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Testimony

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Hearing on Energy and Mineral Requirements for Development of

Renewable and Alternative Fuels Used for Transportation and Other Purposes

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear at this hearing on energy and mineral requirements for development of renewable and alternative fuels used for transportation and other purposes. My name is David Menzie. I am a geologist with the U.S. Geological Survey (USGS) and serve as Chief of the Mineral Information Team's International Minerals Section, a component of the USGS Mineral Resources Program. The USGS is the primary Federal provider of scientific and economic information for objective resource assessments and unbiased research results on national and international mineral potential, production, trade, consumption, and environmental effects. The USGS provide s information to help inform land use and resource planning decisions on specific management units and for national and international economic, foreign policy, and national security decisions.

Rising costs of metals are again heightening concerns about future supplies of these important commodities. Copper is among the metals that have experienced a dramatic increase in price. In January 2003, the price of copper was around $0.70 per pound and it was readily available as copper stocks exceeded 1.2 million metric tons (Mt). At the end of March 2006, copper prices reached $2.46 per pound and stocks were just over 150,000 metric tons (t). Stocks fell to below 50,000 t in July 2004 and some smelters had difficulty in obtaining sources of copper. The recent rise in copper prices is the result of increased copper consumption by developing countries. Some authors suggest that increased consumption of minerals by developing countries is not sustainable either because copper resources are insufficient to meet growing consumption or because the environmental consequences of increased resource production will be too costly.

USGS scientists have addressed the question of future mineral scarcity, with emphasis on copper, in a paper titled "Mineral Resources and Development in the Twenty-first Century" that was published by Resources for the Future in their 2005 book, *Scarcity and Growth Revisited*. This study concluded that although the world has abundant resources of copper, rapid increases in copper consumption may lead to temporary shortages. The USGS considered a number of factors that will affect future supplies of copper, including: (1) rising consumption related to economic growth in developing countries; (2) estimates of copper availability; (3) investment in mineral exploration; (4) the state of the minerals professions; (5) increased scrutiny of and restrictions on mineral extraction; and, (6) increased environmental residuals (pollutants resulting from mineral production and use). I will discuss each of these factors in turn.

1. Economic Growth and Mineral Consumption

Rapid economic development and rising income levels in a number of countries, especially in Asia, have led to a rapid increase in consumption of mineral commodities following a consistent pattern of increasing per capita consumption with increasing income (per capita GDP). Levels of mineral consumption are low in lesser-developed countries with low income levels; however, mineral consumption increases very rapidly as countries begin to industrialize and incomes pass a threshold level. Per capita mineral consumption then stabilizes at higher levels when countries begin to develop the service and information sectors of their economies. The current rapid increase in mineral consumption is the result of a number of large countries approaching or having reached threshold income levels for consumption.

The USGS used the relation between per capita income and per capita copper consumption to estimate copper consumption in the 20 most populous countries in 2020. The results suggest that world copper consumption will increase an estimated 3.1 percent per year from 14.9 Mt in 2000 (our base year) to 27 Mt in 2020. Most of the increased consumption will take place in developing countries. For example, copper consumption in the United States and Japan will increase from 3 Mt and 1.3 Mt in 2000 to 3.5 Mt and 1.4 Mt respectively in 2020, while copper consumption in China and India will increase from 2 Mt and 400,000 t in 2000 to 5.6 Mt and 1.6 Mt respectively in 2020.

2. Estimates of Copper Availability

Currently, about 90% of all copper consumed comes from mining and processing new ores. About 10% of copper is from recycled sources. Recent studies reported in the *Wall Street Journal*, the *Washington Post*, and trade publications question whether recycling rates can be significantly increased. Unless recycling can be dramatically increased, the escalating demand for copper will either have to be met through increased mine production or through substitution of other commodities that exhibit the same properties and can serve the same functions as copper. Economic development increases the demand for a full suite of industrially useful mineral commodities – not just copper. Therefore, limits may exist to the availability of substitute commodities. Thus, much of projected copper consumption is likely to be mine production of copper from reserves.

Copper reserves represent the working inventory of mines; as that inventory is reduced, the reserves will need to be replenished from other (non-reserve) identified resources and by discovering new deposits of copper. There are about 45 Mt of copper reserves in the United States. Identified copper resources in the United States are estimated to be about 260 Mt. About 290 Mt of copper are estimated to exist in undiscovered deposits in the United States based upon a detailed probabilistic assessment of undiscovered mineral resources. World copper reserves are currently about 470 Mt. Total (identified and undiscovered) world copper resources are less well known. An assessment of undiscovered world resources comparable to that for the United States does not exist. Completion of the probabilistic assessment of undiscovered resources for the United States increased previous estimates of United States' total copper resources significantly. Based upon these results, it is expected that the current estimates of total world copper resources (1.6 billion tons) would be significantly increased by a modern global mineral assessment including an estimate of the amount of copper in undiscovered deposits worldwide.

