

September 1, 2025

News and notes



Grapes (*Vitis labrusca*) in my garden – August 25, 2025

After last week's posting on Malawi, one of my readers, Marcus S., suggested that I take a closer look at [Rare Earth Elements](#) (REE), which are one of the resources of that country. I am going to do this over two weeks: this week we'll look at the individual REE and next week we will look at the geology and mineralogy of REE. But before doing that, let's first look at some news items I thought were interesting.

Comments

If anyone has comments on any of my postings, please leave a comment on the LinkedIn page for the posting or email me at raymondreichelt@gmail.com.

Geopolitics

- [Oil Deal Between China and Taliban Falls Apart.](#)
- [Indian Refiners Increase Russian Crude Purchases Despite Tariffs.](#)
- This could become a major geopolitical problem: [Widespread Extent of Irrecoverable Aquifer Depletion Revealed by Country-Wide Analysis of Land Surface Subsidence Hazard in Iran](#); related video [here](#).
- China's problems in Africa: [Africa Wins Again, Chapter 27.](#)

Research and News

- Here is a paper that my friend Marcus participated in writing: [Giant lithium-rich pegmatites in Archean cratons form by remelting refertilised roots of greenstone belts.](#)
- [Quaternary stratigraphy of Bayan borehole in eastern Songnen Plain and its paleoclimate significance.](#)
- [A new tektite strewn field in Australia ejected from a volcanic arc impact crater 11 Myr ago.](#)
- [Evaluating the resolving power of apatite \$^4\text{He}/^3\text{He}\$ thermochronology: Insights from the Fish Canyon Tuff.](#)
- [Depositional model of the Eocene El Kohol Formation \(Central Saharan Atlas, Algeria\): integration of facies analysis, palaeontology and petrography.](#)
- [Petrogenesis and tectonic significance of Kawardha lamproite dykes from the Western Bastar Craton, central India.](#)
- Geochemistry: [Lithium isotope fractionation between mica, quartz, amphibole, feldspars, and granitic melt: Experimental approach and implications for natural granitic systems.](#)
- Cretaceous-Paleogene boundary: [Magnesium, iron, and calcium isotope signatures of Chicxulub impact spherules: Isotopic fingerprint of the projectile and plume thermodynamics.](#)
- [Water storage in the refractory lithospheric mantle.](#)
- [Abiotic synthesis during the interaction of ferrous chloride-rich silicic fluids with marble under high-grade metamorphic conditions.](#)
- The colours of minerals: [Fe-Ti vs. Fe-Fe charge transfers: A comprehensive review and its applications in minerals and glasses.](#)
- Sedimentology: [Experimental confirmation of secondary flows within granular media](#); summary in [The Conversation](#).
- [From eons to epochs: multifractal geological time and the compound multifractal - Poisson process](#); Phys.org summary [here](#).

Bad Science

- [Estimating the predictability of questionable open-access journals](#); Science Daily summary [here](#).
- [The entities enabling scientific fraud at scale are large, resilient, and growing rapidly](#); Redaction Watch summary [here](#).

Plate Tectonics

- [Bimodal Slip Segmentation of the SW Hellenic Megathrust Revealed by the Mw 6.8 Methoni Earthquake Sequence and Tomography](#).
- [Estimation and Attribution of Horizontal Land Motion Measured by the Greenland GNSS Network](#).
- [Combining 3-D Deep Electrical Resistivity Tomography With Magnetic Surveys to Investigate Complex Tectonic Basins: A Case Study From the Central Apennines Seismic Belt \(Italy\)](#).
- [Hellenic Subduction System and Upper-Plate Structures Revealed by Deep High-Resolution Seismic-Reflection Profiles and Seafloor Bathymetry](#).
- [Seismic evidence for oceanic plate delamination offshore Southwest Iberia](#); summary in Science [here](#).
- [Raising the Roof of the World: Intra-Crustal Asian Mantle Supports the Himalayan-Tibetan Orogen](#); Live Science summary [here](#).
- 08/25 [Depth of Ancient Seismicity Along the Woodroffe Thrust \(Central Australia\): Constraints From Pseudotachylytes in Peraluminous Gneisses](#).
- [Oblique Arc–Arc Collision During the Earliest Permian in the Northern Beishan Orogenic Collage, NW China: Constraints From Transpressional Deformation and Geochronological Data](#).

