

# Vanadium

*Michael J. Magyar, the vanadium commodity specialist for the U.S. Geological Survey, has prepared the following information on vanadium, which is an important component of steel.*

Vanadium, the name of which comes from Vanadis, a goddess in Scandinavian mythology, is one of the most important ferrous metals. Vanadium has many uses, but the metal's metallurgical applications, such as an alloying element in iron and steel, account for more than 85 percent of U.S. consumption. The dominant nonmetallurgical use of the metal is as a catalyst for the production of maleic anhydride and sulfuric acid, ceramics, vanadium chemicals and electronics.

Vanadium is considered to be a minor element, but is rather abundant worldwide. Its abundance in Earth's crust is on the order of 100 to 150 parts per million, about twice that of copper and zinc, and 10 times that of lead. It occurs mainly in silicate rocks, but it does not form an important part of any common rock-forming mineral.

Vanadium was discovered by Andrés Manuel del Río (a Spanish mineralogist) in Mexico City, in 1801. The French chemist Hippolyte Victor Collet-Descotils incorrectly declared that del Río's new element was only impure chromium and del Río accepted the statement. In 1831, Sefström of Sweden rediscovered vanadium in a new oxide he found while working with some iron ores, but later that same year Friedrich Wöhler confirmed del Río's earlier discovery. Metallic vanadium was isolated by Henry Enfield Roscoe in 1867, who reduced vanadium chloride with hydrogen.

Most vanadium is consumed as ferrovanadium, which is used to introduce vanadium into steel, improving the steel's strength and toughness. In 2005, production of carbon, full-alloy and high-strength low-alloy steels, in nearly equal amounts, accounted for more than 90 percent of domestic vanadium consumption. Nonmetallurgical applications such as catalysts, ceramics and vanadium batteries were produced from vanadium pentoxide.

In 2005, the United States consumed a reported 3,910 metric tons of contained vanadium, 3 percent lower than in 2004. Also in 2005, the United States imported 11,900 tons of ferrovanadium, and 1,556 tons of other vanadium oxides and hydroxides, collectively valued at \$190 million. Total imports for consumption of these vanadium materials increased by 222 percent from 2004, driven largely by ferrovanadium imports. The United States exported \$40.2 million worth of ferrovanadium and other vanadium oxides and hydroxides — an increase of 49 percent over 2004.

In 2005, the price for domestic ferrovanadium ranged from \$22.00 to \$61.00 per pound of contained vanadium, compared with \$6.20 to \$23.00 per pound reported in 2004. The price rose from about \$22.00 per pound at the beginning of the year, gradually increased to about \$43.00 per pound by the end of April, spiked to about \$61.00 per pound in May, and then gradually dropped to \$22.00 per pound by the end of December.

Nearly all vanadium is produced from primary sources. Five countries recovered significant quantities of vanadium from ores and slag, or petroleum residues. In 2005, the leading

vanadium-producing nations remained China, Russia and South Africa, where the mining and processing of magnetite-bearing ores was the predominant source of vanadium production. Japan and the United States were believed to be the only countries to recover significant quantities of vanadium from petroleum residues.

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Sample of vanadinite. Image from *Minerals in Your World*.