



# Colorado Scientific Society

*The object of the Society is to promote  
The knowledge and understanding of Earth science,  
And it's application to human needs*

## **Cenozoic Altitudes And Paleobotany Of The Western-Interior U.S.**

**By Warren B. Hamilton**

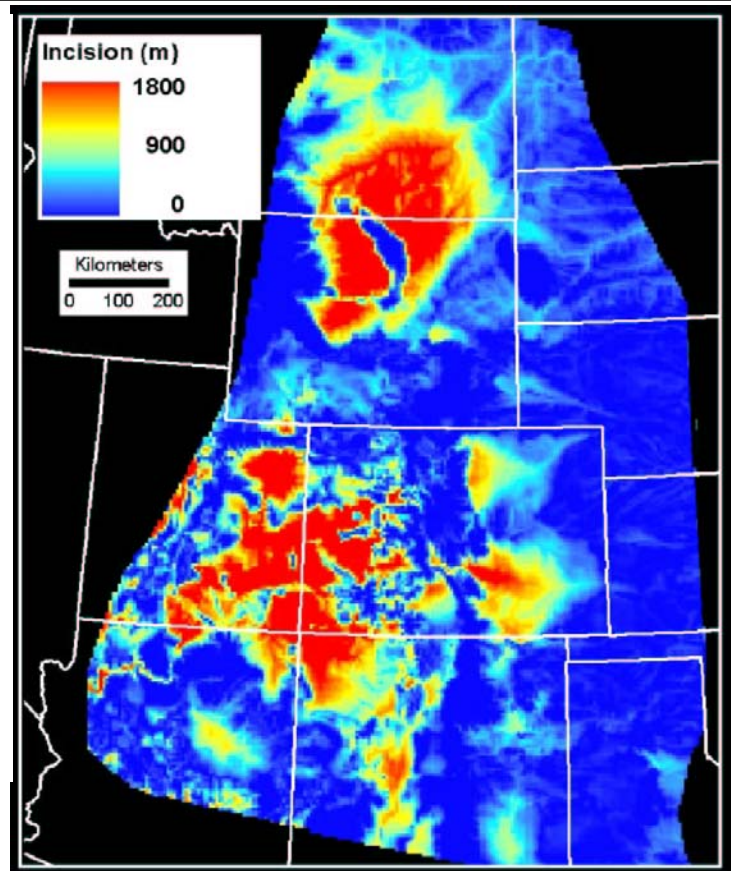
*Department of Geophysics,  
Colorado School of Mines*

*And*

## **Evaluation Of Tectonic And Climatic Controls On Late Cenozoic Incision Of The Rocky Mountains**

**By Paul Heller and Margaret McMillan**

*Department of Geology, University of Wyoming*



**Thursday, September 18, 2003**

**Colorado Mountaineering Center, 710 10<sup>th</sup> Street (NE corner with Washington) Golden, CO  
Social half-hour – 7:00 pm Meeting time – 7:30 pm**

## Abstracts

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### **Cenozoic altitudes and paleobotany of the western-interior U.S.**

By **Warren B. Hamilton**, Department of Geophysics, Colorado School of Mines

A century of geologic research constrains Cenozoic evolution of regional topography. The high Late Cretaceous-early Paleogene continental divide passed near tracts now in central Nevada (the Basin-Range province has since doubled in width, and lowered), and lithostatic head drove thin-skinned Sevier foreland thrusting. The east foot of the thrust belt was near sea level almost to the end of Cretaceous time and likely was little above it when thrusting ceased. The continental divide lay south of since-raised Colorado Plateau in Arizona, which lacked a thrustable stratal wedge. Structural relief of the central and southern Rocky Mountains mostly dates from latest Cretaceous and early Paleogene Laramide crustal shortening, but basins remained low, accumulating sediment, until late Cenozoic regional uplift resulted in the sluicing of basins and incision of the Plateau and mountains. Great Plains floristic determinations of paleoclimates (by Axelrod, MacGinitie, and Leopold) are in accord with this scenario.

