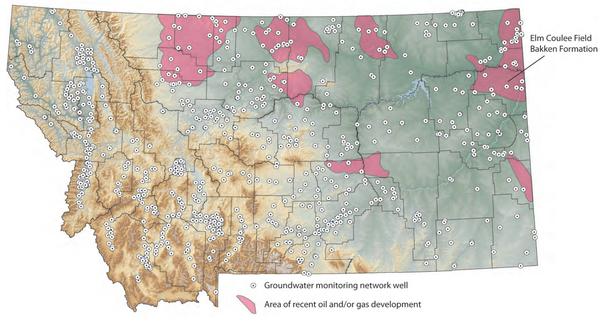
GATHERING THE DATA ON: WATER

GROUND WATER ASSESSMENT: MONITORING THE BASELINE OF GROUNDWATER RESOURCES



The Ground Water Assessment Program improves the understanding of Montana's groundwater resources by collecting, interpreting, and disseminating essential groundwater information. There are three components of the program:

Ground Water Monitoring: Baseline Water-Quality and Water-Level Data
Long-term data from 954 strategically located wells track changes in water levels and water quality in Montana's major aquifers. The map above shows how widespread these wells are, covering most of Montana.

Ground Water Characterization: Assessing Aquifers and Groundwater Quality
- Field work complete in 8 areas (22 counties)
- High-quality data from more than 8,300 wells
- Groundwater samples from more than 2,000 wells
- Released 59 maps and reports describing groundwater conditions

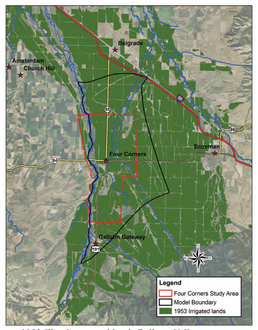
Ground Water Information Center database: Montana's Repository for Groundwater Information
Data collected by MBMG scientists are stored in our Ground Water Information Center database (GWIC), and other agencies and University system researchers are encouraged to submit data to GWIC. The data are integrated into a coherent structure that links different information available for a given well.

GROUND WATER INVESTIGATION PROGRAM: PROVIDING SCIENCE FOR GROUNDWATER MANAGEMENT

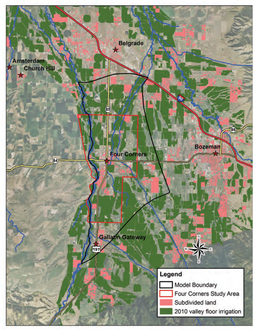
The MBMG's Ground Water Investigation Program (GWIP) answers critical groundwater questions on groundwater/surface-water interaction, impacts of land-use change, development stress, and more. Results are an unbiased, scientific basis for sound, informed water-management decisions.

Typical issues addressed by GWIP:
- Complex groundwater and/or groundwater/surface-water interaction
- Over-appropriation of groundwater
- Stream depletion by groundwater withdrawal
- Aquifer storage and recovery projects
- Water-quality impacts from septic tank density

As an example, information and reports from the Gallatin Valley GWIP projects (Four Corners and Belgrade-Manhattan) will be used by the city of Bozeman in its new water-supply planning process to identify and develop alternative sources of water to satisfy future growth. GWIP will provide detailed information and model files related to the alluvial valley-fill aquifer as a potential source. Figures below show the land-use change in the Gallatin Valley.



