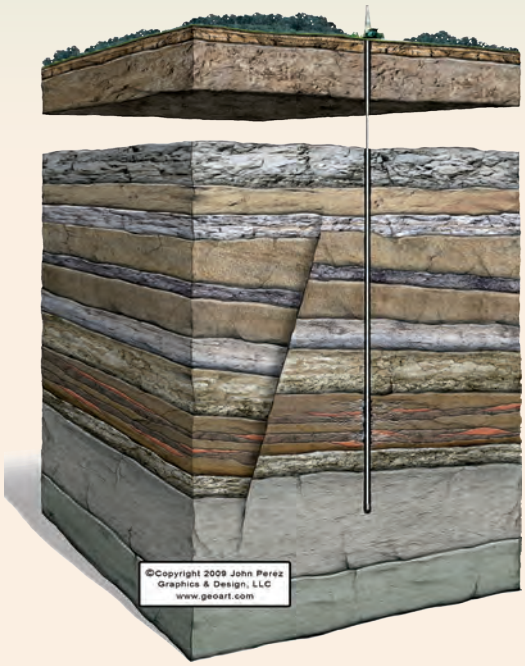
New Mexico Earth Matters

summer 2009

The New Mexico Library of Subsurface Data

New Mexico has a rich legacy of petroleum and mineral exploration and production, most of which has involved subsurface investigations. Hundreds of thousands of holes have been drilled into the subsurface, some to depths of 20,000 feet or more. Considerable data have been collected from these wells in the form of electrical or geophysical logs, cuttings, and rock cores. These materials contain a rich lode of information about the kinds of rocks that lie below the surface, how porous and permeable they are, and even what types of fluids they contain. The logs, cores, and cuttings are initially owned by companies conducting exploration or production operations. However, as companies merge, go out of business, or move on to other opportunities outside New Mexico, these valuable assets become expensive liabilities with high storage costs. Over the years large volumes of subsurface information have simply been discarded. However, many companies have donated such material to "data orphanages" where these materials can be used by the geological community and the public at large.

The New Mexico Bureau of Geology and Mineral Resources is one of the places willing to accept such materials. Our mission includes serving as a repository for these kinds of data. Data in our collections have been acquired from wells drilled throughout the state over the last 90 years. We currently have more than 15 million pieces of unique subsurface data in our collections, much of it stored in seven steel storage buildings on campus. We would house more material if we had funding to construct more buildings. In the past we've been (and still are) in the difficult position of having to decline valuable collections because of insufficient storage space. For example, a large collection of New Mexico cores offered to us during the Conoco–Phillips merger is currently being held at the Oklahoma Geological Survey, awaiting possible repatriation to the bureau, if and when we can construct a new storage center. Other collections have been discarded because neither we nor any other repository could accept them.



Subsurface data reveal an enormous amount about the character of the bedrock, structure, and detailed properties of the rock that are not discernable from the surface.