This voluminous evidence is dismissed by theorists (e.g., Chase, Molnar, England) who assume that present high western-interior regional altitudes could result only from Laramide deformation. They seek support in simplistic analysis of fossil-leaf physiognomy by Wolfe and Gregory. Wolfe rejected floristics and assumed that leaf shapes alone can define mean annual temperatures (MAT), independent of annual distributions of temperature and precipitation. He applied fuzzy multivariate analysis of rank and polynomial (nonlinear and non-normal) variables of size and shape of woody-dicot leaves in small samples. Fit of this model to modern floras is very weak where it works at all—many common assemblages are wholly misfit—but Wolfe applied it rigidly to paleofloras. The Paleogene MATs thus deduced for the western-interior U.S. frequently are too cold (thus increasing deduced altitudes) for the palms, crocodilians, and large tortoises present but ignored. The large climate signal in conifers, monocots, ferns, etc. is also ignored. Global variation of temperature with continental surface altitude is typically 5° to 6°C per kilometer, and this value was used by Axelrod for conversion to paleoaltitude of early Tertiary equable-climate floras using sophisticated climatic variables. Present variation of MAT for the extremely continental (and extended) western U.S. is about 3° per kilometer, which Wolfe used inappropriately for Paleogene floras, thus doubling paleoaltitude conversions. Further, Wolfe's method deduces large, sudden altitude jumps where floral changes signal changes in equability.

Warren Hamilton retired from USGS in 1995, after a long research career emphasizing the tectonic and crustal evolution of western North America, Indonesia, and other regions. He is now in the Department of Geophysics at Colorado School of Mines as a Distinguished Senior Scientist and there works primarily with evolution and dynamics of global mantle and crust. He is a member of the National Academy of Sciences and holds the Penrose Medal of the Geological Society of America.

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### **Evaluation of tectonic and climatic controls on late Cenozoic incision of the Rocky Mountains**

By **Paul Heller and Margaret McMillan**, Department of Geology, University of Wyoming

The Rocky Mountain orogenic plateau is characterized by high elevations (>2 km) and deep post-Laramide incision (up to 1.2 km). While it is not clear when modern elevations were first attained, most studies indicate that incision began during the past 10 m.y. and may coincide with elevation gain. The ultimate cause of downcutting reflects the interplay between regional tectonic uplift and climate change. We evaluate the relative roles of these driving mechanisms by mapping the distribution of, and incision into, a variety of paleodatums.

These datums include high-level subsummit erosion surfaces, the maximum elevation of once continuous remnants of post-Laramide basin deposits, young volcanic flows, and pedimented terraces. These surfaces are not contemporaneous; however, they are all post-Laramide and thus constrain the magnitude of incision.

Results indicate that (1) the incision pattern is broadly domal, paralleling the trend of the Rio Grande Rift in Colorado and the Bighorn Mountains in Wyoming, and decays to the north and east over distances of several hundred kilometers; (2) the pattern of incision matches regional topography of the Rockies, *except* in areas of most active recent tectonics; (3) in several places, most notably the western Great Plains, incision is associated with surfaces that have been post-depositionally tilted, and 4) the turnaround from net aggradation to incision took place  $\sim 6 \pm 1$  Ma.

The distribution of incision suggests that tectonic uplift exerts major control. The broad wavelength of downcutting, which parallels regional isostatic anomaly trends, suggests upper mantle involvement in the origin of uplift. Climate clearly influences second-order features such as knick-zone migration and details of the erosion pattern. Our results appear to differ with those derived from published paleobotanical estimates of elevation change since the end of the Laramide orogeny. However, the uncertainties in those estimates (up to  $\pm 1.5$  km) are not inconsistent with our results.

Dr. Paul Heller has been Professor of Geology at the University of Wyoming since 1983. He was at USGS prior to that. His Ph.D. is from the University of Arizona where he studied under Bill Dickinson. Heller is the author or co-author of 120 articles and abstracts on such diverse topics as alpine lakes, development of ooid textures, sea-floor spreading, mantle plumes, thrust sheet propagation, environmental geology, and the application of stream transport to the understanding of tectonic history. Much of this talk is based on research done by Margaret McMillan for her Ph.D. thesis at the University of Wyoming. McMillan's research was supported by the Colorado Scientific Society.

## **Colorado Scientific Society President's Note, September 2003**

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*By Jim Cappa*

I would like to take this opportunity to welcome all the Colorado Scientific Society members to the Fall 2003 session of Colorado Scientific Society talks. I hope you all had great field seasons. Mine was way too short!

