Fact Sheet

United States Geological Survey
Programs in Montana

The USGS provides maps, reports, and information to help others meet their needs to manage, develop, and protect America's water, energy, mineral, and land resources. We help find natural resources needed to build tomorrow, and supply scientific understanding needed to help minimize or mitigate the effects of natural hazards and environmental damage caused by human activities. The results of our efforts touch the daily lives of almost every American.

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Understanding Our Natural Resources

Montana is rich in a wide variety of natural resources. Conflicting demands to develop or preserve these resources result in considerable controversy over resource-management policies and decisions. For more than 100 years, the U.S. Geological Survey (USGS) has worked closely with Federal, State, and local interests to help provide the scientific knowledge and understanding of the geologic and hydrologic resources of Montana needed for the wise management, development, and protection of those resources. As demands to develop and protect those resources increase, a comprehensive understanding of natural resources becomes increasingly important. Numerous geologic and hydrologic (fig. 1) investigations are being conducted by the USGS throughout Montana.

Mineral Potential in National Forests

A moderate to high potential for the occurrence of undiscovered gold deposits in the Helena National Forest is indicated by historical mining, past and present exploration activities, and geologic, geochemical, and geophysical data from USGS regional studies. Almost $2 billion of economically recoverable gold was discovered recently in the McDonald hot-spring gold deposit on land adjacent to National Forest land near Lincoln. The U.S. Forest Service (USFS) is assessing the potential effects of development of that deposit, as well as undiscovered deposits. Geologic and hydrologic information provided by the USGS is essential to the adequate assessment of the effects of development. Digital geologic maps are the foundation of information used by USFS scientists to assess and manage mineral exploration and development activities. A particularly useful USGS product is a map that illustrates the occurrence of limestones, which could serve to fix (chemically bind) potentially hazardous chemical elements that would be released to the environment through extraction or processing activities.

Figure 1. Hydrologic studies are conducted throughout the State.

Mineral assessments of the Custer and the Gallatin National Forests were conducted at the request of the USFS to determine the distribution of rocks that host mineral resources, to assess the potential for undiscovered resources, and to estimate the amounts of metals present. The Gallatin and part of the Custer National Forests are situated within the Greater Yellowstone Area and are adjacent to Yellowstone National Park. Parts of both forests contain world-class deposits of platinum-group elements and chromium (Stillwater area), an operating gold mine (Mineral Hill mine), and a proposed gold-copper-silver mine in the final permitting stage (New World district). The Stillwater area contains most of the identified resources of platinum-group elements and 75 percent of the identified chromium resources in the United States.

Coal Availability and Quality

Coal usage accounts for one-third of the total energy and more than one-half of the electricity generated in the Nation. The Clean Air Act and its amendments of 1990 have renewed interest in locating coals that are low in hazardous air pollutants, sulfur, and ash content. Montana contains vast reserves of low-sulfur coal that are potentially suitable for energy production. The USGS, in cooperation with the Montana Bureau of Mines and Geology, has developed a comprehensive data base containing information on coal distribution, quality, and land use useful to Federal, State, and local planning, management, and regulatory agencies. Continuing efforts to locate and map coal deposits are being expanded to collect additional information on the quality of coal and to estimate the amount of remaining coal reserves that may be available for power generation under evolving environmental constraints. Studies are being conducted by the USGS in cooperation with the Office of Surface Mining and the Montana Bureau of Mines and Geology to develop models that can be used to help determine the distribution of coals that meet environmental criteria, based on depositional history and tectonic controls. Information stored in the National Coal Resources Data System is available in map and table form for use by other agencies in planning and implementing regional and national energy-production strategies.

Oil and Gas Resources

Eastern Montana is underlain by part of the Williston Basin, a major petroleum-producing basin in the upper Central United States. The Basin contains an

organically rich shale, the Bakken Formation, within which the petroleum is self-generated. The Overthrust Belt, a region of highly deformed strata from which petroleum also is produced, underlies parts of northwestern Montana.

The USGS has been working closely with the Montana Bureau of Mines and Geology and the Gas Research Institute to assess the natural gas and petroleum potential for Montana. The USGS is conducting a geochemical investigation of the "self-sourcing" potential of the Bakken Formation to determine if a better understanding of the process here can be applied in other regions of the country that may be underlain by formations of similar character. If such regions are found elsewhere, then new horizontal drilling technology may be able to unlock major new petroleum reserves.

Hydrogeology of the Helena Valley-Fill Aquifer System

The Helena Valley is located in west-central Montana north and east of Helena. The valley-fill aquifer system that underlies the valley is the sole source of domestic water supply for about 13,000 residents. Continued population growth has resulted in an increase in contaminant load to the shallow parts of the aquifer system from increased septic-tank density, industrial-waste discharge, landfills, accidental spills, and other effects of human activity.

