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Geohazards Research at the Montana Bureau of Mines and Geology

Michael Stickney and Amanda Rossi

The Geohazards Program characterizes and provides information on active faults, earthquakes, and landslides and makes these data available to the scientific community, policy makers, emergency responders, and the public.

Goals

1. Characterize earthquake hazards through site-specific investigations.
2. Generate a statewide database of active faults and landslides.
3. Use seismic data to determine earthquake origin times, locations, and magnitudes to create a seismicity catalog. The current catalog extends back to 1982 and includes more than 86,000 earthquakes.

Earthquake Hazards Studies

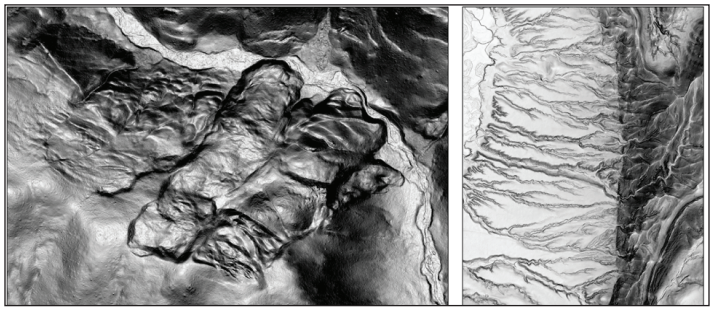
MBMG geologists investigate active faults through field studies to assess earthquake hazards that pose risk to communities in Montana and the Northern Rockies region. Site-specific investigations are needed to obtain geological parameters used for seismic source characterization and provide information on earthquake hazards. These projects involve geological and fault mapping using light detection and ranging (LiDAR) to identify fault scarps that have displaced young surficial deposits in past earthquakes. Fault slip rates are determined using new advances in Quaternary dating techniques (cosmogenic radionuclide, luminescence, and radiocarbon). Paleoseismic studies provide information on prehistoric earthquakes, including timing, frequency, and associated ground deformation to be able to provide earthquake forecasting and probabilistic seismic hazard assessments.

Paleoseismic fault trench excavation on the Bitterroot fault near Lake Como.

Quaternary Faults and Landslides Database

Map data are integrated into online geodatabases of statewide active faults and landslides. The current inventory of active faults and landslides and their geologic parameters will be published as geodatabases and made available within the MBMG Geohazards GIS Data Hub Site to be used for earthquake hazard assessments and updates to the National Seismic Hazard Model. Web mapping applications will allow users to visualize statewide Quaternary faults and landsides with LiDAR data and other available geohazards information (historic earthquakes, landslide susceptibility, and liquefaction susceptibility).

The Quaternary Faults and Landslides Database will be available through the MBMG Geohazards website (www.mbmg.mtech.edu/MontanaGeology/geohazards/).

