

Geological Resource Assessments Subactivity

Program	1999 Estimate	Uncontrol. & Related Chgs	Program Redirect	Program Changes	FY 2000 Budget Request	Change from 1999
Mineral Resources	62,655	1,540	-11,987	-5,000	47,208	-15,447
Energy Resources	26,035	647	-3,784	-1,000	21,898	-4,137
Total Requirements \$000	88,690	2,187	-15,771	-6,000	69,106	-19,584

Note: The Program Redirect column reflects the redirection of funds to the Integrated Science, Science Support, and Facilities activities.

Mineral Resources

Current Program Highlights

Minerals and mineral products are important to the U.S. economy; processed materials of mineral origin accounted for an estimated \$413 billion (5 percent) of the gross domestic product in 1997. The 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 behavior. This information is used to characterize the life cycle of a mineral commodity from deposit formation and discovery to mineral recycling. The Mineral Resources Program continues to increase the availability and usefulness of its data resources by designing and implementing methods for integrating and delivering spatially referenced digital data via the Internet using standard World Wide Web technology and software. At the same time, decision support systems are being designed to make use of these data that will help decision makers formulate economic and environmental policy and provide land managers with decision options when there are conflicting demands for resources.

Environment and Public Health — Environmental effects of mineral deposits that result from natural processes, mining, and mineral processing are key issues in national and global mineral-resource development. The abundance, compositions, and environmental availability of minerals or their contained elements in rocks and soils define the geochemical landscape and directly influence nutrient availability, toxic element concentration, vegetation distribution, and the general health of ecosystems. The MRP conducts geologic, environmental, and public health studies in cooperation with land-management agencies, biologists, medical professionals, States, universities, and industry. MRP supplies objective information, research, and assessments that are used for prioritizing mitigation and restoration projects, developing mitigation and restoration strategies, and formulating regulatory policy. Current MRP activities include examining how minerals affect ecosystem health; assessing abandoned mine lands; characterizing the source, transport, and fate of toxic elements, particularly mercury and

arsenic; and developing regional and national geologic, geochemical, and geophysical baseline and background maps and databases. Through the use of remote-sensing technologies such as imaging spectroscopy, developed by MRP with NASA, Program scientists can map environmentally significant characteristics such as mineral alteration, mineral distribution, and vegetation health.

Sustainability and Societal Need — As world population increases and the world economy expands, so does the demand for natural resources. As described by the National Research Council, “Sustainability represents a growing concern about the adequacy of mineral resources to meet future demands and to do so without unacceptable environmental degradation.” The MRP maintains national databases, develops assessment and analysis methods, and conducts applied research that provides the objective scientific tools for decision-making related to sustainability. The USGS is a world leader in understanding mineral occurrences and developing methodologies for quantitative and qualitative mineral and environmental assessments. Mineral-deposit research provides the fundamental knowledge used to understand where minerals occur and how they interact with the environment. Understanding the origin of mineral deposits and developing genetic components of mineral-deposit life cycle models are fundamental requirements for construction of accurate deposit models and for adequate assessment of the Nation’s mineral resources. Concepts of ore genesis evolve over time as our understanding of geologic and ore-forming processes increases, as new deposit types are recognized, and as technology advances. USGS assessments of the distribution, economic significance, and environmental impact of development of the Nation’s mineral resources are conducted on regional, national, and global scales to meet the needs of land-management agencies and national policy makers. In response to the need to update and maintain urban infrastructure, the MRP is increasing its emphasis on assessments of aggregate resources, such as sand, gravel, and crushed stone. Current program activities include development of environmental models, economic filters, materials flow models, and assessment techniques for selected industrial minerals. In the last three years, MRP has focused on electronically disseminating the national and regional databases of geochemistry, geophysics, mineral and mine localities, and lithology, as well as the extensive science applications developed using the data. We are actively working with our partners on developing an interactive geospatial decision-support system that will be made available on the World Wide Web.

