

Salute to samarium

Stanislav Strekopytov relates the history of rare-earth element samarium, from its geological origins to its geochronological uses.

Many years ago while studying for a degree in mineralogy, I was privileged to visit the Russian Ilmen Mountains, host to two minerals from which several rare-earth elements were discovered — monazite ((Ce, La, Nd, Th)PO₄), and another mineral that was first described in 1839 by the German mineralogist Gustav Rose. He found uranium and tantalum in its composition and thus proposed the name uranotantalite. Gustav's chemist brother Heinrich Rose conducted his own analysis a few years later and found that in fact it contained mostly niobium — an element that was initially named columbium, but that Heinrich 'rediscovered' in 1844 and coined a name for.

To avoid a mismatch between name and composition, Heinrich renamed the mineral 'samaraskite', after Colonel Samarsky-Bykhovets, who had provided him with specimens¹. Whilst at least two other people had provided samples, those from Samarsky were of superior quality — though I do wonder whether it was actually his high status as chief of Russian Mining Engineering Corps that ultimately determined the choice of name.

Samaraskite, found in large quantities in North America in 1878, became the raw material of choice for isolating new rare-earth elements. Lecoq de Boisbaudran isolated a new metal oxide in 1879, and proposed the name samarium, deriving it from the same root as that of the mineral². A year later an oxide of yet another element (later named gadolinium) was separated by Galissard de Marignac, and in 1896 Demarcay found that the samarium oxide

prepared by Lecoq de Boisbaudran contained substantial amount of 'radical Σ', now known as europium.

In 1900, the French pharmaceutical company Chenal, Douilhet & Co. presented a unique collection of rare-earth compounds at the Paris *Exposition Universelle*. These had been prepared from monazite

by Leon Séquard through fractional crystallization — a method developed by Demarcay based on the differences in the solubility of double magnesium nitrates³. Only cerium and yttrium had a commercial use at the time, but the display at the *Exposition* still attracted much interest and represented a great achievement for the French chemical industry. These salts — the purest rare-earth compounds available in those days — were used in a number of chemical studies. However, the authors of *A Treatise on Chemistry* claimed that samarium compounds were only obtained in pure form in 1904 by Urbain and Lacombe⁴. I was fortunate enough to obtain a sample of samarium oxide produced by Chenal, Douilhet & Co. (pictured) and,

to settle the argument myself, analysed it by inductively coupled plasma mass spectrometry. It proved to be 97.6% pure with respect to other rare-earth elements — with the main admixtures being Gd (1.9%), Eu (0.4%) and a little Nd (0.08%).

An important use of rare-earth elements is in high-strength magnets. In the 1970s and 1980s, element 62 was particularly important because of its use in samarium-cobalt permanent magnets (SmCo₅ and Sm₂Co₁₇). At that time, the production of these magnets was limited by the availability of Sm produced from bastnäsite ((Ce, La)CO₃F) and monazite. Since 1985, the high raw materials cost

of SmCo magnets lead to their rapid replacement by Nd₂Fe₁₄B magnets. However, the former are much more resistant to demagnetization at higher temperatures and to corrosion — as a result they are still critical in the aircraft industry and in military applications.

Samarium also serves in nuclear reactor control rods (since ¹⁴⁹Sm is a strong absorber of neutrons) and in organic synthesis, as samarium diiodide, a very common reducing and coupling agent. For example, SmI₂ is used in three separate ways to synthesize paclitaxel (Taxol), a drug used to treat several forms of cancer⁵. In another medical setting, a radioactive ¹⁵³Sm ethylene diamine tetramethylene phosphonate (Quadramet) is used to treat pain when cancer has spread to the bone⁶. The α-decay of ¹⁴⁷Sm to ¹⁴³Nd with a half-life of 1.06 × 10¹¹ years is used to determine the dates and origin of rocks, be it terrestrial or extra-terrestrial. Since both are isotopes of rare-earth elements, the samarium-neodymium geochronometer is barely affected by sedimentary and metamorphic processes, which means it can be used to date rocks that are not suitable for dating by the rubidium-strontium or other methods⁷.

Little could the colonel have imagined that his namesake mineral would give its name to an element that is now used for such diverse purposes. □

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