

Geology News



Ely Creek Falls in Dinosaur National Monument.
photo credit: Lizzy Trower

Editors
Shemin Ge
Dan Mitchell

2018 - 2019

Letter from the Chair Shemin Ge

It is with mixed feelings that I complete my four-year chair term at the end of June 2019. I am truly humbled by the experience and very grateful for having had the opportunity to serve this greatest Department on Earth. You'll be happy to know that Professor Bob Anderson is now the newly minted Department Chair. Bob is not only an accomplished scholar but also an exemplary member of our academic community. We look forward to Bob's leadership.

Being a chair is a lot of work and much more than I anticipated. However, if there is one thing that I can say that made all the work worthwhile, it is the people in our Department. Our dedicated staff, brilliant students, and outstanding researchers and faculty are the best. It is the collective vision of the faculty that steers the ship in the right direction and dedicated every-day efforts of all that keep the ship on course. After sitting at the number two spot for a number of years, CU is ranked for the first time in fall 2018 as the number one best global university for geoscience research and education by US News and World Report. I cannot be more proud of what we have together accomplished. Our faculty and students continue to receive honors and recognitions for their work. Please see more on those in this issue, and do check back often at our Department website under "news and events" to see the latest news.

After a period of robust growth in faculty, the Department is progressing at a more steady pace with a balance between retirements and new hires. We welcomed new Associate Professor Irina Overeem, a quantitative sedimentologist, in fall 2018. Her position was made possible by Jaia Syvitski's retirement last year. We also welcomed Professor Suzanne Anderson, a geomorphologist, in spring 2019. Suzanne transferred from Geography to our Department that is a more suitable intellectual home for her. In January 2019, we celebrated Professor Joe Smyth's 35 years of distinguished career and outstanding contribution to the success of our Department and to the science of mineral physics. Joe is now promoted to Professor Emeritus.

Accompanying the growth was the challenges in staff support, particularly in the of area research grant administration. We are very pleased that the relief is finally arrived. Ms. Ingrid Simecek has recently joined us as a Research Administrator. Ingrid brings in her rich experience and great skills in grant management and she devotes half of her time to our Department (page 11).

Equally satisfying is the progress made in undergraduate advising. The Department and College reached an agreement to address the issues related to inadequate undergraduate advising in the last few years as a result of centralized academic advising and eliminating part-time academic advisors. Drs. Lon Abbott and Jen Stempien, with a one-course reduction for each, are now the official faculty mentors for our undergraduate students and provide much desired disciplinary guidance for our majors

and minors. I am grateful for the support from the College and our Advisory Board for making this possible. Our students will be pleased and better served.

In 2018-2019, we graduated 72 BAs, a record high, plus seven Masters and nine PhDs. We entertained the largest crowd of approximately 450 people at the 2019 spring departmental graduation. Patty Corbetta, our Advisory Board member, was the commencement speaker who shared with our graduates her unique and inspirational career experience from working in government agencies and private industry.

Our graduate students, including thirteen new ones who joined us in fall 2018, continue to be a vibrant force in the Department. In addition to their academic work and thesis research, they're taking charge of many departmental activities including weekly colloquia, bi-weekly coffee social gatherings, and annual BBQs, which makes us all feel a strong sense of community.

One of my most passionate goals as chair is fundraising for graduate student fellowships so that we can offer more competitive financial support packages to recruit more talented graduate students. Many of our Advisory Board members are leading by example. I am pleased to report that we are making great progress. The Bruce Curtis Fellowship finally reached \$1M. The Advisory Board launched a new Marcy and Bruce Benson Graduate Fellowship for Excellence in fall 2018. Inspired by the Bensons, contributions to this Fellowship have been robust, including a \$1M bequest. As this publication goes into press, Mr. Dale Grant just committed to a new \$1M Grant Family Geological Sciences Endowed Fellowship Fund. The Grant Family Fellowship will have an emphasis on GeoEnergy, particularly alternative energy such as geothermal.

The Department also received a \$5M gift from Mr. Paul Rady to endow a chair in petroleum geology. Paul Weimer, the past Benson chair is now the Rady Chair, which gives us the opportunity to recruit a new Benson Chair. The search for the Benson Chair is underway. I am so grateful for the overwhelming support from our alumni and friends.

My awesome graduate students enjoyed minimal advising from me in the past four years. Megan Brown was the luckiest one whose PhD study duration overlapped exactly with my chair term. With independence and brilliance, she graduated on time and is heading to a faculty position at Northern Illinois University.

I would not have survived the chairship without the support of our office staff, Associate Chair Alexis Templeton for her insightful guidance for our graduate students and the graduate program, and Associate Chair Eric Small for his effective leadership in our undergraduate program.

I have no doubt that the past four years will remain as one of my most memorable, fulfilling, gratifying professional experiences. Thank you again for the opportunity and my best wishes to all of you.



Greetings from the Alumni Advisory Board

Dean Miller

The Alumni Advisory Board and the Department have had a good year. One great piece of news is that US News & World Report now ranks Geosciences at CU Boulder as number one in the World! This is a great achievement and is confirmation of the extraordinary quality of the Department faculty and leadership.

The Advisory Board was sorry to see Karen Kelley, our USGS representative, rotate off the Advisory Board. She will be missed. Eric Anderson (M.S. 2003) has stepped in as our USGS representative. Shannon O’Dunn (M.S. 1969) also joined the Advisory Board in spring. We are looking forward to working with both of them.

Big changes are in store for the University and the Department. Bruce Benson, who has so generously supported the Department and the University, is retiring as CU President. Last year, the Department and the CU Advancement team, in coordination with the Alumni Advisory Board, established the Marcy and Bruce Benson Fellowship Fund for Excellence in recognition of the Benson’s professional careers, personal generosity, and lifelong commitment to expanding access to higher education. This fund is designed to address the Department’s need for endowed graduate fellowships, which will increase the Department’s ability to recruit, retain, and graduate the world’s best geoscience students.

The other big news for the Department is that Shemin Ge is stepping down as Chair and Bob Anderson will become the new Department Chair in July.

Dr. Ge has done a remarkable job as Chair and I can say on behalf of the entire Advisory Board that it has been a real pleasure working with her. We are looking forward to working with Bob Anderson and supporting his goals for the Department.

The Advisory Board fundraising subcommittee has been very busy. The subcommittee is developing several initiatives to provide Department alumni greater opportunities to engage with the Department and enhance their connection to the CU geoscience community. The Advisory Board is working with the CU Advancement team to hold an emeritus faculty reception, tentatively scheduled for April 17, 2020, at the Koenig Alumni Center on campus. (see page 31) This will be a great opportunity for Department alumni to reconnect with some of their favorite professors. More information will be forthcoming.

The Board met with Department undergraduates in the fall and graduate students in the spring to discuss their experience in the Department. The undergraduate students identified a concern about academic advising. The Advisory Board followed up with the College of Arts and Sciences and it looks like the issue has been resolved. The graduate students put on a poster session after our spring Advisory Board meeting. It quickly became obvious how CU became number one in the world in geosciences. We have some really remarkable graduate students who are doing cutting-edge research.

My column would not be complete without making a pitch for financial support for the Department. It really is remarkable how successful the Department has been in recruiting top-notch students given that other nearly comparable institutions (I can now say that) with large endowments have a significant recruiting advantage by offering several years of financial support up front. Our Department can’t do that. There are several funds to choose from, including the recently created Marcy and Bruce Benson Fellowship Fund for Excellence and the Peter Birkeland Scholarship Fund, as well as long-standing funds, including the Bill Braddock Fieldwork Endowment and the Bruce Curtis Graduate Student Fellowship in Geological Sciences, among others. You would be surprised how much difference even a small donation can make.

Here is the link: <https://www.colorado.edu/geologicalsciences/alumni/make-gift>.

Have a great summer!

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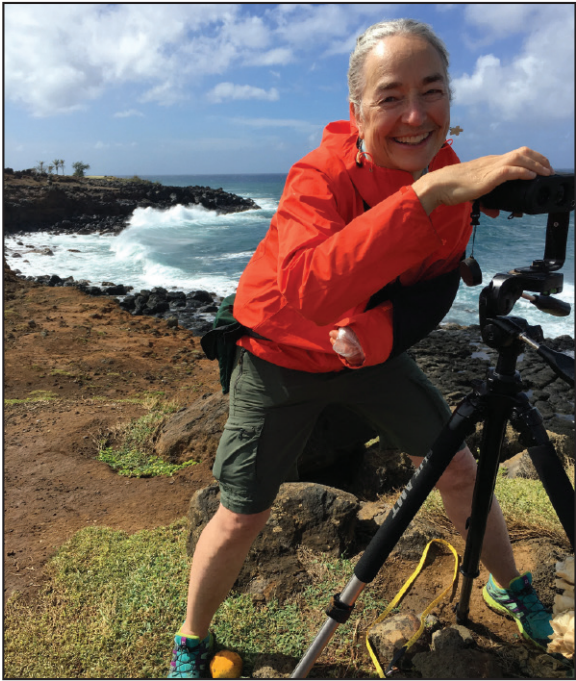
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New Faculty



Suzanne Anderson surveying on the island of Hawaii as part of the USGS National Earthquake Hazards Reduction Program.

Dr. Suzanne Anderson joined the Department of Geological Sciences after 15 years in the Department of Geography at CU. She is a geomorphologist, interested in the interaction of erosion and weathering at Earth's surface, particularly the processes that break down rock.

For the last 12 years, Suzanne has led the ~\$1M/year NSF-funded Boulder Creek Critical Zone Observatory. The project has engaged 11 faculty members (including Geological Sciences faculty Bob Anderson, Anne Sheehan and Greg Tucker... so far), 8 post-docs, and more than 30 graduate students in investigations of the form, function, and evolution of the critical zone—the life-energized, hydrologically-active skin of the Earth—using our backyard as a natural laboratory.

Suzanne has made crossing disciplines a feature of her career. She earned a BS in Chemistry from University of Puget Sound, an MS in Geology from University of Washington (studying periglacial processes), and a PhD in Geology from University of California, Berkeley (studying weathering and surface water hydrology—a mash-up she called chemical geomorphology). In her NSF Earth Sciences Postdoctoral Fellowship at the University of Wyoming she forged collaborations with a glaciologist and a geochemist to address glacial chemical weathering.