1953 Flood-irrigated land, Gallatin Valley



2010 Flood, sprinkler, and subdivision land, Gallatin Valley

INDEPENDENT STUDIES

In addition to our major programs, the MBMG participates as needed in many independent water studies throughout Montana. We currently are working on many projects, including:
- Acid mine-drainage mitigation through land-use changes and source control at an abandoned underground coal mine, Belt
- Monitoring aquifer response to urban sprawl, West Billings
- Water availability in the Madison aquifer in central Montana
- Roosevelt County background water quality
- Groundwater monitoring of flooding underground mines and the Berkeley Pit
- Long-term monitoring of groundwater associated with the Anaconda Smelter Superfund site
- Assisting restoration option evaluation in the Upper Clark Fork River Basin
- Long-term monitoring of chromium concentrations in groundwater at the Mouat chromium repository, Columbus
- Evaluation of arsenic sources in groundwater, Upper Deer Lodge Valley
- Metal concentrations in storm-water runoff, Mill Creek drainage, Anaconda
- Groundwater issues relating to Butte Priority Soils Superfund site
- Blacktail Creek bromide tracer study
- Geochemical evaluation of groundwater associated with mine waste, Butte

MBMG

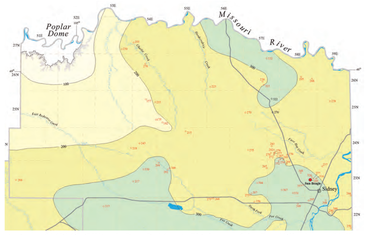
Montana Bureau of Mines and Geology

Providing Data For Thoughtful Resource Development

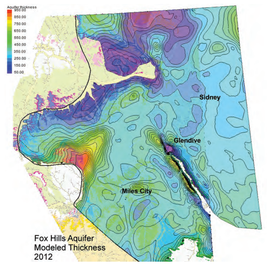
THE BAKKEN EXAMPLE: HOW YEARS OF MBMG RESEARCH APPLY IN A NEW SITUATION

GROUNDWATER ASSESSMENT

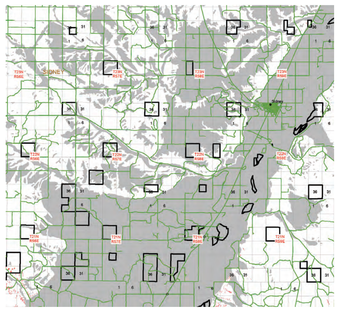
14 Years ahead of the curve:
The Ground Water Assessment Program produced a series of maps in 1999 presenting data related to groundwater resources in the Lower Yellowstone River basin. These data were a critical starting point for evaluating groundwater resources related to development of the Bakken Formation in 2014.



A piece of MBMG GWAA 1, Part B, Map 4, Thickness of the Fox Hills–Lower Hell Creek Aquifer, 1999



SAND AND GRAVEL MAPS



The geology of Montana has been mapped at many scales, but the emphasis has usually been on bedrock. The expanding development of groundwater and other resources has warranted inclusion of more detailed information on the unconsolidated, valley-fill deposits. Recently the demand for sand and gravel for construction has grown, in direct response to the housing boom in many areas and infrastructure development in eastern Montana.

Geologic deposits containing useful quantity and quality of sand and gravel are mapped, but not always identified as such. Conflicts between gravel companies and residents have increased because both usually reside in the same area of the valley.

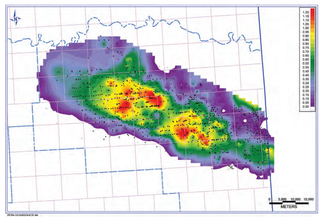
HB486, passed by the 61st Montana Legislature, amended MCA 6-1-601 to include "sand & gravel resources" in growth policies written and established by individual counties in Montana. SB297 established a sand and gravel mapping program and enables the MBMG to evaluate and report on sand and gravel resources in Montana.

RESERVOIR MODELING

Montana's largest "Bakken" field—the Elm Coulee field in Richland County—contains over 1 billion barrels of oil and has been producing since the early 2000s.

It is expected that only about 5–10% of the original oil in place will be recovered during initial pumping or the primary recovery phase of Elm Coulee. To recover additional oil, enhanced oil recovery (EOR) processes must follow. These usually include injecting fluids such as carbon dioxide (CO_2) or water to mobilize additional oil so it can be captured by producing wells.

