COLORADO DEPARTMENT OF NATURAL RESOURCES

ROCKTALK

DIVISION OF MINERALS & GEOLOGY
COLORADO GEOLOGICAL SURVEY

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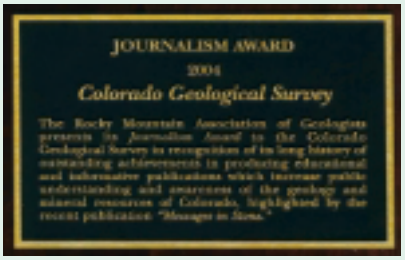
2004—A Rewarding and Awarding Year for the CGS

During 2004, work produced by the Survey garnered a number of awards, of which we are very proud. Matt Morgan received the Colorado Scientific Society's Past President's Award for the Best Paper of 2004 for his presentation of *From Buttes to Bowls: Repeated Inversions in the Landscape of the Colorado Piedmont,* coauthored by Vince Matthews, Jon Thorson, Francisco Gutierrez, and Matt Grizzell. Vince Matthews took second place in the Luncheon Papers series of the Rocky Mountain Association of Geologists for *Horsts and Grabens of Colorado's High Plains,* coauthored by Matt Morgan. *Case history of damage to a school building caused by differentially heaving bedrock,* by Dave Noe was runner up for the Outstanding Paper Award of the American Society of Civil Engineers' *Journal of Performance of Constructed Facilities*.

The CGS publication *Groundwater Atlas of Colorado* was designated a "Notable Document" by the American Library Association's government publications experts. Only five other states had a document so designated. Also, in a review published in the journal *Environmental Geology*, Dr. Phillip Lamoreaux said, *"It is truly one of the finest graphic presentations of this type of information that the Editor-in Chief of Environmental Geology is aware of. It could be a guide for any agency in the world with the responsibility of communicating with the general public as well as the scientific community in an area."*

Messages in Stone: Colorado's Colorful Geology was given the Association of Earth Science Editors' "Outstanding Book Award." *Messages* was also a Finalist for the Colorado Book Award sponsored by the Colorado Center for the Book and is being used as a text in eight colleges around the state.

And finally, the Rocky Mountain Association of Geologists gave a great tribute to the CGS through its 2004 Journalism Award. Because they chose to recognize the entire agency and its record of publication, the full text of the citation follows:



Breaking with a long-standing tradition, the Rocky Mountain Association of Geologists, for the first time, presents its 2004 Journalism Award to an organization instead of a single individual; and that is, the Colorado Geological Survey. The Survey is being recognized for its long history of outstanding achievements in producing educational and highly informative publications for the purpose of increasing public understanding and awareness of the geology and mineral resources of the State of Colorado. This citation was inspired by a recent publication that goes well beyond the Survey's statutory obligation and presents the geology of Colorado in a manner that appeals to an extremely broad public audience.

The Colorado Geological Survey began its long history of disseminating information to the public in 1909 with the publication of the First Report, 1908*—a bulletin-style volume summarizing mineral resources in the Main Tungsten Area of Boulder County and the Montezuma mining District of Summit County, as well as the geology of the Foothills Formation of Northern Colorado and the Hahns Peak Region in Routt County. In the nearly 100 years that have passed since that initial report, the Survey has issued more than 700 publications on such diverse topics as avalanche hazards, coal resources, earthquake activity, fossil occurrences, engineering geology, land use review, environmental geology, water resources, gas and oil resources, general geology, geologic hazards, geothermal resources, mineral resources, swelling soils and heaving bedrock.*

The Survey utilizes a wide range of formats and venues to promote public access to their work. In addition to the traditional paper-based format for reports, large-scale maps and cross sections, the Survey also embraces the ever popular CD-ROM technology for distribution of data-intensive studies, all of which are easily accessed by the public via its Web site http://geosurvey.state.co.us. The Survey currently provides its annual Mineral and Mineral Fuel Activity Report *and its quarterly* RockTalk *newsletter as free downloads from the Web site, as well as mailing over 15,000 printed copies free-of-charge each quarter. The Survey also utilizes venues such as the Colorado State Fair, Denver Gem and Mineral Show, professional and trade organization conferences, as well as luncheon talks to inform the public of its activities and availability of publications.*

One particular publication stands out as a significant tribute to the remarkable State of Colorado and the efforts of the Survey's geoscientists to unravel the mysteries of our complex geologic history, entitled Messages in Stone *(Special Publication 52, 2003). This masterful compilation of text and illustrative photography brings the colorful geology of Colorado alive for all audiences regardless of age or background. This outstanding volume was edited by Vincent Matthews, (now State Geologist), Katie KellerLynn, and Betty Fox. Representing a group effort, contributing authors include (in alphabetical order) James Cappa, Gary Curtiss, Tom Hemborg, John Keller, Katie KellerLynn, Susan Landon, Vincent Matthews, Matt Morgan, David Noe, Pat Rogers, Matthew Sares, Beth Widmann, Laura Wray, and Knox Williams.*

The Colorado Geologic Survey's long-standing dedication to educating the public about the geology and mineral resources of the state provides an invaluable service not only to the citizens and policymakers of Colorado, but also provides immeasurable benefit to our neighboring states in the Rocky Mountain region. For this, the Rocky Mountain Association of Geologists is pleased to recognize the Colorado Geological Survey with its Journalism Award.

From the State Geologist—

2004 was a challenging year for the CGS. A new Executive Director of the DNR, a new State Geologist, a flat appropriation for the fifth straight year, a significant reorganization, and a legislative mandate to study whether the CGS should move to the Colorado School of Mines—all created uncertainty. And, as usual, everyone rose to meet the challenges.

The year was also a rewarding one. We completed a major study on the potential for underground storage of water and aquifer recharge in Colorado that was praised by the Legislature's Joint Committee on Water Resources. We received awards and recognition for our publications and presentations from the Colorado Scientific Society, Rocky Mountain Association of Geologists, Association of Earth Science Editors, Colorado Center for the Book, American Library Association, and Department of Natural Resources.

