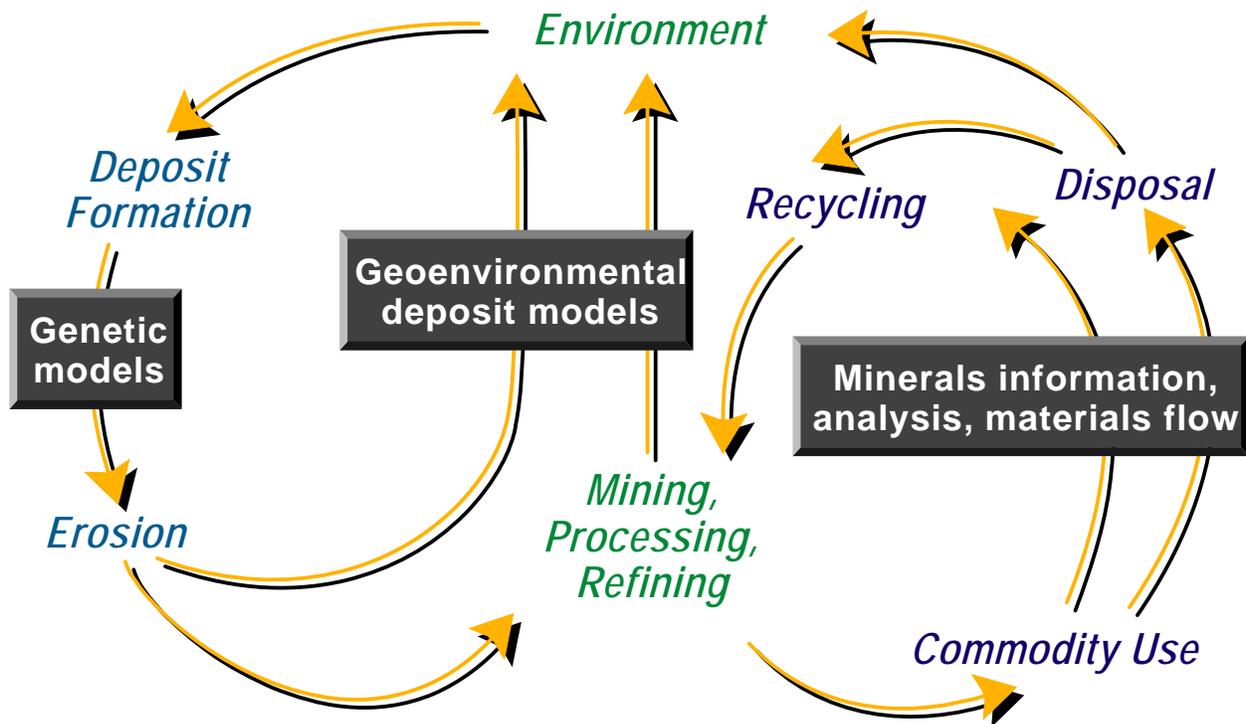




The U.S. Geological Survey Mineral Resources Program Five-Year Plan, 2006-2010



U.S. Department of the Interior
U.S. Geological Survey

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The U.S. Geological Survey Mineral Resources Program Five-Year Plan, 2006-2010

Executive summary

The United States is the world's largest user of mineral commodities and is currently experiencing growth in consumption and price increases in the non-fuel minerals industries. USGS Mineral Resources Program (MRP) is the sole Federal provider of scientific information for objective resource assessments and unbiased research results on mineral potential, production, consumption, and environmental effects. At the same time, MRP provides comprehensive baseline data for the United States in the fields of geochemistry, geophysics, and mineral deposits. These data are used by government agencies, academic research institutions, and the private sector to understand the composition of earth materials and changes in conditions of the Nation's lands over time. The MRP comprises two major functions: (1) a research and assessment function that provides information for land planners and decision makers about where mineral commodities are known and suspected in the Earth's crust and about the environmental consequences of the presence of those commodities and (2) a data collection, analysis, and dissemination function that describes current production and consumption of about 100 mineral commodities, both domestically and internationally for approximately 180 countries. The unique expertise developed by MRP over many decades in response to mineral-resource-related issues is now in demand to support applications such as public health research and remediation of effects of natural hazards.

Vision:

Through world-class research and information management, the MRP provides the nation and the world with the highest quality, most trusted scientific information related to mineral production and mineral resources as well as baseline information on composition and properties of earth materials across the United States and fosters the use of its analyses and information in national and international public and private policy arenas and decision-making.

Mission:

USGS Mineral Resources Program serves the Nation by providing timely and unbiased analyses and comprehensive information related to mineral resources and earth materials required to:

- Improve stewardship of public lands and resources;
- Formulate national and international economic and security policy;
- Sustain prosperity and improve quality of life; and
- Protect and improve public health, safety, and environmental quality.

Future science obligations for MRP include undertaking a new soil geochemical survey which is planned to meet the needs of a broad cross-section of earth science data users, ranging from those responsible for site-based remediation planning to minerals exploration companies

interested in quickly understanding the range of likely concentrations of trace metals in soils. Another exciting opportunity is in the first update of the 1995 national mineral resource assessment, which was the first ever quantitative assessment of potential for undiscovered mineral deposits for the United States. Completion of new national-scale databases should bring marked enhancements to that product and will provide land planners with the best possible basis for decisions regarding future mineral potential and will allow the federal government to assess national mineral needs and requirements.

The long-term goals of the Mineral Resources Program are designed to be ambitious but achievable, with metrics embedded so that progress can be readily measured. Each goal is supported by clear five-year goals for which success can be described in terms of both products and societal response. In all cases, the primary goal is to provide new scientific information that contributes to assuring security of supply of mineral commodities essential to society.

Long-term (greater than 5 years) goals of the Mineral Resources Program:

Research and Assessments

1. Ensure availability of up-to-date quantitative assessments of potential for undiscovered mineral deposits
2. Ensure availability of up-to-date geoenvironmental assessments of priority Federal lands
3. Ensure availability of reliable geologic, geochemical, geophysical, and mineral locality data for the United States

Continuing: Ensure availability of scientific facilities and services required to achieve MRP goals

Minerals Information

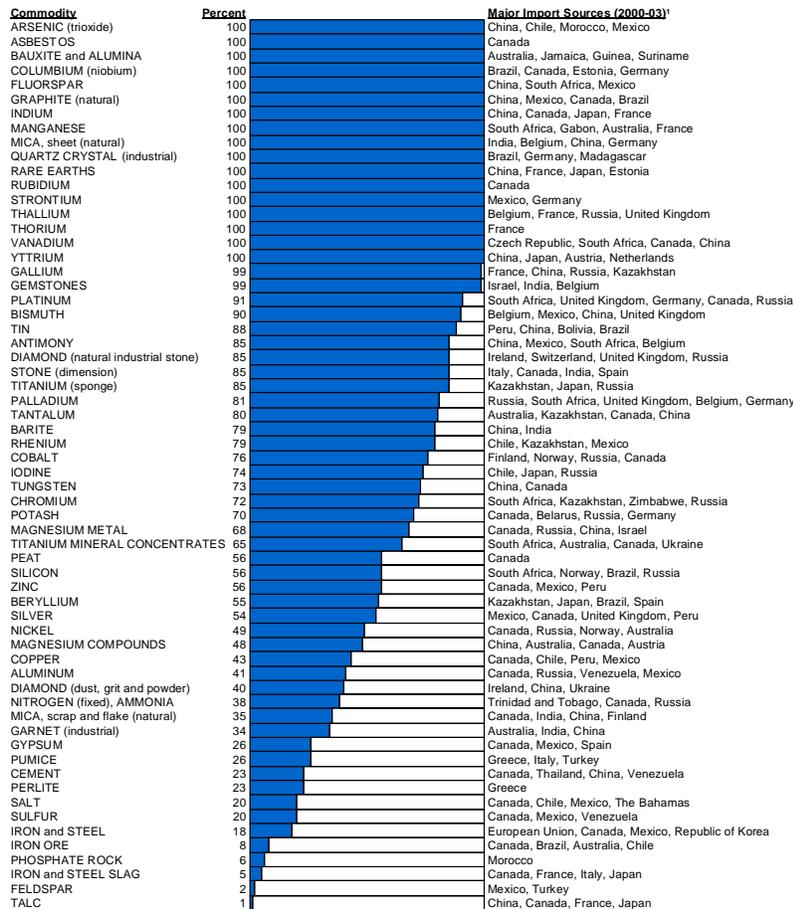
4. Ensure availability of long-term data sets describing mineral production and consumption for national security needs

Five-year goals are designed to move USGS forward in the realm of mineral resources by identifying activities in key areas of the minerals life cycle in which new information, targeted research, and state-of-the-art analyses can make the most difference.

Staffing and facilities challenges abound for MRP because of the wide range of skills required to conduct the program's work and because of many years of flat to declining budgets. MRP addresses these challenges in partnership with region and cost center management and has seen considerable success in these areas in recent years.

Introduction

The United States is the world's largest user of mineral commodities. Every year, about 25,000 lbs. of new non-fuel mineral materials from the earth must be provided for every person in the United States just to maintain our current standard of living (Dorr and Paty, 2002). Processed materials of mineral origin accounted for over \$418 billion in the U.S. economy in 2004 (an increase of 13 percent over 2003). U.S. manufacturers and consumers of mineral products that are critical to the U.S. economy depended on other countries for 100 percent of 17 mineral commodities (an increase of 6 percent over 2003) and for more than 50 percent of 42 mineral commodities (an increase of 8 percent over 2003). Making informed decisions about supply and development of mineral commodities requires current and reliable information about both mineral resources and the consequences of their development.



¹In descending order of import share

The US economy depends on importing significant percentages of 62 non-fuel mineral commodities from trading partners around the world (USGS, 2005, p. 6).

USGS Mineral Resources Program (MRP) is the sole Federal provider of scientific information for objective resource assessments and unbiased research results on mineral potential, production, consumption, and environmental effects. The MRP comprises two major functions: (1) a research and assessment function that provides information for land planners and decision makers about where mineral commodities are known and suspected in the Earth's crust and about the environmental consequences of the presence of those commodities and (2) a data collection, analysis, and dissemination function that describes current production and consumption of about 100 mineral commodities, both domestically and internationally for approximately 180 countries. Each function supports the other, and each meets the needs of different parts of the diverse community of mineral resource information users. Together these activities provide information ranging from that required for site specific land planning decisions to that required for national and international economic decisions.

The responsibility of the USGS for minerals information and research has evolved considerably since the Organic Act of 1879 established the USGS and defined its role as *classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain*. Factors affecting this evolution include changes in the Nation's political and social environment and advances in science and technology (National Research Council, 2001, p. 21-31). For example, expertise that was built in earlier eras to support the search for mineral resources now underpins essential public health-related research by providing systematic information on the composition of earth materials Programs successfully completed in the last 125 years form the basis for the information and expertise with which the MRP will respond to the issues that face our Nation in the next century.

Historical background

Clarence King, the first Director of the USGS, faced an enormous challenge when he set about establishing the bureau in 1879. USGS historian Mary Rabbitt describes the year in which the Survey was established as *one of great monetary uncertainty, when knowledge of precious-metal resources was vital, and one in which the iron and steel industry faced problems in obtaining suitable raw materials, while information about the Nation's mineral wealth, mining and metallurgical techniques, and production statistics was meager* (Rabbitt, 1989, p. 11).

As a result, the focus of the early work of the USGS was on mining geology and included comprehensive studies of the geology and technology of three great mining districts: Leadville in Colorado and the Comstock and Eureka in Nevada. The diversity among these three mining districts provides a look at the range of challenges facing mining in the United States in the late 1800s. The Leadville mining district was just coming into production. The Eureka mining district was in its prime and thought to be completely developed. It was also the subject of litigation about what constituted a lode in terms of mining law. The Comstock mining district was near the end of its production life; when it was studied by the USGS, \$300 million in bullion had been removed from the district. The results of these studies provided guidance to miners on where to look for new deposits and helped investors select prospects. Two years after the USGS was established, the success of reports like these prompted Congress to broaden the agency's purview beyond Federal land to all U.S. lands.

USGS Director King recognized the importance of mineral statistics to the economy of the United States. Realizing that the closure of the quicksilver (mercury) mines in California could significantly affect production at a great number of gold mines in Georgia where mercury was used to recover gold, King advocated the need for mineral statistics. The scope of information necessary to make mineral statistics useful justified the collection and analysis at the Federal level of government. King did not limit the collection of mineral statistics to production data; he envisioned the collection of sample locality descriptions, geologic settings, and mineralogical and chemical data as well. These early data collection activities provided the beginnings for the large databases currently supported by MRP. Although responsibility for collection and maintenance of minerals information has been moved in and out of the USGS over the years and the types of statistics that are collected, analyzed, and disseminated have changed over time, the need for accurate minerals information persists, and meeting the need is currently an important function of MRP.

