The neodymium neologism

From grand challenges of nineteenth century chemistry to powerful technology in small packages, **Brett F. Thornton** and **Shawn C. Burdette** explain why neodymium is the twin element discovered twice by two Carls.

In 1838, Swedish chemist Carl Mosander isolated lanthanum, a new metal that had been hiding in Berzelius' cerium since 1803¹. Two years later, he found yet another metal in cerium — this third component was responsible for a purplish hue in his samples². He named this metal didymium, from a Greek word meaning twin. Didymium shared many chemical properties with lanthanum and thus appeared to be a fraternal twin derived from the same zygotic ore. After 1878, when didymium's visible spectrum was noted to vary depending on its geological source, suspicions grew that didymium contained more than one element³. Didymium would remain on element lists for over four decades, and it is the only element on Mendeleev's 1869 periodic table that does not appear on our modern version.

In the early 1880s, Austrian chemist Carl Auer von Welsbach was separating rare earth elements by repeatedly performing fractional crystallizations — a tedious and time-consuming method that relies on tiny solubility variations of lanthanide double ammonium nitrate salts. In 1885, Welsbach's hard work paid off and led him to a new element. Announcing that didymium had been shown to consist of two elements⁴, he triumphantly proposed two new names — in contrast to the established practice of only naming the less-abundant component. The minor fraction that produced green salts he named praseodymium; the major fraction he renamed neodymium.

No other acknowledged element has ever been renamed because a new element was separated from it. Nor did any contemporary chemists challenge this discovery grab — Mosander died in 1858 and so could not defend didymium. In recent years, however, some voices have been raised: it has been suggested¹ that Welsbach acted pretentiously and because only one new element was separated from didymium, that name should

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have stuck for one of the two elements in question⁵. Nevertheless, Welsbach was not alone in using the 'neo-' prefix during the rush of rare earth element discoveries (many of which were spurious) in the late nineteenth century, but only his neologism stuck.

Welsbach was regarded as a master of commercializing his discoveries, but the difficult separation of rare earth elements limited his options in this area. These elements are often found together because even Mother Nature finds them hard to separate. Neodymium is second only to cerium in crustal abundance amongst the rare earth elements and is far more common than many better-known elements, including lead and tin. In ores such as monazite and bastnäsite, neodymium can account for 12–16% of the ore.

The main application for neodymium in the nineteenth century was mischmetal — a blend of cerium and lanthanum containing small amounts of neodymium and praseodymium — a component of ferrocerium, which was used as the sparking flints for lighters. After mischmetal, colouring glass was one of the first popular applications for neodymium. Melting neodymium oxides into glass induces tints that vary from hot pinks to blues depending on the ambient light source. In lasers, neodymium-doping of

the glass lasing medium became important for high-power applications, including laser fusion research.

The most powerful known permanent magnets are produced from the alloy $\text{Nd}_2\text{Fe}_{14}\text{B}$. Since their invention by industry in 1982, these magnets have become commonplace in speakers, headphones, hard drives, high-performance electric motors and generators, and even superstrong refrigerator magnets. Their ubiquity belies their uniqueness: no other permanent magnets come close to the strength of the $\text{Nd}_2\text{Fe}_{14}\text{B}$ alloy.

Owing to its uses in modern technologies, concerns about the supply of neodymium have grown in recent years. It is generally not recycled from consumer products because of the lack of industrially feasible recovery methods and the small mass percentage present in each product. Moreover, some uses of neodymium (such as in ferrocerium flints, fireworks and phosphors) are dispersive. The readily available small, powerful $\text{Nd}_2\text{Fe}_{14}\text{B}$ magnets in cast-off electronic detritus has even led to creative recycling uses — including building equipment for chemistry education in schools⁶. □

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