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<https://fourcornersgeologicalsociety.org>

FOUR CORNERS GEOLOGICAL SOCIETY

March 2022



MARCH MEETING

SPEAKER: *Dr. Peter Vrolijk, ExxonMobil retired*

TITLE: Searching for rare occurrences in nature: Seeking deep fluid sources off Costa Rica

DATE: *Thursday, March 31st*

TIME & *5:30 - 6:30 pm Social Hour: Drinks and Varied Yummy Small Plates, on the 3rd Floor Balcony (or at the "Wall of Time" Atrium in bad weather)*

LOCATION *Room 710, Sitter Family Hall (Geology Building) Fort Lewis College
6:30 pm - 7:30 pm. Speaker, followed by raffle
ZOOM meeting will start at 6:30 pm.*

ZOOM LINK: *[Click Here for Zoom Meeting Link or https://fortlewis.zoom.us/j/98450213972](https://fortlewis.zoom.us/j/98450213972)*

COVID: *Meeting is at FLC: Per Fort Lewis Policy, VACCINATION IS REQUIRED TO ATTEND IN PERSON. If you are not vaccinated, please use the Zoom option.*

COST: *\$20/person. Please RSVP by Tuesday, March 20th if possible. PLEASE go to the website to pay and register: <https://fourcornersgeologicalsociety.org/event>. Or you can email Jon Harvey at jeharvey@fortlewis.edu 10 students will be sponsored by our long time supporter Jeff Brame. To sign up, contact Dr. Harvey.*



Our Speaker:

Dr. Peter Vrolijk, ExxonMobil retired

Dr. Vrolijk's education includes a B. S. and M. S. from MIT with a master's thesis in experimental sediment transport, and a PhD from the University of California, Santa Cruz studying fluid histories in the Kodiak accretionary complex, Alaska. He spent 27 years pursuing a research career at Exxon and ExxonMobil and has published results on paleothermometers, fault dating of clays, subsurface fluid connectivity methods, and methods to locate and evaluate cold seeps. Some of these pursuits have followed him into retirement, but he also devotes volunteer time to the Mount Evans and Lost Creek Wilderness areas, undergraduate student interviews, and the Geological Society of America.



Peter Vrolijk on a recent trail race outside of Moab, Utah. La Sal Mtns. laccolith in the background.

*a HUGE THANK YOU to
Jeff Brame of Brame GeoScience, LLC for sponsoring 10 Student Dinners
this month.*



MEETING INFORMATION:

<https://fortlewis.zoom.us/j/98450213972>

Meeting ID: 984 5021 3972

If using Phone Audio, dial by your location:

+1 346 248 7799 US (Houston)

+1 669 900 6833 US (San Jose)

Link to a Youtube video about the
autonomous vehicles that were used to
collect marine geological data that Peter will
talk about:

<https://www.youtube.com/watch?v=TzncqatuBZc>



Four Corners Geological Society, P.O. Box 1501, Durango, CO 81302
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Abstract:

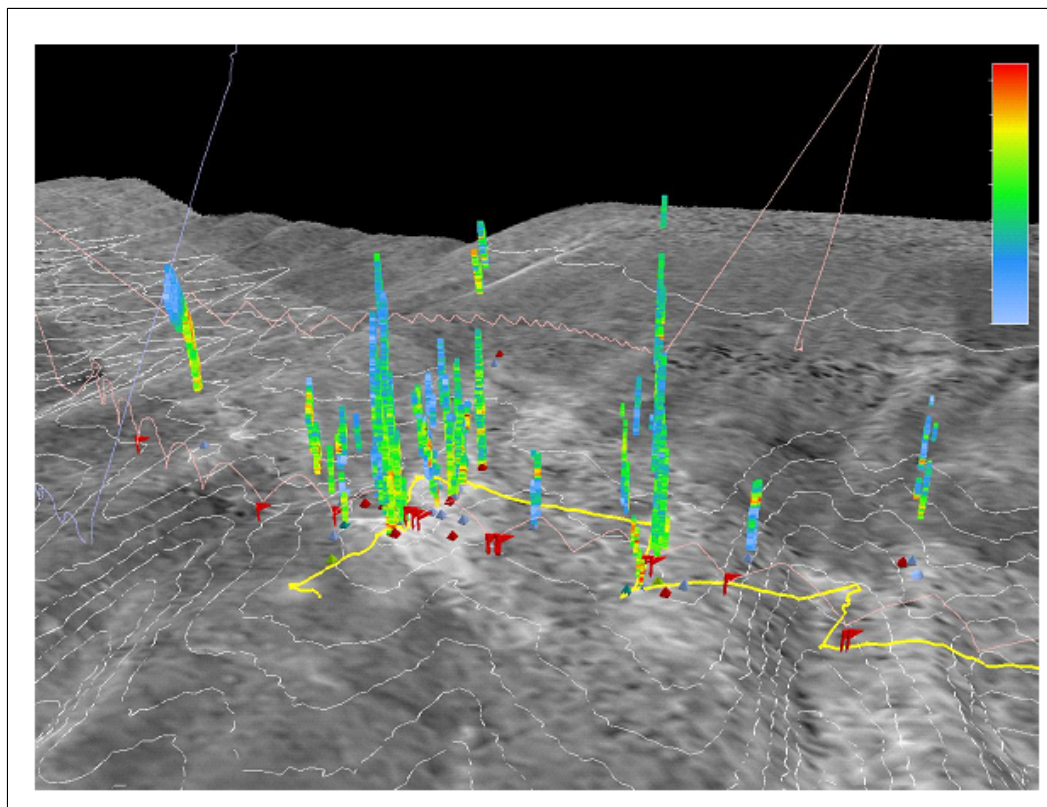
Searching for rare occurrences in nature: Seeking deep fluid sources off Costa Rica

Natural seeps occur at the seafloor as loci of fluid flow where the flux of chemical compounds into the ocean supports unique biologic communities and provides access to proxy samples of deep subsurface processes. Cold seeps accomplish this with minimal heat flux. While individual expertise is applied to locate seeps, such knowledge is nowhere consolidated in the literature, nor are there explicit approaches for identifying specific seep types to address discrete scientific questions. Moreover, autonomous exploration for seeps lacks any clear framework for efficient seep identification and classification.

To address these shortcomings, we developed a Ladder of Seeps applied within new decision-assistance algorithms (Spock) to assist in seep exploration on the Costa Rica margin during the R/V Falkor 181210 cruise in December 2018. This Ladder of Seeps (derived from analogous astrobiology criteria proposed by Neveu et al., 2018) was used to help guide human and computer decision processes for ROV mission planning. The Ladder of Seeps provides a

methodical query structure to identify what information is required to confirm a seep either: (a) supports seafloor life under extreme conditions, (b) supports that community with active seepage (possible fluid sample), or (c) taps fluids that reflect deep, subsurface geologic processes, but the top rung may be modified to address other scientific questions. Moreover, this framework allows us to identify higher likelihood seep targets based on existing incomplete or easily acquired data, including MBES (Multi-beam echo sounder) water column data. The Ladder of Seeps framework is based on information about the instruments used to collect seep information (e.g., are seeps detectable by the instrument with little chance of false positives?) and contextual criteria about the environment in which the data are collected (e.g., temporal variability of seep flux). Finally, the assembled data are considered in light of a Last-Resort interpretation, which is only satisfied once all other plausible data interpretations are excluded by observation. When coupled with decision-making algorithms that incorporate expert opinion with data acquired during the Costa Rica experiment, the Ladder of Seeps proved useful for identifying seeps with deep-sourced fluids, as evidenced by results of geochemistry analyses performed following the expedition.

[Zoom Link is: \(click\)](#)



Costa Rican shelf 3D perspective view (ca. 1 km water depth). White lines are bathymetric contours overlying acoustic backscatter for 30 kHz MBES sonar. Colored columns indicate bubble plumes in water column extracted from sonar data. Yellow line depicts Autonomous Underwater Glider (AUG) path and position of velocity anomalies (red flags) interpreted as bubble plumes.