Economy and Public Policy — The MRP responds to the economic and public policy needs of the Nation by providing long-term national and regional data on mineral potential, production, use, and recycling to land-management agencies, regulatory agencies, industry, academia, and the public. MRP collects, analyzes, and disseminates information on the production and consumption of about 100 mineral commodities, both domestically and internationally for approximately 190 countries. Information on strategic minerals is provided to the Department of Defense for managing the National Defense Stockpile. By monitoring the flow of materials through society, MRP provides information and analyses essential for sustainability indicators, as well as for mineral conservation and recycling, land stewardship, and environmental policy for governments, industry, and the public. Government agencies, financial institutions, and many types of industries use MRP’s monthly metal industry indicators to monitor the health of the U.S. metal industries. Current activities include projects in 20 National Parks, National Forests, and BLM Resource Areas that provide geospatial minerals, geologic, geochemical, and geophysical information for land stewardship and management plans; national geospatial databases that allow rapid response to land management concerns;

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materials flow analyses of key minerals in the economy and environment; and minerals information on over 100 commodities on a monthly, quarterly, semi-annual, and annual basis. In the last three years, the program has focused on electronically disseminating national and regional databases of geochemistry, geophysics, mineral and mine localities, and lithology, as well as the extensive science applications developed using the data. The USGS is actively working with partners to develop an interactive geospatial decision support system that can be served on the World Wide Web, and will assist land managers and policymakers with analysis of natural resources and the potential environmental effects of resource utilization.

Technology and Information Dissemination — USGS minerals research results are available to users in easily accessible, accurate, and timely products. Information is disseminated through traditional paper products, in digital form, over the Internet (<http://minerals.er.usgs.gov/>), by FAXBACK (703-648-4999), through interagency collaborations, and in technical and non-technical public presentations. Geospatial data are a major component of this theme, as is dissemination of timely information about MRP activities and accomplishments. Other components include development of new geophysical and geochemical techniques for mineral-resource studies and the application of mineral-resource expertise and techniques to other societally relevant issues such as mapping earthquake and volcanic hazards, location and evaluation of energy resources, characterization of hydrology, or location of buried ordnance.

Partners — All projects in the program are leveraged by working with partners in other Federal, State, and local agencies, universities, and industry. Over half of the studies conducted have an environmental component and over half of the projects are providing direct scientific support to land management and regulatory agencies. Collaboration with other Federal and State agencies focuses on meeting information needs concerning the lands they administer, including a wide range of topics from land management plans to characterizing Superfund sites. Through university cooperative agreements, the program partners with academia and industry to conduct basic research on ore forming processes and geochemical surficial processes that aid in understanding the environmental consequences of deposit weathering, extraction, and use. Through an extensive network of over 18,000 industry and State collaborators, the program synthesizes and disseminates high quality national and international production data that are useful to policymakers, land managers, industry, environmental community, regulators, economists, and educators.

Recent Accomplishments

Assessment of Foreseeable Mineral Development in Southwestern Montana — At the request of local planners at the Bureau of Land Management and U.S. Forest Service, USGS provided earth science information in support of a joint management plan for administering federal lands for the foreseeable future (10 to 15 years) in southwestern Montana. The planning area contains the four largest talc-producing mines in the U.S., two garnet placer operations, the nation's only mine that produces primary chlorite, and a number of inactive or abandoned gold-silver mines, many of which are the focus of current exploration. In cooperation with the Montana Bureau of Mines and Geology, USGS produced a series of maps that show the area's known and undiscovered mineral resources, and may indicate the location of future exploration and development. These maps were the first "print-on-demand"

geologic map products published by the USGS, ensuring quick release of information and utilizing digital color printing technology.

USGS Responds to Mineral Information Needs in Alaska — In response to a request from Congress, the USGS organized a diverse group of stakeholders including other Federal Agencies, the Alaska Division of Geologic and Geophysical Surveys, the University of Alaska, Native Corporations, and the geologic community as a whole to improve the quality and accessibility of minerals information in Alaska. The results of this effort, started in FY 1998, are: digital cataloging of the 18,000-volume USGS Alaska library and historic holdings of the Alaska Technical Data Unit; updating and posting mineral occurrence records for forty-two 1:250,000-scale quadrangles on the WWW at <http://www-mrs-ak.wr.usgs.gov:80/ardf/>, increasing the number of records by approximately 20 percent; correcting location and sample-media errors in records for 30,000 geochemical samples and posting the data on the Internet in early 1999; and supporting the Alaska Division of Geological and Geophysical Surveys to publish a Guide to Alaska Geologic and Mineral Information, Information Circular 44. The guidebook contains information about the collections of seven libraries and archives in Alaska, as well as information about many other minerals-related subjects. Nine thousand copies were printed in early December, 1998, and to date approximately 25 percent have been distributed.

