

Copper

Daniel Edelstein, the copper commodity specialist for the U.S. Geological Survey, has compiled the following information about copper, a metal closely tied to the development of ancient and modern civilization.

Copper, which was first used more than 10,000 years ago, was the first metal used by humans. The alloying of copper with tin to form bronze — a harder, stronger and more readily cast metal — gave rise to an era bearing its name. Copper (pure metal and its alloys) became a major industrial metal due to its properties of high ductility, malleability, thermal and electrical conductivity, and corrosion resistance. It now ranks third after iron and aluminum in terms of quantities consumed. The United States was the world's largest user of refined copper until 2002 (about 2.4 million tons, 16 percent of world total), when it was surpassed by China, whose apparent consumption nearly doubled over a four-year period.

At least 160 copper minerals have been identified in nature, of which chalcopyrite is the most abundant and economically significant. Geologists have grouped economic copper deposits according to their mode of origin into broad generic classes. The most important of these — porphyry copper deposits and their associated deposits — account for about two-thirds of the world's resources, including most of those found in the Western United States. Approximately one-fourth of the world's identified resources are in strata-bound sedimentary rocks, such as in the African copper belt and the Nonesuch Shale of Michigan. About 5 percent of global copper resources are in volcanic rocks as massive sulfide deposits, such as those that were mined in the Ducktown Basin in Tennessee.

Current U.S. mine production of copper is mostly from the processing of the low-grade porphyry copper deposits in Western states. Historically, however, native copper, sedimentary and massive sulfide deposits have contributed significantly to U.S. copper production. The earliest large-scale domestic production came from the native copper deposits in Upper Michigan, where modern production began in 1844. By the beginning of the 20th century, the United States was by far the world's largest copper producer.

By the start of the 21st century, however, the United States relinquished its role as the world's largest copper producer to Chile. U.S. mine production in 2002 was only 1.14 million tons (down from its peak in 1997 of 1.94 million tons), while Chile's production rose to 4.58 million tons. Large investments in foreign production and global recession led to surplus production, a sustained period of low prices and a series of U.S. mine production curtailments. Consequently, the United States is dependent on imports to meet more than one-third of its refined copper consumption.

The United States, however, has substantial copper reserves (35 million tons), and an estimated 260 and 290 million tons, respectively, of identified and undiscovered copper resources, based on a 1998 mineral-resource assessment by the U.S. Geological Survey. At yearend 2003, world copper prices began to rise as production restraint, recovery in global demand outside of China and continued growth in China led to a copper production deficit. Consequently, annual U.S. mine output is poised to expand by about 200,000 metric tons per year.

In 2003, 13 mines in three states (Arizona, Utah and New Mexico, in descending order) accounted for 99 percent of U.S. domestic copper production. Because of its infinite capability for recycling and the economic advantage of processing secondary materials over mined ore, copper scrap has always been a significant component of domestic copper supply. Brass mills, rod mills, foundries, ingot makers and chemical plants were consumers of refined copper and directly melted scrap.

Uses for copper and copper alloy products included building construction (46 percent), electric and electronic products (23 percent), consumer and general products (11 percent), transportation equipment (10 percent), and industrial machinery and equipment (10 percent). More than 75 percent of copper within these end uses was used in electrical applications.

Originally published as *Geotimes* Mineral Resource of the Month, June 2004
Used with permission



Sample of native copper with ballpoint pen for scale. Image from USGS.