"PREZ SEZ" by David Schiowitz

March 2022

Happy Spring FCGS members!

Thank you to everyone that was able to participate in last month's superb and stimulating meeting. It was a great presentation where Dr. David Gonzales explored the evolution of the Cenozoic landscape in the western San Juan Mountains. Also, at the meeting the Society awarded long-time and essential members Tom Staatz and Kim Gerhardt "Honorary Membership" awards for all the volunteer hours they have dedicated to FCGS over the years!

For our next meeting, Thursday, March 31st, we have Dr. Peter Vrolijk (retired ExxonMobil) with an intriguing talk entitled "Searching for rare occurrences in nature: seeking deep fluid sources off Costa Rica". This sounds like another talk that is not to be missed and I encourage all that are comfortable to attend. Weather permitting, this month's happy-hour will take place on the third floor balcony in Sitter Family Hall, which is all the more reason to attend. Please RSVP for the talk. We understand that some members may not be able to attend, so we will continue to have a Zoom option starting around 6:30 pm ([zoom link](#)).



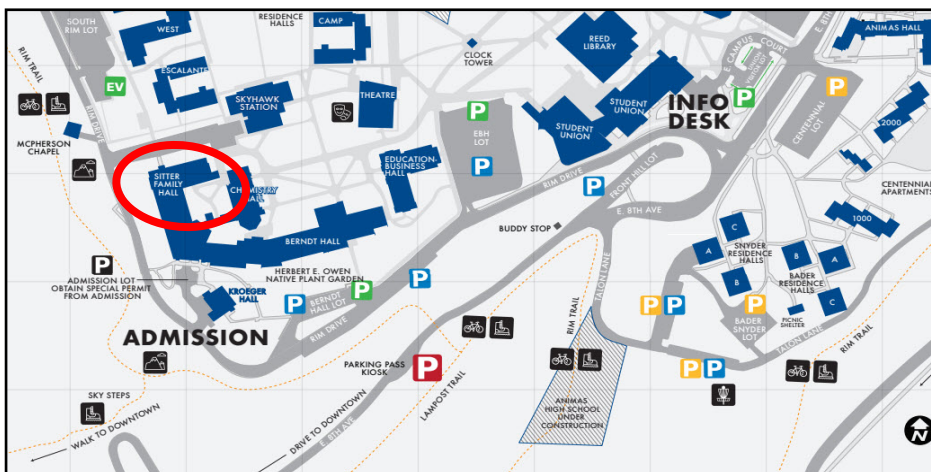
As for society news, FCGS is having a board meeting in early April and we are currently looking for any members that are interested in volunteering to be the next President-Elect for the Society.

Major job duties entail finding and coordinating speakers for the monthly meetings. If you are interested in volunteering please reach out to any member of the board. We are also looking for folks interested in leading or organizing field trips for later this spring, summer, or next fall. Observing and discussing rocks in the field with other like-minded folks is what first attracted me to study geology and it is what continues to keep me intrigued. I have been fortunate to attend a few FCGS field trips and I would love to continue to bring that experience to our young and old members alike. So, please reach out if you are interested in volunteering!

Finally, I would like to thank Jeff Brame for sponsoring 10 students for this month's meeting! Students, please reach out to Dr. Jon Harvey if you would like to attend.

All the best,

David



Map of Meeting Location



Four Corners Geological Society, P.O. Box 1501, Durango, CO 81302
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NEWS FROM THE FOUNDATION

ALERT! Search for a New Director in progress

The Foundation is looking for nominations or volunteers to join our board for a 3-year term. We support geoscience education and research, mainly in the Four Corners region, through grants and scholarships. The time commitment is small on average and can usually be scheduled around other activities. Anyone willing to pitch in and learn is welcome but we'd benefit from a basic knowledge of accounting and investing. By volunteering for this position you have an opportunity to make an important contribution but it does not take much time.

Please contact Mary Gillam, Foundation president (gillam@rmi.net), as soon as possible to learn more.