Understanding the third Largest Gold Producing Region in the World — In partnership with universities, the mining industry, and the State of Nevada, the USGS is investigating the origin of some of the world's largest gold deposits, located in northern Nevada. Nevada provides nearly 75 percent of the Nation's annual \$3.4 billion gold production and nearly 10 percent of the total world gold production. USGS studies provide information that (1) Federal land managers incorporate in their planning process and use as a basis for land use decisions; (2) helps Federal land managers predict where undiscovered mineral resources are likely to occur and what the environmental effects of mineral development might be, (3) enhances exploration strategies by private industry, thereby indirectly contributing to the economic viability of the region and the Nation, and (4) contributes to multidisciplinary databases needed for regional syntheses used in estimating the mineral endowment of the U.S. and planning for resource availability in a global context. Publication of preliminary project results has led directly to new exploration efforts by private industry in the region.

Towards a Science-Based Understanding of Materials and Energy Flows — The USGS hosted a workshop on "Science, Sustainability, and Natural Resources Stewardship - The USGS and Research on Materials and Energy Flows". The workshop brought together managers and researchers from the USGS, other Federal agencies, academia, international organizations, and the private sector to discuss materials and energy flows, industrial ecology, and interrelations among the earth sciences and social sciences. As a result of this workshop, USGS and other governmental researchers and internationally recognized leaders in the field of industrial ecology and materials and energy flows shared their understanding of materials and energy flows, status of on-going research, and results of studies thus far. Collaborative projects were initiated among the participants and outside participants emphasized the value of USGS data in their analyses. Other materials flow activities in FY 1998 included production of fact sheets and circulars for a broad customer base addressing materials flow issues and a study that identifies limestone resources available to use in flue gas desulfurization (FGD) of smokestack emissions from coal-burning electric power plants in the Ohio River region. For this six-State region (Kentucky, Illinois, Indiana, Ohio, Pennsylvania, and West Virginia), the

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study assesses significant issues, such as limestone quarry locations relative to power plants, resource transport distances, and potential consumers of FGD byproducts. Study results have been presented to industry groups, including the American Coal Ash Association.

USGS Designs Decision Support System to Aid Colorado Front Range Planning Efforts—

Through the USGS Infrastructure Initiative, the Infrastructure Resources Project Implementation Team prepared descriptive models of sand and gravel deposits along the South Platte River between Denver and Greeley, Colorado, to predict the gravel potential along the Front Range urban corridor. A prototype Decision Support System (DSS) was developed to assist city and county planners in preparing effective planning strategies and demonstrated at a Stakeholders Meeting for city, county, state, and Federal agencies, the aggregate industry, local educators, and the public. The DSS uses widely available software and illustrates how the layers of data prepared by the project can be integrated with other spatial data to devise and test a variety of land use options when there are competing needs for resources. Decision-makers will be able to understand the effects and consequences of urbanization on resource availability, the effects of resource development on agriculture, and the efficacy of various reclamation approaches. Project scientists conducted a field trip to give Colorado congressional staff the opportunity to observe first-hand the issues surrounding availability of natural aggregate, energy, and water resources in the Denver metro area.

