

2003 IN REVIEW

CGS Expands Presence at State Fair

The CGS had a highly popular new display at the Colorado State Fair in Pueblo last August. The CGS Mineral Room in the Department of Natural Resources (DNR) Building contained two 40-foot-long glass display cases filled with material celebrating Colorado's rich natural resource and geologic heritage. Mining memorabilia, minerals, rocks, and photos illustrated some of the interesting aspects of Colorado's geology. A photographic essay informed people about how our beautiful geology can turn into dangerous hazards if not properly acknowledged.

A display of Colorado diamonds was a big hit. However, the most popular rock of the exhibit turned out to be a fake sample jokingly named glitterite!

Visitors spent considerable time reading about each exhibit, and CGS staff received many highly complimentary comments. Each year, about 50,000–60,000 adults and nearly 10,000 kids visit the DNR Exhibit.

CGS Actively Participates in Two National Meetings

Both the Association of Engineering Geologists (AEG) and

the American Institute of Professional Geologists (AIPG) held their annual meetings in Colorado this fall. CGS geologists were active in planning, presenting papers, and leading field trips. The CGS worked closely with the AEG's Rocky Mountain Section during two years of meeting planning. Jill Carlson, T.C. Wait, Dave Noe, Pat Rogers, and Jon White served on the planning committee.

As one of the leading engineering-geologic groups in Colorado, the CGS took up the challenge of participating and contributing to the meeting's success in every possible way. The CGS helped to spark pre-meeting interest by publishing a special edition of the *RockTalk* newsletter that focused on the geology of central Colorado. It was distributed to the entire AEG membership, as well as to regular *RockTalk* readers. This newsletter was also designed for the AIPG annual meeting, which took place a month later in Greenwood Springs.

CGS personnel participated in the planning, writing, and publishing of a new CD-ROM volume, *Engineering Geology in Colorado—Contributions, Trends, and Case Histories*. This publication, introduced by Governor Bill Owens and produced by the Rocky Mountain



CGS showcases Colorado's rich geological heritage at the Colorado State Fair.



Letter from the Director

The role of the CGS is to serve and inform the people of Colorado by providing sound geologic information and evaluation, and to educate the public about the important role of earth science in everyday life in Colorado.

With this edition of *RockTalk*, we provide a summary of many of the accomplishments of the CGS in 2003. In the pages that follow, we highlight some key publications, several outreach activities, the national Association of Engineering Geologists meeting in Vail, the American Institute of Professional Geologists meeting in Glenwood Springs, a new investigation into artificial recharge potential in Colorado, some interesting facts on Colorado Yule Marble, and the upcoming season of the Colorado Avalanche Information Center.

A total of 27 new publications were produced in 2003. Eight new maps were published, including a landslide susceptibility map of Colorado Springs. The map has been very useful in local land use discussions.

Groundwater Atlas of Colorado. This well-illustrated book provides a comprehensive introduction to groundwater in Colorado. Educators, water professionals, and geologists have commented on its usefulness and the *Atlas* has already been cited in a legal opinion by a Colorado Supreme Court Justice. The easy-to-understand text, diagrams and complete map coverage of Colorado's aquifers provide a wealth of information about this important Colorado resource.

Messages in Stone—Colorado's Colorful Geology. This beautiful, informative book celebrates the com-



plex and fascinating geology of the Centennial State. The thoroughly-researched, well-written book has more than 400 color images. Geoscientists, interested citizens, and college faculty are enthusiastic about this new profile of Colorado's geological heritage.

Engineering Geology in Colorado—Contributions, Trends, and Case Histories. This CD-ROM was jointly published with the Association of Engineering Geologists (Rocky Mountain Section). It contains a first-ever compilation of papers about engineering projects and incidents in Colorado where the state's challenging terrain and geologic conditions are prime considerations. The volume contains 64 technical papers by 99 authors, with 1,380 pages and 384 color pages and plates.

