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The rare earth rush

The dangers of restricted supply from China, along with rising prices, have produced a plethora of rare earth projects around the world. The most advanced are now coming on stream, reports Steve Karpel

It is not often that esoteric technological metals escape from the specialist press and invade popular news media such as newpapers and radio, but the 17 metals known as rare earths have achieved this recently. The reason is their vital application in many modern technologies combined with the fact that one country – China – now dominates supply with around 95% of world production.

When China started imposing lower export quotas, plus tariffs, on rare earths, western countries dependent on this supply accused China of breaking WTO free trade rules and using its leverage to boost prices. It imposed an export quota of just over 30,000 tonnes last year, and a similar volume this year. This compares with a 60,173 tonne quota in 2007 – all tonnages in this article refer to rare earth oxide, REO, content.

The production of leading technologies such as electric vehicles, wind power, computer monitors, mobile devices, hard drives and automotive catalysts, is seen as under threat outside China unless global manufacturers can freely access rare earths.

The USA, the EU and Japan formally and jointly lodged a case with the WTO on March 13th, challenging China's rare earth export restrictions.

But China insists that it is simply trying to regulate the sector in order to cut down on heavy pollution and the irreversible damage being caused by unlimited – and especially unlicensed – mining. To this end, a rare earths industries association was set up in China earlier this month, including some 155 companies, to help restructure the sector and coordinate mining, smelting and processing. It is also intended to create a more stable price mechanism and minimise the price volatility that has plagued the sector, said the Ministry of Industry and Information Technology.

China emphasises that it does not have a monopoly of rare earth resources. Although it has the world's largest reserves – 55 million tonnes of REO content, according to the US Geological Survey – this is only around one-third of the known total. The CIS has 19 million tonnes and the USA 13 million tonnes *(see table)*.

Rare earth supply has become a hot political topic, in the USA in particular. In November, congressman Mike Coffman formed a congressional rare earth caucus to lobby for federal policies for this industry. There have been as many as 10 rare-earth-related bills introduced into the current (112th) Congress.

The Rare Earth Association was also established in Washington DC in October to tackle issues in the sector. One of them is to include strategic defence-related rare earths in the Department of Defense national stockpile in order to assure long-term supply. This will involve persuading the president to include this in the next DoD budget, says the Association's president and ceo, Adam Falkoff.

But Falkoff points out that diplomacy will also be important for resolving global supply issues, and he plans to liaise with the new rare earth industries association in China to try to reach an understanding.

GMEL

Greenland: a new potential source of rare earths

Prices and projects soar

The supply-demand situation has caused rare earth prices to soar over the last three years, although they have eased off since peaking in Q3 2011. For example, cerium oxide rose from $3.88/kg in 2009 to $118.65/kg in Q3 2011 (fob China average, 99% purity), according to Metal Pages. One of the most costly, europium oxide, rose from $492.92/kg in 2009 to $4,900/kg in Q 3 2011, on the same basis.

The end result of all this has been a torrent of exploration and other developmental projects aiming to diversify rare earth supply. There are over 400 new exploration projects, but these are mostly at very early stages. However, some advanced projects will be coming on stream this year or in the near future. Two that have started up are Mountain Pass in the USA and Mt Weld in Australia.

Mountain Pass in California was the world's dominant supplier of rare earths from the 1960s to the 1980s. But rapidly expanding supply from China at low prices, plus regulatory issues, caused the mine to be closed in 2002. Since then, owner Molycorp has been processing its ore stockpiles. Under new ownership since 2008, Molycorp has been undertaking Project Phoenix to modernise and expand the mine, as well as building a state-of-the-art rare earth separation and manufacturing facility at Mountain Pass.

Mining started up again late last year, and the sequential start-up of the manufacturing facility began in February. Under phase 1 of Phoenix, production is expected to reach an annual rate of 19,050 tpy of REO by October this year, while phase 2 is expected to raise capacity to 40,000 tpy of REO by mid-2013.