An important part of what we do as scientists is to make available to the general public guidebooks, maps, and reports that describe the wonders of geology in terms the general public can understand. Just last weekend I watched a wonderful show on the Discovery Channel called "SuperVolcanoes," which described in simple and graphic terms the recent formation of a volcanic dome at the north end of Yellowstone Lake in Wyoming. It is programs like this, somewhat overly dramatic, but beautifully graphic and with the geoscientists working on the project speaking in easily understandable terms, which make our science so amazing to the general public.

Guidebooks are another important way to inform the general public about the geology of Colorado. There have been several attempts at writing general summaries about the geology of Colorado. One of the earliest was in 1927 when Russell George, the State Geologist and Director of the Colorado Geological Survey and professor at the University of Colorado, wrote a wonderful little book called Geology and Natural Resources of Colorado. The book features a simplified, fold-out, color geological map of the state and it describes the geology of Colorado in a chronological manner and then discusses the natural resources, including metals, coal, and oil and gas, industrial minerals, water and soils, mineral waters, parks, fish and game, climate, and scenery. This book is long out of print and probably available in only a few libraries in the State.

When the Colorado Geological Survey was reinstated in 1969, one of its first tasks was to write a general popular guide to the geology of the state. And so in 1972 came the famous Prairie, Peak, and Plateau. John and Halka Chronic (at that time both professors at University of Colorado Boulder) wrote Prairie, Peak, and Plateau and organized it by the geographic regions. They described the geology of each region Colorado in a chronological fashion by geological eras and periods. The book includes sections on minerals, industrial

minerals, coal, and oil and gas, hot springs, water, and—new to the Colorado economy geology scene—oil shale, uranium, and vanadium. In recognition of the changing role of geology in modern day Colorado, a section on environmental geology was included. Prairie, Peak, and Plateau was immensely popular. It went through five printings and sold over 35,000 copies.

The Roadside Geology of Colorado by Halka Chronic is another popular guide to the geology of Colorado focusing on what the traveler can see while driving on the highways of the state. The book was first published in 1980 and went through several printings. Felicie Williams, Halka Chronic's daughter, published a much-improved second edition of Roadside Geology of Colorado in 2002. Other good recent popular treatments of the geology of Colorado include Andrew Taylor's Guide to the Geology of Colorado and Dell Foutz's Geology of Colorado Illustrated.

The most recent, and in my opinion, the best and most colorful popular guide to the geology of Colorado is Messages in Stone. Vince Matthews, Katie KellerLynn, and Betty Fox are the co editors of this beautiful new book released this August by the Colorado Geological Survey. This new book uses a different approach than the other popular guides to the geology of Colorado. The first chapter deals with the rocks and structures of Colorado. Even meteorites are covered in this chapter! The second chapter is a geologic history of Colorado by Eras and Periods. There are numerous pictures and figures depicting the rocks of each Period. The third chapter discusses the varied landforms of Colorado, and the final chapter on the impact of geology on humans discusses economic geology, engineering and environmental geology, and earthquakes. The subtitle for this book is Colorado's Colorful Geology, an apt title for this book, which contains over 400 color photographs and figures. Copies of this book may be ordered from the Colorado Geological Survey, (303) 866 2611, for \$16.95 each.

## REFERENCES

- Chronic, Halka, and Williams, Felicie, 2002, Roadside geology of Colorado (second edition): Missoula, Montana, Mountain Press Publishing Co., 399 p.
- Chronic, John, and Chronic, Halka, 1972, Prairie, peak, and plateau- a guide to the geology of Colorado: Colorado Geological Survey Bulletin 32, 126 p.
- Foutz, Dell, 1994, Geology of Colorado Illustrated: Grand Junction, Colo., Dell Foutz, George, Russell, 1927, Geology and natural resources of Colorado: Boulder, Colo., University of Colorado Press, 228 p.
- Matthews, Vincent, KellerLynn, Katie, and Fox, Betty (eds.), 2003, Messages in Stone- Colorado's colorful geology: Colorado Geological Survey Special Publication 53, 157 p.
- Taylor, Andrew, 1999, Guide to the geology of Colorado: Golden, Colo., Cataract Lode Mining Co., 222 p.

## **Chuck Pillmore, 1930–2003**

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By *Barney Poole*

Charles L. (Chuck) Pillmore passed away in Lakewood, Colorado, on August 22, 2003, at the age of 73. He left behind his wife of 49 years, Arlene, daughter Kathy, son Roy, and seven grandchildren. Daughter Karen preceded him in death.