Paradox Basin, Colorado—Maps, Cross Sections, and Database for Oil, Gas, and CO₂ Fields. This interactive CD-ROM describes the Paradox Basin (an important oil-, gas-, and carbon dioxide-producing region in southwest Colorado). This new report utilizes innovative graphical techniques that allow the user to quickly view data, maps and cross-sections in a visually satisfying way. The report contains a searchable database of all of the fields in the Basin. Each oil and gas field report contains a data sheet on the field plus maps and cross-sections illustrating the geometry of the productive formations. The CD-ROM also contains a geological overview of the Paradox Basin, references, and Petra™ and GeoGraphix™ projects with 1,600 wells and 1,200 raster images of well logs.

A complete list of CGS publications is located on the CGS Web site. See page 4 for ordering instructions.

The CGS continues its tradition of excellence in applied geology for the citizens of Colorado.

Ronald W. Cattany



Jon White explains the function of this rockfall barrier in Glenwood Canyon to AEG participants.

Section of AEG, is a compendium of technical papers about Colorado's geology, the history and evolution of engineering geologic practice in the state, and applications in such areas as transportation, dams, tunnels, underground construction, landslides, rock-falls, earthquakes, faulting, earthquake hazards, expansive and collapsible soil and rock, groundwater and environmental

applications, mine development and remediation, and land-use planning. Jon White, Dave Noe, Peter Barkmann, Vince Matthews, and Karen Berry served as editors of various chapters.

CGS geologists authored, or co-authored, 19 of the 64 peer-reviewed, technical papers for the volume. CGS writers included Jon White, Dave Noe, T.C. Wait, Vince Matthews, Ralf Topper, Sean

Gaffney, Karen Berry, Jill Carlson, Chris Carroll, Andy Gleason, and Celia Greenman.

CGS scientists gave eleven technical presentations at the meeting. Presenters included Dave Noe, Jon White, T.C. Wait, Vince Matthews, Ralf Topper, and Sean Gaffney. The topics of discussion included a general geology overview of Colorado; evaporite karst and collapsible soil; geologic controls of subdivision damage; trenching investigations in dipping bedrock; landslide disaster relief, susceptibility mapping, and photogrammetric analysis; earthquake-hazard evaluation; natural-hazards planning; ground-water resources; and the future of engineering geology in Colorado. In addition, Dave Noe moderated a session on expansive and collapsible soil and rock.

CGS' Jon White, Vince Matthews, and Dave Noe led field trips for the AEG meeting, and Jon White led a field trip for the AIPG meeting.

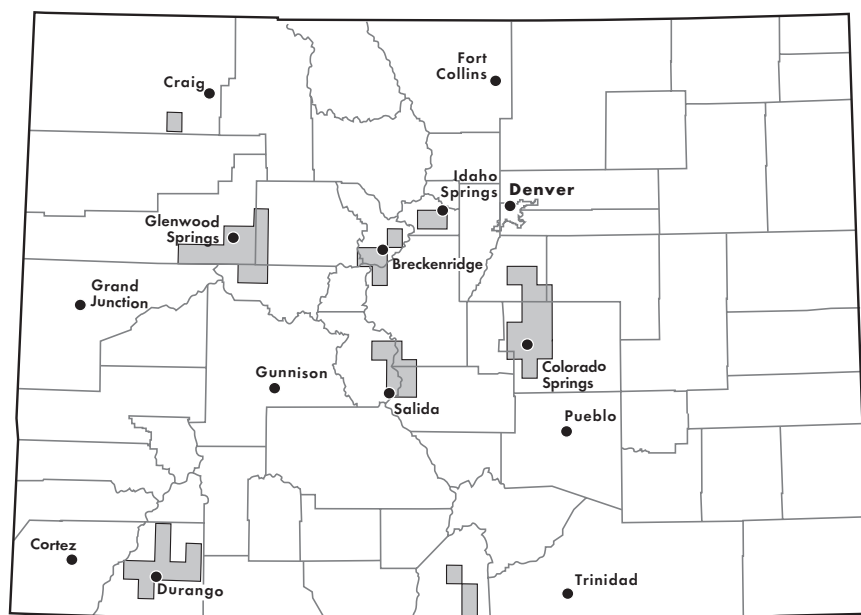
T.C. Wait helped lead a one-day workshop for middle and high school teachers. Teachers prepared lesson plans and projects that allow students to be involved in

hands-on classroom learning in the areas of engineering and environmental geology, hydrology, and the mineral industries.

