

Geosciences Program

NEWSLETTER

For alumni and friends of the geosciences program
Fall 2018


COLORADO MESA
UNIVERSITY
DEPARTMENT OF PHYSICAL AND
ENVIRONMENTAL SCIENCES



Top photo: 2018 Geomorphology Lab on rock glacier at Ophir Pass. Bottom left: Rachael Lohse, 2018 recipient of the prestigious RMAG Neal J. Harr award, showing her strength during the spring AAPG Student Chapter field trip to Little Wildhorse Canyon, UT. Bottom right: Students digging for amethyst crystals near the Nancy Hanks Mine. Pictured (left to right) are Tim Bowers '18, Bri Trump, Dr. Rick Livaccari, JD King, Sherry Buxton, Nicole Mejia-Mendoza, Matt Alfau.




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FROM THE EDITOR

I realize as I put together this issue of the newsletter that a lot of water goes under the bridge, drought or not. New students show up, old ones leave, and graduates come back to visit. Faculty also change. In fact, yours truly is officially now “half-time”. As far as I can tell, that means I do about the same amount of work for half the pay. Ah, well, at least the checks don’t bounce!



On a more serious note, I would like to sincerely thank all of the alumni and friends of the program who have contributed to the various scholarships over the last several years. In particular, I would like personally to thank the anonymous donor of the very large contribution we recently received! We now have multiple endowed scholarships that will provide major support for students at a time when the cost of an education continues to rise. Again, thanks! •

~Larry Jones, Newsletter Editor, Instructor of Geology
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Geosciences Program Newsletter

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WHAT THE HECK IS UP WITH UNAWEEP CANYON?

Unaweep Canyon has long been a source of fascination for geologists. Since the late 1800's geologists have recognized Unaweep canyon as an abandoned canyon. I remember as an undergraduate reading the famous USGS publication by C.B. Hunt and being intrigued by the notion that a big river (Colorado or Gunnison or both) incised this canyon and then abandoned it, leaving behind a dry, infilling canyon. Prof. Andres Aslan and his co-workers have done a great job in unraveling the Quaternary history of Unaweep Canyon. Aslan discussed the details of when river incision occurred, the timing of river abandonment (late Pleistocene) and the possible causes of river abandonment (late Cenozoic exhumation of the Colorado Plateau).



Figure 1. Lando '14, the dog of cataclasis, doing fieldwork in Unaweep Canyon, that's one smart dog! As you can see, Unaweep Canyon does have a U-shape, but it originated as a fluvial V-shaped canyon that has since partly filled in with alluvium and colluvium after the river that carved that canyon abandoned it.

But that is not the end of the story. Other theories have been proposed to explain Unaweep Canyon. Some infer a glacial origin for Unaweep Canyon (Figure 1). Back in the 1970's, former Mesa State geology professor Robert Young and current CMU professor Rex Cole suggested that a Quaternary glacier may have carved the canyon. This idea suffers from the fact that Unaweep was at too low of an elevation in the Quaternary to have a big glacier and the lack of physical evidence for a glacier. G.S. Soreghan and her co-workers from the University of Oklahoma revived the glacier idea in the late 2000's. They suggested that a Permian-aged glacier had carved out the canyon, and a Quaternary river occupied a canyon that already existed. The Permian glaciation model



Figure 2. The spectacular exposure of the steeply, S-dipping, Big Dominguez Canyon Fault (reverse dip-slip and left-lateral strike-slip) near the waterfall. The fact that this is an oblique-slip fault is determined from two observations: 1) the slickenlines found along this fault exposure that rake obliquely westward and 2) the Chinle-Wingate contact across the canyon is down about 50 feet on the north side of the canyon (S-side up).

