

# Colorado Scientific Society

*The objective of the Society is to promote the knowledge and understanding of Earth science, and its application to human needs*

## ***Late Mesozoic to Cenozoic Rotation of the Colorado Plateau: Regional analysis of proposed Euler Pole Rotations from modeling and fault kinematic analysis***

by

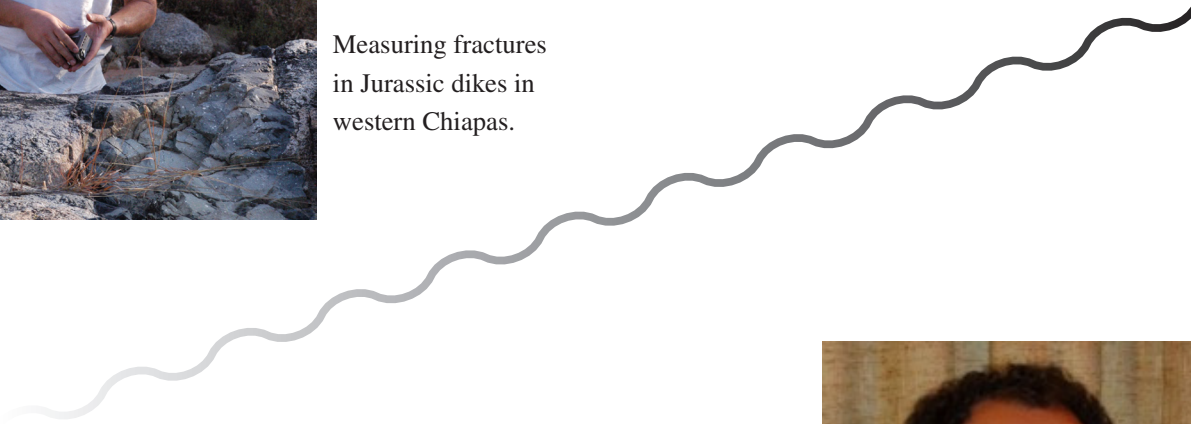
*Dr. Timothy Wawrzyniec*

*Moncrief Chair of Petroleum Geology*

*Western State College of Colorado at Gunnison*



Measuring fractures in Jurassic dikes in western Chiapas.



## **Evolution Confers Morality**

by

*Matt Young*

*Colorado School of Mines*



**Wednesday, May 18, 2011**

**Colorado School of Mines—Dept. of Geology and Geological Sciences**

**Berthoud Hall, Room 241, Golden, Colorado**

**Social half-hour – 6:30 p.m. Meeting time – 7:00 p.m.**

**Heads up!**

# Late Mesozoic to Cenozoic Rotation of the Colorado Plateau: Regional analysis of proposed Euler Pole Rotations from modeling and fault kinematic analysis

by

*Dr. Timothy Wawrzyniec*

*Moncrief Chair of Petroleum Geology*

*Western State College of Colorado at Gunnison*

The late Mesozoic to Cenozoic tectonic evolution of the U.S. Cordilleran foreland is largely described in the context of the Late Cretaceous to early Tertiary Laramide Orogeny and the late Cenozoic Rio Grande Rift. Both tectonic regimes have been associated with tectonic models that require the Colorado Plateau to behave as a microplate that has relatively little internal deformation when placed in the context of strain found at the margins of the Plateau.

A critical test of tectonic models for the Late Cretaceous to early Tertiary Laramide Orogeny is whether plateau rotation models can produce an integrated strain field consistent with foreland geometries and kinematic indicators. Along the northern and eastern margins of the plateau, map-scale folds and arches show a concentric pattern of deformation with fold axes transitioning from NW–SE trending to N–S trending, respectively. Similar patterns are observed for fold features found within the plateau. Related minor fault analyses show a similar pattern of single stage shortening, except near the Sevier tectonic front where SE-directed shortening has been reported within and near the plateau. Evidence for Laramide-age rotation of the plateau is largely found in a measured increase in shortening strain along the eastern margin of the Plateau. The rotation was first described by competing models of Hamilton (1981, 1988) and Chapin and Cather (1981), which sparked an early debate about the importance of either a proximal or distal Euler pole for Laramide-age plateau rotation. To explore the consequences of rigid plateau models, a simple, but properly georeferenced, Euler pole model was used to predict strain fields associated with rotational Colorado Plateau models. Assuming a small rotation ( $\sim 4^\circ$ , which is not paleomagnetically detectable) and a proximal Euler pole, rotation of the plateau produces a pattern of finite shortening directions compatible with field observations. The model also clearly demonstrated that 10–15 km of dextral shear offset east of the plateau would produce 30–60 km of shortening north of the plateau. Moreover, if a distal Euler pole is assumed along with a more generous estimate of dextral shear of 25–40 km, then shortening of north of the plateau must be greater than 400 km. These results clearly favor a proximal Euler pole for Laramide-age plateau rotation and are permissive of established estimates of north-westward plateau rotation that ranges between 15–30 km of dextral offset along the eastern plateau margin (Wawrzyniec and others, 2007).

