SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

Department of Geology and Geological Engineering

2019 Alumni Newsletter

Dr. Jack A. Redden

September 24, 1926 – May 20, 2019

Faculty and Staff in Geology and Geological Engineering – August 2019
Photo credit: Perry Rahn - at his cabin near Hill City

Front row (L to R) – Nuri Uzunlar, Curtis Price, Sarah Keenan, Zeynep Baran, Gokce Ustunisik, Larry Stetler, Laurie Anderson, Kurt Katzenstein, Tim Masterlark, Liangping Li and Roger Nielsen. Back row (L to R) – Foster Sawyer, Darrin Pagnac and Christopher Pellowski. Absent: Arden Davis, Sally Shelton, Bill Roggenthen, Colin Paterson, Kevin Ward, Daniel Soeder, Ed Duke, and Jim Fox. In 1994 below:

Geology and Geological Engineering Department:
Step 1: Dr. Colin Paterson
Step 2: Mrs. Pam Fenner
Step 3: Dr. J. Paul Gries, Dr. James Fox, Dr. M. Rafiq Islam
Step 4: Ms. Suzi Aadland, Dr. Alvis Lisenbee, Dr. Jack Redden
Step 5: Dr. Perry Rahn, Dr. Arden Davis, Dr. Bill Roggenthen

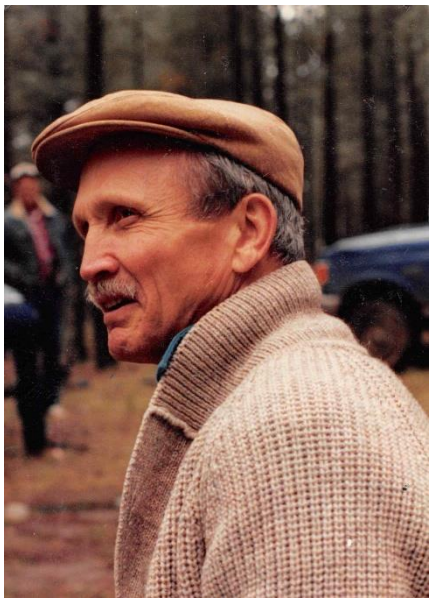
From the interim editor – Christopher Pellowski

Greetings alumni and friends! Please enjoy reading the 2019 edition of the alumni newsletter.

This newsletter is also accessible on the department's alumni newsletter webpage:

https://www.sdsmt.edu/Academics/Departments/Geology-and-Geological-Engineering/Activities-and-Organizations/Alumni-Newsletters/

Dr. Jack A. Redden passes away



Jack Redden passed away on May 20, 2019, at the age of 92. It is a safe bet that no one will ever know the Precambrian rocks of the Black Hills with the intimacy and insight that Jack did. But Jack embodied much more than intellect and a keen sense of observation: he showed us integrity, curiosity, humor, and a deep love of life. Born on a farm in Illinois, the youngest of five children, Jack later joined the Marine Corps, which launched him toward a B.A. degree from Dartmouth and a Ph.D. from Harvard. While finishing his Ph.D. work he was employed by the U.S. Geological Survey to conduct field mapping in the southern Black Hills. Despite several detours, that was the beginning of a relationship that would become Jack's passion. The detours included six years of teaching at Virginia Tech and serving five years as Dean of the newly established Wright State University (Ohio). (For those who knew him, picturing Jack as an administrator for five years is painful!) Ultimately, fate brought Jack back to the Black Hills, joining SDSM&T in 1969, where he taught until his retirement in 1991. Some of us remember Jack retiring several times – always with a grand party. Retirement #1, for example, included belly-dancing lessons. Yet it was in his post-retirement years that Jack accomplished much of his important work on a new geologic map of the Black Hills, published in 2008 with Ed Dewitt of the U.S.G.S. Of course, no geologic map was ever finished in Jack's eyes, so he continued to be sighted in his signature VW beetles on the back roads of the hills. His curiosity and enthusiasm had no bounds. In recent years, he became fascinated (obsessed?) with unusual biological or sedimentary structures in 2.1-billion-year-old rocks of the Nemo area. He was convinced that these "enigmas" represented an unrecognized early life form. He never completely convinced the experts of his interpretation, but they didn't know who they were dealing with – no doubt Jack was on to something and the experts just weren't ready for new ideas.

Many alumni will remember riding around the hills with Jack with some trepidation, whether it be in the state van or his iconic bug – the best way to get there was as fast as possible. Jack likely mapped the rocks as he was driving, on the highway or through the woods. It is said that he also read the Rapid City Journal while he drove from his home near Hill City to work at SDSM&T – he had probably done the crossword puzzle by the time he got to work! He was the forerunner of those who text while driving; of course, the roads were less congested back then. Around the geology department, he was often seen chewing on a cigar. Occasionally he would forget where he had left his cigar, but a few days later would invariably find it among the bits of chalk below the blackboard.

Perry Rahn remembers many canoeing adventures with Jack: "Jack and I canoed down many streams and rivers. Once we did the Cheyenne River below Edgemont. The discharge was low, and we scraped bottom a lot. We got back to our car around midnight. We did the Flathead River, starting at the Canadian border. Beautiful scenery along the border of Glacier Park. Lots of good fishing. His canoe upset in some rapids, but we saved everything except the coffee pot. We did the Smith River near White Sulfur Springs, Montana. Jack and I canoed Rapid Creek one summer day. We started at Hisega and made it to Canyon Lake. We had to wade through waist-high water in places. My dog followed us the whole way. There was always some excitement when you were with Jack."

Jack will also be remembered for his lifelong devotion to his wife, Harriet. They were both active in the Rapid City and Black Hills theater community, often performing together.

Understanding mortality, Jack left behind instructions to his daughters, Becky and Jill: "Things to Say at my Wake." His message to us ended with these lines:

> *Oh yes – and my advice to everyone: KEEP LAUGHING – especially at oneself – it's the elixir of life – keep it up! Never let a day pass without laughter. And if no one else should provide it, laugh at yourself. In fact, laugh at yourself first, because you are the one most likely to overlook the comedy of yourself!*
>
> "You get me?"

With contributions from Tom Loomis, Ed Duke, Colin Paterson, Bill Roggenthen, and Perry Rahn

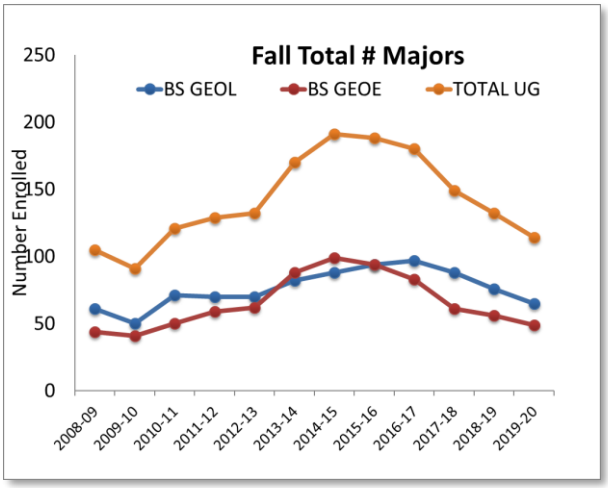
Status of the Department

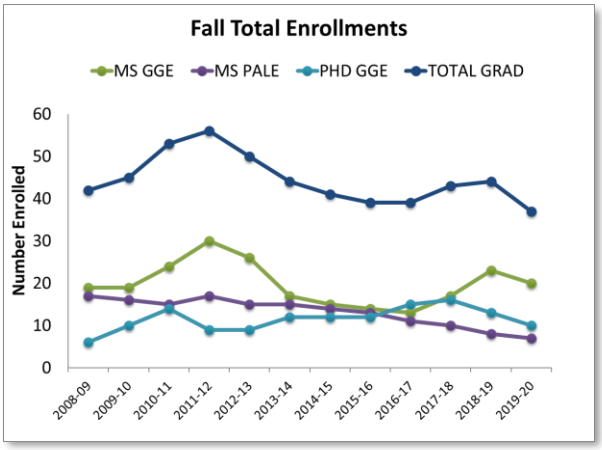
Alumni and friends, I hope your 2019 was a happy and productive one. We have had both ups and downs in the Department of Geology and Geological Engineering (GGE) this year.