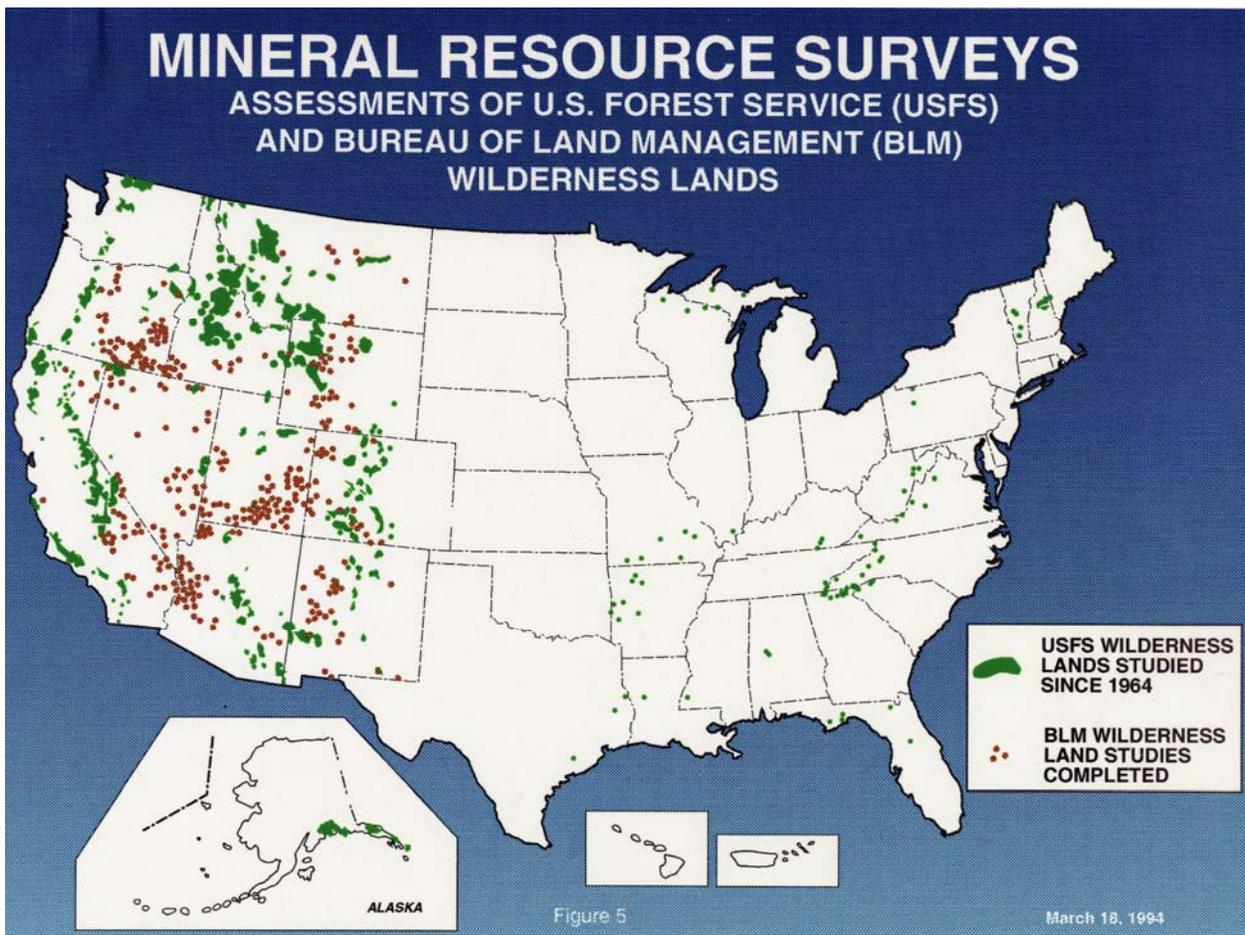
In 1904, the USGS report highlighting the first 25 years of the bureau recorded that *Alaska was purchased from Russia in 1867 for \$7,200,000, but for thirty years it remained practically forgotten. The events of 1898 revived public interest in the Territory, but general knowledge of it*

is still very limited (USGS, 1904, p. 33). In 1895, Congress appropriated \$5,000 for the investigation of the gold and coal deposits of Alaska, but interest in Alaska truly blossomed in 1898 when rich gold deposits were discovered in the Klondike region, triggering a massive gold rush. Interest in mineral resources has remained high in Alaska, and the USGS has supported major mineral investigations over the years. Large-scale projects to assess potential for undiscovered mineral deposits in Alaska began in the 1960s and continue to the present. These large-scale mineral resource assessments have resulted in the identification of a number of areas with mineral potential and, in at least one instance, led to development of a major mine, TeckCominco's Red Dog Mine, the largest zinc mine in the world.

World War I changed popular views on mineral resources. When war broke out in 1914, it was assumed that the conflict would last only a short time. The United States was believed to lack adequate supplies for its needs in only five minerals—tin, nickel, platinum, nitrates, and potash. But the war disrupted normal trade, threatening European allies who relied heavily on the United States for steel, copper, and explosives. By the time the United States entered the war in 1917, the concept of the identification of sources of strategic minerals had been born as it became clear that domestic supplies of key commodities were inadequate in quantity, quality, or both. In support of the war effort, mineral geologists were sent throughout North, Central, and South America in search of strategic minerals. In 1938, strategic mineral investigations were begun with funds from the Public Works Administration. The Strategic Minerals Act, passed in June 1939, appropriated funds for strategic minerals studies only days before the beginning of World War II.

In the post war era, interest in strategic minerals remained high, but there was a renewed focus on assessing the mineral resource potential of Federal lands. The concept of wilderness areas that were closed to development, including mining, had been formalized by the U.S. Forest Service in 1924 with the designation of the Gila Wilderness in the Gila National Forest, New Mexico. The Wilderness Act of 1964 designated 54 National Forest System areas as wilderness (9.3 million acres) and required a study of each area as to its suitability or nonsuitability for wilderness. In addition, included in the provisions of the Wilderness Act was a requirement for the Secretary of the Interior to direct mineral surveys of suitable areas under his jurisdiction in the National Park

and National Wildlife Refuge Systems. In 1965 the USGS began mineral resource assessments of the areas designated in the Wilderness Act; work on those areas was completed in 1983. However, the requirement for mineral surveys was repeated in subsequent land acts and understood to apply to many others acts and many areas managed by Federal land management agencies. Faced with the requirement to provide mineral resource assessments for huge tracts of land, USGS mineral scientists have developed genetic and empirical mineral deposit models and used those models as the basis for revolutionary methods and techniques to perform quantitative mineral resource assessments. These mineral deposit models and mineral resource assessment techniques and methods have been updated over the years and continue to be an area of cutting edge research in MRP.



Locations of mineral resource assessments conducted between 1964 and 1994 in partnership with Federal land management agencies in support of decisions regarding designation of wilderness areas.

In the mid- to late-twentieth century, a number of laws were enacted that reflected the growing awareness of and concern about environmental contamination, both naturally occurring and related to abandoned mine lands. Techniques and methods that had been developed in MRP to support the large-scale mineral-resource assessments were essential to the effort to understand geoenvironmental concerns related to the thousands of abandoned mines that exist on Federal lands administered by the Departments of the Interior and Agriculture. Scientists supported by MRP have been crucial contributors to the interdisciplinary effort to understand environmental degradation associated with abandoned mine sites and continue to supply accurate information to land managers who administer the Federal lands. Understandings of the processes behind observed problems are being applied well beyond the boundaries of Federal lands, both domestically and internationally, and the MRP-funded research is now contributing systematic information required to support a broad range of public health and ecosystem research objectives.

The last decade of the twentieth century saw rapid evolution of powerful techniques for management, visualization, and dissemination of large data sets; this evolution continues in the twenty-first century. Because of its increasing reliance on descriptive and quantitative geospatial data, MRP has invested heavily in data conversion and standardization, as well as in development of data delivery tools that put high quality data and information directly into the hands of partners in land management, other government agencies, private industry, and academia. As these tools become more sophisticated, and as MRP's partners and customers become more able to access the data when and where they require it, USGS research results will be increasingly useful to a diverse group of partners and customers.

The most recent MRP five-year plan was released in November 1999, following a review of the program by the National Research Council in 1996, transfer of the minerals information function from the defunded Bureau of Mines, development of the USGS Geologic Division Science Strategy (Bohlen and others, 1998), and several rounds of internal review and investigation of opportunities for future work. That plan was broad in its coverage and general in its description of program work. The science goals established for MRP at that time were:

Goal 1: Understand the geologic setting and genesis of the Nation's mineral resources in a global context, in order to ensure a sustainable supply of minerals for the Nation's future.

Goal 2: Understand the influence of mineral deposits, mineralizing processes, and mineral-resource development on environmental integrity, ecosystems, public health, and geologic hazards.

Goal 3: Provide objective information and analysis related to minerals issues to support those who make decisions regarding national security, land use, resource policy, and environmental or public health and safety.

Goal 4: Collect, compile, analyze, and disseminate data and develop and maintain national and international databases for timely release of information to all users.

Goal 5: Apply mineral-resource expertise and technologies to non-mineral-resource issues.

All projects funded by MRP since 1999 have addressed one or more of these goals and considerable progress has been made in each. Success in working towards these broad goals has made possible this new five-year plan, which provides clear expectations against which MRP's progress can be measured.

Major authorizing legislation

43 U.S.C. 31 et seq., the USGS Organic Act includes instructions that the USGS is to *classify the public lands and examine the geological structure, mineral resources, and products within and outside the national domain.*

16 U.S.C. 1131, the Wilderness Act of 1964 and numerous subsequent related Acts require the USGS to assess the mineral resources of each area proposed as wilderness or established as wilderness.

16 U.S.C. 3141 et seq., The Alaska National Interest Lands Conservation Act of 1980, section 1010 of the Act requires that the Secretary of the Interior assess the oil, gas, and other mineral potential, and expand the minerals database, for all public lands in Alaska. These responsibilities have been delegated to the USGS and assigned to MRP.

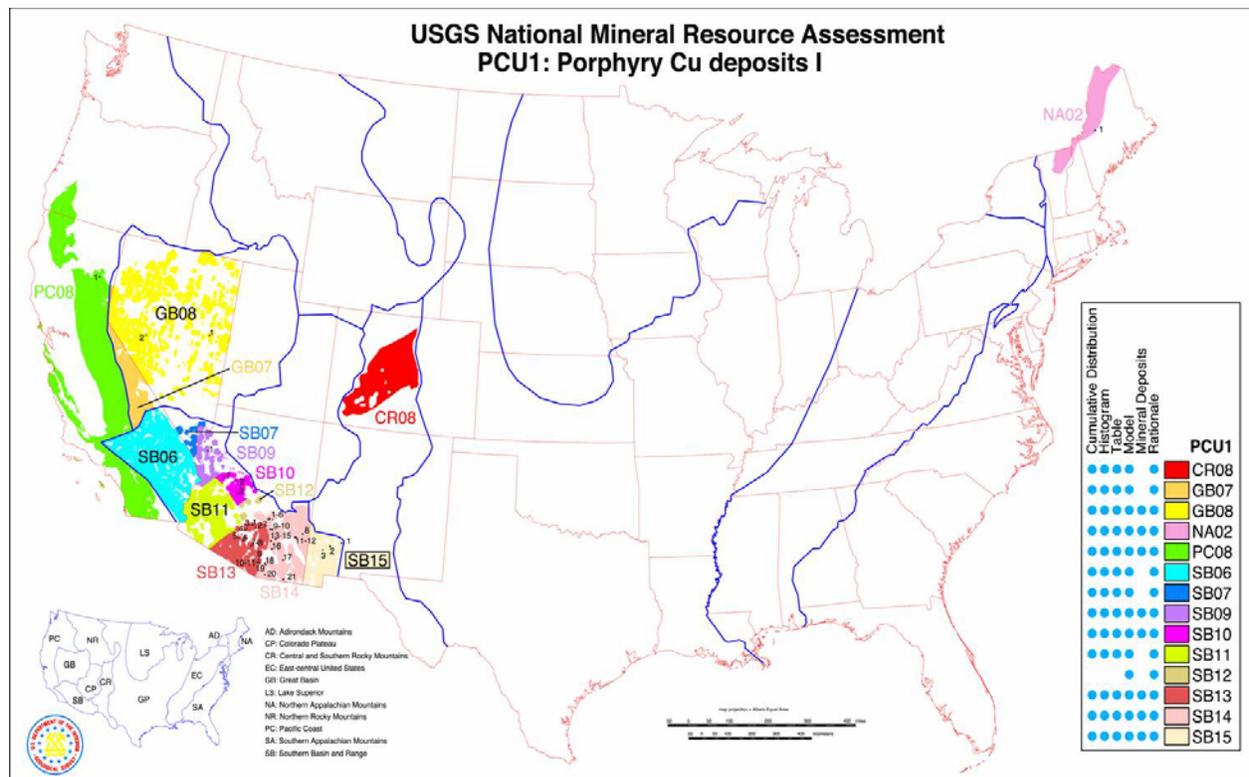
30 U.S.C. 1601 et seq., The Mining and Minerals Policy Act of 1970 and The National Materials and Mineral Policy, Research and Development Act of 1980 reemphasize the responsibility of the USGS to assess the mineral resources of the Nation.

16 U.S.C. 1600 et seq., Forest and Rangeland Renewable Resources Act of 1974, as amended by the **National Forest Management Act of 1976.** USGS is a party to an interagency agreement with Forest Service to assess the mineral resources of National Forests.

50 U.S.C. 98, The Strategic and Critical Materials Stock Piling Act of 1946 as amended by its **Revision Act of 1979**. Section 8 of the Act supports the Survey's programs for assessment of domestic minerals, especially for strategic and critical minerals, to complement the Federal mineral stockpile program.

Description of future initiatives and scientific directions

MRP anticipates finishing several large bodies of work during the life of this five-year plan. As funds and staff are freed up through project completion, opportunities are created to fund new priority work. Completion of national geologic, geochemical, geophysical, and mineral locality databases will make room for a much-anticipated national soil geochemical survey. At the same time, availability of the newly completed national databases will make possible a meaningful revision of the 1995 first-ever national mineral resource assessment of the United States



The 1995 USGS National Assessment determined that for gold, silver, copper, lead, and zinc as much metal remains to be discovered as had been discovered in 1995. Updates to this first-ever assessment, using new data and enhanced methods, will begin in FY 2010.

Similarly, current research in industrial minerals will be completed during the term of this plan. Next generation research will likely be aimed at providing process understandings required to make mineral deposit models and then mineral resource assessments for deposits of commodities required by emerging technologies. Rare metals such as ruthenium and indium were not in demand until recently, but now it is clear that the demand is likely to grow, and MRP must prepare to provide process understandings about how deposits of these and related commodities are formed as well as assessments of potential for undiscovered deposits both within the US and around the world.