Following the cessation of Laramide compression, the U.S. Cordillera is known to have undergone widespread extension, which includes the onset of Rio Grande rifting along the eastern margin of the plateau as early as  $\sim 27$  Ma. From a kinematic perspective, only one model exists to address the motion of the plateau during rifting. Chapin and Cather (1994) proposed an arbitrary Euler pole rotation of CW  $\sim 1.5^\circ$  located in the eastern Uinta Range. This rift plateau rotation model is based on the arbitrary reclassification of rift related accommodation zones as sinistral strike-slip faults and definition of rifting by the onset of geologically sequestered rift-related sediments and volcanic rocks. The latter shows a progressive increase in age of rift sediments and volcanic rocks from north to south along the eastern margin of the plateau. A georeferenced test of this rotation is relatively inconclusive given the small amount of extensional strain on the rift but the standing Euler-pole model remains untenable if one considers the following: (1) the best studied accommodation fault zone (the Embudo Fault Zone) of the rift is not a left-lateral fault, rather it shows dextral shear to the west and sinistral offset to the east, which is offset consistent with scissor motion; and (2) given the kinematic modeling of the Laramide-age rotation, structures along the plateau margin where likely pure strike-slip along the southern part of the eastern margin and transitioned to nearly pure dip-slip near the northern margin. Such a strain gradient would likely have variable topography with increasingly higher uplifts along the eastern margin from south to north. If extension of the eastern margin began uniformly, then it is likely that the earliest rift basins would form in central New Mexico where topography was lower, which would give the appearance of larger extensional strains to the south. Ultimately, given the paucity of available fault kinematic data, an alternative rotational model cannot be established at this time.

Throughout the late Mesozoic and Cenozoic the Colorado Plateau has largely behaved as a microplate, or as a stress guide, that resulted in deformation far into the Cordilleran foreland. Although there is little agreement on the driving mechanism for such deformation, the foreland is clearly coupled to deformation within the Cordilleran hinterland and these strains are relatively small in comparison. Continued kinematic investigations of both Laramide and Rift related faults could only serve to improve our continued understanding of these complex, overlapping tectonic regimes.

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- Hamilton, W.B., 1981, Plate-tectonic mechanism of Laramide deformation: University of Wyoming Contributions to Geology, v. 19, p. 87–92.
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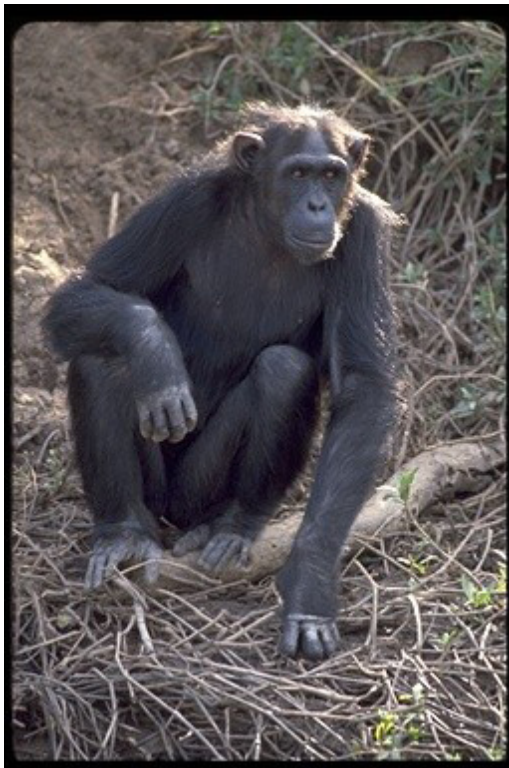
## Evolution Confers Morality

by

*Matt Young*

*Colorado School of Mines*

Our sense of morality is neither supernatural nor mysterious but rather is an evolved trait. It is likely innate rather than learned or cultural. Cooperation exists at all levels in the animal kingdom, and many nonhuman animals display a moral sense. Kin selection shows how a moral sense evolved and why it is applied most strongly to relatives and associates. Morality has evolved—imperfectly as always, but it evolved.



