

Colorado Scientific Society

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

Annual Emmons Lecture

Transtension in Arcs and Orogens



John F. Dewey

Department of Geology, University of California at Davis

Thursday, February 21, 2002

Metals Hall at the Green Center on CSM campus

Social time 7:30

Meeting time 8:00



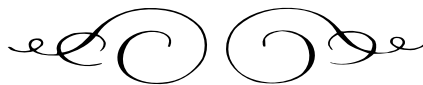
Transtension in Arcs and Orogens

Professor John Dewey, University of California at Davis, Davis, California

Transtension is oblique extension, a combination of coaxial zone-orthogonal extension and non-coaxial zone-parallel shear. It is typical of extensional zones for many reasons, mainly because plate boundary and deformation zones are rarely perfectly orthogonal to plate and block boundaries. The transport direction is defined as the slip vector between the separating blocks or plates. The instantaneous extension direction (X_i) is not parallel with transport direction but bisects the angle between transport direction and the zone boundary orthogonal. The finite extension direction (X) rotates towards transport direction. Lines, planes, and structures in the obtuse angle between transport direction and the zone orthogonal rotate, with vorticity, towards transport direction; those in the acute angle rotate against vorticity towards transport direction. Where the angle (a) between transport direction and the zone orthogonal is less than 70.5° , the principal shortening direction (Z_i) is vertical and the intermediate (shortening) direction (Y_i) is horizontal. This generates sub-horizontal foliation and vertical dikes and fissures and steeply dipping conjugate normal faults intersecting in Y_i and folds and constrictional stretching lineations parallel with X . Where a is greater than 70.5° , Z_i is horizontal and Y_i is vertical, generating vertical foliation and conjugate strike-slip faults (Riedels and anti-Riedels) and folds and lineations parallel with X . Thus, transport direction can be calculated for any deformation zone where the angle $a/2$ can be determined; this is of enormous potential in determining relative plate motions.

Transtension is of great importance but is, as yet, very poorly understood in convergent plate boundary zones. Intra-oceanic juvenile arcs are dominated by transtension where subduction rollback occurs with motion of the over-riding plate away from the trench line. In Newfoundland, a fine example of a transtensionally distended Cambrian-Ordovician arc with oblique dikes and horizontally stretched pillows and supra-subduction-zone ophiolites is superbly exposed with a complicated polyphase structural and igneous history.

Transtension dominated the late extensional “collapse” of several orogens. Orogenic transtension leads to tectonic denudation by crustal thinning and extensional detachment and the development of high temperature/and low-pressure metamorphic assemblages with subhorizontal foliations and stretching directions, so typical of the Tasman belt of Australia and the Variscan belt of Europe. Transtensional X_i and X parallel folds are expressed as periclinal and “corrugations” in extensional detachments in the Cenozoic Basin and Range and in the Silurian Caledonides of western Norway.



RESERVATION FORM (see next page)

I will attend the wine tasting and “Terroir” talk at 240 Union Restaurant on March 21, 2002.

