



# Colorado Scientific Society

*In pursuit of the promotion of knowledge,  
understanding of science,  
and its application to human needs.*

## *Presidential Address*

### **MULTI-STAGE, MULTI-DIRECTIONAL LARAMIDE(?) SHORTENING AND COMPRESSION IN THE SOUTHERN ROCKY MOUNTAINS**

**Eric A. Erslev**  
Department Of Earth Resources  
Colorado State University

**Tuesday, December 15, 1998**  
**Union Square Theatre in the Sheraton Hotel**  
**360 Union Boulevard**  
**Lakewood, Colorado**

**Social Hour: 7:00 p.m.**  
**Meeting Time: 7:30 p.m.**

**Please note: the Presidential address and CSS business meeting are taking place on December 15, the 3<sup>rd</sup> Tuesday, not the usual 2<sup>nd</sup> Tuesday, of this month.**

### **Table of Contents**

Abstract of 1998 Presidential Address .....	2
Some notes from the President-Elect, Ken Pierce .....	3
S.F. Emmons Lecture, 8:00 pm, January 12.....	3
Museums and News.....	4
Earth Science Meetings and Talks.....	4
Status of Memorial Funds, 1998 .....	4
The George Snyder Memorial Fund .....	6
Colorado Scientific Society Officers, Councilors, and Chairpersons .....	8



# Abstract of 1998 Presidential Address

## MULTI-STAGE, MULTI-DIRECTIONAL LARAMIDE(?) SHORTENING AND COMPRESSION IN THE SOUTHERN ROCKY MOUNTAINS

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Despite unequalled geologic control on the upper crust of the Rocky Mountains, the Laramide orogeny remains an enigma. The linkages between plate motions and Laramide deformation are uncertain, with proposed explanations including subcrustal shear during low-angle subduction, crustal delamination and detachment due to plate coupling to the west, and gravitational spreading of the Cordilleran thrust belt.

In the southern Rocky Mountains (south of Wyoming), recent battles between advocates of north-south strike-slip faulting and east-west thrust faulting have centered on attempts to limit strike-slip displacements using sedimentary trends. Unfortunately, the region's abundant crustal weaknesses make assumptions of linear pre-Laramide sedimentary trends suspect at best.

Our research at C.S.U. has used minor fault patterns to document the complex Laramide-to-Recent evolution of the southern Rocky Mountains. The major Laramide arches formed during an early stage of E-W to NE-SW shortening and compression. This deformation is recorded by roughly equal numbers of thrust, right-lateral and left-lateral faults. In western Colorado, these faults are cut by faults indicating a second stage of NW-SE shortening and compression. In central Colorado and New Mexico, faults from a third stage of N-S shortening overprint the above faults. In New Mexico, these faults are dominantly strike-slip, with few associated thrust and normal faults. Neogene Rio Grande extension is recorded by younger north-striking normal faults.

The timing of these orogenic stages is partially constrained near Galisteo, New Mexico, where all fault sets cut the Paleocene Diamond Tail Formation but only the N-S strike-slip and normal faults cut the Eocene Galisteo Formation. In this area, no strike-slip faults cut the 27 Ma Galisteo mafic dike. Near Raton and Taos, however, north-south strike-slip faults cut the 24 Ma Eagle Rock dike and the 27 Ma Llana Quemado volcanic breccia as well as conglomerates containing clasts of 25 Ma tuff. In Colorado, equivalent late-stage shortening directions are indicated by WNW-trending, Miocene-cored synclines in North Park and near State Bridge as well as north-south strike-slip faults cutting mid-Tertiary plutons. Thus, the latest period of strike-slip shortening may have continued into the early Miocene. It may be the missing link spanning the gap between Laramide shortening and Rio Grande rifting.

Our work has shown the validity of both thrust and strike-slip hypotheses, although neither is adequate in exclusion of the other. Early Laramide deformation is consistent with crustal delamination and detachment due to plate coupling to the west. Subsequent shortening directions do not parallel predicted plate convergence vectors, however, and suggest gravitational spreading of the Cordilleran orogenic belt. Middle Tertiary strike-slip faulting may have localized mid-Tertiary igneous activity and provided the precursor for Rio Grande rifting.



