



Colorado Scientific Society

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

Forming the Planets: What's New with the Oldest Events in the Solar System



**by Dr. Bill Bottke,
Director of the Center for the Lunar Origin and Evolution (CLOE)
of NASA's Lunar Science Institute**

Thursday, November 17, 2011
Colorado School of Mines—Dept. of Geology and Geological Sciences
Berthoud Hall, Room 243, Golden, Colorado
Social half-hour – 6:30–7 p.m., Meeting time – 7:00 p.m.

November Talk

Abstract

Forming the Planets: What's New with the Oldest Events in the Solar System

Dr. Bill Bottke, Director of the Center for the Lunar Origin and Evolution (CLOE) of NASA's Lunar Science Institute, discusses several recent advances that are helping to rewrite the history of the Solar System as we know it. It was previously thought that our planets remained more or less in the same location as where they originally formed. New models, illustrated by Bottke's animations, show how the gas giant planets dramatically migrated to new locations nearly a half billion years after their formation. This cataclysmic event scattered asteroids and comets throughout the Solar System and produced huge impact basins on the Earth, Moon, and Mars. Some of the Solar System's most intriguing questions, such as when did life develop on the Earth, and when and where did Mars get its water, may be linked to this last critical phase of planet formation.



Dr. William Bottke is the Assistant Director of the Department for Space Studies at Southwest Research Institute (SwRI) in Boulder, Colorado. Dr. Bottke is also the Director of the Center for Lunar Origin and Evolution (CLOE) of NASA's Lunar Science Institute. His research interests include the collisional and dynamical evolution of small body populations throughout the solar system (e.g., asteroids, comets, irregular satellites, Kuiper belt objects, meteoroids, dust) and the formation and bombardment history of planetesimals, planets and satellites. He is also interested in how near-Earth objects (NEOs) are delivered from their source regions in various asteroid and cometary populations to their observed orbits. He received a B.S. in Physics and Astrophysics from the University of Minnesota in 1988 and a Ph.D. in Planetary Science from the University of Arizona in 1995. He has also been a postdoctoral fellow at both Caltech (1996-1997) and Cornell University (1997-2000). He was awarded the Paolo Farinella Prize in 2011, the prize instituted in honor of Italian astronomer Paolo Farinella (1953–2000).

2011 Colorado Scientific Society Annual Student Night Results:



Members were treated to many outstanding talks and posters by students from across the region. Each of the speakers received a CSS coffee mug, a free one-year membership to the Society, and a cash award as follows:

First Place: Hydrodynamic fractionation of minerals and textures in submarine fans
—Jane Stammer, Colorado School of Mines

Second Place: Buoyancy sources in the western U.S.: Two case studies at different scales
—Will Levandowski, University of Colorado, Boulder

Third Place: Structural controls on mineralization, Boseto Copper Deposits, northwest Botswana (poster)
—Wesley Hall, Eric Nelson, Murray Hitzman, Wallace G. MacKay, Colo. School of Mines

Fun and Nerdy Internet sites:

<http://www.ptable.com> (interactive periodic table)

<http://www2.gi.alaska.edu/ScienceForum/ASF17/1713.html> (first-person descriptions of the 2002 Denali Fault earthquake.)

<http://www.sciencenewsforkids.org/> (Science news for kids.)

<http://earthobservatory.nasa.gov/IOTD/> (NASA image of the day)

Fall 2011 Western San Juan Mountains, CO, Field Trip—*photographs by John Lufkin*



Awesome geology!!!



President's Message from Lisa R. Fisher



It was a great fall, weather-wise, right until the last day of my field season—when we encountered gale force winds and snow in our project area. It's nice to be home! That also means it is time to get back to work on CSS matters—we will be focusing efforts on website redesign, meeting place search, new outreach projects, and plans for the 2013 GSA anniversary meeting.

I would like to thank and congratulate ALL of the students who submitted abstracts to our October Student Night Competition! It was very difficult for our committee to choose winners, and the competition was close. I am encouraged by the work of the upcoming generation of earth scientists. Thanks to Scott Minor and Sue Hirschfeld for running the meeting during my absence!