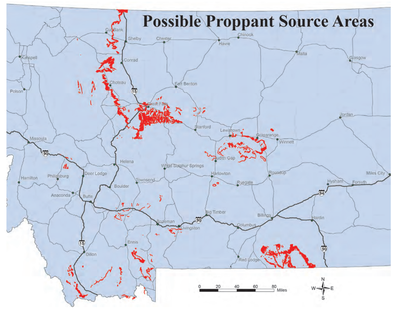
The MBMG and the Montana Tech Petroleum Engineering department have jointly developed a computer-based Elm Coulee reservoir model that will be used to test and simulate EOR methods, operations, and results. Simulating reservoir behavior prior to EOR will improve reservoir performance, increase oil recovery, and extend the life of the Elm Coulee field.



Map showing hydrocarbon pore volume (i.e., original oil in place) of the Bakken Formation in Elm Coulee field located in Richland County, Montana. Hot colors (red, orange, yellow) indicate greater volumes of oil in place.

PROPPANT SOURCES

Hydraulic fracturing ("fracking") is a critical component of drilling and completing productive wells in shale oil reservoirs such as the Bakken Formation in Eastern Montana. The fracking process relies heavily on massive injections of water and chemicals at high pressure to fracture, or crack, the rocks. Sand and other "proppants" are pumped into wells and used to hold the cracks open once pressure is released. Fracking is an expensive process and local sources for frack sand would help to reduce well costs. The MBMG has identified several geologic formations as potential frack sand sources.



DATA DELIVERY (WHAT WE BRING TO YOU EVERY DAY)

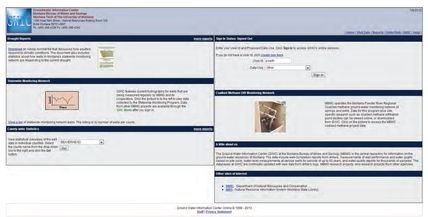
The side panels show all the research we do, gathering data in all areas of natural resources. But a key part of our mission is to disseminate that information to whoever needs it. We consider the public and the legislature our customers.

DATABASES

The MBMG provides data however our users need it—and for many, that means electronically. We provide GIS digital data and downloadable pdfs of most of our maps, a database of abandoned and inactive mines, and databases of coal and coalbed-methane information for Montana, as well as other databases.

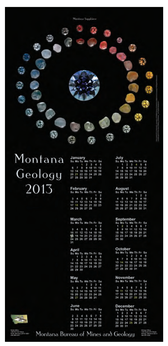
Our most-used database by far is our Ground Water Information Center (GWIC), Montana's official repository of groundwater information. The data include:
- well-completion reports from drillers
- measurements of well performance and water quality based on site visits
- water-level measurements at various wells for periods of up to 60 years
- water-quality reports for thousands of samples

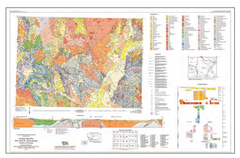
The databases at GWIC are continually updated with new data from driller's logs, MBMG research projects, and research projects from other agencies. **GWIC averages 36,500 direct queries per month.**



PUBLICATIONS

The MBMG's goal is always to get our research out to the public. The Information Services Department manages the MBMG's website, produces printed, print-on-demand, CD, or PDF versions of reports and maps, and creates the MBMG's annual calendar. We also represent the MBMG at meetings, create brochures and posters, and handle publicity, press releases, and public events.





DATA PRESERVATION

The MBMG has accepted donated data from public and private entities for many years. Beginning in 2008, using NGGDPP funds, the MBMG assessed the size and condition of its existing data collections, inventoried them, and purchased scanning equipment to begin scanning and rescuing data from loss, destruction, or media degradation. **To date, more than 1,700 of 4,500 mining property files (containing over 14,000 pages of information) and 1,200 of 6,500 mining and engineering maps have been digitized.** Other MBMG collections include 200,000 aerial photos, and seismic records dating back to 1980. Of specific interest are difficult-to-catalog hand samples, thin sections, and polished rock sections from the Butte underground mines. This project is extensive, and funding is needed to protect these data.