## Some notes from the President-Elect, Ken Pierce

At the December business meeting, we will vote on the following nominations for next year's elective offices:

**Mark Hudson** has agreed to run as President-Elect. Mark is relatively young for a Survey scientist in these days, where he is a general geologist with the National Geologic Mapping team and also a paleomagnetician.

**Emmett Evanoff** of the University of Colorado Museum has agreed to run as councilor. In addition to involvement with CU, Emmett is also associated with the Denver Museum of Natural History.

**Bob Jarrett** has also agreed to run for council. We're delighted to have someone from Water Resources Division of the USGS to be on council and hopefully involve hydrologists and other earth scientists with the Society.

In addition, we have new chairs of the following two key committees.

**Eric Nelson** (CSM) will chair the Program Committee. He did this the year before last and lined up an excellent, interesting, and varied set of talks.

**Sherm Marsh** (USGS, retired) will run the field trip committee. He did this awhile back, and people are still talking about the interesting trips and great meals.

## S.F. Emmons Lecture, 8:00 pm, January 12

Green Center, Colorado School of Mines

**Wally Broecker** will speak on "A threat from the bipolar seesaw"

Abstract: During the last glacial period, Earth's climate underwent frequent large and abrupt global changes. This behavior appears to reflect the ability of the ocean's thermohaline circulation to assume more than one mode of operation. The record in ancient sedimentary rocks suggests that similar abrupt changes plagued the Earth at other times. The trigger mechanism for these reorganizations may have been the antiphasing of polar insolation associated with orbital cycles. Were the ongoing increase in atmospheric CO<sub>2</sub> levels to trigger another such reorganization, it would be bad news for a world striving to feed 11 to 16 billion people.

Wally Broecker is at Lamont-Doherty Earth Observatory of Columbia University and is a member of the National Academy of Sciences. He works on major earth science problems using geochemistry, and is a key researcher in the relation between climate change and the oceans. He is also a great speaker.



## Museums and News

**Friends of Dinosaur Ridge** For information call 697-DINO. Visitors' Center is located at 16831 West Alameda Parkway (north side of Alameda, just west of the C-470 overpass). Open 9 a.m. to 4 p.m. weekdays and weekends. Fireside chats are held at the Morrison Town Hall, 110 Stone Street in Morrison starting at 7 p.m.

## Earth Science Meetings and Talks

**Colorado Scientific Society's** regular meetings are held the 2<sup>nd</sup> Tuesday of the month (unless otherwise advertised, as in this month). Social time begins at 7:00 p.m. and presentations start at 7:30 p.m. For information, contact Eric Erslev at (970) 491-6375 or [erslev@cnr.colorado.edu](mailto:erslev@cnr.colorado.edu).

**Denver International Petroleum Society (DIPS)** meets the 2<sup>nd</sup> Friday of each month at the Wynkoop Brewing Co., 18<sup>th</sup> 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 calling or leaving message with Dan Spancers (303) 446-5701. 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 Cappa, (303) 866-2611.

**Colorado School of Mines Lectures** For Heiland Lectures at 4:00 p.m. on Fridays, contact Michelle Szobody (303) 273-3451. For information on Van Tuyl Lectures, call the Dept. of Geology at (303) 273-3800.

**Colorado State University Geology Lectures** Mondays, 4:10 p.m. in room 109 or 316 of the Natural Resources Building. Call the Dept. of Earth Resources at (970) 491-5661 for further details.

**University of Colorado at Boulder, Geological Sciences Colloquium**  
Wednesdays, 4:00-5:30 p.m., Rm. 180. For schedule, contact Kathy Madsen 303-492-8141

## Status of Memorial Funds, 1998

The Colorado Scientific Society Memorial Fund Program was started in 1984 with the Ogden Tweto Fund and has blossomed to include five funds, the most recent addition being the George Snyder Fund (see separate news item). As a result of generous contributions by family members, friends, and Society members, each of these funds have grown substantially since their inception. As of December 1, 1998, the total value of our Memorial Fund investments was roughly \$142,000 (this includes about \$9,000 in interest reserved for the 1999 awards).