We were able to accomplish some important updates for our operation that will enable us to carry out our work more effectively. By the end of the year we had significantly improved the quality of our office space on the 7th floor; updated everyone's computer hardware and software; organized our 12,000 land-use files into a digital, GIS database; added an earthquake layer to our interactive, Late Cenozoic Fault and Fold Map Server; created an online bookstore; scanned and geo-referenced (in partnership with USGS) all 375 of the 1:24,000 geologic maps in Colorado; and re-designed the look and feel of our Web site to be more user-friendly.

I invite you to visit our new Web presence and online bookstore. Users report that both are easy to use. If you find that they are not, let me know. What you now find on our Web site is but a taste of what is to come. We will have much, much more on Colorado geology including an excellent photo gallery. So visit early, and visit often.

Vince Matthews

Scarp Investigations on the Eastern Plains

The CGS is investigating Colorado's eastern plains for evidence of young faulting and earth movements. Unlike the state's mountain and plateau areas, not much is known about past earthquake activity in this part of Colorado. In 2004, our efforts concentrated on a 95-mile-long feature that we informally call the Anton scarp. A large trench was dug into the 80-foot high slope near Anton (~90 miles east of Denver) and described in detail. In addition, El Paso Natural Gas graciously allowed us access to their Cheyenne Plains Pipeline trench, which we logged along a 28 mile long traverse. CGS staff for this project included Vince Matthews, Dave Noe, Peter Barkmann, Jennifer McHarge, Matt Morgan, Beth Widmann, Andy Gleason, Pam Mencin, and Mary Brady. Renowned paleoseismologist, Jim McCalpin, was the contractor in charge of trenching and logging.

Geologists logging the 15-foot deep, 600-foot trench

Multiple Award Winning Publication passes 225,000 in sales!

DNR Executive Director Russell George presented Dave Noe and the CGS a "gold record" for reaching the mark of selling 225,000 copies of *A Guide to Swelling Soils for Colorado Homebuyers and Homeowners*. The book, authored by Noe, Candace Jochim and William Pat Rogers, was published by the CGS in 1997. It is the winner of both the Frye and the Burwell Awards from the Geological Society of America. Not content with success, Dave Noe is currently preparing an updated and revised edition.

Colorado Avalanche Information Opened for 22nd Season

The CAIC opened for the winter of 2004–05 on November 1, 2004. Thus, it began its 22nd season of providing avalanche services to mitigate the problems caused by snow avalanches to transportation, industry and recreation in Colorado. A staff of 12 forecasters provides education and forecast services to CDOT, Colorado ski resorts, and backcountry recreationalists—all to make Colorado's winter environment a little safer.

Avalanche Statistics and Forecasting

The following statistics from the 2003–04 winter season will help put the avalanche problem in perspective. The CAIC logged a total of 2,116 avalanches, which was slightly below the long-term average of 2,300 avalanches per winter. Avalanches reportedly caught 61 people, eight sustained serious injuries, and three were killed (which was half the average of six deaths per year). Direct property damage was estimated at only $20,000 (well below average), while economic loss was several million dollars. One example of economic loss would be revenue lost by a ski resort when the highway was blocked by avalanches.

More than 500 avalanches hit state highways, but not a single serious incident occurred. The goal of the highway forecast program is to keep Colorado highways as safe as possible to all who drive over the high avalanche-prone passes, and to the CDOT maintenance personnel who are sometimes at risk while plowing snow during and after storms. There has not been an avalanche-related highway fatality since the CAIC began working with CDOT in 1992. A secondary goal is to keep avalanche road closures to a minimum, and we are achieving that goal as well.

The CAIC daily forecasts are provided to industry clients and the public via e-mail, fax, Web site, radio stations, and seven hotlines around the state.

Education Outreach

Avalanche education and safety training is another important service of the CAIC. The CAIC offers its potentially-life-saving courses to the public and industry professionals, including CDOT maintenance personnel. Last winter the CAIC presented 95 classes to about 2,800 people. In the last 10 years, the CAIC has held 800 classes and provided safety training to about 34,000 people.

The CAIC's Web site (geosurvey.state.co.us/avalanche/) serves a valuable outreach function. Generating 1.3 million hits last year, it is a source of daily forecast information as well as educational information. The CAIC posts reports on all significant avalanche accidents, and provides avalanche statistics for the entire United States for the last several years. Finally, one feature begun in 2002 has caught the public's fancy, and that is the Danger Rose. Updated daily, the Danger Rose graphically portrays the backcountry avalanche by elevation and slope aspect (direction) for primary mountain regions. It's a quick, visual way for the public to see where the danger is concentrated.

Visit our online bookstore for a poster on Colorado Avalanches.

Large slides near the Continental Divide. Photo by Scott Toepfer.

NASA study

Matt Sares, David Bird, and consulting remote sensing geologists continued their work on a NASA grant using hyperspectral remote sensing to characterize source rocks of acid rock drainage (ARD) and downstream water quality impacts. The study area is the upper Arkansas River basin near Leadville.

Previous years focused on natural ARD in the Lake Creek watershed upstream of Twin Lakes Reservoir. This year, the focus was on the mainstem of the Arkansas River and mining-related sources of ARD. The river has little direct ARD drainage since active water treatment plants were installed on the Leadville Drain and California Gulch, but historic mine tailings washed downstream provide a continuing source of metals to the Arkansas River. Hyperspectral imagery has been processed in selected areas along the river to identify areas of tailings and characterize the mineralogy of these deposits.

Project geologists have been involved in several outreach events to explain the project to potential users of the technology. Presentations were given at NASA and EPA Headquarters in Washington, DC, National States Geographic Information Council Conference, Office of Surface Mining Geospatial Technology Conference, Tailings and Mine Waste Conference, American Society of Mining and Reclamation Conference. The project team also hosted the annual Colorado-AIPG field workshop in the project study area near Leadville.

Upper Arkansas River Basin, view to the west from Leadville Mining District. Leadville is at middle right, Turquoise Lake is just west of Leadville, and Mount Massive at the skyline on left. The CGS is carrying out NASA-funded research into natural and anthropogenic contamination of waters in this area.