CGS Completes Fiftieth Geologic Map

This past field season, the CGS completed the fiftieth geologic map under the STATEMAP component of the National Cooperative Geologic Mapping Program. STATEMAP is a partnership among the states and the U.S. Geological Survey. Funding for these maps is through a federal grant that matches state funds 1:1. The state matching funds come from severance tax paid on the production of natural gas, oil, coal, and minerals. All of these geologic maps are at a scale of 1:24,000, or about 2.7 inches to the mile. The CGS began mapping under this program in 1992.

In addition to CGS geologists, students and faculty from Fort Lewis College, Western State College, Adams State College, Colorado College, Colorado School of Mines, University of Colorado, and Colorado State University participated in this mapping effort.



Index map of Colorado showing locations of 50 quadrangles mapped by CGS.

A MESSAGE FROM THE EXECUTIVE DIRECTOR



On behalf of Governor Bill Owens, I would like to congratulate the Colorado Geological Survey on its outstanding performance in 2003.

The CGS participated in several events of national importance. The Association of Engineering Geologists and the American Institute of Professional Geologists annual meetings focused the spotlight on the geological sciences in Colorado. The Western States Seismic Policy Council recognized CGS for the first online publication in the Department of Natural Resources with its "Excellence in the Use of New Technology Award." The winning publication is *Colorado Late Cenozoic Fault and Fold Database and Internet Map Server*.

Dr. Vince Matthews accepted the prestigious award from the Council.



The CGS also participated in efforts important to Colorado's future. The assessment of underground water storage sites in Colorado is an important component of the statewide water supply assessment. The results will help the Colorado Water Conservation Board and water providers throughout Colorado identify additional storage options for future water demands.

The CGS' activities in the areas of water supply, mineral and energy assessments, geologic hazards, abandoned mine characterizations, mapping and scientific publications are key to the core mission of the Department of Natural Resources.

Greg E. Walcher

how to order CGS publications

Mail:

Colorado Geological Survey,
1313 Sherman Street,
Room 715, Denver, CO 80203

New CGS Web site address:
<http://geosurvey.state.co.us>

Phone: (303) 866-4762

Fax: (303) 866-2461

E-mail:

cgspubs@state.co.us
VISA® and MasterCard®



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SHIPPING AND HANDLING

Please contact the CGS for shipping and handling costs.

Discounts

Available on bulk orders.

Call for a complete
publication list

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Information Series 66

Directory of Colorado Water Quality
Data \$20.00

Information Series 67

Colorado Mineral and Mineral Fuel
Activity, 2002 \$6.00

Map Series 42

Colorado Springs Landslide Susceptibility
Map, El Paso County, Colorado \$25.00

Resource Series 41

Available Coal Resources of the Williams
Fork Formation in the Yampa Coal Field,
Routt and Moffat Counties, Colorado
\$15.00

Resource Series 43

Paradox Basin, Colorado Maps, Cross
Sections, and Database for Oil, Gas and
CO₂ Fields \$18.00

publications continued on p. 6

CGS Outreach Reaches Many Audiences

In its effort to inform the people of Colorado about the important role of earth science in everyday life in Colorado, CGS scientists gave 50 presentations and led nine field trips in 2003. Audiences ranged from professional geoscientists to elementary school children.

One of the major ways the CGS fulfills its mission is by publishing information through reports and maps. Last year the CGS published 27 new reports including eight maps, and sold more than 35,000 copies of its publications.