The Memorial Funds honor the following individuals (date of inception) and primary objectives:  
 Ogden Tweto (1984): Field-based earth-science research in Colorado and adjacent areas  
 Stephen Oriel (1986): Geologic studies of the Idaho-Wyoming thrust belt and associated topics  
 Edwin Eckel (1990): Engineering geologic studies in the United States  
 William-Pierce (1994): Studies of the Heart Mountain Fault, Wyoming, and associated problems  
 George Snyder (1998): Studies of Precambrian igneous/metamorphic geology and basement tectonics in the Rocky Mountain region.

As you may know, we only use interest from the Funds to finance the awards, so the financial condition of the Funds parallel short- and long-term interest rates (currently 5-6%). During 1998, we earned fixed interest income from GNMA and FNMA bonds (\$10K-30K each) that mature over the next 5-10 years and preferred corporate stocks. Most of the stocks were purchased in March 1998, after many of our bonds were recalled as a result of declining interest rates. As a result, we now receive an average of about 6.5% interest from our long-term investments.

Over the past 14 years, the Society has awarded 96 scholarship grants for an aggregate value of \$67,807. As a result of continued fund contributions, the number and amounts of awards have generally increased each year (see table below). However, our long-term goal is to increase the average amount of individual grants from the about \$700 to the \$1000 level (inflation has decreased the buying power of those scholarship dollars by about 50% since 1984). Therefore, your continued support of this important and highly visible program will be much appreciated. Contributions to any or all funds can be made on the attached Dues Form. Please remember that your **entire** contribution goes towards generating interest for the grants and that your contribution is 100% tax deductible since the Society is a non-profit Section 501 (c)(3) organization.

**Number of Awards**

(Partial grants co-sponsored by 2 funds)

**Amount of Awards (\$)**

(\* No research proposals received this year)

Year	Tweto	Oriel	Eckel	Pierce	Total per year
1984	3				3
1985	3				3
1986	2	0			2
1987	2	1			3
1988	1	1			2
1989	2	1			3
1990	3.5	1.5	0		5
1991	4	2	1		7
1992	5	2	2		9
1993	4.5	1.5	2		8
1994	5	2.5	2.5	0	10
1995	5	2	2	1	10
1996	4	3	2	2	11
1997	4	3	2	1	10
1998	5	3	3	*0	11
<b>Totals</b>	<b>53</b>	<b>23.5</b>	<b>16.5</b>	<b>4</b>	<b>96</b>

Tweto	Oriel	Eckel	Pierce	Total Amount (average grant)
1300				1300 (433)
1050				1050 (350)
650	0			650 (325)
1700	400			2100 (700)
900	450			1350 (675)
1940	530			2470 (823)
2910	1190	0		4100 (820)
3100	1500	650		5250 (750)
3500	1890	1270		6660 (740)
3030	1290	1000		5320 (665)
3590	1600	1450	0	6640 (664)
2900	1400	1200	850	6350 (635)
2900	1800	1300	1900	7900 (718)
3900	2400	1750	1700	9050 (905)
3545	2100	1972	*0	7617 (692)
<b>\$36,915</b>	<b>\$16,550</b>	<b>\$14,742</b>	<b>\$4,450</b>	<b>\$67,807 (706)</b>



# The George Snyder Memorial Fund

George Snyder was an exceptional field geologist who spent 42 years with the U.S. Geological Survey. His field areas included the Aleutian Islands, Kentucky, Connecticut, Colorado, and finally Wyoming. Principally through field studies in Colorado and Wyoming, George became a respected authority on Precambrian geology and tectonics. Administratively, George was Chief of the Denver Publication Unit and later served two years as the Deputy Assistant Chief Geologist for the USGS in Washington, D.C. He retired from the USGS in 1994, but continued to publish detailed maps of Wyoming Precambrian geology as an Emeritus Scientist. His final effort, the *Geologic map, petrochemistry, and geochronology of the Precambrian rocks of the Bull Camp Peak area, Albany County, Wyoming* (USGS Geologic Investigations Map I-2236), was published just three weeks after his death on August 16, 1998.