Mine Subsidence Information Center

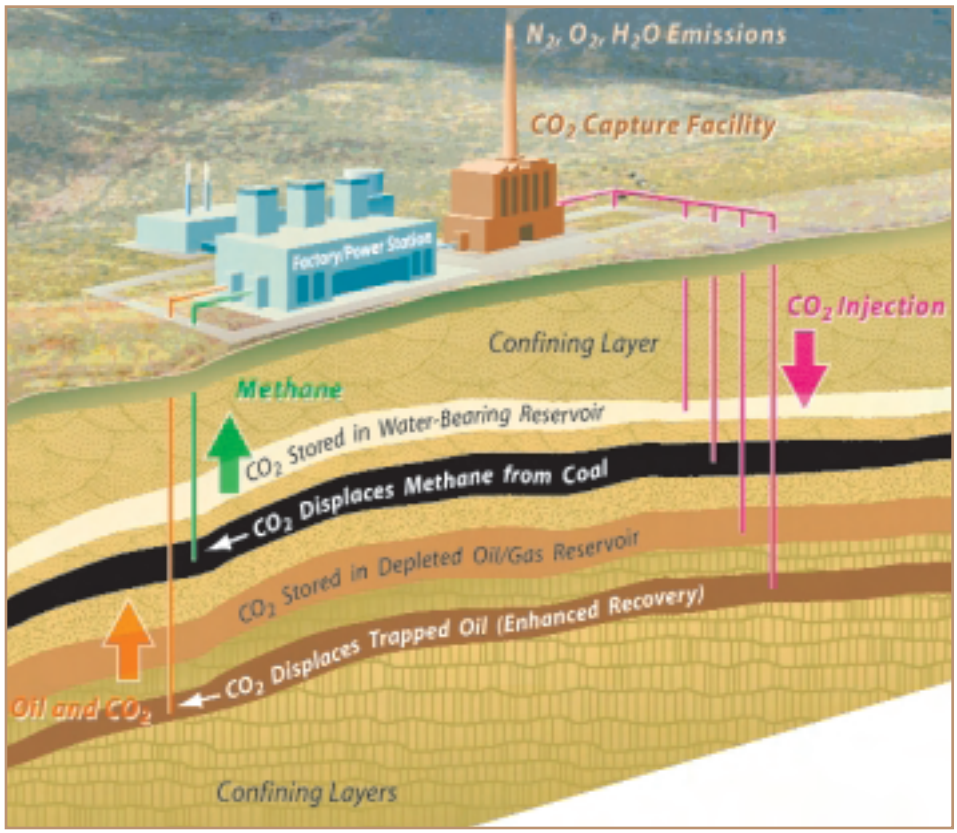
The Mine Subsidence Information Center (MSIC) is operated by the CGS under a grant from the Office of Surface Mining. Its purpose is to provide information to the public regarding the locations of abandoned coal mines throughout the state. The CGS maintains a library of reports and maps that address mine subsidence hazards and risks, and we distribute information about the Colorado Mine Subsidence Protection Program (MSPP).

We have recently upgraded our Web site to make more information available about coal mine subsidence, the MSIC, and the MSPP program (under "Programs and Projects"). Also available on the site are scanned images of Extent of Mining maps for Colorado's Front Range. About 25% of our 3,000 detailed mine map sheets were scanned during 2004; copies of these maps are available to the public at a modest charge, by special order. Celia Greenman manages this program.

Subsidence into shallow abandoned coal mines near Marshall, Colorado

CO_2 Sequestration Study

In August 2003, the U.S. Department of Energy and its National Energy Technology Laboratory announced the formation of seven regional partnerships as part of a nationwide network to study the most suitable carbon sequestration methods for specific areas of the country. The CGS (Genevieve Young, Beth Widmann, and Jim Cappa) is participating in the Southwest Regional Partnership whose primary goal is to determine an optimum strategy for minimizing greenhouse gas intensity in the southwest. The Southwest Partnership is led by the New Mexico Institute of Mining and Technology and comprises a large, diverse group of expert organizations and individuals specializing in carbon sequestration science and engineering, as well as public policy and outreach. These partners include 21 state government agencies and universities, five major electric utility industries, several oil, gas and coal companies, three federal agencies, the Navajo Nation and several non-government organizations.



Idealized diagram illustrating how CO_2 could be captured at a power plant, then injected into the ground to help produce more fossil fuel to power the facility.

In the absence of action, annual CO_2 emissions in the Southwest Partnership Region are expected to rise from 500 million tons per year (2001) to nearly 750 million tons per year by 2012. The region can offset much of this growth through various sequestration technologies. The region contains the principal CO_2 pipeline infrastructure in the country; there is the potential to offset natural CO_2 production with flue gas sequestration from the numerous large coal-fired plants, and there are diverse terrestrial, geologic, and mineralization options available. The Partnership is laying out the framework necessary for assessing optimum sequestration strategies for the Southwest Region. The main approach includes (1) dissemination of existing regulatory/permitting requirements, (2) assessing and initiating public acceptance of possible sequestration approaches, and (3) evaluation and ranking of the most appropriate sequestration technologies for capture and storage of CO_2 in the Southwest Region. The Partnership is also identifying potential gaps in monitoring and verification approaches needed to validate long-term storage efforts.

The CGS has been gathering a wide variety of geological data to evaluate geologic storage options in the Southwest Region, which include unminable coal beds, natural gas and CO_2 fields, depleted and marginal oil fields, and deep saline aquifers. One option that the Partnership is exploring is the viability of supplanting the CO_2 currently produced from natural CO_2 reservoirs (used for improved oil recovery and enhanced coalbed methane applications) with anthropogenic (man-made) power plant CO_2. Although terrestrial CO_2 sequestration appears to be a viable alternative in several parts of the Southwest Region, the Partnership recognizes that the rate of CO_2 emissions caused by drought-related forest fires and wind dispersal of cropland soil may increase under a range of plausible, dryer-than-usual climate futures. In some parts of the Southwest Region it is important to evaluate the tradeoffs associated with using saline aquifers as CO_2 sequestration reservoirs when they might ultimately be needed as a source of potable, post-desalination water for human consumption in this rapidly growing region.