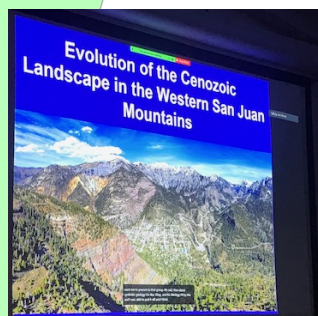


May is the month we elect new FCGS officers for the coming year. Please consider volunteering to fill an office, especially the upcoming President-Elect position or helping with field trips or the Field Trip committee. The main duty of the President-Elect is to help find and coordinate speakers for our meetings. If you are interested in volunteering, please reach out to any member of the board or email fcgeosociety@yahoo.com. Field trips have always been our most fun and educational activities. We are looking for folks interested in leading or organizing field trips for later this spring, summer, or next fall.





Congratulations to Kim and Tom on being awarded Honorary Memberships!



FCGS February Meeting at FLC

IN MEMORY OF OUR FRIEND AND LONG-TIME MEMBER, JOHN OTT

With great sadness we say goodbye to a good friend and member, John Ott, who passed away suddenly at his home on March 6th. Johnny was one of the warmest, kindest, just nice guys you could ever know. He was someone you could always really count on to be there and to do what is right.



John was born in 1961 in Mancos and spent much of his youth logging, fishing, & trapping in the La Plata Mountains. John graduated from FLC with his geology degree in 1983. He worked for several years exploring for gold in the western USA & Canada but he found his true passion after he met and married the love of his life, Julie James in 1990.

John devoted himself to understanding the water systems of the Animas Valley by taking leadership roles with the Animas Ditch Co & the Animas Valley Water Co. This work prepared him for his roles as a Water Quality Control Commissioner for the state, the SW Water District, and a member of the Citizens Advisory Group.

His was deeply passionate about his family. He and Julie raised three sons, Gunther, Abraham & Stanton on the James Ranch and ran James Ranch Trees.

He unreservedly supported all his boys' activities which led him to coach youth soccer teams, co-lead the 4-H club, and was fully committed to the Durango Nordic team. His warmth, enthusiasm for life great hugs and big smile will be deeply missed.

In lieu of flowers please donate to the John Ott memorial fund (www.savory.global/johnott) hosted by the Savory Institute which will help his boys continue his legacy of land stewardship.

RMS-AAPG ANNUAL MEETING Denver • July 24-27, 2022



www.aapgrms.org/annual-meeting/2022-denver



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NEWS FROM AROUND THE REGION

RMS-SEPM March Webinar

March 29th; 12-1 pm MT

Sarah Springer, Risk, Modeling and Characterization Integration Manager, Central Plateau Cleanup Company (CPCCo)

"THE HANFORD SITE"

Our webinar this month illustrates the power of subsurface models in supporting good decisions. We turn our focus to the Pasco Basin in southeastern Washington and the fluvial and flood deposits of the Plio-Pleistocene. Whereas many may be familiar with the geology below the Columbia River Basalts, and the variable success of exploration wells (and uncountable destroyed drill bits) below the basalt, the topic of this month's webinar is on how subsurface modeling of the complex near-surface geology has impacted soil and water remediation projects at the Hanford nuclear weapons complex. Our speaker is Sarah Springer, Risk, Modeling and Characterization Integration Manager at CPCCo. Sarah will show how the wealth of subsurface data at Hanford (e.g., 12,000+ boreholes and 5,000 groundwater wells) has informed the geologic modeling and interpretation of the subsurface to help remediation efforts as the Hanford Site is cleaned up.

Please join us for this interesting and important webinar, which is a great example of how skills that are typically associated with the oil and gas industry are also relevant in the environmental sector.

To register or get more info, go to https://www.rmssepm.org/calendar-feed/2022/3/29-sardendra?ss_source=sscampaigs&ss_campaign_id=623506cbd5c

[c7b0f60cb86b0&ss_email_id=62350ee1f0cdf0495a4838d6&ss_campaign_name=Have+you+signed+up+for+our+March+29th+webinar%3F++&ss_campaign_sent_date=2022-03-18T23%3A01%3A40Z](https://www.rmssepm.org/calendar-feed/2022/3/29-sardendra?ss_source=sscampaigs&ss_campaign_id=623506cbd5c)

Please submit reservations by 10:00 a.m (MT) the day before the talk.