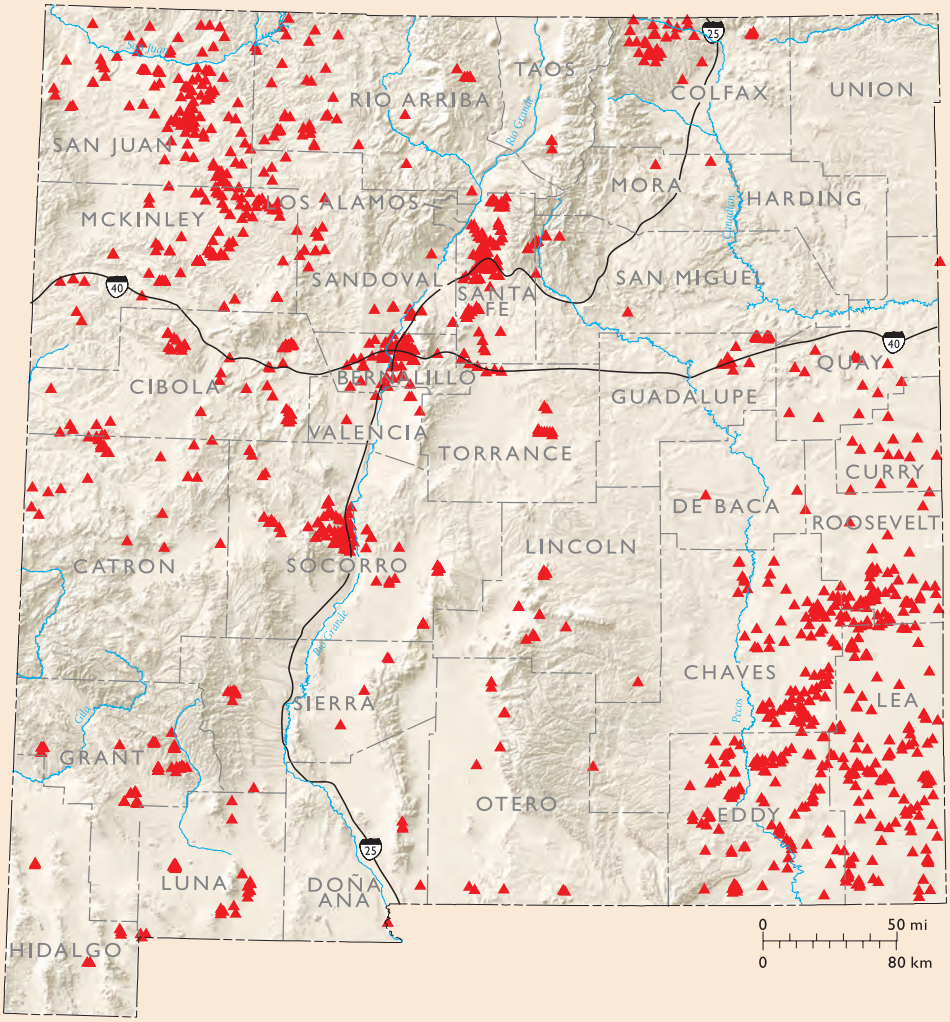
What Does the Library Include?

Major collections in the New Mexico Library of Subsurface Data include:

- More than 540,000 linear feet of core from 1,433 drill holes
- 50,773 boxes of cuttings from 16,639 drill holes, representing 150 million feet of drill hole
- 3,296 sidewall cores from 124 drill holes
- 280 boxes of core chips from 135 drill holes
- Oil and gas well logs from 49,757 drill holes
- Uranium drill hole well logs from 14,210 drill holes
- Lithology logs of cuttings descriptions from 6,024 drill holes
- Drillers logs from 15,824 oil, gas, and water wells
- Scout cards/scout tickets for 106,500 oil and gas wells
- Petroleum exploration maps
- Oil and gas pool boundary maps
- Weekly reports of drilling progress of oil and gas wells, dating from 1931

Our library contains extensive collections of geophysical and sample well logs from more than 60,000 oil, natural gas, mineral, and water exploration and production drill holes. These well logs are made shortly after a well has been drilled. They represent vertically continuous records of the properties of the rock surrounding the borehole (such as electrical resistivity, natural radioactivity, density, and porosity) and are typically used to define mineral, reservoir, and aquifer properties. Although not a replacement for drill cores or cuttings, well logs can be used to describe and interpret the strata penetrated.

We maintain extensive collections of scout cards, scout tickets, and other well records that detail the location, depths drilled, drilling results, and well construction of more than 100,000 wells drilled throughout the state. Many of the items



Wells in New Mexico for which we have core material.

in our collections are handwritten or typed and are one-of-a-kind well histories not available elsewhere. They are used frequently by professional geologists, researchers, and the general public to obtain information from wells drilled on their land regarding water, mineral, oil, and natural gas resources.

Replicating our collections (by drilling, logging, and/or coring new wells) would cost an estimated $30 billion and would take decades to achieve. Coring operations in wells are complex and expensive. For deep holes, it can take an entire day to obtain a single 30-foot section of core, not counting the weeks or months it takes to drill a single well. Lengthy cores can cost more than $100,000, in addition to the $1 million or more that it may cost to drill the well.