Establishing and communicating the consequences and tradeoffs between alternative emissions reduction strategies is the initial step required in formulating an effective and publicly acceptable sequestration program. As additional details about the project become available, they may be accessed on the Partnership's Web site at http://southwestcarbonpartnership.org/.

Study Concerning Whether the CGS should move to the Colorado School of Mines

House Bill 04-1359 required that a collaborative study be conducted by the Department of Natural Resources (DNR) and the Colorado School of Mines (CSM) relating to the possible relocation of the Colorado Geological Survey (CGS) and the manner in which the Survey could most effectively serve the needs of the State of Colorado.

The bill required that both the DNR and the CSM appoint four people to conduct this study. The appointments made by DNR Executive Director Russell George and CSM President John Trefny included:

Department of Natural Resources

- Shane Henry, Assistant Director of DNR for Lands, Energy and Forestry
- Vince Matthews, Colorado State Geologist (CGS)
- Matt Sares, Manager of Environmental Geology Section (CGS)
- Patricia Schindler, Manager of Administration and Business Services (CGS)

Colorado School of Mines

- Murray Hitzman, Professor and Department Head for Geology and Geological Engineering
- Dan Montez, Associate Vice President for Finance and Operations
- Terry Young, Professor and Department Head for Geophysics
- Bob Weimer, Professor Emeritus and Consultant

The Committee worked on the study from early September to December. During this time the Committee:

- Held fourteen committee meetings;
- Met with the principals involved, including Rep. Ramey Johnson, DNR Executive Director Russ George, and CSM President John Trefny;
- Held a public meeting to gather feedback on the proposed scope document;
- Toured both the current space of the Colorado Geological Survey in Denver and key areas of the Colorado School of Mines' campus;
- Worked with key personnel from Mines and the Survey regarding issues pertinent to the study such as space and infrastructure needs (i.e. IT support); personnel-related items (i.e. differences in personnel systems); library capabilities; etc.;
- Created a dedicated Web site for the study: http://www.is.mines.edu/fo/Geo_reloc/;
- Had facilitated discussions on the specific items listed in the legislation;
- Conducted a study of the surrounding western states regarding how their Surveys are currently structured;
- Documented the extensive collaboration already existing between the CGS and the CSM;
- Held a second public meeting to gather feedback on the DRAFT report; and
- completed the required report and summary of public input and submitted it to the legislature.

The committee studied the benefits and disadvantages of three options:

1. No change in location or administrative structure;
2. A physical change of location and a change in administrative structure; and
3. A physical change of location, but no change in administrative structure.

Each of the three options has both benefits and disadvantages for the DNR, the CGS, and the CSM. While the committee reached a consensus that the CGS should not become part of the administrative structure of the CSM, the committee was unable to reach a consensus view on a possible physical relocation of the CGS to the Mines campus.

The Final Report of the completed study is located online at http://www.is.mines.edu/fo/Geo_reloc/.

The current and future location of the Colorado Geological Survey

Land Use Reviews

One of the CGS' prime mandates is to provide expert technical reviews of development plans for counties, cities, and school districts. These reviews are meant to ensure the geologic suitability of development projects. During 2004, we conducted over 450 land use reviews by request. This level of activity is lower than our nine-year average of 500 cases. It may indicate that Colorado's long-lived building boom is tapering off, at least for now.

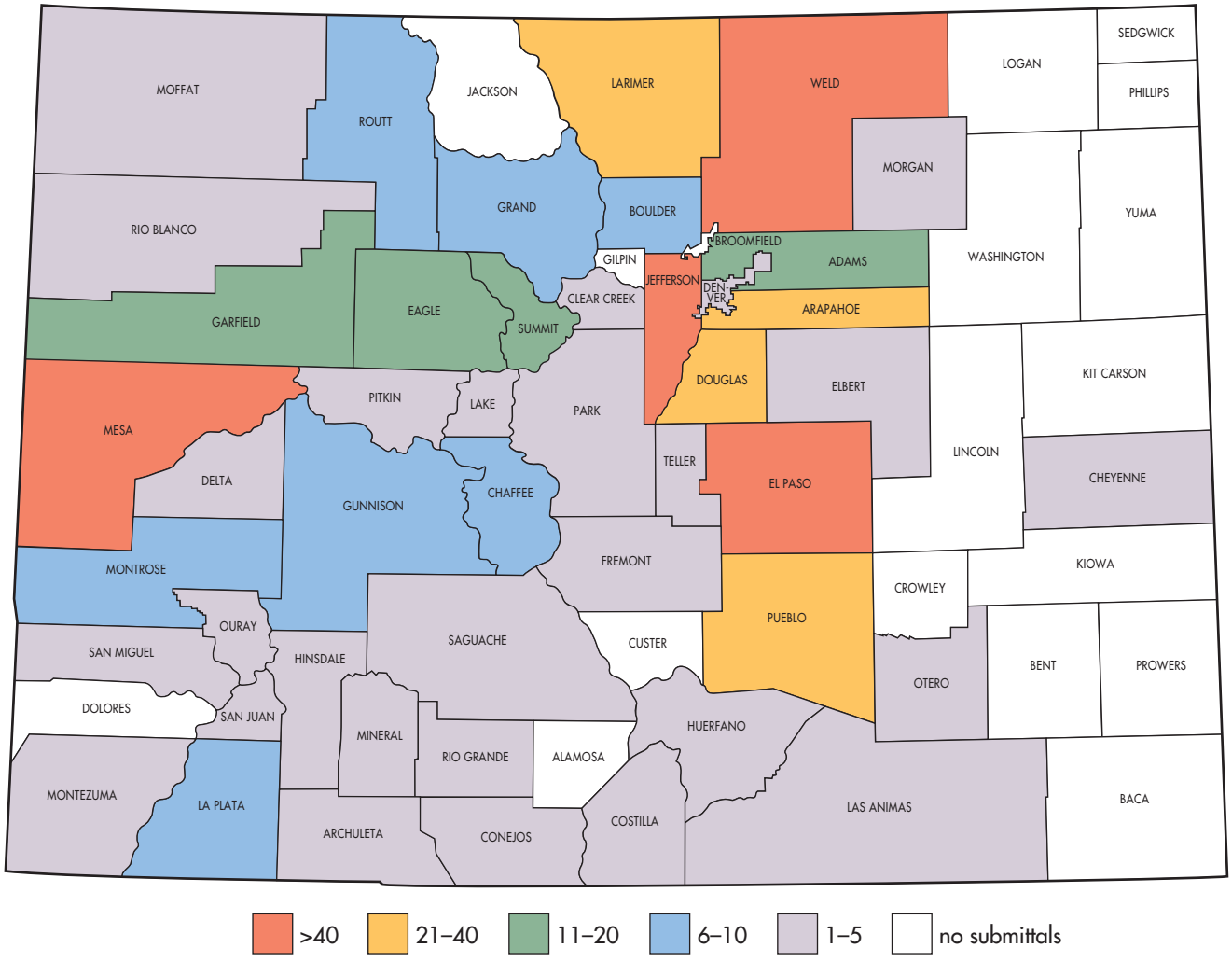
Despite the slowdown, many of the reviews we conducted were time intensive, in part due to development moving onto increasingly difficult terrain. The potential for geologic hazards is higher in many of these areas.