Paleontology

- [A reappraisal of the vegetation from the dinosaur-bearing Bahariya Formation \(lower Cenomanian; Cretaceous\), Egypt](#).
- [The first specimen with skin preserved of *Lariosaurus* \(Eusauropterygia\) from the Middle Triassic of Monte San Giorgio \(Switzerland\) allows inferences about its swimming method](#).
- [Selective preservation of coleoid soft tissues in Lebanese Konservat-Lagerstätten](#).
- [Extreme armour in the world's oldest ankylosaur](#); Phys.org summary [here](#).
- Canary Islands: [Unraveling the Strange Case of the First Canarian Land Fauna \(Lower Pliocene\)](#).
- [New predatory beetle larvae from about 100 million years ago and possible niche differentiation effects in the Kachin amber forest](#).
- [Near-complete ichthyosaur fossil given to Australian Age of Dinosaurs museum](#).

- Saskatchewan: [Dinosaur expert talks Scotty, the world's largest T Rex.](#)
- [McGill team discovers Canada's first dinosaur-era dragonfly fossil](#); peer reviewed paper [here](#), behind a paywall.

Mining and Energy

- [E-Power stakes more graphite ground in Québec.](#)
- [Ukraine launches tender for major lithium deposit.](#)
- [What's Working: Rural Colorado taps into flow of geothermal development. Here's how one family caught the current.](#)
- [Australia's Largest Rare Earth Miner Plans US Expansion To Compete With China.](#)
- Copper: [A quiet revolution is unfolding in the mining sector.](#)
- [Annual US Crude Production Sets New Record in 2024, But Growth Pace Slows: EIA.](#)
- [America's first modular nuclear reactor begins construction near Idaho lab.](#)
- Biomass energy: [UK Regulator Investigates Drax Over Biomass Claims.](#)
- Mineral deposit geology: [Growth rims in uraninite: Evidence of episodic changes in hydrothermal fluid composition in Rohil uranium deposit, Rajasthan, India.](#)
- [Ungava region: Prospect of iron mine near Aupaluk spurs discussion.](#)
- Nova Scotia: [New Mine to Create Over 700 Jobs, Boost Province's GDP by \\$2.1 Billion.](#)
- Related to day's post: [Rare earth prices hit two-year peak after MP Materials stops China shipments.](#)
- [In 2019, Researchers Discover a Fungus Capable of Metabolizing Gold — Now Some Already Want It to Lead Future Space Mining.](#)
- [US adds copper, potash, silicon in critical minerals list shake-up.](#)

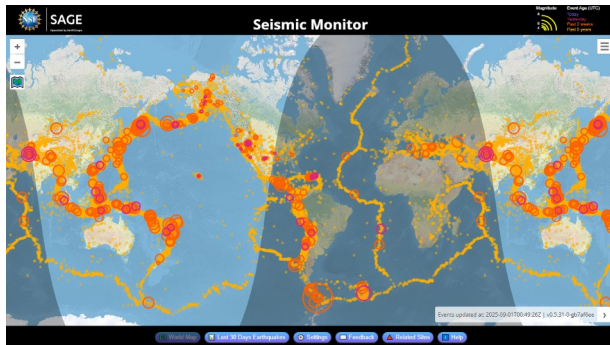
Environmental Geology and Hydrogeology

- DuPont: [Chemical giant hit with record \\$2 billion settlement after contaminating US region: 'Some of the highest levels'.](#)
- [The limitations of nitrate-sensitive zoning for groundwater protection from pesticides in Denmark.](#)
- United Kingdom: [New research published on brownfield land.](#)
- [B.C. coal mine penalized after dust emissions reach 375% over limit.](#)
- [Australia has banned 3 'forever chemicals' – but Europe wants to ban all 14,000 as a precaution.](#)