These evolutionary shifts in program focus are much aided by cost center and regional interaction with customers and collaborators across the Nation and around the world. As the needs of land managers, other Federal agencies, partners in industry and non-governmental organizations, and academic colleagues are brought to light, program shifts are made in response. This synergy between regional and program management also helps to identify where on the landscape projects can be conducted most successfully and achieve greatest benefit.

Mission and long-term goals

Vision:

Through world-class research and information management, the MRP provides the nation and the world with the highest quality, most trusted scientific information related to mineral production and mineral resources as well as baseline information on composition and properties of earth materials across the United States and fosters the use of its analyses and information in national and international public and private policy arenas and decision-making.

Mission:

USGS Mineral Resources Program serves the Nation by providing timely and unbiased analyses and comprehensive information related to mineral resources and earth materials required to:

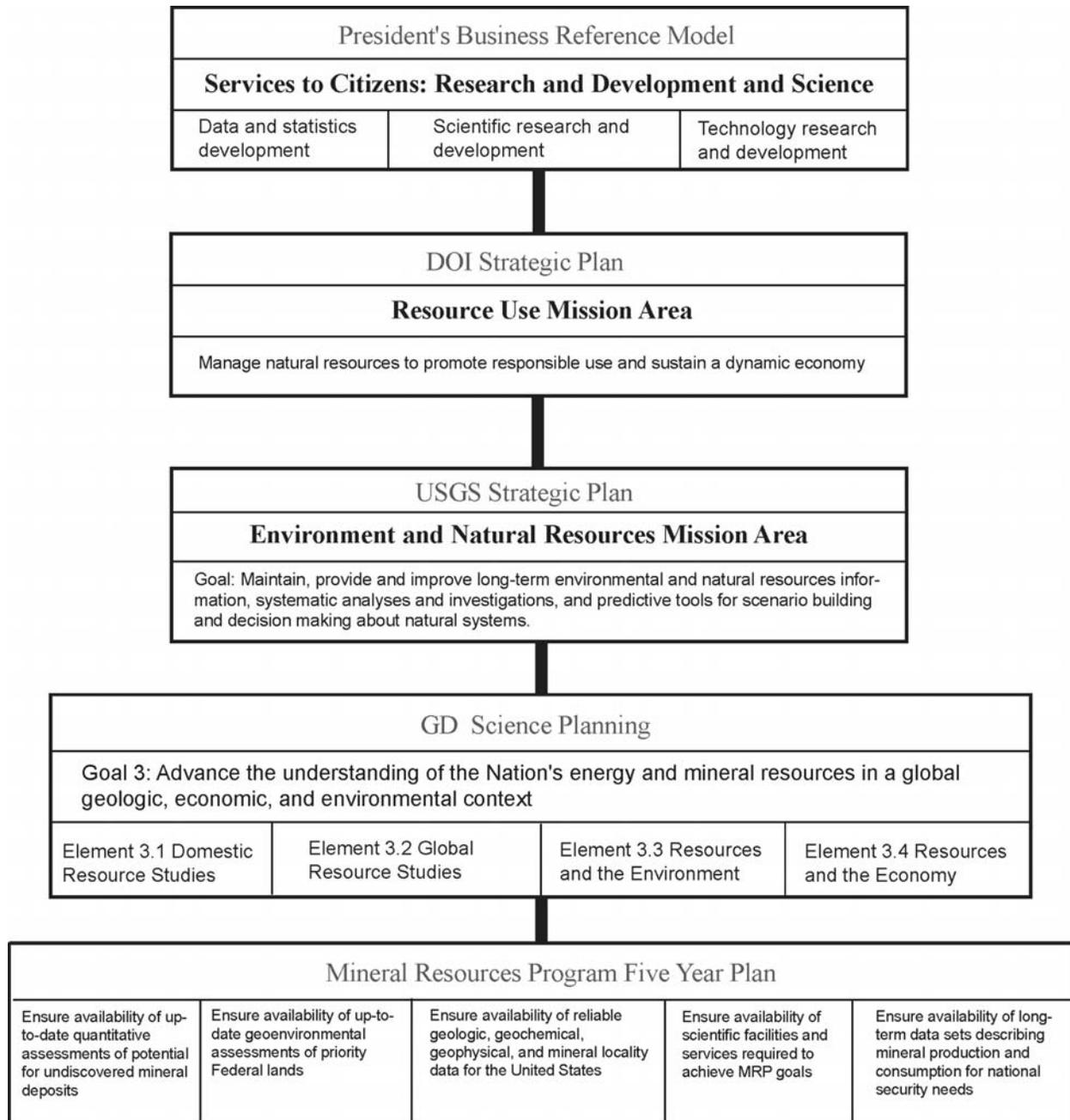
- Improve stewardship of public lands and resources;
- Formulate national and international economic and security policy;
- Sustain prosperity and improve quality of life; and
- Protect and improve public health, safety, and environmental quality.

The USGS Mineral Resources Program responds to the President's Business Reference Model, the Department of the Interior Strategic Plan (U.S. Department of the Interior, 2003), the USGS Strategic Plan, and the Geologic Discipline Science Strategy (Bohlen and others, 1998). The Department of the Interior's mission is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities. The Mineral Resources Program supports the DOI Mission of protecting and managing the Nation's non-fuel mineral resources and provides scientific information about those resources. The MRP mission is consistent with:

- DOI's Strategic Plan mission area Resource Use, in which the strategic goal is Manage natural resources to promote responsible use and sustain a dynamic economy; the end outcome goal is Manage or influence resources to enhance public benefit, promote responsible use, and ensure optimal value – Non-energy minerals; and strategy 4 is Improve information base, resource management and technical assistance;
- the USGS mission: *Provide the Nation with reliable, unbiased information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy and mineral resources; and enhance and protect our quality of life; and*
- the Geology Science Strategy goal 3 – *Advance the understanding of the Nation's energy and mineral resources in a global geologic, economic, and environmental context.* In addition, because MRP houses most of USGS' expertise in geochemistry of solids and potential field geophysics, selected MRP-funded staff and projects contribute to three additional goals identified by Bohlen and others (1998): goal 5 – *Establish the geologic framework for ecosystem structure and function;* goal 6 – *Interpret the links between human health and geologic processes;* and goal 7 – *Determine the geologic controls on ground-water resources and hazardous waste isolation.*

As described in the Program Assessment Rating Tool (PART) review, the MRP role is clearly defined and unique from other Federal, State, local, or private entities. The MRP was reviewed in FY 2003 for the FY 2005 budget using the PART and was found to be working effectively

with partners and fulfilling its missions, and, as a result, received a score of 80. The details of the PART review of MRP are available on pages 209-222 of the document found at <http://www.gpo.gov/fdsys/pkg/BUDGET-2006-BUD/pdf/BUDGET-2006-BUD-19.pdf>



MRP's goals in relation to key strategic documents, as of November 2005.

In its most recent review of the MRP, the National Research Council (2003) identified four federal roles in mineral science and engineering, which are described briefly in the following table:

Role ¹	Rationale (examples)
an unbiased national source of science and information	Government agencies need information in carrying out their regulatory and administrative responsibilities; Federal government has a unique role in addressing issues of national jurisdiction and significance (mineral assessments and databases)
basic research on mineral resources	Basic research would most likely be underfunded if left solely to the private sector; government agencies have national jurisdiction, long-term continuity, large multidisciplinary teams of scientists, and highly specialized facilities (geoenvironmental models and mineral deposit research)
advisory	Federal agencies need to make public policy decisions relating to mineral issues; if required information were not available from USGS, similar expertise would have to be developed within the individual agencies; USGS serves as a national source of unbiased and impartial advice; in times of crisis interdisciplinary expertise can contribute to solutions of a variety of problems (World Trade Center dust studies; rescue of Quecreek miners)
international—undertaking or supporting international activities that are in the national interest	Facilitating more diversified sources of certain minerals; using mineral activities to support economic development and poverty alleviation in the poorest regions of the world; opportunity to provide technical advice and assistance in developing nations (global mineral resource assessment)

The long-term goals of the Mineral Resources Program are designed to be ambitious but achievable, with metrics embedded so that progress can be readily measured. The NRC’s outline of roles for federal scientists in the realm of mineral resources and earth materials makes it clear

¹ National Research Council, 2003, p. 24-28.

that the need for unbiased scientific information should be the common thread linking all MRP activities. Each of the long-term goals listed here meets that basic test: each strives to provide an essential component of scientific information required to underpin a secure supply of non-fuel minerals for the United States.

Long-term (greater than 5 years) goals of the Mineral Resources Program:

Research and Assessments

1. Ensure availability of up-to-date quantitative assessments of potential for undiscovered mineral deposits
2. Ensure availability of up-to-date geoenvironmental assessments of priority Federal lands
3. Ensure availability of reliable geologic, geochemical, geophysical, and mineral locality data for the United States

Continuing: Ensure availability of scientific facilities and services required to achieve MRP goals

Minerals Information

4. Ensure availability of long-term data sets describing mineral production and consumption for national security needs

MRP works for a balance between basic and applied research that provides world-class earth science research and data for policy and decision makers, land managers, other federal and state agencies, the mineral resources industries, foreign governments, nongovernmental organizations, academia, other scientists, and the public. Program funding is allocated for projects whose products further the stated goals and adjusted as required to accommodate increases or decreases in staffing, fixed costs, and overall funds availability.

Prioritization of specific projects undertaken in support of the research and assessment goals is based on five characteristics. Preference will be given to

- commodities for which current and future supplies are not secure,
- commodities for which increased demand is anticipated,

- deposit types that have highest likelihood of occurring on U.S. Federal lands,
- deposit types that have largest economic or environmental impact, and
- proposals to work on lands where access is not an issue and cooperation from land owners or managers has been secured.

In addition, MRP allocates funding (\$250,000 in FY 2005) to an external grants program, Mineral Resources External Research Program (MRERP), in support of its long-term and five-year goals. Beginning in FY 2006, applicants to this program will be required to demonstrate how their proposed research will assist MRP in reaching the goals outlined in this plan.

Applicants are particularly encouraged to identify linkages with existing MRP-funded projects and are provided with project descriptive material with which to identify linkages. This grants program offers an opportunity to attract scientists with skills and interests not available within the USGS workforce and provides support for applied research in economic geology and related fields.

Recipients of MRERP grants, FY 2004 and 2005

Principal investigator(s)	Affiliation(s)	Proposal title
Michael Brown, Boswell Wing, and Sarah Penniston-Dorland	University of Maryland	Petrogenesis of the Platreef, Bushveld Complex, South Africa, Interrogated Using Mass-Independent Sulfur Isotopes
John Dilles	Oregon State University	The mineralogy and origin of hydrothermally altered Quaternary volcanic rocks on the south flank of Lassen volcano, California
Lang Farmer	University of Colorado	Petrogenesis of Cretaceous, Gold-Related Plutons, Eastern Tintina Gold Province, Alaska and Yukon: Implications for Ore Genesis and Resource Distribution in the Northern Cordillera
Richard Fifarek	Southern Illinois University, Carbondale	Magmatic fluid evolution during the transition from porphyry Cu-Au to high sulfidation Au-Ag deposits: Fluid inclusion evidence from the Pierina (Peru) and Summitville (USA) deposits
Paul Layer and Rainer Newberry	University of Alaska, Fairbanks	A long-term effort to determine ⁴⁰ Ar/ ³⁹ Ar ages of Alaskan mineral deposits
Reed Lewis and Jeffrey Vervoort	Idaho Geological Survey, University of Idaho, and Washington State University	Identification of Proterozoic basement domains southwest of the Belt-Purcell basin, northern Idaho
Edmond Mathez	American Museum of Natural History	Investigations of the Geochemical Evolution of the Stillwater Complex and Origin of Platinum Group Element Deposits from Analysis of Lead Isotopes
Joann Mossa	University of Florida	Geospatial analysis of channel planform change in mined river floodplains: Impacts and implications for resource extraction policy

Paul Mueller and David Foster	University of Florida	Relationship of Lithospheric Age and Composition to Mineral Resources Within, Beneath, and Adjacent to the Belt Basin
Philippe Ross and James Ranville	Colorado School of Mines	Evaluating the influence of soil geochemical characteristics on metal bioavailability
James Saunders and Willis Hames	Auburn University	Geochronology of Volcanic-Hosted Low-Sulfidation Au-Ag Deposits, Winnemucca-Sleeper Mine area, Northern Great Basin, USA
Aaron Slowey and Gordon Brown	Stanford University	Environmental Chemistry of Mercury in Sulfidogenic Sediments: A Key to Understanding the Ecological Impact of Mercury and Gold Mining

