

OCTOBER 2019 NEWSLETTER

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OCTOBER DINNER MEETING

SPEAKERS: John C. Lorenz and Scott P. Cooper, Fracture Studies, LLC

TITLE: Comparison of Natural Fracture Systems in Low-Permeability Sandstones of the San Juan, Piceance, Raton and Green River Basins

DATE: Thursday, October 10th

LOCATION: Fort Lewis College, Sitter Family Hall, Room 710

TIME: 5:30pm, Social at Wall of Time, 6:00 Dinner, 6:45 Talk

COST: \$20pp with RSVP by deadline, \$25 post deadline and while food lasts, \$2pp talk only.

STUDENTS: 20 students can attend for free. Please contact Dr. Gary Gianniny (Gianniny_g@fortlewis.edu).

RSVP: By Tuesday, October 8th at 5pm to Jim Corken

(rjcork@aol.com / 970-759-2567) or online:

<https://fourcornersgeologicalsociety.org/event/october-talk-comparison-of-the-natural-fracture-systems-in-low-permeability-sandstones-of-the-san-juan-piceance-raton-and-green-river-basins/>



THANK YOU STUDENT SPONSORS!

Chuck Baltzer - 5

Gary Gianniny - 2

Jim Corken - 5

Jon Harvey - 1

Tom Ann Casey - 2

Sabina Kraushaar 1

FCGS - 4

Fractures in the lower Cutler Fm. (Halgaito). Comb Ridge, UT. Photo by Kim Gerhardt



Four Corners Geological Society, P.O. Box 1501, Durango, CO 81302
www.fourcornersgeologicalsociety.org

Save the Date!

November 21st @ FLC:
Scott Fields

December 12th @ TBD

January 16th @ TBD

February 20th @ TBD

March 12th @ TBD

April 16th @ FLC:
Graduating Seniors present
Senior Theses.

April 30th @ TBD

BIOGRAPHY: John C. Lorenz, Ph.D. Fracture Studies LLC



John Lorenz earned an undergraduate BA, with a double major in geology and anthropology, from Oberlin College in 1972. After serving in the Peace Corps, Morocco, he earned his MSc, on the Moroccan Triassic, at the University of South Carolina (1975), and PhD, on Cretaceous strata in Libya and Montana, at Princeton University (1981). John has worked for the US Geological Survey in Louisiana and New Mexico, and for Sandia National Laboratories where he was the geologist for the tight-gas Multiwell Experiment in the Piceance basin. John has been a consultant, specializing in fractured reservoir characterization and effects, since 2007.

Dr. Lorenz has served as elected Editor (2001-2004) and President (2009-2010) of the American Association of Petroleum Geologists. As President he supported the advancement of the geosciences and their applications to hydrocarbon-related problems. His published papers on natural and induced fractures in reservoirs that range geographically from the Lisburne Limestone in Alaska to the Spraberry Formation in Texas. These papers and presentations have been awarded the AAPG Levorsen and Jules Braunstein awards. He has worked closely with the oil and gas industry on problems involving reservoir dimensions and in situ permeability, gaining extensive hands-on experience with core analysis and fieldwork. He has led field trips, presented core workshops, and taught short courses for the industry-oriented geological community.



BIOGRAPHY: Scott P. Cooper, M.S., Fracture Studies LLC

Scott Cooper earned a Bachelor of Science degree in geology from the South Dakota School of Mines (1997) under Dr. Alvis Lisenbee and Dr. James Fox. He received his Master of Science in geology from the New Mexico Institute of Mining and Technology (2000) working with graduate research and academic advisors Dr. Laurel Goodwin and Dr. John Lorenz. The thesis topic was fracture characterization and modeling of Teapot Dome, a basement-cored anticline in central Wyoming.

Scott was a Senior Member of the Technical Staff at Sandia National Laboratories, a Department of Energy Research Laboratory, working on projects related to outcrop and subsurface fracture studies with applications to reservoir characterization, production and CO₂ sequestration. He has been working in partnership with Dr. John Lorenz since 2008 at FractureStudies LLC on naturally fractured reservoir characterization projects around the world.