We mourn the loss of Emeritus Professor Jack Redden. Jack is a legend on campus and for anyone doing geology in the Black Hills. We also lost a graduate student, Houston Wagner, this fall. Houston was working with Zeynep Baran with anticipation of completing his thesis in May. We mourn these losses in our department family.

We have a new Assistant Director in the Museum of Geology. Emily Berry joined the Museum this spring, has a bachelor's degree from Colby College, and brings with her experience as a middle school teacher at Little Wound School in Kyle, South Dakota. In addition, Kayleigh Johnson joined us this year as the vertebrate preparator and lab manager of the PRL. Kayleigh holds a BS in Geology and MS in Paleontology from SD Mines. Both Emily and Kayleigh are doing great things to build connections with both the university and with the larger Rapid City community. The Museum is also undergoing an accreditation review through the American Alliance of Museum this year.

The number of undergraduate majors declined slightly in 2019-20, although the number of B.S. degrees awarded remains strong (40 graduated in 2018-19). We currently have 114 GEOL and GEOE majors. In our graduate programs, enrollment overall is down slightly (currently 37), while seeing 12 degree completions in 2018-19 (7 MS GGE, 3 MS PALE, and 2 PhD students).

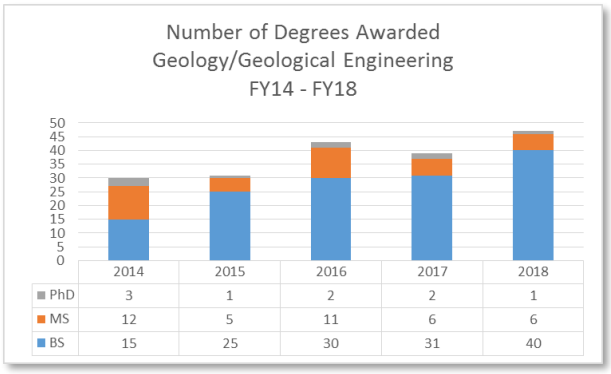




Career placement of our undergraduates is strengthening. In 2017-18 (the latest numbers available), GEOE had 100% placement and GEOL had 86% placement. This fall we had 33 companies and agencies recruiting our students at the Fall Career Fair (15 in 2015, and 24 in 2016, 29 in 2017, and 31 in 2018).

We are working to increase the visibility of our excellent programs and students. If you are on Facebook, please check out the series "This Week in Lab…" that highlights what our students do in our classes. We also are working with the President's Office and the SD Mines Foundation on securing state support and donor contributions to construct a new MI building. We also are working on building a new field camp facility in the northern Black Hills. **We welcome any assistance that alumni and industry partners can provide in promoting SD Mines, GGE, and our students!**

We continue to strive to build our research programs in the department. Research awards help support both undergraduate and graduate students and provide them opportunities for research experiences in the field and laboratory. Please check out faculty entries to see the great things they and their students are up to.



	2014	2015	2016	2017	2018
PhD	3	1	2	2	1
MS	12	5	11	6	6
BS	15	25	30	31	40

We would like to acknowledge the gifts we received for the Department or the Museum of Geology. In Fiscal Year 2019, we received $280,425, for additions to existing endowments. In addition, we received $258,478 in unendowed gifts to the department and $75,707 to the Museum of Geology. Most of the funds for the Museum were provided by a gift from alumna Rachel Benton to support National Park Service Collections. Rachel's gift supported five undergraduate interns in summer 2019 as well as a Research Assistant and student worker in 2019-20. We are very excited to have the opportunity to rehouse, care for and catalog these important collections and also train students in current collections care practices.

We thank all friends, alumni, and corporate partners for your generous support of our students and programs. For 2019-20 we are provided 34 undergraduates with departmental scholarships and 13 graduate students with departmental fellowships. We also helped support travel expenses for students to attend professional meetings, co-sponsored (with the Field Station) the department's fall trip (this year to Yellowstone), hosted guest speakers from industry, government and academia on campus, and provided funds for new faculty to build their research and teaching programs. **I hope you will think of us as part of your charitable giving plan now and in future years**. I would be happy to chat with you about the department's needs and goals at any time.

Finally, all the best to you for the New Year.

Laurie Anderson News

This year is a bit unusual for me, as I have taken on additional administrative duties for fiscal year 2020. I am serving as Interim Head of Mining Engineering and Management while Lance Roberts serves as Interim Provost and Vice President of Academic Affairs. It has been great to get to know and work with another group of faculty in the MI building. Those activities, however, have cut into my research, especially this fall, when I'm teaching three classes.

That said, with collaborators and students, I published one paper on the Eocene-Oligocene boundary transition in the southeastern US (based on work done when I was at LSU), another on endosymbiosis in lucinid bivalves (part of a collaborative Dimensions of Biodiversity grant from NSF), and a number of abstracts. We also closed-out our collections grant to catalog invertebrate collections in the Museum of Geology. In our five years of support we digitized 889,796 specimens, provided research assistants to 8 graduate students, and trained 13 undergraduate student workers. These collections were used in college classes in paleontology at Texas A&M University and SD

Mines, in museum curation courses at SD Mines, and in a museum exhibit design course at SD Mines. Collections also have been used in one MS thesis and three senior theses at SD Mines. An overview of the project, written by Kayleigh Johnson, is available on the Museum's blog "Transforming Time into Space" (https://mogcollections.wordpress.com/).

2019 GGE Department news:

January:

Dr. Darrin Pagnac - STEAM Café and Research@Mines: Dinosaurs: A Catalyst for Critical Thought
https://www.sdsmt.edu/News/SD-Mines,-SDPB-and-Hay-Camp-Brewing-Company--Present-STEAM-Caf%c3%a9/

https://www.sdsmt.edu/Research/?month=1&year=2019

Dr. Darrin Pagnac - SD Public Radio interview and KEVN article
https://listen.sdpb.org/post/dinosaurs-catalyst-critical-thought

https://www.blackhillsfox.com/content/news/Dinosaurs-used-to-develop-critical-thinking-504407591.html

Dr. Kurt Katzenstein – Missouri River water for Rapid City? Study is underway
https://rapidcityjournal.com/news/local/missouri-river-water-for-rapid-city-study-is-underway/article_002e2e9c-9dc6-545b-a790-23ce80456c33.html?utm_medium=social&utm_source=facebook&utm_campaign=user-share

Museum of Geology invites public to bring in rocks, minerals or fossils for identification
https://www.sdsmt.edu/News/Museum-of-Geology-Invites-Public-to-Bring-in-Rocks,-Minerals-or-Fossils-for-Identification/

March:

Dr. Kevin Ward – Research@Mines: SD Mines Seismometer Upgrade Allows Geologists to Detect Earthquakes Around the World
https://www.sdsmt.edu/Research/Research@Mines/SD-Mines-Seismometer-Upgrade/

April:

Mr. Daniel Soeder – Research@Mines: Finding the Flame in the Flaming Fountain
https://www.sdsmt.edu/Research/Research@Mines/Finding-the-Flame-in-the-Flaming-Fountain/

https://www.usnews.com/news/best-states/south-dakota/articles/2019-10-05/flaming-fountain-at-south-dakotas-capitol-needs-repairs

August:

Mr. Daniel Soeder – Research@Mines: SD Mines' Energy Resources Initiative publishes new book "The Fossil Fuel Revolution"
https://www.sdsmt.edu/Research/Research@Mines/New-Book-%e2%80%9cThe-Fossil-Fuel-Revolution%e2%80%9d/#.XWk8zXtMGgo

Mr. Kenny Brown – Retired, lifelong rancher pursues his passion of paleontology
https://www.blackhillsfox.com/content/news/514739101.html

July:

Ms. Kayleigh Johnson - Forest Service, School of Mines Collaborate on Passport in Time
https://listen.sdpb.org/post/forest-service-school-mines-collaberate-passport-time

September:

Dr. Kevin Ward – Research@Mines: Monitoring the Deep-Arrays of Seismometers Give Geoscientists New Insights into Earthquakes and Volcanic Eruptions
https://www.sdsmt.edu/Research/Research@Mines/Seismometer-Research/

October:

Dr. Sarah Keenan – STEAM Café: Life After Death: Ecological Impacts of Animal Decomposition
https://www.sdsmt.edu/News/Fall-2019-STEAM-Cafe/