The CGS continues to conduct land use reviews throughout the mountain and plateau areas of central and western Colorado, and along the Front Range Urban Corridor. The following map shows that, on average, we receive the most review requests from Mesa, Jefferson, Weld, and El Paso Counties. Not far behind are Larimer, Douglas, Arapahoe, and Pueblo Counties.

The CGS Web site contains more information about the Land Use Review program (under "Programs and Projects"). Celia Greenman manages this program.

CGS geologists make on-site visits for each land use review they conduct. At the site, they look for potential geologic hazards, such as this rock that deformed a tree when it fell from above.

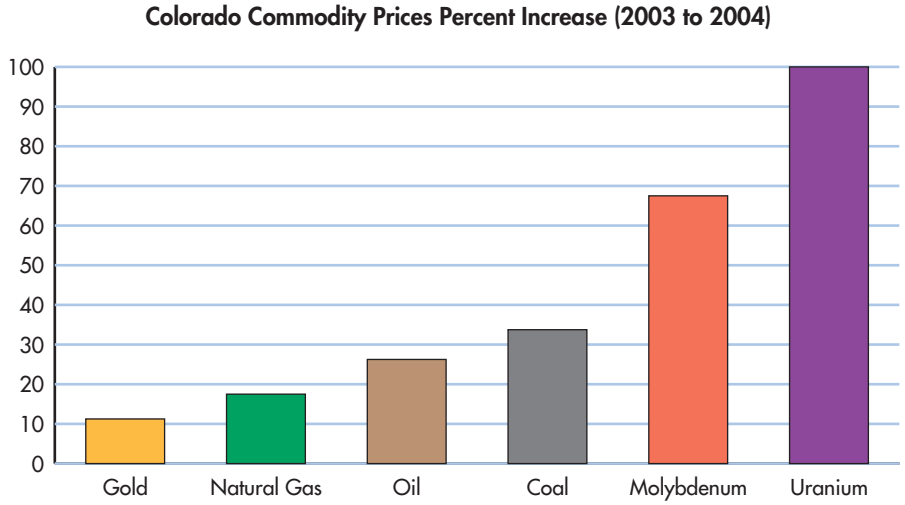
Average annual number of land use reviews conducted by the CGS, by county, 1999–2004



Value of Colorado Minerals and Mineral Fuels Soars

One of the CGS' statutory mandates is "to promote economic development of mineral resources." We must have done a good job because the value of all of Colorado's mineral and mineral fuel resources drastically increased in the past year. As an example, the price of molybdenum increased from a low of $2 per pound in 2002 to a high of $37 per pound in December 2004. Vanadium, which is often produced with uranium, increased from $1.90 per pound in December of 2004 to $9.50 per pound in February, 2005.

Historically Colorado's mineral and mineral fuel value has averaged about $4 billion per year. Last year it doubled to more than $8 billion! And, it may be close to $10 billion in 2005. Read all about it in the CGS' *2004 Mineral and Mineral Fuel Activity Report*.



Percentage Increase in Annual Average Price

Musher Madness

CGS geologist T.C. Wait was profiled, along with her sled dogs, in the December 2004 issue of *AEG News,* newsletter of the Association of Engineering Geologists. TC and her husband spend many weekends in the winter racing their dogs. In March they were Chief Handlers for a Colorado team competing in Alaska's 1,100-mile Iditarod Race.

T.C. Wait with three of her sixteen sled dogs.

Minerals

The MMF staff continues its long tradition of writing annual reports that describe the activity of the mineral and mineral fuel industries of Colorado, and their economic impact. The annual report published by the CGS in the spring of every year is a comprehensive review with production and exploration information, and news of mergers, start-ups and closures.

The CGS also writes reports for the Mining Engineering magazine for their May issue, which is an annual "round up" of mining activity by states. The narrative portion of the U.S. Geological annual minerals report is also written by CGS staff. In the fall of every year the MMF staff participates in the University of Colorado Leeds Business School Annual Business Economic Outlook Forum. This forum offers a quick review of business and production activity for each of Colorado's economic sectors and a forecast for the upcoming year.

In 2004, the CGS released a new *Directory of Active and Permitted Mines in Colorado*. The publication, released in CD format, includes a full-size, cartographic-quality map of the state showing the locations of each mine with a number corresponding to a listing in the text directory. The directory lists details of each mine, such as owner, contact information, location, annual production (if available), and basic geological information such as formation name and age. The CD contains GIS shapefiles of the mines, the directory in both Access and PDF format, and the map, which is PDF format. A full-size print of the color map may be obtained on demand from the CGS, for those without large-format printing capabilities.