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Matt Young is Senior Lecturer in physics at the Colorado School of Mines, a regular contributor to the influential evolution blog *The Panda's Thumb*, and president of Colorado Citizens for Science. His most recent book, written with Fairview teacher Paul Strode, is *Why Evolution Works (and Creationism Fails)*. Formerly, he was a Physicist at the National Institute of Standards and Technology and held faculty positions at Rensselaer Polytechnic Institute and the University of Waterloo. He has published roughly 100 scientific papers and reports; written three books on optics, technical writing, and science and religion; and coedited the book *Why Intelligent Design Fails*.

## President's Message from Lisa R. Fisher



On April 21, CSS welcomed Dr. Thomas Strasser for our 49th Annual Emmons Lecture. As you may remember, Dr. Strasser was originally scheduled for January, but was caught in the East Coast Blizzard and had to reschedule. Some CSS members, myself included, were able to spend time with Dr. Strasser while he was in Denver. He enjoyed a tour of our local area—we took him to Red Rocks, Dinosaur Ridge, Genessee, Buffalo Bill's Grave (Sue Hirschfeld's signs sponsored by CSS are still up!), CSM Mineral Museum, and area eateries. I think we all enjoyed varied scientific discussions and exploring several aspects of his new research.

Dr. Strasser's talk was certainly well-presented and thought provoking. His preliminary results open up many new questions and directions for future research in Paleolithic archeology of Crete, which lead to further questions about our preconceived notions of our ancient ancestors and their technology and intelligence. This is "science in action"—cross-disciplinary sharing of new ideas, crucial to scientific advance.

Because the Green Center was not available, we decided to try the new Golden High School auditorium. There were some initial "growing pains" with using the new system, but we did finally get the smart room projector running—and on time! The screen was nice and large, the seats comfortable, and there was lots of room in the lobby for snacks and visiting. If we use the auditorium again, we PROMISE to get the sound system figured out. Let me know if you liked the facility.

The Past Presidents Annual Dinner was held April 29 at the Golden Hotel. This proved to be a relaxed, enjoyable evening, in a pleasant setting. Thanks to all who attended.

CSS participated in the Geological Society of America's Annual Business Meeting April 30–May 1, our first as an Associated Society. The various Divisions, Sections, and Associated Societies met, in workshops and in whole, attacking problems in Education, Public Policy, and Publishing. We met old and new friends and had many interesting discussions about the problems facing the geosciences and also science in general. While ideas were exchanged and directions set at this meeting, it will still be up to the individual groups to carry out the work involved in effecting change. This is where CSS can step up to do our part. I will write up a short report about the meeting, and outline how CSS members can volunteer and participate.

By the time this newsletter reaches you, the Spring Field Trip to Glenwood Canyon, May 6–8, will have returned. We hope they had a great trip and look forward to a report!

The May meeting, as already stated on the cover, will be held Wednesday, May 18, at CSM's Berthoud Hall. I am looking forward to hearing about Tim Wawrzyniec's (Western State College of Colorado) work on the Colorado Plateau, always a subject of interest. Our second speaker, Matt Young (Colorado School of Mines, Dept. of Physics), has been very committed to the evolution-creation battle, and is currently president of Colorado Citizens for Science and a member of Colorado Evolution Response Team. While battling creationism and intelligent design are certainly critical (and much appreciated by all of us!), it is much more interesting to delve into evolutionary mechanisms and the odd results they can produce. Is human cultural and moral behavior actually a result of evolution? Let's listen and find out!

A great summer to all, and best to those going out to the field. Towards the end of summer, look for announcements about our Fall programs and Family Day activities in late summer!

