

GEOLOGICAL SOCIETY OF AMERICA MEETING HIGHLIGHTS CGS ACTIVITIES

CGS's Scientific Contributions

Having Denver as the site of the annual meeting of the Geological Society of America (GSA) made October an exciting month for CGS, and gave the agency a perfect opportunity to showcase both the quality and quantity of its project results and its talented staff. CGS scientists organized and led field trips, organized and co-chaired topical sessions, and presented talks, papers, and posters. Approximately 6,300 people attended this 114th meeting of GSA, and CGS scientists made good use of the broad exposure. Many of these activities and results represent partnerships with other geoscientists. We appreciate the many people and organizations with whom we cooperate.

The attractive CGS booth (below), designed and assembled

by Larry Scott and Jason Wilson, gave geologists from all over the world a chance to learn more about the geological aspects of Colorado. The exhibits created for GSA are also used for many other outreach events. In addition to showcasing CGS activities, the booth affords an excellent opportunity for selling our publications.

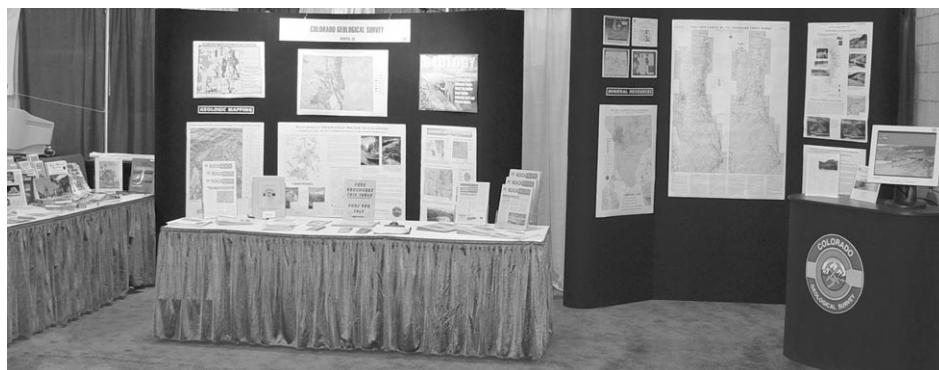
Field Trips

CGS geologists led three of the field trips offered by GSA and attended by geologists from across the country. Bob Kirkham, Chris Carroll, Celia Greenman, and Dave Noe organized and led trips along the Front Range and in the Glenwood Springs area. The trips viewed features of Colorado evaporites, river incision, coal mining, subsidence, and geologic hazards.

Chris Carroll and Celia Greenman led a field trip along

the Front Range called "Modern-Day Consequences of Historic Coal Mining in the Foothills and Boulder-Weld Coal Fields, Colorado." They showed the participants the extensive areas of mining, discussed the historical aspects of mining, and highlighted hazards associated with the old mines such as subsidence and coal fires. They also threw in a little local geology for the out-of-towners. Chris Carroll built his part of the field trip upon the information gathered for his new publication, *Historic Coal Mines of Colorado*. Celia drew on her experience as manager of the CGS Subsidence Library that archives old maps and plans of abandoned coal mines, and from her experience in fielding questions about mine subsidence hazards along the Front Range Urban Corridor.

Bob Kirkham was a co-leader on a field trip entitled "Active Incision-Driven Evaporite Tectonism, Glenwood Springs, Colorado." This



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THE SCIENTIFIC METHOD

Each January, the Colorado Geological Survey looks back at our activities and we present that information to you, our readers, as our first *RockTalk* of the new year. This year, in a variation on that theme, we've decided to tell you about our activities at the international gathering of the Geological Society of America (GSA).

With 16,000 members in 85 countries, GSA's annual meeting attracts scientists from virtually every specialty in the geosciences. Although it is headquartered right here in Colorado, GSA's annual meeting is held in major cities all over the country. Having the GSA meeting in Denver in November 2002 was an exceptional opportunity for CGS scientists to meet with their peers and discuss our work and results of the last few years.