Mr. Cooper is an American Association of Petroleum Geologists, Division of Professional Affairs Certified Petroleum Geologist. He has published papers highlighting outcrop and subsurface fracture studies from Wyoming, Utah, Colorado, New Mexico, Texas and beyond. He has also led numerous field trips and taught short courses for the oil and gas industry throughout his career. Detailed descriptions of projects, published papers and links to open-file reports and papers are available at www.fracturestudies.com.





Deformation band.

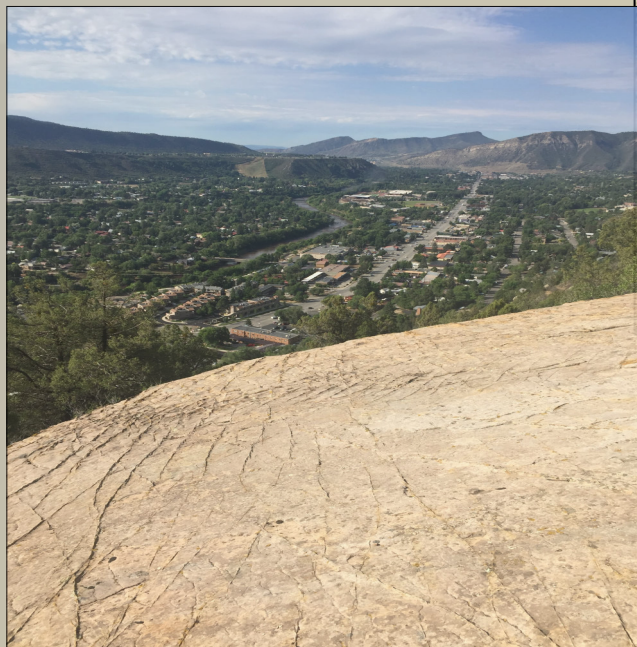
ABSTRACT: Subsurface sandstones in four studied Rocky Mountain basins are universally fractured. Matrix permeabilities are in the microdarcy range, but the permeability of matrix-fracture systems, measured by well tests, is typically in the millidarcy range and highly anisotropic.

Significant natural fractures have been documented by cores taken from as deep as 18,300 ft, but not all fracturing creates economic reservoirs. The most common fractures are vertical, extension fractures, filled or partially filled by quartz, calcite, and locally with kaolinite. Reservoirs in the middle of basins and away from faults and folds typically contain widely spaced (a few tens of feet) regional fractures. These fractures have been locally reactivated and/or enhanced where they overlie deep-seated basement faults, and such reactivated systems have been the most productive targets. Average fracture spacing may be less than a foot in these systems, and shear reactivation of irregular fractures props them open.

Unfortunately, such fault-related fractures also commonly contain mobile water. Reservoirs near overthrust basin margins



El Vado lake.



Fractures in Burro Canyon Fm. north of Durango.
Photo by Ron Brogden

locally display near-horizontal shear fractures, and reservoirs in complex structural positions consist of highly fractured rock. Widespread conjugate fractures are present in some strata and offer potentially rewarding, interconnected fracture systems, but are difficult to predict and document.

Exploiting fractured reservoirs is difficult: most attempts to produce gas from deviated holes have fared poorly even though great numbers of fractures were intersected, and hydraulic-fracture stimulations are as likely to damage natural-fracture permeability as to enhance it.



Fault in Pennsylvanian strata along highway 550 near Purgatory.
Photo by Ron Brogden



Fractures along rim of San Juan River at mouth of Grand Gulch. View to east. Photo by Kim Gerhardt.



"PREZ SEZ" by Sabina Kraushaar



Since the last meeting, the leaves have started to change and fall is in the air. We are VERY excited to put on a fall field trip up at Molas Pass in the lovely San Juan Mountains. A big thanks to Jim Corken for spearheading this field trip effort. We are also very lucky to have John Lorenz and Scott Cooper coming to give a talk to our group on October 10th. They

have authored some of the best structural geology papers in the Four Corners area (San Juan Basin in particular!) and have added to the understanding of the structural evolution of this area. Should be an excellent talk - hope to see you there.