Our November 17 meeting will again be in CSM's Berthoud Hall room 243, so please join us there for a talk by Bill Bottke presenting recent advances in planetary formation. It appears that our solar system had been a little more active in its formative years than we had thought!

Also join us on Saturday night, December 3, for a CSS Family Event at the Denver Astronomical Society's Chamberlin Observatory Open House. We will send out an email with more detail, but please save the date! November-December is my favorite time of the year to look at the night sky. I enjoy the area of sky with Orion and the Pleiades. If inclement or cloudy weather does not allow viewing with the 20" telescope, we will receive an astronomical presentation and a tour of the workings of the historic observatory. Do note that the 1890s construction, along with the complex workings of the telescope, are not ADA compliant. The Denver Astronomical Society hosts the events at the Chamberlin Observatory and this is a great opportunity to meet and greet fellow science enthusiasts and learn! *Family-friendly!!*

It is again time to call for nominations and volunteers for CSS officers, councilors, committee chairs, and general volunteers! We have several positions to fill: President-Elect, 2 councilor positions, and various committee chairs, including Outreach. Send me your nominations ASAP. Please donate time to your Society!

A special call is out for volunteers to drive the upcoming GSA 125th Anniversary Meeting in Denver in 2013. CSS, as an Associated Society of GSA, will be involved! More to come, and we welcome your ideas on how we can participate.



For Educators: **Colorado Science Conference** for Professional Development; sponsored by CAST (Colorado Association of Science Teachers) and affiliated organizations, to be held on Friday, Nov. 18, at the Denver Merchandise

Mart Expo Hall, 58th Ave. at I-25. This year's Keynote Address will be by Dr. Phil Plait, author of "Bad Astronomy." 8 a.m.–3:45 p.m., followed by a reception with annual awards presentations, and with three optional postconference workshops on Saturday, Nov. 19, including a tour of Dinosaur Ridge. For more information see: <http://www.coloradocast.org/professionaldevelopment>.



Upcoming CSS Family Event on December 3rd: Chamberlin Observatory Open House hosted by the Denver Astronomical Society (DAS). Guests can view the heavens through the observatory's famous 20-inch aperture Alvan Clark-Saegmuller refractor for a \$1 per-person fee. An added bonus on Open House nights is that DAS members set up their telescopes on the observatory grounds (Observatory Park) to share with anyone and everyone interested in the wonders of the universe—stars, planets, galaxies, nebulae, star clusters and more!



Nov. 19, Littleton Gem and Mineral Club Annual Silent Auction, Sat., Noon–5 p.m. at Columbine Hills Church, 9700 Old Coal Mine Avenue, Littleton. Set-up will begin at 11:30 a.m. with the auction beginning at 12:00 p.m. Non-members are asked to not bring more than 12 specimens to sell. The club



retains twenty (20) percent of the selling price. The verbal auction and a short business meeting will start at 12:30 p.m. There will be minerals, gems, jewelry, fossils, books and much more available for bidding at the silent auction. Food and drinks will be provided by the club and its members. For more information please email info@littletongemandmineralclub.com or call (303) 840-1177.

Dec. 9–11, Flatirons Mineral Club Show, Boulder County Fairgrounds, Main Exhibits Building at Hover Road & Nelson Road, Longmont, CO; 10–6 Fri., 9–5 Sat., 10–5 Sun.; for more information see <http://bcn.boulder.co.us/community/fmc/>



Studies Shed New Light on Denver Basin Groundwater— *Colorado Geological Survey*

The Colorado Geological Survey has released three significant new reports on groundwater in the Denver Basin. The reports, representing more than a decade of research, provide the most detailed information yet on the varied distribution of groundwater in the Denver Basin and show the most productive aquifers are concentrated near the mountain front and diminish

to the east.