Science moves forward based on this kind of vigorous peer-review process. A good scientist starts with the best available information then adds new ideas and moves the concept along. Scientists may work alone, or in small groups, for weeks or months or even years! But, it is critical that the scientists share their methods and results with other experts in the field; only then will the conclusions be widely accepted. Discussion and debate, often very vigorous, means that only the best ideas with strong documentation and theoretical underpinnings go forward.

Thus, this fall's GSA meeting in Denver gave our CGS scientists

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trip was an exposé of the important scientific findings from CGS's geologic mapping program in the Glenwood Springs area. CGS geologists mapped twelve 7.5-minute quadrangles covering more than 600 square miles. The studies revealed a large area where groundwater dissolved huge volumes of evaporite causing a one-half mile vertical collapse of the ground surface. Precise dating of young volcanic flows of different ages and paleomagnetic analyses complemented the mapping and helped document the timing and extent of collapse. These studies also documented the incision history of the Glenwood Canyon over the last ten million years. The mapping and dating demonstrated that two-thirds of the canyon was cut during the past three million years.

Dave Noe co-led a field trip on how to lead a field trip for the public. His trip, "Consequences of Living with Geology: A Model Field Trip for the General Public," was co-sponsored by GSA Engineering Geology Division, GSA Geoscience Education Division, and American Institute of Professional Geologists.

Dave showed the participants sites along the Front Range affecting everyday life in Colorado including mine subsidence, flooding, underground gas storage, swelling soils, and natural-resource deposits and discussed how such features affect us. This trip was to educate geologists on how to present geologic hazards and mitigation possibilities to the public, and on decision makers. The trip grew out of the many successful trips Dave and his group have led, particularly his popular "Bouncing Boulders, Rising Rivers, and Sneaky Soils."

Session Convenors

Peter Barkmann and **Vince Matthews** each co-sponsored and co-chaired topical sessions of oral presentations. Peter's session was

entitled, "Denver Basin Bedrock Aquifers-Past, Present, and Future." Eleven papers in the session covered a wide spectrum of technical, administrative, and water management topics of this important issue for the citizens of the Front Range. This session received good coverage in the *Rocky Mountain News*.

Vince's session was called "Rumbling in below the radar: Earthquake hazards in areas where seismic potential is underrecognized" and had ten papers covering a variety of topics in areas such as Colorado, New Mexico, Utah, Missouri, the Central U.S., Massachusetts, India, and Jordan. The session highlighted the common problems of adequately identifying the earthquake hazard in high-risk, low probability areas, such as Colorado.

Oral Papers Presented

CGS geologists presented a total of eight oral papers on a variety of topics.

Karen Berry presented a paper on mitigation efforts for a subdivision on the flanks of Table Mountain in Golden. Her analysis showed that a fire on the mountain could subsequently lead to severe erosion problems. She calculated the volumes of sediment likely to threaten the subdivision in order to design a proper catchment basin in order to protect the new homes from damage. Her talk was entitled "Designing for post-fire erosion and sedimentation: A Colorado case study." Karen has been involved in a variety of erosion prevention efforts in Colorado. CGS has produced erodible soils maps for Jefferson and Douglas Counties.

Karen Morgan talked about CGS's first online publication. The title of her talk was "Colorado Late Cenozoic Fault and Fold Database and Internet Map Server: User-



Chris Carroll pointing out a feature on the field trip that visited old coal mines along the Front Range.

friendly Technology for Complex Information." Co-authors were **Matthew Morgan, Beth Widmann, Robert Kirkham, and Randal Phillips**. Following Karen's successful presentation of the paper, the group was asked to contribute the paper in written form to a special topical-issue of the Journal of Environmental and Engineering Geosciences. Karen described the user-friendly capabilities of this database which is tied to an online map server. The map shows the known Late Cenozoic faults (those that cut Miocene or younger strata) color-coded by age including four different colors for faults that cut Quaternary strata. The user can zoom to different levels and activate or de-activate six different layers. Double clicking on a fault brings up a data sheet for that fault listing a host of information such as length, sense of movement, geomorphic expression, age of faulted deposits, and references.