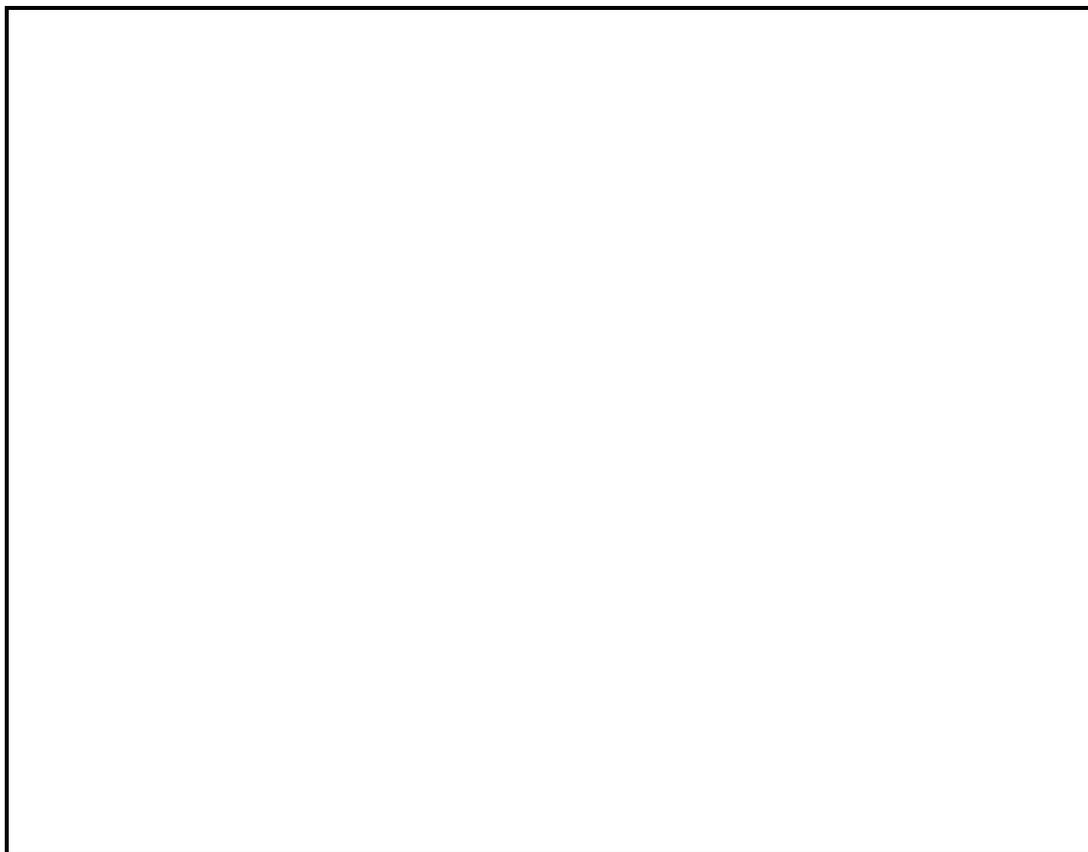


Figure G-6 - Materials extracted from the Earth are necessary to produce our most fundamental needs – food, clothing, and shelter. Materials are needed to maintain and improve our standard of living.

Understanding the whole system of materials flow, from source to ultimate disposition, can help us better manage the use of natural resources and protect the environment.

Cyanide Degradation Studies — In cooperation with several mining companies, the USGS is conducting studies of cyanide and its degradation products at cyanide heap-leach gold mining operations. These operations utilize approximately 140 million pounds of cyanide per year in the Great Basin. Beginning in 1999, EPA Toxic Chemical Release Inventory (TCRI) reporting regulations will require mines to account for all the cyanide that is brought to a mine site. A scientific understanding of the loss and destruction of cyanide is therefore important for TCRI reporting, for minimizing cyanide loss during the life of its use in the extraction of metals (thereby increasing extraction efficiency), and for closure of heap-leach gold mines. As part of the study of the behavior of cyanide in the environment, the project has developed a truck-based mobile analytical laboratory to perform cyanide analyses on-site. Until now, there has been no way to measure the effectiveness of the various recommended methods for collecting and preserving water samples containing cyanide. It has been known for some time that there is significant potential for changes in cyanide chemistry between the time samples are collected in the field and the time the samples are analyzed in the laboratory. The mobile lab has provided important new information on the stability of some metal-cyanide complexes, which will lead to modifications in the way the mining industry and regulators handle samples collected in the field and the way samples are analyzed in the laboratory. One outcome of the mobile-lab testing suggests that even brief exposure to UV radiation can cause significant changes to cobalt-cyanide and iron-cyanide complexes. The resulting recommendation is to shield samples from sunlight by wrapping sample bottles in foil, a much simpler and less expensive approach than existing sample-handling protocols, which require keeping the samples chilled.

Hot Springs Contribute Metals and Nutrients to Lakes in Yellowstone National Park — During the summer of 1998, an extinct hydrothermal vent was discovered in the Mary Bay volcanic deposits along the bluffs of the Yellowstone Lake shore; study of this vent provides a cross-sectional view into the subsurface feeder zones associated with hot spring systems analogous to those actively venting on the Yellowstone Lake bottom today. These active hot springs, currently a focus of a joint USGS–University of Wisconsin–Milwaukee study using a remotely operated submersible, contribute metals and nutrient elements to the lake, which supports thriving communities of bacteria, zooplankton, and schools of cutthroat trout that feed in the vent waters. Detailed mapping and characterization of the volcanic deposits have provided information about the age and duration of deep hydrothermal systems and a new understanding of the processes by which geothermal systems form mineral deposits, about the potential geologic hazards, and about the characteristics of lake ecosystems in the Park.