The Lewis and Clark City-County Health Department entered into a cooperative study with the USGS to investigate ground-water conditions in the valley to provide a basis for developing a ground-water-protection strategy. The study was designed to document current ground-water-quality conditions, to determine aquifer characteristics, and to develop a water budget for the aquifer system.

A comprehensive ground-water monitoring network was established as part of the study to provide information on the ground-water levels and quality. In addition, historical information from previous investigations was compiled to document changes in ground-water conditions.

A ground-water-flow model was developed to simulate and help evaluate conceptual models of the valley-fill aquifer system. Quantifiable sources of recharge, including streamflow, canal leakage, irrigation return flow, and precipitation, were identified and measured. Discharges from the aquifer system, including pumpage, upward leakage to Lake Helena, and drainage to canals and streams, were estimated. Simulations made with the ground-water-flow model indicated that considerable recharge to the aquifer system occurred as inflow from fractured-bedrock aquifers surrounding the valley-fill material.

On the basis of results of the study, the Lewis and Clark City-County Health Department expanded its ground-water-protection strategy to include monitoring of bedrock aquifers that contribute water to the valley-fill system. Results also will be useful to water-resource evaluations in similar hydrogeologic settings.

Geologic Mapping

Proper management of public lands and integration of land-use policies for public and private lands requires extensive geologic information to understand the consequences and effects of various land-management decisions. The USGS, in cooperation with the Montana Bureau of Mines and Geology, is creating digital geological data bases of mineral and energy resources; composition, characteristics, and distribution of bedrock and surficial deposits; characteristics and location of rock fractures; and location of natural hazards. Geologic mapping information is needed by management and regulatory agencies to assess the future effects of mineral, energy, and forest-products development on agriculture, water resources, fish and wildlife habitat, and recreational features; the distribution and movement of metals in soil and water from abandoned mines and hazardous-waste sites; the geologic hazards (earthquakes, floods, landslides, volcanic ashfalls) and environmental changes (erosion and deposition) that may adversely affect populations and infrastructure; and the effects of liquid- and solid-waste disposal.

Digital Mapping Activities

The USGS is cooperating with Federal, State, and local agencies to produce digital maps that provide a common base for numerous planning and land-use-management activities. A data-sharing agreement with the Montana Department of Fish, Wildlife and Parks is providing digital map data for environmentally sensitive areas in exchange for positional and boundary information on wildlife refuges and game preserves. The USGS recently provided 1:24,000-scale digital map data for use in creating new maps for the management of the Mount Haggin Wildlife Management Area. The USGS also is cooperating with Federal agencies to produce data for a digital map revision project for Great Falls. The USGS, in cooperation with the National Park Service, is preparing digital photographic map images of Glacier National Park. A cooperative program with the Bureau of Indian Affairs is providing digital-mapping products for the Rocky Boys Indian Reservation.

Hydrologic Data Collection

Streamflow information is needed by numerous Federal, State, local, and tribal governments and private entities for flood forecasting and warning; operation and management of reservoirs used for irrigation storage, flood control, and power generation; design of bridges, culverts, abutments, and other highway structures; management of irrigation projects, waste-discharge facilities, and public water supplies; water-rights adjudication; recreation; and other purposes. Much of the streamflow information is provided by the USGS through cooperative programs with Federal, State, and local agencies.

The USGS first measured streamflow in the Missouri River at Fort Benton in 1881, and a streamflow-gaging station has been continually operated at the site since 1890. Streamflow information has been monitored at hundreds of sites throughout Montana, and many stations have more than 80 years of continuous record. In 1994, the USGS collected continuous streamflow records at 198 sites and monitored streamflow during critical irrigation periods at an additional 108 locations (fig. 2). Of the streamflow-gaging stations in Montana, 80 are equipped with realtime data-collection systems that provide users with nearly instantaneous information about streamflow conditions.

Measuring stream discharge at every potentially significant site is neither practical nor feasible. Techniques that provide estimates of streamflow with quantifiable precision and accuracy have been developed by the USGS. These methods can be used in some circumstances as an alterna-