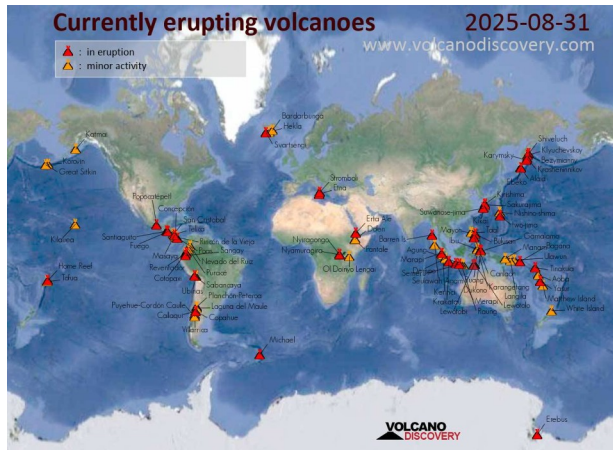
Glaciers and Climate Change

- [Massive losses and gains of northern land carbon stocks since the Last Glacial Maximum](#); Phys.org summary [here](#).
- [Opinion from Geologist Prof. Ian Plimer](#), says that CO₂ is not a problem.
- Glacial rebound video: [Nordic rebound - GIA and mantle viscosity](#).
- [Elevated atmospheric CO2 drove spatial variability in terrestrial organic carbon burial during the Toarcian hyperthermal](#).
- [Carbon drawdown by algal blooms during Antarctic Cold Reversal from sedimentary ancient DNA](#).
- [Making mud sexy: Scientists search for climate change answers in Quebec sea floor](#).
- [Investigating the Influence of Climate Seasonality on Glacier Mass Changes in High Mountain Asia via GRACE Observations](#); Phys.org summary [here](#).

Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

Volcanoes

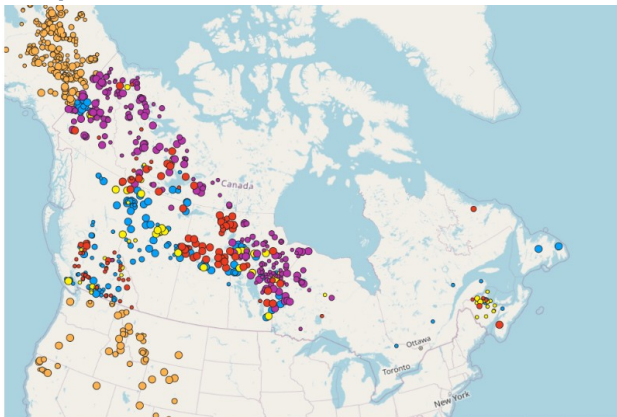
- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- United States Geological Survey (USGS) Volcano Observatories:
 - [Cascades Volcano Observatory Weekly Update](#).
 - Volcano Watch – [Cracks in the 2018 Kīlauea lava delta: what do they mean?](#)
 - [Photo & Video Chronology – August 25, 2025 – Sampling episode 31 at the summit of Kīlauea](#).

- Yellowstone Caldera Chronicles: [Cascade volcanoes are so much more than towering peaks.](#)
- [Mount Etna glows with lava as eruptions light the night sky.](#)
- [Japan releases AI-generated Mount Fuji eruption video to encourage Tokyo residents to be prepared.](#)

Earthquakes

- [Euro-Mediterranean Seismological Centre \(EMSC\).](#)
- [Earthquakes Monitoring Live Worldwide.](#)
- [Back to the Source: Connecting the Seismological Observations of Le Teil Earthquake \(Mw 4.9, 2019/11/11, France\) to the Local Geology.](#)
- Earthquake research: [Interevent Variability in Ground-Motion Prediction Models: The Role of the Source Parameter Selection.](#)
- [Scenarios demonstrate earthquake early warning benefits for Alaska.](#)

Wildfires and Other Geohazards



Interactive Wildfire Map August 31, 2025

Credit: ©[Canadian Wildland Fire Information System](#)

- [N.W.T. wildfire prompts evacuation order for Fort Providence.](#)
- [Europe experienced its worst wildfire season on record this year.](#)
- [Wildfires spread in Oregon, California as hot and dry weather lingers across the West.](#)

Free Geology Books and Other Stuff

Free geology books can be downloaded from these sites:

- [OreZone Readers and Experts Telegram Channel](#); the Ore Zone channel also shows employment opportunities for geologists.