Suzanne has two current graduate students. MA student Noah Hoffman will finish their thesis this summer on flowpath delineation in a semi-arid

headwater using hydrochemistry data. PhD student Brittany Selander is studying the evolution of the rock-dominated walls of Boulder Canyon. She will use her GSA student grant funding to begin monitoring crack width in fractures with and without trees growing in them. In August 2019, Carleton grad Lauren Salberg will begin working on a Master's degree project on groundwater-surface water interactions (jointly supervised with Shemin Ge).

Suzanne was elected to be a Fellow of the Geological Society of America this year, an honor also awarded this year to her husband, Bob Anderson. They're tickled at the double family distinction!

Dr. Irina Overeem joined the Department of Geological Sciences as an Associate Professor in fall of 2018. Overeem graduated from Delft University of Technology, The Netherlands, with a degree in Civil Engineering and Applied Earth Sciences in 2002. Her research focuses on understanding sedimentary systems, especially river and coastal processes, with a focus on deltas.

Irina's own long-term research goal is to develop predictive surface process models, which should become tools to explore and quantify responses of the Earth system to changing environmental conditions. She uses physics-based numerical models of sediment transport and morphodynamics, but always uses field observations to critically assess model performance and ground truth model findings. She has special interest and concern for rapidly changing regions of the world. The fact that global changes are amplified in specific locations, like the Arctic regions or along low-lying deltaic coasts, makes them natural laboratories.

Irina Overeem in the Canadian Rockies.



Dr. Overeem leads a group of three postdocs, and two new graduate students will join in the fall of 2019. Her research group works on projects spread across the globe from sedimentary processes associated with Greenlandic Ice Sheet melt, to Arctic rivers and permafrost thaw, to floodplain sedimentation and sea level rise in the Ganges-Brahmaputra delta. These projects have resulted in several significant papers on delta dynamics in *Nature Geoscience* and *Geophysical Research Letters*, and recently in innovative applied science ideas on Sediment Resources in Greenland featured in *Nature Geoscience*, *Science* and *Nature Sustainability*.

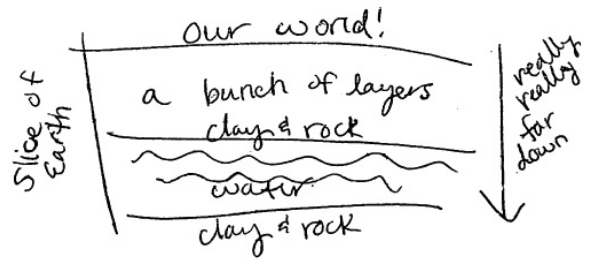
Irina is the Deputy Director of the Community Surface Dynamics Modeling System, a large NSF project led out of the University of Colorado, which promotes the modeling of surface processes by developing and disseminating integrated software modules that predict fluxes of water, sediment and nutrients in landscapes and their sedimentary basins.

She has been dedicated to science communication; she served as the CSDMS Education and Knowledge Transfer expert for several years previous, and earned a University of Colorado Science Communication Fellowship in that period. Currently, she partakes in the Steering Committee of the SEARCH, a group that actively seeks to communicate research findings on Arctic Environmental Change to US policy makers and stakeholders.

Faculty News and Activities

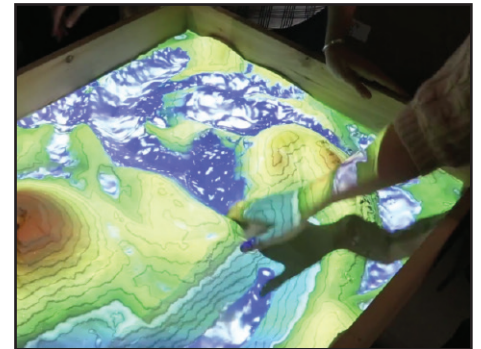
Leilani Arthurs conducts learning sciences research in the areas of geocognition (i.e., how people think about Earth processes and phenomena) and geoscientific skill development (e.g., map reading and interpretation skills).

The driving motivation behind Arthurs' research is to help cultivate among our undergraduate student body future geoscientists, Earth Science teachers, and scientifically savvy citizens who are more expert-like in the ways they think about and live on Earth. Her interdisciplinary research focuses on two sides of Geoscience Education, learning geoscience and teaching geoscience. To conduct this research, she draws on her geoscience disciplinary expertise as well as her training in the social sciences, learning sciences, cognitive science, and linguistics. This research applies to learning, teaching, and communicating geoscience to the public. For example, characterizing students' conceptions about groundwater, as shown in the upper right-hand image, is used to develop instructional activities to help them develop more expert-like conceptual understandings.



Arthurs' research on teaching is concerned with the professional development of STEM college instructors, the opportunities they have available to them to learn and grow as instructors, and the challenges and triumphs that are parts of their experiences as instructors. For this research, she relies on her training in the social sciences, particularly with respect to issues of justice and equity and research methodologies. Using a systems approach where the processes of teaching and learning are intimately connected, Arthurs is motivated to help empower geoscience and other STEM students and instructors to navigate their shared learning environments in ways that promote STEM learning and cultivate enduring mutual respect, individual accountability, diversity, and inclusivity. Instructors and students can co-create learning environments in which they thrive.

During the past year, Arthurs worked with undergraduate students, graduate students, colleagues in our department, and colleagues at other institutions. Undergraduate Thomas Clifford worked on two projects about scalar thinking and presented at the fall 2018 GSA annual meeting. Clifford graduated in December 2018 and is now a graduate student under the direction of Dr. Anne Sheehan. Undergraduate Brooke Holman successfully completed a UROP project about climate science communication. Undergraduates Shelby Litton and Joel Rice, worked on general map reading skills. Graduate student Sarah Baumann joined the lab in fall 2018 and studies how undergraduates develop contour map reading skills with and without augmented reality sandbox activities as shown in the image to the right.



During the past year, Arthurs also worked with graduate students and faculty members on the Department's Action Team to develop an assessment tool that can be used to evaluate the undergraduate geology and geophysics programs at CUB. In October 2018, NSF granted Arthurs (Lead PI) and colleagues

at two other institutions a \$3,000,000 five-year award to continue her research in the area of STEM professional development on teaching. She is excited about this award because it provides the opportunity for her and her colleagues to investigate professional development opportunities and the lived experiences of STEM instructors in many departments and at a diverse range of institutions of higher education.



Large geoscience course taught by Arthurs using a student-centered teaching approach. photo credit: Leilani Arthurs

This project builds on an earlier \$2,000,000 NSF award for which Arthurs was a co-PI, and the team is excited about the potential contributions this new multi-institutional collaboration will yield. In June 2019, Arthurs was awarded a one-year IMPART award to conduct a study of STEM instructors' experiences in the classroom and how they impact the quality of their work life and retention in the profession. This award supports the investigation of disrespect, microaggressions, and bullying of STEM instructors. This is an understudied area of import for a variety of reasons. It is also worth examination within the backdrop of national calls for STEM instructors to adopt more student-centered teaching approaches, which bring them into more direct contact with students than traditional lecture-only approaches.

Professor Budd accepting the SEPM honorary membership award at this year's AAPG annual convention and expo. Pictured in the background is the current president of SEPM, Lynn Soreghan. photo credit: Rebekah Simon



Professor David Budd received the Honorary Membership in the SEPM Society for Sedimentary Geology which acknowledges excellence in professional achievements and extraordinary service to the Society.

In order to receive the honor, candidates must be active members of the national Society; recognized as having made outstanding research, teaching, or administrative contributions to paleontology, sedimentology, stratigraphy or allied disciplines; and have served the aims of the Society through elected offices, committees, or other significant contributions. A records of sustained professional achievements and dedicated Society service are essential qualifications. Candidates for this honor may be characterized by acknowledged publication records and service to the Society as an elected officer. Other factors are taken into consideration for Honorary Membership including that the candidate has contributed professionally, and to the Society in less apparent ways.

Honorary Membership in the Society is a privilege and honor and thus is restricted to a select few. The Society limits the total number of living Honorary Members to one percent of the total membership or more than one elected each year in order to control the size of the body of Honorary Members as a means of preserving their prestigious rank. Congratulations Dr. Budd!

Associate Professor Brian Hynek spent the 10 weeks over the 2018-2019 holidays assisting NASA with their annual meteorite search in Antarctica. He was selected as part of a team of six scientists (plus two mountaineers) to travel to the Davis-Ward region of the Transantarctic mountains and spend six weeks living in a tent in one of the most remote field camps on Earth, about 150 miles from the south pole (the nearest neighbors). Collectively, the group found 865 meteorites, including several precious samples from the Moon, that will be studied for years. While there



Associate Professor Brian Hynek represents CU in Antarctica.

were 24 hours of sunlight in the height of summer, the temps were often -10°F and with strong winds. Professor Hynek enjoyed the simple life of survival on the ice – despite the 2000 emails that were waiting in his inbox when he returned.

Brian published a paper detailing the first microbiological study of a Mars analog volcanic crater lake atop the Poas volcano in Costa Rica in the journal of *Astrobiology*. This lake is one of the most acidic ones on Earth, often at a pH below 0, hosting rapid temperature swings, and with weekly phreatic volcanic eruptions. Yet, there was still microbiological life present – but just one species. The results showed that an acid-tolerant Bacterium was alive in the lake.

This work is assessing the limits of life on Earth and applying the results to ancient Martian hydrothermal systems. Current work, funded by a 2018 CU LEAP grant to map the genome of this bacterium is currently underway, assisted by undergraduate research assistant Justin Wang. The lake no longer exists – it was blown away with a major and still ongoing volcanic eruptions that started five days after Hynek's field team completed their sampling at the site.

He also spent half of September 2018, in Patagonia, flying drones over relict deltas that are analogs to ancient Martian fluvial systems. On Mars, most of the deltas exhibit stepped topography, which is quite rare on Earth. The stepped Patagonia deltas from this study developed via rapid fluctuations in lake level from ice/moraine dams and glacial processes in the Pleistocene. The data, combined with morphodynamical supercomputer models, are being used to compare with topographic expressions of ancient Martian deltas to the ones in Patagonia to infer their climatic/hydrologic conditions associated with their formation. Preliminary results show that

many deltas on Mars may have formed under rapidly rising lake levels and/or glacial conditions. MSc student Joseph Butterfield is contributing to the study.