Name: _____

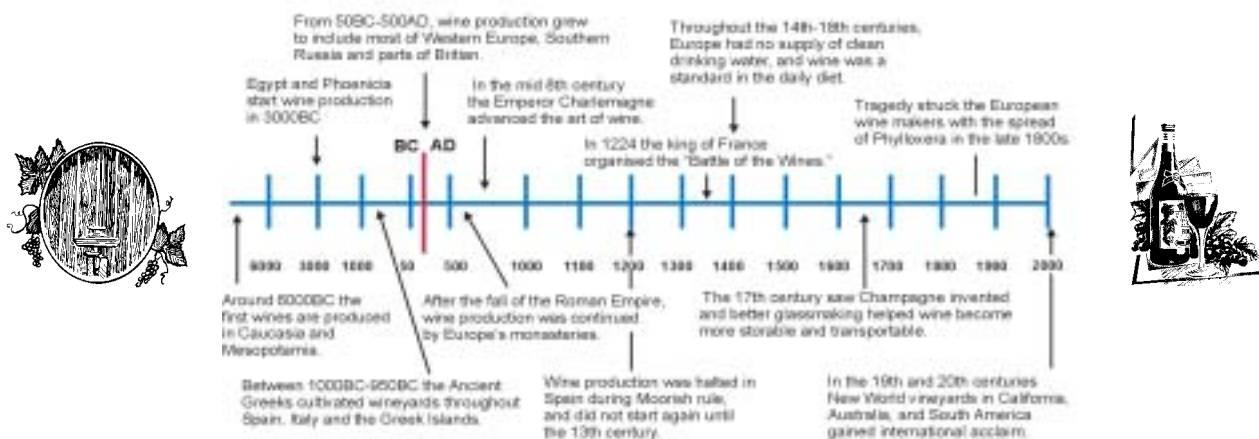
Phone Number: _____

Email address: _____

Please send to:
Eric P. Nelson, CSS President
GE Department
Colorado School of Mines
Golden, CO 80401

Next Month: March 21st, 2002

The Wine Timeline



Terroir - the connection between wine and geology !!

Wine, wine, wine. Not whine, whine, whine. "The peoples of the Mediterranean began to emerge from barbarism when they learnt to cultivate the olive and the vine." (*Thucydides, Greek Historian, 5th Century BC*) Thus began a long history of wine production and enjoyment by humans (and, perhaps, a few pet dogs). The chart above (<http://www.history-of-wine.com/html/timeline.html>) shows some of events along this long history.

The wine industry represents a large portion of the economy of many countries and states (including Colorado!), and the connection of geology with wine production has received much attention in the past decade. For the March 21 meeting this year, we have something different and special planned. We have invited Dr. Lawrence D. Meinert, Professor of economic geology at Washington State University, to present a talk. Larry's main research interest is using the basic principles of geology and geochemistry to predict or find ore deposits. However, he is also an expert on "terroir," the French term for type of soil and other geographic factors that influence the quality of wine like altitude, position relative to the sun, angle of incline, and water drainage. Larry has assembled an incredibly interesting talk (given in 2001 at Colorado School of Mines) about the terroir of the excellent wines of Washington State. This includes a great discussion (with really excellent slides) of how two major geological events have affected wine growing in the region: the Cascade volcanic chain, and the catastrophic floods from the glacially-dammed Lake Missoula that formed the Channeled Scablands a few thousand years ago.

We will hold this event at the 240 Union Restaurant, where we will combine Dr. Meinert's talk with a wine tasting. We plan to offer a number of wines, comparing Washington state wines with similar wines from other regions. In order to keep cost down, we will offer bread and snacks with the wine, rather than a full dinner. The estimated cost will be about \$30.00 per person. I encourage all who enjoy wine and excellent geology talks to attend. You will be glad you did.

Because only a limited number of people will fit in the room available (~35-45 people), we ask you to fill out and send in the reservation form located at the bottom of the previous page.

A Note from the President

Eric P. Nelson, President, Colorado Scientific Society

January 17 was a busy day. Other than the normal daily battles and fire control at the office, the CSS Council met for the first time this year, and later that evening we heard two excellent talks at the January society meeting. Vince Matthews, back in the state after a long sabbatical, gave a stimulating talk on the Colorado Geological Survey's analysis of seismic potential in the state (and having moved here from California, you thought you were escaping from impending seismic disaster, ha !?). Bob Raynolds then thrilled us with wonderful photos and stories of the geology and culture of Tibet. He even brought a box of 'Yak paraphernalia' for us to look through. At the Council meeting, many exciting issues were discussed. Some of the initiatives are explained below.

Planned "History of the CSS" Update - Of special interest is a proposed initiative to revise and update the *History of the Colorado Scientific Society 1882-1993*. The first edition, compiled and written by Edwin Eckel in 1978, was updated in 1993. It has been nearly a decade since the second edition, and it is only through the hard work and good memories of CSS members that we can keep a record of the society. Marjorie E. MacLachlan, Michael Machette, Scott Lundstrom, and Peter Belanger volunteered to start a committee for the update, and would like to encourage any society members to volunteer to help add to the collective memory. Particularly needed is someone involved with desktop publishing. Those interested should contact Marjorie at 303-986-7192, or jcmemaclachlan@aol.com.