The Value of Subsurface Data

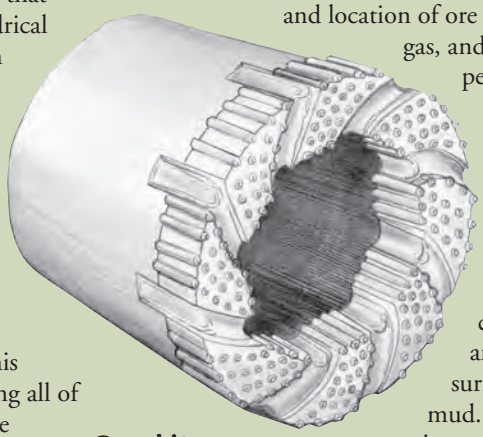
The purpose of housing these materials is not just to preserve a record of past activities. The stored subsurface materials provide us with our only direct evidence of what lies below the surface of the state. That, in turn, can yield clues to new oil and gas exploration plays, help to quantify our current ground water resources, or help us to locate deeper, saline water supplies that someday may be suitable for desalination. As a result of data acquired from these subsurface materials, recent gas discoveries in the Tucumcari area brought a major petroleum company (Shell) back to New Mexico for the first time in many decades. These discoveries ultimately will bring many hundreds of millions of dollars into state coffers and provide substantial private-sector employment. The initial discoveries were made by small, independent oil companies using an exploration model published by the New Mexico Bureau of Geology and Mineral Resources. An editorial in the Oil & Gas Journal in 2003 described the close partnership between research on subsurface materials done at state geological surveys (specifically the New Mexico Bureau of Geology) and the work of small, private companies in raising funds and drilling those prospects.

Another example of the importance of these subsurface data collections is the aquifer mapping and characterization work conducted over the past decade throughout the state by the Office of the State Engineer, the New Mexico Bureau of Geology, the U.S. Geological Survey, and other agencies. The Albuquerque Basin was the site of the most ambitious of these studies, but comparable projects have been or are being carried out in many other parts of the state, including the Española Basin, the Taos region, and the Sacramento Mountains/Tularosa Basin area. The three-dimensional geological reconstructions, and the associated water-flow modeling of those areas, are based on a combination of

Our subsurface data collection includes 540,000 linear feet of core that is carefully archived in seven steel buildings on campus.

How Are Subsurface Materials Obtained?

Cores are acquired when a well is drilled using a special drill bit that cuts (or bores) a cylindrical column of rock, which accumulates in the drill pipe. During coring operations, only 30 feet of core can be taken at a time before the coring bit and lowest part of the drill pipe must be retrieved from the drill hole. This process requires hoisting all of the drill pipe out of the drill hole. After the core is retrieved, the coring bit and drill pipe must then be reassembled and lowered back into the borehole. For this reason, cores are not often taken during drilling operations. The cores are in situ samples of rocks from a known location and depth. For practical purposes, they are irreplaceable sources of information regarding the exploration for and location of ore deposits, oil, natural gas, and coal and are indispensable for geologic and engineering studies related to aquifer assessment and CO_2 sequestration.



Core bit

Drill cuttings are tiny pieces of rock that are cut by a conventional drill bit and are washed to the surface with the drilling mud. Unlike cores, drill cuttings are generally collected at regular intervals (10 feet in most wells) for every well as part of the drilling process. Our collection includes cuttings from 16,865 oil, natural gas, water, and mining drill holes. Most oil and gas wells are 5,000 to 20,000 feet deep; with cuttings sampled every 10 feet, a single well may have 500 to 2,000 samples. Although not as useful as cores, the cuttings are actual specimens of rock obtained from the deep subsurface through the drilling process. In the hands of a skilled geologist, cuttings can yield information not available through other indirect means (such as well logs), including mineralogy, rock type, permeability, and porosity.

Conventional drill bit

surface geologic mapping and studies of logs, cores, and cuttings from wells in the studied areas. These studies have radically revised our understanding of how much (or, more accurately, how little) potable water is available in most of these areas.

The Future Importance of Subsurface Data

The traditional successes we've achieved in the use of stored subsurface materials is a compelling argument for their continued storage and curation. However, it is the unconventional and as yet unrecognized uses of these materials that drives us to preserve them for future generations. One growing unconventional use is in understanding the potential for geological sequestration of carbon dioxide (CO_2) captured from fossil fuel power plants. If we are going to inject significant volumes of CO_2 into underground storage sites (old oil and gas fields or highly saline aquifers), we need to understand exactly how the high-pressure, super-critical liquid CO_2 will react with host rocks at potential sequestration sites. Stored cores are saving millions of dollars by providing actual reservoir materials for laboratory experiments, sparing the need to drill and core new wells.