Brian is building a drone program for geological analysis through a 2018 CU Innovative Seed Grant program award. This includes drones for high resolution imagery and digital elevation models of field locations that span fluvial geomorphology to mineralogical studies with visible-near-IR reflectance of active volcanoes. The goal of this work is to assess likely conditions on early Mars by detailing sediment transport in fluvial-lacustrine settings and alteration processes associated with hydrothermal systems in active volcanoes on modern Earth with applications to ancient Mars.

Lastly, Dr. Hynek, along with Professor Greg Tucker and PhD candidate John Gemperline, have received a new $> \$500,000$ grant from NASA to complete landscape evolution models of ancient Mars, when networks of valleys incised the planet's surface. There is a big debate regarding the climate of ancient Mars – whether it was warm and wet allowing copious precipitation and runoff to form the observed river valleys or if it was cold and icy and the river valleys formed via glacial runoff. Landscape evolution models pioneered by Professor Tucker and adapted to Mars are being used to test these two end-members and models in between, by assessing incision of a landscape with widespread rainfall and resultant incision versus meltwater from an icecap. Our initial results show that there are clear differences in the development of drainage networks between the two cases. This work also involves Alan Howard (University of Virginia, Emeritus) and Professor Edwin Kite at the University of Chicago.



Miller team recovering sediment cores from a lake near Qikiqtarjuaq: PhD student Sarah Crump, Postdoc Greg de Wet, and Inuit assistants Gordie Audlakiak and Lucasie Poisey. May 2018. photo credit: Gifford Miller

Professor Giff Miller and his team, with new techniques and old mud, reconstruct past Arctic warmth to anticipate the future.

The Arctic is warming faster than any other region of the planet. Landscapes that have been continuously ice-covered for millennia are now being revealed as cold-based ice recedes under warming summers. What will that mean for the Inuit living there; how will vegetation change? Those are some of the questions that Giff Miller, Julio Sepúlveda and CU grad students Sarah Crump and Jon Raberg, and postdoc Greg deWet, along with colleagues at the University at Buffalo, the University of Alaska Fairbanks, and Curtin University in Australia, are tackling under a new NSF-funded project “PACEMAP” that brings together ecologists, geologists, and paleoclimatologists, with organic geochemists and geneticists, to utilize the past to predict the future.

Capitalizing on lake sediment deposited in past warm times across the eastern Canadian Arctic, including the Early Holocene, the Last Interglacial (MIS 5e), and the penultimate interglacial (MIS 7), the field teams recover pristine, continuous sedimentary archives that capture these warm intervals. They are using molecular approaches to reconstruct changes in climate, hydrology, and vegetation through past warm times. Julio, Greg, and Jon are using bacterial membrane lipids, called branched glycerol dialkyl tetraethers (brGDGTs), to reconstruct climate back through time. The distribution of these compounds in modern environments has been empirically shown to track environmental temperature, and one of the goals of the project is to create a calibration for Arctic Canada. Sarah, working with Mike Bunce at Curtin University, is using ancient sedimentary DNA extracted from interglacial sediment to provide a more authentic reconstruction of local vegetation communities, where long-distance pollen dispersal compromises pollen records. This approach, relatively

untested on such long timescales, also involves modern validation work, where ecologists working with Skip Walker (CU PhD) at UAF, map the modern vegetation around their study sites to compare with DNA extracted from surface sediments at the coring sites.

Their goal is to derive algorithms that will allow them to predict the evolution of Arctic vegetation by 2100 CE using summer temperature estimates from climate models under various future emissions scenarios. In 2019 they will deploy five field teams collecting sediment cores and mapping modern vegetation along a transect from the forest-tundra ecotone to polar desert sites in Canada’s far north.



Gifford Miller with friendly, curious Inuit boys in Clyde River, Baffin Island. photo credit: Jason Briner

Assistant Professor Julio Sepúlveda’s research group

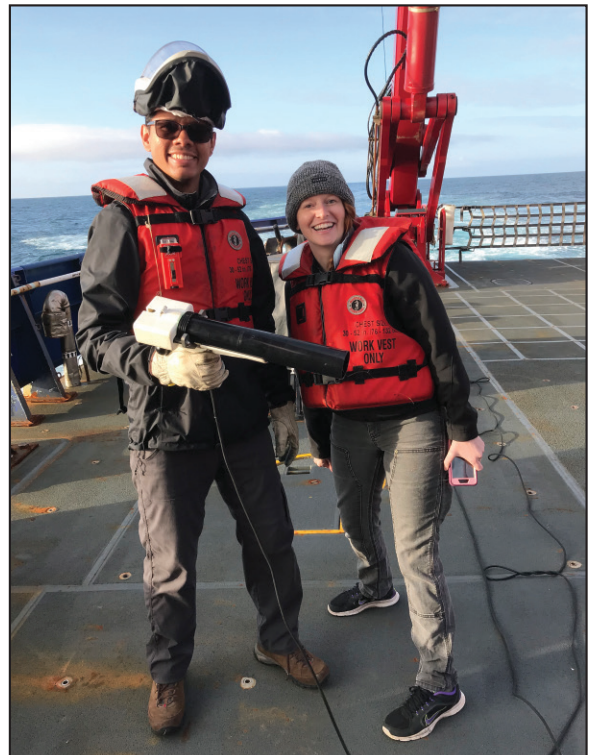
The Organic Geochemistry Lab (OG Lab) congratulates our recent graduates. GEOL major Jonn van Oosten graduated with honors working under the supervision of grad student Garrett Boudinot His honors thesis was titled: Nitrogen cycle dynamics during the Cretaceous Oceanic Anoxic Event 2 (OAE2; ~94 Ma) in the Western Interior Seaway. ENVS major Lucy Camuti graduated with honors working under the supervision of postdoc Greg de Wet. Her honors thesis was titled: Bacterial Lipids in Holocene Sediments from Baffin Island: Insights into temperature reconstructions in Arctic Environments. Additionally, GEOL majors Katie Quinn and Olabambo Oladipo completed GEOL Mentorships under the supervision of grad students Lina Pérez and Sebastian Cantarero, respectively. Furthermore, Drs. David Harning and Sarah Crump (advisor Giff Miller) defended their PhD theses in spring 2019, which included chapters based on their work in the OG Lab. Finally, postdoc Aaron “Ari” Meilijson, the first postdoc in their group, returned to the University of Haifa, Israel in September 2018 after spending two years in their group.

The OG Lab also welcomed new visitors and members during the last year. GEOL major Jamila Smith (State University of New York at Fredonia) was a 2018 SMART summer fellow working under the supervision of grad student Lina Pérez (Refining the Use of Plant Waxes as a Proxy for Past Changes in Vegetation and Climate in the Tropical Andes of Colombia). Dr. Stephanie Kusch from the University of Cologne, Germany visited their lab in spring 2019 to collaborate on the analysis of bacterial hopanoids in oxygen-depleted marine environments. Postdoc Lineke Woelders joined our group in fall 2018 after obtaining her PhD from KU Leuven, Belgium. She is currently working on an NSF-funded project titled “Timing and Paleoceanographic Impacts of the Onset of Arctic-Baffin Bay Throughflow” (with Ann Jennings’ and Tom Marchitto’s labs). Postdoc David Colwyn (Snell’s lab) is collaborating with the OGL on an NSF-funded postdoctoral fellowship titled “Cenozoic History of Polar Amplification in South-Central Alaska”. He comes to CU after obtaining his PhD from Yale University. Postdoc Dr. Joep van Dijk joined us in spring 2019 after obtaining his PhD from ETH Zurich, Switzerland. He is currently working on a project titled “Compound-specific isotopic constraints on carbon and nitrogen cycling across the Cretaceous-Paleogene Mass Extinction Event” with support from an Early Postdoc Mobility Fellowship from the Swiss National Science Foundation.

The group is involved in multiple projects aiming to improve the use of molecular markers (biomarkers) and their stable isotope composition as proxies for microbial processes, climate change, and oceanography today and through Earth’s history. Projects include the paleoceanography of the Cretaceous western interior seaway (G. Boudinot), the Cretaceous-Paleogene (K/Pg) boundary (J. van Dijk), the Eocene and Miocene Mediterranean Basin (A. Meilijson), and the Quaternary of the eastern tropical south Pacific (J. Sepúlveda) and Baffin Bay (G. de Wet). They are also reconstructing the climate history of Alaska during the Cretaceous (J. Sepúlveda) and Cenozoic (D. Colwyn), the Tropical Andes during the Pliocene-Pleistocene (L. Pérez), and Baffin Bay (L. Woelders) and Iceland (J. Raberg) during the Quaternary. Furthermore, they are studying microbial processes and calibrating biomarkers in marine oxygen minimum zones (S. Cantarero), Arctic (J. Raberg) and tropical (L. Pérez) soils and lakes, and the subsurface of Oman (with the Templeton group).

Professor Anne Sheehan and graduate students Enrique Chon and Jefferson Yarce participated in deployments of ocean bottom seismometers offshore Kodiak, Alaska in summer 2018. The deployments

were part of the Alaska Amphibious Array Community Seismic Experiment (AACSE) which Sheehan is a PI on. Summer 2019 has more Alaska field work planned, with on-land seismic station servicing on the Alaska peninsula with graduate student Melody Zhang and an offshore seismic reflection experiment to sample the Alaska peninsula megathrust fault zone. Closer to home, their work studying earthquakes in Colorado continues, with a telemetered seismic network in NE Colorado operated by graduate students Enrique Chon and Tom Clifford, and a new investigation of an earthquake swarm near the Great Sand Dunes National Park led by graduate student Jackson Bell. Postdoc Jakir Hossen and visiting sabbatical researcher Leo Ramirez-Guzman have brought new expertise in tsunami modeling and strong ground motion studies to our research group, and a tsunami reading group was initiated to bring together local researchers from CU, NOAA, and UNAVCO with common interests in tsunami hazards and research. Student presentations at professional conferences this year included Neesha Schnepf presenting her work on ocean circulation’s geoelectric fields at the 24th EM induction workshop in Denmark, Steven Plescia’s presentation on teleseismic coda wave autocorrelation imaging at AGU, Enrique Chon’s presentations at induced seismicity workshops in Canada and Switzerland, and presentations by Jefferson Yarce, Jackson Bell, and Hongda Wang at the Seismological Society of America meeting in Seattle.



Jefferson Yarce and UCSC graduate Heather Shaddox participating in ocean bottom seismometer deployment offshore Kodiak, Alaska, July 2018.