An important aspect of the current drive for more diverse rare earth supply is vertical integration in order to add maximum value to mine resources and ensure truly independent sources of rare earth products. This has included end-users (such as automotive or engineering companies) getting involved in the supply chain via joint ventures or other contracts.

Molycorp has been building up a "mine-to-magnet" integrated structure. It owns Molycorp Tolleson (formerly Santoku America) in Arizona, which makes high-purity rare earth metals and ▶

DEFINITIONS

The rare earths are defined as the 15 lanthanide elements from lanthanum (no. 57) to lutetium (no. 71), and the two related group 3 metals scandium (21) and yttrium (39) are usually also included.

The rare earth metals are not particularly rare in nature – the most common of the group are more geologically abundant than copper, lead or gold, for example. However, economically mineable orebodies are few, and ore separation into individual rare earths is complex.

The group of 17 metals is also subdivided into the light elements (LREE) and the less abundant heavy rare earths (HREE). There is no official definition of where the demarcation lies, but the US Geological Survey defines LREE as the metals from lanthanum to europium (no. 63) plus scandium, and HREE as gadolinium (no. 64) to lutetium plus yttrium.

RISING DEMAND FORECASTS

Current annual demand for rare earths is about 136,000 tonnes (as rare earth oxide content), of which China produces about 130,000 tonnes. World demand is forecast by Freedonia Group, USA, to grow 7.1% annually to 180,000 tonnes in 2015. The Chinese Rare Earth Industry Association forecasts global demand rising to 210,000 tonnes in 2015, with China's own demand rising to 130,000 tonnes in this period.

According to the Industrial Minerals Company of Australia, world demand will rise to 185,000 tonnes in 2015, with China's consumption increasing from 73,000 tonnes in 2010 to 110,000 tonnes in 2015. Its data show that permanent magnets are the biggest single application for rare earths, driven in particular by the neodymium-iron-boron system. Magnets accounted for 21% of demand in 2010, with catalysts (20%), metal alloys (18%), polishing (15%), glass (9%), phosphors (7%) and ceramics (5%) being the other main sectors. It forecasts that magnets will increase to 26% of the greater total demand in 2015, followed by metal alloys (19%), polishing (16.5%), catalysts (15.5%), glass (6%), phosphors (6%) and ceramics (5.5%).

Neodymium and dysprosium are expected to have the fastest-growing consumption, while cerium will remain the most widely-used, accounting for almost one-third of the 2015 tonnage, according to Freedonia. Lanthanum and neodymium are forecast to be the second and third most utilised rare earths.

alloys, and last year acquired 100% of Silmet, which produces high-purity RE metals and oxides in Sillamae, Estonia. In March, Molycorp announced that it will buy Neo Material Technologies, USA, for $1.3 billion, a leading RE processor and manufacturer of NdFeB bonded magnets.

The main products from Mountain Pass will be the light rare earths lanthanum, cerium, neodymium and praseodymium.

Although the ore REO content only includes about 1% of heavy rare earths, the company says that its high throughput and high recovery rates will enable it to produce commercially significant quantities of HREEs such as europium, terbium, dysprosium and yttrium.

Australia will be a significant new source of rare earths with projects such as Mount Weld, Nolans Bore and Dubbo Zirconia *(see table)*. Lynas Corporation has been mining at Mount Weld, Western Australia, since 2008 and completed the concentrator plant there in May 2011. With an average resource grade of 7.9%, Lynas says that the ore is the richest known RE deposit in the world. Current reserves are 2.1 million tonnes grading 15.5% REO.

The company decided to build the separation plant near Kuantan, Malaysia, because of the greater local supply of water, power and other materials, as well as the technical expertise in a dedicated industrial park. The Lynas Advanced Materials Plant (Lamp) is due to come on stream in the current quarter with an initial capacity of 11,000 tpy of REO. This will double when phase 2 starts up next year.

