconium Oxychloride (the key indicator of the zirconium chemical industry) prices increased by 40% since the end of last year, resulting in the highest prices for 4-5 years.

It's not often that you come across a junior with a decent cash flow situation, and very rare indeed to find one so strong. The company's gold sales have enabled them to remain safely on the right side of the rare-earth market, and the case for REE supply outside of China has never been better. Alkane have one of the world's largest in-ground resources of zirconium, hafnium, niobium, yttrium and rare earth elements; so large, in fact, it is expected to process 1,000,000 tonnes of ore each year over a period of 70 years or more, the first 20 of which are already fully permitted. I'll say it one more time; this is going to be one hell of a year for Alkane Resources.