CGS Geologists Serve as Presidents of Local Societies

Jim Cappa, Chief of Minerals and Mineral Resources Section, served as President of the Colorado Scientific Society for 2003. The Colorado Scientific Society was formed in 1882, making it the oldest scientific society in the Rocky Mountains. Jim's presidential address in December was, "What's Happening in the Mineral and Mineral Fuel Industries in Colorado?"

Peter Barkmann served as President of the Colorado Ground Water Association, an organization composed of groundwater professionals and students. During his term Peter increased attendance at meetings by 50 percent and



Peter Barkmann and Jim Cappa practicing their gaveling technique

formed an alliance with the Colorado Water Well Contractors Association.

Colorado Avalanche Information Center (CAIC) Comes of Age

The CGS' Colorado Avalanche Information Center opened for its 21st season on November 1. The CAIC serves winter highway and backcountry users in two critical ways: avalanche forecasting and safety education. The impact of CAIC's efforts for residents and visitors alike are documentable and significant.

A staff of 11 forecasters is on the job to provide forecast services to Colorado Department of Transportation (CDOT), Colorado ski resorts, and backcountry recreationists—all to make Colorado's winter environment a little safer. There has not been an avalanche-related highway fatality since the CAIC began working with the CDOT. Also, road closures have been kept to a minimum. 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.

Avalanche education and safety training are other crucial services of the CAIC. The CAIC offers its potentially life-saving courses to the public and industry professionals—including CDOT maintenance personnel. One staff professional serves as Education Coordinator, while all staff forecasters share the responsibilities of teaching avalanche awareness. In the last ten years, the CAIC has taught 775 classes that provided safety training to 34,300 people. During that time, the state's avalanche-related deaths for every 100,000 in population has decreased, whereas the other four major avalanche states have all experienced a marked increase in avalanche-related deaths



An avalanche roars in the San Juan Mountains

for every 100,000 in population.

The CAIC's Web site (<http://geosurvey.state.co.us/avalanche/>) generated almost one million hits last year. The site 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. A new feature, the Danger Rose, has caught the public's fancy. Updated daily, the Danger Rose graphically portrays the backcountry avalanche conditions by elevation and slope aspect (direction) for primary mountain regions. It is a quick, visual way for the public to see where the danger is concentrated.

The following statistics from the 2002-03 winter season placed the avalanche problem in perspective. The CAIC logged a total of 2,418 avalanches. Avalanche warnings (widespread high or extreme avalanche danger) were posted on 19 days. Avalanches caught 91 people, 14 sustained serious injuries, and 6 were killed (all were near-average numbers).

Direct property damage was estimated at \$163,500, 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.) There were 704 avalanches that hit state highways, but not a single serious incident.

The CAIC was honored last winter when Francois Sivardiere, head of the French Avalanche Association based in Grenoble, chose the CAIC for a six-week sabbatical to learn more about the ways and methods of U.S. avalanche centers.

New Employees

Two new folks joined our staff since the last update—Genevieve Young and Peter Barkmann. Both are already making significant contributions to our programs.

Peter Barkmann is a hydrogeologist with 21 years of experience in the areas of groundwater resource evaluation, artificial recharge of groundwater, site hydrogeologic investigations, water well design and performance analysis, environmental site characterization and remedial design, geologic characterization, and project management. Peter has significant experience with water production wells in the Denver Basin aquifer system and is the past president of the Colorado Groundwater Association. Peter is a certified

professional geologist and is licensed in Wyoming.