RMAG April Luncheon

April 6, 2022; 12:00-1:00 pm MT; In-Person and Online

Maggiano's Little Italy, 500 16th St. Mall, #150, Denver, CO 80202

" Old Dog, New Tricks: A Multiscale Re-Evaluation of the Sequence Stratigraphic Framework in the Emerging Mowry Shale Unconventional Play "

Speaker: Alexa Socianu, PDC Energy

ABSTRACT:

The Mowry Shale is a prolific source rock in numerous Laramide basins, having expelled large volumes of oil and gas into adjacent conventional reservoirs. Operators are now testing the Mowry as an unconventional reservoir in the Powder River Basin (PRB) and, to a lesser extent, the Bighorn Basin (BHB). During the Albian to Cenomanian, the Mowry seaway was separated from warmer southern waters of the Tethys Ocean. Cold, boreal waters yielded a hemipelagic mixture of clay, radiolaria, marine kerogen, and fish debris while volcanism to the west provided sporadic input of silica-rich ash. Terrigenous silt and sand delivered by high-energy events frequently punctuated this suspension fallout. An understanding of the multiscale heterogeneity and controls on reservoir quality within a



sequence stratigraphic framework helps in defining sweet spots and optimum horizontal targets.

End-member facies in the PRB range from micro-crystalline quartz-rich mudstone, derived from intrabasinal biogenic silica, to bioturbated and ripple cross-laminated muddy siltstone. Intervening facies include siliceous mudstone with varying amounts of silt laminae and bioturbated silty mudstone. In the more proximal BHB, bioturbated muddy sandstone and ripple cross-laminated to hummocky cross-stratified sandstones occur.

Gradational successions of these facies, with upward increasing detrital content and bioturbation, characterize most Mowry parasequences. Abrupt decreases in grain size, with bentonite and/or clay-rich mudstone sitting directly on coarser grained parasequence tops, represent flooding surfaces. In the distal portions of the PRB, some parasequences transition to an apparent fining-upward pattern that actually reflects biosiliceous material with lower gamma response dominating the base of the package becoming clay-rich with higher gamma values at the top of the parasequence.

Multiple parasequences stack to form upward coarsening regressive packages interpreted as highstand systems tracts (HSTs). At least three HSTs make up the Mowry Shale. They are variably capped by very thin inferred transgressive systems tracts and condensed sections. Our sequence stratigraphic interpretation is quite different from previous models and has important implications for defining and mapping the best lateral target.

Core data demonstrate the middle Mowry HST hosts the highest organic content, hydrocarbon saturations, and proportion of biosiliceous facies. Higher maturity biosiliceous facies are nearly 25x more permeable than samples of the identical facies in the earliest oil window. We suggest the optimal horizontal target for Mowry production in the PRB is in the uppermost parasequence of this HST, where detrital silt content, moveable hydrocarbons, and mechanical properties are optimized. In this zone silt provides storage and permeability pathways, silica cement generates a brittle framework for hydraulic fracturing, and organic matter increases hydrocarbon saturation and matrix permeability.

Hybrid luncheon schedule:

11:15am: In-person check-in opens

12:00pm: Online event opens

12:00pm: Lunch service begins

12:15pm: Talk begins

1:00pm: Talk/Q&A session ends; Online event closes

Hybrid Luncheon costs:

Member Lunch: \$35

Non-Member Lunch: \$40

Walk-in without Lunch: \$15

Member Online: \$10

Non-member Online: \$20

Student online: Free

To register or get more info, go to : [Link here](#)

A login link will be sent following registration.





FOUR CORNERS GEOLOGICAL SOCIETY

P.O. Box 1501, Durango, CO 81302

MEMBERSHIP RENEWAL or APPLICATION: June 1, 2022 to May 31, 2023



*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 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.

Please donate to the Foundation to support student research. Make out your check to: "Four Corners Geological Foundation" and include it in the envelope with your dues.

- *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)