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### GSA SPRING LEADERSHIP MEETING FOR DIVISIONS, SECTIONS and ASSOCIATED SOCIETIES

**Paul Belanger** attended the Saturday session as a representative of CSS. There were 3 breakout sessions: Education, Public Policy and Publications. Paul attended in the Public Policy discussion. After introductions, the group broke out into sub-groups, re-assembling at the end and came up with these results:

1. We asked GSA to develop a group of experts willing to communicate effectively with mainstream media (CNN, NBC, ABC, etc./equivalents) and the public when geosciences' expertise is needed. They are to be experts vetted by GSA and to have their names and contact information readily accessible. Qualities sought: Scientifically solid, respected, camera friendly with the ability to target the level of the audience, place an event in perspective and provide a consistent message with credibility and put a good face on geology. If there is a policy statement on the topic at hand (see below) their message should be consistent with that as a representative of GSA. Familiarity with: Natural disasters, earthquakes, tsunamis, volcanic eruptions, energy (nuclear, fossil fuel, fracturing, etc.), resources (REE, etc.), environmental issues, minerals as problems and solutions to the environment, etc.
2. Once developed be proactive in communication with the media when a geologic event and/or topic makes the news.
3. Find mechanisms to better communicate our science to the public: snippets from resource issues to the environment, etc.

4. Help change institutional thinking and culture about the importance of faculty being involved in talking with the media, service to society, etc.

Part of public policy is also responsible for website links: <http://geosociety.org/geopolicy/> with a sidebar link to GSA position statements at <http://geosociety.org/positions/index.htm#d> that lead to various policy statements such as:

Climate Change  
Earth Science Research  
Energy and Mineral Resources  
Geologic Mapping  
Land-use Management  
Natural Hazards  
Nuclear Test Ban Treaty Monitoring  
Water Resources

Teaching Earth Science in Schools  
Teaching Evolution  
Data Preservation  
Open Access to Data  
Diversity in the Geosciences  
Involvement by Federal Scientists in Scientific Society Leadership  
Valuing Professional Contributions to Geoscience Public Policy and Education  
Visas for Foreign Scientists and Students



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## Rare Earth Elements, by Pete Modreski

A mineral resource topic much in the news these days is rare earth elements—necessary for many current and developing technologies, but getting to be in short supply worldwide—almost all world production comes from China, which has begun to limit their exports. You might be interested in several USGS resources online about rare earths:

USGS Fact Sheet 087-02, Rare Earth Elements—Critical Resources for High Technology, by Gordon B. Haxel, James B. Hedrick, and Greta J. Orris; 2002, 4 pp.  
<http://pubs.usgs.gov/fs/2002/fs087-02/fs087-02.pdf>

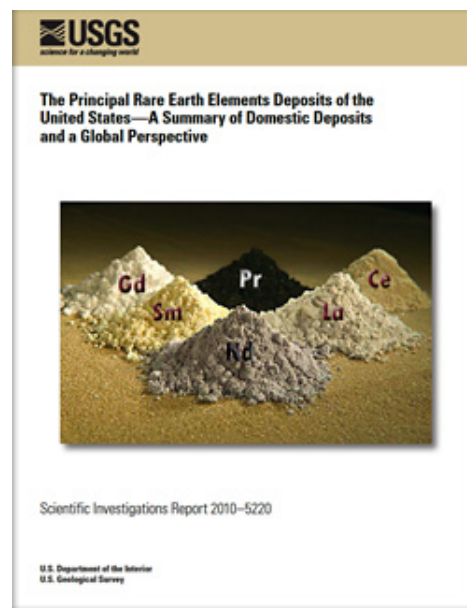
A newer and much more detailed USGS report: The Principal Rare Earth Elements Deposits of the United States—A Summary of Domestic Deposits and a Global Perspective, by Keith R. Long, Bradley S. Van Gosen, Nora K. Foley, and Daniel Cordier; USGS Scientific Investigations Report 2010–5220; 2010, 96 + vi pages, <http://pubs.usgs.gov/sir/2010/5220/>

This online link goes to a summary description, from which you can download the PDF of the complete report (4.2 Mb, 104 total pages). The report contains descriptions, with some maps and photos, of the principal known potential rare earth deposits in the U.S., covering some 29 deposits or regions of deposits—two of which are in Colorado. A Denver-based company, Molycorp, is in the process of reopening the one major U.S. recent and likely future producer of rare-earth elements, the Mountain Pass carbonatite deposit located near the CA–NV border.

