USGS FACT SHEET 2009-3031, COPPER—A METAL FOR THE AGES

(DOEBRICH, 2009)

USGS
science for a changing world

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Cu
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copper
63.55

USGS Mineral Resources Program

Copper—A Metal for the Ages

As part of a broad mission to conduct research and provide information on nonfuel mineral resources, the U.S. Geological Survey (USGS) supports science to understand

- *How and where copper resources form and concentrate in the Earth's crust*
- *How copper resources interact with the environment to affect human and ecosystem health*
- *How trends in supply of and demand for copper vary in the domestic and international markets*
- *Where future copper resources might be found*

Why is this important? Read on to learn about copper and the important role it plays in the national economy, national security, and the lives of Americans every day.

Copper was one of the first metals ever extracted and used by humans, and it has made vital contributions to sustaining and improving society since the dawn of civilization. Copper was first used in coins and ornaments starting about 8000 B.C., and at about 5500 B.C., copper tools helped civilization emerge from the Stone Age. The discovery that copper alloyed with tin produces bronze marked the beginning of the Bronze Age at about 3000 B.C.

Copper is easily stretched, molded, and shaped; is resistant to corrosion; and conducts heat and electricity efficiently. As a result, copper was important to early humans and continues to be a material of choice for a variety of domestic, industrial, and high-technology applications today.

How Do We Use Copper?

Presently, copper is used in building construction, power generation and transmission, electronic product manufacturing, and the production of industrial machinery and transportation vehicles. Copper wiring and plumbing are integral to the appliances, heating and cooling systems, and telecommunications links used every day in homes and businesses. Copper is an essential component in the motors, wiring, radiators, connectors, brakes, and bearings used in cars and trucks. The average car contains 1.5 kilometers (0.9 mile) of copper wire, and the total amount of copper ranges from 20 kilograms (44 pounds) in small cars to 45 kilograms (99 pounds) in luxury and hybrid vehicles.

As in ancient times, copper remains a component of coinage used in many countries, but many new uses have been identified. One of copper's more recent applications includes its use in frequently touched surfaces (such as brass doorknobs), where copper's antimicrobial properties reduce the transfer of germs and disease. Semiconductor manufacturers have also begun using copper for circuitry in silicon chips, which enables microprocessors to operate faster and use less energy. Copper rotors have also recently been found to increase the efficiency of electric motors, which are a major consumer of electric power.

The excellent alloying properties of copper have made it invaluable when combined with other metals, such as zinc (to form brass), tin (to form bronze), or nickel. These alloys have desirable characteristics and, depending on their composition, are developed for highly specialized applications. For example, copper-nickel alloy is applied to the hulls of ships because it does not corrode in seawater and reduces the adhesion of marine life, such as barnacles, thereby reducing drag and increasing fuel efficiency. Brass is more malleable and has better acoustic properties than pure copper or zinc; consequently, it is used in a variety of musical instruments, including trumpets, trombones, bells, and cymbals.

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Where Does Copper Come From?

Copper occurs in many forms, but the circumstances that control how, when, and where it is deposited are highly variable. As a result, copper occurs in many different minerals. Chalcopyrite is the most abundant and economically significant of the copper minerals.

Research designed to better understand the geologic processes that produce mineral deposits, including copper deposits, is an important component of the USGS Mineral Resources Program. Copper deposits are broadly classified on the basis of how the deposits formed. Porphyry copper deposits, which are associated with igneous intrusions, yield about two-thirds of the world's copper and are therefore the world's most important type of copper deposit. Large copper deposits of this type are found in mountainous regions of western North and South America.

Another important type of copper deposit—the type contained in sedimentary rocks—accounts for approximately one-fourth of the world's identified copper resources. These deposits occur in such areas as the central African copper belt and the Zechstein basin of Eastern Europe.

Individual copper deposits may contain hundreds of millions of tons of copper-bearing rock and commonly are developed by using open-pit mining methods. Mining operations, which usually follow ore discovery by many years, often last for decades. Although many historic mining operations were not required to conduct their mining activities in ways that would reduce their impact on the environment, current Federal and State regulations do require that mining operations use environmentally sound practices to minimize the effects of mineral development on human and ecosystem health.

