

# United States Geological Survey

## Programs in Wyoming

WYO

*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.*

### Oil and Gas Resources

Several petroleum-resource projects are being conducted by the U.S. Geological Survey (USGS) in Wyoming. Among the most prolific petroleum-producing basins in the State are the Wind River and the Greater Green River. The USGS, in cooperation with the Bureau of Indian Affairs (BIA), has been investigating the petroleum potential on Indian lands in the Wind River Basin and has provided the BIA and the Indian tribes with geologic information needed to determine that potential.

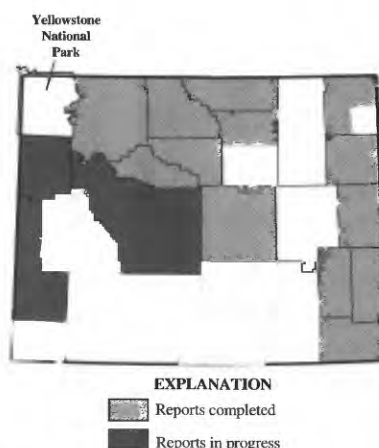
USGS investigations indicate that the Greater Green River Basin may contain a vast, untapped supply of clean-burning natural gas. This gas may be in low-permeability reservoirs from which production is difficult, but new recovery techniques may make the gas more readily available and economically viable.

### Copper and Zinc Resources in Southeastern Wyoming

In the Hartville Uplift, which is north of Cheyenne, USGS scientists identified favorable areas for copper and zinc deposits. The USGS is conducting more-detailed studies to determine the geologic setting of this complex area. This information will help target exploration by mineral-resource companies.

### Hydrologic Information for Local Water Management

General information about the occurrence, variability, and quality of surface and ground water within political boundaries commonly is needed for local water management. To meet that need, the USGS, in cooperation with the Wyoming State Engineer, has conducted a series of county-level water-resources investigations in Wyoming since the 1950's (fig. 1);



**Figure 1.** County water-resources investigations in Wyoming.

studies in progress (1995) include Fremont, Lincoln, and Teton Counties. The USGS, in cooperation with the Shoshone Tribe, the Northern Arapahoe Tribe, and the Bureau of Indian Affairs, recently (1994) completed a similar investigation of the Wind River Indian Reservation. Results of the investigations are used by all levels of government to manage and protect Wyoming's finite water resources under ever-increasing demands.

### Flood Investigations

Where human activity meets rivers and streams, hydrologic and hydraulic information about floodflows is needed. Since 1958, the USGS, mainly in cooperation with the Wyoming Department of Transportation, has conducted a series of integrated investigations to determine the flood characteristics of Wyoming streams. Stations were installed on streams in small drainage basins to collect maximum flood-stage or flood-discharge data to supplement data from continuous-record stream-flow-gaging stations. USGS hydrologists use the station information to develop and refine procedures for estimating the size of floods of a given frequency at unmeasured sites throughout Wyoming. These procedures are being used by government agen-

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cies and private engineering and natural-resource companies to delineate areas of potential inundation, to determine the optimum size of highway bridges and culverts for safety and cost effectiveness, and to plan drainage systems at surface mines.

### Ground-Water Studies

Although about 90 percent of the water used in Wyoming is from rivers and streams, only ground water is available in many areas. For many decades, the USGS, principally in cooperation with the Wyoming State Engineer, has conducted small- and large-scale studies of this ground-water resource. The following are examples of the cooperative studies: a statewide series of hydrologic atlases that provide ground-water and related information for the major geologic basins of Wyoming, numerous quantitative studies of the availability of ground water for irrigation and the estimated effects of future ground-water withdrawals, and a continuous, long-term monitoring of water levels and water quality in a statewide network of observation wells. Several large multi-State studies of regional aquifers that are

partly in Wyoming were sponsored by the USGS—the Madison Limestone and the Northern Great Plains aquifer systems in northeastern Wyoming, the High Plains aquifer in southeastern Wyoming, and the Upper Colorado River Basin aquifer system in southwestern Wyoming.

## **Selenium in the Environment**

Although selenium is an essential element for animals and humans, excessive amounts can have potentially adverse effects on fish, birds, and human health. In Wyoming, areas where water flows over and through seleniferous soil and rocks are of special concern, especially where water drains into wildlife refuges, wetlands, lakes, reservoirs, and streams.