This time around, I'd like to share a quote from one of my favorite authors of all time, John McPhee. After reading his book "Basin and Range" about a decade ago, I decided that I wanted to study geology in college, and subsequently ended up studying the Basin and Range in graduate school. Here is a classic John McPhee snippet for your enjoyment:

"I used to sit in class and listen to the terms come floating down like paper airplanes. Geology was called a descriptive science, and with its pitted outwash plains and drowned rivers, its hanging tributaries and starved coastlines, it was nothing if not descriptive. It was a

fountain of metaphor - of isostatic adjustments and degraded channels, of angular unconformities and shifting divides, of rootless mountains and bitter lakes. Streams eroded headward, digging from two sides into mountain or hill, avidly struggling towards each other until the divide between the two broke down, and the two rivers that did the breaking now became confluent (one yielding to the other, giving up its direction of flow and going the opposite way) to become a single stream. Stream capture.... Geologists communicated in English; and they could name things in a manner that sent shivers through the bones. They had roof pendants in their discordant batholiths, mosaic conglomerates in desert pavement. There was ultrabasic, deep-ocean, mottled green-and-black rock - or serpentine. There was the slip face of the barchan dune. In 1841, a paleontologist had decided that the big creatures of the Mesozoic were 'fearfully great lizards' and had therefore named them dinosaurs. There were festooned crossbeds and limestone sinks, pillow lavas and petrified trees, incised meanders and defeated streams. There were dike swarms and slickensides, explosion pits, volcanic bombs. Pulsating glaciers. Hogbacks. Radiolarian ooze."

Hope this gives you some geologic inspiration! Thanks for being a part of the Four Corners Geological Society, and thanks to our dedicated volunteers (Jonathan Harvey, Tim Rynott, Kim Gerhardt, Tom Ann Casey, Tom Staatz, Jim Corken and Jolin Cordalis) who make it all happen

Sabina

RECRUITING MEMBERS FOR FIELD TRIP COMMITTEE

Did you enjoy the Geology of the Durango Area, April 2018? The Upper San Juan Float Trip, June 2018? Hiking Sand Canyon with the FCGS, October 2018? Fruitland Methane Seeps and Hydrology, May 2019? Geology of the Ouray Area, June 2019? Will you be on the Molas Pass Hike / Train trip this weekend? Then...



**Join the Field Trip Committee
and take us to a whole new place!**



Four Corners Geological Society, P.O. Box 1501, Durango, CO 81302
www.fourcornersgeologicalsociety.org

SEPTEMBER MEETING

with
Dr. Richard Goldfarb, CSM



2020 MEETING NEWS

by Kim Gerhardt,
General Co-Chair, FCGS

RMS-AAPG 2020 Meeting planning is rocketing along this fall! Please see page 7. After soliciting fieldtrips, technical sessions, core workshops and short courses we've reached the tipping point of possibly having to prune some areas back. Lower attendance than expected at the RMS-AAPG meeting in Cheyenne last month is forcing us to rethink parts of the program. Here is a summary by committee.

TECHNICAL PROGRAM:

SESSIONS & CORES: We have 12 session themes, 8 have confirmed chairs. These have changed since the September newsletter so please check them out on page 7. Abstract submission will open in January. There is sure to be further modification of the program this spring based on submissions received. The core workshops have evolved into core poster sessions, meaning more informal presentations with all-day access. We have gained two new cores (Mancos from the Piceance Basin and Cane Creek Shale from Utah) following commitments from RMS-SEPM and UGS.

FIELDTRIPS: We now have 10 field trips plus a GeoTrain running to the meeting from Denver to Grand Junction. Cheyenne offered 5 fieldtrips but could only run 2. We will obviously have to cut our lineup back. In our favor though, this is everyone's last chance to take a fieldtrip on the western slope until 2024 given the future schedule of RMS meetings (2021 Denver, 2022 Denver, 2023 North Dakota, 2024 Salt Lake City).