suffers from the same problem as a Quaternary glacier: the lack of any physical evidence for glaciation in the canyon. The Soreghan group obtained a big NSF grant with the goal of finding evidence for Permian glaciation. Since no Permian rocks are found outcropping in Unaweep (a problem for the Permian glaciation model), they drilled a hole in the center of Unaweep Canyon expecting to find buried Permian glacial deposits. Instead, they found about 1,000 feet of Quaternary-age colluvial and alluvial valley fill. The fill did contain some Permian pollen (detrital pollen gets everywhere, so that means nothing), but according to them, the pollen was 'evidence' of Permian glaciation. At other locations in Unaweep, they 'discovered' outcrops they interpreted to be Permian glacial tillite deposits. I have seen these 'tillites', and they are merely mechanical spheroidal weathering of in situ Proterozoic meta-granite, with a continuous planar fabric across the outcrop, not rolled boulders! They are hardly 'tillites'. The glaciation models should be dismissed. The only 'real' evidence for glaciation is apparent U-shaped of Unaweep canyon, but it has that shape because it is a partly filled in V-shaped valley, as the Univ. of Oklahoma inadvertently confirmed with their drill hole.

So that is the end of the glaciation story, and now Structural Geology comes into the picture. The question that remains unanswered is why did the river choose to deeply incise where it did? I think that Unaweep Canyon was occupied by the river because the bedrock was previously fractured and weakened by Laramide-age deformation, specifically an extensional

graben system that parallels Unaweep Canyon. We are currently working to find evidence for Laramide-age faulting (Figure 2). Evidence for Laramide-age faulting is ubiquitous and can be found 'hiding in plain sight'. Not only are there faults, but, in places, these faults are mineralized. Locals have been mining Laramide-age faults in Unaweep Canyon since the late 1800's. Some gold has been found, but not in great abundance, yet... Amethyst is the most famous mineral to come out of Unaweep Canyon. The color of the amethyst varies from light purple to very dark purple to black. The work of student **Tim Bowers '18** demonstrated that the color variations of Unaweep amethyst are related to the presence of Fe and Mn in the amethyst, with the darkest purple and black amethyst being high in Mn. Fieldwork with Tim Bowers and former students **Adam Trumbo '14** and **Mike Feil '14**, has revealed the presence of faults that both cut across and parallel the canyon.

The key to understanding the Laramide-age faulting is the strain compatible pattern of the faults that suggests a link between deformation along the monoclines and reverse faults found along the Colorado National Monument and the faulting in Unaweep Canyon. Laramide-age deformation along the Uncompahgre Plateau is controlled by a series of WNW-ESE striking, left-lateral strike-slip faults. These controlling faults bend right into compressive orientations resulting in the classic Colorado Plateau-style reverse faults and monoclines as seen in the Colorado National Monument. Conversely, in Unaweep and subparallel Big Dominguez Canyons, the controlling left-lateral strike-slip faults bend left into extensional grabens that display a lazy-'S' pattern in map view. In Unaweep Canyon, deeply-cutting left-lateral strike-slip faults and associated normal faults opened gaps in the Earth's crust that were filled by hydrothermal fluids that formed mineralized breccias. The faults that cut across Unaweep Canyon are characterized by spectacular vertical 'walls' up to 150 m wide of mineralized and altered implosion breccia. Breccias associated with these faults are matrix-supported, with no grain-size grading, suggesting that they formed as implosion breccia.

Hydrothermal mineral veins within Unaweep Canyon formed in at least two phases synkinematic with Laramide deformation (figure 3). Phase 1 includes coarsely crystalline calcite with included hematite and coarsely-crystalline, euhedral, Mn-bearing quartz (dark purple amethyst). This was followed by phase 2 pale green to pale blue fluorite that replaced the earlier Phase 1 calcite and a second episode of quartz crystallization in vugs (small cavities) within the fluorite. Phase 2 quartz is medium to very coarse-grained, clear, milky to pale purple amethyst (not as dark as Phase 1 amethyst). Phase 2 alteration minerals occur as both open space fillings along faults and as partial replacements of phase 1 minerals. Phase 1 and 2 minerals are found along faults as well-preserved veins with massive crystals or pulverized into implosion breccias due to synkinematic



Figure 3. Mineralization associated with a canyon-parallel normal. The left side shows coarsely crystalline Phase 1 calcite with included hematite, partly replaced by Phase 3 Cu-carbonates (malachite-azurite). The right side image shows Phase 2 pale purple amethyst.

deformation. Late- to post-kinematic mineralization includes sulfides (galena, pyrite, auriferous chalcopyrite) and supergene Cu-carbonates (azurite, malachite) and Fe-oxides (limonite, goethite) forming along veins that cut the implosion breccia.