Throughout his many years with the Colorado Scientific Society, Pillmore was an active, and much beloved, member. In addition to chairing and serving on many Society committees, he was president in 1984. He promoted



Photo courtesy of Dan Miggins

Student Night, was involved in many of the more memorable Society field trips, was instrumental in establishing the Ogden Tweto Memorial Fund in 1984, and was elected Honorary Life Member of the Society in 1989.

For most of his professional career, Chuck was active in geologic mapping, coal resource evaluations, and aerial photogrammetry. These interests served him well as he became deeply involved in the scientific hunt for field sites containing the Cretaceous-Tertiary (K-T) boundary. He formed working relationships with leading investigators around the world and became close friends with asteroid-impact specialist Walter Alvarez and planetary scientist Eugene Shoemaker, who named a planet (large asteroid) after Chuck (Pillmore 4368). The Smithsonian Institution removed a room-sized sample of one of Chuck's K-T boundary sites for an exhibit on impact structures and dinosaur extinctions. Chuck also found the first confirmed footprint of a *T. rex* dinosaur. The fossil footprint was named for him (*Tyrannosauipus pillmorei*) by noted fossil-track specialist Martin Lockley.

Chuck was born in Boulder, Colorado, on April 7, 1930. He graduated from Lafayette High School in 1947 and from the University of Colorado (B.A., 1952; M.S., 1954). After graduation, Pillmore joined the U.S. Geological Survey in Washington, D.C., as a geologist in the Photogeology Section of the Alaskan Geology Branch. During this period, Chuck and coworker Robert Morris invented and patented two photogrammetric devices. Chuck later worked in several administrative units of the Geological Survey including the Eastern States Branch, Organic Fuels Branch, Coal Resources Branch, and the Central Regional Geology Branch. His work in the Raton Basin (New Mexico and Colorado) began in 1961 but was interrupted several times for various administrative and technical assignments. From 1975–1980, he was Chief of the Denver Technical Reports Unit of the Office of Scientific Publications where he was a leader in introducing word processing to authors of scientific reports. Beginning in 1977, he researched automated photogrammetric mapping systems and developed a computer-assisted photogrammetric mapping system for geologic studies using a PG-2 plotter, and he subsequently established and managed the Photogrammetric Plotter Laboratory in Denver.

After his administrative hitch in publications, he returned to the Raton Basin where he prepared 1:100,000-scale coal folio maps and other geologic maps. Related research included his successful search for K-T boundary sites in the Raton Basin, where his field investigations provided a solid foundation for the discovery of geochemical anomalies of iridium and other elements in an altered clay layer at the boundary. He retired in 1993 but continued work as Scientist Emeritus in the Raton Basin and elsewhere. His continued interest in impact structures and the K-T boundary led him to participate in several international meetings on that topic. He was a popular speaker and field-trip leader and remained active in educational outreach virtually up to the time of his death. Chuck authored or coauthored more than 115 maps, articles, and abstracts during his productive career with the USGS. He received a Meritorious Service Award in 1988.

Chuck was a member of the Geological Society of America, Colorado Scientific Society, Rocky Mountain Association of Geologists, New Mexico Geological Society, Geological Society of Washington (D.C.), and American Society of Photogrammetry and Remote Sensing.

A memorial service will be held at 4:00 p.m. on Saturday, September 13, 2003, at the Jefferson Unitarian Church located at 14350 West 32nd Avenue, in Golden. His family requests that donations be made to the "Colorado Scientific Society Memorial Funds" in Chuck's memory. Mail contributions to: Colorado Scientific Society, P.O. Box 150495, Lakewood, CO 80215-0495.

## **History of the Colorado Scientific Society**

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Want to refresh your memory about the illustrious history of this society? Help is here. A revision of the History of the Colorado Scientific Society is now available. For general distribution, and at no cost, two versions are available: Screen version is 2 MB; a Print version is 41 MB.

# Field Trip and Fall Symposium information

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By *Emmett Evanoff*

## *Spring Denver Basin field trip*

The first Colorado Scientific Society brown-bag field trip was held on Saturday, June 21. The trip examined the Upper Cretaceous, lower Paleocene, and early Eocene rocks of the Denver Basin; it was led by Bob Raynolds of the Denver Museum of Nature and Science. Bob vividly linked the stratigraphy, tectonics, and groundwater resources of these rocks into a comprehensive story of the Laramide development of the Denver Basin and the Front Range. Highlights of the trip included a grand overview at Daniels Park, a climb to another spectacular overlook on Wildcat Mountain, a walk into the depths of Castlewood Canyon, and finally a view of the lower Eocene paleosol near Parker. The trip's 19 participants enjoyed the first non-rainy Saturday in June.

