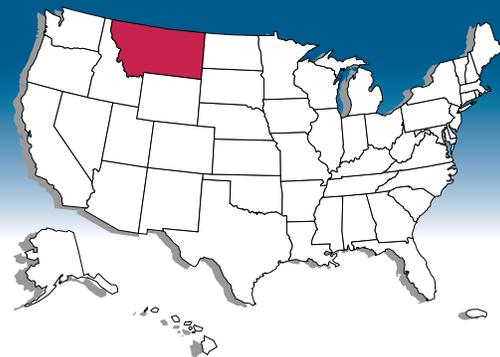




# U.S. Geological Survey Programs in Montana

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



Montana has 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. This information is 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 scientific 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 contribute to the 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 otherwise would be released to the environment through extraction or processing activities.

## 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 that contains information on coal distribution, quality, and land use that is 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 and that are 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.

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## Biological-Resources Studies

The USGS Biological Resources Division (formerly the National Biological Service) conducts research throughout Montana on wildlife and fisheries issues. The USGS Northern Prairie Science Center is conducting studies to assess the use by grassland bird populations of lands enrolled in the Conservation Reserve Program. The Midcontinent Ecological Science Center (MESC) is providing information on global climate change, status and trends of natural resources, ecology of threatened species, aquatic ecosystems, and wildlife ecology in Glacier National Park and Yellowstone National Park. Research is also being conducted on the distribution, movements, habitat use, food habits, and population dynamics of grizzly bears in the Greater Yellowstone Ecosystem. In a partnership with the Aldo Leopold Wilderness Research Institute, MESC provides coordination and direction to ecological and human dimensions research relevant to the understanding and management of wilderness and other protected areas.

Two Cooperative Research Units are active in Montana. The Fisheries Unit is located at Montana State University in Bozeman and provides information to

help managers develop fish-harvest regulations. The Wildlife Unit, in Missoula at the University of Montana, provides information on the impacts of predation on waterfowl populations and the effects of habitat fragmentation on populations.

## Oil and Gas Resources

Eastern Montana is underlain by part of the Williston Basin, which is 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-sourcing” (the rocks that now hold the oil also are believed to be the rocks that harbored the organic matter from which the oil was derived). The Overthrust Belt is a region of highly deformed strata from which petroleum also is produced, and it 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.

## 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 ash-falls) and environmental changes (erosion and deposition) that may adversely affect populations and infrastructure; and the effects of liquid- and solid-waste disposal.

## Earthquake Hazards

The USGS, the Montana Bureau of Mines and Geology, and the Idaho Geological Survey are conducting a cooperative research project to enhance understanding of earthquake hazards common to Montana and Idaho. The team of scientists is studying Quaternary faulting, the stratigraphic record of paleoliquefaction, and the present-day seismicity associated with the Lewis and Clark Zone. The Zone is a 60,000-square-kilometer area of western Montana and northern Idaho that is geologically related to the Lewis and Clark Line, which is a fault or shear zone that extends more than 300 kilometers from Helena, Montana, to Coeur d’Alene, Idaho. The Zone includes major population areas of western Montana and northern Idaho, as well as the main transportation and lifeline corridors in the region. It is a hub of tourism, particularly in the summer, connecting visitors to Glacier–Waterton and Yellowstone Parks, as well as the coastal Northwest and Canada.

The USGS 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, the NEIC has developed and is deploying the U.S. National Seismograph Network (USNSN), which, when completed, will consist of about 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 information on earthquakes to the public.

## Topographic Mapping

The USGS is cooperating with Federal, State, and local agencies to produce digital maps that provide a common base for numerous activities. The use of maps and digital cartographic data is widespread, and requirements for this information are expanding dramatically. The USGS strives to ensure that map data in graphic and digital forms are available to the public through timely and effective data-collection and revision procedures.

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 planning, natural-resource monitoring, and other technical applications. These maps have long been favorites with the general public for a wide variety of outdoor uses.

The USGS and the Montana Department of Environmental Quality have entered into a partnership for the production of 1:24,000-scale digital elevation models (DEM’s) that cover a part of south-central Montana. DEM data consist of an array of regularly spaced elevations registered to a topographic map. The Department of Environmental Quality applies DEM’s in its search for suitable locations for new transmission lines, large pipelines, and electricity-generating plants.

## Sharing Spatial Data

Data-sharing partnerships between the USGS and the non-Federal sector have been formed through the National Spatial Data Infrastructure (NSDI) Competitive Cooperative Agreements Program. This Program provides funding to State and local government agencies, academia,

and the private sector to encourage resource-sharing projects through the use of technology, networking, and inter-agency coordination. Organizations in Montana have been funded by the program to pursue two NSDI projects.