New Map Shows Locations of Active Mines Across the U.S. — The USGS published a colorful wall map showing more than 4,000 active mines and mineral processing plants in the United States for 74 types of nonfuel minerals, coal, and uranium. The map was produced in cooperation with the National Mining Association (NMA), the Mine Safety and Health Administration (MSHA), and the Energy Information Administration (EIA). The poster information is plotted on a rock-type map of the United States at a scale of 1:6,000,000, and the relationship between rock type and mine location is explained. Smaller scale maps, also on the poster, show the location of related mineral commodity groups, such as precious metals mines. Map images and other data on the poster have been made available on the Internet at <http://minerals.er.usgs.gov/minerals/pubs/mapdata/>.

Zinc, Copper, Gold, and Silver in Northern Maine — USGS studies in Aroostook County in northern Maine, characterized the geologic and geochemical setting of the Bald Mountain deposit, a large accumulation of zinc and copper sulfide minerals, together with iron sulfide minerals, which are capped by a gold- and silver-bearing weathering zone. Field and laboratory studies identified important structural controls on the localization of the deposit, its volcanologic setting, and on mineralization that took place both on and beneath the sea floor, approximately 440 million years ago. Results of this study have changed the definition of permissible terrains for this kind of deposit in the northeastern U.S. with the result that industry will alter their exploration criteria and the state will have a better tool to assess the mineral potential of lands slated for exchange or disposal. Robert G. Marvinney, Director and State Geologist of the Maine Geological Survey, has joined USGS scientists in the field each of the last three summers and believes the project is providing important new information to his agency.

Figure G-7 - Annual increases in the dissemination of USGS Minerals Information publications via the Internet are projected to continue and reach 450,000 in 1999.

Customer Use of On-line Minerals Information Reaches New High — More reports and Internet links have been added to USGS statistics and information on the global supply, demand, and flow of minerals and materials essential to the U.S. economy, national security, and environmental protection on the World Wide Web at <http://minerals.er.usgs.gov/minerals/>. Customer use of USGS mineral commodity and country reports has increased to a new high. During 1998, about 11,000 to 15,000 customers each month downloaded publications from the website on more than 100 minerals and materials as well as the mineral industries of 190 countries; even greater use is projected in FY 1999. These data are used by other Federal agencies for statistical analysis of U.S. trade and

production and for making economic forecasts and by industry to estimate market share and evaluate market trends.

First Digital Regional Geologic Map in Alaska — The first digital regional geologic map in Alaska is the result of a cooperative effort of the USGS and the Alaska Division of Oil and Gas. The map covers an area of approximately 320,000 square kilometers (205,000 square miles), an area greater in size than the state of California, and brings together many of the geological advances realized by USGS regional studies over the last 25 years. Both agencies benefitted by leveraging their resources. The Alaska Division of Oil and Gas was interested in attracting the oil and gas industry to explore the interior basins of the state, considered to be the last major on-shore frontier in the United States. The USGS has a major programmatic thrust in the Alaskan interior related to understanding the sustainability of the Nation's mineral resources. As anticipated, this map is of significant use as a tool for evaluating the mineral potential of the area.

Arsenic, Mercury, and Water Quality — Water quality in the Sierra Nevada gold belt of California is affected by arsenic released from mine drainage and tailings associated with hard rock gold mines and by mercury used in placer gold mines. USGS studies suggest that seasonal release of arsenic occurs from organic-rich bottom sediments in lakes created by tailings impoundments. These studies provide scientific information for remediation efforts being carried out by the EPA and the California Department of Toxic Substances Control. USGS studies of mercury-contaminated sediments generated during placer gold mining have shown that up to half of the mercury present in impacted creek waters is ionic mercury, a chemical form readily available for methylation. Methyl mercury is the form of mercury especially available to aquatic animals. Mercury-contaminated sediments are localized in abandoned sluices and behind hydraulic mining debris-control dams, some of which are located on U.S. Forest Service (USFS) lands. These studies provide the USFS and California State Regional Water Quality Control Board with the first geochemical evaluation of the potential environmental risk to fisheries in reservoirs downstream from these mercury-contaminated sites.

Mapping the Distribution of Metal-Contaminated Sediments, Coeur d'Alene Basin, Northern Idaho — USGS geologists, geochemists, and hydrologists are working with the EPA to determine the nature and distribution of mine waste materials in the Coeur d'Alene basin and the geochemical, hydrologic, and sedimentary processes that mobilize them. The EPA has undertaken a Remedial Investigation/Feasibility Study (RI/FS) of the entire basin (beyond the confines of the present Bunker Hill Superfund Site), and the USGS is providing information relevant to the nature and extent of metal-contaminated soils and to the development of remediation strategies. New USGS surficial geologic mapping of the Coeur d'Alene River valley downstream from the mining district allows the EPA to extend the results of their detailed point-sampling program over the valley floor where metal-contaminated sediments have been deposited. The USGS surficial geologic map also serves as a base map for the EPA RI/FS and is helping to delineate the probable geographic footprints of proposed remediation alternatives.