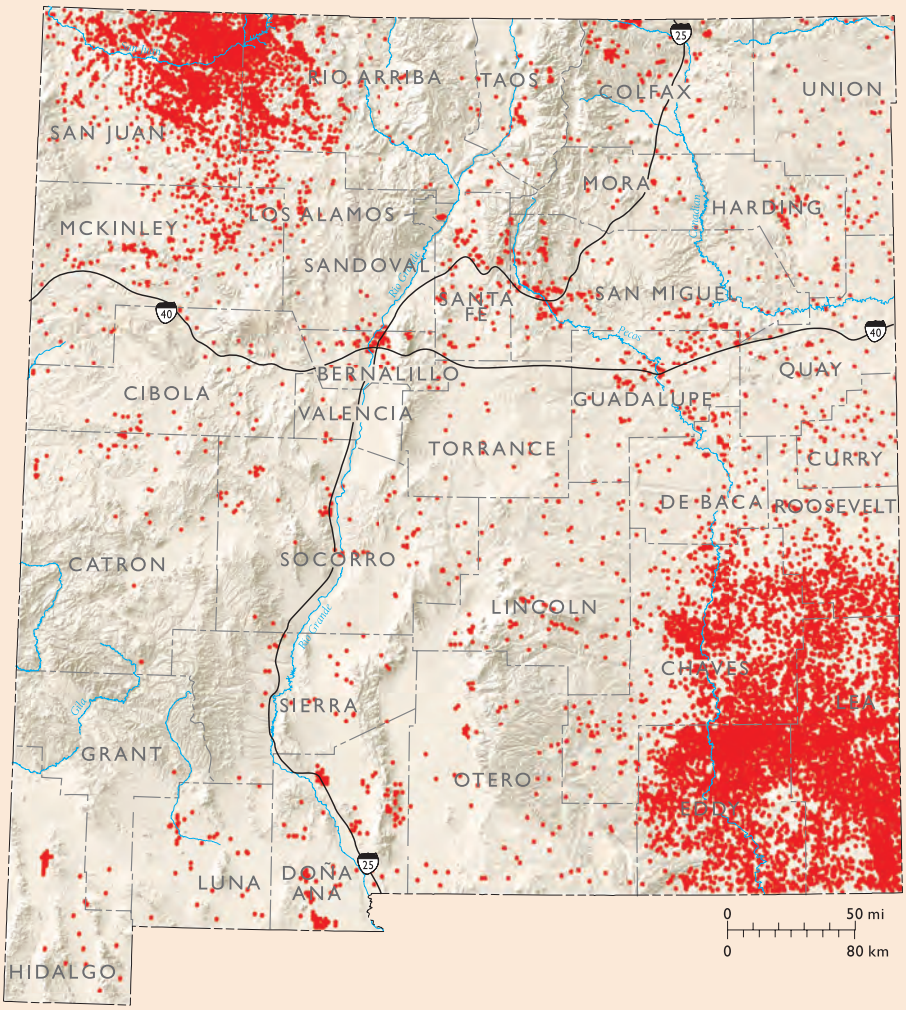
Another likely future use will involve reanalyzing core materials from metals mining sites. New Mexico has thousands of abandoned metals mines and a modest number of active ones. Most represent sites at which conventional materials—copper, gold, silver, lead, zinc, or uranium—were mined. But are old mining sites really no longer of economic interest? New uses are being found for many materials, so prices for some metals have risen to the point where sub-economic deposits of the past are now economic (indeed, we are even mining some old waste rock piles because their metals content is higher than remaining ore deposits). We have developed new mining methodologies, especially for uranium, that allow mining of deposits that were once considered unminable. In addition, we are now searching for elements that were never even considered to have uses in the past. A good example is found in the area of solar cell production, an industry that is transitioning to thin-film technologies in which wafer-like layers incorporating elements such as cadmium, tellurium, indium, gallium, or selenium are greatly increasing the efficiency of solar panels. But where do we find supplies of these elements sufficient to power a new world of renewable energy? We can start by analyzing cores from existing ore deposits that have only been partially mined to see if those elements are present in economic

This box contains 12 linear feet of core from a well in Dark Canyon, in southeastern New Mexico.

amounts or if they might be found in the waste rock or tailings deposits from former mining operations.