Dr. Sarah Keenan – SD Public Radio interview
https://listen.sdpb.org/post/steam-cafe-life-after-death

Ms. Sally Shelton – Research@Mines: Buffalo Bones Return to the Black Hills to be Preserved for Study
https://www.sdsmt.edu/Research/Research@Mines/Buffalo-Bones-Return-to-the-Black-Hills/#.XbdPMdVMHV8

Ms. Sally Shelton – School of Mines gets a new collection of old bones
https://www.blackhillsfox.com/content/news/School-of-Mines-gets-a-new-collection-of-old-bones-563724281.html

Dr. Tim Masterlark: Colorful sunsets and powerful volcanoes – the link between geology and weather
https://www.newscenter1.tv/colorful-sunsets-and-powerful-volcanoes-the-link-between-geology-and-weather/

Mr. Daniel Soeder and Dr. Scyller Borglum (PhD GeolE 18): Discussion held at SDSM&T on a book co-authored by a South Dakota politician
https://www.blackhillsfox.com/content/news/Discussion-held-at-SDSMT-on-a-book-co-authored-by-a-South-Dakota-politician--564076851.html

Mr. Daniel Soeder and Ms. Heidi Sieverding (MS GeolE 01): CO_2 Research at SDSM&T
https://listen.sdpb.org/post/co2-research-sdsmt

November:

Dr. Kurt Katzenstein – Missouri River pipeline to Rapid City could cost as much as $1.87 billion, study says
https://rapidcityjournal.com/news/local/missouri-river-pipeline-to-rapid-city-could-cost-as-much/article_7ea8076f-233f-598a-a468-a6bd4b55c980.html

Scholarships help change lives…

The Fall 2019 entering freshman class of 474 includes 29 GGE students. Many of these students indicated that they chose our program because they value a hands-on education and they are excited to study geology in the Black Hills region. Several also attended either the Geology Rocks or Fossils youth camps.

The institution recently moved to a new scholarship model whereby qualified students are guaranteed scholarships all four years of their career with the institution picking up the cost for the first two years and the departments continuing the scholarships for the final two years. We feel that this is a good model. However, as a large portion of our continuing student scholarship funds are now earmarked to fund continuing scholarships established during a student's freshman year, we now have limited funds to provide scholarships to transfer students and students who establish themselves as strong students after arriving here. As such, we are always in need of additional scholarship funds.

Every scholarship has a story behind it (video for the Foundation's 2019 scholarship drive).

https://www.youtube.com/watch?v=JDyyKCSdsOE

SD Mines Foundation – ways to give

https://foundation.sdsmt.edu/giving/donate-now

Christopher Pellowski

It was a slightly different year at Ranch A with only one five-week session being offered this past summer. We had a decline in the number of students who applied and consolidated them into one session. During this session, we had 15 students from 12 universities. The weather this year was fairly wet with numerous storms passing through each week and this certainly made for some hot and humid days in the field.

Session 2, 2019 group photo at Ranch A

I met Dr. Jack Redden my first year as a graduate student and learned about his research regarding the idea of Precambrian life forms. I was able to assist him in picking out a flatbed scanner that we could use to scan the wetted samples that were cut with the large Hillquist rock saw. I was absolutely amazed at how fast one person could single-handedly wear out a diamond rock saw blade. After printing off the scans, Jack would begin drawing outlines of his enigmas on the printed images and showing them to me doing his best to convince me of their existence.

I fondly recall going on a field trip with him to collect some of those samples. After a white-knuckled ride to the outcrop in his VW Beetle, I got out to put on my field belt and backpack only to answer to his call of what on Earth was taking so long as he was already half-way up the hillside. I thought this was quite impressive for a guy who is 75 years old, or 40 years my senior, as I nearly struggled at times just to keep up with him.

It was an honor when Jack reviewed the draft version of the 7.5-minute Hermosa geologic quadrangle that I co-authored with Dr. Alvis Lisenbee as he had left behind a cigar stain on the map, essentially baptizing it, to signify his approval.

Finally, I feel very privileged to have had the various opportunities to be on the outcrop with a geologist like Jack as he passionately shared his knowledge of Black Hills geology with all of us as shown in the photo below.

Dr. Jack Redden providing an overview of the geologic history for the Black Hills at the 2010 GSA Rocky Mountain regional meeting field trip.

I taught the Geol 351 Earth Resources and the Environment class in the spring semester with 23 students enrolled. The class was made up of mostly geology students along with a few students from Civil and Environmental Engineering, Materials and Metallurgical Engineering and Mining Engineering and Management. The students enjoyed a visit from District 32 Representative Dr. Scyller Borglum (PhD GeolE 18) on the importance of engaging future engineers and scientists to address the issues regarding Earth's resources and society. This year I am serving on five department committees and will be teaching Geol 451 Economic Geology during the Spring 2020 semester with three students already signed up.

Educational outreach activities this year have included participating in the Rapid City Area Schools (RCAS) District STEAM nights with a recent visit to the Horace Mann Elementary School in addition to the RCAS 8th Grade College and Career Exploration Fair to get students thinking about a future career in a STEM field.

Dr. Pellowski visiting with students about minerals that are part of their everyday life at the RCAS 8th Grade College and Career Exploration Fair held at Western Dakota Technical Institute.

The GGE Department is beginning to use social media as a recruiting tool to attract the interest of prospective students. I created the series of Facebook posts called "This week in lab…" in conjunction with the faculty and University Marketing and Communications as a way to provide an inside look at the different field-related and hands-on activities our majors engage in each week.

Another idea that we have is to recruit assistance from our alumni, particularly those who have graduated in the last five to 10 years, by providing a 30-second video or a photograph of you with an explanation of 50 words or less on the greatest impact a degree from SD Mines has made on your career that we could either share or post to our social media. Please feel free to send the videos, links or photographs with text to me to be posted for future recruiting efforts. We welcome any thoughts/suggestions you have on how to further develop our recruitment efforts.

Be sure to visit and like us on Facebook and follow our posts.

LIKE US ON facebook

https://www.facebook.com/SDSMTGeologyGeologicalEngineering

Dan Soeder, Energy Resources Initiative

The Energy Resources Initiative (ERI) continues to grow at SD Mines, moving into focused research areas that range from potential oil and gas resources in South Dakota to international studies with the Chinese Academy of Sciences on carbon dioxide sequestration in the subsurface. The first ERI graduate RA, Dr. Scyller Borglum, has been serving in the South Dakota state legislature as a Representative from Rapid City, and is a candidate for the United States Senate. The current ERI graduate RA, Ms. Disha Gupta, has been investigating the petroleum potential of the Pierre Shale for her thesis research.

A new textbook was released by Elsevier on August 16, 2019 called The Fossil Fuel Revolution: Shale Gas and Tight Oil by Daniel J. Soeder and Scyller J. Borglum. The hope for this book is to become a standard reference on the geology and production engineering of unconventional oil and gas resources.

(https://www.elsevier.com/books/the-fossil-fuel-revolution/soeder/978-0-12-815397-0)

Publications such as this are raising the visibility of the ERI and SD Mines world-wide. Writing is in progress on a new book titled "Fracking and the Environment" to be published by Springer in 2020.

The Pierre Shale is a Late Cretaceous deposit in the Western Interior Seaway that occurs across most of South Dakota. Some parts of the formation are rich in organic material, but because it is often present at shallow depths, including surface outcrops near the Black Hills and along the Missouri River, the thermal maturity is thought by many to be too low for the shale to have generated significant oil. Nevertheless, oil is commonly observed when drilling through this unit, and the source of this oil has been an interesting question. Total organic carbon is greater than 6% by volume in parts of the Pierre Shale, and the material consists largely of Type II kerogen, which is oil prone. With support from the ERI, GGE graduate student Disha Gupta is investigating the Pierre Shale for her thesis research using a type of pyrolysis called Source Rock Analysis to determine organic content and thermal maturity, along with vitrinite reflectance to obtain a second measure of thermal maturity. These data should help to define if oil in the Pierre Shale is self-sourced.

Several representatives from the South Dakota state legislature have heard about this investigation and approached us for information concerning the petroleum potential of the Pierre Shale. A resolution to fund some of this research is expected to be introduced during the next legislative session.