Our study estimated that approximately 1.1 billion tons of copper will need to be added to reserves if the world is to meet projected copper consumption at present recycling rates and to maintain reserves at the same level relative to copper production. The study concluded that to meet anticipated copper consumption between 2000 and 2020 and to maintain a proportional amount of reserves will require more than three times the amount of copper as is contained in the 5 largest deposits currently known (Chuquicamata, El Teniente, Escondida, and Las Bronces in Chile and Morenci in Arizona). Although some of this material exists in discovered deposits, much of the material will need to come from undiscovered deposits. Because a small number of very large deposits typically contain the majority of copper resources, a small number of large undiscovered deposits will be critical to supplying copper in the future.

Based on available information, it appears that sufficient supplies of copper exist to meet the needs of developing countries; however, the production of these resources will depend upon a number of factors including adequate levels of mineral exploration, the development of new technologies for mineral discovery and production, and social and legal environments that allow for mineral exploration and production.

3. Investment in Mineral Exploration

An analysis of mineral exploration budgets, together with organizational changes within corporations engaged in mineral exploration, and within universities that teach economic geology, mineral economics, and mining engineering illustrates reasons for concern. Although significant resources exist, a ready inventory of copper may not be available to meet the increased demand imposed by developing economies. A strong focus on exploration for gold and diamonds, coupled with declining levels of exploration spending, likely contributed to the temporary shortages of copper last year. Mineral exploration budgets increased throughout the early 1990s, reaching a peak of $5.2 billion in 1997 and then declining sharply after 1997. Exploration budgets reached a low of $1.9 billion in 2002 before rebounding to $5.1 billion in 2005. Prices of most mineral commodities rose sharply in 2004 .

4. State of the Minerals Professions

During the late 1990s, many large companies restructured to eliminate grass-roots exploration (exploration in untested areas where mineral deposits are not known to exist). In some cases, economic geologists who had been in these companies formed or joined junior companies; in other cases, they left the industry. The restructuring of mineral exploration

has most likely resulted in fewer exploration geologists funded by smaller exploration budgets.

Over the next 20 years, an increasing proportion of resources that remain to be discovered are likely to be in concealed deposits that lie beneath significant quantities of covering rock or sediments. Such deposits will be more difficult to discover and will likely be more costly to produce. Reorganization in universities that teach economic geology, mineral economics, and mining engineering has resulted in smaller academic departments to teach scientists and engineers needed to meet the technical challenges that will be presented by future mineral exploration and development.

5. Increased Scrutiny of and Restrictions on Mineral Extraction

Our study concluded that a further cause for concern about society's ability to produce the amount of minerals that will be needed by developing countries is the increasing social scrutiny of and restrictions on mineral resource extraction. In the United States, the amount of land open to mineral exploration has declined significantly since the passage of the original Wilderness Act in 1964. In addition, population growth in urban areas of the mountain west (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) has led to increased scrutiny of domestic mineral development projects. Scrutiny of mineral projects outside of the United States is also increasing as mineral-producing countries are demanding greater control over their natural resources.

6. Increased Environmental Residuals from Mineral Production and Use

Increased mineral consumption, increased residuals from mineral production and use, and disposal of mineral products that are implicit in the growth of developing economies will require the implementation of new strategies to reduce residuals from resource production and to increase recycling. On average, about 350 t of waste rock and 147 t of tailings are generated for each ton of copper produced. Assuming that grades of ore produced do not change, the model implies that mining and milling of copper ores will produce about 130 billion tons of waste rock and 56 billion tons of tailings between 2000 and 2020. Copper smelting can release both sulfur dioxide and arsenic to the atmosphere and hydrosphere. Amounts of these materials that might be released depend on the proportions of copper and arsenic that are processed by pyrometallurgical methods (using high temperatures to transform metals and their ores) and the technology employed in the smelter. The amount of waste rock and tailings are unlikely to be reduced unless copper ores are leached in place. The amounts of arsenic and sulfur dioxide released into the environment are more likely to be reduced by adoption of new technologies.

In addition to the residuals that are the direct result of producing commodities, there are residuals that enter the environment from use and final disposal of goods manufactured from the commodity. An increase in recycling could reduce the magnitude of these residuals.

To summarize, Mr. Chairman, our study concluded that although the world has abundant resources of copper, rapid increases in copper consumption can lead to temporary shortages of copper. Reasons for these temporary shortages may include: reduced investment in mineral exploration; a decline in the number of exploration geologists, mining engineers, and mineral economists; increased restriction on mineral extraction; increased environmental costs from mineral extraction and use; and increased costs of discovering new copper resources.

Thank you for the opportunity to discuss the growing demand for global mineral resources, such as copper. I am pleased to respond to any questions that you and Members of the Subcommittee may have.