And of course, we have additional usage and statistical information posted online about rare earths in our mineral commodities web pages, [http://minerals.usgs.gov/minerals/pubs/commodity/rare\\_earths/](http://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/)

Quoting the introductory paragraph from the above-listed USGS SIR 2010-5220:

“The rare earth elements (REE) are fifteen elements with atomic numbers 57 through 71, from lanthanum to lutetium (“lanthanides”), plus yttrium (39), which is chemically similar to the lanthanide elements and thus typically included with the rare earth elements. Although industrial demand for these elements is relatively small in tonnage terms, they are essential for a diverse and expanding array of high-technology applications. REE-containing magnets, metal alloys for batteries and light-weight structures, and phosphors are essential for many current and emerging alternative energy technologies, such as electric vehicles, energy-efficient lighting, and wind power. REE are also critical for a number of key defense systems and other advanced materials.”



**CSS Memorial Funds Report: 2011 Student Research Grants Awarded**  
**By Scott Minor**  
**Chair, Memorial Funds Committee**

Since 1984, the Colorado Scientific Society has established six Memorial Funds that are supported by the gifts of members and friends. Interest earned on these funds has been used to help support the graduate research of 212 students, awarding a total of \$168,885 (an average of almost \$800 per grant). This is an extraordinary achievement for an organization of our size and exemplifies the commitment of CSS members to promote high-quality research in the earth sciences through charitable contributions to the Memorial Funds.

This year we received 25 applications for Memorial Funds grants and we were able to fund 14 of those applicants. Grants were awarded to one undergraduate, 8 M.S., and 5 Ph.D. research projects. Fourteen monetary awards totaling \$11,285 were made from the five Memorial Funds. The Tweto and Oriel Funds for research in the Rocky Mountains supported all or part of seven proposals for \$5,085 total. The Eckel Fund for research in engineering geology awarded \$1,700 to support two proposals. The Snyder Fund for research on Precambrian geology of the Rocky Mountains awarded \$3,000 to three proposals. A total of \$1,500 for two proposals for research on Quaternary geologic problems was awarded from the Pierce Fund. The review panel consisted of Matt Morgan (CGS), Scott Lundstrom (USGS), Don Sweetkind (USGS), and Scott Minor (USGS). My deepest thanks to Matt, Scott, and Don for taking time out of their busy schedules to help evaluate and rank each of the student applications and select the awardees. Below are this year's winners sorted by fund. Congratulations to each of the grant awardees!

**Tweto and Oriel Funds**

- Evan Anderson (Ph.D. student, University of Colorado, Boulder) \$958: "The microchemistry of Green River insects: resolving the taphonomy of lacustrine carbonaceous compressions."
- Alberto Carminate (M.S. student, University of Florida) \$1,050: "Low-T thermochronology of south-central ID: an investigation of interactions between uplift, extension, and hotspot processes."
- Catherine Cox, Anya Reitz, and Ryan Isherwood (Undergraduate students, Colorado School of Mines) \$250: "Analysis of the origin of the Crestone crater, CO."
- Kevin Hobbs (Ph.D. student, University of New Mexico) \$500: "A paleoclimatic survey of the Paleocene sediments of the San Juan Basin, NM."
- Ethan Lake (Ph.D. student, University of Texas, Austin) \$750: "Giant ignimbrites of southwestern CO: new geochemical and thermal insights into the origins of super eruptions."
- Christopher Peterson (M.S. student, University of Nevada, Reno) \$1,000: "Geologic mapping of northwestern North Park, CO, with emphasis in sedimentology of the Coalmont Formation."
- Caroline Pew (Ph.D. student, University of Washington) \$577: "Floral response to climate change during the Paleocene-Eocene thermal maximum in Hanna Basin, WY."

**Eckel Fund**

- Kate Allstadt (Ph.D. student, University of Washington) \$500: "Shallow repeating seismic events under an alpine glacier on Mount Rainier, WA: evidence for seasonal stick-slip glacier sliding events or volcanic earthquakes?"
- Mu (Anne) Ji (M.S. student, Colorado State University) \$1,200: "Changes in arsenopyrite dissolution rates over 130 years in arsenic contaminated floodplain deposits, Black Hills, SD."

**Snyder Fund**

- Victor Guevara (M.S. student, University of Montana) \$1,000: "Thermochronological constraints on the Clearwater metamorphic core complex, ID."
- Robert Mahon (M.S. student, Idaho State University) \$1,000: "Geologic map of the Saddle Peak Hills and a portion of the Old Ixex Pass 7.5' quads, sequence stratigraphy of the Beck Spring Dolomite and age constraints from the Pahrup Group, Death Valley, CA."
- Matthew Sophy (M.S. student, University of New Mexico) \$1,000: "Characterization of geothermal resources around Sierra Cuchillo, NM."