Three-dimensional Studies for Land-use Planning in the Southwest — The USGS has integrated new and existing geologic, geophysical, and geochemical data and remotely sensed imagery to provide three-dimensional visualizations of the upper Santa Cruz River and San

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Pedro River basins, southeastern Arizona. Major land management issues in this region revolve around rapid urbanization, water supply, mineral resources extraction, and protection of a fragile ecosystem. Three-dimensional basin studies are used to assess the effects of water withdrawal or recharge on subbasin aquifers and surface water, the potential for ground-water contamination from porphyry copper and related mineral deposits, and the potential for undiscovered mineral resources. The methods used in this study allow use of the data at both local and regional scales, providing the opportunity to evaluate regional impacts of local decisions and local impacts of regional decisions.

Abandoned Mine Lands, Boulder River Watershed, Montana — As part of the USGS Abandoned Mine Lands Initiative, the USGS provided information used by Federal land managing agencies to make decisions regarding remediation and water quality in the Boulder River watershed, Montana. The information: (1) characterized and ranked the acid-generating potential of and toxic metal solubility in 19 mine-waste dumps with a mass of about 100,000 tons; (2) assessed the chemical and mineralogical characteristics and acid-neutralizing potential of fresh and altered rocks and soils; (3) assessed the acid-neutralizing potential of the minerals in intrusive rocks and suggested that acid-generating mine wastes might safely be placed in igneous-rock repositories near the waste dumps; and (4) assessed the mineralogical characteristics and acid-neutralizing potential of drill core samples from eight sites being considered for metal-mine waste repositories. Findings of this study showed that the acid-neutralizing potential of the tested rocks varied 10 fold. In addition, pyrite was identified in several of the core samples; pyrite-bearing rock would not provide an acceptable waste repository because it has the potential to generate more acid.

Scientific Framework Data Integration and Delivery —The MRP is developing methodologies for integrating and delivering its extensive holdings of spatially referenced digital data to all users. A requirement for integration of diverse data sets is standard data models and exchange protocols. In a cooperative effort with the NCGM Program, State Geological Surveys through the AASG, the Geological Survey of Canada, and non-governmental users, a standard data model has been designed for the storage of digital geologic maps and preliminary testing of data entry tools is underway. Current versions of the data model and tools, and a discussion forum are available on the Internet at <http://geology.usgs.gov/dm/>. The spatial data delivery mechanism makes use of world wide web technology so that users with Web access and standard browsers are able to browse MRP's data holdings. MRP's data web site went on line for internal users in FY 1998 with a wide selection of geologic, geochemical, geophysical, and mineral resource data sets varying from local to global in scope. Users can query and search the data holdings, download individual data sets, and create maps on-line from the data sets. Planning is underway for additional data sets, additional capability to download electronic files that can be used to plot full-scale maps, enhanced search and display capabilities, and expanded sever capacity to serve MRP data to all interested users.

Justification for Program Change

Funding for the Mineral Resources Program would be reduced by \$5.0 million.

	FY 2000 Request	Program Change
\$(000)	47,208	-5,000

- Over the past two years, the USGS has collaborated with other Federal agencies, state agencies, universities, Native corporations, Alaska libraries, and industry to improve access to mineral information in Alaska. A digital catalog of the 18,000-volume Alaska library has been developed and a Guidebook to Alaska Geologic and Minerals Information has been published. Updating of records describing Alaska mines, prospects, and mineral occurrences is about two-thirds complete, and the updated records are available through the Internet. Geochemical analyses have been updated for about one-third of the state; the revised data are available through the Internet. A \$2.0 million funding reduction for this project is being proposed given higher priority needs requested elsewhere in the FY 2000 budget.
- \$3.0 million is being redirected to fund higher priorities as the following activities have been completed: investigations of industrial minerals along the northern Colorado Front Range; and map and reports have been produced as a result of studies in support of EPA remedial actions in the Couer d'Alene Basin and studies of the distribution of contaminants affecting the Spokane aquifer. In addition, lower priority gold deposit studies in Nevada will be terminated.