Try it for yourself at <http://geosurvey.state.co.us/pubs/ceno/index.htm>.

Peter E. Barkmann presented a paper on "Vertical Hydraulic Connection Between Aquifers Within the Denver Basin in the Vicinity of

Parker, Colorado." He reported on studies that show there is less vertical conductivity between aquifers than previously thought. Peter and his co-author took a core sample from the aquifer under Parker. Analyses of the rock in different parts of the core demonstrate that water will not flow through the rock easily in all zones. This shows that although there may be as much water beneath Denver as in Lake Erie (as some claim), it may not be possible to get as much of it out of the ground as previously anticipated. The ramifications of this discovery are not good news for future water supplies in the Denver Basin, and show that much better characterization of the basin is needed.

T. C. Wait presented a paper co-authored by **Jon White** on "Landslide Susceptibility Mapping in Colorado Springs, Colorado." Here they reported on CGS's mapping in the STATEMAP program and their studies in the Colorado Springs area evaluating the landslides for FEMA and preparing a GIS-based Landslide Susceptibility Map for the city of Colorado Springs. They noted that Colorado Springs experienced damaging

landslides in 1995 and 1999 which led to a more receptive environment for mitigating the effects of landslides. As development spreads into higher ground, the risk of landslides increases.

Vince Matthews gave a paper entitled "Is Colorado a Low-Hazard Area for Earthquakes?" He reported on the growing body of knowledge that suggests that Colorado may not be as safe from earthquake damage as widely believed. He also illustrated why it is so difficult in Colorado and the rest of the Inter-Mountain West to obtain the kind of geologic information necessary to make an impact on the National Earthquake Hazard Maps.

Sean Gaffney presented a paper co-authored with **Jon White** on "Instrumentation of the Debeque Canyon Landslide at Interstate 70 in Western Colorado." The paper is an outgrowth of the studies that CGS and the Colorado Department of Transportation (CDOT) have conducted for four years on this massive landslide. The instrumentation records the movement of various parts of the slide, and also triggers an alarm alerting investigators when there is a sudden movement. The landslide continues to creep at a steady rate but also has periodically moved suddenly, disrupting the roadway. In 1978 the road surface heaved 21 feet vertically. In 1998 it heaved 14 feet vertically and nine feet laterally. A catastrophic release of the rock mass could block the highway and Colorado River.

Matt Sares and David Bird co-authored a paper entitled "Characterization of Acidic Drainage through Ground and Hyper-spectral Remote Sensing." Matt reported on their NASA-funded project that evaluates remote-sensing techniques to determine whether they can be used as a means to distinguish between natural and human sources of acid and metals in a drainage. The first part of their

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Historic Coal Mines of Colorado \$15.00

Information Series 65

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Map Series 34

Collapsible Soils and Evaporite Karst
Hazards of the Roaring Fork River Corri-
dor, Garfield, Eagle, and Pitkin Counties,
Colorado \$8.00

publications continued on p. 6

study is going on in the Lake Creek drainage, a tributary to the Arkansas River. The second part of the study will concentrate on the upper Arkansas River between Leadville and Granite. This grant was made possible because of the groundbreaking work done by CGS on natural causes of acidic stream contamination reported on in our 2000 open file report, "Naturally Degraded Surface Waters Associated with Hydrothermally Altered Terrane in Colorado."