Geothermal energy development is likely to see substantial growth in the near future, and stored information from older wells provides clues to which areas have the best potential for geothermal energy production. The logs for most oil and gas wells have at least one temperature reading taken at the maximum depth of the well. Although not always completely reliable (the circulation of drilling fluids can affect readings), these measurements at least provide minimum temperatures at depth. Because data typically are available for many wells in an area, reasonable corrections can be calculated. More complete temperature surveys are available for a few wells, and that information is extremely useful in evaluating geothermal potential.

Although we cannot confidently predict future uses and needs, it is clear that preservation of subsurface materials has real and lasting purpose. Most states and some federal agencies already store some geological and geophysical information and materials, although the quality of curation is variable and the coordination of these many collections is minimal. In recognition of those facts, the federal Energy Bill of 2005 included a section that authorized the establishment of a National Geological and Geophysical Data Preservation Program, with a goal of identifying, cataloging, and preserving geologic data collections that are housed primarily at state geological surveys. The program was authorized at $30 million per year for five years and is administered through the U.S. Geological Survey. We are currently developing digital catalogs of cores, cuttings, well logs, and other data types in our collections and are in our third year of working with this program. Unfortunately, in four years of operation, less than $3.5 million has actually been appropriated for this program, and the only substantial accomplishment to date has been the beginning of a national database of existing holdings in the various repositories across this country. The Energy Bill of 2009 contains new provisions reauthorizing this program and adding increased spending authorization for construction of new or improved storage facilities.



Wells in New Mexico for which we have cuttings.

Accessing the Collection

Just as a good library consists of more than just stored and cataloged books and other media, a good geological data repository consists of more than just stored subsurface data. The staff at a subsurface data facility can provide invaluable help for a user. Our subsurface data holdings are overseen by a professional petroleum geologist, Ron Broadhead, and two able support staff, Amy Trivitt-Kracke and Annabelle Lopez. They not only curate the collection, but also provide users with informed help that greatly reduces the frustrations that can accompany a visit to a facility with mountains of data. Our cores, cuttings, well logs, and other records are used weekly at our facilities, and such materials are also shipped, at cost, to offsite researchers. We are always willing to provide tours of the facility. We hope that readers will recognize the value of these collections and help us, at both state and national levels, to support their preservation.

—Ron Broadhead and Peter A. Scholle

Ron Broadhead is a principal senior petroleum geologist with the New Mexico Bureau of Geology and Mineral Resources in Socorro, where he has worked for nearly 30 years. Most recently he has been involved in oil and gas resource assessments of the Tucumcari Basin, the Permian Basin, and Colfax and Mora Counties.

Peter Scholle is state geologist and director of the New Mexico Bureau of Geology and Mineral Resources. His varied career has included 9 years with the U.S. Geological Survey, 17 years of university teaching, 10 years at the New Mexico Bureau of Geology and Mineral Resources, and many years of working with or consulting in the oil and gas industry.

For more information or to schedule an appointment to visit the subsurface data library, e-mail us at atrivitt@nmt.edu

BUREAU NEWS

STATEMAP Award for 2010

The New Mexico Bureau of Geology and Mineral Resources geologic mapping program recently completed its sixteenth year of geologic mapping under the STATEMAP component of the National Cooperative Geologic Mapping Program. This program is managed by the U.S. Geological Survey and supports geologic mapping at the federal, state, and university levels. The program requires a 50/50 match of state funds to requested federal dollars. New Mexico's geologic mapping priorities are set by the 45-member STATEMAP Advisory Committee, which includes hydrologists, geologists, and planners from state, local, federal, tribal, and private organizations. This broad group of experts helps steer the mapping program to address some of the state's most pressing needs, often related but not limited to water resource issues.

For the 2009–10 mapping year, the bureau was awarded $228,572 for mapping in New Mexico. Matched with state dollars, this funding will help us complete mapping of fourteen 7.5-minute quadrangles and begin work on six additional quadrangles. Over the 16-plus-year history of the STATEMAP Program, New Mexico is ranked # 1 in acquiring federal dollars for mapping, with our cumulative awards totaling $3,263,883. Much of the success of STATEMAP is due to the requirement that maps be designed to address critical societal and/or scientific issues, including water quality, water availability, geologic hazards (earthquakes, floods, unstable soils), mineral resources, transportation, and environmental problems throughout the state. Our program has received widespread support and acclaim from political leaders, government agency scientists, university professors, professional hydrologists and engineers, water planners, and others. The New Mexico geologic mapping program will continue to be proactive in its efforts to provide timely baseline geologic information in critical areas of the state.