Membership Drive - As promised, we have begun a membership drive (if only it worked as easily as a cattle drive!). Jim Yount of USGS is heading up the initiative which will involve revising an advertising pamphlet, and contacting many universities, societies, and businesses involved in geoscience and related fields. Again, volunteers are needed; please contact Jim at 303-236-5397, or jyount@usgs.gov.

Website Improvements - Bill Wingle, our webwizard, has added a very nice search engine on the website. I tested it and it works great! We have also added the CSS constitution and bylaws to the website, for those needing some late-night reading material.

Newsletter Improvements - Notice the new Interview Column?! This month we offer the views of Tom Casadevall, who heads up the USGS in Denver. We have also added some "geo-trivia" to keep our members reminded of just how geologically incredible our state is. Thanks to Vince Matthews of CGS, and in the future to Nolan Doesken, the Assistant State Meteorologist!

Phase Out of Newsletter Mailings - In this age of the Internet and email, it seems a waste to place stamps on paper and send them via 'snail-mail'. The funds (and manpower) used to send out hardcopy could be put to much better use, for example with memorial fund grants and outreach projects. The CSS council has agreed that such mailings should be phased out, and we are asking CSS members to begin receiving the newsletter in other ways. The newsletter (including back issues) can now be read on, or downloaded from, the CSS website (<http://www.coloscisoc.org/>); formats for download include HTML or PDF. Advantages include color and direct web links to other important websites. For those wishing to stop receiving hardcopy in the mail, please contact Cindy Rice at 303-236-1989, or crice@usgs.gov.

Planned Field Trips

Our field trip chairperson, Emmett Evanoff, is hoping to organize a one-day field trip to the Lyons sandstone quarry on May 11. Plans are still pending. He has also a proposed longer field trip, either to the San Juan Mountains, or to Yellowstone National Park. Dates and details are still to be decided. We would like to see strong participation this year, as the field trips promise some exciting geology and scenery.

In closing, I will leave you with these words taken from Harry Kent and Karen Porter's introductory message in the 1980 *Colorado Geology* volume published by RMAG:



“[In 1960] the future energy demands of the nation presumably could be met overseas, energy- and mineral-resource exploration were in a marked decline, and employment prospects for geologists were limited. Within the state of Colorado, the pressures of urbanization and burgeoning population were still largely in the future...basic research and application became essential, and the geologic professions again became essential to the future of the state”

Clearly some of these statements could be applied again today, 40 years later. Energy- and especially mineral-resource exploration have experienced declines, and employment prospects are limited once again. Nonetheless, population and related urbanization have increased remarkable, and have brought new challenges for geoscientists (see Tom Casadevall’s comments in the Interview Column). Kent and Porter were right, basic research and application, and the related geologic professions *are* essential to the future of the state. Let’s keep the Colorado Scientific Society alive and well and an active force in insuring that geologic professions help direct the future of Colorado.

Interview Column

Tom Casadevall – Top Dog at USGS in Denver

This new column is designed to offer CSS members a view into the thoughts and opinions of prominent (and not-so-prominent) geoscientists in Colorado. Various members will act as interviewers, and I pulled the short straw this time. For this first column, I chose to interview Tom Casadevall, USGS Regional Director of the Central Region. Not being a seasoned journalist, I arrived without a modern recording device, and had to rely on good old fashion note taking. Therefore the interview response is somewhat paraphrased, and hopefully not garbled!

Tom appears to have been a good choice, as he has spent 32 years in Colorado, and presently heads up an agency that employs the largest group of geoscientists in the state. In fact, he oversees about 3100 employees in four disciplines (geology, hydrology, biology, and geography). The Central Region encompasses 15 states between the Mississippi River and the Continental Divide, although some of the geoscientists in Tom’s group have projects in other states. Of about 500 geoscientists in the geological discipline based in Colorado, many are working on Colorado projects. These include the Front Range Infrastructure project involved with nonmetallic resources (e.g., sand and gravel) for projects like Denver International Airport and the perimeter highways in Denver, geohazards assessment programs, and energy assessment programs. Many of these projects involve collaboration with the Colorado Geological Survey.