- [The Groundwater Project](#) has many groundwater geology books for free download; also they now have a [Free Online Learning Module: Pumping Test Analysis](#).
- Free Groundwater Modeling Course – [HydroGeoCenter](#).
- From Western Australia: [Carbonatite, lamprophyre and host rocks in the northern Aileron Province](#).
- Two volumes of Geology of Indonesia now can be accessed for [FREE/GRATIS](#). The books can be accessed from: vol 1 <https://lnkd.in/eH6Gcka4>; vol 2 <https://lnkd.in/egTYmpjk>.
- Brett Davis' book on veins in a deforming rock mass: "[The Veining Bible](#)"; also at [this site](#).
- From the Mineralogical Society of America: [Handbook of Mineralogy](#).

Upcoming Events

- [The 52nd Congress of the International Association of Hydrogeologists, 15-19 September 2025, Melbourne Australia](#).
- [GeoManitoba 2025 78th Annual Canadian Geotechnical Society Conference & 9th Canadian Permafrost Conference, RBC Convention Centre, Winnipeg, Manitoba, September 21 – 24, 2025](#).
- [29 September – 1 October 2025, Stuttgart, Germany, Nature Conference on Advancing Perovskite-Based Photovoltaics](#).
- [Thursday 2nd October 2025, Early Career Hydrogeology Conference 2025, Leeds U.K.](#)
- Australia: [12–18 October 2025, Earth Science Week](#).
- November 3 – 4, 2025 [Central Canada Mineral Exploration Convention 2025](#) Victoria Inn Hotel & Convention Centre, 1808 Wellington Avenue, Winnipeg, Manitoba R3H 0G3, Canada, Early Bird pricing is in effect until midnight October 1.
- [5th International Professional Geology Conference \(IPGC\), November 5 to 7, 2025, Zaragoza, Spain](#).
- [Saskatchewan Geological Open House, December 1 to 3, 2025, Delta Bessborough Hotel, Saskatoon](#); Registration for the 2025 Conference now open.
- [Groundwater Week 2025, December 9-11, 2025 in New Orleans](#).
- 2025 [Society of Petroleum Engineers Distinguished Lecturer Schedule](#).
- [List of geoscience events in 2025 from the International Union of Geological Sciences](#).
- [American Geophysical Union List of Upcoming Meetings](#).
- The Geological Society: [Events & Courses](#).
- [“Geology Hour” Online](#), evenings on the 3rd Monday of the Month from the Geological Society of the Oregon Country.