2009 Decision-Makers Field Conference

In May 2009 the New Mexico Bureau of Geology and Mineral Resources conducted its sixth decision-makers field conference. First conducted in 2001, these conferences are designed to address a wide range of resource and environmental issues affecting the future of New Mexico and its citizens, to provide an opportunity to visit many of the sites involved in legislative concerns, and to hear balanced opinions regarding current scientific knowledge on these matters. The 2009 conference focused on *Water, Natural Resources, and the Urban Landscape: The Albuquerque Region* and was held in Albuquerque, New Mexico. Attendees included 28 members of the state legislature. The 3-day conference included stops in the greater Albuquerque area and addressed diverse topics that included water supply and quality issues related to the Rio Grande and ground water in the Albuquerque Basin, geologic hazards, aggregate extraction, and urban ecosystems. The guidebook developed to accompany the conference includes 23 non-technical papers on these topics and is now available to the general public through our publication sales office (see back page). This year's conference would not have been possible without the generous contributions of many government agencies and other organizations, including the New Mexico Department of Homeland Security and Emergency Management, and the New Mexico Interstate Stream Commission.

Rockin' Around New Mexico

The New Mexico Bureau of Geology and Mineral Resources conducted the 2009 annual teacher's workshop, "Rockin' Around New Mexico," on July 6–8, 2009. Twenty-three teachers, representing grades K-12 from across the state, participated in the workshop, which was based in Grants. Day 1 included classroom activities associated with nuclear education, isotopic dating of rocks, and an overview of uranium geology and mining. The group went in the field on the second day, visiting the Homestake and Rio Algom reclaimed uranium mill tailings facilities and the Mount Taylor underground uranium mine. The third day included a brief overview of volcanoes followed by field stops to view volcanic features. Classroom exercises on earthquake safety concluded the workshop. Teachers talked about the value of "hands-on" experiences in broadening their understanding of the topics. They appreciated the large number of student activities, exercises, and experiments provided, and said they would use many of them in the classroom. For information on the 2010 workshop, contact Susie Welch at susie@nmt.edu.

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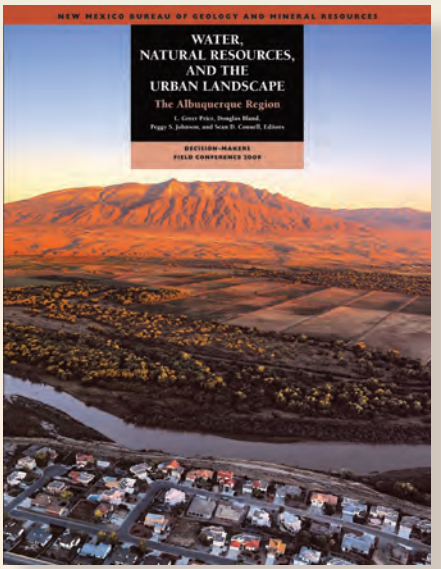

Water, Natural Resources, and the Urban Landscape: The Albuquerque Region, L. Greer Price, Douglas Bland, Peggy S. Johnson, and Sean D. Connell, editors, 2009. ISBN: 978-1-883905-27-9. *$15 plus shipping and handling and taxes, where applicable.*

This collection of 23 articles provides a broad overview of geologic and resource management issues related to the rapidly growing Albuquerque area. Written for a general audience, the articles address the most critical of these issues, including water supply strategies for the future, geologic hazards of the Albuquerque area, saline waters and deep, non-potable aquifers, and flood control challenges. Several articles provide a broad overview of the geology and hydrology of the Albuquerque region. Produced in conjunction with the sixth Decision-Makers Field Conference held in May 2009, this volume addresses a wide range of problems, solutions, and opportunities affecting the future of New Mexico. Full color.

Bibliography of New Mexico Geology, now accessible online at:
http://geoinfo.nmt.edu/libraries/gic/bibliography/home.cfm
This comprehensive online bibliography currently contains 40,000 bibliographic records. It includes all 12 published bureau bibliographies, which cover the 1800s through 1987. Bibliographic data from 1988 onward have been compiled directly into the database. Entries are indexed by keywords, county, geologic formation, and time period. The bibliography's continuing development and maintenance is directed by Maureen Wilks, the bureau's geological librarian.

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