All three publications document in different ways that the strata, from which many of the people living along the southern Front Range obtain their groundwater, are highly variable. Together, they present a science-based perspective of the complex geometry of the freshwater-bearing strata that resulted from a dynamic geologic history. This new perspective shows a non-uniform distribution of strata with favorable aquifer characteristics across the basin. Because of the way the strata formed, the thickest and most productive sandstones concentrate near the mountain front and diminish to the east.

The reports will help regulators, modelers, consultants, policymakers, and planners better understand the variability of water productivity in the Denver Basin, a major source of water supply for populous regions south of Denver. One of the publications is the result of a collaborative effort with the Denver Museum of Nature & Science (DMNS).

The first report; Geology of Upper Cretaceous, Paleocene and Eocene Strata in the Southwestern Denver Basin, Colorado; is a compilation of more than 1,000 square miles of surface mapping of the aquifers where they are exposed along the mountain front. The mapping was originally carried out at a scale of 1:24,000 and is compiled into a 1:50,000 map consisting of two plates. This compilation also presents a simplified naming classification for the geologic strata of the Denver Basin.

The second report; Bedrock Geology, Structure, and Isopach [thickness] Maps of the Upper Cretaceous to Paleogene Strata between Greeley and Colorado Springs, Colorado; takes what was learned by mapping at the surface and extends it into the subsurface using data from nearly 3,000 wells. This report was a collaborative effort with DMNS, whose personnel also spent more than a decade independently working on the strata in the Denver Basin. The report contains seven maps that illustrate the thickness, depth, and distribution of the various freshwater-bearing strata in the Denver Basin. It also contains a depth map to the Niobrara Formation, and a thickness map of the Pierre Shale that separates the Niobrara from the freshwater aquifers. An additional three maps of ancient landscapes illustrate why the sandstone aquifers are concentrated near the mountain front. Included with this report is an illustrative poster that explains the various environments within which the strata were deposited. The poster is also sold separately.

The third publication; Cross Sections of the Freshwater Bearing Strata of the Denver Basin between Greeley and Colorado Springs, Colorado; contains four north-south, and eleven east-west, detailed cross sections of the strata in the Denver Basin. These cross-sections integrate surface geologic mapping with subsurface well data to graphically illustrate variability in the types of strata across the entire basin. This report is oriented toward the professional community, rather than the general public.

All three publications come in hard copy and include DVDs with detailed PDFs of the plates and GIS shapefiles containing metadata. The publications can be ordered from the Colorado Geological Survey at 303-866-2611 or in the online bookstore at <http://geosurveystore.state.co.us/>.



Paul K. Sims, age 93, died Oct. 29, 2011. Born in Newton, Illinois on Sept. 8, 1918. Ph.D. Geology, Princeton. Illinois Geological Survey, 1943–1944. University of Minnesota, Professor and Director of Minnesota Geological Survey, 1961–1973. U.S. Geological Survey, 1946–1961, 1973–Retired USGS. Worked particularly on the Precambrian of the Colorado Front Range, Minnesota, Wisconsin and Michigan, and on ore deposits, as iron in New Jersey, lead-zinc in the Metalline district of Washington, and gold in the Archean of South Pass area of Wyoming. President of Colorado Scientific Society in 1957 and became an honorary member in 1977. Meritorious Service Award, U.S. Department of Interior, 1985. Goldich Medal of Institute of Lake Superior Geology.

CSM – SEG Student Chapter Mini-Symposium on Rare Earth Element Geology

December 2, 2011

10:00 AM – 2:45 PM

Ben Parker Student Center, Ballroom A
Colorado School of Mines
Golden, Colorado USA

The CSM SEG Student Chapter is hosting a mini-symposium on rare earth element geology on December 2, 2011, 10–3 p.m., at the Ben Parker Student Center, Ballroom A, on the CSM Campus. It has become a large event, with over 75 people registered so far (~50 seats remaining), so anyone interested should RSVP as soon as possible. More details can be found at our website: <http://geology.mines.edu/econgeol/segevents.html>.