The Montana GIS (Geographic Information System) Data Clearinghouse project is a collaboration of the Montana Natural Resource Information System and the interagency Montana GIS Technical Working Group. This project is establishing multiple NSDI nodes, implementing the Federal Geographic Data Committee (FGDC)–metadata standards, implementing the Spatial Data Transfer Standard, updating the Montana GIS standards plan to bring it in line with FGDC goals, designing tools for accessing geospatial data, and providing more communication opportunities for geospatial data users within the State.

The Montana Local Government GIS Coalition Project is facilitating local government participation in the NSDI. The Coalition, which is being led by the Montana State University Geographic Information and Analysis Center, is encouraging data sharing among local government and private organizations, working with local governments to develop a metadata plan in compliance with the FGDC metadata standard, building a local government data repository, establishing an NSDI clearinghouse node on the World Wide Web (WWW) for local governments, and implementing a Montana Local Government GIS users list server on the Internet. The Coalition's WWW node can be accessed at:

<http://nris.msl.mt.gov/>

## Hydrologic Activities and Realtime Reporting

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 hydroelectric 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 continuous records that span more than 80 years. In 1996, the USGS collected continuous streamflow records at 190 sites and monitored streamflow during critical irrigation periods at an additional 109 locations (fig. 1). Of the streamflow-gaging stations in Montana, more than 100 are equipped with realtime data-collection systems. Realtime data for 46 stations and other information are available on the WWW at: <http://montana.usgs.gov/>

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 alternative 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.

The USGS, in cooperation with State and Federal agencies, has collected information on ground-water levels, and quality, well yields, and aquifer properties at more than 24,000 sites throughout Montana. Currently (1996), water-level recorders are installed on 22 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. 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.

Hydrologic data collected by the USGS are stored in the National Water Information System data bases and are available to the public. Hydrologic data and the results of numerous investigations also are available to the public through various types of reports.

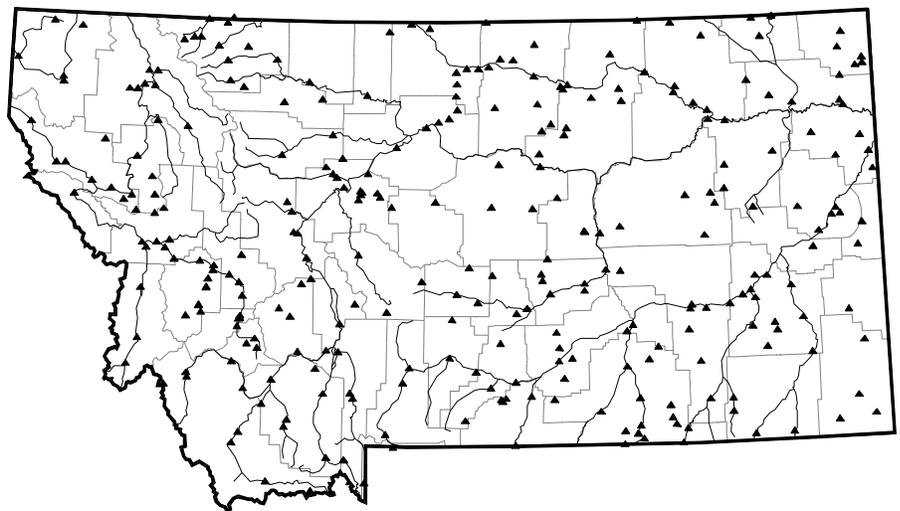


Figure 1. Streamflow-monitoring sites in Montana.

## 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 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 with 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.

## Information Centers

The Earth Science Information Centers (ESIC's) provide information about USGS programs, products, and technological developments to the public. The ESIC in Butte was established under a cooperative agreement between the USGS and the Montana Bureau of Mines and Geology. As part of the national ESIC network, this office provides information on such earth science topics as cartography, geography, digital data, remote sensing, geology, geophysics, geochemistry, hydrology, geohydrology, aerial photography and land use. It is supported by the USGS with reference

materials, technical assistance, training and outreach activities, and access to USGS data bases.

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.

The Montana District Office of the USGS provides hydrologic information, assistance in ordering maps and publications, and details of studies being conducted by the USGS in the State. The office also can help provide information on USGS activities nationwide.

## 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, among others, 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 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.

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

## For More Information

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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**

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

U.S. Geological Survey  
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