Five-year goals

Research and Assessments

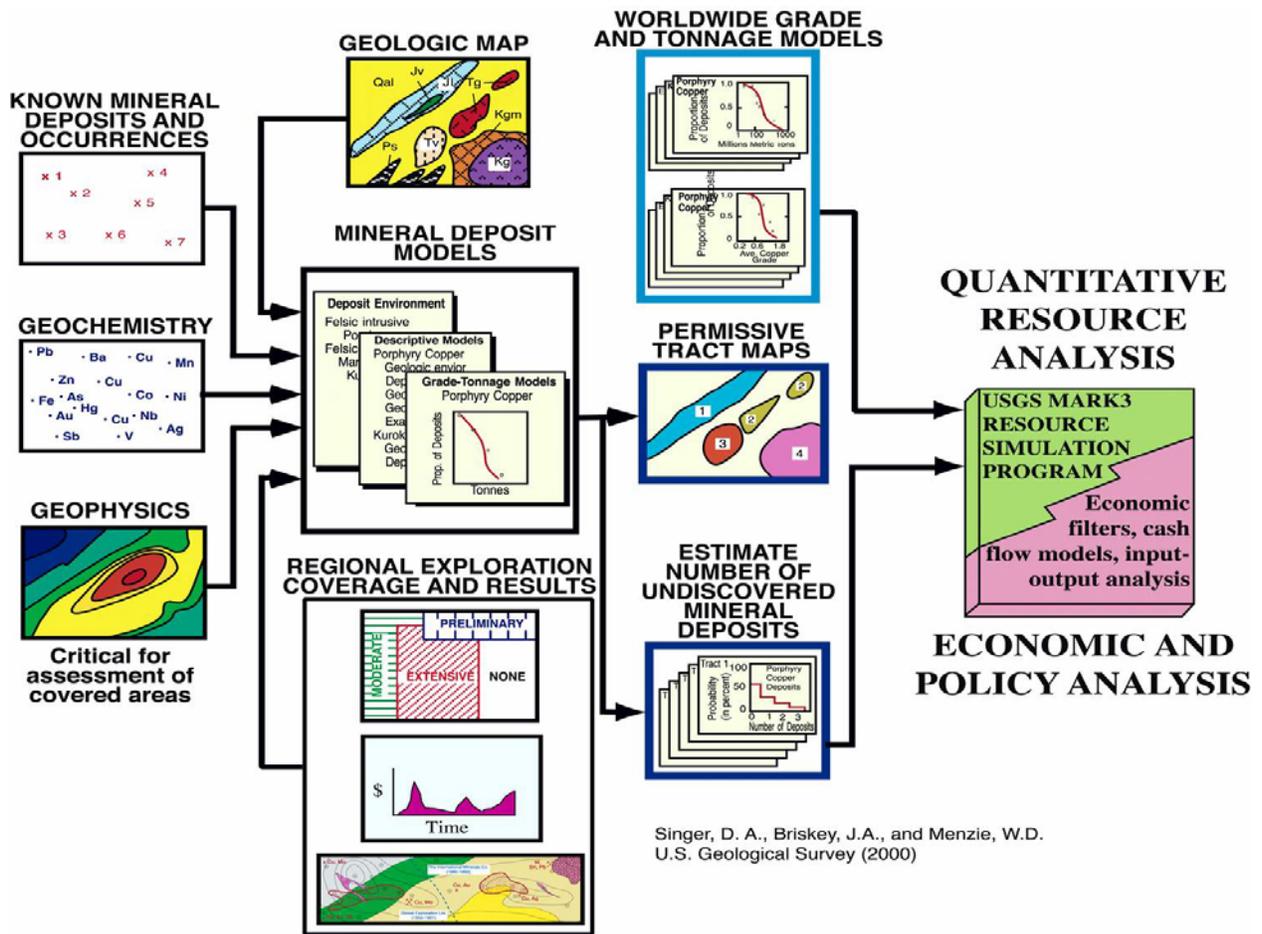
Long-term goal 1: Ensure availability of up-to-date quantitative assessments of potential for undiscovered mineral deposits

Five-year goals:

- 1.1. Complete quantitative global mineral resource assessment for copper, potash, and platinum group elements (approximately \$2.5 million/year through FY 2009, decreasing to \$1.25 million in FY 2010)
- 1.2. Meet Federal land managers' need for timely mineral resource information (in central Colorado: approximately \$2 million/year through FY 2007, then approximately \$500,000 in FY 2008; in next identified priority area, approximately \$1.6 million in FY 2008, increasing to about \$2 million in FY 2009 and FY 2010)
- 1.3. Conduct research targeted at reducing uncertainty in mineral resource assessments (approximately \$7.5 million/year)
- 1.4. Begin consultation, planning, and data gathering required to update the 1995 National Mineral Resource Assessment (approximately \$100,000 in FY 2009, increasing to \$750,000 in FY 2010)

Making wise choices that lead to a secure supply of mineral commodities requires information regarding the locations, quality, and quantity of resources. MRP provides unbiased earth science information, culminating in quantitative mineral resource assessments, to address challenges in securing mineral resource supplies for the United States and to address the minerals-related

information needs of other Federal agencies. Much of the early work of preparing for an assessment, no matter what the scale, involves research that results in reliable basic data required to understand the geologic history and characteristics of the area to be assessed. With these data in hand, interdisciplinary teams of experts analyze everything available with a goal of identifying characteristics suggestive of undiscovered mineral deposits and offering clues to location, quality, and quantity of undiscovered deposits.



Modern mineral resource assessments rely on integration of fundamental geologic data, mineral deposit models, expert analysis, and statistical modeling. The result is quantitative information that can be used as part of economic and other policy analyses.

Both scientists and decision makers are challenged by the uncertainty associated with the current state-of-the-art in mineral resource assessments. For this reason, MRP funds considerable research aimed at reducing uncertainty. Among the sources of uncertainty in amounts of economic resources are: number of undiscovered deposits, possible locations of these deposits, and possible grades and tonnages of the deposits. To reduce uncertainty in spatial locations and

probability of occurrence of undiscovered resources, MRP will conduct regional geologic and/or metallogenic studies of significant mineralized terranes. Present assessments delineate lands based on geologic settings that are small on a national basis but broad from the standpoint of local land management. This research is aimed at reducing the spatial uncertainty of resource locations in order to improve stewardship of public lands and resources.

A second type of uncertainty underlying quantitative mineral resource assessments is uncertainty in genetic models for many types of mineral deposits. This uncertainty varies significantly amongst different deposit types and metallogenic provinces. These genetic factors include: (1) a lack of understanding of the sources of metals, ligands, and fluids that form the deposits, (2) the tectonic and structural controls on fluid flow, ranging from regional to deposit scales, (3) the phenomena driving fluid circulation, (4) the timing and duration of deposit formation, and (5) phenomena that control the concentration of metals in ore-forming fluids and the mechanisms by which these metals are precipitated. To reduce the uncertainty in the genetic models of mineral deposits used for quantitative mineral resource assessments, MRP will conduct genetic studies of important deposit types and their geologic environments, using the priorities outlined on page 16.

Modern assessments are quantitative and estimate quantities, values, and locations of undiscovered mineral resources in a form that conveys both economic viability and uncertainty associated with the resources. Unbiased information on the distribution of undiscovered mineral resources is needed in order to understand the consequences of their possible exploitation. Although the USGS has been the world leader in quantitative estimation of undiscovered mineral resources, opportunities exist to make significant improvements with new and refined methodologies that can reduce the large uncertainties in the estimates.

The fundamental ingredients of undiscovered mineral resource estimation are the number of deposits, their grades and tonnages, and their locations. For many deposit types, general locations and grades and tonnages have been fairly well captured by proper use of mineral deposit models, including grade and tonnage models. Estimating numbers of undiscovered mineral deposits has been less completely specified. Emerging research demonstrates that estimates can be based on frequencies of deposits per unit of permissive area in control areas

(mineral deposit density models) in the same way that grade and tonnage frequencies are models of sizes and qualities of undiscovered deposits. Planned research, including work on new deposit density models with stochastic processes and spatial distributions of deposits, offers tools for increasing specification of these estimates.

Because most undiscovered resources in the United States (and many other countries) are not exposed at the earth's surface, it is necessary to explicitly address the added uncertainty in predicting locations of resources that lie under non-mineral bearing rocks, dense vegetation, or other types of cover. Research is needed to develop and test a system that can spatially predict geologic settings related to deposit types under cover based on geophysics and extrapolated geology and geochemistry. This work will necessarily rely on multivariate methods and perhaps probabilistic neural networks to estimate probabilities of different geologic settings associated with different deposit types. Research on structural or tectonic settings of mineral deposits by type is also needed to more specifically locate more likely sites of mineralization. The overall objective is to more accurately predict locations of undiscovered mineral resources.

Delineating possible locations of undiscovered mineral deposits requires the integration of disparate geologic data sets. This task has typically been done by experts because of the complexity of dealing with different scale maps, sampling densities, and kinds of data. Substantial research is needed for the seamless integration of disparate geologic data to make unbiased estimates in quantitative assessments.

Preliminary research suggests that perhaps the greatest opportunity for reducing uncertainty in assessments lies in lowering uncertainty associated with tonnage estimates of undiscovered deposits. Selecting the correct deposit model is the most important way of controlling errors because mineral deposit models are the best-known predictor of tonnage. Research is necessary on ways to reduce the tonnage uncertainty within deposit types in order to reduce the substantial uncertainty that remains when deposit type is known.

Another area in which there is considerable uncertainty is in assessments for scarce metals such as rare-earth elements, platinum, ruthenium, and indium. These metals are increasingly used in

new technologies such as advanced batteries and fuel cell electronic vehicles and in every-day devices such as cell phones, video monitors, and some diodes. The market for many of these rare metals is expected to grow at a high rate for the foreseeable future. Many of these metals are also critical raw materials for a number of developing alternative energy and information technology markets. The high demand for them is likely to result in constraints on the availability of some of these materials in coming years because there are presently few suppliers and therefore high prices of many of these materials. MRP research in industrial mineral commodities will transition toward understanding how deposits of these rare metals are formed and what characteristics they have that can be used in mineral resource assessments.

Successes in frontier technologies such as electronics and alternative energy production depend both on breakthrough research and on the availability of advanced materials. In order to identify which rare mineral materials might adversely affect success in advanced technology fields MRP intends to hold a workshop in FY 2006 where external technology experts will interact with internal USGS economic geologists. We expect to use this forum to identify the needs and opportunities where MRP can have a significant effect. The workshop in FY 2006 will be used to define new project proposals and guide their selection and start in FY 2007.

Research by MRP that reduces the uncertainty in mineral resource assessments will spur consideration of alternative geologic settings for all mineral materials and encourage increased diversity of supply and, as a result, help sustain prosperity and improve quality of life.

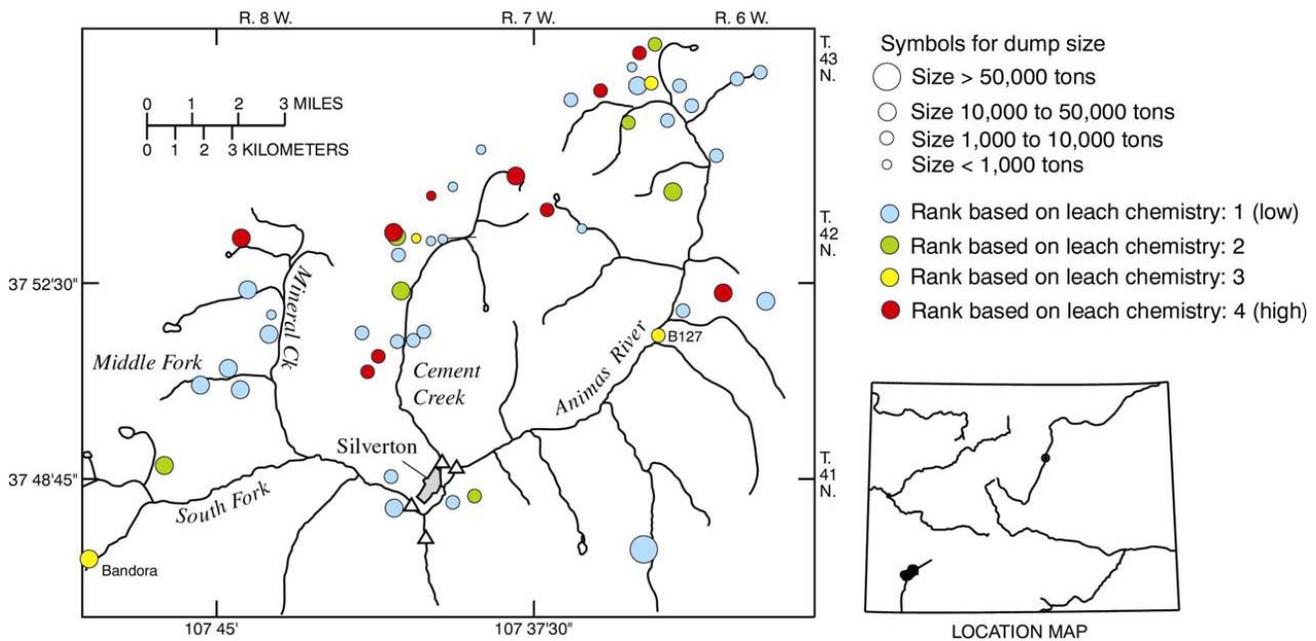
Long-term goal 2: Ensure availability of up-to-date geoenvironmental assessments of priority Federal lands

Five-year goals:

- 2.1. Develop protocols for geoenvironmental models and complete geoenvironmental models for priority deposit types (approximately \$1 million in FY 2006, decreasing to \$750,000 thereafter)
- 2.2. Complete prototype geoenvironmental assessment of priority lands identified by Federal land managers (approximately \$1 million/year)

2.3. Conduct research targeted at reducing uncertainty in geoenvironmental models and assessments (approximately \$2.7 million in FY 2006, decreasing to \$2 million by FY 2010)

In their short report titled *Mineral Resources and Sustainability*, the National Research Council identified seven key challenges for earth scientists. One of those challenges is *To use basic science to improve environmental management and restoration ecology associated with mining and mineral processing* (National Research Council, 1996b). The discussion specifically identifies environmental ore-deposit models as the tool required to meet this challenge. USGS scientists have begun the process of developing models of this type.



Remediation priorities for abandoned mine sites in the Animas Basin, Colorado were based on empirical studies of characteristics such as dump size and leach chemistry (among others). New research on geoenvironmental models will provide a framework for this kind of analysis, as well as permitting prediction of future states of mined and unmined lands (modified from Fey and others, 2000).

During the life of this plan, MRP will develop priority geoenvironmental models, test them in a prototype assessment, and conduct research necessary to reduce uncertainties arising from lack of understanding of the processes that occur when mineral deposits are exposed at the earth's surface, whether by natural erosion or by mining.

Models describing the environmental geochemistry of unmined and mined mineral deposits and mine wastes provide a powerful tool to anticipate environmental challenges with unmined deposits and to characterize environmental challenges associated with abandoned mines. Such insights are invaluable to land management agencies with responsibility for permitting new mines, reclamation of abandoned mine lands, and contributing to the maintenance of sustainable mineral supplies at minimal costs to the environment. At present, geoenvironmental models are largely empirical and descriptive. The lack of quantification and the limited number of completed case studies inhibit their predictive capability.

