Rare Earth Elements

History

The Rare Earth Elements, or more simply Rare Earths, were not revealed in a single discovery. From the discovery of Gadolinite in Sweden in 1794 to the discovery of Promethium in the United States in 1945, it took 151 years for the entire group to be isolated and identified[i]. Geologically, rare earths occur in a variety of different minerals, and do not all occur in any one mineral[ii].

Geology

Rare Earths are a collection of 17 elements which comprise the 15 lanthanides, scandium, and yttrium. The name Rare Earths is actually a misnomer as the collection of elements known as the "Rare Earths" are not actually that rare, with some of them more abundant in the earth's crust than Copper or the precious metals of Gold, Silver and the Platinum Group Metals. What is rare however, are deposits where they have accumulated in sufficient concentrations to make mining economically viable[iii]. The most common ores mined for Rare Earths are Bastnäsite, Monazite, and Rare Earth Laterite.

Properties

Rare Earths can be divided into two categories "light-group rare-earth element" (LREE) or "heavy-group rare-earth element" (HREE). The categorisation of a Rare Earth as either a LREE or a HREE is based on its electron configuration. The LREEs are defined as Lanthanum, atomic number 57 through Gadolinium, atomic number 64. HREEs are defined as Terbium, atomic number 65 through Lutetium, atomic number 71[iv]. The 17 Rare Earths are: scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

A collection of rare earth oxides, Clockwise from top center: praseodymium, cerium, lanthanum, neodymium, samarium, and gadolinium.
Source: US Department of Agriculture

Use

Given the variety of metals, the list of applications for Rare Earth Element is immense. What is remarkable is that so many of these uses are for extremely high-tech applications. Rare Earths are essential for the manufacture of cars, computers, smart phones, LCD, plasma screens and more. They are also used in a variety of lasers (medical, industrial and defence, CDs, DVD, etc), powerful rare earth magnets which are used in wind turbines, and thanks to their reactivity they are also used extensively as catalytic convertors. Rare Earths are also used to make planes, satellites, welding goggles and a range of speciality glasses. This extensive list is just a fraction of the uses of Rare Earth elements[v].

Victoria

In Victoria, there are monazite deposits near Bonang in the State's far east and Elphinstone [vi]. The heavy mineral sands mining operation at Donald, in the Murray Basin, has been also been producing rare earth bearing Monazite which has been export to China[vii].

The Rare Earths cerium, lanthanum, and yttrium from the mineral monazite, were mined in large quantities through the mining of heavy mineral sands, across Australia. However, current production focused on Rare Earths in Australia is limited to the Mount Weld deposit in WA, which has so far only been been stockpiling ore to be transported to a Malaysian plant for processing. Feasibility studies are currently underway to assess the economic potential of developing deposits in the Northern Territory and New South Wales. These sites combined could see Australia become a producer of Rare Earths once again[viii].

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[i] Rare Earth Element Hand Book http://www.reehandbook.com/intro.html .
[ii] *Rare Earths 2010 Minerals Yearbook*, U.S. Department of the Interior, U.S. Geological Survey http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/myb1-2010-raree.pdf
[iii] Rare Earth Element Hand Book http://www.reehandbook.com/intro.html
[iv] Hoatson, D.M., Jaireth, S. and Miezitis, Y., 2011. *The major rare-earth-element deposits of Australia:*

geological setting, exploration, and resources. Geoscience Australia

[v] Ibid Rare Earth Element Hand Book

[vi] Victorian Government, Department of Primary Industries: Mineral Sands Fact Sheet http://www.dpi.vic.gov.au/earth-resources/minerals/industrial-minerals/a-z-of-industrial-minerals/mineral-sands

[vii] *Astron Limited 2011 Annual Report* http://www.astronlimited.com/___pdf/ASX_Update/Astron/E%20-%20Quarterly,%20Interim%20and%20Annual%20Reporting/17102011%20Annual%20Report%20to%20shareholders.pdf ; and Australian Mines Atlas – Thorium Fact Sheet http://www.australianminesatlas.gov.au/aimr/commodity/thorium.html#_ftn4

[viii] GeoScience Australia - Rare Earth Elements http://www.ga.gov.au/minerals/mineral-resources/rare-earth-elements.html#