SHORT COURSES: The Cheyenne meeting only ran 2 courses out of 5 offered. Now that RMAG is marketing training very aggressively in Denver and URTEC conferences are scheduled there as well, attendance at RMS short courses is down as most attendees are RMAG members. They've already taken the courses at home. We need to re-think our lineup to drop those courses which have been seen in Denver and offer more unique ones.

PUBLICITY: We had an ad in the Cheyenne *Program with Abstracts*, we stuffed postcards in their registration bags and we handed out business cards with our meeting information to attendees and exhibitors. In November we will run our first ad in the AAPG Explorer and will (hopefully) have our website up: www.rmsaapg2020.com.

EXHIBITORS & SPONSORS: All the Cheyenne Exhibitors I spoke to (15) committed to coming to our meeting. Dave Abrahamson (GJGS) is working up an Exhibitor floorplan at the Two Rivers Convention Center in Grand Junction to be included in a flyer sent to potential exhibitors this winter. They will have room for 50(!) exhibitors. This is twice as many as we had in 2010 and a big boost to the bottom line for us – if we can fill the booths. Tom Ann Casey (co-chair of the Sponsorship Committee) worked the meeting as well getting names and contact lists. She and John Youle will be working up the sponsorship flyer and starting to reach out this winter too.

FINANCE & BUDGET: The General Co-Chairs were added to the convention checking account giving us access to look at the account online and also for me (the FCGS Co-Chair) to order a debit card. This will facilitate paying upfront meeting costs from our side without having to request a check from the F&B chair, Bill Hood, in Grand Junction. We also asked for and received a modification to the RMS profit sharing plan so that now the FCGS and the GJGS will each receive 25% of meeting profits following the convention rather than 20%. Please remember that there is no financial risk to either society from this meeting. Convention costs are paid for out of a checking account seeded by the Rocky Mountain Section of AAPG. Should meeting income not cover costs the RMS makes up the deficit. We just won't get the bonus income we are working for.

SPECIAL & SOCIAL EVENTS: We have several intriguing options for luncheon speakers but no decision yet. There WILL be wine-tasting at the Monday night event (private tour of the Dinosaur Museum in Fruita with delicious hors d'oeuvres). There may also be wine tours during the meeting. The new edition of Scott Tinker's 2012 movie SWITCH is a strong possibility for Tuesday night at the Avalon Theater. Guest tours only attracted 7 participants in Cheyenne and will likely be dropped. But – hold your breath – geology bike tours on the extensive trail system around Grand Junction and Fruita are in!

More news to come!
Stay tuned to this column!

Thanks,
Kim



20/20 VISION

TURN HINDSIGHT / TO FORESIGHT

at the

**ROCKY MOUNTAIN SECTION AAPG MEETING,
SEPTEMBER 13-16th, 2020,
TWO RIVERS CONVENTION CENTER, GRAND JUNCTION, CO.**



CO-HOSTED BY:

**THE GRAND JUNCTION GEOLOGICAL SOCIETY &
THE FOUR CORNERS GEOLOGICAL SOCIETY**

Mitch Bowers Photography, www.imagewerx.us

TECHNICAL SESSIONS

- *The Powder River Basin Shale Play.* S. Sonnenberg
- *The Mancos Shale /Western Niobrara Equivalent: Sedimentology, Geo-chemistry and Physical Properties.* S. Cumella and R. Swank.
- *The San Juan Basin: From Conventional Reservoirs to Resource Plays.* C. Head.
- *The Pennsylvanian System in the Paradox Basin and Beyond.* G. Gianniny.
- *Lacustrine Basins: Sed/Strat and Petroleum Systems.* R. Brinkerhoff, M. Vandenberg, D. Schumde.
- *Clastic Reservoirs of the Rockies: Sequence Stratigraphy, Reservoir Quality and Producibility.* [No Chair].
- *Structural and Tectonic Reinterpretations in the Rocky Mountain Region.* [No Chair]
- *Geochemistry and Basin Modelling of Pre-Cretaceous Rocky Mountain Petroleum Systems.* P. Lillis.
- *Non-Methane Gas Fields.* J. Brame.
- *Energy Minerals of Western CO., A Special Session in Honor of Bill Chenoweth.* E. Wilson.
- *History of Exploration and Production in the Uinta-Piceance Area.* M. Silverman
- *Machine Learning, Artificial Intelligence and Meta-data Mining.* [No Chair].

