Light Rare Earth Elements (LREE) opportunities in Queensland

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What are the Rare Earths?

The Rare Earth Elements (REE) are a group of chemical elements that exhibit a range of special (some unique) properties which are used in many modern technologies and "green" technologies. The International Union of Pure and Applied Chemistry defines the Rare Earth Elements as the 15 lanthanides and yttrium and scandium.

The REEs are subdivided into Light Rare Earth Elements (LREE) and Heavy Rare Earth Elements (HREE). Authors disagree on which elements are included in the LREE group, but here, the following elements are included in the LREE group: lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), and gadolinium (Gd) – also known as the Cerium Group.

The **LREE group** are some of a range of strategic elements that have not been exploited in significant quantities, but which are now attracting interest because of likely new sources and their potential use in new technologies.

Economically global REE production is estimated at 112,500 tonnes, with an economic value of 4–6 billion dollars (http://www.frontierrareearths.com/industry-data/rare-earth-market). However, technologies which rely on these elements are worth many trillions of dollars.

Why LREE are considered 'critical'

The LREEs are considered critical because of their increasing importance in modern and green technologies. The REE can be regarded as the 'vitamins' required for the shift from a carbon based economy to the new 21st century electron economy.

In 2011, China produced over 95% of the world's REEs, mostly from Inner Mongolia, even though it had only 37% of proven resources. However, by 2012, those numbers are reported to have slipped to 90% and 23% respectively. Issues around the security of supply of REEs are mainly due to the dominance of China in the market. In 2009, China announced plans to reduce its export quota, ostensibly to conserve scarce resources and protect the environment. Chinese officials have indicated further reductions in future. In 2012, the USA, EU, and Japan confronted China at the WTO about these export restrictions which have damaged industries outside China and forced producers and users of REEs to relocate to China as Chinese industries are supplied with REEs at significantly lower prices than foreign companies. In 2014, the WTO found in favour of the US, EU and Japan. China's response to the findings is not yet known.

Foreign countries are increasingly exploring for REE in order to reduce the world's dependence on China and several deposits have been found (including the Mount Weld deposit in Western Australia). However, given the dependence of many new technologies on the REE and the reliance on China for their supply, the elements are listed at the top of the Critical Elements as defined by Geoscience Australia.

For the LREE, supply of neodymium is considered to be the most critical over the next 5 years. Many of the other LREE are not as critical because deposits containing them are more common and are capable of exploitation in the near future.

How do we use LREE?

Each of the LREE has different uses, despite a broad chemical similarity (http://www.chemicool.com/elements):

Lanthanum

- Lanthanum is used in large quantities in nickel metal hydride (NiMH) rechargeable batteries for hybrid automobiles, together with cerium, praseodymium, and neodymium. A Toyota Prius battery requires about 10 kg of lanthanum.
- High quality camera and telescope lenses contain lanthanum making use of its high refractive index and low dispersion.
- Lanthanum is used as a petroleum cracking catalyst in oil refineries, producing shorter chain hydrocarbons.
- It is also used to make flint and in hydrogen storage.

Cerium

- Cerium is used as a catalytic converter to reduce carbon monoxide emissions in the exhaust fumes from automobiles.
- It is used as a mechano-chemical polishing powder for glass in TV monitors and mirrors.
- As an additive in glass it reduces UV transmission. This is particularly useful in automobiles to reduce the UV damage to upholstery.
- Cerium is used in carbon-arc lighting, especially in the motion picture industry (together with praseodymium).

Praseodymium

- Praseodymium is used in high-intensity permanent magnets, which are essential in electric motors and generators used in hybrid cars and wind turbines.
- It is used as an alloy with magnesium creating a high strength metal for aircraft engines.

- Praseodymium is used as a colourant in glass and enamels.
- Together with cerium it is used in high intensity carbon arc lights.
- Praseodymium is used to make specialised yellow glass goggles for glass blowers and welders.

Neodymium

- Neodymium is used to create powerful magnets (NIB magnets), with the ability to lift 1000 times their own weight. These are used in computers, mobile phones, medical equipment, electric cars, wind turbines and audio systems.
- Neodymium is used to produce crystals (neodymium-doped yttrium aluminum garnet) in lasers. These ND:YAG lasers have numerous applications, e.g. in medicine to treat skin cancers; laser hair removal; and in industry to cut and weld steel.
- Neodymium produces violet colours in glass and ceramics.

Promethium

- Promethium is used in atomic batteries for spacecraft and guided missiles.

Samarium

- Samarium's main use is in samarium–cobalt alloy magnets for headphones and small motors, quartz watches and camera shutters. These magnets retain their magnetism to 700°C and are used in precision-guided weapons.
- Samarium is also used in lasers.

Europium

- Europium is used as a phosphor to produce red and blue colours in LCD screens. Without Europium, the vivid reds on our video screens and mobile phones would be difficult to achieve.
- Europium is used to produce a white light in compact fluorescent bulbs.
- Europium is used in phosphors in anti-forgery marks on Euro banknotes.
- Europium isotopes are also good neutron absorbers and are used in nuclear reactor control rods.

Gadolinium

- Gadolinium compounds are used as green phosphors in colour television picture tubes.
- Gadolinium is used to make gadolinium–yttrium garnets which have microwave applications.
- Because of its magnetic properties, gadolinium is used in magnetic resonance imaging (MRI).
- Gadolinium is also used as an additive to steel to improve its resistance to high temperatures.

Because all these uses are in modern technologies and 'green' technologies, it is only in the last twenty years that the REEs have become such valuable commodities.

Where are LREE found in Queensland?

LREEs are known from many parts of Queensland but are concentrated in northwest Queensland.

LREE occur in the tailings at the Mary Kathleen uranium (U) mine east of Mount Isa. The deposit is hydrothermal, related to ~1540 Ma granites, and had a grade of 3% total REE. Although Mary Kathleen was a uranium mine, it was essentially a rare earths orebody containing U.

The breakdown of the REEs as oxides for the Mary Kathleen deposit are:

lanthanum oxide:	35%
cerium oxide:	50%
praseodymium oxide:	3%
neodymium oxide:	11%
others:	1%

The distribution of LREE in Queensland was tested during a regional national geochemical survey and several drainage systems in Queensland showed anomalous LREE concentrations in the sediments. Currently there has been no testing to determine their source.

Read more

http://en.wikipedia.org/wiki/Rare_earth_element

http://www.chemicool.com/elements/

http://www.frontierrareearths.com/industry-data/rare-earth-market

http://www.weee-forum.org/system/files/documents/201108_critical_rare_earths.pdf

Gschneider, K.A., Jr .,1966: *Rare Earths – The Fraternal Fifteen.* U.S. Atomic Energy Commission, Division of Technical Information, Washington DC.

Further information

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