The Petrophysical Engineering and Research Laboratory (PEARL) is envisioned as a state-of-the-art facility to study unconventional and conventional hydrocarbon-producing reservoirs. Construction is underway on a high-precision, steady-state permeameter for the investigation of net stress response, hysteresis, threshold pressures, and multi-phase fluid interactions in ultra-low permeability rocks like shale. The goal is to use the PEARL in combination with existing

instruments at SD Mines, such as the transmission electron microscope, scanning electron microscope, rock mechanics presses, and the GCTS triaxial test system to develop an overall institutional capacity for characterizing tight rocks. This has applications to shale gas and tight oil, enhanced geothermal systems, geologic sequestration of carbon dioxide, and for the isolation of chemical and nuclear waste.

The ERI was in the local news last spring for our evaluation of the "Flaming Fountain" veterans' memorial in Pierre adjacent to the State Capitol building. The memorial is built around an uncapped, free-flowing well drilled into the Dakota aquifer back in 1910 to provide gas and warm water to light and heat the Capitol building and a number of state government facilities in Pierre. Because of corrosion problems and a gas leak, the well was uncapped in the 1960s and allowed to flow freely into Capitol Lake, becoming the Flaming Fountain when the Capitol groundskeeper flared off the remaining gas. By 2008, the fountain would no longer sustain a flame, and the State Engineer asked us to help evaluate the situation. Construction of a methane sensor for monitoring groundwater near shale gas wells had just been completed in the ERI lab and it needed to be tested. Since there was likely some methane still coming to the surface at the Flaming Fountain, the detector was used to monitor the concentration of natural gas for several months at no cost to the state. The data showed that dissolved methane is being brought to the surface in the groundwater, but the levels are far too low to sustain a flame. The Flaming Fountain will flame no more. We recommended that this century-old well be properly plugged and that a new memorial be constructed at the site using commercial natural gas for a flame and water pumped from the lake.

Because of the research and publications of the ERI, SD Mines has the opportunity to step onto the world stage as a go-to resource for technical advice related to shale gas. Dan Soeder gave an invited keynote address on "Shale gas and tight oil potential in China and lessons from the U.S." at the International Young Scholars Forum on Physics and Chemistry in Geomaterials convened in Wuhan, China by the Chinese Academy of Sciences in April 2019. The ERI is working with Dr. Liwei Zhang of the Chinese Academy to develop a joint U.S.-China program for investigating the injection of CO2 into shale to improve the recovery efficiency of natural gas, manage reservoir pressures, and sequester CO2 from the atmosphere. The objective is to perform laboratory tests and numerical modeling that culminates in a field demonstration on a Chinese gas shale.

Another program development effort underway is in response to interest from the Rosebud Economic Development Corp. (REDCO) for using local energy resources at a new housing development planned on the Rosebud Reservation. Geothermal water from the Dakota aquifer is available here for deep direct use heating, and natural gas from the overlying Niobrara Formation could provide electricity for emergencies, or even for everyday use if abundant enough. The tribe is seeking funding from DOE to characterize and test these resources, with the ERI and GGE faculty engaged as technical advisors.

PUBLICATIONS

Hannon, Michael J., Jr., Tarlovsky Tucker, Yael, and Soeder, Daniel J., 2019, Quantifying the effects of gaseous pore pressure and net confining stress on low-permeability cores using the "RaSSCAL" steady-state permeameter: *Journal of Petroleum Science and Engineering*, v. 179, p. 1136-1150

Soeder, Daniel J. and Borglum, Scyller J., 2019, The Fossil Fuel Revolution: Shale Gas and Tight Oil: Elsevier Publishing, Cambridge, MA, 336 p.

PRESENTATIONS

Groundwater Quality and Hydraulic Fracturing: Current Understanding and Science Needs: National Ground Water Association Summit and Exhibition, Las Vegas, Nevada, December 3-6, 2018.

Fracking and Stray Gas in Groundwater: It's Complicated: Western SD Hydrology Conference, Rapid City, SD, April 11, 2019

Understanding the environmental impacts of tight oil and shale gas development, Saskatchewan Geological Society, Regina, SK, April 17, 2019.

Shale gas and tight oil potential in China and lessons from the U.S.: International Young Scholars Forum on Physics and Chemistry in Geomaterials, Chinese Academy of Sciences, Wuhan, China, April 28, 2019.

Environmental risk assessment of shale development in the U.S.: Responsible Development of Low-Permeability Hydrocarbon Resources (ReDeveLoP), University of Calgary, Calgary, AB, May 28-30, 2019.

Off the Grid: Developing resilient energy infrastructure from indigenous resources: Hawaii University International Conferences on STEM/STEAM and Education, Honolulu, HI, June 5-7, 2019.

Natural Gas in Groundwater: The Story of South Dakota's Flaming Fountain: Geological Society of America Annual Meeting, Phoenix, AZ, September 24, 2019

Adapting a Laboratory Methane Sensor for Field Monitoring: American Geophysical Union Fall Meeting, San Francisco, CA, December 9-13, 2019.

2020 upcoming presentations:

Dan Soeder: The Fossil Fuel Revolution, Fracking and the Environment: 36th International Geological Congress, Delhi, India, March 2-8, 2020.

Disha Gupta: Assessment of Tight Oil in Pierre Shale of South Dakota: 36th International Geological Congress, Delhi, India, March 2-8, 2020.

SD Mines students emplacing the methane sensor in Pierre at the Flaming Fountain Memorial in April 2019

Dan Soeder presenting a talk on “Shale gas and tight oil potential in China and lessons from the U.S.” at a Chinese Academy of Sciences seminar in Wuhan, China, April 2019.

From our Emeritus Professors:

Arden D. Davis
Professor Emeritus of Geological Engineering

One of the projects I worked on during the past year is a proposed water pipeline from the Missouri River to the Black Hills area. Dr. Kurt Katzenstein was the principal investigator, and Dr. Scott Kenner and I assisted, with help and guidance from Mark Anderson of the U.S. Geological Survey. Two geological engineering undergraduate students and a civil engineering graduate student also worked with us. The late Dr. Alvis Lisenbee originally was a member of the research group. Syed Huq (M.S. GEOE) provided invaluable advice about the Mni Wiconi water pipeline distribution network.

Our group completed the pipeline research work in early December, with funding from a grant by the West Dakota Water Development District. We looked at future water needs for the Rapid City area and western Pennington County, and compared these projected needs to available supplies from surface water and groundwater in the Black Hills. The West Dakota Water Development District and the City of Rapid City hold future-use permits for water from the Missouri River, so we considered potential routes and engineering options for a pipeline to western Pennington County. Although the water might not be needed immediately if the area enjoys average to above-average precipitation in coming years, we could face a water shortage in the future if a severe and prolonged drought occurs. To paraphrase something Dr. Gries once said, I might be "the most surprised guy in town" if we don't have a few droughts along the way. Because large infrastructure projects such as this could have a lead time of decades, it's not too early to start planning now. One of the engineering options is a three-foot diameter pipeline for the allotment of 10,000 acre-feet/year for the West Dakota Water Development District. A second option considered a six-foot diameter pipeline for the combined allotment of 76,000 acre-feet/year for Rapid City and the West Dakota Water Development District. The development costs could range from more than half a billion dollars, for the smaller pipeline, to about $1.9 billion dollars for the larger option, so the project would need federal and state assistance.

In mid to late May, I taught a three-credit environmental field camp course through the Black Hills Natural Sciences Field Station. This year, Mark Anderson joined in teaching the class. Mark recently retired as director of the Rapid City office of the U.S. Geological Survey, which is now called the Dakota Water Science Center. He also has served on the President's Science Advisory Council under President Clinton and President Bush, so his expertise in water added an extra dimension to the course and made it a rewarding experience for us. Mark and I hope to expand the environmental / groundwater field camp to a variable three to four credit option, with additional emphasis on groundwater sustainability. This year we had students from Colorado State University, Earlham College, the University of Nebraska-Omaha, and the University of Mississippi. In past years, students have attended from Harvard, Brown, Rutgers, the University of California-Berkeley, Radford, the University of Minnesota, the University of Wisconsin-Milwaukee, North Dakota State University, Kansas State University, the University of Arizona, Rice University, the University of North Carolina, Denison University, Portland State, Appalachian State, Whitman College, and other schools. Below are two photos of Cascade Falls, at one of our field camp project sites, taken by Dr. Liangping Li when he joined us during most of our field visits two years ago.