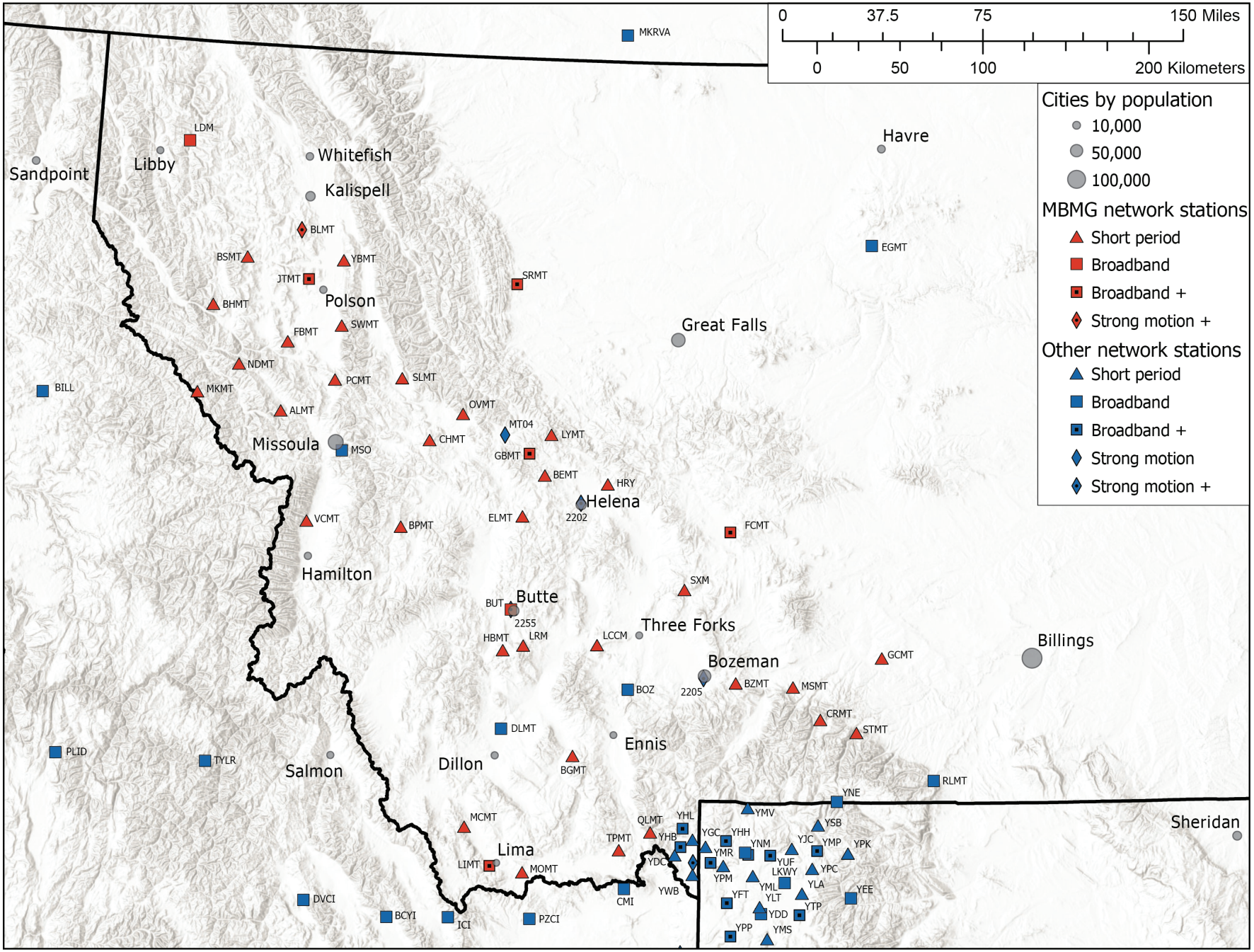


LiDAR datasets for Jefferson County showing examples of hazardous landslides (left) and faults (right) with evidence of geologically recent displacement. Basemap is a slopeshade DEM (relief) derived from LiDAR data.