The potential environmental challenges associated with new mine development and the environmental impacts of abandoned mines result from the complex interplay of a variety of chemical and physical processes, many of which are mediated by micro-organisms. To plan for improved mitigation of future mines and to remedy existing threats to human health, ecosystems, and water resources, a thorough understanding of the underlying processes and their interactions is required. Increased understanding of necessary processes and links between them can best be addressed by focused studies involving investigations into the release, transport, and fate of metals and related compounds, by the use of multidisciplinary approaches, and by the use of emerging techniques to trace the behavior of metals and related compounds throughout the cycle of release, transport, and fate. Within the USGS, several programs in the Water and Biologic Resources Disciplines have parallel interests, including Toxic Substances Hydrology, Biological Contaminants, the National Water-Quality Assessment, and the National Research Program. None of these programs focuses directly on metals and associated compounds related to mineral resources, but each has goals, skills, and capabilities that complement MRP's work. Therefore, the results of this research will contribute to activities within the Water Resources and Biologic Resources disciplines. Some projects will be accomplished through collaboration with researchers working with related programs elsewhere in USGS' Geology, Water Resources, and Biologic Resources Disciplines.

Environmental challenges associated with as-yet undeveloped deposits and abandoned mines begin with the complex oxidative weathering of sulfide minerals, which releases metals and acid to the environment. The current understanding of these processes is dominated by laboratory

studies of selected minerals conducted under highly controlled conditions, or by case studies of complex, individual field sites, for which a variety of processes may be occurring simultaneously. Increased understanding of these processes, particularly the ability to predict their significance under conditions outside the laboratory or closely monitored field sites, will require integrated approaches. New research will target additional mineral systems or their components, in the laboratory under a greater variety of conditions, additional field systems of selected ore-deposit types in selected climatic settings, and the development of methods to relate quantitatively laboratory studies to field settings.

The greatest limitation of an empirical approach as a predictive tool is the lack of data for all relevant deposit types in all of the relevant climatic or hydrologic settings. To overcome this obstacle, the primary climatic factors controlling these environmental signatures, such as temperature and amount of precipitation, must be identified and their roles must be more completely understood to enable predictions beyond the confines of the empirical database of selected deposit types and climatic settings. The database currently under construction for the geoenvironmental models effort should incorporate quantitative climatologic and hydrologic data for specific sites included in the database to facilitate the identification of the links between hydrologic and climatic setting to environmental response. This activity is essential for building quantitative predictive models from the current set of empirical descriptive models.

Long-term goal 3: Ensure availability of reliable geologic, geochemical, geophysical, and mineral locality data for the United States

Five-year goals:

- 3.1. Complete data collection for all four data types at a scale suitable for regional analysis (approximately \$2.5 million in FY 2006)
- 3.2. Complete regional analysis using newly populated data sets (approximately \$900,000 in FY 2006; almost \$3 million in FY 2007 and beyond)
- 3.3. Conduct research resulting in basic geologic, geochemical, geophysical, and mineral potential information for frontier areas of the United States (approximately \$3.2 million/year)

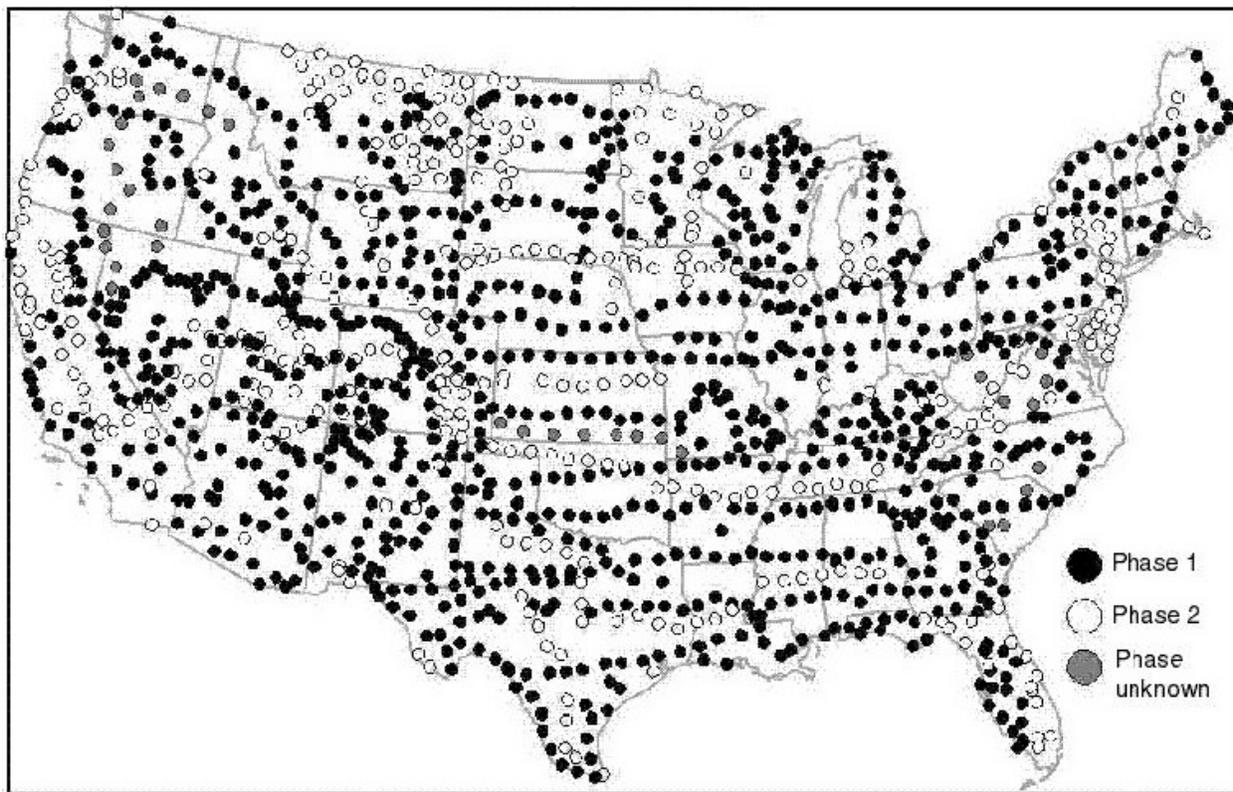
- 3.4. Establish peer-reviewed protocols for a new soil geochemical survey of the United States and begin sample collecting phase (approximately \$1 million in FY 2006, increasing to approximately \$3 million in FY 2010)
- 3.5. Maintain and disseminate databases for geologic, geochemical, geophysical, and mineral locality data (approximately \$1.7 million/year)

Two recent National Research Council reports pointed to the importance of documenting national geochemical baselines and backgrounds as a basis against which to measure ecosystem status in the future (National Research Council, 1996a, p. 33-36; National Research Council, 2001, p. 112). MRP undertook this challenge beginning in FY 1997 and expects to complete data collection in FY 2006 and 2007. The data are being made available via the World Wide Web when quality assurance and quality control procedures are completed. Analysis of these rich new data sets by USGS scientists and others will provide tools for recognizing the most environmentally challenged parts of the country, as well as for establishing realistic remediation goals that are specific to local conditions. Having these data will significantly improve MRP's next national mineral resource assessment (see long-term goal 1), and will assist land managers with identifying site-specific anomalies as they plan for development of roads, mine sites, quarries, and other infrastructure. These basic data are essential to MRP's continued progress in improving the information base from which DOI can manage or influence resource use (U.S. Department of the Interior, 2003, p. 39)

Many areas in the United States have been well studied and have modern geologic maps, recent geochemical and geophysical surveys, and up-to-date inventories of known mineral localities. However, Alaska has these critical data for only select areas. The bulk of the state is genuinely a frontier area with respect to geologic information. For example, regional scale geologic data for large tracts of the state (e.g., much of southwestern Alaska) is based on reconnaissance studies completed 30 or more years ago. Geochemical stream-sediment sample sites for parts of the state are so widely spaced (e.g., 1 per 100 mi²) that metallogenic trends cannot be recognized. Airborne geophysical data were collected along flightlines spaced no closer than 6 miles over large areas. The mineral endowment of large tracts of Alaska is thought to be high based on what little is known, but less uncertainty in resource estimates requires data of all kinds at larger map scales. Collection of new baseline geologic, geochemical and geophysical data in these regions

has the high probability of revealing undiscovered mineral resources that will add to the Nation's mineral supplies.

With the completion of national-scale data collection for stream-sediment geochemistry in FY 2006 and 2007, MRP has the opportunity to address a challenge identified by the National Research Council (NRC) in its report *Evolutionary and Revolutionary Technologies for Mining* (2002, p. 21). In that report, the NRC stated that increased efficiencies could be realized in minerals exploration if there were a more thorough understanding of the *complex processes that result in soil formation and the behavior of various elements in different soil types*... In addition, they noted that *research in soil science could produce significant spin-offs that would affect geochemical exploration and would contribute to a more thorough understanding of soil ecology for agriculture*. Other opportunities in soil science include increased understanding of how organisms concentrate metals, and understanding how the presence of specific organisms or suites of organisms can be used as indicators of processes occurring in soils.



The only comprehensive, national-scale soil geochemical data for the US result from opportunistic collection of 1,323 samples at these sites between 1958 and 1976. MRP and partner agencies have begun the process of determining how best to update this critical data set using modern sampling and analytical methods, in order to provide baseline data essential to understanding variability in chemical composition of the Nation's soils.

These challenges can be addressed by MRP scientists and partners from other Federal agencies, academia, and state geological surveys as part of a planned new national soil geochemical survey. A collaborative planning process began with a workshop in FY 2003 and continues through pilot studies underway through FY 2006. By the end of FY 2006, MRP intends to have convened a review panel to identify research opportunities that will be available when new data are available using the protocols for sample collection, analysis, and sample and data management. Migration of funds towards this activity will begin in FY 2007, with a goal of allocating enough funds so that routine sample collection, the most costly part of national-scale database development, can begin. Total time required to complete sample collection and analysis will depend on funding.

Continuing goal: Ensure availability of scientific facilities and services required to achieve MRP goals

- C.1. Geochemical research and development laboratories (approximately \$2.5 million/year)
- C.2. Geophysical research and development laboratories (approximately \$900,000/year; more would be desirable)
- C.3. Project-level geographic information systems and information management (approximately \$2.6 million/year)

Research and data collection in MRP require support from state-of-the art analytical and geospatial laboratories that provide consistent, quality assured analyses and spatial data used in mineral resource and mineral environmental investigations. Analytical techniques, methods, and standards developed by these labs are relied upon and support work by other national and international labs. These labs conduct essential basic and applied research in methods of analysis required to meet MRP goals. In addition, they provide quality assurance and quality control for MRP's routine chemical analyses that are contracted out to major commercial firms.

Minerals Information and Analysis

Long-term goal 4: Ensure availability of long-term data sets describing mineral production and consumption for national security needs

Five-year goals:

- 4.1. Provide timely and authoritative data and information, including data on production, trade, and industry structure, on industrial minerals, international minerals, and metals to Government and private decision makers and the public (approximately \$11 million/year)
- 4.2. Provide timely and authoritative data and analyses of the minerals cycle, issues related to sustainable development, and materials flow to private and Government decision makers and the public (approximately \$2.5 million/year)
- 4.3. Convert minerals information canvass forms to electronic formats (approximately \$250,000/year through FY 2008)

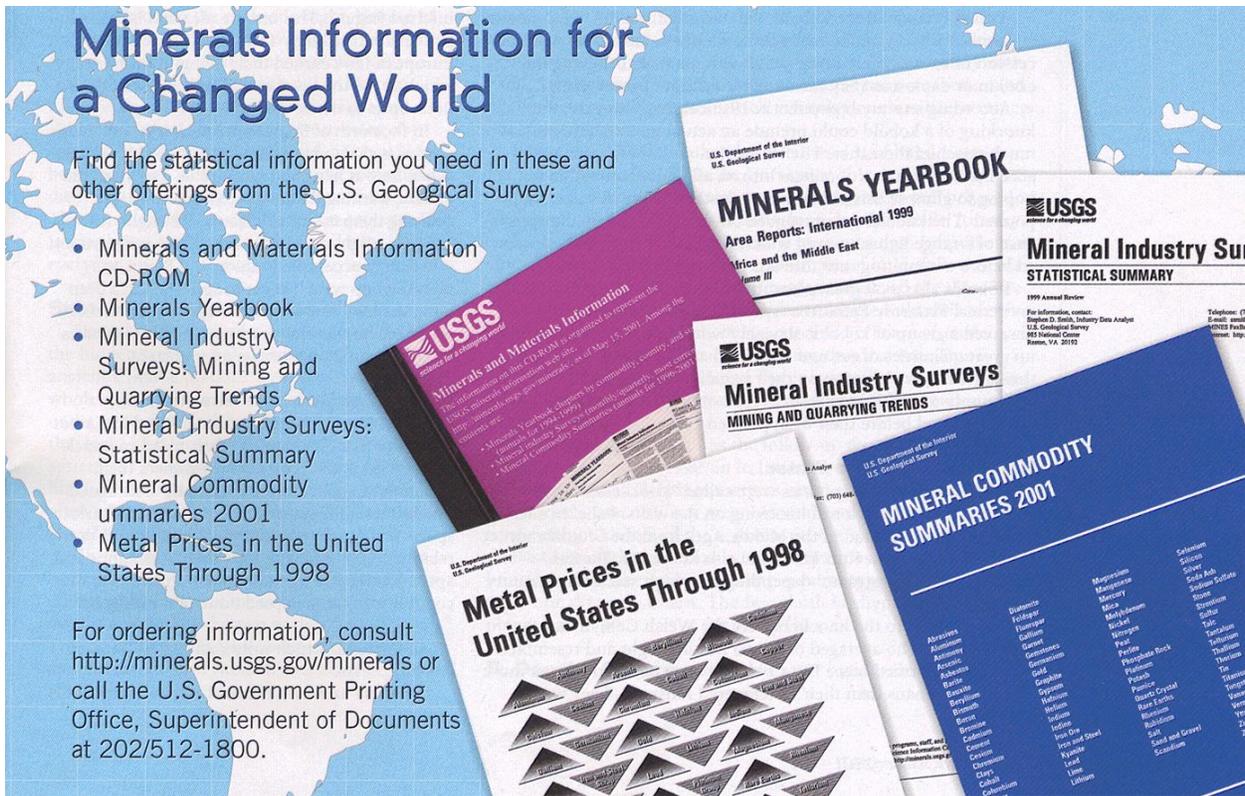
MRP's ongoing minerals information activities include canvassing the non-fuel mining and mineral processing industry in the United States for data on mineral consumption, recycling, inventory stocks, and shipments. Projects also collect and publish production data, trade data, and other information for about 100 commodities and 185 countries. MRP publishes aggregated statistics in about 725 monthly, quarterly, semiannual, annual, and special reports such as the Minerals Yearbook and the Mineral Commodity Summaries. Finally, mineral commodity and country specialists provide expert information on the mineral industries and markets to government agencies, private companies, trade associations, academia, and the general public.