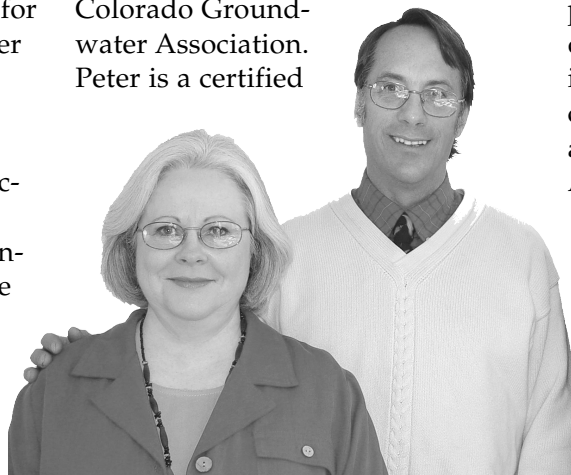
Genevieve Young is the new petroleum geologist for the Mineral and Mineral Fuels Section. She has BS and MS degrees in Geological Engineering from the Colorado School of Mines. Most recently, Genevieve worked as a consultant in the oil and gas industry. Prior to that, she worked for Advanced Resources International and other private industry firms.

Colorado's Mineral Economy Is Strong

One of the CGS' statutory charges is "to promote the economic development of mineral resources." The mineral and mineral fuel resources segment of Colorado's economy continues to be strong. Each year the CGS prepares and publishes a full report on the natural resource industries in Colorado. Also, the CGS contributes information to the Business Economic Outlook Forum sponsored by the University of Colorado's Leeds School of Business.

The year 2003 is estimated to be the seventeenth straight year that natural gas production has increased in Colorado. Coal production also appears headed for a new record. Oil production is predicted to be constant for the fifth straight year; this is a significant accomplishment because Colorado's oil production suffered a five-year decline prior to 1999. The oft-ignored but crucial production of crushed stone and sand and gravel also showed an increase last year. And, the always-alluring gold continued to pour out of Colorado's mountains at a rate, only 12 percent below the modern record year of 1996.

Colorado's history is the development and use of natural resources. This aspect of the economy continues to be signifi-



publications continued from p. 4

Special Publication 52

Messages in Stone, Colorado's Colorful Geology \$16.95

MESSAGES IN STONE

Colorado's Colorful Geology



Special Publication 53

Ground Water Atlas of Colorado

\$40.00

Special Publication 55

Engineering Geology in Colorado: Contributions, Trends and Case Histories \$30.00

Open-File Map 01-1

Geologic Map of the Castle Rock Gulch Quadrangle, Chaffee and Park Counties, Colorado \$10.00

Open-File Map 01-2

Geologic Map of the Gibson Gulch Quadrangle, Garfield County, Colorado \$10.00

Open-File Map 02-2

Geologic Map of the Elsmere Quadrangle, El Paso County, Colorado \$9.00

Open-File Map 02-3

Geologic Map of the Keystone Quadrangle, Summit County, Colorado \$9.00

Open-File Map 03-2

Geologic Hazards of the Georgetown, Idaho Springs, and Squaw Pass Quadrangles, Clear Creek Counties, Colorado \$15.00

Open-File Map 03-4

Published Faults of the Colorado Front Range \$25.00

Open-File Map 03-6

Geologic Map of the Black Forest Quadrangle, El Paso County, Colorado \$10.00

Open-File Map 03-8

Geologic Map of the Falcon NW Quadrangle, El Paso County, Colorado \$9.00

Open-File Report 03-13

History, Geology, and Environmental Setting of the Southern Cross and 7D Mines, Hahns Peak Mining District, Routt National Forest, Routt County, Colorado \$18.00

Open-File Map 03-15

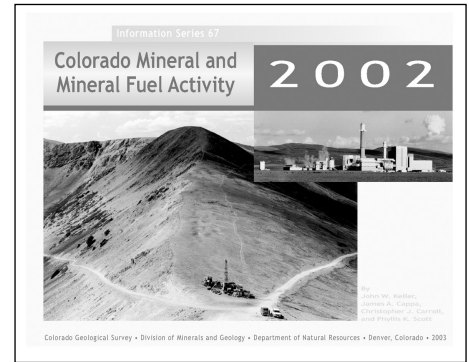
Geologic Map of the Taylor Ranch Quadrangle, ? County, Colorado \$9.00