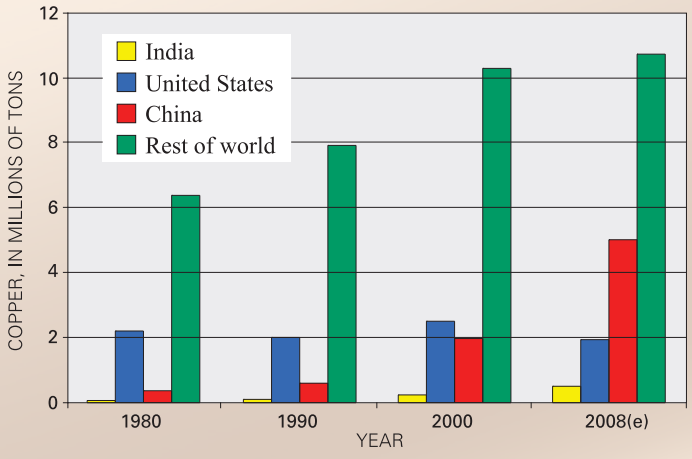
USGS mineral environmental research helps characterize the natural and human interactions between copper deposits and the surrounding aquatic and terrestrial ecosystems. Research helps define the natural baseline conditions before mining begins and after mine closure. USGS scientists are investigating climatic, geologic, and hydrologic variables to better understand the resource-environment interactions.

Visible from space, the Bingham Canyon copper mine in Utah has produced more than 12 million tons of porphyry copper. The mine is more than 4 kilometers (2.5 miles) across at the top and 800 meters (0.5 mile) deep and is one of the engineering wonders of the world. Photograph by C.G. Cunningham, USGS.

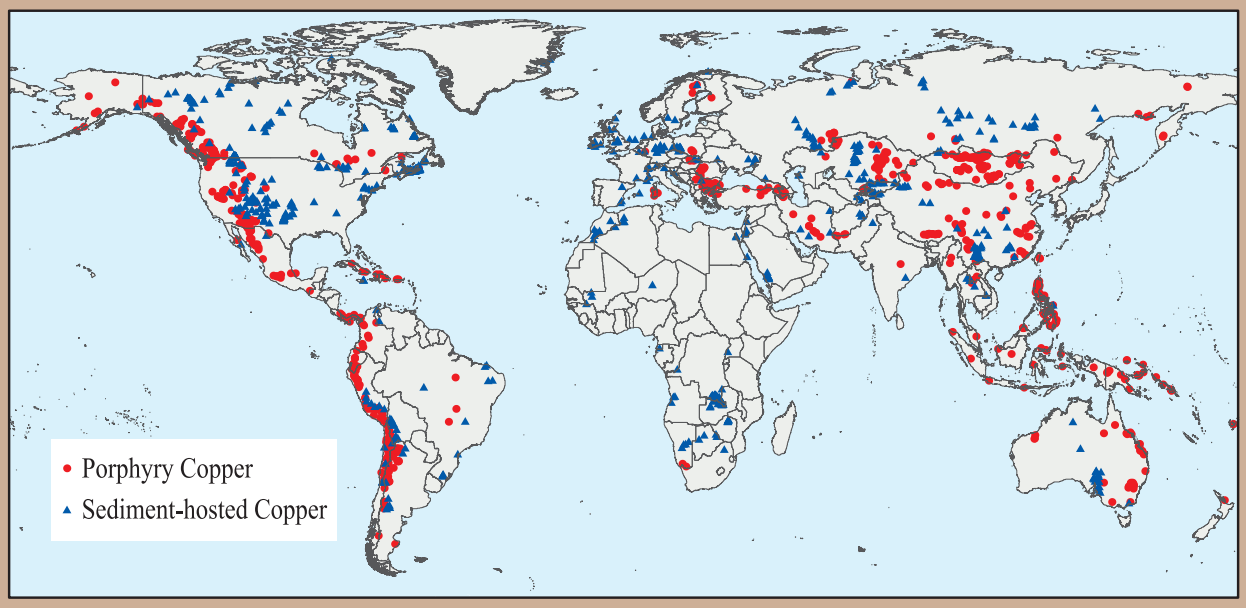
Did you know?... At least 160 copper-bearing minerals have been identified in nature; some of the more familiar minerals are chalcopyrite, malachite, azurite, and turquoise

Copper consumption changes from 1980 through 2008 for India, the United States, China, and the rest of the world

The qualities of copper that have made it the material of choice for a variety of domestic, industrial, and high-technology applications have resulted in a steady rise in global copper consumption. USGS studies of copper consumption show some interesting trends for the 1980 to 2008 time period. Copper consumption in emerging economies, such as China and India, rose considerably, whereas the consumption rate in industrialized economies, such as the United States, fell slightly. Until 2002, the United States was the leading copper consumer and annually used about 16 percent of total world refined copper (about 2.4 million tons). In 2002, the United States was overtaken by China as the world's leading user of refined copper. The booming economy in China contributed to a tripling of its annual refined copper consumption during the 8 years from 1999 to 2007. Data for 2008 are estimates (e) based on data for three-quarters of the year.