— Wesley S. Hall, CSM-SEG Student Chapter President

Presenters:

Yasushi Watanabe, Geological Survey of Japan – AIST
Brad Van Gosen, USGS
Philip Verplanck, USGS
Michael Lee Berger, University of Colorado, Molycorp
Dick Grauch, Scientist Emeritus, USGS
Roderick Eggert, Colorado School of Mines
Mandi Reinshagen, CSM, Consulting geologist to
Rare Element Resources



Opportunity for Undergrads and Recent Graduates—NYC

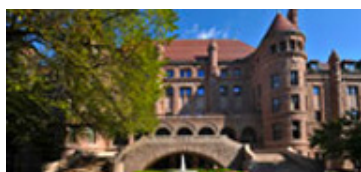
The American Museum of Natural History has developed a new opportunity for individuals with undergraduate degrees in Earth Science and related fields who may be interested in pursuing a teaching career in secondary schools. The program is a Masters of Art in Teaching with a specialization in Earth Science.

Designed as an urban residency program in partnership with six schools in the New York City area, the program will be offered by a faculty that draws from the Museum's Division of Physical Sciences (curators and post docs in the Earth and Planetary and Astrophysics Departments) and the Education Division (educators with experience in teacher training and mentoring).

In a 15-month, full-time, rigorous program, students will be in residence for two summers at the Museum both teaching in our youth programs and participating in Earth and Space science research activities with our curators, and, during the school year, in residence at two different NYC area schools, four days per week from September through January and February through June. At the same time they will be completing 36 credits of graduate level courses in both science and pedagogy at the Museum and online.

While not for the faint of heart, for the right students it will be an excellent opportunity—all candidates accepted into the program will receive a tuition waiver and will be paid a stipend to cover living expenses during the 15 month program (\$30,000), along with medical benefits. In exchange, they need to commit to seeking employment in a high-need school in NY State for a minimum of 4 years following graduation. During the pilot phase we will be looking to accept two cohorts of 25 students each (first cohort starting in June 2012 and the second cohort starting in June 2013).

So, we are actively recruiting now for candidates for the first cohort. One critical caveat is that applicants must be U.S. Citizens or Legal Residents. Interested folks should go to the web site (amnh.org/education/mat) and, in addition, there is a flyer on this website: <http://research.amnh.org/eps/f/AMNH%20MAT%20Flyer%20V6b.pdf>. The online application is now available, and applications for cohort 1 close 1/31/12.



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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

Café Scientifique Nov. 15 *David Schimel, National Ecological Observatory Network, "The Ecological Landscape!"*

Dec. 13 *Baylor Fox-Kemper, Department of Atmospheric and Oceanic Sciences, UC Boulder, "The future of El Niño." Meets at: The Wynkoop, 1634 18th St., Denver, evening science talks 6:30–8 p.m. Arrive early to get a seat. Free, except for beer.*
<http://www.cafescicolorado.org>

CO-AIPG Nov. 15 *Sam Gowan, Ph.D., President of AIPG and President, Alpha Geoscience, Clifton Park, NY, "The Cause of the Retsof Salt Mine Collapse." 11:30 AM social gathering; Noon lunch & subsequent talk. Meetings at the Petroleum Club (3rd Floor in the Denver Athletic Club building), 1325 Glenarm Street, Denver. Make an advance reservation so that seating and food prep. are adequate to cover attendance. Cost is \$25 with advance reservation and \$30 at the door. Talk only is \$5. Paid parking is available along the street (metered) or in the adjacent parking lots and parking structure. Contact Jim Russell by Noon on Nov. 11 for reservations at 303-278-4456 (h), 303-815-3901 (c), or via e-mail at summitdatasvcs@msn.com.*

Colorado School of Mines, Van Tuyl Lectures Thursdays from 4–5 p.m. in Berthoud Hall room 241. **Nov. 17** *Elizabeth Keating, Los Alamos National Lab, "Assessing the impact of CO₂ and brine leakage on shallow groundwater quality: Results from a natural analog study in New Mexico, USA."* **Dec. 8** *Mark Rowan, Rowan Consulting, Inc., "Allochthonous salt tectonics: from simple models to complex reality."* http://geology.mines.edu/calendar/Van_Tuyl.html