## *Fall San Juans field trip*

Space is still available for the Fall field trip on September 19–22, which will visit the volcanic history of central Colorado and the northeast San Juan Mountains. Peter Lipman and Chuck Chapin will be the guides. If you are interested, contact Emmett Evanoff at [emmettevanoff@earthlink.net](mailto:emmettevanoff@earthlink.net) or at 303-444-2644. Registered participants will receive information concerning the details of the trip in early September.

## *CSS Fall Symposium: Geology of the Front Range*

The first CSS Fall Symposium will take place next month. A one-day symposium on Saturday, October 18, will be followed by a one-day field trip on October 19. The symposium presentations discuss various aspects of the geology of the Front Range, such as Precambrian history, Ancestral Rocky Mountain history, Laramide tectonics, and post-Laramide tectonics. Other topics such as Laramide volcanism and Pleistocene glacial history may also be included.

**Saturday symposium:** Large lecture hall, Benson Earth Sciences Building, Univ. of Colorado, Boulder

**Sunday field trip:** Meet at the Cold Springs Park-n-Ride, Sixth Avenue and Simms Street, Lakewood

**Fees:** Saturday symposium – No charge. Sunday field trip – About \$35 for transportation and lunch.

**More information:** Look in the October CSS Newsletter for more information and a registration form

It is my hope that this symposium will be a biennial event (we'll skip the years that GSA meets in Denver) that will present topics of regional interest. Please attend and help make this event a success so that future symposia are possible.



## *A View Through the Brown Cloud*

*by Lisa Ramirez Rukstales*

Welcome back from another field season, albeit a hotter than usual one. Hopefully everyone wore his or her dorky hats, bug juice, and sunscreen. Mosquito repellent has taken on a whole new meaning thanks to the West Nile virus. It just seems wrong to worry about something so teensy, but worry is what mommies do best! My “little” Scott Diego is seven months old now and I have the biceps to prove it. Mosquitoes aside, my big worry now is if he's getting enough stimulation and education so he can keep up with the 21<sup>st</sup> century techno-infant. Daddy lets him bang on the keyboard, but mommy is doing the basics that will help him succeed in life in Colorado. You know, math: uno, dos, tres...; colors: Red neck, Green card, White trash; music: Shake your Groove Thang! The good news is that Scott Diego's diverse background will allow him to be a part of our melting pot's majority and/or minority depending on which is more convenient for “la universidad” scholarships in 2021!! Our memorial funds for Eduardo Eckel, Jorge Snyder, and Estévan Oriol have a nice “north and south of the border” ring to them. ¡Olé!



# Earth Science Meetings and Talks



*Newsletter items must be received by the 4th of each month. Items may include special events, open houses, etc...thanks!*



**Colorado Scientific Society's** regular meetings are held the 3rd Thursday of the month at the American Mountaineering Center in Golden (unless otherwise advertised). Social time begins at 7:00 p.m. and talks start at 7:30 p.m. For information, contact Jim Cappa at (303) 866-3393, [jim.cappa@state.co.us](mailto:jim.cappa@state.co.us)

**Denver Mining Club** meets every Monday (except when noted) at Country Buffet near Bowles and Wadsworth (at 8100 W. Crestline Ave.) 11:30 a.m.-1:00 p.m. **How I found the famous Camp Bird Mine and made millions**, Sept. 8, Tom Walsh (portrayed by John Stewart, Historian). **Resource opportunities on Alaska Native Lands**, Sept. 15, Norm Phillips, Resource Development Manager, Doyon, Ltd. **Colorado Mining District identification - Creating order out of chaos from the mining literature**, Sept. 22, Lisa Dunn, Head of Reference, CSM Library. **Ancient Celtic copper mining in America (1800 B.C. to 500 A.D.)**, Sept. 29, Warren Andrews, Mining Engineer, Professional Surveyor and historian. For additional information contact Dick Beach, (303) 986-6535 .