As part of the U.S. Department of the Interior's National Irrigation Water-Quality Program, the USGS, together with the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the Bureau of Indian Affairs, the Shoshone Tribe, and the Northern Arapahoe Tribe, conducted studies of three areas in Wyoming—the Kendrick Reclamation Project near Casper, the Riverton Reclamation Project, and the Wind River Indian Reservation. The studies were developed to determine whether irrigation drainage has the potential to affect fish, birds, and human health adversely. Samples of water, bottom sediments, and fish and bird tissue were collected to analyze for selenium and other trace elements. Selenium concentrations in the food chain at the Kendrick area exceeded threshold concentrations known to cause adverse effects in fish and aquatic birds. Selenium concentrations at Riverton and the Reservation were less than those threshold concentrations. Results of the studies are being used by local, State, and Federal agencies to help evaluate potential cleanup options, irrigation practices, and changes in land use in the Kendrick area.

The USGS, in cooperation with the Wyoming Water Development Commission, studied the potential for degradation of the quality of water that would be stored in the proposed (1990) Sandstone Reservoir in south-central Wyoming. This reservoir would store water for use within and outside of the Little Snake River drainage basin. Water stored in the

reservoir would flood soil and rock outcrops containing selenium. It was determined that concentrations of selenium in reservoir water would not exceed drinking-water regulations established by the U.S. Environmental Protection Agency.

The USGS, in cooperation with the Wyoming Water Resources Center, the Wyoming Department of Environmental Quality, and the Office of Surface Mining, is studying processes that affect the solubility of selenium in coal-mine backfill material. Selenium in the backfill material can become unstable after mining, thus making selenium more soluble in ground water. Better understanding of the processes affecting selenium solubility will be useful to the mining industry and to State and Federal agencies for developing effective reclamation techniques for surface coal mines.

## **Wetland Studies in Yellowstone National Park**

The USGS, in cooperation with the National Park Service (NPS), recently sampled sediments from 55 wetlands associated with thermal features in geyser basins and with fractured volcanic rocks in Yellowstone National Park to evaluate trace elements in the sediments. Concentrations of naturally occurring manganese, arsenic, and zinc as large as several thousand parts per million and lesser concentrations of other trace elements as large as several hundred parts per million have been detected in the sampled wetland sediments receiving thermal water. Arsenic concentrations exceeding 100 parts per million have been detected in the sampled wetlands receiving thermal water in the Norris, the Gibbon, and the Lower Geyser Basins and at Mammoth, Obsidian Cliffs, and Lake Butte. Concentrations of zinc, yttrium, and rare-earth elements as large as a few hundred parts per million have been detected in sediments from wetlands formed on fractured volcanic rocks. As a result of this study and planned future USGS efforts, NPS officials will have information that will permit better management of water quality and wetlands in the Park.

## **Studies of Soil and Water Contamination**

The USGS is assisting the U.S. Air Force in studies of soil and water contamination at F.E. Warren Air Force Base, Wyoming. The contamination, combined with the proximity of numerous suburban domestic wells, were factors in the Base being placed on the National Priorities List by the U.S. Environmental Protection Agency in February 1990. The USGS is characterizing the hydrology to predict the movement of contaminants on the Base and from the Base in surface and ground water. The results of these studies are the basis for assessments of the actual and potentially adverse effects that contamination might have on human health and the environment and for the design of clean-up options, if needed.

## **Volcanic and Earthquake Hazards in the Yellowstone Region**

The geologic features and phenomena in the Yellowstone region in northwestern Wyoming are the results of active volcanic and mountain-building processes that have persisted for several million years. Volcanic eruptions and large earthquakes have occurred many times in Yellowstone's recent past and will likely continue to affect the region. The USGS, in cooperation with the NPS and the University of Utah, is studying past volcanic and seismic activity in Yellowstone and monitoring signs of continued activity. These signs include frequent small earthquakes, rapid uplift and subsidence of the ground surface, and persistent, but ever-changing, hydrothermal activity. One of the goals is to provide the scientific basis for timely warnings of any future volcanic and earthquake activities.