In summary, Unaweep Canyon is an exhumed Laramide-age extensional graben system. Evidence for faulting and synkinematic mineralization is ubiquitous. •

~ Rick Livaccari, rlivacca@coloradomesa.edu

CLUB ACTIVITIES

The American Association of Petroleum Geologists (AAPG) Student Chapter at Colorado Mesa University

Colorado Mesa University AAPG Student Chapter is starting the academic school year with a whole new team of officers: Jordan Walker (President), Jon Hutson (Vice President), Jordan Drake (Treasurer), Brandi Maher (Secretary), and Nicole Mejia-Mendoza (CAB Representative). Dr. Cassandra Fenton (Instructor of Geology at CMU) begins her third year as the club's faculty advisor.

Officers introduced themselves to members at the first fall meeting and outlined plans for field trips, fund raising, and guest speakers. They also set up a 'suggestions and feedback box' for members regarding meetings, goals, field trips, and other activities that AAPG might sponsor. Check out the CMU AAPG page on Facebook to see the latest on club meetings and activities.

The Chapter is interested in hosting speakers, particularly those who would like to talk about local geology or who can provide job-finding guidance to geology graduates. The Chapter would also be interested in hearing from geologists who would like to take students on local field trips. Interested individuals should contact AAPG Student Chapter President Jordan Walker: jtwalker@mavs.coloradomesa.edu. •

GEOLOGY PROGRAM RECEIVES MAJOR GIFT!

We are very pleased to announce that the CMU Geosciences Program has received a gift of nearly \$600,000 from an anonymous donor to establish an endowment that will fund numerous CMU geology student scholarships and student field research activities. This endowment will provide major annual support in perpetuity. Although not a CMU alumnus, the donor is a retired geologist who, being impressed with the quality of the program, desires to provide students with opportunities that he did not have. We are working with the CMU Foundation to enable our students to apply for scholarships to be awarded in the 2019-20 academic year. Thank you very much! Our students and the faculty are deeply appreciative of your generosity! •

This endowment will provide major annual support in perpetuity.



The Grand Junction Geological Society gave awards for best presentations at the April meeting to (pictured left to right) Kathleen Dykstra, Tim Bowers, Adam Nawacki, Rachael Lohse.

COORDINATOR'S CORNER

PROGRAM HIGHLIGHTS – Since last spring, the Geosciences program highlights have included a very fun Spring mineral-collecting field trip to Unaweep Canyon attended by ~25 CMU students and faculty (see photo on cover), end-of-the-year research presentations by the graduating seniors at the April meeting of the Grand Junction Geological Society and CMU Student Showcase, and graduation of 12 students at May commencement. Virtually all of our May graduates found employment with either consulting or oil field service companies. Summer activities included field camp and field and laboratory research by several students (see Student Spotlights). Professor Rex Cole obtained a new drone that he hopes to use for teaching and research activities! The fall semester is starting well. About 35 students and faculty attended the Western Slope Field Conference in Ouray, and the program is in the process of hiring a new tenure-track Geology faculty member specializing in Geochemistry. The program likely will

hire a new Hydrology faculty member to replace Dr. Gigi Richard who resigned for personal reasons. We'll miss you Gigi! Thanks for all your service to CMU! Kerry Riley joined the faculty this fall, and she is teaching several of the courses vacated by Gigi's departure. Kerry is wrapping up her Ph.D. in Geology at Utah State University and plans to defend her dissertation this winter. Kerry is off to a great start, but she is very busy (see Faculty Profile)!

STUDENT AWARDS – Numerous students received program as well as school-wide awards at the end of the school year in May. **Rachel Lohse '18** received the prestigious RMAG Neal J. Harr award (see photo on cover). **Justin Humenik** was awarded the Richard D. Dayvault Endowed Memorial Scholarship, and **Jordan Walker** and **Kevin Mills** received the newly endowed Geosciences Tuition Scholarship. **Evan Pellowski '18** received the William C. Hood student research award, and **Adam Nawacki '18** received the Verner C. Johnson Geology/GIS award.