Minerals Information for a Changed World

Find the statistical information you need in these and other offerings from the U.S. Geological Survey:

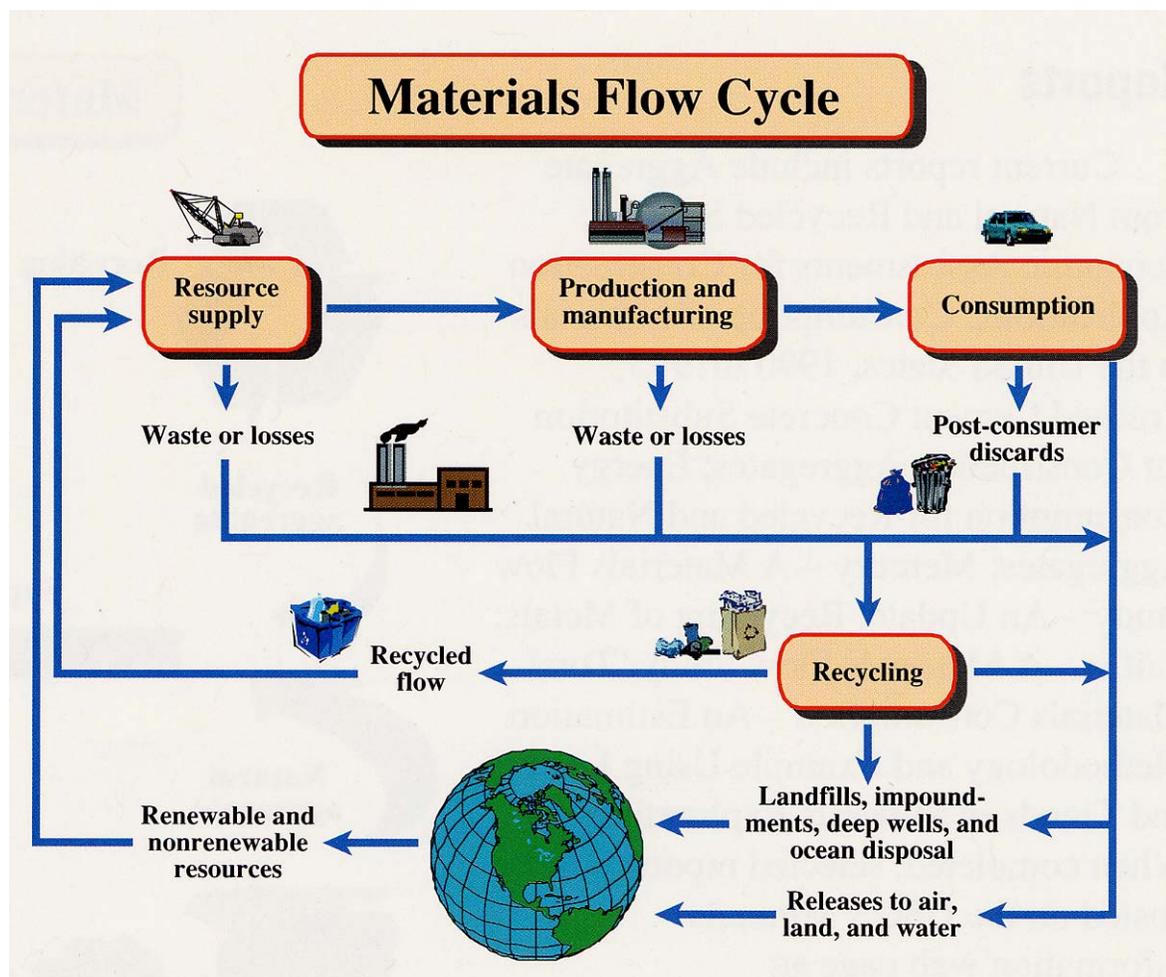
- Minerals and Materials Information CD-ROM
- Minerals Yearbook
- Mineral Industry Surveys: Mining and Quarrying Trends
- Mineral Industry Surveys: Statistical Summary
- Mineral Commodity Summaries 2001
- Metal Prices in the United States Through 1998

For ordering information, consult <http://minerals.usgs.gov/minerals> or call the U.S. Government Printing Office, Superintendent of Documents at 202/512-1800.



Following the tragic events of September 11, 2001, USGS minerals information publications were highlighted by the National Mining Association in their monthly publication, Mining Voice, in October 2001.

In addition to continuing the collection, analysis, and publication of basic information on the production and use of mineral commodities, MRP anticipates expanding its research and analysis of minerals and materials life cycles and future uses of minerals and materials. Examples of this type of work include materials flow studies of individual commodities, increased emphasis on analysis of data on the international trade of minerals and mineral products, and investigation of the use of minerals in critical emerging technologies. This work will build upon the basic data collection and topical studies such as *The New Materials Society*. In addition, future efforts will more explicitly emphasize the role that minerals play in the economic and physical security of the Nation by expanding collaboration with other Federal agencies.



Mineral materials flow through the economy on pathways that are generally similar to many other materials; USGS research identifies specific pathways for individual non-fuel mineral commodities as well as linkages between commodities.

MRP conversion of minerals information canvass forms to electronic formats satisfies one portion of the USGS response to the Government Paperwork Elimination Act (GPEA). The project has challenges in both staffing and funding but has made good progress to date (July 2005) and is scheduled for completion in 2008. This work is one part of what is required to ensure that the minerals information required by the Nation is collected, managed, and made available using the most up-to-date technologies available with current funding constraints.

Current MRP activities in the sphere of minerals information and analysis are built on a long tradition of voluntary collaboration between the U.S. government, private sector mineral producers, and governments of many other countries. The precise nature of the information collected and analyzed, the commodities for which data are collected, and the number and content of publications through which these data are made available have changed with changes

in need, technology, and funding. During the life of this plan (FY 2006-2010) significant adjustments are anticipated in both the products of this function and the organization through which those products are created. The objectives will remain the same: to provide the Nation with the most important information on the most significant commodities, in formats that meet customer and partner needs, and in a timely manner. In FY 2006, MRP will work with regional management to consult with Federal, private, and academic partners on priorities and opportunities in the realm of minerals information and analysis. Acting on the results of those consultations, regional management will make such adjustments as are necessary to ensure that the highest priority data are provided in a manner consistent with available funding.

Performance measures

Completion of the work described in the five-year goals identified in this plan will provide the Nation with a wide array of high quality scientific information related to mineral production and mineral resources, as well as baseline information on composition and properties of earth materials across the United States. This information and analyses derived from it will be used in national and international public and private policy arenas and decision-making. The variety of products produced crosses the entire spectrum of the minerals life cycle, from descriptions of the processes by which mineral deposits are formed right through to analyses of the economic effects of recycling non-fuel mineral commodities.

MRP is the sole USGS program addressing DOI's Resource Use strategic goal of managing non-energy resources to enhance public benefit, promoting responsible use, and ensuring optimal value of non-energy minerals (U.S. Department of the Interior, 2003, p. 39). The long-term and five-year goals outlined in this document will result in outputs and outcomes that satisfy this DOI goal, and also meet the goals established in the OMB PART process, and the USGS and Geologic Discipline strategic plans.

To clearly measure USGS progress in meeting these goals, four outcome measures were identified in partnership with DOI and OMB and designed to roll up into the intermediate goal of improving the information base, information management, and technical assistance. These measures are:

- percent of the United States with geologic, geochemical, geophysical, and mineral locality data;

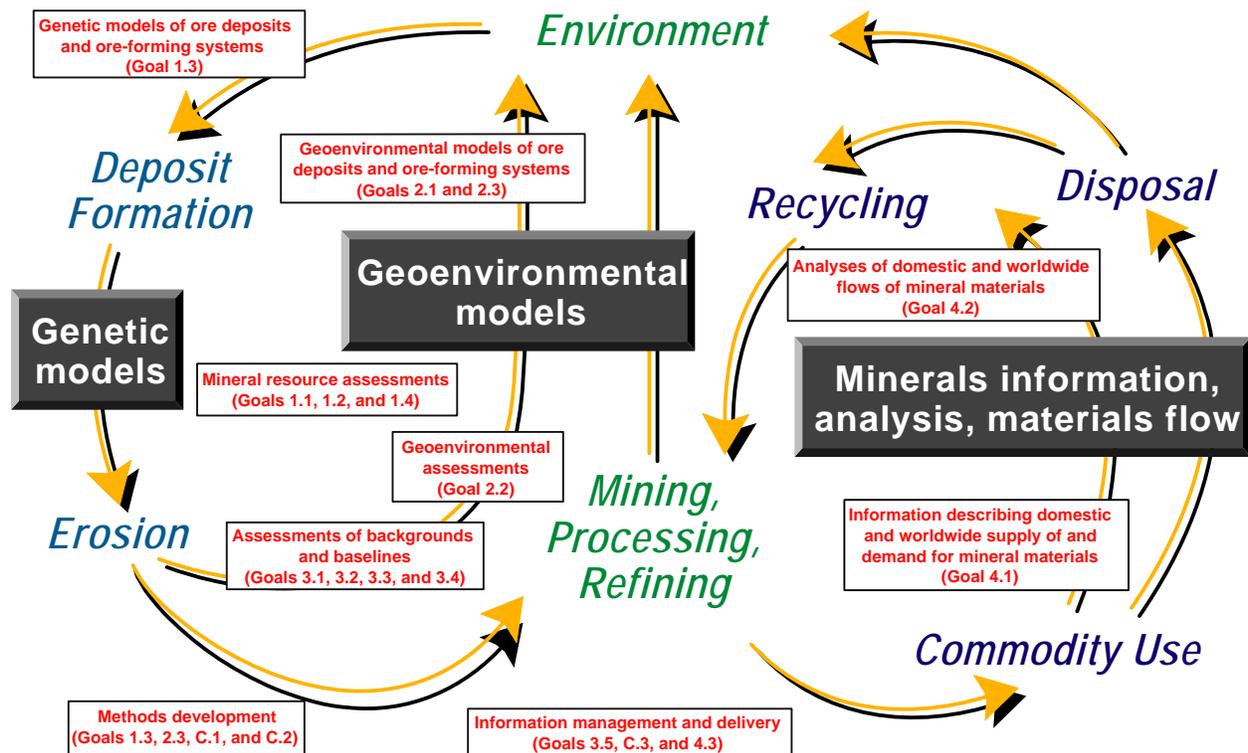
- percent of customers satisfied with the timeliness of data;
- percent of customers who have their minerals data needs met; and
- percent of studies validated through appropriate peer review or independent review.

Outputs that are reported quarterly and measured annually reflect both the research and assessments and minerals information functions and include

- number of systematic analyses and investigations delivered to customers,
- number of cumulative gigabytes of data managed,
- number of formal workshops or training provided to customers,
- number of mineral commodity reports available for decisions, and
- percent of targeted analyses delivered which are cited by identified partners within 3 years after analysis delivered.