Open-File Reports 02-23; 03-5,7,10,11,12

Evaluation of Mineral and Mineral Fuel Potential of (Weld; Lincoln; Las Animas; Crowley and Otero; El Paso; Douglas and Elbert; Adams, Arapahoe, and Denver; Baca) Counties State Mineral Lands Administered by the Colorado State Land Board

(call or check Web site) \$15-20.00

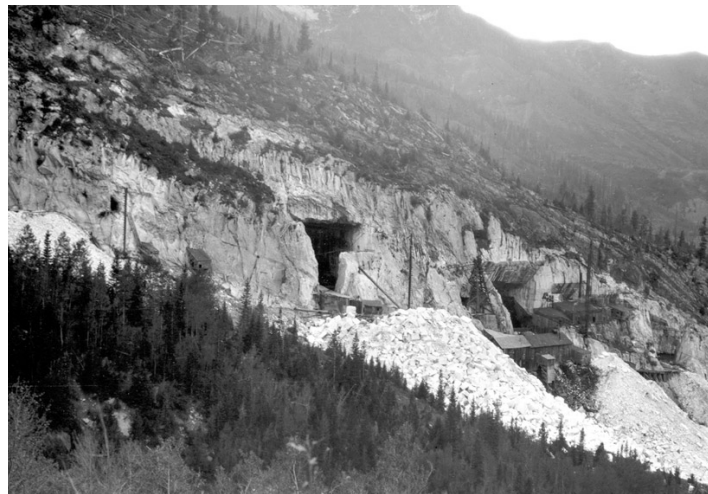
cant. The production of mineral and mineral fuels in the state averages about \$4 billion each year in actual revenue and contributes \$6.1 billion to the gross state product. More than 13,000 Colorado citizens earn a living directly from these industries, and many more benefit economically. Direct income to state and county budgets is over \$200 million per year. Colorado ranks fifth in the nation in natural gas reserves, eleventh in oil reserves, first in coalbed methane reserves, and second in bituminous coal reserves.



Be the most informed on your block by reading CGS' annual MMF activity report.

Yule Marble Proposed for Official State Rock

At the urging of Girl Scout Troop 357, Representative Betty Boyd is planning to introduce a bill to make Yule Marble Colorado's official state rock. As legislators consider this proposal, they will never be very far from the real thing; the stairs and floors of the State Capitol 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.



Yule Marble Quarry circa 1935

Yule Marble is unique in several ways. The marble was formed from Leadville Limestone by contact metamorphism, whereas the Vermont and Georgia marbles were formed by regional metamorphism. The wide spacing of the natural fractures allows the producer to quarry larger blocks than most other quarries in the world. The character of the marble is exceptional and is better for sculpting than Michelangelo's favorite Carrara Marble. Its chemical purity, as well as its small and uniform grain size, has led to its use in many experiments in rock mechanics.

The geology of the marble and the history of the town of Marble are fascinating parts of Colorado's history. For more information, visit the CGS Web site at http://geosurvey.state.co.us/general_info/YuleMarble_files/frame.htm for an online slide show on Yule Marble.

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Water Storage ... Underground?

If water is the essential lifeblood needed to make Colorado livable and economically strong, then water storage is its heart. Throughout the Centennial State's history, its semi-arid climate, periodic multi-year drought cycles, and population growth have all conspired to highlight the need for water storage. Once again, recent drought and population growth have made Coloradans critically aware of the need for additional water storage to support the current economy and projected growth.

Historically, surface water reservoirs have been the primary means of storing water to meet Colorado's needs. For several reasons, building large new reservoirs has become more complicated and costly, requiring years—even decades—of planning and construction.

At the request of Governor Bill Owens, the CGS is studying alternative means of increasing water-storage capacity by storing water underground through artificial recharge. Artificial recharge is defined as any engineered system designed to introduce water to, and store water in, underlying aquifers.