During the past year I've continued to work with CalxAqua, a company that several faculty members at SDSMT formed as a commercial entity for removal of arsenic and heavy metals from water. The methods we've developed are especially effective for removing lead and cadmium, in addition to arsenic and some other contaminants. Our most recent work involves development of treatment facilities for removing fluoride and selenium from mine water. These two contaminants have been a challenge, and although the methods haven't achieved the > 99% removal that we've seen with lead and cadmium, there are some geochemical similarities. In the case of fluoride ion removal, we believe that a calcium fluoride precipitate could be forming. Selenium is next to arsenic in the periodic table and shares some characteristics. Both are oxyanions. Dissolved arsenic can occur as in reduced form as arsenite ion, As(III), or oxidized as arsenate, As(V). Dissolved selenium can occur in reduced form as selenite ion, Se(IV), or oxidized as selenate, Se(VI), as well as other species. During arsenic removal, we believe a hydrated calcium arsenate is precipitating. During selenium removal, it seems possible that a form of calcium selanate is precipitating.

Some of the other owners of CalxAqua include Dr. David Dixon (Chemical Engineering), Dr. Cathleen Webb (formerly in the Chemistry Department, now Department Head and Associate Dean at Western Kentucky University), and Dr. Jenifer Sorensen (Minnesota Department of Natural Resources).

After retirement, I'm continuing to share an office with Perry Rahn in MI 327B. Perry and I have had some interesting discussions on radon, tritium, groundwater velocities in the Inyan Kara aquifer, slope stability, and fluctuations of spring discharge in areas affected by groundwater pumping. We continue to do some consulting work.

It has been enjoyable to work with Dr. Liangping Li, who now teaches groundwater in the geological engineering program. I've edited some papers we've worked on and given some guest lectures in his courses. I also served as a reviewer during the past year for the journal of *Environmental Earth Sciences* and the journal of *Water, Air, and Soil Pollution.*

As we like to do each summer, my wife and I spent about 2 ½ months at our farmstead in Minnesota. Before leaving in late August we were able to eat some early sweet corn, later-maturing sweet corn, green beans, and potatoes from the garden.

It was pleasant to visit with graduates and Professional Advisory Board members recently, including Jeanne Goodman, Janet Carter, Barb Nielsen, Stuart Buchholz, Richard Arnold, Ray Wuolo, David Hammond, Sherwin Artus, Steve O'Rourke, Bill Siok, Andy Farke, Syed Huq, Roberta (Fivecoate) Hudson, Joe Peterlin, Kathleen Grigg, Joshua Valder, Bill Eldridge, Kyle Davis, Jenifer Sorensen, Scott Letasi, Renel Hall-Beck, Cathy Hayes-Daly, Chance Costello, Erik Smith, Jonathan McKaskey, Karl Koth, Kathryn Johnson, Brad Stock, Matt Minnick, Jennifer Bednar, Mike Wiles, Steve Mezger, Bruce Peterman, Heidi Sieverding, Jim Sanovia, Patrick Kozak, Greg Kipp, Haile Betemariam, Mitch Kannenberg, Crystal Hocking, Kristin Pratscher, Bruce Woodhouse, Joyce Fry, Mike Buswell, Halim Mutlu, Zuhair Hafi, Dave Kyllonen, Jeff Sussman, Todd Anderson, Fleford Redoloza, Carson Reimers, Frank Torvik, Colton Medler, Greg Goeser, and many others – my apologies if I've left off anyone's name. Please stop by and visit if you're in the area.

Cascade Falls in the southern Black Hills, about one mile downstream from Cascade Springs. Photo by Dr. Liangping Li.

Students checking the 70° F temperature of Cascade Creek after taking pH measurements. Photo by Dr. Liangping Li. Calcareous tufa precipitates as the water loses CO_2 and the pH increases.

Colin Paterson

Becci and I spent December through April in Te Anau, Fiordland National Park, New Zealand, and spent much of our time biking, hiking, and backpacking, including a 2-week volunteer ranger program protecting the endangered yellow-eyed penguins (hoiho) at Nugget Point on the south coast. The penguins are threatened not only by predators and migration of their food source as ocean temperatures warm, but also by tourists clamoring to view them.

The **Society of Economic Geologists student chapter**, headed by Noah Casey, is still active in the department with about 10-15 members involved in monthly meetings and field trips. Four students (sophomore to graduate) went on the SEG-sponsored trip to the northern Black Hills looking at roadside outcrops of several types of ore deposits. Dr Kelli McCormick (Mining) and I as faculty advisors are still struggling to maintain interest by the department students in the SEG student chapter, but do appreciate the undergraduate students who have stepped up to serve as officers. We were saddened to lose one of our former treasurers and graduate student, **Houston Wagner**, who passed away in November, just a few weeks after participating in our SEG field trip. He was a likeable, humorous, and smart student, who was just embarking on a funded research project with an exploration company, and his passing affected all of us in the department.

In November, I and Kathleen Christopherson, Alvis's partner, helped prepare and lead the **Dr Alvis Lisenbee Legacy Fundraiser** event to support geological displays in the Journey Museum as well as student scholarships. It was held at the Journey Museum on a Friday evening, and drew a large audience of faculty, students, and community members who were invited to take home any minerals, rocks, books, maps, etc. that Alvis had collected through his career, in return for an optional donation. Its success was measured in the considerable funds collected, and the small amount of materials remaining at the end of the evening!

SEG Student Chapter group at the park by the Homestake Open Cut, Lead. Houston Wagner is second from left.

From the Faculty:

Dr. Zeynep Baran

Dear Alumni, Faculty, and Students,

First, I wish you and your family a happy holiday season, a Merry Christmas and a wonderful new year. I hope 2020 comes with all the best for you and your family! This passing year, I was busy with teaching structural geology in Spring 2019 and Geology of Nevada (graduate-level seminar) in Fall 2019, while working on ongoing research projects at the same time. Interactions with students from our Geology, Geological Engineering and Mining Engineering programs in Structural Geology class was pretty good and very enjoyable with help of incorporation of new demonstrations, experiments, and teaching tools in my class.

I arranged a field trip for my Geology of NV class and visited 3 states in 3 days with attending students. We visited Bare Mountain Core Complex around Beatty, NV and had a research meeting with Coeur Mining geologists to discuss fascinating geology out there.

In Bare Mountain region, we visited 4 mining sites with different geologic settings at each location. We discussed how gold mineralization has been controlled by different types of structures at each mine. It was a great and enlightening discussion with Coeur mining researchers who provided important information about regional geology and helped us get access to safe parts of each site.

One of the stops had gold mineralization within Proterozoic-Paleozoic metasedimentary rocks of the footwall block of Fluorspar Canyon Detachment. The second type was hosted within synextensional volcanosedimentary units in the

hanging wall of the detachment fault. Our last stop had thrust fault-controlled gold mineralization and younger extensional/transtensional high-angle faults with kinematic indicators.

We made another stop at one of the Quaternary cinder cones of southern Nevada volcanic field. Students had a chance to climb up to the top of one of the cinder cones and during the first day, they observed Proterozoic to Quaternary metasedimentary, volcanic, and volcanosedimentary rocks within such a unique and complex tectonic setting where earlier compressional structures are overprinted by later extensional and strike-slip tectonics.

We spent our second day in the Death Valley National Park, CA and made stops at must-see locations (Zabriskie point, Artist's drive, Badwater basin, Devil's Golf Course, Mesquite Sand Dunes etc.) within the park. Before and after this field trip, we read peer-reviewed journal articles about the region and students had the opportunity to observe some structures and rocks that they have been mentioned in those papers.

It was exciting for students to be in Badwater Basin which as presently at the elevation of 279 feet (~85 m) below the sea level. Borax samples in Devil's golf course also sparked some interest and we had discussion about formation of those minerals in the region and geologic history of the Death Valley and surrounding uplifted mountain blocks. Furnace Creek visitor center had great displays and exhibition of the park's geologic features.

One of our stops, Artist's drive where Miocene volcanic-intercalated sedimentary rocks display beautiful ink, green, purple and blue colors due to oxidation of different metals.