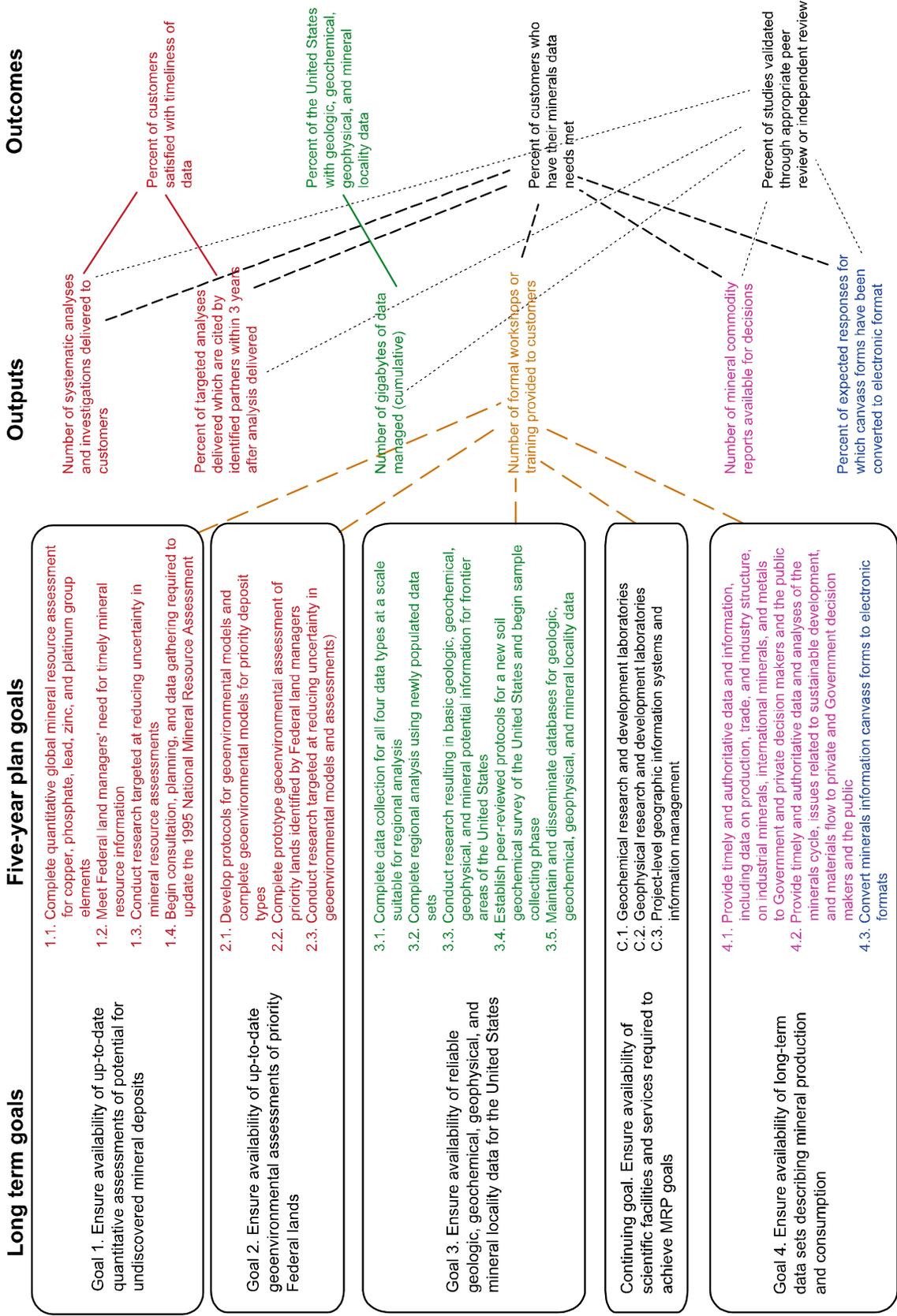
Two efficiency measures are tracked:

- percent of expected responses for which canvass forms have been converted to electronic format, and
- average cost of a systematic analysis or investigation.



Life cycle of mineralized systems, showing products and goals of this five-year plan for MRP.

U.S. Geological Survey, Mineral Resources Program, Goals and measures, FY 2006-2010



Linkages between goals outlined in this plan and performance measures

Budget and performance integration

The section describing the five-year goals for MRP contains funding information for each goal, based on the assumption of flat funding to MRP over the life of this plan. The distribution of funds allocated reflects programmatic priorities, expected availability of staff, and estimates of investments required to achieve the identified five-year goals. The following table summarizes anticipated funds outlays for the life of this plan. It demonstrates USGS' intention to maintain emphasis on (and funding for) assessing potential for undiscovered mineral deposits, to decrease emphasis on geoenvironmental assessments, to increase emphasis on providing essential baseline data for the United States, and to maintain level funding for required scientific facilities and for long-term databases on mineral production and consumption. Annual targets for the performance measures to which MRP reports (see section above) will reflect these adjustments in funding.

	Anticipated funding level (\$1,000s)				
	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Long-term goal 1: Ensure availability of up-to-date quantitative assessments of potential for undiscovered mineral deposits	12,100	12,300	12,100	12,000	11,700
Long-term goal 2: Ensure availability of up-to-date geoenvironmental assessments of priority Federal lands	4,750	4,300	4,100	3,900	3,700
Long-term goal 3: Ensure availability of reliable geologic, geochemical, geophysical, and mineral locality data for the United States	9,400	9,650	10,050	10,350	10,850
Continuing goal: Ensure availability of scientific facilities and services required to achieve MRP goals	6,000	6,000	6,000	6,000	6,000
Long-term goal 4: Ensure availability of long-term data sets describing mineral production and consumption	13,600	13,600	13,600	13,600	13,600
Fixed costs	6,700	6,700	6,700	6,700	6,700
Total	52,550	52,550	52,550	52,550	52,550

This budget scenario provides no funds for increased costs associated with salary and facility cost increases. For this reason, each year at this funding level will require a decrease in productivity; these decreases will be cumulative and by 2010 will result in fewer staff and fewer products delivered.

In addition to reporting on performance, MRP uses the system developed by DOI's National Business Center to capture cost data and relate those costs to the DOI Strategic Plan (U.S. Department of the Interior, 2003). The Activity Based Cost/Management (ABC/M) system is a management tool that provides information about the cost of doing work and how work aligns with the Department's strategic objectives (U.S. Department of the Interior, 2005). ABC/M provides information on: unit cost of production of all DOI work activities, cost of executing goals and strategies in DOI's strategic plan, performance against targets, minimum efficient workload, predicting costs for changing workloads, and organizations where cost efficiency needs to be improved.

MRP-funded project work is coded to USGS-specific work activities, through which project work is tied to the Department's strategic plan. Beginning in FY 2006, codes will be assigned to individual tasks within projects, to provide more specific reporting of the types of work undertaken, their costs, and their association with MRP performance measures and DOI strategic goals. The table below demonstrates the connections between work activities (as codified in the ABC code definitions), outputs (the things that are measured in the performance measures described in the section above), and funding. The funds data shown are for FY 2005, the second year for which data are available. We expect to see significant changes in FY 2006 because of the shift to task-level coding. Coding at the project level, as was required in FY 2004 and FY 2005, makes it impossible to separate research from the mineral resource and mineral environmental assessments that are the reason for the research. Similarly with project level coding it is not possible to identify technical assistance that is provided in the course of conducting assessments to aid in specific land planning processes.

Department of the Interior Mission Area: Resource Use			
Strategic Goal: Manage resources to promote responsible use and sustain a dynamic economy			
End Outcome Goal: Manage or influence resource use to enhance public benefit, promote responsible use, and ensure optimal value—Non-energy minerals			
Strategy 4: Improve information base, information management, and technical assistance			
Work Activity	Code	Output	Percent of total funds (FY 2005)
Collect data to inform decisions on mineral resources	F7	# of gigabytes (annually)	9.1
Conduct assessments to inform decisions on mineral resources	N0	Analyses and investigations delivered	12.3
Conduct research to inform decisions on mineral resources	N1	Analyses and investigations delivered	56.1
Manage and distribute data to inform decisions on mineral resources	U8	# of cumulative gigabytes accessible (prior years + current)	9.3
Plan/evaluate programs to inform decisions on mineral resources	19	Plans, evaluations, reports	1.4
Provide technical assistance to inform decisions on mineral resources	Y6	Technical assistance instance, issue, or event	0.9
Manage non-energy mineral programs	44	(indirect work activity, not associated with an output)	10.9

Program review

MRP employs many approaches to seeking feedback on the value of its research and data collection and the effectiveness of its products. Information on these issues is sought in many places and through many mechanisms, including: (1) soliciting NRC reviews every 5-7 years, (2) customer surveys every 3 years, (3) meeting with customers at scientific and technical meetings, (4) initiating direct contact with customers particularly when projects are planned or are concluding, (5) collection and analysis of web statistics, (6) convening and/or contributing to scientific and technical stakeholder meetings, and (7) participating in interagency steering committees.

Beginning in 2005, MRP will have an advisory committee established under the Federal Advisory Committee Act. Eight external members will be selected by the USGS Director based on established records of distinguished service and expertise in mineral resources and earth materials and will represent the industrial, academic, and governmental mineral and earth

materials communities. The governmental members will include at least one member each from the Bureau of Land Management and the U.S. Forest Service and one member from state government. The draft charter for this advisory committee describes its function as:

The Committee shall periodically review the five-year plan and scientific and technical progress of the Mineral Resources Program, including goals and objectives, capabilities and research needs, guidance on achieving major objectives, and establishing and utilizing performance goals. The Committee may review current or future mineral science and earth materials issues as they relate to the Mineral Resources Program and make recommendations to the U. S. Geological Survey (USGS) regarding those issues. Issues to be examined may be recommended by consensus of the Committee or by the Chair. The Committee will submit an annual report relating reviews and recommendations to the Director of the USGS.

Baselines and funding targets for MRP projects are listed in the Geology Discipline Annual Science Plans, annual project work plans and proposals, and in annual Federal budget justifications. Each project proposing to conduct MRP-funded research is reviewed by a panel of internal and external subject matter experts to ensure that it addresses USGS and MRP science plan priorities and goals, that it is designed to meet the stated goals within the time and budget available, that appropriately skilled staff are assigned to conduct the work, that appropriate stakeholders have been identified and contacted, and that the anticipated products will meet the needs of the intended audience. Projects with expected lifetimes of more than three years are reviewed at the middle of their expected life span (typically in the third or fourth year). End-of-project reviews are conducted to ensure that products met stated goals and that results were communicated effectively to the intended audience; if not, corrective measures are taken.

Expertise and capabilities

To reach its goals, MRP depends on a diverse and geographically distributed scientific and technical staff to produce timely, impartial, high-quality products in mineral resource research and assessments and minerals information. The skills currently required include a combination of geologic, geochemical, geophysical, and minerals-information expertise. The large number of mineral commodities and deposit types about which information is required makes staffing particularly challenging. MRP requires expertise in earth materials of all types and all ages, in geochemical processes that occur from the Earth's surface to many miles deep in the crust, in commodities as diverse as salt and chromium, in all geophysical methods, as well as skills in information technology, document translation to English from Spanish, Chinese, Russian, and

Arabic (among other languages), scientific visualization, and report preparation. At present, staff funded by MRP are housed in Reston, Denver, Menlo Park, Anchorage, and a number of small field offices in the conterminous United States. This distribution strengthens MRP's ability to interact with the diverse users of minerals information across the Nation.

In partnership with regional management, MRP works toward the following strategic goals:

- Attract high-quality, motivated staff with areas of expertise that fit present and future anticipated research challenges
- Provide training opportunities for existing staff to develop new skills, knowledge, and expertise consistent with present and future core competency needs
- Increase the influx of new skills and ideas through a combination of permanent and short-term hires, volunteers, post-doctoral positions, and reassignments, and through participation in internal and external scientific reviews, workshops, and technical symposia
- Partner with Biologic Resources and Water Resources Disciplines, other Federal agencies, and States to augment staff to meet increasing needs for biological, ecosystem, soils science, hydrologic, and other expertise
- Maintain mineral-resource and earth materials expertise and facilities in the three USGS centers in Reston, Denver, and Menlo Park and in field offices in Anchorage, Reno, Spokane, and Tucson
- Provide opportunities for staff to move among centers or co-locate with teams from other Divisions or Federal agencies to facilitate implementation of inter-programmatic and interdivisional activities and exchange of expertise and ideas.

The following areas have been identified (2005) by MRP managers as requiring additional expertise to meet program goals:

- Research chemistry
- Gamma-ray geophysics
- Regional geochemistry
- Regional geophysics
- Spatial analysis
- Mineral resource assessment

- Alaskan geology
- South American geology
- Economic geology
- Minerals information

The following new skills have been identified (2005) as necessary to effectively carry out future program work:

- Fluid flow modeling
- Geomicrobiology (including some experience with toxicology and epidemiology)
- Economics
- Mining engineering
- Soil science/soil chemistry
- Surficial geologic mapping with economic geology expertise
- Spatial data modeling and analysis

The MRP continues to evolve towards a research- and information-based program that assists others in using the results of USGS research and data collection to meet the needs of land

What do MRP's land management partners say about our work?

Region 1 benefited greatly from your efforts to get us ready for the current round of planning...

The usefulness of basic data availability in common formats ... is hard to overstate at all levels of analysis and problem solving... The ability to assemble needed basic data, do analysis, derive custom products and make decisions is a great step forward...

It is impossible to guess all the analysis questions we will face. This places a premium on pure basic information layers that preserve maximum flexibility.

Jim Shelden, USDA-Forest Service, Region 1

The basic data that is obtained from the Central Colorado Project will be used for many years, meets the needs of the Forest Service, and is warmly welcomed.

Rusty Dersch, USDA-Forest Service, Region 2

management agencies and a broad spectrum of professional and general users. Drivers range from the desire for efficiency in government (as shown in processes such as the PART and Activity Based Costing) to an increased concern with risk and desire for certainty in assessments, whether of risk or of potential for undiscovered mineral deposits. These drivers will require increasing both quantification of all aspects of our work and an ability to generalize from location-specific research results to regional, national, and global integration. These requirements put a premium on staff who are accomplished in a scientific discipline, such as low temperature aqueous geochemistry, and in

statistics, geographic information systems, and other methods of quantification and display, and who can mature into leadership roles in integration of data and information over large geographic areas. The staffing mix available to MRP at present (July 2005) does not include enough of these skills. Evolution towards these areas of expertise, whether through training, replacement of staff, or other measures, will be required for MRP to be successful in meeting its goals.

In addition, MRP will increasingly require high-level staff with well developed written and oral communication skills, including skills in fields far from geology, such as marketing. These staff will have responsibility for working with others who want to use MRP data, and will have to be rewarded for their non-scientific skills at least as much as for their science, as it is increasingly difficult to stay current in technical fields and perform the essential management, outreach, and communications functions.

The most significant challenge to achieving the required mix of expertise and capabilities continues to be the flat funding climate in which MRP has operated for many years. Meeting the Nation's need for high quality, scientific information about mineral production and mineral resources as well as baseline information about earth materials will require continued commitment of human and capital resources. Careful project management, collaborative priority setting, and attention to workforce planning will not be enough to sustain MRP's productivity toward the end of this planning horizon and into the next plan.

Enhancement of the fledgling external grants program will provide opportunities to build new partnerships with academic and private-sector experts, and may be a mechanism for supporting topic- and site-specific research that provides understandings required for regional-, national-, and global-scale integrated products such as mineral resource assessments. This approach is limited by the fact that Federal grants programs are in place explicitly to benefit the grantee, rather than the government, but even with this limitation, collaboration between grantees and MRP projects will likely yield research results that meet a variety of needs, including those of the USGS.