Dave Noe's presentation, "Bentonitic Claystone-Geologic Hazards, Engineering Properties, and Land Use Issues," explained how expansive soil and bedrock, as well as landslides, are major hazards associated with bentonitic claystones. These hazards cause substantial damage to homes, public buildings, utility infrastructure, roads and other transportation corridors in Colorado and throughout North America. He further talked about a procedure in south-west Denver that is helping to mitigate these possible hazards. CGS's



PowerPoint presentation of CGS activities and programs. This flat-screen monitor was connected to a laptop that continually cycled through a presentation showing the various aspects of CGS activities to participants at the Geological Society of America Annual Meeting.

award-winning publication (SP 43) on swelling soils is written for homeowners dealing with these issues and has now sold more than 150,000 copies.

Dave also co-authored a paper entitled "Field Reflectance Spectroscopy as a Tool for Determining the Swell Potential of Smectitic Soils." The paper reported on a 100-foot-long and fifteen-foot-deep trench dug to measure reflectance properties of the Pierre shale that is so damaging to homes in south-west metropolitan Denver. More than 30,000 measurements were taken of the soils exposed in the trench. The ultimate goal of the study is to determine whether remote sensing can detect these potentially damaging soils.

Poster Presentations

In addition to the formal, oral presentations, GSA sponsors poster sessions in which a geologist is assigned a booth wherein she/he displays illustrations about a particular topic of their work. Other geologists can peruse their illustrations at their leisure and then discuss/debate the conclusions with the author(s). Occasionally, several geologists may drop by and join in spirited discussions. Remember the axiom, three geologists, four opinions.

Jon White and Bob Kirkham co-presented a poster session entitled "Evaporite Karst Hazards of the Lower Fork River Valley, West-Central, Colorado." This presentation was an outgrowth of the geologic mapping that Bob did on nine quadrangles in CGS's STATEMAP program in the Glenwood Springs area and White's new publication, "Collapsible Soils and Evaporite Karst Hazards of the Roaring Fork River Corridor, Garfield, Eagle, and Pitkin Counties, Colorado." Their poster illustrated hazards such as sinkholes, ground fissures, subsidence troughs, and high concentrations of dissolved salts in surface and groundwater in

the area south of Glenwood Springs.

Dave Noe co-presented a poster entitled "Geologic Field Trips for the General Public" in a session on Geoscience Education. His display illustrated useful ideas and techniques illustrated in the field trip that he co-led before the meeting entitled "The Consequences of Living with Geology." Educating the public and decision makers on the ramifications of developing in areas of geologically hazardous conditions is a growing interest nationwide, and CGS helps provide this service in Colorado.

Although the GSA annual meeting highlighted many activities of CGS, it was only the tip of the iceberg for 2002.

from the director continued from p. 2

the opportunity to present their work to other leaders in our fields. Tested and honed, this work now comes back to CGS, where we will continue our primary activity of producing practical applications from these scientific results. All of this is done to facilitate the mission of CGS "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 sciences in everyday life in Colorado."

In this *RockTalk*, we present a short overview of the many and varied studies on which CGS scientists are working. We invite you to take a look, and be assured that we are observing good scientific practices. Expect to see maps, books and Web sites in the coming year that provide the results of the studies to you, the citizens of Colorado. And, as always, please don't hesitate to contact any of us at CGS to learn more about our projects.

OTHER OUTSTANDING CGS PROJECTS AND EVENTS THIS PAST YEAR

CGS Co-hosts the Western States Seismic Policy Council (WSSPC) Annual Conference

Vicki Cowart and Tommy Grier, directors of the Colorado Geological Survey and the Colorado Office of Emergency Management (OEM), co-hosted the WSSPC Annual Conference held in Denver in September. The theme of the conference was "Earthquake Risk: From Awareness to Action-A Mile High Challenge." The conference focused on "Low Frequency, High Consequence Events," which are particularly applicable to Colorado.