In the evening of our second day, we drove back to Las Vegas, NV for our Grand Canyon tour. We visited Grand Canyon National Park and walked along the South Rim Trail of Time which depicts rock types and 2 billion year of geologic history.

After successful completion of another MS thesis by my MS student Cody Stock in Spring 2019, I have received 2-year extension on available research funds for my Nevada project supported by Coeur mining. I recruited a new MS GEOL student Mathew Weinberger who joined our department in August and came all the way from warm and nice Florida (yes, when he applied for our graduate program, I mentioned it gets cold here in SD!). He and Jessica Fabin, GEOL undergraduate student will be working on this project and their field work is now being scheduled for the new year.

My other two students, Laura Rochlitz and Devin Last continue their thesis work and they are getting prepared for their proposal and defense exams. Devin is very interested in Petroleum research and his thesis project focuses on deformation structures and their structural analysis based on available well log data from Piceance Basin – Douglas Creek Arch. Along three major traverses in different directions, he will correlate well logs to document any significant deformation structure and its place in tectonic framework.

Laura will be working on available thin section sets from Menderes core complex and Ruby Mountain complex to document major deformation mechanisms and structures playing important role on formation and exhumation of core complexes. This project will help us better understand rheology of the crust, types of deformation mechanisms and structures forming in highly-extending terrains with different stretching factors and geologic backgrounds.

I also continued our collaboration with another industry research partner, the Vice president of Exploration Dr. Robert Brozdowski from Mineral Mountain Resources and collected valuable new data and a new sample set from older drillings. I have submitted a research proposal to this company to support another MS thesis. This proposal was written and submitted with the intention to support my MS student Houston Wagner's thesis work. However, we all got shocked with sudden loss of Houston on November 11. We will always remember him as a kind, respectful and hardworking colleague.

Another research collaboration and collaborative proposal submission with Dr. Lisa Rebenitsch from Computer Science and Engineering were done over Summer and Fall 2019. This project focuses on application of virtual reality technology in geology for teaching and research purposes. It is very important that geoscience society is seeking out solutions and accommodations to increase participation of disabled people and this type of research projects can help us make significant contribution to accessibility issues in geosciences applications.

I have submitted a new manuscript to Tectonophysics and another one to GSA Special issue (by invitation). Both papers will have my MS students as the first authors and I will be contributing, second author. Two more papers are currently under revision for submission after the new year. I am optimistic about 2020 that it will be much better and more productive year for all of us.

Other than work, we are excited to welcome a new year and having a blessed holiday season with our son, Altan. He is now 4 years old and continue his fast and healthy growth. We had a chance to visit family members after 5 years and introduced Altan first time to our big families in Turkey during this summer. It was a lot of fun, lots of delicious Turkish food, and a lot of good memories! I also had an opportunity to visit Aegean region which was subject of my PhD dissertation and collected some new rock samples to continue my research on core complexes. I believe it will be interesting experience to look at those rocks again after gaining much more experience in that special area.

I currently enjoy being a volunteer at one of nonprofit organizations in town and spending my spare time with my family. I feel lucky to have my beautiful family and to be a member of a larger family, SDSMT. I wish you and your family as a part of our SDSMT family have a very happy New Year and Merry Christmas. Zeynep Baran

Dr. Kurt Katzenstein

I hope you had a great 2019. The Katzenstein family enjoyed another great year. Our two older daughters, Brianne (9) and Hannah (7), enjoyed playing both soccer and basketball this year on both recreational and tournament (traveling) teams. Our youngest, Leslie (5), started kindergarten this year and is looking forward to playing sports this summer. As usual, I joined my father and a few family friends for a backpacking trip in the Sierras in July. I was even able to convince Colin Paterson to join us this time! We had an enjoyable low-key trip and saw many beautiful waterfalls in northern Yosemite.

Mt. Roosevelt, Black Hills

Hanging with dad on his birthday.

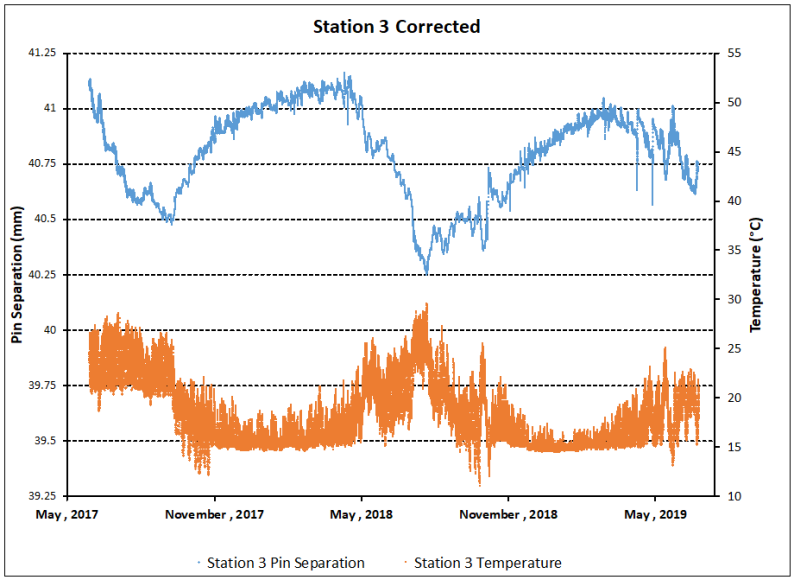
Mt. Conness from the Young Lakes in the Sierra Nevada

Once again, I led the Geology Rocks youth camp and I was able to convince Dr. Ward to join me this year, thanks Kevin! We had a great group of 20 enthusiastic high school students and we only had to endure one nickel-sized hailstorm which was generous enough to hold off until about 5 minutes after we got camp set up at Sheridan Lake! I participated in numerous outreach events including utilizing the sediment flume to teach every 2nd – 5th grade student at St. Elizabeth Seton Elementary School about stream channel evolution, and other events at Central, Stevens, and Sturgis high schools, as well as events on campus such as Go to Mines, Engineer's Week, Women in Science and Engineering, etc.

In Badlands National Park with Geology Rocks!

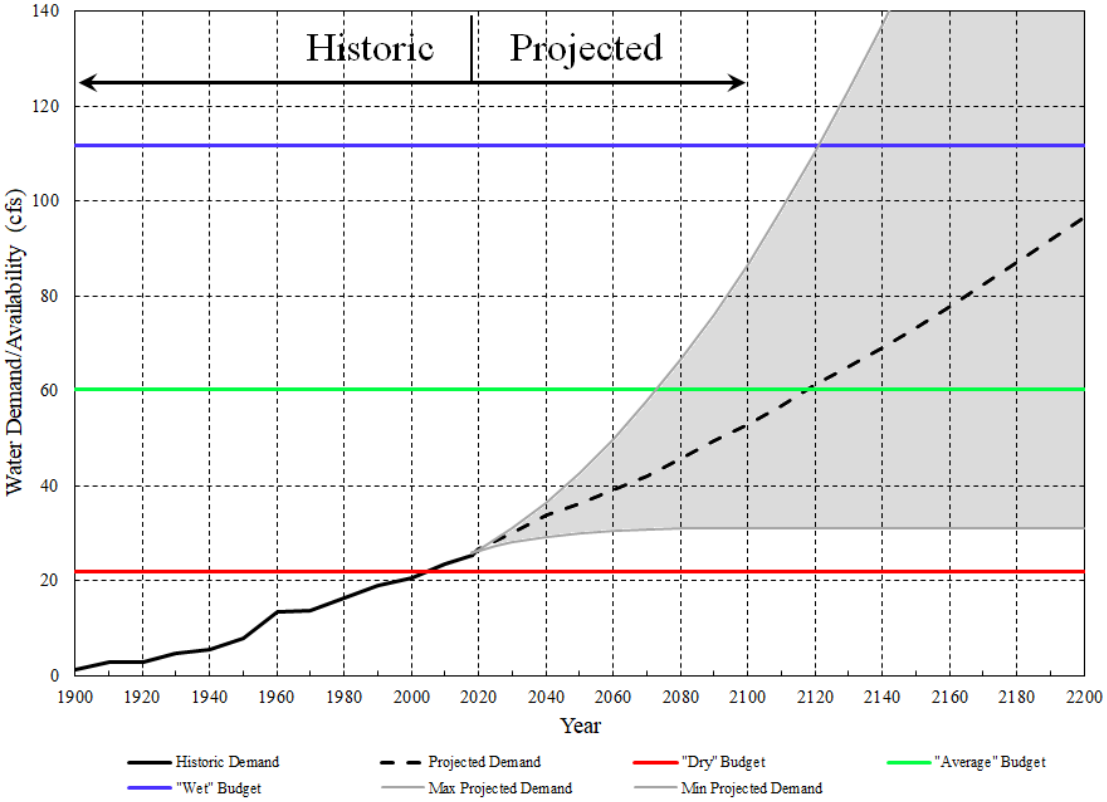
2nd graders enjoying the AR sandbox

I participated in the final year of our NIOSH funded ($1,250,000) grant to investigate ventilation strategies to combat radon in block-caving mining operations, I spearheaded a project funded by the West Dakota Water Development District investigating the possible future need for and feasibility of constructing a pipeline to deliver water to the Black Hills region from the Missouri River, and I continued ongoing work at Dinosaur National Monument monitoring crack aperture variation on the in-situ bone bed there.