The Association of Women Geoscientists award went to **Kathleen Dykstra '18** and **Laura Green**, and the Mark Garman award went to **Darby Spence**. The GJ Gem and Mineral Club Scholarship was awarded to **Brianna Trump**, and GJ Geological Society Field Camp Scholarships were awarded to **Adam Nawacki '18**, **Jordan Drake**, **Morgan Pratte** and **Tim Bowers '18**. Tim, along with **Rachael Lohse '18**, **Adam Nawacki '18**, and **Kathleen Dykstra '18**, also received Best Student Presentation awards at the April meeting of the GJ Geological Society (see photo). Lastly, **Tim Bowers '18** was awarded the Coveted Red Plaid Shirt Award and the Best Poster Presentation at the annual CMU Student Showcase.

Thanks again to everyone for your continued interest and support of CMU Geosciences students and our program. We hope everyone is well, and that we see you soon! •

~ **Andres Aslan**, Geology Program Coordinator

FACULTY PROFILE

Kerry Riley, Instructor of Geology

University of Colorado (B.A.), Boise State University (M.S.), Utah State University (Ph.D, nearing completion)

Kerry Riley is the newest faculty member in the Geosciences Program. She comes to CMU directly from Utah State University in Logan, UT where she is currently finishing her Ph. D. Kerry was born in Morgantown, West Virginia where she became fascinated with moving water and how it shapes the surface of the Earth. Kerry loves to get outside and explore with her four-year-old daughter, Piper, and twelve-year-old dog, Tennessee. She also loves snowboarding, bluegrass music, growing food and native landscaping, and running rivers in her free time.

Kerry moved west after high school and participated in the Pacific Northwest Youth Corp building trails and working on public lands in Oregon and Washington before going to college. Kerry received her undergraduate degree from the University of Colorado in 2004 with a double major in Physical Geography and Environmental Studies. During her undergraduate studies at CU-Boulder Kerry started raft guiding in the summers. After

Kerry is currently wrapping up her dissertation which investigates relations among climate, lithology, long-term erosion rates, and episodic cut-fill patterns in ephemeral streams...

college, Kerry relaxed and spent time as a snowboard instructor, science teacher, AmeriCorps member, and year-round river guide in New Zealand.

Returning to graduate school in 2009 to pursue a master's degree in Geosciences did not hold back Kerry's passion for rivers. At Boise State University, Kerry investigated relationships among fire,



Kerry Riley with her daughter, Piper.

climate, vegetation, and fire-related erosion in the Middle Fork Salmon River, Idaho. This research allowed her to combine her interest in rivers with her enthusiasm for science and curiosity about the natural world. Kerry's master's research required her to raft on a 100-mile stretch of class III-IV whitewater in the middle of a large wilderness area to access her research sites.

Kerry is currently wrapping up her dissertation in Geology with a focus on Geomorphology and Earth Surface Processes at Utah State. Her dissertation investigates relations among climate, lithology, long-term erosion rates, and episodic cut-fill patterns in ephemeral streams in the Grand Staircase region of the Colorado Plateau in southern Utah. For her dissertation, Kerry developed a chronology of alluviation and entrenchment in Johnson Wash (a tributary to Kanab Creek) for comparison with other arroyo cut-fill reconstructions to test whether arroyo cut-fill events were regionally synchronous suggesting a climate-driven process. Kerry used optically stimulated luminescence (OSL), radiocarbon, and

stratigraphic relationships to develop the chronology of alluviation and to date Pleistocene terraces. Kerry also investigated how millennial-scale erosion rates vary as a function of lithology, topography, and Holocene/Pleistocene climate change using cosmogenic Beryllium-10. In the final piece of her dissertation, Kerry used an extensive dataset of alluvial radiocarbon collected from arroyo walls to reconstruct decadal to millennial scale fire activity in the region. These data were used to understand regional, large-scale, long-term relations among climate, vegetation change, and fire activity.