## **Earthquake Near Rock Springs**

On February 3, 1995, at 8:26 a.m., a magnitude 5.4 earthquake occurred near Rock Springs. The seismic waves from this event were picked up by the seismic stations of the University of Utah to the south and stations of the USGS national seismic network. These signals were transmitted by satellite and leased telephone lines to the USGS National Earthquake Information Center (NEIC) where com-



puters automatically analyzed the signals and sent an alert message with location and magnitude to the Union Pacific Railroad (UP) dispatch center in Omaha, as well as other places. The UP stopped 24 trains in the epicentral region until the tracks could be inspected for damage.

Two notable achievements are demonstrated by the response to the February 3rd earthquake—the successful recording, transmitting, analyzing, and broadcasting of earthquake information automatically nationwide and the cooperation among the government (USGS), industry (the UP), and academic sectors (State universities). Working together, they are creating an efficient and effective seismic-event alert system.

Through its earthquake hazards reduction program, the USGS supports the operation of regional seismic networks, usually at State universities, in the Western United States. Over the past few years, the USGS has taken the lead in coordinating the work of these networks with that of the NEIC to form the National Seismic System, which provides more timely and accurate earthquake information. The UP took an interest in the National Seismic System concept as a way to receive rapid earthquake information from a single source, the USGS earthquake center. Over the past 2 years, the Union Pacific Foundation has provided small grants to eight regional seismic networks in the West to be used, in part, "...in fostering the ambitions and goals of the Council of the Seismic System."

## **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. Wyoming is covered by 1,922 maps at this scale, which is useful for civil engineering, land-use planning, natural-resource monitoring, and other technical applications. USGS topographic maps also have long been favorites with the general public for outdoor

uses, including hiking, camping, exploring, and back-country fishing expeditions.

For many years, the USGS has had a long-term relation with the Wyoming Geographic Information Advisory Council (formerly the Wyoming State Mapping Advisory Council) through the Wyoming State Engineer's Office. This relation has led to several accomplishments—accelerated completion of statewide coverage of 1:24,000-scale paper topographic maps, preparation of 1:100,000-scale computerized (digital) maps for identification of irrigated areas in the Wind River area and other parts of Wyoming, and revised 1:24,000-scale paper and digital topographic maps covering the Cheyenne area. The cooperation between the USGS and the State has provided accurate map products to the public at a nominal cost.

The USGS, in cooperation with Federal agencies in Wyoming, produces computerized (digital) files of aerial photographs covering the same areas as specific topographic maps. These digital images provide "snapshots" of the Earth's surface. The images can be displayed or used with a computer-based geographic information system to extract various information and update existing cartographic data. One of these projects includes coverage of Yellowstone National Park for the NPS.

## **Earth Observation Data**

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

## **National Coal Resources Data System State Cooperatives**

Current, credible, understandable, and standardized information on the location, quantity, and quality of the coal resources of the United States is needed by Federal, State, and regional planners, as well as scientists and industry. The USGS, in cooperation with the State Geological Surveys, including the Geological Survey of Wyo-

ming, initiated a study in 1975 to develop the National Coal Resources Data System (NCRDS). The USGS provides the central hardware, software, and analytical capabilities; the USGS and the States contribute data and use the data bases. Currently (1995), Wyoming and 21 other States, representing 98 percent of current U.S. coal production, are participating in cooperative projects. The NCRDS data bases provide baseline information that can be accessed for annual State resource updates and recast to meet many needs.

## **Coal-Quality Studies**

The Clean Air Act Amendments of 1990 created a renewed interest in locating coals that have low concentrations of hazardous air pollutants (HAP's), sulfur, and ash. Coal of Tertiary age in Wyoming, Montana, and North Dakota have low sulfur and ash contents, but detailed studies of the distribution of HAP's have only recently begun. USGS scientists have developed models for the distribution of coal on the basis of the environment that shaped and formed these deposits. The USGS, in cooperation with the Office of Surface Mining and the Geological Survey of Wyoming, is evaluating the models in anticipation of increased coal production during the next two decades. This work is an important step because most of the coal in these States is on publicly owned land.