Vince Matthews organized the traditional pre-meeting field trip and co-led it with Jim McCalpin of GEO-HAZ Consulting, Jeff Coe of the USGS, and Jeff Brislawn of the OEM. Participants traveled along Trail Ridge Road in Rocky Mountain National Park, and viewed sackungen features up close and personal. Many participants had not heard of these features, which are widespread throughout the alpine areas of Colorado and can be confused with young faulting. Discussions of the geology and emergency response to the Lawn Lake Flood of 1982 and the Big Thompson flood of 1976 stimulated much interest in the high flood hazard in Colorado's narrow canyons.

Vicki Cowart chaired a panel on "Why Data Make a Difference." Panel members were Art Frankel, head of the United States Geological Survey's Earthquake Hazard Mapping team, and **Vince Matthews**, CGS's Senior Science Advisor. Both agreed on the necessity of obtaining much more data in Colorado and on the difficulty of obtaining it.

Federal Grants

During 2002, CGS received 14 grants from a variety of federal agencies, including: the National Science Foundation; the U.S. Geological Survey, the Office of Surface Mining, the National Aeronautics and Space Administration, the Environmental Protection Agency, and the U.S. Forest Service. These grants supported work in geologic mapping, mine subsidence, natural degradation of waters, wetlands, coal, earthquake hazards, abandoned mine sites, post-fire geologic hazards, avalanches, and swelling soils.

Mineral Resources

Mineral and Mineral Fuel Resources saw another productive year. In addition to the annual *Mineral and Mineral Fuel Industry Activity Report*, the group produced a variety of useful and interesting products. A database and map of bottom-hole temperatures in the Denver and San Juan Basins compiles information from more than 11,000 wells. The CD-ROM of historic coal mines in Colorado documents 1,737 coal operations between 1864 and 2002. Evaluations of mineral resources on lands administered by the State Land Board were completed for Archuleta, Bent, Delta, Hinsdale, La Plata, Logan, Mesa, Mineral, Ouray, Pueblo, Rio Blanco, San Juan, San Miguel, and Washington Counties, and were released on CD-ROMs.

Open-File Report 01-3

Geologic Map of Pikeview Quadrangle, El Paso County, Colorado \$10.00

Open-File Report 01-5

Geologic Map of Georgetown Quadrangle, Clear Creek County, Colorado \$10.00

Open-File Report 01-11

History, Geology, and Environmental Setting of the Tweed Mine, Pike/San Isabel National Forest, Chaffee County, Colorado \$15.00

Open-File Report 01-12

History, Geology, and Environmental Setting of the Lienhart Mine, Pike/San Isabel National Forest, Chaffee County, Colorado \$15.00

Open-File Report 01-13

History, Geology, and Environmental Setting of Selected Mines in the Chalk Creek Mining District, Pike/San Isabel National Forest, Chaffee County, Colorado \$15.00

Open-File Report 01-14

History, Geology, and Environmental Setting of the Griffin and Wilkesbarre Mines, Pike/San Isabel National Forest, Lake County, Colorado \$15.00

Open-File Report 02-8

Soil and Bedrock Conditions and Construction Considerations, North-Central Douglas County, Colorado \$10.00

Open-File Report 02-12

Sand and Gravel Resources Adjacent to the Colorado River Valley, Garfield County, Colorado \$15.00

Open-File Report 02-13

History, Geology, and Environmental Setting of Selected Mines Near Ophir, Uncompahgre National Forest, San Miguel County, Colorado \$15.00

Open-File Report 02-15

Evaluation of Bottom-hole Temperatures in the Denver and San Juan Basins of Colorado \$15.00

Other Open File Reports

Evaluations of Mineral and Mineral Fuel Potential on State Lands

A series of reports on CD-ROMs that inventory and evaluate the mineral and mineral fuel resource potential of the 4 million+ acres of state lands administered by the State Land Board. \$15.00–\$25.00

MENTIONED IN THIS ISSUE

Special Publication 35

Colorado's Dinosaurs \$15.00

Special Publication 43

A Guide to Swelling Soils for Colorado Homebuyers and Homeowners \$7.00

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Celia Greenman, Jim Soule,
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Mineral Fuels

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Minerals

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A new, oil and gas fields map shows outlines and names of the fields, the age of the producing formation, and the type of commodity produced, as well as showing the location of pipelines, refineries, and processing plants. Sand and gravel resources along the Colorado River in Garfield County are documented in CD-ROM format. And, a new, digital inventory of industrial mineral and construction mineral mines in Colorado includes data on all mine permit locations applied for between 1973 and mid-2001.