Professor Gregory Tucker had principal involvement in The Community Surface Dynamics Modeling System (CSDMS.) For more see page 11. U.S. National Science Foundation EAR Division, PI: G. Tucker, with co-investigators E. Hutton, A. Kettner, and I. Overeem, 2018-21, and received \$3,616,768 in support. Also received was the Topographic response to the transition from snowmelt- to rainfall-triggered extremes. U.S. National Science Foundation EAR Division, PI: M. Rossi, with co-investigators R. Anderson and G. Tucker, 2018-21, which totaled \$404,990.

Professor Paul Weimer taught a field course in sedimentary geology during the fall semester, and Geology of Colorado in the spring. He is looking forward to his upcoming sabbatical. Paul supervised 5 graduate and 2 undergraduate students this past year. Their research focuses on the deep-water margins of Colombia, southwest Madagascar (Morondavo Basin), Myanmar, Delaware Basin, Gulf of Mexico, and Los Angeles Basin. He serves on the Executive Committee of the American Geosciences Institute (AGI).

He restarted the Interactive Geology Program (igp.colorado.edu.) after a three-year hiatus in funding (suspended animation). Private donations of more than \$1.0 million over 5 years is guaranteed. Sammie Crowder and Veronica Zoeckler are full-time animators, and four additional animators work part-time--Jim Adson (Brisbane), Joseph Rogers (Upsala), Pax Harris, Alex Rideout (both Boulder). With additional funding, more staff will be added.

They are now embarking on a five-year plan with three primary goals: (1) videos of the 48 states using extensive computer animation, (2) 3D animations of nature scenes through time, and (3) a cellphone app that senses the user's geo-location, and shows that location's geologic evolution through time.

Initially, they plan to develop a series of animated videos that show the evolution of the geology for each state in the continental United States. These animations will be similar to the ones that they created for the State of Colorado. The purpose of these videos is to provide Education (K-12) and outreach in a number of deliverables for each state and region.

The project is being developed under the aegis of the American Geosciences Institute (AGI), Denver Museum of Nature and Science (DMNS), Association of State Geologists (ASG), and private funds.

IGP had a three-day booth displaying their newest wares at the AAPG Convention in San Antonio in May. A special highlight was three 3D scenes that can be viewed on 3D VR glasses. In essence, viewers can have a videogame-like experience, and walk through any designed geologic scene.

Joseph Smyth Retires



Joseph Smyth, and former graduate student Steven Jacobsen at Professor Smyth's retirement party.

Professor Joseph Smyth received his PhD from the University of Chicago in 1970 and started his research fellowship at Harvard shortly after. Joe also served at Los Alamos National Laboratory until 1983 when he came to the University of Colorado Boulder to teach mineralogy. Professor Smyth has been an important faculty member in the Department running the XRD lab for our faculty and students. Joe received the Humboldt Senior Research Fellow at the University of Bayreuth, Germany in 2004-2005. After 35 years of service to the Department of Geological Sciences and the University of Colorado Boulder, Professor Smyth retired. Joe's retirement party was held on January 18th, 2019. Many faculty, students and friends came to wish Joe well. The time was filled with great stories and a brief history of all that Joe has done here and abroad. Thank you Joe!

Fred Luiszer Retires

Dr. Fred Luiszer received his PhD in Geology at CU Boulder. His advisor was Professor Emeritus Edwin Larson. Fred has served the Department in many areas including; the Laboratory for Environmental and Geological Sciences (LEGS) and Benson Earth Sciences Building Proctor. With over 30 years of service to CU and the Department of Geological Sciences, Fred retired in September, 2018. Thank you Fred!

Fred Luiszer enjoys spelunking as one of his favorite hobbies.



Department Welcomes Research Grant Specialist.

The Department of Geological Sciences is happy to welcome **Ingrid Simecek** to the administrative team. She is a Certified Research Administrator and will help the Department to manage the multiple research grants and projects that we are currently involved with. Ingrid brings a large amount of experience and great skills in grant management. She will share her expertise with both the Geology department as well as Geography. With the addition of Ingrid, we hope to see an increase in our research grant funding.



The Community Surface Dynamics Modeling System

Greg Tucker and Irina Overeem

All 7.6 billion of us live on earth's dynamic surface. Increasingly, the study of our planet's surface—its topography, bathymetry, geomorphology, and stratigraphy—involves computational modeling. For the past dozen years, CU Boulder has hosted the Community Surface Dynamics Modeling System, which serves as a global hub for earth-surface process modeling. CSDMS (pronounced “systems”) launched in 2007, with support from an initial five-year NSF grant awarded to J.P.M. Syvitski, with Irina Overeem serving as Education and Knowledge Transfer Coordinator. Syvitski served as director from 2007 to 2017, before passing the torch to the current director, Greg Tucker, and deputy director, Irina Overeem.

The Community Surface Dynamics Modeling System (CSDMS) deals with the Earth's surface: the ever-changing, dynamic interface between lithosphere, hydrosphere, cryosphere, and atmosphere. CSDMS helps accelerate research in the earth-surface sciences by providing support for community building, computing technology, and educational resources. For example, the CSDMS Integration Facility builds and disseminates integrated software modules to compute the erosion, transport, and deposition of sediments across the earth's surface, on a range of time and space scales. To enable modular, reusable software components, CSDMS develops and promotes standards and best practices in scientific software. Each year, CSDMS brings about 130 researchers and students to CU Boulder for its annual All-Hands meeting.

Thanks to renewed support from the National Science Foundation, fall 2018 saw the inauguration of the third phase of CSDMS activity: CSDMS 3.0. This new phase embraces new opportunities provided by the explosion in geodetic data, while taking advantage of new developments in computing technology. For example, the February 2019 release of the new Python Modeling Tool (pymt) provides the community with the ability to run any of a collection of component models and utilities directly from a Python environment, using a simple and standardized set of control functions—even when the underlying code is written in a different language, such as Fortran or C++. For those interested in exploring the dynamics of integrated systems, components can be linked together; for those who wish to test hypotheses, they can be swapped in and out. By eliminating many of the common software headaches in computation work, this modular “plug-and-play” approach frees geoscientists to focus on the science at hand.

To learn more about CSDMS, check out the web portal at <https://csdms.colorado.edu>, or contact Greg and Irina's team at csdms@colorado.edu.



CSDMS
community surface
dynamics modeling system

Sands are Running Out, Except in Greenland

Irina Overeem and Mette Bendixen

Glacial dynamics of the Greenland Ice sheet grind down bedrock and produce large amounts of sediment, which then is carried to the ice sheet margin in basal ice or by subglacial meltwater rivers (Overeem et al., 2017). At many places along the coast these sediments accumulated in sandy deltas. Quantitative comparison of a recently rediscovered archive of rare WWII aerial photos with the more recent satellite record demonstrates that these deltas are now rapidly prograding into fjords. Future acceleration in glacial flow and ice sheet melt will likely further amplify Greenland's supply of sediment to the coastal zone. This abundance in sediment is in stark contrast to the rapid depletion of sand and gravel resources globally. The worldwide demand for these resources has grown exponentially; largely due to urbanization, infrastructure improvements in developing economies and due to enhancement of coastal protection in response to climate change.

Associate Professor Irina Overeem and Postdoctoral Fellow Dr. Mette Bendixen cast an unconventional, yet potentially lucrative solution, published in *Nature Sustainability* this year (Bendixen et al., 2019). In the paper, Bendixen and Overeem with co-authors from the University of Copenhagen and the Rhode Island School of Design ask whether that abundance of sand and gravel could provide an opportunity for Greenland to become a global exporter of aggregates and relieve an increasing global demand? Greenland seeks to diversify its economy, and has emphasized an economic development strategy focused on new mining industry

The magnitude of sand delivery to the coastal zones by Greenland Ice Sheet meltwater is significant and of potential value for the Greenlandic economy. However, a great deal of uncertainty exists around what impacts sand mining would have on the local environment and communities. Future research in collaboration with Greenlandic government and industry partners will be essential to document the persistence and quality of sand delivered to the coast and how sand mining impacts local ecosystems and associated ecosystem services.

A melting Greenland icesheet causes sea level rise and affects coastal regions worldwide, but perhaps the byproduct of glacial melt, sand, is an unexpected benefit.



Associate Professor Irina Overeem installing turbidity and stage measurement station in Greenland Delta.



The Geology Club at Great Sand Dunes National Park, CO. photo credit: Amro Al Hakami

Paul Rady Donates \$90M to Colorado Universities, Including CU Geology

Paul Weimer

In 2018, Paul M. Rady made a series of donations that will shape the future of geologic and engineering education in Colorado. Mr. Rady is the CEO and founder of Antero Resources in Denver. A Geology graduate of Western State College in Gunnison (1978), he received an MS from Western Washington State in 1981. After working with Amoco and Bill Barrett Resources, Mr. Rady established Antero Resources in 2002. By 2017, Antero Resources had become a large producer of NGLs in United States.

Mr. Rady's phenomenal gift has three components:

- \$5 million for a new Endowed Chair for CU Boulder Geology.
- An \$80 million gift to Western State to establish an innovative joint engineering program with the University of Colorado at Boulder. Western State undergraduates can now take certain CU Boulder classes with CU Boulder faculty, while remaining in Gunnison. The resulting undergraduate degree will be a B.S. in Mechanical Engineering or Computer Science from CU Boulder.
- Two \$2.5 million Endowed Chairs for CU Boulder Engineering.

Mr. Rady's gift for Geology was generously matched by Chancellor Philip DeStefano, so that its total value is \$6.2 million. Paul specifically requested that Paul Weimer be the first recipient of this Endowed Chair, starting in July 2019. This means that the Benson Endowed Chair, which Paul Weimer has held since 1999, is now open. Therefore, the Geology Department will begin actively recruiting in fall 2019, so that the position can be filled sometime in 2020.

Paul Rady had no previous affiliation with the CU Boulder campus, other than supporting Paul Weimer's outreach efforts in animation with private donations in excess of \$1 million. He has also supported Paul Weimer's research in the Piceance Basin, encouraged students to study at CU Geology, and met with Geology classes on several occasions.