CORE POSTER SESSIONS

- Aneth Field: Stratigraphy, Facies and Petrology of a Carbonate Mound. New Observations Following the Acquisition of Resolute Core by UGS in 2017.
- Cane Creek Shale: New core being drilled in 2020 north of Moab in a joint project between UGS and the DOE.
- Mancos Shale Oil Window in the San Juan Basin. Extensive core from DJR Energy, not previously available to the public.
- Mancos Shale /Western Niobrara in the Piceance Basin. To be facilitated by SEPM.

SHORT COURSES

- Geo-programming using Python for Data Mining of State and Federal Databases. M. Bauer.
- DI Data Analytics
- Nuclear Magnetic Resonance (NMR) Wireline Logs. H. Daigle.



**COME FOR THE
MEETING, STAY FOR
WINE FEST!**

FIELD TRIPS

Theme: Cretaceous Sedimentary Reservoirs

- *Marginal Marine Reservoir Architecture and Stratigraphy of the Book Cliffs,* K. Shanley & Boyles.
- *High Resolution Sequence Stratigraphy and Implications for Cretaceous Glacio-Eustasy of the Gallup System, NM.,* W. Lin.
- *Niobrara of the Northern San Juan Basin: Pagosa Springs, Piedra, Durango and Ridgeway, CO.,* W. Nelson.
- *Piceance lles & Williams Fork near Grand Junction with Implications for Hydrocarbon Development,* R. Cole, M. Kirschbaum & S. Cumella.
- *The Burro Cyn. Fm/ along the Gunnison River, Whitewater - Delta,* R. Cole & others.

Theme: Pennsylvanian: Paradox Basin - Seds & Salt Structures - Ancestral Rockies

- *Salt Tectonics in the Eastern Paradox Basin,* R. Langford & K. Giles.
- *Sedimentology, Structure & Salt Movement in Eastern Canyonlands,* B. Johnson.
- *Structure: Moab to San Rafael Swell Concentrating on the Moab Fault, Little Grand Wash Fault, Salt Wash Fault and the Swell,* E. Petrie & P. Eichhbul.
- *The Uncompahgre Uplift,* V. Johnson.

Theme: Tertiary Lacustrine Deposits

- *The Green River Fm. in the Uinta and Piceance Basins.* M. Vandenberg & R. Brinkerhoff.

Other:

- *Ride the GeoTrain from Denver to Grand Junction.* B.C. Burke.

PRINCIPLES OF HYDRAULIC FRACTURING

by PTTC ROCKIES

**DURANGO, COLORADO
OCTOBER 14TH**



Description

The fee of \$375 includes snacks, class notes, and PDH certificate. The Instructor will be Dr. Jennifer Miskimins of the Colorado School of Mines

Course Objectives

This two-day short course is directed at engineering and geoscience professionals involved in hydraulic fracture stimulation of oil and gas wells. The primary focus is stimulation design for tight gas and unconventional reservoirs, but the topics covered apply generally to hydraulic fracture stimulation of all reservoirs. Specific topics include rock mechanics, stresses, modeling, perforating for stimulation, fracture fluid rheology, predicting conductivity, pre-treatment injection tests, proppant transport, and horizontal well stimulation. The main course objective is to review and discuss topics critical for optimizing hydraulic fracturing treatments.

What Participants Can Reasonably Expect to Learn

An emphasis is placed on fracturing treatment design and the input data required to optimize such treatments. The course stresses the interrelationships between data and disciplines in fracture design optimization.