George served as President of the Colorado Scientific Society in 1977 and became a lifetime Honorary Member in 1981. He was a frequent leader of Society field trips dating back to the 1970s. He also was instrumental in helping establish the Memorial Funds investment policies in the 1980s and served several times on the Memorial Funds Committee, most recently in 1996.

In October 1998, a new Memorial Fund was established in his honor by the Colorado Scientific Society. The purpose of the George Snyder Memorial Fund is to support field-based studies in the Rocky Mountains, particularly those involving Precambrian igneous and metamorphic geology and associated basement tectonics. We have received a sizable gift from his children's trust and a generous contribution from Arthur French that is being matched by a gift from the Mobil Oil Foundation. We also have received memorial contributions from members of the Colorado Scientific Society as well as friends and relatives. These contributions insure lasting support for field-based studies of Precambrian geology in the Rocky Mountains. The Society welcomes contributions to the George Snyder Memorial Fund.



**COLORADO SCIENTIFIC SOCIETY**  
**1999 DUES AND MEMORIAL FUND CONTRIBUTIONS**

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(Last Name)	(First Name)	(Initial)	(Telephone)
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(Mailing Address)	(E-mail Address)
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**DUES:** Dues are for the calendar year and help support the monthly meetings, newsletter, field trips, family night, and the Emmons Lecture.

Regular Members (\$15) .....		
Corresponding Members (\$10).....		
Student Members (\$5) .....		

**MEMORIAL FUNDS:** Supports earth-science research grants to graduate students. If not specified as to the fund, contribution will be distributed equally:

(A) Ogden Tweto Memorial Fund .....		
(B) Steven Oriol Memorial Fund .....		
(C) Edwin Eckel Memorial Fund .....		
(D) Bill Pierce-Heart Mountain Fund .....		
(E) George Synder Memorial Fund .....		

This contribution in memory of \_\_\_\_\_

**ENDOWMENT FUND:** Funds are used to support the Society's operations and special activities:.....

**TOTAL CONTRIBUTION (DUES AND FUNDS):** .....

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Please make your dues and/or contribution checks payable to the Colorado Scientific Society and specify the Fund(s) to which you are contributing.

All Colorado Scientific Society activities depend on volunteer help. Please mark those activities that you can help with. We will pass your name on to the appropriate Committee Chairperson.

- Audio Visual   Fund Raising   Newsletter   Science Fair  
 Geologic Signs History   Sci. Program   Student Night  
 Field Trips   Membership   Publicity   Web Site

<b>Send this form &amp; your check to:</b>	<b>Colorado Scientific Society</b> <b>P.O. Box 150495</b> <b>Lakewood, CO 80215-0495</b>
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Visit CSS at <http://rainbow.rmi.net/~css/>



## Colorado Scientific Society Officers, Councilors, and Chairpersons

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President-Elect: Ken Pierce, USGS, 236-1244  
Treasurer: Michael N. Machette, USGS, 273-8612  
Secretary: Stephen F. Personius, USGS, 273-8611  
Past President: Karl Kellogg, USGS, 236-1305

### COUNCILORS

1996-1998: James A. Cappa, CGS, 866-2611  
1996-1998: Richard B. Wanty, USGS, 236-1819  
1997-1999: Michelle L. Tuttle, USGS, 273-8626  
1997-1999: William D. Nesse, UNC, (970) 351-2830  
1998-2000: Eric Nelson, CSM, 273-3811  
1998-2000: Ted Ball, Consultant

### COMMITTEE CHAIRPERSONS

Arrangements:	Aaron John Kullman, CSM, 273-3066
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Field Trips:	Lee Shropshire, UNC, (970) 351-2285
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Memorial Funds Treasurer:	Michael N. Machette, USGS, 273-8612
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Science Fair:	Chuck Weisenberg, 279-7629
Webmaster:	Randy Schumann, USGS, 236-1525

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