2002 Wildfires

During late May 2002, several major wildfires broke out in Colorado. In June, July and August, CGS participated in several recovery and assistance efforts. We assisted the U.S. Geological Survey with post-fire hazard mapping of debris flows, flooding, and erosion and sedimentation areas (see <http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-02-0323/> and <http://pubs.usgs.gov/of/2002/ofr-02-0379/>). Our digital mapping capabilities enabled us to get one of our new

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THIS ISSUE

Editors: Vince Matthews and Betty Fox
Production: Cheryl Brchan

STATEMAP quadrangles covering Missionary Ridge in the hands of emergency responders quickly. Also, we assisted the U.S. Forest Service in delineating potential avalanche zones in burned areas, assisted the U.S. Natural Resources Conservation Service with sediment modeling and sedimentation issues, served on several boards and panels that coordinated interagency response, and met with citizen groups to advise them about debris flow hazards. **Karen Berry** and **Andy Gleason** were the principal CGS geologists who worked on this project, while **Jill Carlson** and **Dave Noe** also participated.

Colorado Avalanche Information Center (CAIC)

The CAIC opened for the 2002-03 season in early November. This year two new field offices were added in Breckenridge and Crested Butte, complementing the existing offices in Silverton, Eisenhower Tunnel, Carbondale and Pagosa Springs.

This past year saw completion of the conversion of 18 years of weather and avalanche data into an Access database, completion of a digital atlas showing avalanche paths on all Colorado highways, and completion of a Web-based, clickable map that provides the user with site specific information on factors relevant to avalanche hazard. Two full-time safety instructors will continue to provide training that helps thousands of back-country visitors have a safer experience during avalanche season.

Rock Doctor Asks, "Did You Know?"

Did you know that the Rocky Mountains have fifty-eight peaks over 14,000 feet high, all of them in Colorado; that Colorado has 740 peaks between 13,000 and 14,000 feet high; that Colorado has the highest average elevation of any state (6800 feet), with more than two vertical miles between its lowest (3,313 feet) and highest (14,433 feet) points; that Grand Mesa is touted as the world's highest flat-topped mountain with heights above 10,500 feet, 380,000 acres, and more than 300 lakes?

The question of how many 14,000+ foot peaks are in Colorado depends on whom you ask. The "fourteeners" Web site claims 53, Colorado Mountain Club

claims 54, and the book *Colorado's Fourteeners* claims 55. The United States Geological Survey has the official responsibility for measuring, mapping and naming topographic features in the United States. They list, by name, 58 summits in Colorado that have elevations more than 14,000 feet above sea level!

GIS Day

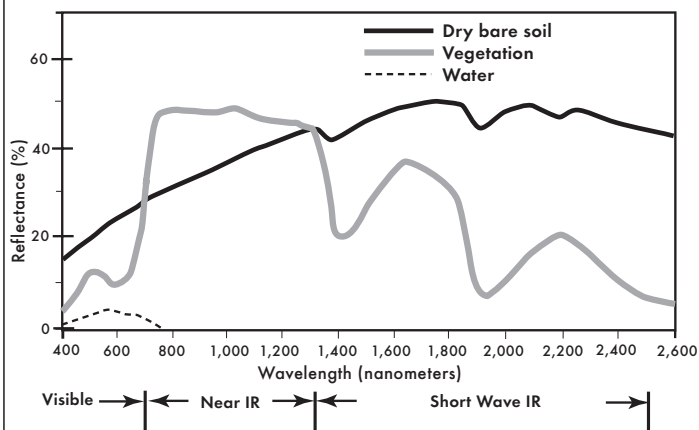


CGS' GTS group put on a program of activities for National GIS Day. These CGS folks are practicing their newly acquired GPS skills at Red Rocks Park near Denver.