Although Tom as been with the USGS for 25 years, he started his career in the minerals industry working in, and studying, the Sunnyside and other mines in the San Juan Mountains. When asked about the minerals industry and employment for geoscientists in Colorado, Tom noted that he has seen a change over the years from resource industry-based employment to more environmental-based employment. He noted that the shift away from mining of metallic resources has resulted most recently from a drop in metal prices, but also from a change in demographics with doubling in the population since about 1970.

Tom feels that the most interesting aspect of Colorado geology is the variety seen here, although his first love appears to be volcanic geology, something Colorado has plenty of. Asked if he gets to do geology any more, the answer was no, but that he has been involved in some “hobby geology.” A recent example was helping to produce some spectacular geologic maps and offering nightly geo-talks for the Ride-The-Rockies bicycle tour.

Regarding important issues facing geoscientists in Colorado, Tom says we need good geoscience to help inform politicians in the decision making process. The state is growing fast and there is pressure on the environment from related development. Secondly, Tom feels that we need to help maintain the geoscience profession in Colorado, as currently there are not enough young geologists available.

In summary, I feel that Tom Casadevall is an excellent geoscientist who knows the geology and issues in Colorado very well, and I, personally, am glad he is top dog of the Central Region and an active member of CSS.



A View Through the Brown Cloud

by Lisa Ramirez Bader

Yeeeehaw! The annual Denver Stock Show and Ro-day-o turned out to be fun for the whole family. Eight of us, from age 3 to 71, turned out for a full Sunday of events. You must get there early to allow time for moseying around the vendor's stalls. Silver and leather temptations were tough to ignore but a growling stomach led us outdoors to the BBQ tent. Mm mmm good! Back inside the show started with a blaze of laser lights and fireworks and then settled into the familiar bronc riding and cow wrestling. At the end of two hours the score was Chawboys 3, Livestock 13. It was quite amusing to watch the critters outsmart the wranglers. After the show we headed over to the "Dog Agility Games" where dogs of all shapes and sizes run a timed course of high jumps, tunnels, teeter-totters, and the like. The crowd favorites weren't necessarily the winners. One was a loping blue tick hound that would burst into a mournful howl right in the middle of his run. He brought a hillbilly tear to my eye. Next stop, the hog pens at feeding time. Mistake! These porkers squeal so loudly for their Purina pig chow that ears were ringing for hours afterwards. Last but not least was the exhibition hall with more vendors hawking tasty beef jerky, western wear, furniture, horse trailers, and every type of faux cowboy decor a prairie mansion yuppie could wish for. Each year I look forward to the January stock show because for just one day I am reminded of how the West Was Won - hard work in the dirt and capitalism! All geologists can relate to that.



Coming next month!

The Interview Column: Jim Shannon interviews Steve Turner, Newmont Mining Corporation's Chief Geologist, on new initiatives. Newmont is headquartered in Denver, and both men have Ph.D.s from Colorado School of Mines. Steve's thoughts will be of great interest in the current climate within the mining industry, especially given the importance of this industry in the history of Colorado.

Ongoing USGS Activities in Colorado: Dave Moore (USGS-Denver) will provide us with a brief report of his ongoing efforts to produce regional Quaternary geologic maps spanning most of central Colorado.



Earth Science Meetings and Talks

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



Colorado Scientific Society's regular meetings are held the 3rd Thursday of the month at the Colorado Mountaineering Center in Golden (unless otherwise advertised). Social time begins at 7:00 p.m. and talks start at 7:30 p.m. For info., contact Eric Nelson at 303-273-3811, enelson@mines.edu

USGS Geologic Division Colloquium Thursdays, 1:30 p.m., Foord Rm., Building 20, entrance W3, Denver Federal Center. For information call Laura Strickland at 303-236-5302, or email: lstrickland@usgs.gov Call for cyber talk info. **February 14** Paleoproterozoic basement in SW North America: Our contribution to the Rodinia Supercontinent reconstructions by Alex Iriondo, USGS/GD/Crustal Imaging and Characterization. **February 28** MESC Analyzing the Public Policy Decision Process by Berton Lee Lamb, USGS/BRD.