GATHERING THE DATA ON: EARTH

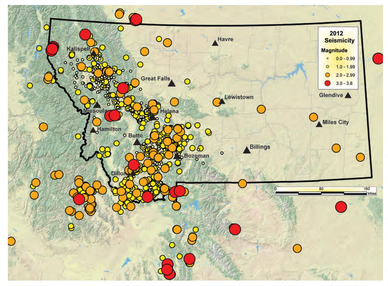
LANDSLIDE MAPPING

The Big Sky area is about 25 miles north of the Yellowstone region, the most seismically active part of the entire Intermountain seismic belt. Steep mountain slopes, moderately to steeply dipping sedimentary-rock bedding, steeply dipping planes of weakness, and moisture from heavy annual snowfall create conditions conducive to landslide development.

The Montana Bureau of Mines and Geology is preparing a map of the landslides in the Big Sky area: where different types of landslides have occurred, and where rock glaciers are present. This is just one of the types of hazard maps the MBMG produces for the use of Montana citizens and legislators.

Figure 2. Sign indicating landslide area along Highway 64, Big Sky.

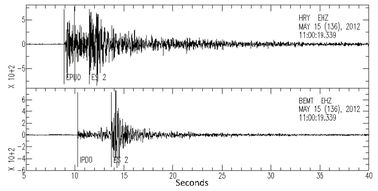
EARTHQUAKES



This epicenter map shows the locations of 1,895 earthquakes that occurred in 2012 in Montana and surrounding areas, which were located using data from the Montana regional seismograph network. Residents reported feeling 19 of these earthquakes, but none were large enough to cause damage.

The seismograph network also records non-earthquake events such as mining and construction blasts and explosions. Data from man-made seismic events are archived but not included in the earthquake catalog.

The MBMG is a cooperating agency in the Advanced National Seismic System and exchanges seismic data in real-time with other surrounding seismic networks. Preliminary locations and magnitudes for significant local seismic events (those larger than magnitude 2.5–3.0) are determined within 2–3 minutes of their occurrence and forwarded to the U.S. Geological Survey for inclusion on a national earthquake webpage. In the event of a felt earthquake, MBMG Earthquake Studies staff also serve as the contact point for media and the public to get information.



Seismograph recordings of a magnitude 1.6 earthquake on May 15, 2012 that occurred 5 miles north of the Montana State Capitol.

COAL

With approximately 120 billion tons, Montana leads the nation in demonstrated coal reserves, consistently produces about 4 percent of the nation's supply, and ranks 5th in annual coal production. Five surface mines and one underground mine produced about 42 million short tons in 2011.

Montana's largest coal fields, such as the Otter Creek coal deposit, are found in the Powder River Basin (PRB) in southeastern Montana. The MBMG has conducted several coal availability studies that more accurately determine the quantity and distribution of mineable reserves. These studies were combined into a regional Coal Resource Assessment of the entire Montana PRB in cooperation with the USGS.

A dragline removes overburden and exposes the coal seam at Western Energy's Rosebud Mine near Colstrip, MT.

The MBMG also does critical work in groundwater monitoring around coal mines. Our 40-year history of monitoring provides significant information on the aquifers and is looked to internationally as a groundwater monitoring model. These ongoing monitoring efforts complement short-term, intensive investigations into aquifers that are experiencing increased use or quality issues.

An intensive isotope and chemistry profile of the region's coal aquifers and streams was initiated this year to provide a clearer understanding of the role coal aquifers play in surface-water flows in the Powder River Basin. This study will be completed on the Tongue River, the Powder River, Hanging Woman Creek, and Otter Creek, all streams that flow through coalbed-methane fields or are sourced from coal aquifer springs such as Otter Creek.