Roughly two years of crack monitoring data at Dinosaur NM

Vibrating wire crackmeter



Historic and projected water demand in the Rapid City region compared to dry, average, and wet year water supply.

I hope everyone has a wonderful 2020!

Sarah W. Keenan

Hi GGE Alumni—Where did 2019 go? It has been an exciting (and busy) year.

I developed two courses in 2019: a graduate-level course on paleoenvironments, and an upper-level undergraduate and graduate course on aqueous geochemistry, which will become part of our core geology curriculum starting in Fall 2020.

Mentoring students at Mines has been incredibly rewarding. This past spring, Seth Vandenberg received 2nd place in the SDSMT student research symposium for his poster on fossil taphonomy from the Pierre Shale, which was part of his senior research project. I've been busy setting up the analytical lab in PRL and recruiting students. Grace DeVault joined our MS Paleo program and is my first graduate student! She is going to be researching fossils from the Pig Dig Site, a locality collected from Badlands National Park. I was able to publish 3 peer-reviewed papers and a book chapter this year:

Keenan, S.W., Schaeffer, S. M., and DeBruyn, J.M. (2019). Spatial changes in soil stable isotopic composition in response to carrion decomposition. *Biogeosciences*, DOI: 10.5194/bg-16-3929-2019.

Keenan, S.W. and DeBruyn, J. M. (2019). Changes to vertebrate tissue stable isotope ($\delta^{15}N$) composition during decomposition. *Scientific Reports*, 9:9929, DOI: 10.1038/s41598-019-46368-5.

Keenan, S.W., Pasteris, J.D., Wang, A., and Warren, D.E. (2019). Heterogeneous bioapatite carbonation in western painted turtles is unchanged after anoxia. *Comparative Biochemistry and Physiology, Part A*, 233: 74-83.

Keenan, S.W. (2019) Fossilization. Encyclopedia of Geology. Elsevier (*in press*).

This past summer I was invited to speak at the Geobiology Symposium in Banff, Canada, which included a trip to the Burgess Shale! To be able to visit and touch some of our best and earliest evidence for Cambrian life was a bucket-list moment for sure. I also participated in an Early Career Faculty Workshop in Baltimore, MD (with Dr. Ward), which included a visit to NSF. It was an incredible experience to network with similar early career faculty and to develop new collaborations. I also organized and lead a session at the National Speleological Society Convention in Cookeville, TN for the Biology Section—we had a record number of student presenters this year, which was awesome. Dr. Ward and I also organized the fall departmental field trip to Yellowstone National Park in August. We were able to bring students, most for the first time, to the incredible geologic mecca. We camped in the park and woke up to the dulcet tones of elk. We're looking for suggestions for Fall 2020!

I was filmed (along with Dr. Pagnac) as part of an upcoming PBS special on paleontology of the West with Emily Graslie, Chief Curiosity Correspondent for the Chicago Field Museum (and Rapid City native). We spent the day talking about animal decomposition and filming at Kenny Brown's ranch. Keep an eye out in 2020 for this 3-hour special!

Outside of Mines, I've been hiking, backpacking, and birding. Birding highlights of the year were: Stellar's jay (at Yoho National Park), American three toed woodpecker (hiking up Black Elk Peak), and western meadowlarks (everywhere). The GGE department recently had a night out with the Rapid City Rush—it was an awesome event with faculty, alumni, students, and family!

Wishing you all a happy and healthy holiday season!

Liangping Li

Alumni and friends, Happy New Year and Merry Christmas! In 2019, I continued teaching Groundwater course (GEOE/CEE 475/575L) for undergraduate and graduate students in fall and spring semesters. I am developing a new required course for geological engineering major: GEOE 456/556/L: Statistical Methods for Geology and Geological Engineering. This course will cover basic data analytical methods such as geo-statistics, principal component analysis and machine learning. It will be offered in fall 2020, if it is approved by Board of Regents.

For the research, I had four master graduate students graduated:

- Zhendan Cao, Geology Major, "*Bridging iterative Ensemble Smoother and multiple-point geostatistics for better flow and transport modeling*", Outstanding GGE Graduate Student Award
- Colton Medler, Geological Engineering Major, "*Time-Lapse Seismic Imaging of Hydraulic Fracturing at Sanford Underground Research Facility Using Continuous Active Source Seismic Monitoring*", Outstanding GGE Graduate Student Award
- Fleford Redoloza, Geological Engineering Major, "*A Novel Approach for Well Placement Design in Groundwater Management: Extremal Optimization*", Outstanding GGE Graduate Student Award

- Ryan Puzel, Geology Major, "*Streamflow Losses from the White River Along the White clay Fault Zone Near Oglala, South Dakota*"

Geology and Geological Engineering Department Nominee for the 2019 SD Mine Research Award

In addition, I published four papers *(*Corresponding author; # Student advised)*:

- Cao, Z[#], **Li, L.*,** and Chen, K. (2018) *Bridging Iternative Ensemble Smoother and multiple-point geostatistics for better flow and transport modeling*, Journal of Hydrology, 565, 411- 421. *(Impact factor: 4.4)*
- **Li, L.*,** Zhang, M., and Zhang, M (2018) *Gas-Water-Rock Interactions and implications for Geoenvironmental Issues*. Geofluids. Article ID 6847392. (*Impact factor: 2.0)*
- Redoloza, F[#], and **Li, L.*** (2019) *A novel method for well placement design in groundwater management: Extremal optimization*. Advances in Water Resources. Volume 132, 103405 *(Impact factor: 3.7)*
- Zhang, M., Wu, L., Zhang, J., and **Li, L.** (2019) *The 2009 Jiweishan rock avalanche, Wulong, China: deposit characteristics and implications for its fragmentation*, Landslides, 16(5), 893-906. *(Impact factor: 3.8)*

Tim Masterlark

In recognition of our science and engineering heritage at the South Dakota School of Mines, I will summarize 2019 by the numbers. I am on a positive trajectory. Enrollment in my Spring Semester of GEOL 201-Physical Geology reached 96 students, which gives a formidable ratio for Student Credit Hours/FTE. My h-index is 24 and I have 1688 citations at the time of this writing. However, this number is quickly increasing, and I expect to achieve 1700 citations by the new year.

I am pleased to report that the USGS will fund one of my proposals from 2019. While I will complete my current NASA grant at the end of December, this new grant from USGS preserves the continuous stream of funding that underpins my academic career. Dr. Sui (Jay) Tung left us in May to join a research team at Arizona State University. This was a bitter-sweet loss. On one hand, Jay was a power-house of productivity. His publication rate was such that I had the dubious responsibility of asking him to stop submitting manuscripts for publication, because I ran out of funds for the publication charges. On the other hand, his move to Arizona will allow him to build his own research enterprise, which was jump-started by a grant awarded by SCEC last summer. Nonetheless, Jay and I already have plans for continued collaboration. I was invited to join the NASA Earth Surface and Interior (ESI) Team. We had our first meeting in La Jolla, CA, in November, during which I exposed the need for NASA ESI to include a Numerical Modeling emphasis. The remainder of the Team voiced overwhelming support for this need, which will be critical for interpreting the anticipated data tsunami from the upcoming NASA-ISRO NISAR mission. This mission is expected to produce a data stream of InSAR data 100x greater than that of any previous InSAR mission.