**Pierce Fund**

- Rebecca Deal (M.S. student, University of North Carolina) \$900: "Temporal and spatial variability of high-resolution, post-last glacial maximum climate records, southern San Juan Mountains, Colorado."
- Rose Feinstein (M.S. student, University of Houston) \$600: "Effects of catastrophic blowdown on the channel morphology of headwater streams in the Routt National Forest, Colorado."



## Earth Science Meetings and Talks

*Newsletter items must be received by the 25th of each month.*



Colorado Scientific Society's regular meetings are held the 3rd Thursday of the month at the Colorado School of Mines in Golden (unless otherwise advertised). Social time begins at 6:30 p.m. and talks start at 7:00 p.m. For more information, contact Lisa Fisher, at 303-215-0480, [lisa.fisher@escalantemines.com](mailto:lisa.fisher@escalantemines.com)

### Editors and friends,

Similar to last year's display of topaz specimens loaned to us by various Colorado mineral collectors, please mention in your newsletters that our featured Colorado minerals this year are those that contain rare earth elements. Some of the more common representatives include:

Allanite, Ancyllite, Bastnasite, Bazzite, Betafite, Brannerite, Brockite, Cerianite, Cerite, Euxenite, Fergusonite, Fluocerite, Fluorite (Yttrian), Gadolinite, Monazite, Parisite, Pyrochlore, Polycrase, Samarskite, Synchysite, Xenotime, Yttrocolumbite, and Yttrotantalite.

We are asking whether collectors can loan us specimens of any of the above minerals, from which we will choose the dozen or so most impressive/aesthetic pieces (from as many collectors as possible) for display. Specimens should arrive in our Museum sometime before August 1st, so we can begin creating the exhibit. The loan paperwork is simple and the loan period will be for one year. This will be one of the new displays we want to feature at our Annual Open House on September 14, from 6 P.M.–9 P.M. Please contact me if you have any questions or concerns.

Of course, all your club members are welcome to attend our Annual Open House. Come meet some of our Museum Advisory Council members, Student Aids, volunteers, members of the Friends of the Colorado School of Mines Museum, see our new acquisitions, our ever evolving collection, and our newest displays. Some of you might even enjoy a visit to our Gift Shop. We hope to see you then.

Cordially,

**Bruce Geller, Director**  
**CSM Geology Museum**

**Denver Mining Club May 16.** *Tim Coutts, Fellow Emeritus, National Renewable Energy Laboratory, "Thermophotovoltaics (TPVs)."* **May 23.** *David Holmes, Geologist/Marketing Specialist, U.S. Bureau of Indian Affairs, "Future Aggregate Supply in South Florida—A Scary Proposition."* **May 30.** *No Meeting. Memorial Day.* The DMC meets every Monday at the Littleton Country Buffet near Bowles and Wadsworth (8100 W. Crestline Ave., in the shopping center) 11:30–1:00. Purchase of lunch required. <http://www.denverminingclub.org>

**Denver Museum of Nature and Science Thurs., May. 19, 6:30 p.m.,** The Science Lounge—Through the Glass: The Walrus and the Cocktail: Over 100 years of tantalizing tales echo through Museum halls. Hear about scientific expeditions to far flung parts of the world and learn how a walrus, musk ox, and wolf made the Museum their home. Track clues on a zoological scavenger hunt and search for secrets too ghostly to reveal here. Peek behind the diorama glass, and get inspired to create one of your own. \$8 members, \$10 nonmembers (21+ only). Cash bar. <http://www.dmns.org/learn/adults/the-science-lounge>

**May 14. Silent Auction sponsored by the Colorado Chapter, Friends of Mineralogy.** Clement Community Center, 1580 Yarrow St. (just west of Colfax & Wadsworth), Lakewood, CO. Minerals, rocks, books, etc.; all are invited to come. <http://friendsofmineralogycolorado.org/>



### Now available! CSS glass mugs!!

Receive a mug with your \$7.00 donation to CSS!

Mugs will be available at the May meeting, or from Lisa Rukstales in Building 20 at the Denver Fed. Ctr. (Beer *not* included.)

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