## **Interior Columbia River Basin Ecosystem Management Project**

The USGS is providing earth science information that will be used to develop a land-management plan and a broad scientific assessment of the resources for the Interior Columbia River Basin Ecosystem Management Project led by the U.S. Forest Service and the Bureau of Land Management. This project, which in Wyoming consists of the Snake River Basin, applies ecological, economic, social, and managerial principles to the Interior Columbia River Basin in seven States. Scientific studies conducted by USGS will:

- Integrate geology and geologic processes into landscape modeling
- Predict areas of soil erosion

- Assess the potential for undiscovered energy and mineral resources
- Provide information for assessment of economic and social impacts of major earthquakes or volcanic eruptions
- Illustrate variations in abundance of earth materials that affect ecosystem health
- Help develop maps showing potential habitat for various species

These studies are part of the project goals to develop an environmental impact statement and to conduct a scientific evaluation of issues affecting the Interior Columbia River Basin.

## Geologic Mapping

Recent geologic mapping by the USGS in the Jackson Hole area addresses several

issues important to local residents, as well as to visitors to this scenic part of the State. The mapping project emphasizes three aspects of the geology of this area—the glacial history of the valley, the extent of recent faulting, and the geology associated with 10 archeological sites around Jackson Lake. The work is coordinated with and benefits Grand Teton National Park, the Bureau of Reclamation, the Bridger-Teton National Forest, and Yellowstone National Park.

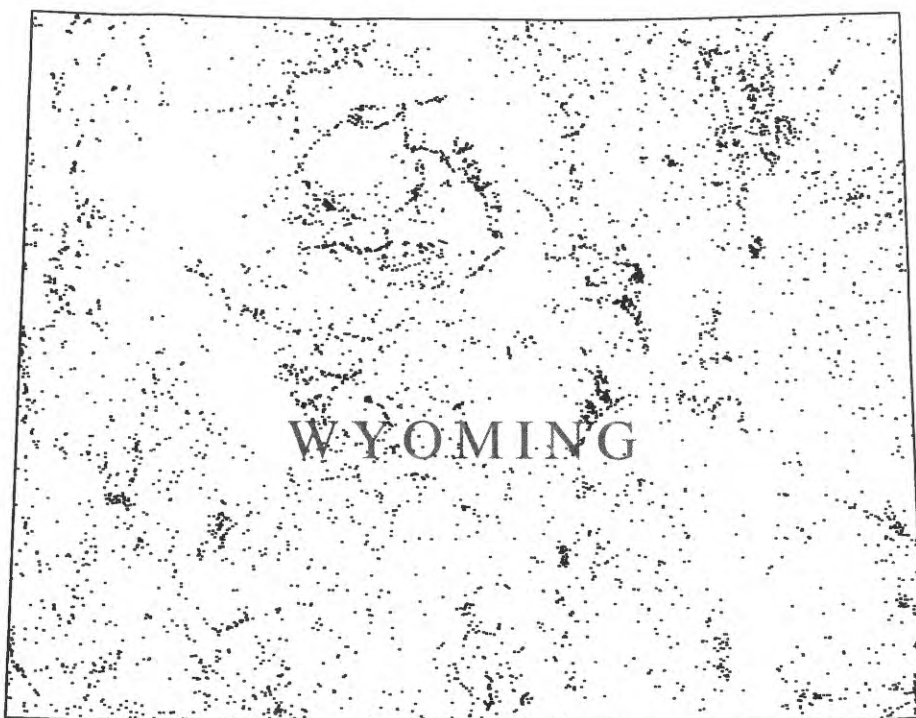
## Collection of Hydrologic Data

Since 1895, the USGS has collected continuous, intermittent, and single-measurement surface-water data at more than 2,000 sites throughout Wyoming (fig. 2). Water-quality data have been

collected at more than 1,600 sites. About 180 surface-water stations currently (1995) are in operation. The data-collection program is carried out in cooperation with many local, State, and Federal agencies. These data are used for the daily administration and management of water resources and for interpretive hydrologic studies. The data also are important for determining the extent and severity of droughts, characterizing and predicting conditions during floods, and monitoring the effects of human activities on stream-flow and water quality.

## Cooperative Programs

The USGS cooperates with more than 30 local, State, and Federal agencies in Wyoming. Local agencies include county and municipal agencies, natural-resource agencies, and county and regional planning 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-funds basis. In addition to agencies already mentioned, the USGS cooperates with the cities of Cheyenne and Evanston, the Midvale Irrigation District, the Teton County Natural Resources District, the Wyoming Department of Agriculture, the Wyoming Game and Fish Department, Teton County, the Fremont County Weed and Pest Control District, and the U.S. Army Corps of Engineers.



**Figure 2.** Surface- and water-quality data-collection sites in Wyoming.

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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.