Colorado School of Mines, Heiland Lectures at 4:00 p.m. on Fridays, contact Michelle Szobody 303-273-3451. , **Van Tuyl Lectures February 6**, Global Oil and Gas Resources by Tom Ahlbrandt, USGS; **February 21**, National Energy Policy by Katy Makeig, AGI Congressional Fellow; **February 28**, Metal Zoning in the Viburnum Trend, MO by Craig McClung



Colorado State University Geology Lectures Mondays, 4:10 p.m., room 316 of the Natural Resources Bldg. Call the Dept. of Earth Resources at 970-491-5661 for details, or go to: <http://www.cnr.colostate.edu/ER/seminars/index.html> **February 26, 2002**, Fingerprints on Wyoming's rock of ages: clues to the growth of continents, Carol Frost, University of Wyoming

Denver International Petroleum Society (DIPS) meets the 2nd Friday of each month at the Wynkoop Brewing Co., 18th and Wynkoop Sts. Reception begins at 11:30 a.m., lunch 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 a.m. Wed. 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 Mining Club meets every Thursday (except when noted) at Country Harvest Buffet at Villa Italia, 7200 W. Alameda Ave., Lakewood, 11:30 a.m.–1:00 p.m. **February 7**, Three-Dimensional Visualization and Analysis of Geologic Data Jim Reed, Director of Research and Development, RockWareEarth Science Software. **February 14**, Mining Opportunities in the Americas, Gil Cisneros, President and CEO, Chamber of the Americas. **February 21**, Stereo Vision and 3D Modelling for Remote Control of Mining Equipment J. P. H. Steele, Professor, Western Mining Resource Center, Colorado School of Mines. **February 28**, Energy and Mineral Resources of Afghanistan Lindsey V. Maness, Jr., Geologist, Bahram Jafari, Petroleum Engineer, Farookh (Fred) Djahanguiri, Mining Engineer, and Abdullah Ayazi, Engineer.

Denver Region Exploration Geologists' Society (DREGS) meets in the Consolidated Mutual Water Company 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 info. contact Jim Piper, 303-932-0134, or the website <http://www.dregs.org>.

Denver Well Logging Society (DWLS) meets on the 3rd 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. Call Elice Wickham at 303-573-2781 for reservations. Web page: <http://dwls.spwla.org>

Friends of Dinosaur Ridge and the Morrison Natural History Museum 7:00 p.m. at Red Rocks Elementary School at the west end of Morrison. **February 12**, Junk Science and How to Recognize It, by Jeff Stephenson, Educations Collections Manager, Denver Musium of Nature and Science. Call 303-697-DINO for more information.

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 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. Meeting location: Denver Petroleum Club, Anaconda Tower, 555-17th St., 37th floor. **February 15** Depositional Environments, Stratigraphic Framework and Reservoir Characterization of the Mud-Rich Turbidite System in the Lewis Shale, Washakie Basin, Wyoming by Steve Goolsby. **February 22** RMAG/DGS 3D Seismic Symposium at the Hyatt Regency in downtown Denver

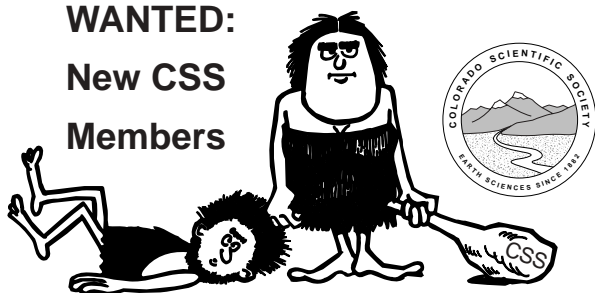
University of Colorado at Boulder, Geological Sciences Colloquium Wednesdays, 4:00-5:30 p.m., Rm. 180. Refreshments at 3:30 p.m on the 3rd floor. For info., call 303-492-8141. Web page: <http://www.colorado.edu/GeolSci/hotlist.html>. **February 6**, Meteorites from Mars: Interplanetary exchange of rocks and microbes by Jay Melosh, University of Arizona.

For a constantly updated, online geo-calendar, visit the Colorado Geological Survey at: http://geosurvey.state.co.us/pubs/outreach_cal/GEOCALENDAR.htm

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Lakewood, CO 80215-0495

<http://www.coloscisoc.org>

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