On November 2, 2018, EMARC sponsored a special dinner to honor Paul Rady and his vision for Colorado education. Many of the CU Geology alumni who attended played a key role in establishing EMARC's applied program via high-impact research while at CU. Five of these alumni spoke at the event: Hal Miller, Thomas Villamil, Barry McBride, Marco Arreguin, and John Roesink. Each explained how their CU Geology training had led to significant careers, and expressed their gratitude to Mr. Rady for his donation. The dinner concluded with a special gift for Mr. Rady: an original geologic map of Gunnison and Mt. Antero from the 1877 Hayden Geological Survey-- the first survey to map the Colorado territory.

Paul Rady's philanthropy is simply extraordinary for our state, and specifically for our Department.



L-R: Becky Simon, Travis Payeur, Katherine Pfeiffer, Lucas Haas, Laura Stamp, Paul Rady, Paul Weimer, Dan Postal, Will Gutterman and Drew Scherer.



Structural Geology field course, Group Shot, Little Wildhorse Slot Canyon, San Rafael Swell, a Laramide Fault Propagation fold and blind thrust. photo credit: Karl Mueller

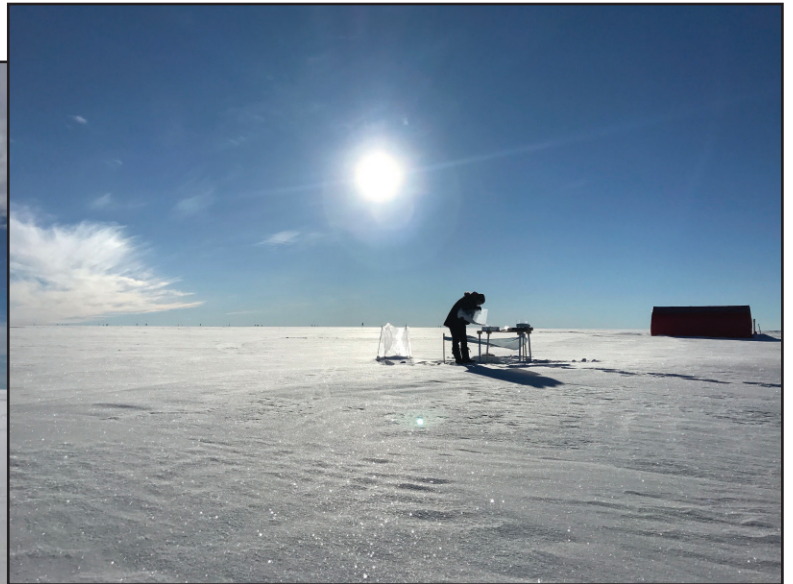


Bob Anderson giving insight during the Bill Bradley New Graduate Student Field Trip. photo credit: Houston Kempton

In the Field



William Skorski operating a drone at the East Greenland Ice-Core Project field site.



Abby Thayer sampling at the East Greenland Ice-Core Project field site.

William Skorski and Abby Thayer were at the Greenland Ice Sheet for 6 weeks each working at the East Greenland Ice-Core Project field site.

Link to the project: <https://eastgrip.org/>



The Mocqui Caverns near Kanab, UT during the field sedimentology course.
photo credit: Lizzy Trower



Geology Club at Moab, UT. photo credit: Amro Al Hakami

**Your generous support helps to fund many of our graduate
and undergraduate field trips.
Thank you!**

Marcy and Bruce Benson Fellowship Fund for Excellence



A Decade of Leadership

Completing their 11th year of leadership, Bruce and Marcy Benson are the longest tenured president and first lady of the University of Colorado in the past 65 years. Since taking the helm of his alma mater, President Benson has enhanced CU's standing as one of the nation's leading public universities. During his tenure, CU's research funding has reached record levels, supporting the university's research strengths in biotechnology, health care, energy and aerospace engineering, among others. Annual philanthropic support for CU has increased from \$135 million to \$440 million.

Marcy Benson has volunteered for the University of Colorado in several capacities, including co-chairing (with her husband) two fundraising campaigns of \$1 billion and \$1.5 billion respectively, and continues to work with the university on a variety of fundraising and other initiatives. Since the early 1990s, she has been an active community volunteer, serving on the Board of Directors of Children's Hospital Colorado, chairing the Children's Hospital Foundation, co-chairing the campaign that was a major driving force to build the new hospital on the University of Colorado Anschutz Medical Campus, and assuming many other leadership roles in the state.

A tribute to the Bensons' leadership for the Department of Geological Sciences at the University of Colorado Boulder

In the best of worlds, each generation inspires the next. The world-renowned Department of Geological Sciences at CU Boulder has long held this tradition. Our highly accomplished faculty and alumni have educated undergraduate and graduate students for decades, setting them up for success in many diverse fields of geology. Bruce D. Benson (Geol'64), and his wife, Marcy Benson, stand out as two of our most inspirational leaders.



President Bruce Benson chatting with students during the 2018 fall Geology Advisory Board Meeting,

Over 20 years ago, the Bensons made a transformational gift that provided a new home for the Department of Geological Sciences. The Benson Earth Sciences building has given the department the opportunity to flourish. The students and faculty inside these classrooms and research labs have propelled the department into top rankings internationally over the past two decades.

In recognition of the Bensons' distinguished professional careers, personal generosity and lifelong commitment to expanding access to higher education, the Geological Sciences Advisory Board, in coordination with the Geological Sciences Department and CU Advancement, created the **Marcy and Bruce Benson Fellowship Fund for Excellence.**

This fund responds to the department's acute need for endowed graduate fellowships, increasing the department's ability to recruit, retain and graduate the world's best geoscience students. As an endowed fellowship, it will return enough money annually to support a graduate student position in perpetuity. These students will embody the commitment and talent required to push themselves, this department, the university and the entire field of geology to the highest levels of success.

2019 Geology BBQ and Student Awards at Martin Park

photos credit: Kara Bajdas



Undergraduate Teaching News

Introduction to Petroleum Geology resurrected by Alumnus and Advisory Board member Dr. Penny Patterson

After a hiatus of roughly 6 years, the undergraduate course Introduction to Petroleum Geology (GEOL 3540) was offered spring 2019 and taught by Penny Patterson, Ph.D., who recently retired as a Senior Technical Advisor of ExxonMobil. The course had an initial enrollment limit of 24 students with many more students that were wait-listed for the course. A larger classroom had to be located, which enabled a total of 34 students to register for the course. This remarkable number of students enrolled in the course clearly indicates the high level of interest that the upper division undergraduates have in learning about the oil and gas industry.

Basic concepts of petroleum geology are important to learn, whether you are planning for a career the petroleum industry, you are interested in analyzing current news articles on oil and gas companies and their portfolios, or you would like to assess some mineral rights that a long, lost relative bequeathed to you. Hence, the Introduction to Petroleum Geology course was developed to provide undergraduate students with the fundamental tools and concepts



to review, analyze, and critically assess conventional and unconventional hydrocarbon resource plays. Additional insights and information about the latest developments in the petroleum industry were provided by three guest lecturers-- Edmund "Gus" Gustason, Ph.D. (Enerplus); Peter Vrolijk, Ph.D. (retired, ExxonMobil); and Steve Marks (Marks Oil).

For the second time since 2016, nine CU geology students, accompanied by Lon Abbott, headed to southeastern Australia in July 2018 to participate in a joint undergraduate field class with professors and nine students from Australia's University of Wollongong. While honing their field skills, the students examined world-class geology completely different from anything on offer in the western U.S.

The course focused on the diverse geology of the Outback's rugged Flinders Ranges, which contain probably the world's best Neoproterozoic stratigraphic record. Students used sedimentary clues to deduce the varied depositional environments of the Neoproterozoic layers that accumulated in the then-active Adelaide rift basin. One highlight of this extraordinary section is an outstanding record of two global glacial events that have become famous as the "Snowball Earth" events in which many geologists believe the Earth was completely encased in ice.

At the Arkaroola Reserve we examined the sedimentary record of the older "Sturtian" snowball event and in the Flinders Ranges National Park we scrutinized deposits from the later "Marinoan" glaciation. The Marinoan event brought the Cryogenian (i.e. ice time) Period of geologic time to a close. Next came the Ediacaran Period, during which multi-cellular life first evolved on Earth. We analyzed the rocks at the world standard definition for this period boundary, known as the Global Boundary Stratotype Section and Point (GSSP) in the famous Brachina Gorge. Students were also able to find some weird and wonderful Ediacaran animals on outcrops in the gorge.

The Arkaroola Reserve has so many geologic similarities to Mars that it is used as a Mars simulation training area. The reserve is owned by the family of Reg Sprigg, the geologist who first discovered the

Ediacaran fauna in 1946 while mapping the nearby Ediacaran Hills. Reg's son is a serious amateur astronomer who has built an observatory at the Arkaroola lodge. The reserve is about as far from a city as one can get in 2018, so it is a certified "Dark Sky" site. The group was treated to a spectacular observatory session one night while we were there.

Next it was on to Adelaide, where students examined striated glacial pavements left behind by yet another major glacial event, the Late Paleozoic glaciation that Alfred Wegner used to bolster his argument for the former existence of the supercontinent Gondwana. The Hallett Cove glacial pavement is in a stunning setting atop a picturesque seacliff, which showed the CU students that Australia is more than just Outback desert.

The American and Australian students bonded during the long road trip through the Outback. The Australian students were especially excited to visit the Prairie Hotel in the dusty Outback town of Parachilna, which bills itself as the "Ediacaran Capital of the World". The hotel (a pub to Americans) is the inspiration for a famous Australian country music song called "Prairie Hotel Parachilna". The Australians played the tune repeatedly as we cruised through the Outback, to the delight of their American colleagues.

In July 2019 a contingent of nine Wollongong students will come to Colorado to explore our state's equally special geologic history, the second time this joint "Geology of Colorado" class has been offered. Three students and a professor from Ecuador's ESPOL Institute will join us this year. The Ecuadorians have already offered to host the 2020 version of this growing "home and home" field geology class tradition in Ecuador and the Galapagos, so stay tuned for news of more exotic field geology to come.

The group in Parachilna, South Australia, home of the Ediacaran fossils.



Undergraduate Researchers Reveal a Bulls-eye of Miocene Erosion in Colorado's Elk Mountains

Lon Abbott

Thanks to a Tim Wawrzniec Fellowship from the Rocky Mountain Biological Laboratory (RMBL), a team of undergraduate researchers associated with the department's Collaborative Inquiry-based Research Community (CIRC) is deciphering the erosion history of Colorado's Elk and West Elk mountain ranges using low-temperature thermochronology.