September 1, 2025

Rare Earth Elements – Part 1

Introduction

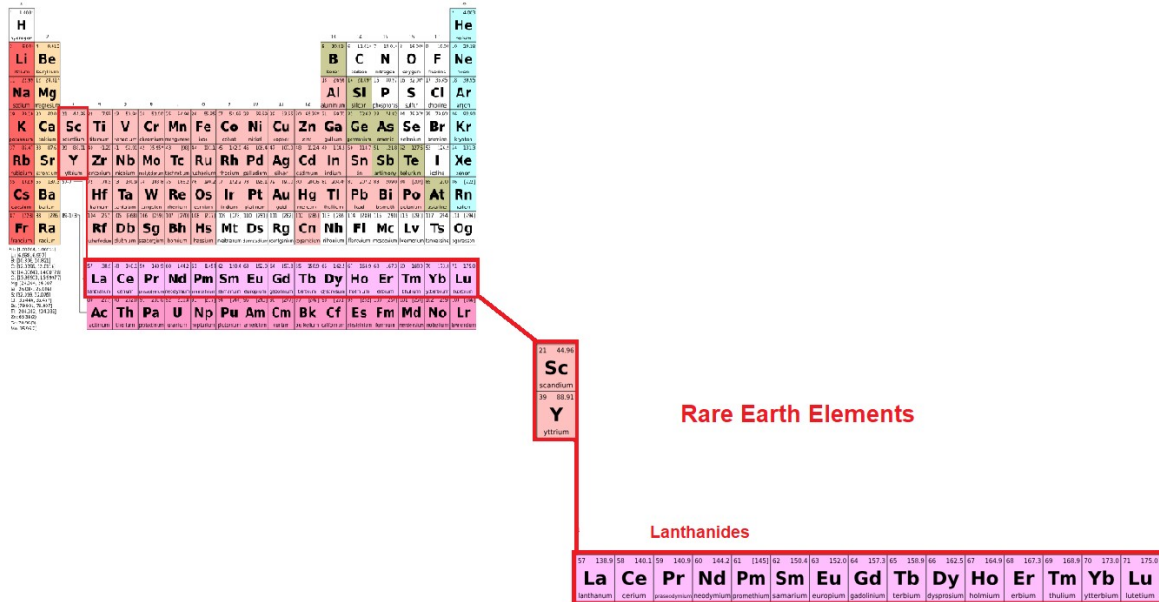


Figure 1 – REE on the Periodic Table

[Modified, László Németh, Creative Commons CC 0.0 Universal Public Domain Dedication](#)

This week, we'll take a look at [Rare Earth Elements](#) (REE), their discovery and uses. Next week we'll look at the geology and world-wide occurrences of REE in [rare earth minerals](#).

On the [Periodic Table of the Elements](#), REE are the 15 elements in the [Lanthanide Series](#) plus [Scandium](#) and [Yttrium](#). The name “rare earths” goes back to the early chemists who found these elements in minerals; in those days “earths” was a synonym for minerals.

So, let's take a closer look at each of the REEs.

Scandium



Figure 2 – Thortveitite from Ljoslandsåsen, Norway

[Credit: Robert M. Lavinsky, Creative Commons Attribution-Share Alike 3.0 Unported license](#)

[Scandium](#) was discovered in 1879 by the Swedish chemist [Lars Fredrik Nilson](#) at [Uppsala University](#), Sweden. Nilson discovered Scandium in a sample of [euxenite](#) and named it after Scandinavia. Since its first discovery, the element has been found in more than 800 minerals, most commonly in the mineral [thortveitite](#).

Among the uses of Scandium are: light alloys of aluminium and scandium are used for [aerospace components](#); as an additive in [metal-halide lamps](#) and [mercury-vapour lamps](#); and as a [radioactive tracing agent](#) in oil production.

Yttrium



Figure 3 – Bastnaesite from Burundi
Credit: Ji-Elle, Creative Commons Attribution-Share Alike 3.0 Unported license

[Yttrium](#) is typically found in minerals such as [monazite](#), [bastnaesite](#), and [xenotime](#). The element was first discovered in 1794 by the Finnish chemist and physicist [Johan Gadolin](#) in a rock from the island of [Ytterby](#) near Stockholm, Sweden.

Yttrium has a wide variety of uses, including:

- [Yttrium aluminium garnet \(YAG\) laser](#); [Yttrium vanadate](#) (YVO_4) as host for [europium in television red phosphor](#);
- Yttrium barium copper oxide (YBCO) [high-temperature superconductors](#);
- [Yttrium stabilized zirconia](#) (YSZ) is used in tooth crowns, as refractory material, in metal alloys used in jet engines, and coatings of engines and industrial gas turbines;
- For measuring oxygen and pH of hot water solutions, i.e. [in fuel cells](#); in [jewelry](#) - for its hardness and optical properties; [Yttrium iron garnet](#) (YIG) is used in microwave filters;
- In [energy-efficient light bulbs](#) (part of triphosphor white phosphor coating in fluorescent tubes, CFLs and CCFLs, and yellow phosphor coating in white LEDs); and
- In spark plugs, gas mantles, additive to steel, aluminium and magnesium alloys, cancer treatments, camera and refractive telescope lenses, and battery cathodes (LYP).

Lanthanum



Figure 4 – Monazite from Madagascar

Credit: [Robert M. Lavinsky](#), [Creative Commons Attribution-Share Alike 3.0 Unported license](#)

Also found in bastnaesite and monazite, [Lanthanum](#) was discovered by the Swedish chemist [Carl Gustaf Mosander](#) in 1839 at the [Karolinska Institute](#). Mosander found Lanthanum in a cerium sample and named it after the Greek word, λανθανεῖν (lanthaneíni) which means to lie hidden since the element had long remained hidden among the [Cerium](#) in which it was eventually found.

Lanthanum is used in high refractive index and alkali-resistant [glass](#) such as camera and refractive telescope lenses; in [battery electrodes](#) and [anodes](#); and in [cracking catalyst](#) for oil refineries.