Kerry moved to Grand Junction in August of 2018 and is currently an Instructor of Geology at CMU. She is currently teaching Weather and Climate, Oceanography, and Environmental Geology. Kerry was excited to get into the field with students at the Western Slope Field Conference in

Kerry aspires to be a lifelong learner and strongly believes in the effectiveness of experiential 'hands-on' education because of the unforgettable experiences she has had doing fieldwork...

Ouray, CO and at the Friends of the Pleistocene fieldtrip in Moab, UT. During the spring semester of 2019, Kerry will be teaching Introduction to GIS, Cartography, Weather and Climate, and Oceanography. Additionally, Kerry is teaching a one credit Geology of Canyon Country during spring break 2019, which will entail a multi-day river trip. Kerry feels at home in the outdoors and is excited to share her love and passion for rivers and the Earth with students. Kerry aspires to be a lifelong learner and strongly believes in the effectiveness of experiential 'hands-on' education because of the unforgettable experiences she has had doing fieldwork along tumbling rivers and in dry arroyos, managing natural resources in State Parks with AmeriCorps, and guiding river trips around the world through many different landscapes. •

STUDENT SPOTLIGHT

Nicole Mejia-Mendoza (expected graduation Fall '20) and **Alex Jacquez-Caro** (expected graduation Spring '20) participated in student-faculty research at New Mexico Tech (NMT) in Socorro, NM under the tutelage of **Professor Andres Aslan** in July. The team conducted summer field work in western Colorado collecting samples of ancient river gravel and then traveled to NMT to work in the Geochronology lab preparing samples for $^{40}\text{Ar}/^{39}\text{Ar}$ dating. The goal of the work is to use $^{40}\text{Ar}/^{39}\text{Ar}$ dating of detrital sanidine to constrain the ages of ancient rivers of western Colorado. This novel approach uses the youngest age population of sanidine grains in river sediments to calculate sediment ages, and this technique is being applied to ancient river sediments on Grand Mesa and the Uncompahgre Plateau. Nicole and Alex learned sample preparation and mineral separation techniques, and were given a tour of the $^{40}\text{Ar}/^{39}\text{Ar}$ lab. Alex and Nicole hope to use their summer experience to help replicate NMT's lab techniques at CMU in the future! •

Cullen Meurer (see photo at right; expected graduation May '19) spent part of the summer in Alaska participating in the Juneau Icefield Research Program (JIRP). Cullen and the other program participants, representing students from across the country, spent two months living on and studying the Juneau Icefield. The group skied and backpacked to several camps while conducting glaciology research. Cullen worked with a group of students and faculty surveying the ice field with a goal of using the current and past data to calculate changes in the ice field topography and flow rate. Cullen is the second CMU Geology student to participate in the JIRP program, following in the footsteps of **Donald Jarrin '16** (see Maverick Geologists). •



MAVERICK GEOLOGISTS (ALUMNI NEWS)

Nolan McDonald '16 began working full-time as a geographer for the Kaart Group of Grand Junction after several months as a part-time intern. The Kaart Group maps road networks internationally on OpenStreetMap, an open-source map of the world. Nolan traveled to Peru, Chile, Argentina, Ecuador, the United Arab Emirates, and Oman for data acquisition. Learning a little Spanish helped him immensely and was really fun for him. After working for about two years, Nolan resigned from Kaart and went back to CMU to complete PHYS II, CHEM II, and CALC II at CMU in preparation for applying to graduate schools. Nolan says it was a little rough coming back to school at first but didn't take long to readjust. Over the summer, Nolan was employed by the U.S. Forest Service in Alaska as a seasonal Physical Science Technician in their Minerals Department. He hopes to eventually pursue a career with the government.



Nolan McDonald on a trip to Peru while working for the Kaart Group.

His advice to students or recent grads looking for work is to learn to sell yourself and to be persistent.