Colorado State University, Dept of Geosciences, Rm 320 Warner College of Natural Resources Bldg., Mondays, 4:00 pm. 970-491-5661. **Thursday, Nov. 17 at noon**, *Dr. Jacob Lowenstern, USGS/YVO, "Magma intrusion, hydrothermal processes and gas chemistry at the Yellowstone Caldera."* **Nov. 28** *Dr. Scott Denning, CSU, "Anthropogenic climate change: How it works on decadal to millennial time scales."* <http://warnercnr.colostate.edu/geo-training/>

Denver Mining Club Nov. 14 *Dr. John Poate, VP for Research & Technology Transfer, Colorado School of Mines, "The impact of research at the Colorado School of Mines." 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 buffet lunch required.*
<http://www.denverminingclub.org>

Denver Museum of Nature and Science Nov. 16 7:00 p.m., "How to clone a mammoth," by DNA researcher Beth Shapiro, Ph.D. Ricketson Auditorium. \$12 member, \$15 nonmember. <http://www.dmns.org/learn/adults/after-hours/>

Rocky Mountain Association of Geologists (RMAG) Dec. 7 *Dr. Nick Harris, "Application of natural gas geochemistry to migration and filling models in large tight gas sand reservoirs of the Rocky Mountains." Reservations by recording at 303-623-5396 until 10:30 a.m., Monday prior to talk. Luncheon \$30. Talk only (no reservation)—\$5. Denver Marriott City Ctr., 17th & California. <http://www.rmag.org/>*

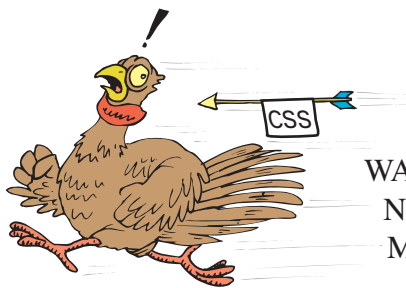
SME COLORADO SECTION Nov. 17 Dinner at The Golden Hotel, Golden, CO, *Preston Chiaro, Rio Tinto, Head of Technology & Innovation, "The Mine of the Future."* Cash Bar Reception: 5:30; Dinner: 6:00–7:00 p.m. Cost: \$45 per person. Students welcome at \$15 per person with reservation. Pay at the door. Check or cash, please. No credit cards. No shows will be billed. Reservations to Cathy Begej by Friday, Nov. 11th. Email: CathyBegejSME@gmail.com; Phone: 720-889-6112 Driving directions and a location map can be accessed at thegoldenhotel.com. 800 Eleventh Street, Golden, Colorado 80401

Univ. of Colorado, Boulder, Geol. Sciences Colloquium Nov. 16 *Lon Abbott, CU Boulder, "Rates of Quaternary landscape change in the eastern Grand Canyon."* **Nov. 30** *Yasushi Watanabe, "Rare Earths–RASEI lecture." Weds., 4:00 p.m., Benson Earth Sci. Auditorium, Rm. 180. Refreshments at 3:30 p.m. on the 3rd floor. <http://www.colorado.edu/geolsci/>*

Western Interior Paleontological Society WIPS meets the first Monday of every month, Sept. to May, except for the December holiday auction that is held on a Saturday. Doors open at 6:30 p.m., talk at 7 p.m., Ricketson Auditorium, Denver Museum of Nature & Science (all welcome, no admission charge). <http://www.westernpaleo.org/events.php>

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WANTED:
New CSS
Members

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		2011–2013: Jeremy McCreary 303–744–0907 jeremy@cliffshade.com

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Program:	VOLUNTEERS NEEDED! CONTACT LISA FISHER FOR MORE INFO.!
Publicity:	
Science Fair:	Chuck Weisenberg, 303–238–8806, cweisenbrg@msn.com
Webmaster:	Table Mountain Web Design, 303-278-2701, bwarden@tablemntn.com



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