Between 30-35 million years ago (Ma), numerous granite laccoliths intruded sedimentary rocks in an area the Colorado Geological Survey calls the 'laccolith triangle', which stretches from Aspen in the east to Crawford in the west and from Crested Butte in the south to Mount Sopris in the north. Because the plutons are far more resistant than the surrounding sedimentary rock, subsequent erosion has produced a distinctive topography of big granitic mountains rising high above their surroundings (Mount Sopris and Crested Butte are two excellent examples). The granites form a "bull's-eye" surrounded by Miocene basalt flows (Grand Mesa and the Flattops are good examples), whose presence requires minimal post-Miocene erosion. Our team wanted to know: When did the erosion that exposed the granites inside the bulls-eye occur and how much material was eroded?

Becky Flowers and Jim Metcalf have just the right tool to answer that question: apatite (U-Th)/He thermochronology (AHe). A rock's AHe age reveals when it was last at a temperature of approximately 65 °C, a temperature typical for rocks 1.5-2 kilometers beneath the surface. Becky, Jim, and Lon Abbott thus began collaborating with a host of undergraduate researchers to find an answer.

Coleman Hiatt was the first CU researcher to confront that question. He did AHe dating of the Crystal Pluton, in the heart of the laccolith triangle near Marble, Colorado, for his Honors thesis in 2016. Coleman's AHe ages of 9-11 Ma for the Crystal Pluton revealed that 1.5-2 km of material has been removed since then. Noah McCorkel took up the baton in 2017. For his Honors thesis Noah did AHe dating of the Whiterock Pluton, also in the laccolith triangle near the RMBL field station in Gothic. His 8-16 Ma ages confirmed Coleman's results. Nicole Gonzalez and Kristin Putnam tackled AHe dating of rocks outside the bulls-eye's perimeter. Sure enough, rocks from along U.S. Highway 50 east and west of Gunnison and also in Glenwood Canyon all have AHe ages much older than mid-Miocene.

Evan Schanock then tested two more areas inside the bulls-eye, at Crested Butte and along the Kebler Pass road, obtaining 9-14 Ma ages that confirm the

laccolith triangle has experienced 1.5-2 km of erosion in the last 10-15 million years whereas the surrounding areas have not. Why? We aren't sure, but among the options are a mid-Miocene batholithic intrusion or a lithospheric "drip", either of which could bow up the Elk/West Elk area, subjecting it to extensive localized erosion.

Current students Shelby Litton, Eric Ruggles, Bob O'Neill, and Mitchell Ramba are analyzing yet more samples, seeking to define the bulls-eye's perimeter more precisely. They are headed to RMBL in August 2019 for one final field season, accompanied by Lon, Lang Farmer, and Coleman, who is now pursuing his PhD at Utah State University funded by a National Science Foundation Graduate Fellowship. The goal: collect more AHe data, sample lamprophyric dikes (which are associated with mantle drips elsewhere), and do ^3He analysis of area hot springs (^3He comes from the mantle; Coleman now specializes in its analysis) to test various hypothesized explanations for this unusual bulls-eye of rapid mid-Miocene erosion that has produced an iconic Colorado mountain landscape.



Evan Schanock and Becky Flowers collect an AHe sample from the summit of Crested Butte.



The Collaborative Inquiry-Based Research Community (CIRC) Lon Abbott

The department's Collaborative Inquiry-based Research Community (CIRC) for undergraduate students completed its third year of existence in spring 2019. Lon Abbott and Jennifer Stempien started the CIRC in September 2016 with a Chancellor's Grant for Excellence in STEM Education. CIRC students engage in two complementary activities. First, everyone participates in the weekly, graduate-style Geology Majors research Seminar (GeMS). Each seminar session is devoted to discussion of a published scientific paper, listening to a graduate student or faculty member present a talk about their research, or a discussion about how to conduct research or how to search for graduate schools. The papers we read focus on the CIRC's broad scientific theme, which is the geologic evolution of the American West. The second activity is an individual student research project in whatever sub-discipline especially interests the student. Projects have been funded through the Department's Mentorship program (made possible by alumni donations), CU's Undergraduate Research Opportunities (UROP) program, faculty grants, or by grants from outside organizations such as Geological Society of America (GSA) and Rocky Mountain Biological Laboratory (RMBL).

The CIRC is designed to include students at various stages in their undergraduate career, which lends a strong peer-mentoring component to the group. The staggered graduation dates for CIRC students also makes the group self-sustaining; there are always seasoned students on hand to mentor their younger colleagues and share with them the excitement and the challenges inherent in the undergraduate research experience.

Twenty-nine students have participated in the CIRC during the three years. Twenty of those students have graduated, while seven will continue their CU geology studies and their CIRC participation in the fall. Eleven of the 20 graduating students did so with Honors, eleven are currently enrolled in graduate school, two more have applied for graduate school, and three are currently employed in geology or an allied STEM field. CIRC students have also been successful in research and grant writing. They have co-authored 11 abstracts presented at professional meetings, serving as senior authors on five of those, and six CIRC students have written proposals that secured external research funding during their undergraduate careers. Participating faculty and researchers are experts in multiple areas of geoscience, which opens up a world of possibilities for participating students to embark on a research project that applies a tool they find appealing to a problem they find intriguing. Jim Metcalf, Jennifer Stempien, and Lon Abbott

are regular participants in the GeMS seminar; CIRC students have conducted independent research with Katie Snell, Becky Flowers, Bob Anderson, Greg Tucker, Shemin Ge, Kevin Mahan, Alexis Templeton, Carolyn Crow, Aaron Bell, Rachel Glade, James Metcalf, and Lon Abbott.

This year marked the end of the Chancellor's Grant funding so in April 2019 Lon, Jen, and Bob Anderson submitted an NSF grant seeking funds to keep it going. If funded, the grant would provide scholarship money for low-income participants and expand the CIRC's reach through collaborations with Northglenn High School, one of the country's leading STEM-focused high schools, and Red Rocks Community College, . Fingers crossed that it is funded!

L-R: Corey Flynn, Sierra Baker, Spencer Ziegler, and Toby Halamka take a break from their examination of ultramylonite in the Homestake Shear Zone during a CIRC fieldtrip.



The CIRC crew threw a party during the final GeMS seminar of spring 2019. Back row, from left to right: Sheena Skinner, Rebecca Holmes, Shelby Litton, Jennifer Stempien, Alexis Ahlert, Jim Metcalf; Middle row, from left to right: Cyrus Young, Spencer Ziegler, Lon Abbott, Cynthia Tong, and Estevan Mungula; Front row, from left to right: Evan Tucker, Anna Todd, and Toby Halamka.

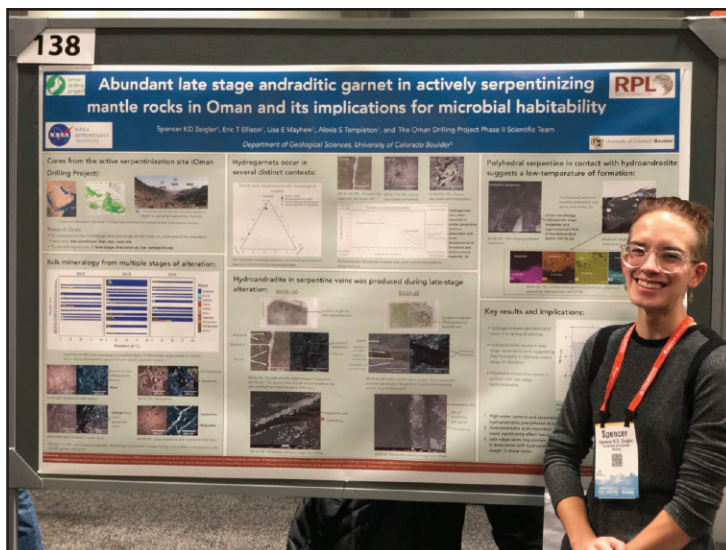


2018-2019 Undergraduate Mentoring Projects

Alexis Ahlert successfully defended her Senior Honor's Thesis titled "Investigating Hydraulic Communication Between Wells During Hydraulic Fracturing Treatments in the Piceance Basin, Colorado, USA". Her thesis used numerical modeling to test the impact of geologic and engineered parameters on well-to-well hydraulic communication for gas production wells in western Colorado. This work was supervised by **Megan Brown, Rebekah Simon, and Shemin Ge**. Alexis will attend the University of Kansas in the fall for graduate school.

The Organic Geochemistry Lab was fortunate to have **Olabambo Oladipo** working with PhD student Sebastian Cantarero and Professor Dr. Julio Sepúlveda during the fall 2018 and spring 2019 semesters. Olabambo participated in ongoing research utilizing lipidomics to assess the impact of microbial communities on the carbon cycle in oxygen deficient waters. He helped in preparing and analyzing the lipid content of water column filtrates from an anoxic marine zone in northern Chile and Peru using gas/liquid chromatography mass spectrometry techniques. His work was critical in identifying and quantifying a great diversity of microbial lipids present in these systems to better our understanding of the microbial role on marine carbon cycling.

Spencer Zeigler worked closely with Research Associate Eric Ellison, Dr. Lisa Mayhew and Prof. Alexis Templeton in the Geomicrobiology & Geochemistry laboratory in 2018. Earlier that year, the Rock-Powered Life NASA Astrobiology Institute project (<https://www.colorado.edu/lab/rockpoweredlife/>) that Templeton lead's successfully recovered 1000 meters of deep peridotite core from the Samail ophiolite in Oman, in order to determine the water/rock reactions and subsurface microbial activity occurring during modern low temperature "serpentinization". Spencer was recruited to the project to help with detailed mineralogical and petrological characterization of 100 core samples. She learned how to conduct quantitative x-ray diffraction and Raman spectroscopy analyses to complement her optical petrology observations. Spencer also gained exposure to transmission electron microscopy and electron microprobe analyses to characterize the structure and chemistry of the finely intergrown phases in vein networks. In her work, Spencer identified unique mineral assemblages in highly altered harzburgite and dunites that included abundant low-temperature garnets, such as hydroandradite and hydrogrossular. Spencer presented her results at the American Geophysical Union meeting in Washington, D.C. in December 2018.