**Denver International Petroleum Society** meets the 2<sup>nd</sup> Friday of each month at the Wynkoop Brewing Co., 18th and Wynkoop Streets. Reception begins at 11:30 a.m., luncheon at 12 p.m., program at 12:30 p.m. Make reservations (required) by leaving message at (303) 623-5396. Reservations accepted after 8 a.m. on Friday until 10:30 a.m. on Wednesday prior to the meeting. Cancellations accepted until 11:00 am Wednesday prior to the meeting. Cost: \$15 for lunches; talk only is available for \$2 (make checks payable to "D.I.P.S."). Contact Keith Murray at (303) 986-8554 for information.

**Denver Region Exploration Geologists' Society (DREGS)** meets in the Mutual Consolidated Water Building, 12700 West 27th Avenue, Lakewood. Social hour 6:00-7:00 p.m. Technical presentation at 7:00 p.m. Meetings are normally scheduled for the first Monday of each month. For information contact Jim Piper, (303) 932-0137, or the website <http://www.dregs.org>.

**Denver Well Logging Society (DWLS)** meets on the third Tuesday of each month, Sept. through May. Lunch and a technical talk at the Wynkoop Brewery begins at 11:30 a.m., 18th and Wynkoop Sts. in Denver. Subject matter usually deals with the application of well logs to oil and gas exploration. Sept. 16, **Direct oil measurements using NMR logs**, Dick Merkel, Senior Petrophysicist, System Technology Associates. This month only contact Sadie Osieczanek (via email) or at (303) 770-4235 for reservations. Web page: <http://dwls.spwla.org>.

**Rocky Mountain Association of Geologists (RMAG)** Reception at 11:30 a.m., lunch at 12:00 p.m., talk at 12:30 p.m. Reservations are taken by recording at 303-623-5396 until 10:30 a.m., Wed. before the luncheon. Cancellations are taken until 11:00 a.m. on Wed. at 303-573-8621. Luncheon cost is \$20 payable to RMAG at the door. Reservations are not required for talk only—cost is \$3. September 19, no Friday Lunch, RMAG/PTTC Symposium at the Downtown Denver Marriott Hotel, **The Petroleum Systems and Reservoirs of Southwest Wyoming**, Oct. 3, 2003, Greg Anderson, Tom Brown, **Depositional, Diagenetic and Structural Control on Natural Gas Production from the Frontier Formation, Moxa Arch, Wyoming**, Meeting location: Denver Petroleum Club, Anaconda Tower, 555-17th St, 37th floor. Web page: <http://www.rmag.org>.

**University of Colorado at Boulder, Geological Sciences Colloquium** Wednesdays, 4:00-5:30 p.m., Rm. 180.

Refreshments at 3:30 p.m. on the 3rd floor. For info., call 303-492-8141. Web page: <http://www.colorado.edu/GeolSci>.

**Unusual modern and Quaternary carbonate sedimentation in Bear Lake, Utah-Idaho: A Pacific climate connection?** Sept. 9, Walter Dean, USGS, Denver. **Evidence for Upper Mantle Flow Associated with the African Superplume**, Sept. 17, Mark Behn, Carnegie Institution of Washington. **Spatial relation between main earthquake slip and its aftershock distribution**, Sept. 24, Shamita Das, Oxford University.

**Friends of Dinosaur Ridge** 7:00 pm at Red Rocks Elementary School in Morrison, CO. Join now.

Web page: <http://www.dinoridge.org>.

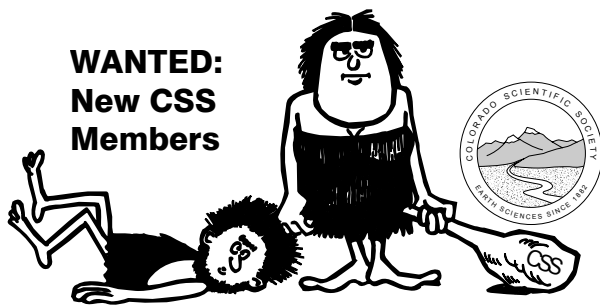
**Colorado School of Mines, Van Tuyl Lectures** Fridays from 3:00 pm to 4:00 pm in Berthoud Hall room 108. Web page:

<http://www.mines.edu/academic/geology/calendar/vantuyl.html> Everyone is cordially invited to attend the grand opening reception for the new Geology Museum at Mines, 1310 Maple Street, Golden, Wednesday, September 10, 2003, 7-9 p.m. Hors d'oeuvres, cash bar and silent auction.

**For a constantly updated, online geo-calendar, visit the Colorado Geological Survey at**  
<http://geosurvey.state.co.us>

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