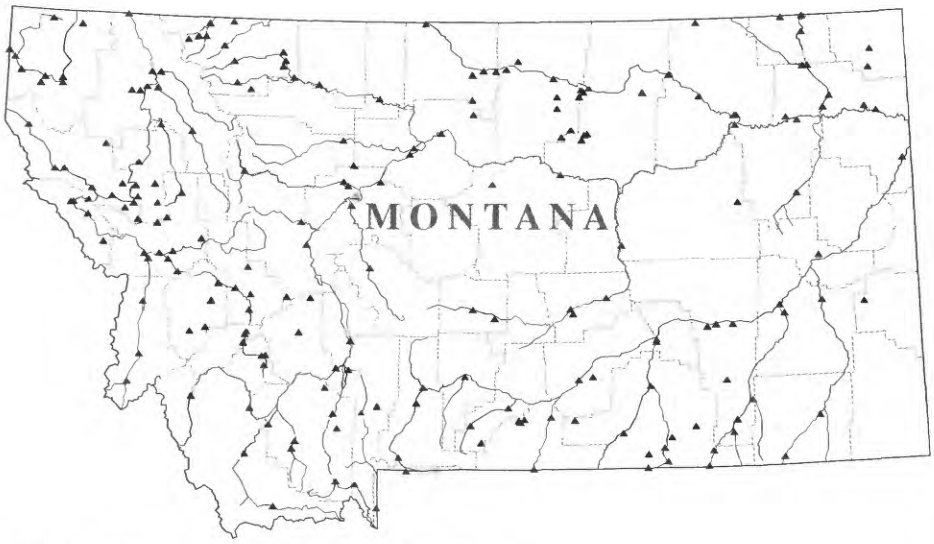

Figure 2. Streamflow-monitoring sites in Montana.

tive to more expensive and time-consuming streamflow-gaging methods.

The USGS, in cooperation with State and Federal agencies, also has developed several methods for estimating the magnitude and frequency of floods in Montana on the basis of information from more than 500 streamflow and peak-discharge monitoring sites in and near Montana. Techniques outlined in several USGS reports can be used to estimate peak discharges for various recurrence intervals from readily obtainable information on drainage-basin characteristics and stream-channel features. These techniques are used extensively in the design and construction of bridges, culverts, levees, diversion structures, dams, and spillways. Flood-frequency information also is used by planners and managers for land-use management of flood plains and the establishment of actuarial flood-insurance rates.

Information about ground-water conditions in Montana can be obtained from the USGS Ground-Water Site Inventory data base. The USGS has collected information on ground-water levels, ground-water quality, well yields, and aquifer properties at more than 23,500 sites throughout Montana. Currently (1995), water-level recorders are installed on 15 wells to monitor water-level changes at selected locations. Periodic water-level measurements are available for several hundred wells for periods of more than 50 years. Water-quality data are available for about 26,000 sites in Montana (fig. 3). Information ranges from one-time field measurements of specific conductance (an indicator of dissolved-solids concentration) to many years of periodic sampling for chemical constituents.

Trace Elements in the Upper Clark Fork Basin

Tailings from past metal mining and smelting activities have been dispersed along stream channels and flood plains since the 1880's in the upper Clark Fork Basin of western Montana. Areas affected by these activities, from Butte to Milltown Reservoir, have been designated as Superfund sites by the U.S. Environmental Protection Agency and are scheduled for remedial cleanup activities. The USGS, in cooperation with several Federal and State agencies, conducted an inventory of ground-water resources in the area and has been collecting information on the source, distribution, concentration, and movement of trace elements in aquatic biota, surface water, and suspended sediment since 1985.

Information collected from existing wells in the upper Clark Fork Basin was used to map ground-water-flow patterns, areas of ground-water discharge to the river, and ground-water quality. Although concentrations of arsenic were small in all ground-water samples, concentrations were largest in water from alluvium located near the river. Suspended-sediment and trace-element concentrations in the Clark Fork and its major tributaries were compared to aquatic life criteria for chronic and acute toxicity. Concentrations of copper and lead indicated a persistent source of metals in the upper basin and potential biological risk.

Information from the USGS studies and monitoring activities provides valuable baseline data to evaluate the effects of current and planned remedial measures to control or reduce levels of trace elements in streamflow, ground water, and sediment.

National Mapping Program

Among the most popular and versatile products of the USGS are its 1:24,000-scale topographic maps (1 inch on the map represents 2,000 feet on the ground). These maps depict basic natural and cultural features of the landscape, such as lakes and streams, highways and railroads, boundaries, and geographic names. Contour lines are used to depict the elevation and shape of terrain. Montana is covered by 2,995 maps at this scale, which is useful for civil engineering, land-use plan-