Attention Alumni

By completing and mailing in this form, you can help us do a better job of keeping up with you, your whereabouts, and your career or family news. We all enjoy reading about classmates and not-so-close-mates who survived Boulder in whatever era! So send us some news or some recollections—we promise to use them.

Name _____ Date _____

Address _____

Degree(s) (years and institutions) _____

Current Position/Employer _____

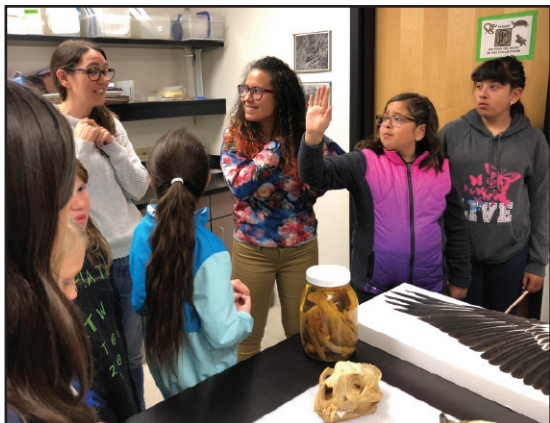
News About Yourself/Family/Friends _____

Mail to: Geology News, Department of Geological Sciences, 399 UCB,
University of Colorado, Boulder, CO 80309-0399

Or Email your Alumni News to:
GeoAlum@Colorado.EDU

Graduate Student Research, Outreach, and Recognitions

Lina Perez Angel participated as an active member in the Girls At the Museum Exploring Science program (GAMES) from the museum of natural history of CU Boulder during the fall of 2018 and this spring. She was in charge of a group of girls that came to do the activities once a week.



Lina Perez Angel (Center) working with girls from GAMES.



Lina Perez Angel in the field digging some soil.

Magali Barba through the CIRES Diversity and Inclusion Program, launched SOLESS, the Society of Latinxs/Hispanics in Earth and Space Science. SOLESS is the first national geoscience organization serving Latinx/Hispanics. During AGU, she hosted a SOLESS Mixer which had 20 participants. In January, she lead a collaborative effort between SOLESS, Inspiring Girls Expeditions (IGE), and GeoLatinas to translate the IGE website from English to Spanish to promote inclusion.

Charlie Shobe received a Marie Curie postdoctoral fellowship from the EU for his upcoming postdoc at the GFZ Potsdam.



Michael Frothingham is the recipient of the 2019 Stone/Holberg Scholarship from the Rocky Mountain Association of Geologists Foundation. Michael's research proposal is titled: "Crystal- to crustal-scale seismic anisotropy of continental crust." He also works closely with Research Professor Vera Schulte-Pelkum.

Rachel Havranek is the recipient of the 2019 Dudley and Marion Bolyard University of Colorado Scholarship.

Sarah Black (photo on the right) defended her PhD in spring 2018, which entailed a comprehensive look at Icelandic hydrothermal systems that are akin to those that operated on Mars billions of years ago. While the relict ones only left the alteration minerals behind, the ones we study on Earth are currently active. The active systems in Iceland, Costa Rica, Nicaragua and Hawaii provide key insights into the environmental conditions that operated on ancient Mars, and their potential habitability. Sarah interrogated these terrestrial systems in the field, conducted hydrothermal experiments in the lab, and from the results assessed the habitability of ancient Mars.



Graduate Student First-authored Publications

Barba-Sevilla, M., Baird, B., Liel, A., & Tiampo, K. (2018), Hazard Implications of the 2016 Mw 5.0 Cushing, OK Earthquake from a Joint Analysis of Damage and InSAR Data. *Remote Sensing*, 10(11), 1715. <https://doi.org/10.3390/rs10111715>.

Brown, M.R. and S. Ge, (2018), Distinguishing fluid flow path from pore pressure diffusion for induced seismicity, *Bulletin of Seismological Society of America*, 108(6), 3684-3686, <https://doi.org/10.1785/0120180149>.

Evans, S. G., Ge, S., Voss, C. I., & Molotch, N. P. (2018), The role of frozen soil in groundwater discharge predictions for warming alpine watersheds. *Water Resources Research*, 54. <https://doi.org/10.1002/2017WR022098>.

Feucht, D. W., Bedrosian, P. A., & Sheehan, A. F. (2019), Lithospheric signature of late Cenozoic extension in electrical resistivity structure of the Rio Grande rift, New Mexico, USA. *Journal of Geophysical Research: Solid Earth*, 124, 2331–2351. <https://doi.org/10.1029/2018JB016242>.

Glade, R.C. and R.S. Anderson, (2018), Quasi-steady evolution of hillslopes in layered landscapes: An analytic approach. *JGR-Earth Surface*. <https://doi.org/10.1002/2017JF004466>.

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Your generous support helps to fund many of our graduate programs and research initiatives enabling our graduate students the ability to positively impact the world around us.

Thank you!

The Geology Club at Gunnison National Park, CO.
photo credit: Amro Al Hakami





Undergraduate Student Awards

T. Keith Marks Scholarship Award

Joseph Gomora
Andres Lopes-Alba
Carlton Mueller
Katie Quinn
Anna Todd

Winners of the T. Keith Marks Scholarship Award won through an essay competition.

Kolber Scholarship Award

Alexis Ahlert
Kunmanee (Mac) Bubphamanee
Nicole Gonzalez
Toby Halamka

Wyatt Hansen
Sarah Jamison-Todd
Mitchell Ramba
Evan Tucker

Rocky Mountain Association of Geologists "Pick" Award

Carlton Mueller



Patty Corbetta delivering the spring 2019 commencement address during the department graduation ceremony.

Student-nominated Marinus Smith Award for making a positive impact on their students
Lon Abbott
Rachel Glade

Graduate Student Awards

Department Fellowships

Made possible by the **Bruce Curtis & Penny Patterson Funds**

Ciara Asamoto	Rachel Havranek
Enrique Chon	Jonathan Raberg
John Gemperline	Jennifer Reeve
Ellie Hara	Eric Smyth

Bruce Curtis Scholarship

Jackson Bell
Rachel Havranek

Keith T. Marks Scholarship

Melissa Bernardino
Garrett Boudinot

O'Dunn Scholarship

Nadine Reitman
Mike Zawaski

Spetzler Family Fund

Sarah Baumann
Sarah Leventhal
Mike Lotto

Association of Woman Geoscientists

Outstanding Woman Geoscience Student
Nadine Reitman
Baylee Sergent

May 9th 2019 spring graduation ceremony. Bachelor of Arts graduates.



May 9th, 2019 spring graduation ceremony. PhD and Master's graduates.



Degrees Awarded

(Fall 2018- Spring 2019)

BA Geology Majors

Ali Abdul-aziz Alahmed
Abdullah Ahmed Alfarhan
Thamer Almahamidh
Khalid AlMukhaizeem
Abdullah Alraddadi
Reem Alrowaihed
Ahmed Alrashid
Hesham Alsaigh
Saleh A Aluwaiyedh
Sabrina Troncoso Arvizú
Zachary R. Austin
Dylan Bailey
Phillip Banks
Rodrigo Davila Barron
Brooke Boyd
Dylan A. Brazier
Robert Carlisle
Jackson Carter
Soisiri Charin
Thomas Clifford
Salvatore D'Ambrosio

Maxwell Dike
Elias Ellis
Mohammed Osama Fantani
Kevin Fletcher
Corey James Flynn
Jacob Fuessel
Joey Gomora
Amro Al Hakami
Toby Ann Halamka
Haley Hall
Mior Muhammad Ikhsan bin Hamdan
Muhammad Shafiq Mohamad Haniffa
Melanie Elizabeth Hopek
Mohamad Faiz Ikhwan Ismail
Muhammad Ariff Idlan Bin Ismail
Jack D. Kamby
Jordan Kaschinske
Lyal Abdullah Khan
Chelsie Maryanna Kowalski
Brendan Martello
Gabrielle Matheson

Alexa Medina
Hayden Myers
Olabambo Oladipo
Michael Olson
Devon Robb
Miguel Sean Rogers
Muhammad Faris bin Rozain
Evan Schanock
Drew Scherer
Pooja Sheevam
David Sigal
Stuart Alan Smith II
Duncan Tillman
Sean Michael Tostanoski
Blake E. Ulrich
Owen Somerville Van de Graaf
Chase Wainwright
Andrew J. Whittle
Luke Wiederaenders
Spencer K.D. Zeigler
Calli Zupancic

BA Geology Majors with honors

Alexis Ahlert **magna cum laude**
Christopher John Benben **cum laude**
Kunmanee Bubphamanee **summa cum laude**
Wyatt K. Hansen **summa cum laude**

Carlton D. Mueller **magna cum laude**
Kasdi Nata Sujono **magna cum laude**
Anna Todd **summa cum laude**
Evan Tucker **summa cum laude**
Jonn Van Oosten-Edl **cum laude**



Victoria Crystal enjoying the feeling of accomplishment during the 2019 spring graduation ceremony.

2018 fall graduating students.

MS Candidates Graduating with Degrees

	Advisor(s)	Thesis
Madelaine Atteberry	Dr. Jaelyn Eberle	A description and phylogenetic analysis of three new earliest Paleocene (Puercan) periptychid 'condylarths' from the Great Divide Basin, WY.
Victoria Crystal	Dr. Jaelyn Eberle Dr. Katie Snell	Local and regional forest heterogeneity after the Cretaceous-Paleogene Boundary in the Denver Basin, Colorado, USA, and implications for the origins of rainforests.
Tyler J. Kane	Dr. Kate Campbell Dr. Alexis Templeton	Mechanisms of uranium ore passivation during in situ phosphate injections.
Alexandra Michell	Dr. Eric Small	Forest canopy and topography effects on the density, depth, and water equivalent of a snowpack.
Katherine M. Pfeiffer	Dr. Shemin Ge	Geothermal gradient and its role on induced seismicity in Raton Basin.
Kathy Robinson	Dr. Rebecca Flowers	Rutile (U-Th)/He thermochronology.
Laura K. Stamp	Dr. Paul Weimer	A depositional framework of deepwater stratigraphy in Huntington Beach Field, CA.