Who Should Attend

The course is primarily intended to offer an introduction to hydraulic fracture design and optimization. Those new to the industry, new to hydraulic fracturing completions, or just interested in a refresher on hydraulic fracturing concepts will benefit most from the course.

The Instructor

Dr. Miskimins holds B.S., M.S., and Ph.D. degrees in petroleum engineering. Prior to joining CSM, she worked for Marathon Oil Company in a variety of locations. Dr. Miskimins is the founder and past Director of the Fracturing, Acidizing, Stimulation Technology (FAST) Consortium at CSM. She teaches a variety of short courses including completions and stimulation classes. She is a member of SPE, SPWLA, and AAPG and was an SPE Distinguished Lecturer for 2010-2011 and 2013-2014.

For More Information and to Register

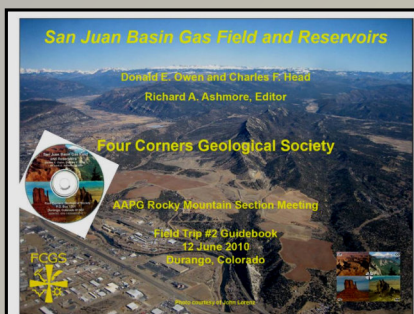
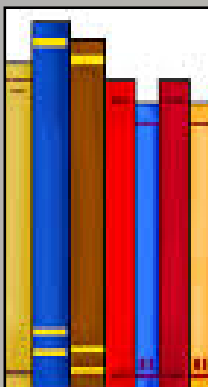
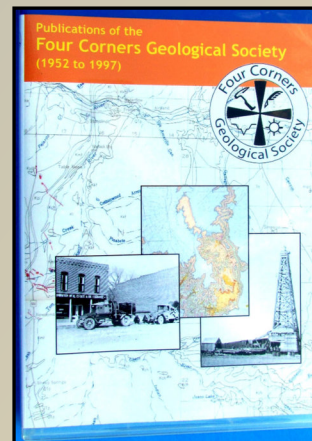
<https://www.eventbrite.com/e/principles-of-hydraulic-fracturing-tickets-69361639531>



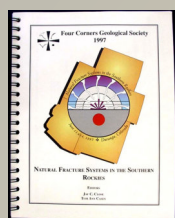
FCGS PUBLICATIONS

Order online at: <https://fourcornersgeologicalsociety.org/bookstore/>

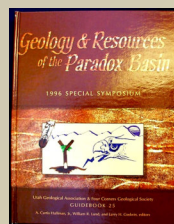
Publications of the Society: 1952-1997. This disk contains all publications of the Four Corners Geological Society (FCGS) from 1952-1997. Includes several which are out of print in hardcopy. Many contain classic papers on the geology of the Four Corners region. Much of the emphasis, but not all, is on exploration for oil and gas. Twenty publications in all. **UPDATED** - now includes Owen & Head, 2010, San Juan Basin Gas Fields and reservoirs. **\$105.**



San Juan Basin Gas Fields and Reservoirs: A Field Guide on CD. 2010, D.E. Owen and C.F. Head. A (CD) field guide of a 200 mile traverse from Durango and back into the heart of the San Juan Basin. Discussion covers Cretaceous and Tertiary reservoir outcrops, landforms, stratigraphy, history of exploration and development, and the hydrocarbon system of the basin. **\$25.**



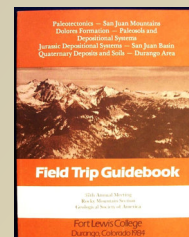
Natural Fracture Systems in the Southern Rockies. 1997. Sixteen full-length papers and 12 abstracts covering a variety of topics on natural fracture systems. Soft-spiral bound. 210p. **\$45**



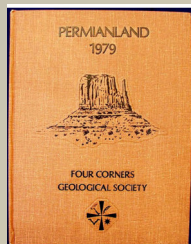
Geology & Resources of the Paradox Basin. Special Symposium with Utah Geological Association. 1996. A.C. Huffman, ed. Thirty-three technical papers and road log. Hardbound. 460p. **\$65.**