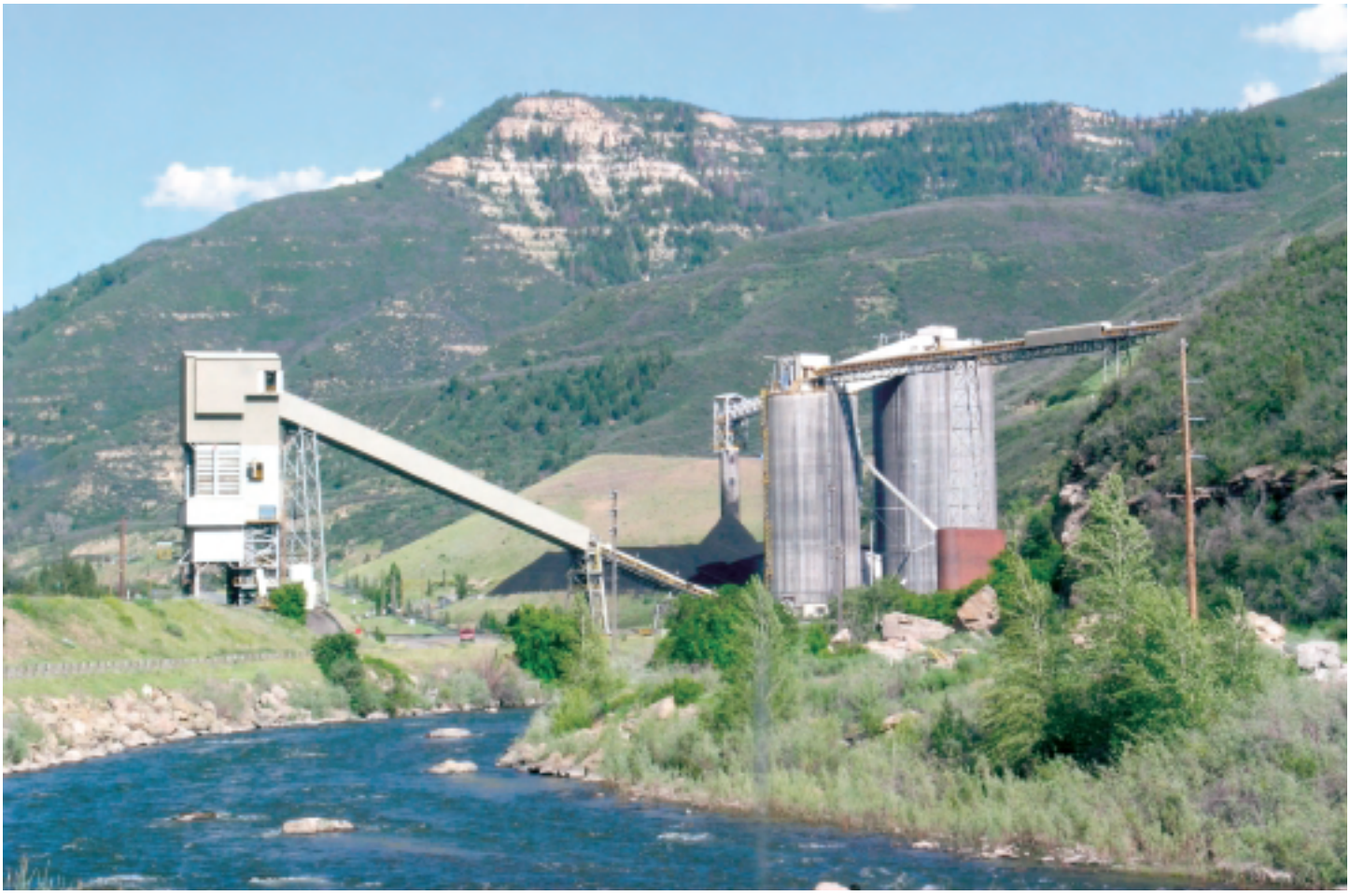
The CGS is working on a cooperative project with the U.S. Geological Survey as part of their Central Colorado Assessment Project. The CGS is updating the Mineral Resource Data System (MRDS) database, which is the major digital source of mineral resource information for Colorado and the rest of the U.S. The database was originally designed in the 1970s and various scientists have entered new data into the database periodically since that time. The CGS staff is working cooperatively with U.S. Geological Survey scientists to upgrade and update the Colorado portion of the database based on new or more complete information. The location of many of the older MRDS records are often too generalized, and sometimes they are altogether wrong; using GIS software and more careful literature research, the locations for mineral deposit records can be markedly improved.

Coal

The CGS provides the public with useful information regarding coal geology in Colorado. In 2004 the CGS published *2003 Summary of Coal Resources in Colorado,* CGS Special Publication 54. This 25-page document describes the statewide coal resources on a basin-by-basin review. Each of the eight general coal regions in the state are described in detail for geology, coal resources and production, coal quality, and mining. Information about each of the 28 coal fields is included so that the user can quickly identify many of the coal characteristics for any field. This publication is an update to six previous CGS coal summaries, which was last revised in 1995.

Other projects in 2004 include Federal Grant involvement with the U.S. Geological Survey. As part of a cooperative agreement, the CGS conducted a Coal Availability study of the Raton Mesa Coal Region. Emphasis was placed on the coal geology of the Trinidad Coal Field in Las Animas County, an area that has seen enormous growth in the coalbed methane industry recently. Using drilling information from over 400 wells in the county, the CGS compiled a stratigraphic database of coal correlations for the coal-bearing Vermejo and Raton Formations. This database, along with digital GIS shapefiles for the project was completed in December 2004. The shapefiles include geologic outcrops for the Upper Cretaceous and Paleocene rocks in the basin, coal zone (11 zones) and coal bed (41 individual beds) areal extents, railroads, roads, urban areas, state wildlife areas, faults, sills, dikes, and other pertinent files. The goal of Coal Availability project is to measure the amount of coal that can be mined in a region after subtracting the volume of coal restricted by land use and technological factors. The Raton Mesa project was the seventh annual grant that the CGS has completed.

CGS staff also completed work on the National Coal Resource Data System (NCRDS) program. This U.S. Geological Survey program is a 30-year compilation of coal quality and stratigraphic data compiled into two large databases. These national databases contain mostly public information from coal mines, drill holes, coal-bed methane wells, and measured sections of coal. The CGS is charged with compiling stratigraphic and coal quality information for the state of Colorado from regional information collected through coal availability and other studies.