One of the most compelling advantages of incorporating artificial recharge in a water management plan is adaptability. A project can be installed in a phased manner that can translate into vastly reduced costs. Project design can be modified as phases progress based on experience, advances in technology, and changes in objectives. This is in sharp contrast to many surface-

water storage facilities that may need to be installed at full capacity at the start.

The CGS study's focus is a statewide assessment of the location, geology, and the physical ability of various aquifers within Colorado to store water through artificial recharge. Artificial recharge is not new to Colorado. The study is also documenting current and past artificial recharge projects within Colorado. There are at least 17 active and 19 inactive artificial recharge operations in Colorado.

Although the study focuses on Colorado, the use of artificial recharge in the U.S. and internationally is being researched to investigate best-practices that might be applicable to Colorado. Artificial recharge projects have been documented in at least 32 states in the U.S. and at least 26 countries worldwide.

Unconventional types of underground water storage are also being assessed, such as the use of abandoned coal mines, metal



Dillion Reservoir and dust being blown from the dry lakebed during the summer of 2002. Stranded boat docks in foreground.

mines, and caves as water storage vessels. One coal-mine recharge project is being implemented by the city of Arvada at the Leyden

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Mineral Fuels

Chris Carroll, Genevieve Young

Minerals

John Keller, Beth Widmann

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THIS ISSUE

Editor: Vince Matthews

Production: Cheryl Brchan



An artificial recharge facility in Highlands Ranch has low visual impact.

Mine—a former natural gas storage facility north of Golden.

Artificial recharge of groundwater is one strategy among several that can help meet current and future water demands. Other ways to help our water situation include conservation, surface water reservoir enhancement, rehabilitation of existing reservoirs, and inducement or enhancement of natural groundwater recharge.

The CGS will present the results of its current investigation at the March meeting of the Colorado Water Conservation Board.

Colorado Geology Book Sales Booming

Messages in Stone—Colorado's Colorful Geology (Special Publication 52) was released in time for the Colorado State Fair this summer. It became the best

seller at the Department of Natural Resources store during the Fair. The book was used as a text during the fall semester at a local college. While this publication is written for the general public, it is also of interest to professional earth scientists and students. It not only displays Colorado's fantastic geologic features, but also serves as a primer on geologic principles and concepts. Three broad categories are discussed and illustrated: Colorado's rocks and structures; Colorado's geologic history; and the impact of Colorado's geology on humans

which includes water, economic resources, and geologic hazards.

Dr. Vince Matthews, senior editor for the publication, said, "This heavily illustrated book discusses the breadth and depth of Colorado's rich geologic resources. I knew that Colorado's geology was special, but researching this book made me aware of many new and exciting facets of the State's well-displayed, diverse geology. We are fortunate to have had so many talented people contribute their knowledge, photographs, and time to make this publication enjoyable and informative."

CGS GARAGE SALE

Order by March 15; Call Betty at 303-866-4762

- 50¢** —Proceedings of Symposium on Geothermal Energy and Colorado
- A Summary of the Geology of the San Luis Basin, Colorado
- \$1** —Bibliography and Index of Colo. Geology, 1875 to 1975
- Snow-Avalanche Hazard Analysis for Land-Use Planning and Engineering
- Colorado Coal Analyses, 1975
- Geothermal Energy Development in Colorado
- Geology and Resource Potential of Strategic Minerals in Colorado
- Inventory of Nonmetallic Mining and Processing Operations in Colo.
- Mineral Resources Survey of Mesa County: A Model Study
- Geothermal Resources Assessment of Canon City Area, Colorado
- The Governor's First Conference on Environmental Geology
- Hydrogeologic and Geothermal Investigation of Pagosa Springs
- Proceedings of the 33rd Annual Highway Geology Symposium
- Debris-Flow Hazard in the Immediate Vicinity of Ouray, Colorado
- \$2** —Bibliography and Index of Colorado Geology, 1984-1989
- Proceedings of a Conf. on Coal Mine Subsidence in the Rocky Mtn. West



ROCKTALK

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