Strontium's scarlet sparkles

From sugar beets to TV screens, **François-Xavier Coudert** explores the history, applications and perils of the Scottish element, strontium

Strontium takes its name from the Scottish village of Strontian (*Sròn an t-Sìthein*), making it the only element named after a place in the United Kingdom. Adair Crawford in 1790 recognized that the ore extracted from the lead mines of Strontian, and sold as 'aerated barytes', had different chemical properties from the barium minerals known at the time. This was confirmed by other chemists, in particular Friedrich Gabriel Sulzer in 1791 and Thomas Charles Hope in 1793, who named this mineral 'strontianite' and 'strontites', respectively.

The isolation of strontium in its metallic form is credited to Sir Humphry Davy in 1808. Earlier that year, Jöns Jacob Berzelius and Magnus Martin af Pontin had performed an electrolysis of calcium oxide at a mercury electrode to produce a calcium–mercury amalgam. Learning of this result, Davy applied the new technique to four different alkaline earths and subsequently proceeded to distil the mercury off, thus isolating a small quantity of the elements that he named barium, strontium, calcium, and magnium (now known as magnesium).

Strontium is a soft silvery or yellowish metal that behaves in a similar manner to the other alkaline earth metals in group 2. Although abundant in the Earth's crust — ranking 15th at 340 ppm, very close to barium — relatively few strontium minerals are known. The most common are celestine (strontium sulfate, $SrSO_4$, named for its delicate blue color) and strontianite (strontium carbonate, $SrCO_3$). The former occurs in large sedimentary deposits, from which 300,000 tons of celestine are mined annually, mostly from China.

The first industrial use of strontium was in the production of sugar from sugar beet in the nineteenth century. Beet molasses, a by-product of sugar production from sugar beet, contains 50% sugar by weight. This sugar was extracted by desugarization using the so-called strontian process: strontium hydroxide $Sr(OH)_2$ reacted with soluble sugars in near-boiling molasses to form poorly soluble strontium saccharate compounds. These were subsequently filtered and recovered by cooling and exposure to carbonation. Strontium hydroxide was then regenerated by calcination in the presence of steam. Nowadays, desugarization is instead performed using a similar lime-based process, or through ion-exclusion chromatography.

The second large-scale application of strontium was in colour television cathode ray tubes, accounting for up to 75% of US strontium consumption in the latter part of the twentieth century. It was used in the faceplate glass to block X-ray emissions without compromising the transparency of the tube. Strontium carbonate was added to the glass melt, where it was converted to strontium oxide. With replacement of cathode ray tubes by flat-panel displays, the largest remaining consumer of strontium compounds is the production of ferrite ceramic magnets. Strontium ferrite, $SrFe_{12}O_{19}$, is among the most common ferrite permanent magnets, used for devices such as refrigerator magnets, loudspeakers and small electric motors. Other uses of strontium in our daily lives correspond more to niche applications, including imitation diamonds (strontium titanate), glow-in-the-dark toys (europium-doped strontium aluminate), and toothpastes for sensitive teeth (strontium chloride).

One application of element 38, however, has stood the test of time: the use of its red flame, described as crimson, scarlet or carmine, depending on the author. *Chemical News* noted in 1918 that strontium's sole employment in the UK was in the manufacture of signal lights, flares and fireworks. Today, pyrotechnics still accounts for 30% of the use of primary strontium compounds, in the form of chloride, sulfate, carbonate, nitrate or oxalate. If you see purple fireworks, they also likely contain strontium salts, in combination with copper salts (which emit blue light).

In the human body strontium is absorbed in the same manner as its neighbour in group 2, calcium, and mostly deposited in the bones. This makes strontium fairly innocuous, and it has even been investigated for the prevention and treatment of bone diseases such as osteoporosis. Concurrently however this also makes its longest-lived radioactive isotope ^{90}Sr — generated by nuclear reactors and nuclear tests — dangerous as it promotes bone cancer. In controlled amounts, ^{89}Sr and ^{90}Sr have also found use in radiotherapy for the treatment of cancers that have spread to the bone.

Aside from anthropogenic applications, element 38 is also involved in a biological riddle. The Acantharea class of protozoa have skeletons made of celestine, puzzling scientists as to the evolutionary benefits behind this peculiar choice of building material. ❐

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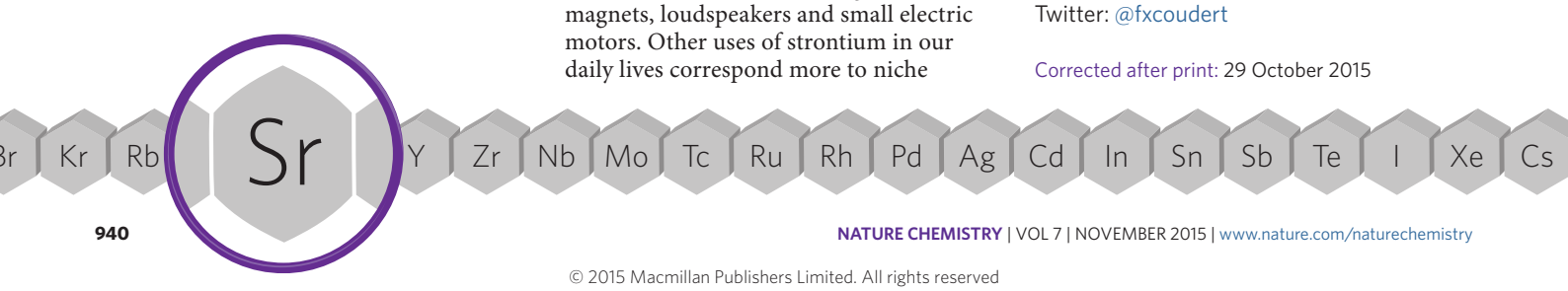

Correction

In the In Your Element article 'Strontium's scarlet sparkles' (*Nature Chem.* **7,** 940; 2015), the years in the first paragraph were incorrect. These were corrected in the online versions after print on 29 October 2015.