Coal loading facilities and coal stockpile at the Arch Coal/Mountain Coal West Elk Mine, Gunnison County, Colorado. North Fork of the Gunnison River is in the foreground, and West Beckwith Mountain in the background.

Artificial Recharge Report Published

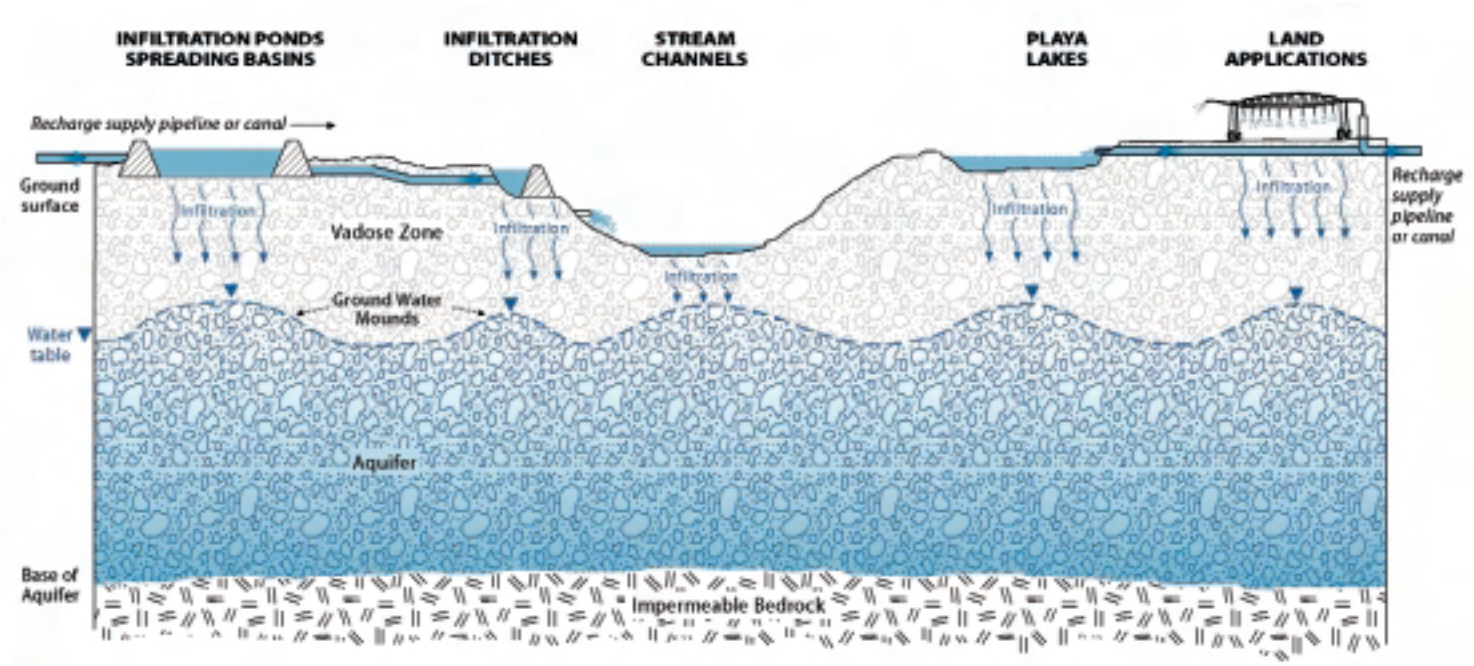
The CGS completed a major study, requested by Governor Owens, on the possibility of underground water storage in Colorado. The report, *Artificial Recharge of Ground Water in Colorado—A Statewide Assessment* examines the underground alternative to large surface-water reservoirs, by using the storage capacity available in the state's numerous and extensive aquifers.

Artificial recharge is defined as any engineered system designed to introduce water to, and store water in, underlying aquifers. The CGS first conducted a review of projects across the nation and the globe. Our study focused on a statewide assessment of the location, geology, and physical ability of various aquifers (and unconventional sites like mines and caves) within Colorado to store water through artificial recharge. Artificial recharge is not new to Colorado. In fact, the first known application of artificial recharge was in 1939 at Olds Reservoir near Keenesburg. Currently, the lower South Platte River Valley and the San Luis Valley are significant active recharge areas, recharging up to 300,000 acre-feet in wet years. The report ranks the hydrogeologic potential of various aquifers throughout Colorado to store water and has identified storage volumes available in each aquifer.

Building large new surface-water reservoirs is a complicated and costly process, requiring years—even decades—of planning and construction. Artificial recharge has the advantages of shorter term, phased implementation, much lower evaporative water loss, and adaptability to changing conditions or water management objectives. Project design can be modified as implementation proceeds based on experience, advances in technology, and changes in objectives. Because of this flexibility, underground water storage can be an attractive alternative to help water providers and planners meet future water demands.

CGS hydrogeologists have been busy getting the word out about this important study, presenting the results of the report to the Colorado Water Conservation Board, State Legislature's Water Resources Review Committee, Colorado Ground Water Commission, Colorado Ground Water Association, and the Colorado chapter of American Institute of Professional Geologists. The report is available at the CGS as Environmental Geology Series 13 (EG-13) on CD-ROM.

Denver Basin Aquifer Recharge Demonstration Project well house near Highlands Ranch. Wells used for groundwater recharge can be installed wherever the best aquifer conditions occur because of their small area of disturbance—even in the midst of a subdivision.



Examples of artificial recharge by surface infiltration methods. Water for recharge is applied at the surface in man-made or natural depressions to infiltrate down to the underlying water table.

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2004 Publications

In 2004 we were able to clear out a backlog of maps with the publication of 14 new 1:24,000 scale geologic maps. Three each were in La Plata, El Paso, Douglas, and Summit Counties; and one each in Costilla and Chaffee Counties. We have streamlined our mapmaking process to the point where we are now able to get all of our maps published within 18 months of the beginning of fieldwork.