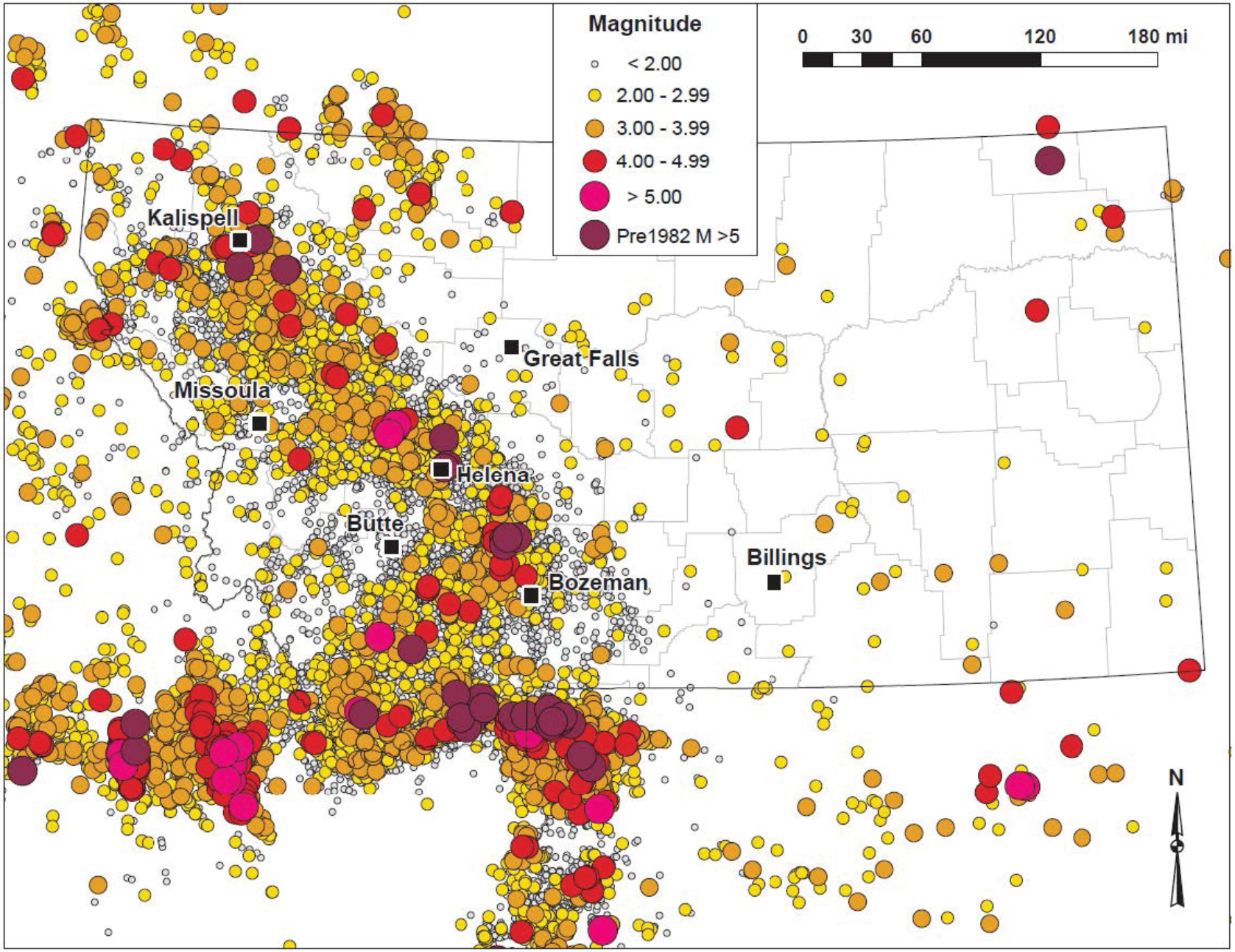
Earthquake Monitoring Studies

Western Montana has a history of large, damaging earthquakes and remains seismically active. Most earthquakes occur 3 to 10 miles deep along faults that do not extend to Earth's surface. Seismic hazards associated with "blind" faults cannot be evaluated with traditional surficial fault mapping and are best studied with data from a permanent network of seismograph stations. As the population and infrastructure of earthquake-prone western Montana continues to grow, the exposure to seismic hazards—the risk—increases.

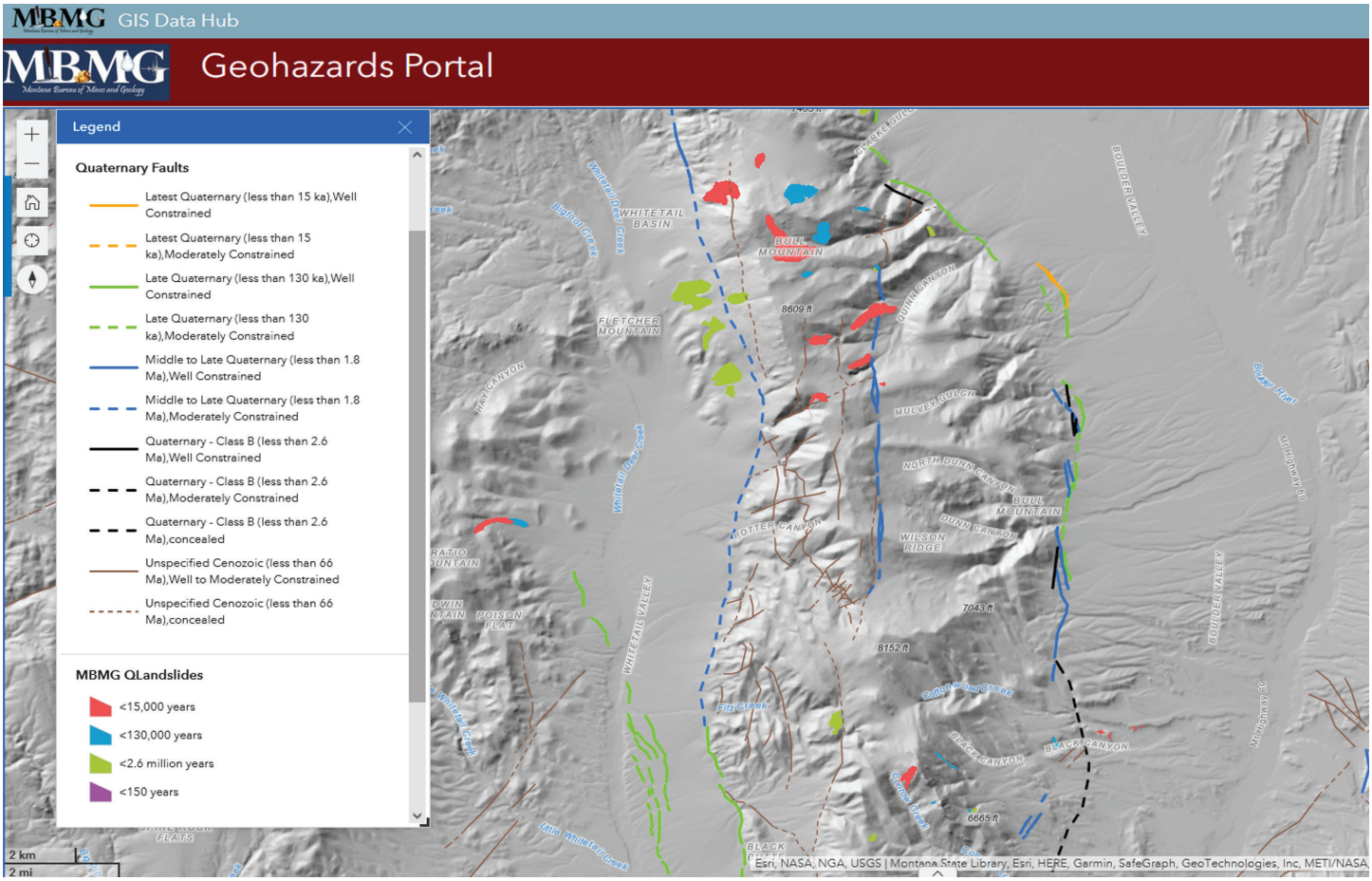
The MBMG operates a network of 45 seismic monitoring stations throughout western Montana, the most seismically active region of the State. The MBMG records data from 158 local and regional seismograph stations in real-time from 16 different networks. Most of the MBMG seismograph stations utilize outdated analog instruments (red triangles on seismic network map) that have been in service for decades and badly need updating. To improve the density of seismic monitoring stations and enhance public outreach and education, the MBMG purchased 20 low-cost Raspberry Shake home seismographs.