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Following her CMU graduation with a B.S. degree in Geology, **Marisa Boraas-Connors '14** completed a M.S. degree in Geology at Colorado State University. Subsequently, Marisa and her husband, Greg, moved back to Grand Junction,



Marisa Boraas-Connors testing concrete for Peak Ready Mix in Grand Junction.

and Marisa began work for Peak Ready Mix in Grand Junction working in concrete-testing quality control. She works with samples from five concrete plants including facilities in Craig, CO, Moab, UT, and Farmington, NM. Specifically, her work entails designing and modifying concrete mixes, testing plastic and hardened concrete, and testing aggregates (sand and gravel)

for use in concrete. She utilizes geology and chemistry in order to understand how certain lithologies and components of concrete affect the properties of the designs from batching to finishing, and strength to durability. Marisa currently holds an NRMCA (National Ready Mix Concrete Association) Level IV technologist certification, one of only 220 people in the US!

Marisa currently works with several other CMU geology grads including **Robert Gasnick '15** (Peak Ready Mix), **Lilli (Clark) Smith '15** (Elam Construction), **Lisa Van Kirk '16** (Elam Construction), **Trevor Potter '18** (Elam Construction), and **Nick Cholas '18** (Elam Construction).

Donald (DJ) Jarrin graduated from CMU in December of 2016 and subsequently worked for the Colorado State Parks system before enlisting in the U.S. Army to begin training in military intelligence as a Geospatial Intelligence Imagery Analyst. Following completion of his basic training in February of 2018,



Donald Jarrin ('16) with his son, Lucas, and new wife!

DJ attended his specialty training in Ft. Huachuca, AZ, where he was 3rd in his class and received a challenge coin. DJ, his new wife, and young son are moving to Ft Drum, NY where he will await deployment to Afghanistan. DJ stopped by campus to say hello in September, and we wish him well in his new career!

Jeff Foster '91, reported in as follows: (I) received USGS/NAGT summer internship and worked in the Grand Junction USGS office during the summer of 1991. I was hired by USGS full-time as a hydrologic technician in January 1992 in Twin Falls, ID. In 1993 I transferred with USGS to the Rocky Mountain Arsenal (Superfund) in Commerce City, CO. In 1995 I transferred to the USGS Grand Junction office. In 2006 I transferred to the USGS Meeker Field Office in Meeker, CO to become the technician-in-charge, and in 2010 I transferred back to the USGS Grand Junction office where I still work today.

I've been a hydrologic technician for all of my USGS career, with the majority of the work involving stream gaging and surface water quality sampling, except that most of my work at Rocky Mountain Arsenal was groundwater sampling.

Michael Gustafson started school at CMU when I was a senior and we've remained friends over the years. Michael started working at USGS in Grand Junction in 2010, and we've had some great times working together at USGS since then. I'm still in touch with some of the other CMU geology students from my era, **William Monroe, Stacey Groves, Betsy Brownlee, Vicki Schmitz** (Vicki is married now and I can't remember her maiden name) and **Robin Kibler**. Some of the students I've lost touch with are **Joe Gregson, Melody Ackerman, Mark Coury** (spelling?), **Sean Norris, Phil Everhardt, Steve Lappin, Carol (Tyler) Strong, Jill Baker** and **Beth Egghart** (her married name, I don't recall her maiden name). I can picture the faces but have forgotten the names of several other students that graduated ahead of me.

We always like to hear from our former students. If you can, please drop by or send an email and let us know what you are doing! •

SPRING FIELD TRIP APRIL 6, 2019

The annual Spring Geology Program field trip for alumni and students is scheduled for Saturday, April 6, 2019. The trip is still in the planning stages, but possible destinations include Canyonlands, Dinosaur National Monument, Unaweep Canyon, or Black Canyon. Please mark your calendars. Details will follow in the Spring newsletter. •

Thanks for the generous donations!

The Geosciences Program and students greatly appreciate the strong financial support provided by the following alumni and friends of the program.

RICHARD D. DAYVAULT ENDOWED MEMORIAL SCHOLARSHIP

Richard and Cathy Barkley

GEOLOGY EQUIPMENT

Barry Brinton
Lee Cassin
Cassandra Fenton
Junichi Funayama
William Hood
Marie Hudson
Liz Meyer
Sam Meyer
Heidi Schoenstein
John Trammell
Russ Walker