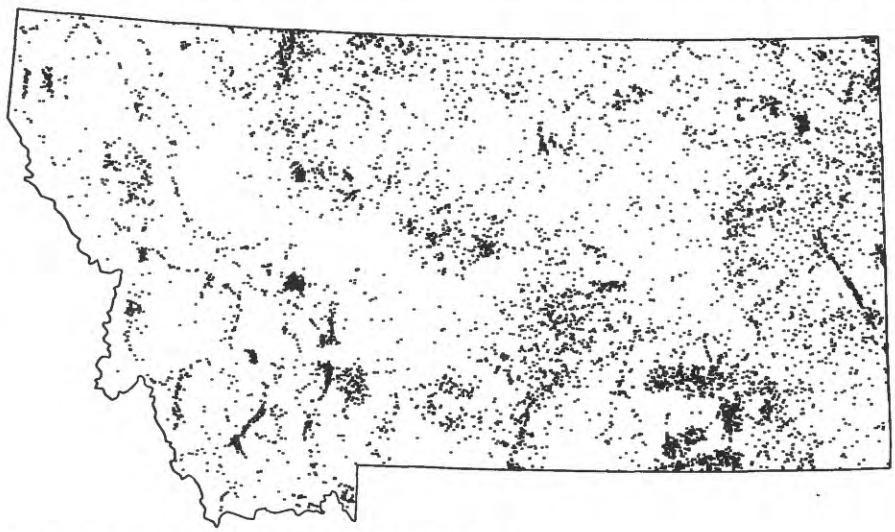

Figure 3. Water-quality data-collection sites in Montana.

ning, natural-resource monitoring, and other technical applications. These maps have long been favorites with the general public for outdoor uses, including hiking, camping, exploring, and back-country fishing expeditions.

Earth Observation Data

Through its Earth Resources Observation Systems (EROS) Data Center near Sioux Falls, South Dakota, the USGS distributes a variety of aerial photographs and satellite image-data products that cover the entire State. Mapping photographs of some sites date back about 40 years. Satellite images dating from 1972 can be used to study changes in regional landscapes.

The EROS Data Center also receives earth-observation images from sensors on board orbiting weather satellites to determine vegetation conditions, or the relative "dryness" or "greenness," of vegetation cover over the conterminous United States. Weekly updates of greenness or dryness of vegetation conditions are produced for use in the National Fire Damage Assessment Program. The information is transmitted electronically to the U.S. Department of Agriculture's National Computing Center in Kansas City, Missouri, where it is distributed nationally over computer networks to Federal and State fire-management agencies, which use the information to determine local fire-danger conditions and, where appropriate, to issue safety advisories. Comparisons with historical data are made to measure current conditions against normal conditions and to construct computer models that use information on vegetation conditions and weather to forecast fire-danger conditions. These forecasts are used in the allocation of regional firefighting resources.

Geologic Information Centers

The National Earthquake Information Center (NEIC) in Golden, Colorado, collects, processes, and distributes information from more than 20,000 seismic events each year. This information is distributed in the form of alerts, bulletins, and routine catalogs to emergency-management officials at Federal and State levels, operators of critical facilities, news media, the general public, and the earthquake research community. These catalogs of recent and historical earthquake information are used in earthquake hazards assessments. To fulfill its mission better, the NEIC has developed and is deploying the U.S. National Seismograph Network (USNSN), which, when completed, will consist of approximately 60 seismograph stations nationwide. The USNSN monitors nationwide seismicity, provides early notification of seismic events to national level emergency-services personnel, maintains an archive of high-quality digital data on national seismicity, and provides public information on earthquakes.

The Center for Environmental Geochemistry and Geophysics (CEGG) focuses on environmental geoscience research and information exchange. The CEGG coordinates and supports basic and applied research on the natural and human-induced environmental effects associated with geologic sources—especially those related to mineral and energy resources and their development. Some examples of currently supported investigations include environmental geochemistry of historical mining and smelting activities, transport and fate of toxic elements in natural systems, and use of naturally occurring minerals as scavengers for toxic metals.

Cooperative Programs

The USGS cooperates with more than 25 Federal, State, and local agencies in Montana. Cooperators include county planning agencies and health departments, public natural-resource agencies, Indian reservations, and numerous Federal agencies. Cooperative activities include water-resources data collection, interpretive water-availability and water-quality studies, mineral-resource assessments, and mapping. When local and State agencies are involved, activities typically are funded on a matching basis. In addition to agencies already mentioned, the USGS cooperates with the U.S. Army Corps of Engineers; the Bureau of Indian Affairs; the Bureau of Reclamation; the Montana Department of Natural Resources and Conservation; the Montana Department of State Lands; the Montana Department of Transportation; the Confederated Salish and Kootenai Tribes of the Flathead Reservation; the Fort Peck Tribes; the Blackfeet Nation; the Wyoming State Engineer; and Ravalli County, to name only a few.

The USGS provides support to the Montana Water Resources Research Center, which conducts a program of research, education, and information and technology transfer.

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National Earthquake Information Center
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Additional earth science information can be found by accessing the USGS "Home Page" on the World Wide Web at "http://www.usgs.gov".

For more information on all USGS reports and products (including maps, images, and computerized data) call 1-800-USA-MAPS.

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