Seismograph stations recorded in real time at the Earthquake Studies Office and used for ongoing seismicity. Red symbols are seismograph stations operated by the MBMG; squares show modern digital stations while triangles show older analog stations. Black squares are stations operated by the U.S. Geological Survey. Open triangles are stations operated by other networks including the University of Utah, Idaho National Labs, University of Washington, Idaho Geological Survey, Canadian Geological Survey, and Alberta Geological Survey. Open circles are Raspberry Shake stations hosted by homeowners and schools. Most of these within Montana were provided by MBMG.



Epicenter locations for earthquakes in MBMG catalog since 1982 plus previous M 5+ events.



Preview of the MBMG Quaternary Faults and Landslides web application in the upcoming MBMG Data Hub, showing the Bull Mountains area.

Current seismograms from the MBMG network are available at the MBMG Earthquake Studies Office website (www.mbmg.mtech.edu/MontanaGeology/geohazards/Earthquakes/), along with a listing of recent earthquakes.

Funding and Projects

Grants from the Federal Emergency Management Agency (FEMA) and the Montana Department of Emergency Services (DES) provided support to map active faults and landslides using LiDAR in several counties. Recent datasets from newly available LiDAR surveys in Montana reveal numerous hazardous active faults and landslides that were previously unrecognized.

The Geohazards Program has also successfully acquired multiple funded grants from the U.S. Geological Survey's National Earthquake Hazards Reduction Program (NEHRP) for field investigations of active faults and paleoseismological investigations of the Bitterroot fault. The goal of these projects is to constrain fault slip rates, Holocene chronology of paleoearthquakes, and probabilistic fault displacement to better characterize the hazards of potentially damaging earthquakes in the Bitterroot and Missoula Valleys.

The Earthquake Studies Office recently received a Department of Natural Resources and Conservation (DNRC) Reclamation and Development Grant to purchase and install 10 new digital seismograph stations to upgrade the existing seismic network and enhance seismic monitoring coverage of the most active parts of Montana.

About the MBMG

Established in 1919, the Montana Bureau of Mines and Geology (MBMG) continues to fulfill its mandate to collect and publish information on Montana's geology to promote orderly and responsible development of the energy, groundwater, and mineral resources of the State. A non-regulatory state agency, the MBMG provides extensive advisory, technical, and informational services on the State's geologic, mineral, energy, and water resources. The MBMG is increasingly involved in studies of the environmental impacts to land and water caused either by past practices in hard-rock mining or by current activities in agriculture and industry. The Montana Bureau of Mines and Geology is the principal source of Earth science information for the citizens of Montana. More information is available at mbmg.mtech.edu.