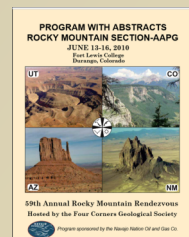
Four-Corners Oil & Gas Fields, Vols I, II, and III. Oil & gas field papers include geologic setting, discovery well drilling and completion practices, and reservoir data for each field. Vol. I&II (1978) includes 242 field papers, 726p. Vol. III (1983) has 95 field papers, 415p. Looseleaf ring binders. **\$60.**



Field Guide - Durango Vicinity. 1984, 37th Annual Meeting of Rocky Mountain Section GSA. Includes excellent road guide. Softbound. 209p. **\$22.**



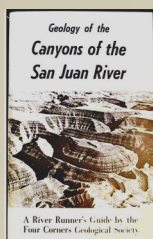
Permianland. 1979. Ninth field conference. Hardbound. 186p. **\$22**



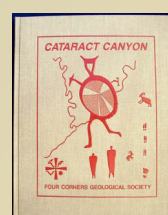
Program with Abstracts: RMS-AAPG 2010. Programs with Abstracts Volume and CD from the 2010 Rocky Mountain Section AAPG 59th Annual Rocky Mountain Rendezvous in Durango, CO, June 13-16th 2010. **\$5.**



FOR RIVER RUNNERS!!



Geology of the Canyons of the San Juan River. 1974. The classic geologic river guide to the San Juan River from Bluff, Utah to Clay Hills Crossing. Softbound, water-resistant. 94p. **\$15.**



Cataract Canyon and Vicinity, 1987, John A. Campbell, Editor. FCGS Tenth Field Conference. Twenty eight papers, Hardbound, 199p. **\$25.**





FOUR CORNERS GEOLOGICAL SOCIETY

P.O. Box 1501, Durango, CO 81302

MEMBERSHIP RENEWAL or APPLICATION: June 1, 2019 to May 31, 2020



*Name: _____

*Address: _____ City: _____ State: _____ Zip: _____

*Email: _____ Phone: _____

*Employer: _____

Please Identify a Membership Category:

Active Member	\$25	Any person engaged in the practice or teaching of geology or who holds a Bachelor's Degree in geological science from a college of acceptable academic standards. Degree requirement may be waived if applicant has adequate professional experience. *Highest Degree, Type and Year: _____ *College / University: _____
Associate Member	\$25	Any person who is a graduate of a college of acceptable academic standards with major studies related to, or associated with, geology. Degree requirement may be waived if applicant has adequate professional experience. *Highest Degree, Type and Year: _____ *College / University: _____
Student Member	Free	Any undergraduate or graduate student majoring in geology at a college of acceptable academic standards. *College / University: _____ *Year expected to graduate: _____
Emeritus Member	Free	An Active Member of 65 years old or older who has been a member for 25 years including time spent in military service. *Year emeritus status was awarded: _____
Honorary Member	Free	An Active Member who has contributed distinguished service to the profession of geology and to the betterment of the FCGS. Determination is made by the FCGS Executive Committee. *Year honorarium was awarded: _____

Other Professional Interests:

** Required information for new members. Current Members, please update.*

*Please check your interests:

- ☐ Sedimentology & stratigraphy
- ☐ Structure & tectonics
- ☐ Mineralogy, petrology, geochemistry
- ☐ Igneous geology, volcanology
- ☐ Ore geology and hard rock mining
- ☐ Other mineral extraction
- ☐ Petroleum geology
- ☐ Geophysics
- ☐ Geological engineering
- ☐ Geomorphology
- ☐ Quaternary geology
- ☐ Hydrology & water resources
- ☐ Environmental geology
- ☐ Geography / GIS
- ☐ Other interest (see box)

Please either print, complete and return this form with your check for dues made payable to: "Four Corners Geological Society" and mail to the address above or go online to fourcornersgeologicalsociety.org .