Facilities

MRP managers work with cost center and regional managers in all regions to make effective use of space and facilities. Programmatic concerns in this area are largely with ensuring that adequate facilities are available to conduct research without wasting resources. At present (2005), MRP-funded projects have access to state-of-the art geochemical, geophysical, and computer laboratories across the nation. MRP shares facilities with many other USGS programs which not only minimizes costs, but also provides a shared environment in which interdisciplinary teams learn from each other and work together on projects that meet the needs of more than one program.

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References cited

- Bohlen, S.R., Halley, R.B., Hickman, S.H., Johnson, S.Y., Lowenstern, J.B., Muhs, D.R., Plumlee, G.S., Thompson, G.A., Trauger, D.L., and Zoback, M., 1998, *Geology for a Changing World—A Science Strategy for the Geologic Division of the U.S. Geological Survey 2000-2010: U.S. Geological Survey Circular 1172.*
- Dorr, A.P., and Paty, A.H., 2002, *Minerals—Foundations of Society: Alexandria, Va., American Geological Institute, 96 p.*

- Fey, David L., Nash, J. Thomas, Yager, Douglas B., Desborough, George A., 2000, Analytical results for mine dump samples and leachate solutions, upper Animas River watershed, San Juan County, Colorado: U.S. Geological Survey Open-File Report 2000-338, 16p. (available from <http://pubs.usgs.gov/of/2000/ofr-00-0338/>)
- National Research Council, 1996a, Mineral Resources and Society—A Review of the U.S. Geological Survey's Mineral Resource Surveys Program Plan: Washington, D.C., National Academies Press, 87 p.
- National Research Council, 1996b, Mineral Resources and Sustainability—Challenges for earth scientists: Washington, D.C., National Academies Press, 26 p.
- National Research Council, 2001, Future Roles and Opportunities for the U.S. Geological Survey: Washington, DC, National Academies Press, 179 p.
- National Research Council, 2002, Evolutionary and Revolutionary Technologies for Mining: Washington, D.C., National Academies Press, 85 p.
- National Research Council, 2003, Future Challenges for the U.S. Geological Survey's Mineral Resources Program: Washington, DC, National Academies Press, 139 p.
- Rabbitt, M.C., 1989, The United States Geological Survey—1879–1989: U.S. Geological Survey Circular 1050, 52 p.
- U.S. Department of the Interior, 2003, U.S. Department of the Interior Strategic Plan Fiscal Year 2003-2008, 92 p. (available from http://www.doi.gov/ppp/strat_plan_fy2003_2008.pdf)
- U.S. Department of the Interior, 2005, The Department of the Interior Activity Base Cost/Management (ABC/M) Initiative Information Paper (available from <http://www.doiu.nbc.gov/abc/html/white.html>)
- U.S. Geological Survey, 1904, The United States Geological Survey—Its origin, development, organization, and operations: U.S. Geological Survey Bulletin 227, 121 p.
- U.S. Geological Survey, 2005, Mineral commodity summaries: U.S. Government Printing Office, Washington, 197 p.

Appendix: Partners and customers

In its last five-year plan, MRP identified development of partnerships as a goal separate from the research and data collection goals. In this five-year plan, no such separate goal appears. All work activities are expected to be conducted in partnership with others; identification of stakeholders begins in the early idea-generating phases of project development and projects are not complete until results have been successfully communicated both within the project team and to appropriate audiences outside the project itself.

The following list demonstrates four different types of relationships between MRP-funded projects and their partners and customers, as well as the diversity of organizations with which the projects collaborate. It is current as of June 2005.

Cooperators

Cooperators fund or provide logistical support for the USGS to produce scientific products or conduct scientific research that fosters the goals and objectives of the Program (or have provided support in the past), and directly use program information. Information format is tailored to cooperator needs

Alaska Department of Fish and Game	Environmental Protection Agency
American Coal Ash Association	Fish and Wildlife Service
American Iron and Steel Institute	Gypsum Association
American Iron Ore Association	Iluka Resources Exploration Inc.
Bristol Environmental & Engineering Services Corporation (Bristol Bay Native Corporation)	Institute of Makers of Explosives
Bureau of Indian Affairs, Division of Energy and Mineral Resources	National Aeronautics and Space Administration
Bureau of Land Management	National Science Foundation
Bureau of Reclamation	National Stone, Sand and Gravel Association
Department of Commerce	Office of Science and Technology Policy
Department of Defense	Strategic Environmental Research and Development Program (DOD/DOE/EPA)
Department of Defense, Defense Logistics Agency	U.S. Agency for International Development
Department of Energy	U.S. Forest Service
Department of State	World Bank, The

Collaborators

USGS works closely with scientific collaborators to produce products required by the collaborators or other clients. In some cases, the USGS provides funding for the collaboration. In other cases, a separate client provides the funding.

Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys	Battelle Memorial Institute
Alaska Department of Natural Resources, Division of Oil and Gas	British Lime Association
American Iron and Steel Institute	Bureau of Land Management
American Geological Institute, Geotimes	Bureau of Reclamation
AngloGold	California Geological Survey
Arizona Department of Water Resources	Calista Native Corporation
Arkansas State University	Central Intelligence Agency
ASARCO	City of Tempe, Ariz.
Asbestos Information Association	City of Santa Fe, N. Mex.
Barrick Goldstrike	Colorado Department of Natural Resources
	Colorado Geological Survey
	Colorado Rock Products Association

Colorado School of Mines
 Colorado State University (Dept. of Geosciences, Dept.
 of Wildlife Biology, Wildlife Biology Co-op Unit)
 Denver Metro Wastewater Reclamation District
 Department of Agriculture
 Department of Defense
 Department of Defense, Industrial College of the
 Armed Forces
 Department of Energy, Energy Information
 Administration
 Department of Homeland Security, U.S. Customs and
 Border Protection
 Department of Labor, Bureau of Labor Statistics
 Department of the Interior Borderlands Field
 Coordinating Committee
 Eastern Washington University
 European Cement Association (CEMBUREAU)
 Federal Reserve Board
 Fertilizer Institute, The
 Fertilizer Research Institute, The
 Florida Institute of Phosphate Research
 Florida Limerock Association
 Florida Phosphate Council
 Freiberg University
 Geological Society of Nevada
 Geological Survey of Canada
 Gypsum Association
 Hualapai Nation (AZ)
 Idaho Geological Survey
 Industrial Diamond Association
 Industrial Minerals
 Industrial Minerals and Rocks, 7th edition
 Institute for Defense Analyses
 Interagency Panel on Climate Change
 International Fertilizer Industry Association
 International Magnesium Association
 International Peat Society
 IUSGS-UNESCO Deposit Modeling Program
 Lawrence Berkeley National Laboratory
 Macalester College Dept. of Geology
 Mackay School of Mines, University of Nevada, Reno
 Marquette University
 Mineral Information Institute
 Minerals Management Service
 Mining Engineering
 Minnesota Department of Natural Resources
 Montana Bureau of Mines and Geology
 Montana Department of Natural Resources
 Monterey Bay Aquarium Research Institute
 National Aeronautics and Space Administration
 National Academy of Sciences, National Research
 Council
 National Geographic Society
 National Institute for Occupational Safety and Health
 National Institute of Public Health and the Environment
 National Institute of Standards and Technology
 National Slag Association
 National Geospatial-Intelligence Agency (Cortana
 Corporation)
 National Lime Association
 National Mining Association
 National Institute of Standards and Technology
 National Park Service
 National Science Foundation
 Natural Resources Canada
 Natural Resources Conservation Service
 Nature Conservancy, The
 Nevada Bureau of Mines and Geology
 New Mexico Bureau of Mines and Mineral Resources
 New Mexico Environment Department
 Newmont
 Norwegian Geological Survey
 Nova Scotia Dept of Natural Resources
 Overseas Private Investment Corporation
 Pennsylvania State University, The
 Petro-Canada
 Phelps Dodge
 Placer Dome
 Portland Cement Association
 Potash and Phosphate Institute
 Raw Materials Group, The
 Salt River Project Association
 Slag Cement Association, The
 Smithsonian Institution
 Society for Mining, Metallurgy, and Exploration
 Solution Mining Research Institute
 South Dakota School of Mines
 Southern Illinois University
 South Platte Heritage Program
 Southwest Florida Water Management District
 Stanford University
 Steel Recycling Institute
 Sulphur Institute, The
 Tahoe Regional Planning Authority
 Teck Cominco American, Inc.
 United Nations
 United Nations, Conference on Trade and Development
 United Nations, Statistics Division
 University of Alaska, Anchorage
 University of Alaska, Fairbanks
 University of Arizona
 University of British Columbia
 University of Denver
 University of Idaho
 University of Maryland
 University of Michigan
 University of Nevada Las Vegas
 University of Oklahoma
 University of Oregon
 University of Utah
 University of Wisconsin-Milwaukee
 U.S. Army Corp of Engineers

U.S. Census Bureau
U.S. Dept. of Defense Advanced Research Projects Agency
U.S. International Trade Commission
U.S. National Committee of the International Peat Society
U.S. Senate
U.S. Trade and Development Agency
Vanderbilt University

Vermiculite Association, The
Washington Department of Natural Resources
Washington State University
Women in Mining
Woods Hole Oceanographic Institute
World Almanac and Book of Facts, The
Yale University
Yellowstone National Park

Clients

Clients directly use program information. Information format is tailored to their needs, no exchange of funds or support of program.

45 States (Minerals Yearbook; 45 MOUs; 51 users)
Acid Drainage Technology Institute
Alaska Native Corporations
Aluminum Association, Inc.
American Bureau of Metal Statistics
Arizona cities of Tucson, Nogales, and Green Valley
Arizona Dept of Transportation
Asbestos Institute (Canada)
BIA Council of Energy Resource Tribes
Bismuth Institute
Bureau of Land Management
Ceramic Society Bulletin
Cobalt Development Institute
Congressional Budget Office
Copper Development Association
Council on Environmental Quality
Department of Justice/Anti-Trust
Diamond Registry Bulletin, The
DOI - Office of Policy Analysis
Electric Vehicle Battery Readiness Working Group
Encyclopedia Americana, Annual
FAO/LTN
Federal Bureau of Investigation
Federal Emergency Management Agency
Federal Reserve Bank of New York
International Cadmium Association
International Center for Aggregates Research
International Fertilizer Industry Association, The
International Tungsten Association
Rocky Mountain Regional Hazardous Substances Research Center

International Chromium Development Association
International Copper Study Group
International Lead and Zinc Study Group
International Monetary Fund
International Nickel Study Group
International Titanium Association
Lead Industries Association
Metropolitan Dade County Environmental Resources Management
Missouri Division of Geology and Land Survey
Mine Safety and Health Administration
Rappaport Diamond Reporter
Rocky Mountain Regional Hazardous Substances Research Center
Salt Institute, The
Selenium-Tellurium Development Association
South Florida Water Management District
Sulphur Institute, The
Sulphur Institute's Market Study group
UNCTAD/UN
University of Alaska, Fairbanks
U.S. Environmental Protection Agency
U.S. Trade Representative
U.S. Treasury
U.S. Customs Service
U.S. Department of Agriculture
U.S. Forest Service
Western Governors' Association
World Resources Institute

Grantees

USGS provides funding (FY 2004 and 2005) for projects conducted by another Federal, State, or local agency, or university.

Alaska Dept of Natural Resources
American Museum of Natural History
ARLIS (Alaska Resources Library & Information Services)

Auburn University
Colorado School of Mines
Eastern Washington University
Idaho Geological Survey

North Carolina Geological Survey
Oregon State University
South Carolina Geological Survey
Southern Illinois University, Carbondale
Stanford University
University of Alaska, Fairbanks
University of Alaska, Fairbanks, Geophysical Institute
University of Arizona
University of California

University of Colorado
University of Florida
University of Idaho
University of Illinois
University of Nevada Las Vegas
University of Nevada-Reno
University of Utah
Virginia Geological Survey
Washington State University

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Customers use information that is easily and publicly available. USGS does not specifically tailor the information to meet their needs for format. There is no exchange of funds or provision of support. This list is limited to those who have identified themselves to USGS.

190 countries
Alaska Native Corporations
Alaska Division of Geological and Geophysical Surveys
American Metal Market
American National Soda Ash Association
Associated Press
Balfour Holdings
Blue Johnson & Association
British Sulphur North America
Burlington Northern Railroad
Business Week
Calista Native Corporation
Charles Rivers Association
Chase Manhattan
Chemical Bank
Chemical Market Reporter
Colorado River Salinity Control Forum
CONSUL Inc.
Credit Lyonnais
CRU Publishing Ltd.
Doan Agricultural Services
Ferticon Ltd.
Fertilizer International
Financial institutions
Gemological Institute of America
Gold Institute, The
Goldman Sachs
Grinding Wheel Institute/Abrasive Grain Association
Gunnison Basin Selenium Task Force
Industrial Minerals Association-North America
Isonex
J.P. Morgan
Mellon Bank

Metal Bulletin
Metal Pages
National Research Council
NatWest Securities
Nevada Department of Environmental Protection
News organizations
New York Times, The
National Oceanic and Atmospheric Administration
Pike and Fisher
Platts Metal Week
Port of Portland, Oreg.
Port of Stockton, Calif.
Port of Tampa, Fla.
Potash & Phosphate Institute
Prof. School of Forestry and Environmental Studies
Reuters News Service
Rock Products
Roskill Information Services Ltd.
Royal Bank of Montreal
SRI International
State geological surveys
Tampa Electric Corp.
Union Bank of Switzerland
Union Pacific Railroad
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service
U.S. Nuclear Regulatory Commission
Wall Street Journal
WEFA Group (Wharton), The
Woodrow Wilson International Center for Scholars,
The
World Bank, The
Yellowstone National Park