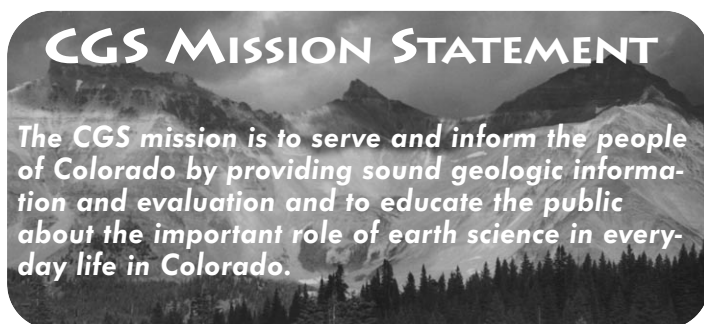
Correction

Correction for January 2003 *RockTalk*

In the October 2002 issue of *RockTalk*, a graph on page 12 showing spectral reflectance curves for soil and vegetation was incorrect. Below 1400 nm the curves colors were inadvertently switched. The corrected version appears here. Thanks to Denise Laes for alerting us to our mistake.



Typical spectral reflectance curves for vegetation, soil, and water MODIFIED FROM LILLESAND AND KIEFER, 1987



Mapping Program Sets Record

CGS mapped eight 7.5-minute geologic quadrangles in 2002, a record number of maps in one year for CGS. Five maps were in the Colorado Springs area, one in the Durango area, one in the San Luis Valley, and one at Copper Mountain. This brings the total of geologic quadrangles mapped by CGS to 43.



CGS Geologist Beth Widmann discusses her mapping results in the Copper Mountain quadrangle with Bruce Bryant and Karl Kellogg of the USGS and co-mapper Paul Bartos of CSM. A September snowstorm made this field review a bit more adventuresome than normal. Beth is saying, "Yes guys, we really are going to climb up to 12,000 feet in this stuff."

BOOK REVIEW

Colorado's Dinosaurs

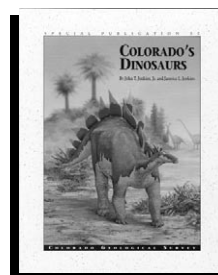
By John T. Jenkins, Jr. and
Jannice L. Jenkins

Did you know that three of the world's four largest dinosaurs were discovered right here in Colorado? The book *Colorado's Dinosaurs* takes one on a journey through the paleontological discoveries that launched this nation's dinosaur research, while giving you, the reader, the information you need to set out on your own expedition. For those of you who have observed Colorado's dinosaurs from the periphery, this is your chance to learn more about the ancient environment that contributed to the preservation of so many dinosaur fossils, making formations such as the Chinle and Morrison famous.

Colorado's Dinosaurs begins with a look back in time through the eyes of the area's first human inhabitants and their impressions of dinosaur fossils. These questions are then repeated by our modern paleontologists who find similarities in the different lines of dinosaur evolution and leading to the understanding of how dinosaurs lived and interacted with one another. For the beginner, *Colorado's Dinosaurs* provides a clear explanation of why discoveries are made, where they are, and the challenges of deciphering fossilized remains.

I thoroughly enjoyed the attention this book gives to building basic concepts along with the history of paleontological discoveries of Colorado. Dinosaur skeletons excavated in our state are on display in museums and universities throughout the United States, and have lead to many of the advances in the science of paleontology. *Colorado's Dinosaurs* brings this history alive in bone crushing vividness.

—Review by Melissa Ingrisano



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