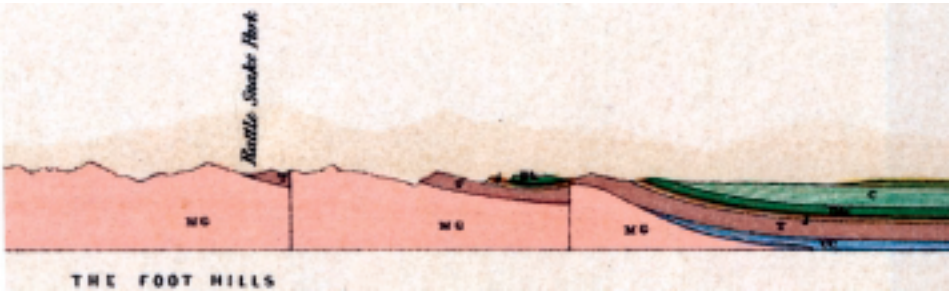
We also started a Historical Geologic Map Reprint series in which we offer the following geologic maps of the state: 1873/1877 (Hayden), 1913 (George); 1935 (Burbank, Lovering, Goddard, and Eckel), and 1979 (Tweto). We also offer six Hayden 1877 1:253,400 maps of the western ⅔ of the state and accompanying cross sections.

We have two informative, little-publicized series that contain a plethora of valuable information about mining history and mineral resources. The first is a series of reports done for the U.S. Forest Service on various mining localities around the state. Each of these reports contains a detailed history and bibliography of the prominent mines within the area, the geology of the surrounding district and deposits, and a characterization of the ground and surface water near the mines investigated.

The second is a study of the mineral resources of the 4 million acres of state-owned mineral lands. These county reports discuss the general mineral and mineral fuel potential of the entire county and each state land tract in detail. Because these lands are scattered across the state, there is probably one or more near you. The reports are a great starting point for understanding the mineral potential of each county.

Finally we started a poster series for classroom use. Currently available are posters in Colorado mineral resources, geologic hazards, avalanches, water contamination, geologic mapping, and the official state geologic symbols (rock, fossil, mineral, and gemstone). View the "Resources for Teachers" spot on our Web site.

Visit our new, online bookstore at http://dnr.state.co.us/geostore/default.aspx.



Portion of a cross section from the Hayden Geologic Atlas (1877). Reprints of sheets with nine cross sections each are available from the bookstore.

Yule Marble Becomes Colorado's Official State Rock

At the urging of a Girl Scout Troop, Representative Betty Boyd introduced a bill to make Yule Marble Colorado's official State Rock. The CGS presented testimony about the special characteristics of Yule Marble. As legislators considered the proposal, they were never very far from the real thing, because some of the floors and trim in the State Capitol Building are made of Yule Marble. It has also been used in the construction of more than 30 buildings in Colorado and more than 100 buildings across the country including the Lincoln Memorial and the Tomb of the Unknowns. For lots more information on Yule Marble, including a PowerPoint show and a poster, visit http://geosurvey.state.co.us/Default.aspx?tabid=284.

Governor Bill Owens signs the bill that makes Yule Marble Colorado's official state rock. Note the marble floor in the Capitol.

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Russell George, Director

Division of Minerals and Geology
Ronald W. Cattany, Director

Colorado Geological Survey
Vince Matthews, State Geologist

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Fax: (303) 866-2461
E-mail: cgspubs@state.co.us
Web site: http://geosurvey.state.co.us

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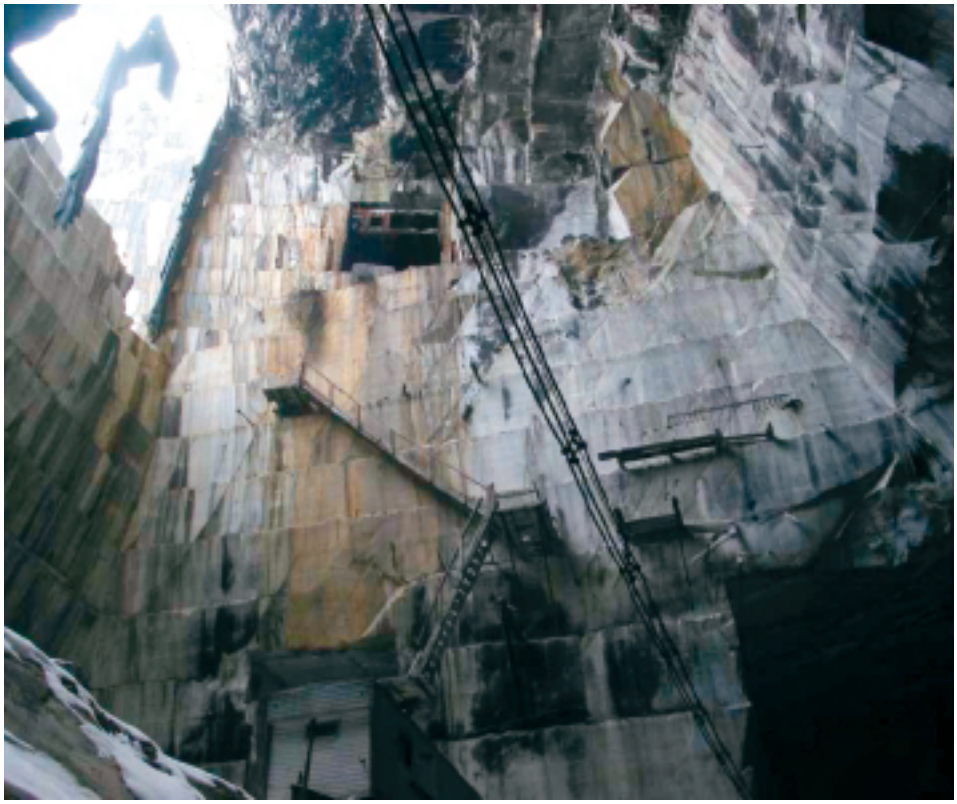

The underground Yule Marble quarry.

ROCKTALK

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Denver, CO 80203

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