Heavy Rare Earth Elements (HREE) 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 and "green" technologies. The International Union of Pure and Applied Chemistry defines the Rare Earth Elements as the 15 lanthanides together with yttrium and scandium.

The REEs are subdivided into Light Rare Earth Elements (LREE) and Heavy Rare Earth Elements (HREE), although authors disagree on which elements are assigned to each group. Here, the following elements are included in the HREE group: terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). The **HREE group** are some of a range of strategic elements that have not been exploited in significant quantities, but which are now attracting new interest because of likely new sources and potential use in new technologies.

HREEs are less abundant than the LREE and are thus of higher value. Some HREE are listed as critical as the use of these elements is outstripping supply.

Predictions of REE demand and supply outside China show that several elements are likely to be in critically short supply in the next 10–15 years. HREE which have a high importance for clean energy technologies and have a high supply risk are listed as critical and include dysprosium, terbium and yttrium.

Global REE production is estimated at 112,500 tonnes, with an economic value of $4–6 billion. However technologies that rely on these elements are worth many trillions of dollars.

Why HREE are considered 'critical'

The HREEs are considered critical because of their increasing importance in modern and green technologies. The HREE 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 were 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 the 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 USA, 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.

It should be noted that, of the REEs, neodymium and dysprosium are considered the most critical over the next 5 years. While many of the HREE are not used in such large quantities as the LREE, they are rarer and not as abundant.

How do we use the HREE?

Each of the HREEs has different uses—many of them employed in modern car manufacture, alloys and lighting.

Terbium

- **LCD Screens.** Terbium is used as a phosphor to create the vivid yellow-green colours.
- **Metal Alloys.** Terbium is sometimes used to help 'channel' the inherent ferromagnetism of transition metals such as iron and cobalt.
- **Compact fluorescent lamps.** Together with europium (blue and red), terbium (yellow-green) produces 'trichromatic' lighting which gives a much higher light output for a given amount of electrical energy.

Dysprosium

- **Hybrid cars and wind turbines.** Dysprosium is used in high-intensity permanent magnets which are essential in the electric motors and generators of hybrid cars and wind turbines.
- **Metal halide lamps.** Dysprosium is used in metal halide lamps which produce high intensity bright light.
- **Medical uses.** Dysprosium-165 is injected into joints to treat rheumatoid arthritis.
- **Metal Alloys.** Dysprosium is sometimes used to help 'channel' the inherent ferromagnetism of transition metals such as iron and cobalt.
- **Meters.** Dysprosium is used in meters to measure an individual's or an object's exposure to ionising radiation.

Holmium

- **Hybrid cars and wind energy.** Holmium has the highest magnetic strength of any element, and therefore is used to create the strongest artificially generated magnetic fields, when placed within high-strength magnets.
- **Nuclear reactors.** Since it can absorb nuclear fission-bred neutrons, holium is also used in nuclear control rods.
- **Glass making.** Holmium is used as a colourant in glass and enamels, and also as a calibration standard for optical spectrophotometers.
- **Lasers.** Holmium is used in medical, dental and fibre optic lasers.

Erbium

- **Camera filters.** Erbium is used as a photographic filter.
- **Alloys.** When added to vanadium, erbium lowers hardness and improves workability.
- **Lasers and fibre optics.** Erbium lasers are used in laser surgery and dentistry.
- **Glass and ceramics.** Erbium compounds have a pink colour and are sometimes used as a colourant for glass.

Thulium

- **Lasers.** Thulium-based lasers are used in laser surgery.
- **X-ray devices.** Thulium is used as a radiation source in X-ray machines (particularly portable X-ray machines). It does not need extensive radiation protection—only a lead cup.
- **Banknotes.** Because thulium fluoresces with a blue colour in ultraviolet light, it is added to euro banknotes as a measure against counterfeiting.

Ytterbium

- **X-ray.** Ytterbium is used in portable X-ray machines, requiring lower energies than other sources.
- **Clocks.** Ytterbium is used in the world's most stable atomic clocks.
- **Lasers.** Ytterbium lasers are highly efficient with long lifetimes and can generate short pulses.
- **Earthquake monitors.** Ytterbium metal increases its electrical resistivity when under high stress and is used in earthquake detectors.
- **Flares.** Ytterbium can be used to replace magnesium in flares, having higher emissions in the infra-red range.

Lutetium

- **Medical uses.** Lutetium is used in Positron Emission Tomography (PET) scanners.
- **Lighting.** Lutetium is used as a phosphor in LED light bulbs.
- **Lenses.** It is also used in high refractive index lenses.

Yttrium

- **Television.** Yttrium is one of the elements used (with europium) to produce red colours in television sets.
- **Bulbs.** Yttrium phosphors are used in energy efficient fluorescent lamps.
- **Medical uses.** The radioactive isotope yttrium-90 is used in the treatment of various cancers .
- **Aerospace.** Yttrium stabilised zirconium oxide is used to make high temperature aerospace surfaces and barriers.
- **Superconductors.** Yttrium is used to make superconductors which operate above the temperature of liquid nitrogen.
- **Alloys.** It is used to increase the strength of aluminium and magnesium alloys.
- **Lenses.** It is also used in camera index lenses.

Scandium

- **Alloys.** A small amount of scandium increases the strength and corrosion resistance of aluminium alloys.
- **Fuel Cells.** Scandium is used to make solid oxide fuel cells to increase efficiency at lower temperatures.
- **Lighting.** High intensity discharge lamps use scandium to produce lighting that is similar to daylight for film sets and sporting arenas.

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

Where are HREE found in Queensland?

HREE are identified at several exploration locations in Queensland but are concentrated in northwest Queensland (such as the Milo Prospect). None are at the resource identification stage. REEs are known from many parts of Queensland.

Yttrium is known in Queensland from the Korella prospect associated with phosphate mineralisation in the Georgina Basin south of Mount Isa.

Scandium is known at two of the SCONI deposits (Lucknow, Kokomo) in north Queensland, two of only three defined scandium resources in the world.

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

Further information

GSQ hotline
Email: geological_info@dnrm.qld.gov.au
Telephone: +61 7 3006 4666

Geological Survey of Queensland
Level 12, 61 Mary St Brisbane Qld 4000

www.dnrm.qld.gov.au