PhD Candidates Graduating with Degrees

Melissa Bernardino	Dr. Craig Jones	Decrypting the upper mantle seismic structure of the Sierra Nevada, CA and vicinity: Insights from Vp/Vs, anisotropy, and attenuation.
Megan R.M. Brown	Dr. Shemin Ge	Mechanisms and mitigation of injection-induced earthquakes.
Sarah E. Crump	Dr. Gifford Miller	Deconvolving climatic and non-climatic controls on Holocene glacier and ecological change on Baffin Island, Arctic Canada.
Emily Fairfax	Dr. Eric Small	Building climate resiliency in a warming world: From beaver dams to undergraduate education.
Rachel C. Glade	Dr. Robert Anderson	Hillslope evolution in block-controlled landscapes.
David J. Harning	Dr. Gifford Miller	Refining the climate, glacier, and volcanic history of Iceland during the Holocene.
Phil Orlandini	Dr. Kevin Mahan	The Cora Lake Shear Zone: A natural laboratory in the continental lower crust.
Simon Pendleton	Dr. Gifford Miller	Holocene glacier fluctuations and Quaternary ice sheet evolution on Cumberland Peninsula, Baffin Island.
Charles M. Shobe	Dr. Greg Tucker	River erosion in block-controlled landscapes.

In Memoriam

Dr. John Conrad Harms (PhD'59)

passed away peacefully at age 87 on June 26, 2018 after suffering a series of fatal strokes. He was the faithful husband of Bobbe

for 68 years, loving father of Greg (deceased), John "Buzz" (deceased) and Alison Cejka (Darrell). Also doting grandfather of 9 and great-grandfather of 21 with one more bun in the



oven. After graduating from Columbia University in New York, he served his country in the army and received his doctorate in geology from the University of Colorado. He was instrumental in the notable advances made by the Marathon Oil research group, worked as an independent consultant around the world, and continued to develop oil and gas resources and equipment until his final days. John was a prolific publisher of many papers, receiving multiple awards including the lifetime achievement award.

His many travels included Pakistan, Bangladesh, Somalia, Egypt, Yemen (where he was offered a second wife, which he politely declined), Ecuador, Peru, Scotland, Norway and even Montana. He also loved classical music, opera, southwestern art, sports, fly fishing, church, friends and a good joke. He will be dearly missed by all.

Eric William Gillespie

(BA'87) was born in Denver, Colorado on December 28, 1964 to William Howard Gillespie and Maryann (Bieniek) Gillespie, and passed away at his home in Northglenn, Colorado on November 28, 2017, one month before his 53rd birthday.



Beth Hanson, joined her husband of almost 50 years, Bruce Hanson, in the Place God prepared for them on May 9, 2019. Beth fought cancer for years but succumbed just days after the passing of Bruce. She was born in DeRidder, LA on January 31, 1941 to Ira Ellis Warren and Lora Oneta Warren (Beach). In addition to her parents, she was predeceased by her younger brother Johnny Warren, and her husband Bruce Hanson. She is survived by her brother Richard Warren (wife Rose); daughter Susan Hanson; daughter

Rebecca (Hanson) Vaughn (husband Josh) and grandchildren Calvin, Jackson, and Chloe; son Robert Hanson (wife Beth) and grandchildren Ryan, Brooke, and Warren; son Eric Hanson (wife Barbara) and grandchildren Moriah, Erica, Christian, and Marta.

Beth's family moved from Deridder to Plains, Texas in 1943. In 1949 they moved to Nucla, CO. Beth graduated from high school as valedictorian, with a National Merit Scholarship, and a four-year music scholarship to Western State College. Beth's love for reading, music, and the outdoors endured her entire life, but most of all she was guided by her deep personal faith in her Savior; a legacy from her parents that she passed to her children and grandchildren.



L-R: Gifford Miller, Bruce Hanson, Beth Hanson Chuck Stern, Mary Kraus. Beth and the Chairs that she faithfully assisted.

Beth met and married Bruce Hanson, the love of her life. It truly seems that God intended them for each other. Son Eric and daughter Rebecca entered their lives soon after. Beth was an amazing mother. During her years of single motherhood, she cared and provided for Susan and Robert, teaching them self-reliance and independence by example. It is hard to give adequate credit to Beth for her life and how she loved her family, friends, and Lord. She was an adventurer and was thrilled by traveling and being immersed in other cultures and making new friends. She and Bruce shared the hobby of photography, and never traveled without documenting their journeys. Traveling was a way of life for the first fifteen years of their marriage, and they lived in Somalia, Australia, Colorado, New Mexico, and Montana during that time, settling in Ft. Collins in 1978. No matter where she lived, her efforts created a beautiful, nurturing home for her family. Early in her life she discovered an incredible gift for cooking. Time spent traveling always resulted in a broadening of her already impressive culinary repertoire, as she incorporated other culture's foods. She seemingly effortlessly and routinely created evening meals that would have been flattering

for five-star restaurants in cities around the world, and she took real joy in entertaining her family and friends.

Beth always made efforts to reach out to the people around her in meaningful ways. Her love and commitment to God was reflected in all her relationships. Having lived away from family in foreign lands during the holidays, and having lost her brother Johnny while she lived in Somalia, there was a special place in her heart for the lonely. She befriended the elderly and international students, and was a foster parent to several youth in the 70's and 80's. Most holidays some adopted soul who would have otherwise been without family became part of ours because of her invitation.

Beth rejoined the workforce in the eighties, working at CSU Veterinary Hospital. She transferred to CU in the late eighties. She started in the Forestry Department, worked briefly in the Athletic Department, and then found her niche in the CU School of Geologic Studies, where she retired from the position of Executive Assistant to the Dean of Geology in 2007. She continued to work in that department several years following her retirement on a part-time basis.

Beth's sense of adventure endured despite challenges associated with age and health. At 76, with Bruce being 86 and on oxygen, they purchased a motor home so that they could continue to adventure and enjoy the outdoors. Beth was a force of nature – a decision made was a goal accomplished for her, no matter what hurdles stood in her way. Beth was a loving, empowering wife in response to Bruce's devotion and intentional love.

Beth is so deeply missed by her children, grandchildren, and friends. I know God was ready for Bruce and Beth to arrive, and that He must have grand plans for them, always moving "Onward and Upward". So begins the Great Adventure!

Eugene Merle Shearer (BA'48; MS'51)

Born in Kansas City, MO to parents Merle and Helen Shearer, "Gene" Shearer passed away at Littleton Hospital Sunday, September 30th at age 94 surrounded by his family. Gene is survived by his wife, C. Grace Shearer, their children; Laura Gorman, Virginia McGrane, Carol Young and Andrew Shearer as well as his eight grandchildren and six great-grandchildren. Gene and Grace celebrated their 70th wedding anniversary in March of this year and Grace's 90th Birthday just weeks ago.

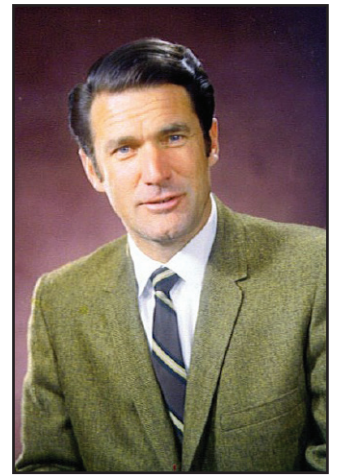
Gene was a Tech Sargent in the United States Marines during World War II. As a communications officer, he was stationed in the Marshall Islands in the South Pacific and was part of the occupying force in Tokyo and Hiroshima, Japan near the end of the war.

After the war, Gene and Grace were married in Kansas City in 1948 and made their home initially

in Boulder Canyon while Gene went to school at the University of Colorado where he lettered in gymnastics and received his undergraduate and master's degrees in geology. They moved to Denver with their first two children and he founded a geological consulting business, Knox Bergman and Shearer (KBS), in the early 1950's. KBS

was re-named Intrasearch in the 1970's and had offices in Denver and Billings, MT. The company was an innovator in aerial mapping and surface geology during the heyday of world-wide energy exploration. Gene worked on projects in Alaska, the lower 48 states, Europe, North Africa, Australia and Southeast Asia during his career. He also gave back to his industry by being a founder and active participant in the Denver Petroleum Club, The Rocky Mountain Association of Geologists (RMAG) and was on the advisory board for the University of Colorado Geology School. He was a life-long learner in his field of expertise.

Gene was versatile and accomplished in many areas of his life including a childhood background in classical violin and paying for part of his college education by playing guitar in jazz groups in Boulder and socially throughout his life with friends and colleagues in the Denver area. He was an accomplished handball player, skier, tennis player, scuba diver and private airplane pilot. Gene was an enthusiastic outdoorsman - camping, hiking, and hunting in North America and fresh and salt water fishing in many locations around the world. Gene and Grace travelled extensively and engendered a love of travel in their children.



Gerald E. Abrahms (Geol'55)
Boyd R. Brown (Geol'56)
Craig O. Canon (Geol'61)
Dean L. Christensen (Geol'57)
Don U. Deere (MGeol'49)
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Wilbur A. Smyth (Geol'53)
Leo A. Speno (Geol'55; MS'58; MD'62)
Catherine Woodburn (Geol ex'21)
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Alumni and Emeritus

Emeritus Professor William Hay receives Honorary Doctorate Degree of Kiel University's Faculty of Mathematics and Natural Sciences for his exceptionally successful commitment to the development of marine geosciences and palaeoclimatology. Congrats!



Tim Grove (BA'71) - At this year's AGU meeting in Washington DC I received the Harry H. Hess Medal of AGU. You can find the citation and my response at this url: <https://eos.org/agu-news/timothy-l-grove-receives-2018-harry-h-hess-medal>

I thought I would bring it to your attention, because I talk about the significant and positive influence that Bill Braddock had on my development as an undergraduate in CU Geology (I graduated in 1971, Phi Beta Kappa). I thought you might be interested.

Jeff Wright (BA'83) - I recently received the 2017-2018 issue of Geology News. It's inspiring to read about all the great faculty and students getting their advanced degrees and doing all the amazing science. The fact the CU Geological Sciences department is now rated the second best global university in Geosciences is a wonderful accomplishment. Congratulations!

Doug Nelson (BA'50) - Thanks for sending me "The Geology News" publication though I'm not sure I deserve it. I wanted a degree in geology but could not pass the required prerequisites so I ended up with a distributed major in geology, geography and history. However, geology and I have been very close friends since 1950. I've been looking for oil, gas and other minerals ever since. Thanks again!

Emeritus professors - Bill Bradley, Pete Birkeland, and Wes Le Masurier at a working lunch.



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