Cerium

Another element found in bastnaesite and monazite, [Cerium](#) was discovered in 1803 by three chemists: two Swedish chemists, [Jöns Jacob Berzelius](#) and [Wilhelm Hisinger](#), working together, and independently by the German chemist [Martin Klaproth](#). The element was named after the Roman [goddess of fertility](#) and also the [dwarf planet discovered in 1801](#).

Cerium is used as a chemical [oxidizing agent](#), a [polishing powder](#), yellow [pigment](#) in glass and ceramics, [catalyst for self-cleaning ovens](#), fluid [catalytic cracking catalyst](#) for oil refineries, [ferrocium flints](#) for lighters, and [hydrophobic coatings](#) for turbine blades.

Praseodymium

Principally extracted from being bastnaesite and monazite, [Praseodymium](#) was discovered in 1885 by Austrian chemist [Carl Auer von Welsbach](#) while working as an unpaid (!!!) research assistant at the University of Vienna. The name Praseodymium comes from the Greek prasinos (πράσινος), meaning "green".

Praseodymium is used in: [rare-earth magnets](#), [lasers](#), core material for [carbon arc lighting](#), pigment in [glasses and enamels](#), an additive in didymium (praseodymium and [neodymium](#)) glass used in [welding goggles](#), ferrocium flints, and as a dopant of [fluoride glass](#) in single-mode [fiber optical amplifiers](#).

Neodymium

Another rare earth element commonly extracted from bastnaesite and monazite, [Neodymium](#) was discovered by Carl Welsbach in 1885 concurrent with his discovery of praseodymium. The name "Neodymium" is derived from the Greek words neos (νέος), new, and didymos (διδύμος), twin.

Neodymium (also spelled Neodidymium) is used in: [rare-earth magnets](#), [lasers](#), pigments in [glass and ceramics](#), [didymium glass](#), [ceramic capacitors](#), and for [electric motors in electric vehicles](#).

Promethium



Figure 5 – Eagle Eating Prometheus' Entrails
Credit: [Daderot](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#), [2.5 Generic](#), [2.0 Generic](#) and [1.0 Generic](#) licence

[Promethium](#) is named after the Greek god [Prometheus](#), who gave mankind fire and was punished for it. The element was discovered at the [Oak Ridge National Laboratory](#), Tennessee in 1945 by chemists [Jacob .A. Marinsky](#), [Charles D. Coryell](#), and [Lawrence E. Glendenin](#) as a byproduct of the [Manhattan Project](#). Promethium is artificially [produced in nuclear reactors](#) when uranium-235 or plutonium-239 is bombarded with neutrons.

Promethium is [used](#) in [atomic batteries](#), [luminous paint](#), and [cancer treatment isotopes](#).

Samarium



Figure 6 – Samarskite from the Spinelli Quarry, Connecticut, USA
Credit: [Robert M. Lavinsky](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license

Yet another REE generally found in bastnaesite and monazite, [Samarium](#) was first found in the mineral [samarskite](#) by the French chemist [Paul-Émile Lecoq de Boisbaudran](#) in 1879 in Paris. Boisbaudran named the element after the mineral in which he had found it. The mineral samarskite was in turn named after in honor of [Colonel Vasilii Yevgrafovich Samarskii-Bykhovets](#), a Russian mining engineer. Samarium is used for: [samarium-cobalt magnets](#), [lasers](#), for [neutron capture](#), and in the [control rods](#) of nuclear reactors.

Europium

Named after the continent of Europe in 1901 by its discoverer, French chemist, [Eugène-Anatole Demarçay](#), [Europium](#) is also typically found in bastnaesite and monazite. It is used for: [red and blue phosphors](#) for smartphone screens, mercury-vapour lamps, and fluorescent lamps; in [lasers](#), in [nuclear control rods](#), as a nuclear magnetic resonance (NMR) [relaxation agent](#).