Did you know?... The United States was the world's largest copper producer until 2000; beginning in 2000, Chile became the world's leading copper producer



Distribution of known copper deposits in 2008. Red indicates copper associated with igneous intrusions (porphyry copper deposits) and blue indicates copper contained in sedimentary rocks (sediment-hosted copper deposits).

Did you know?... Before 1982, the U.S. penny was made entirely of copper; since 1982, the U.S. penny has been only coated with copper

Worldwide Supply of and Demand for Copper

The world's production (supply) and consumption (demand) of copper have increased dramatically in the past 25 years. As large developing countries have entered the global market, demand for mineral commodities, including copper, has increased. In the past 20 years, the Andean region of South America has emerged as the world's most productive copper region. In 2007, about 45 percent of the world's copper was produced from the Andes Mountains; the United States produced 8 percent. Virtually all copper produced in the United States comes from, in decreasing order of production, Arizona, Utah, New Mexico, Nevada, or Montana.

The risk of disruption to the global copper supply is considered to be low because copper production is globally dispersed and is not limited to a single country or region. Because of its importance in construction and power transmission, however, the impact of any copper supply disruption would be high.

Copper is one of the most widely recycled of all metals; approximately one-third of all copper consumed worldwide is recycled. Recycled copper and its alloys can be remelted and used directly or further reprocessed to refined copper without losing any of the metal's chemical or physical properties.

Did you know?... Copper is one of the few metals that occur in nature in native form. Because of this, it was one of the first metals used by ancient peoples and it continues to be an important metal today

How Do We Ensure Adequate Supplies of Copper for the Future?

To help predict where *future* copper resources might be located, USGS scientists study how and where *known* copper resources are concentrated in the Earth's crust and use that knowledge to assess the potential for undiscovered copper resources. Techniques to assess mineral resource potential have been developed and refined by the USGS to support the stewardship of Federal lands and to better evaluate mineral resource availability in a global context.

In the 1990s, the USGS conducted an assessment of U.S. copper resources and concluded that nearly as much copper remained to be found as had already been discovered. Specifically, the USGS found that about 350 million tons of copper had been discovered and estimated that about 290 million tons of copper remained undiscovered in the United States.

Building on the success of the U.S. national mineral resource assessment, the USGS has undertaken a global copper resource assessment in collaboration with international partners. An assessment of undiscovered porphyry copper resources in the Andes Mountains of South America was recently released; the authors conclude that more copper remains to be found there than has already been discovered. Specifically, about 590 million tons of copper has been discovered and about 750 million tons of copper is estimated to remain as undiscovered porphyry copper deposits.

Mineral resource assessments are dynamic. Because they provide a snapshot that reflects our best understanding of how and where ore is located, the assessments must be updated periodically as better data and concepts are developed. Current research by the USGS involves updating mineral deposit models and mineral environmental models for copper and other important nonfuel commodities and improving the techniques used to assess for concealed mineral resource potential. The results of this research will provide new information to decrease uncertainty in future mineral resource assessments.

Did you know?... Every American born in 2008 will use an estimated 595 kilograms (1,309 pounds) of copper in his or her lifetime

In 1886, the Statue of Liberty represented the largest use of copper in a single structure. To build the statue, about 80 tons of copper sheet was cut and hammered to a thickness of about 2.3 millimeters (3/32 inch), or about that of two U.S. pennies placed together. Photograph courtesy of National Park Service.

For More Information

For more technical information

- On production and consumption of copper: http://minerals.usgs.gov/minerals/pubs/commodity/copper/
- On porphyry copper deposit models: http://pubs.usgs.gov/of/2008/1321/
- On porphyry copper deposits of the world: http://pubs.usgs.gov/of/2008/1155/
- On sediment-hosted copper deposits of the world: http://pubs.usgs.gov/of/2003/of03-107/
- On the assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: http://pubs.usgs.gov/circ/c1178/
- On the assessment of porphyry copper deposits in the Andes Mountains of South America: http://pubs.usgs.gov/of/2008/1253/

The USGS Mineral Resources Program is the sole Federal provider of research and information on copper and other nonfuel mineral resources.

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Cu
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copper
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Did you know?... Copper is necessary for human health; the best sources of dietary copper include seafood, organ meats, whole grains, nuts, raisins, legumes, and chocolate

Text prepared by Jeff Doebrich. Graphics and design by Linda Masonic