The Lamp has faced opposition from local people worried about its potential environmental impact, and there were demonstrations against it in February, in spite of it having been scrutinised and given approval by both the International Atomic Energy Authority and the Malaysian Atomic Energy Licensing Board. "Lynas has reached out directly to more than 10,000 local residents, community leaders, villagers and families to explain the workings of the plant, its safety protocols and procedures and, importantly, the company's goals and values," says a Lynas spokesman. "It is now engaging in a conversation with the Malaysian community that will continue for the life of the plant."

Lynas has formed a strategic alliance with Japan's Sojitz for funding and long-term (10-year) off-take, and it is also negotiating a joint venture with Germany's Siemens for magnet manufacture.

Other Australian projects are not so far advanced. Arafura Resources' Nolans Bore, north of Alice Springs, is undergoing a feasibility study that is not expected to be completed before 3Q 2013. On this basis, first production will not be until at least 2016, says Richard Brescianini, gm exploration & development. Concentrate will be shipped to a separation plant in Whyalla, South Australia, which will produce 20,000 tpy of REO.

Alkane Resources' Dubbo Zirconia project in New South Wales has a low RE grade at 0.9%, but this contains a high fraction of yttrium which gives it a 25% proportion of HREO out of the total. Managing director Ian Chalmers points out that this is a polymetallic project, with zirconium and niobium contributing about 60% of revenue. "We hope to commence construction in the second half of 2013 which would see us in production in late 2014," he says. A throughput of 1 million tpy of ore would give about 4,600 tpy of rare earths.

Two of the biggest resources undergoing feasibility study are Nechalacho at Thor Lake, Northwest Territories, Canada, with 315 million tonnes and Kvanefjeld (zone 2) in Greenland with 242 million tonnes. Again, although the REO grades are modest, they have quite high fractions of heavy rare earths at 17% and 14%, respectively.

With these and many other projects being developed, the supply of rare earths is unquestionably about to diversify geographically. But will this eventually result in surplus, and hence lower prices that will cut into margins? With a projected 7% annual demand growth – and restricted exports from China – producers hope that this is unlikely.

Moreover, several projects do not depend solely (or even predominantly) on rare earths, and so will be less sensitive to their price. For example, Dubbo Zirconia will also produce zirconium, niobium and tantalum, Kvanefjeld will produce uranium, Nechalacho will produce zirconium, niobium and tantalum, and Nolans Bore will produce uranium, phosphate and gypsum.

ADVANCED PROJECTS OUTSIDE CHINA

Project, country	Developer	REO resource (tonnes, grade)	HREE (% TREO)	Remarks
Mt Weld, Australia	Lynas	23.9M@7.9%	3	Mine operating; separation plant from Q2 2012.
Mountain Pass, USA	Molycorp	31.6M@6.6%	1	Mine operating; 40,000 tpy by mid-2013.
Kvanefjeld, Greenland	GMEL	242M@1.1%	14	Feasibility by Q2 2013.
Nolans Bore, Australia	Arafura Resources	46M@2.5%	4	Feasibility from Q3 2013.
Dubbo Zirconia, Australia	Alkane Resources	73.2M@0.9%	25	Start due in late 2014.
Nechalacho, Canada	Avalon Rare Metals	315M@1.4%	17	Feasibility by end 2012.
Dong Pao, Vietnam	Toyota Tsusho, Sojitz, Lavreco	0.65M total	na	3,000 tpy by 2013; 7,000 tpy by 2014.

Source: company data

MINE PRODUCTION AND RESERVES*

	2011	Reserves
USA	0	13,000,000
Australia	0	1,600,000
Brazil	550	48,000
China	130,000	55,000,000
CIS	na	19,000,000
India	3,000	3,100,000
Malaysia	30	30,000
Others	na	22,000,000

**tonnes of rare earth oxide (REO) content. Source: USGS*