New Collaboration in Minerals Research

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Each year nearly 25 tons of materials are produced for each resident in the United States. These essential commodities, ranging from metals to fertilizers to construction materials to coal, contribute about $500 billion to the U.S. gross domestic product. Even if it produced no mineral resources whatsoever, however, the United States would need to be at the forefront of mineral issues because it is the world’s largest consumer of mineral resources. Responsible and sustainable utilization of mineral resources is critical to societal well-being in the 21st century.

Nevertheless, the number of universities in the United States supporting research and teaching programs in economic geology and mining technology over the past two decades has declined precipitously. If current trends continue, within two decades there may be fewer than 10 U.S. universities with any geoscience faculty working on mineral deposits (down from greater than 50 in 1980).

In addition to the economic and other impacts, we face a disastrous loss in the technical expertise needed for our minerals-based society. Despite recommendations by the National Research Council and others, expansions to research and information-gathering efforts on mineral resources have not taken place, largely due to financial constraints.

A possible solution to this challenge is to foster the creation of collaborative mineral-resource research centers, involving universities, federal and state agencies, the mining industry, and other stakeholders. This approach has been very successful in Australia, with the industry-led Australian Mineral Industries Research Association (now known as AMIRA International) and the University of Tasmania-based Centre for Ore Deposit Research, which both maintain large programs and support many research projects worldwide.

Recognizing the opportunities that can come from cooperative interactions, the U.S. Geological Survey (USGS) has increased its involvement with universities and other organizations. Over the past 15 years, USGS has been increasing its presence on the University of Arizona (UA) campus. And it has cooperative agreements with the University of Nevada, Reno, and Eastern Washington University. At UA, the Center for Mineral Resources (CMR), operated under the auspices of UA and USGS, has sponsored collaboration on projects of mutual interest since 1992.

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CMR also has productive relationships with several mining companies. It has become clear to both UA and USGS that cooperative research partnerships are a cost-effective mechanism for leveraging the resources and strengths of the existing organizations.

Over the next five years, a significant number of USGS research positions will be moved to or created in Tucson. USGS expertise, in mineral resources, earth-surface processes and water resources, combined with UA’s internationally known programs, in mineral resources research, mining engineering, hydrology and related fields, present an exceptional opportunity to address a wide range of issues related to mineral resources. In addition, such research has application to issues as diverse as clean water supply, global climate change, natural hazards, ecosystems and human health — a natural complement to other research activities at UA and other regional universities. UA and USGS have also recently established the Earth Surface Processes Research Institute in Tucson.

In light of these developments, UA and USGS recently held a meeting to consider the needs for mineral resources expertise at all scales, from local to global and from years to centuries, and how the CMR might address these issues. In December 2003, 22 experts in mineral resources from government, academia and industry, including people from various offices of USGS, UA, the mining industry and researchers from Canada and Australia, attended a two-day meeting in Tucson. The purpose was to articulate a vision of the broad-based and long-term opportunities for mineral resources science, including a decade-scale plan for enhancing and sustaining an active, creative and collaborative mineral resources research community in Tucson and the western United States.

The workshop participants recommended that CMR focus on two multidisciplinary themes: mineral resource life cycles and regional metallogeny (the study of the origins of mineral deposits). Life cycles of mineral deposits and their products comprise the geologic systems that concentrate and redistribute materials in the crust, as well as the manifolds of human interaction with these materials, including mining and materials flow. These encompass major scientific questions that will fundamentally affect our global future.

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The participants also concluded that regional metallogeny is a major component of life cycle studies and is essential to mineral resource assessment, the discovery of new ore deposits and the issue of sustainable development. Conversely, the life cycle approach can serve as a planning framework for regional metallogeny studies. These studies can address the life cycle of mining within a district or region and include information on potential environmental problems, with suggestions for ameliorating them. Such studies are aimed at developing an understanding of the critical geological factors that explain the presence of ore deposit types within geologically defined areas. These factors underpin successful assessments of resource potential, as well as provide industry with key guides for exploration.

Some commitments presently in place are already building and enhancing the government and university collaboration in development in Tucson. UA has committed to the renewal of the existing cooperative agreement, which will be expanded to include disciplines beyond mineral
Molybdenum is a metallic element that is most frequently used in alloy and stainless steels, which together represent the single largest market for molybdenum. Molybdenum has also proven invaluable in carbon steel, cast iron and superalloys. Its alloying versatility is unmatched because its addition enhances material performance under high stress conditions, expanded temperature ranges and in highly corrosive environments. The metal is also used in catalysts, other chemicals, lubricants and many other applications.

Molybdenum does not occur in metallic form in nature. Although a number of molybdenum-bearing minerals have been identified, the only one of commercial significance is molybdenite — a natural molybdenum sulfide. Roasting plants convert molybdenite concentrate to molybdenic oxide (generally known as “tech-oxide”), which produces intermediate products, such as ferromolybdenum, metal powder and various chemicals. A unique feature of molybdenum, in contrast to other heavy metals, is the low toxicity of its compounds.

In World War I, molybdenum was widely used in steel as a replacement for tungsten, which was in short supply. The development of flotation technology to concentrate the molybdenite ore from a massive, disseminated porphyry deposit in Climax, Colo., which became the site of the world’s premier molybdenum mine.

After the war ended, the Climax Molybdenum Company established a research laboratory to expand the uses of molybdenum. Initial successes included the introduction of low-alloy steels into the automobile industry and development of a line of molybdenum-bearing high-speed and tool steels. After World War II, additional research resulted in development of markets for molybdenum-containing structural steel.

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About half of the world’s known reserves of molybdenum are found in the Western Cordillera of North America and South America. More than 95 percent of the world’s supply of molybdenum is mined from porphyry molybdenum deposits in which primary copper sulfides and/or molybdenite occur as disseminated grains and in stockworks of quartz veins. About half of the molybdenum mined worldwide comes from mines where it is the primary mineral produced, and the rest is recovered as a byproduct from copper mining.

Metallurgical applications dominated molybdenum use in 2003, accounting for about 80 percent of total consumption. In 2003, ferromolybdenum accounted for 39 percent of the molybdenum-bearing forms used to make steel, a 3 percent increase from that of 2002. In 2003, exports of molybdenum contained in materials (molybdenum content of exported molybdenum) were about 21,000 metric tons (t), valued at $168 million. Imports for consumption of molybdenum contained in materials (products) were about 10,500 t, valued at $125 million.

In 2003, U.S. mine production (molybdenum contained in concentrate) was estimated to be 34,100 t, a 5 percent increase from 32,600 t in 2002. World mine production of molybdenum in 2003 increased to 127,000 t, a 5 percent increase from 123,000 t in 2002. In descending order of production, the United States, Chile, China, Peru, Canada, Armenia, and Mexico provided almost 94 percent of the world production of molybdenum. The U.S. share of world production was 27 percent in 2003, the same as in 2002. Chile, China, and the United States also possessed about 85 percent of the estimated 19 million metric tons of molybdenum in the world reserve base.

Visit http://minerals.usgs.gov/minerals for more on molybdenum.