The Second Discovery of Vanadium

James L. Marshall, Beta Eta '71, and Virginia R. Marshall, Beta Eta '03
Department of Chemistry, University of North Texas, Denton TX 76203-5070, jimm@unt.edu

This article follows the previous "Rediscovery" articles in the Hexagon, "Don Andrés Manuel del Río and Mexico," and "The Undiscovery of Vanadium."2

The Falun Mine. The "oldest copper mine in Sweden"3 in Falun (Figure 1), 200 kilometers northwest of Stockholm (Figure 2), was first worked in the 13th century and ceased production in 1992.4 Today this mine can be visited by tourists, who can don hardhats and descend by elevator to explore the huge caverns below, full of labyrinths adorned with waxen ferric sulfate stalactites and ancient wooden ladders. At the surface of the main shaft is a museum that reviews the history of Falun and Swedish mines. The Falun mine is now a national landmark and boasts a popular "virtual reality show."5

Local myths relate that the mineral riches of Falun were first discovered when an errant goat named Käre returned to its flock with red horns, dyed by iron-rich soil of the region. Copper itself was first mined by peasant farmers who discovered Stora Kopparberget (the "Great Copper Mountain") at Falun—a millennium ago at the end of the Viking Age. The area was a poor agricultural region with a seemingly inexhaustible supply of the highly valued commodity of copper, which was easy to transport and to coin. The village of Falun thrived, and a complex society of interdependent miners, shops, smiths, and inns developed, overseen by the mayor in his ornate manor home. When a worker was killed in a mining accident, the widow was provided with a tavern to secure a livelihood for the family. Continued excavation created a cavern so huge that the ore-cart horses lived permanently underground; every so often these animals would be hauled to the surface to prevent permanent blindness. By 1641, when Falun gained its charter, it was already the second largest city in Sweden. Kopparberget provided much of the wealth necessary to support the vigorous foreign policy of Sweden during the 17th century.1

In 1774 Johann Gottlieb Gahn (Figure 3), master assayer at the Falun mine, discovered manganese by reducing Braunstein (German "brown stone," known today as pyrolusite, manganese oxide) with charcoal6 in his "smithy" furnace (Figure 4).6 It had been known for centuries that treatment of glass with braunstein (Swedish brunsten) would decolorize the product or impart a violet color to the final product. Because of its ability to "clean up" green or yellow glass, braunstein was known as sapo intir (glass soap).7 Gahn was a brilliant assayer who published little but was well respected in scientific Sweden; he was an expert in the use of the blowpipe and did much to promote the copper industry of Sweden. It is probable that Gahn was the first person to notice that a crystal retains its morphology when cleaved: when a sample of "dogtooth spar" (calcite, CaCO3) fell accidentally and shattered, Gahn noticed that the rhomboid shape of the original crystal was retained in each of the fragments.7 An exhibit on Gahn and his scientific equipment may be viewed in the Falun Mine Museum.

When Gottlieb Gahn died in 1818, his laboratory (Figure 4) was passed on to the newly formed Falun Mining School (Figure 5). In 1831 Nils Selström (Figure 6), a medical doctor who was the first Director at the School, discovered vanadium from some iron ore from Taberg, Sweden. Selström was well known for his fine contributions to the iron industry.
including new designs of iron manufacture and an account of history of iron mining in Sweden."

Taberg's ore was valuable because it was very rich in iron (20-30%) and singularly free of harmful impurities that interfered with the smelting and forging of the final product. Sefström had been curious about an empirical test* developed for iron; it had been previously observed that muriatic acid (hydrochloric acid) dissolved iron to give a black powder (presumably iron phosphide) when the iron was "brittle." Sefström was surprised to find that the iron from Taberg was malleable and yet gave a positive "muriatic test." He investigated the black powder and found a new metal that behaved somewhat like chromium or uranium (both of which exhibited highly colored yellow salts), but which was clearly a new element. Berzelius in Stockholm checked the analysis, and the announcement was made in 1831 that a new element had been discovered.* They searched for a name beginning with "V" because most other letters of the alphabet had been taken. During his tests for chromium and uranium Sefström had produced salts and solutions having beautiful colors so they called it "Vanadium" after Freya ("Vanadis," the Scandinavian Goddess of Love and Fertility, renowned for her beauty). The buildings of the Mining School in Falun (Figure 3), where the vanadium work was performed, were taken down in 1970 and now the site is occupied by a modern business and shopping area. (Figures 7,8).

Taberg, Sweden. Taberg Mountain juts 140 meters above the surrounding wooded plain (Figure 9), which the authors reached via a 3-hour freeway drive from Stockholm. A tourist bureau at the base of the mountain offered interesting literature and exhibits, and a road led to the summit, which sported a restaurant and a park. The view from the park included a
beautiful panorama of the countryside, and in the center of the park was a huge cavity that had been excavated by miners since the 1500s. The base of the mountain was strewn with talus slopes of this mineral broken off the black cliffs (Figure 9). The most fascinating aspect of Taberg was its unique composition—the entire mountain was composed of magnetite (Note 1). The unusual chemistry of the soil gives rise to unusual lichens, mosses, and other plants, which led Carl Linnaeus to visit in 1741. Strolling about the magnetic mountain, we found that magnetic compasses were ineffective, and intriguing demonstrations could be performed (Figure 10).

Wöhler's Discovery that del Rio's Erythronium Was Identical to Vanadium.