Gadolinium

[Gadolinium](#) was named in 1886 by its discoverer [Jean Charles Galissard de Marignac](#) after the chemist Johan Gadolin. It is another REE typically found in bastnaesite and monazite. Gadolinium has a wide variety of uses in [high refractive index glass](#) for lasers and X-ray tubes; [in computer bubble memories](#); for [neutron capture](#), as an [contrast agent](#) in magnetic resonant imaging (MRI), [NMR relaxation agent](#), steel and chromium [alloys](#) additive, [magnetic refrigeration](#) (using significant magnetocaloric effect), [positron emission tomography scintillator detectors](#), a substrate for [magneto-optical films](#), high performance [high-temperature superconductors](#), ceramic electrolyte used in [solid oxide fuel cells](#), and [oxygen detectors](#).

Terbium



Figure 7 - Euxenite from Vegusdal, Norway
Credit: [Aangelo](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#), [2.5 Generic](#), [2.0 Generic](#) and [1.0 Generic](#) licence

Discovered by Carl Gustaf Mosander in 1834 and named after the island of Ytterby near Stockholm, Sweden. Originally discovered in the mineral [gadolinite](#), [terbium](#) is generally found in bastnaesite and monazite but also in euxenite. It is one of the rarest elements in the lanthanides group.

Terbium is used as an [additive](#) in neodymium based magnets, [in lasers](#), as the [green phosphors in fluorescent lamps](#), in magnetostrictive alloys such as [terfenol-D](#), for [naval sonar systems](#), and as a [stabilizer](#) of fuel cells.

Dysprosium



Figure 8 – Fergusonite from Madagascar
Credit: [Robert M. Lavinsky](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license

Extracted from the minerals bastnaesite and monazite, as well as from some other minerals like [fergusonite](#) and xenotime. [Dysprosium](#) was discovered by Paul-Emile Lecoq de Boisbaudran in 1886. Boisbaudran named the element after the Greek word δυσπρόσιτος (dysprositos), meaning "hard to get".

Dysprosium is used as an [additive in neodymium based magnets](#), in [lasers](#), in magnetostrictive alloys such as terfenol-D, and in [hard disk drives](#).

Holmium

Commercially obtained from monazite, bastnaesite, and xenotime, [Holmium](#) was discovered in 1878 by Swedish chemist [Per Teodor Cleve](#), and independently by the Swiss chemists [Jacques-Louis Soret](#) and [Marc Delafontaine](#). It was named after Stockholm, Sweden.

Holmium is used in: [surgical lasers](#), wavelength [calibration standards](#) for optical spectrophotometers, in [magnets](#), and in [nuclear control rods](#).

Erbium

Named in 1843 after the Ytterby, Sweden by its discoverer, Carl Gustav Mosander, [Erbium](#) is another REE mainly found in monazite and bastnaesite. Erbium is used for: [infrared surgical lasers](#), [vanadium steel](#), and in [fiber-optic technology](#).

Thulium

Found in monazite, [Thulium](#) was named by its discoverer Per Teodor Cleve in 1874 after the mythical land of [Thule](#), thought to refer to Scandinavia. Thulium is used for: [portable X-ray machines](#); [metal-halide lamps](#); and [surgical lasers](#).

Ytterbium

Yet another element named after Ytterby, Sweden, [Ytterbium](#) is also chiefly produced from monzonite. Ytterbium was discovered in 1878 by the Swiss chemist Jean Charles Galissard de Marignac and is used: for [infrared lasers](#), as a [chemical reducing agent](#), for [decoy flares](#), in [stainless steel](#), for [strain gauges](#), and in [nuclear medicine](#).

Lutetium

The name [Lutetium](#) was derived from the Roman word 'Lutetia', the ancient name for the French city of Paris. Discovered in 1907 by French chemist [Georges Urbain](#), Lutetium was also independently discovered by the American chemist [Charles James](#), and the Austrian scientist Carl Auer von Welsbach.

Lutetium is commercially obtained from the mineral monazite and is used: in positron emission tomography scan [detectors](#), in [high-refractive-index glass](#), in [lutetium tantalate](#) hosts for [phosphors](#), and in [catalysts](#) used in refineries.

Summary

That's it for this short summary of REE. There are a lot of uses for REE, and many of them connected to modern technologies. Competition for REE is a significant [geopolitical struggle](#). Next week we will look closer at the geology and mineralogy of REE.

Standard Caveat

[J. Robert Oppenheimer on freedom and scientific inquiry](#)

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.