Friedrich Wöhler (1800-1882, Figure 11), fresh from his studies with Berzelius in Stockholm (1823-1824), made several important chemical discoveries at the Stadtische Gewerbeschule [Municipal Technical School] in Berlin (Figures 12,13). Here, in 1828, Wöhler was the first to synthesize urea from an inorganic salt, thus disproving the "vital theory" of organic compounds. At this school he also prepared metallic aluminum, beryllium, and yttrium. He narrowly missed the "second" discovery of vanadium by reinvestigating del Río's plomo pardo supplied by Humboldt, who had brought a sample to Berlin in 1805. Unfortunately, Wöhler had been delayed in his research because of health problems. After hearing of the Scandinavian discovery, the chagrined Wöhler cried, "I was a jackass [Ich war ein Esel] not to have discovered it 2 years earlier;" Berzelius consoled Wöhler, saying that "it required more genius to synthesize urea than to discover ten new elements." Wöhler procured a sample of Swedish vanadium and verified it was identical to the plomo pardo element that del Río had named erythronium.

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Figure 8. Gruvagatan ("Mine Street") runs from Falu Gruva ("Falu Mine," N 60° 36.01, E 15° 36.95) to the center of town where it becomes Bergskolegränd. At the south corner of Trotzgatan and Bergskolegränd was located Gahn's laboratory (N 60° 36.35, E 15° 38.10). Sefström's laboratory was located at the crook of Åsgatan (N 60° 36.31, E 15° 38.10).

Figure 9. Taberg Mountain (N 57° 40.73, E 14° 04.93) is 10 kilometers south of Jonköping, Småland, which is connected by expressway to Stockholm, 300 kilometers to the northeast. At the summit can be seen a restaurant; about the base are scattered tons of debris broken from the dark cliffs.

Figure 10. The entire Taberg Mountain is magnetic, composed of a form of magnetite (Fe3O4). Here, a rare earth magnet easily holds up one of the shards broken off the cliff.

Figure 11. This statue of Friedrich Wöhler stands at Wöhler Platz, Göttingen, Germany (N 51° 31.81, E 09° 56.17) between the former site of Wöhler's former laboratory (right, out of view) and the building where Friedrich Stromeyer discovered cadmium in 1817 (left, out of view).
Should “Vanadium” Be Renamed “Erythronium”?

Two centuries later, it is now accepted that del Rio should be given credit for discovery of vanadium. Since the principle has long been adopted that the person who first discovers an element should be given the right to name it, in 1947 two Mexican chemists proposed that the name “erythronium” should retroactively substitute “vanadium.” The timing of this suggestion was appropriate. During the 1940s the rash of discoveries of the artificial elements prompted a lively discussion of the criteria needed to establish the claim of discovery and the priority to name new elements. It is a miscarriage of justice that the response to the 1947 Mexican article—a brief addendum to the article written by F. A. Paneth—was a rejection based on the false assertion that del Rio relinquished all claim to the discovery of the new element. Unfortunately, the chemical community has historically resisted a return to an earlier name, even after it has been determined that the original discoverer should be given credit—examples include not only erythronium/vanadium, but also columbium/nio- bium, and possibly caseocuprum/futetum. Furthermore, there no longer exists any agency which can officially change the names for the natural elements: it has long been stipulated by the IUPAC that, in the arena of the nomenclature of elements, it deals only with new, artificial elements. It is unfortunate that it is too late to heed the plea of Featherstonhaugh: “We believe that the tree of knowledge flourishes most, where the love of justice is strong. If we would have truth, we must plant justice... If we would have truth, we must plant...”

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Literature Cited

9. N. G. Sefström,”Sur le vanadium, metal nouveau,” 1831, Ann. chim. phys., 105-111. The original announcement of Berzelius confirming Sefström’s work was published in Jernkontorets Annalar, Nov. 1830.
spokespersons regarding nomenclature for the IUPAC.


27. F. W. Featherstonhaugh, quoted in reference 18.


Notes

Note 1. The 1.2 million-year-old geological formation at Taberg is an iron-titanium-vanadium deposit covering an area of 1 x 0.5 kilometers, extending to a depth of at least 500 meters. The unique composition is magnetite (Fe₃O₄) with small amounts of titanium (<5%) and vanadium (<1%), admixed with olivine (ferrous silicate).

Note 2. Upon the independence of Mexico, all Spanish-born residents were forced to leave Mexico; del Río moved to Philadelphia in 1829 where he was taken under the wing of the geologist George W. Featherstonhaugh. The tenure of del Río in Philadelphia lasted six years, when he convinced the Mexican government that “Mexico was his true country” and that he should be permitted to return. Featherstonhaugh (1780-1866), a polymath of incredible versatility, was born in London and educated at Oxford. Traveling to the United States (1806) he engaged in agricultural research: railroad development; literary works (translation of Cicero and writing his own plays); editorship (founding the Monthly American Journal of Geology and Natural Science); and geological surveys of the western country (as the first United States Geologist). Returning to England (1838) he was appointed British consul to France; published works on his travels and translations from Italian literature; and involved himself in invective criticism of the U.S. South (writing Excursion Through the Slave States).

Note 3. It was the contention of Paneth that del Río had irrevocably renounced his claim because del Río thought, even to his dying day, that he had been investigating not a new element, but chromium. The literature, however, utterly refutes this contention, on the basis of direct quotations from del Río. Del Rio never had official status on the IUPAC, even though he voiced his opinions frequently on discoveries and nomenclature of new elements and had a prestigious record of accounts of historical chemistry; it was outrageous for him to claim to “speak in authority” on this topic. It appears, therefore, that not only the Atlantic Ocean, but also the Rio Grande, was a barrier to easy interchange between scientific minds.