The Black Hills are an amazing resource. The snow is deeper, the winds are harder, and the temperature is cooler. Not wanting to waste an opportunity, I spent my entire snow-day running through the Black Elk Wilderness area. The visibility at Harney Peak approached zero.

I was selected to serve as the Honorary Commander of the Munitions Squadron, 28th Bomb Wing, Ellsworth Air Force Base. This service provides many opportunities for me to engage and better understand the needs and perspectives of our local military personnel. These activities span a Black-Tie Birthday celebration for the USAF to suiting-up in padded clothing and being run-down by SF German Shepherds. The scientist in me was dying to know if one can feel the teeth through the padding. The answer is a resounding “Yes”. I was tapped to serve as the faculty advisor for the Veterans Resource Center (VRC) at the South Dakota School of Mines beginning the 2020 academic year. Thanks to excellent leadership, the VRC was integral in advancing the South Dakota School of Mines as one of the most veteran-friendly universities in the nation.

On the personal side, I spent 2019 looking for walls and barriers -and tearing them down. While I am not yet willing to reveal my plans for this upcoming year, stay tuned for next year's newsletter. I hope to achieve something truly extraordinary in 2020. Curious? -You can follow me on Twitter @_IronLion and Facebook to find out more.

Darrin Pagnac

Happy Holidays, alumni!

2019 turned out to be one of the busiest and most productive of my time here at SD Mines. My students and I are busy with so many great and impacting projects.

As always, I spent a great deal of time in the field this year. I held two field paleontology camps this summer, the first in June at Badlands National Park, and the second, as always, on the Missouri River near Chamberlain, SD, in July and August. Both were extremely successful.

Spectacular overlook near Notch Trail.

As part of a two-year collaboration with the National Park Service, I spent four weeks prospecting the upper Oligocene/lower Miocene Sharps Formation for vertebrate fossils. My crew of four students and I, focusing on the paleontology, worked collaboratively with researchers from Tulane University, who dealt with the stratigraphy and paleopedology.

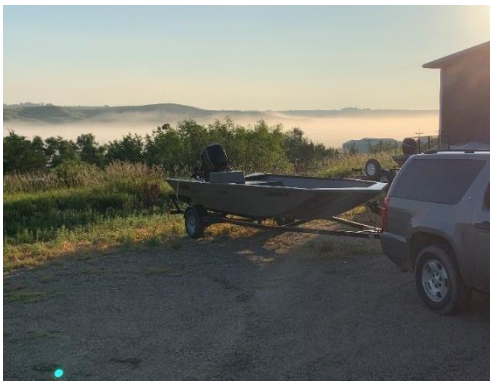
Students excavating an oreodont skeleton at Badlands National Park.

This work was, by far, some of the most amazing field work I have ever engaged in. The Sharps Formation is very, very productive, and we documented numerous new fossils throughout our time at the park. The scenery was absolutely spectacular, and we were privileged to experience parts of Badlands National Park that very few people get to see. Additionally, our work was very productive. We discovered at least six new prolific microfossil sites and found almost ninety new large mammal specimens. Several new papers will result from this work.

Once again, we spent another month on the Missouri River in July and August prospecting the Niobrara and Pierre formations for late Cretaceous marine fossils. For the past two years we've had to conduct these surveys without a boat, as our main source of transportation sprung an

irreparable leak in 2017. This year, however, we were back in business with a new hull and 60hp motor. Both served us very well during the survey.

This season on the Missouri River was also a great success. Although high precipitation rates kept the water levels very high, we were still able to access several miles of shoreline. We managed to locate dozens of new specimens, including an articulated vertebral column of a large shark, which is very rare, and the skull of a short-necked plesiosaur.



Our new vessel ready to "set sail" in the morning fog.

Over the past year I have seen three of my master's students finish their work and move on to more success. Julie Driebergen completed her thesis on amphibians from the Oligocene of North Dakota and is now in a doctoral program at the University of Minnesota. Jacque Belock finished her work on Cretaceous marsupial fossils from the Red Owl Quarry and is now a paleo consultant with SWCA Associates out of Denver. Finally, Shannon Harrel is completing her work on the effects of natural abrasion on microwear in mammal teeth. She will finish in December and join the workforce soon thereafter.

The beginning of 2020 will also be quite busy as I'll be completing a manuscript on my research into diversity in field settings. I'll also be preparing a new laboratory course to be held alongside Search for Our Past (our historical geology course). The laboratory will focus on developing the practical skills students need in the field, including map reading, use of the Brunton compass and Jacob staff, and foundational compilation and interpretation of stratigraphic sections. This spring will be busy!

Best wishes for a happy and healthy holiday season and a great 2020!

Students jacketing shark vertebrae.

Curtis Price

Curtis Price (http://webpages.sdsmt.edu/~cprice/index.html)

Greetings and best wishes to all SD Mines GGE friends and alumni! I am a Lecturer in geospatial technology, so I teach seven courses over the year, including three courses in Geographic Information Systems (GIS), Intro to Remote Sensing, and Surveying for Mining and Geological Engineers.

My activities connect to the community. We host GIS workshops (http://sdsmt.edu/gisworkshops) twice a year in January and May that bring in people from local mining companies, state and local government, and a few students to get a one-week GIS "crash course". I am also on the board of the Black Hills Digital Mapping Association (which our Dr. Sawyer helped found in the early 1990s), which holds a technical meeting on campus in October each year (http://bhdma.org). This meeting continues to grow, and it's a great opportunity for our students (who get free admission) to learn about geospatial technology activities in our local area. During this year's meeting I held a fun afternoon training class "Getting Mappy with ArcGIS Online", with the help of Dr. Elizabeth Fayer from BHSU, that brought in an interesting variety of people, including some K-12 teachers!

This December marks the end of my post-retirement appointment at USGS; last summer I worked at the USGS office in Rapid City, helping with on tools related to the National Hydrography Dataset-Plus (http://nhd.usgs.gov).

A new activity for me this term has been chairing the Undergraduate Recruitment committee. We have been making special efforts to connect with visiting students and build personal relationships with accepted students to encourage them to come to SD Mines. This includes the development of a "swag bag" of materials and information (developed with the support of Newmont Goldcorp) that we provide to visiting students, and faculty phone calls to all accepted GGE students. We are also applying for an NSF grant to add a summer educational experience for high school teachers to complement to the success Drs. Katzenstein and Pagnac have had attracting high quality students to GGE through their summer high school camps. Although we are working against a trend of lower enrollment statewide and nationally, we are holding our own, and aim to buck those trends. If you have any ideas on recruiting, feel free to contact me or the other committee members (Drs. Katzenstein, Pagnac, Uzunlar, and Ward). Also do what you can personally to get the word out. Dr Pellowski has been doing great work on the GGE Facebook page this last term ("This Week In Lab"), if you do social media (Instagram, Twitter, LinkedIn, etc.) you can help out by sharing this content out there in your networks. Also keep your eye out for students to send to us; one conversation could be really important!

This has been a challenging term for us with the passing of two of our promising students, Torger Henckel (an undergraduate Mining student who was my Surveying teaching assistant) and our GEOL MS student Houston Wagner. The GGE and MEM departments, with help from the SD Mines Counseling office and Campus Ministries) have truly pulled together to support each other and these student's families. These losses have reminded us that life is precious, and also that we are fortunate to be part of a wonderful SD Mines family.

Curtis Price doing “rod man” duty for Dr Stetler’s fluvial geomorphology lab

GEOE/MEM 201L students surveying underground at Otho Mine near Keystone, SD.

Foster Sawyer

Greetings and warm regards to the students, alumni, and friends of the Department of Geology & Geological Engineering! Another busy year has zoomed past with lots of fun and exciting activities around the department as usual! Highlights of my year included graduating two Ph.D. advisees, advising several undergraduate student research projects, teaching two field camps, and of course teaching, advising, and interacting with all of our wonderful students throughout the year.

It is my great pleasure to report that Andrew Clift completed his dissertation and graduated in May, 2019, and Umit Yildiz completed his dissertation during the fall 2019 semester and graduated in December, 2019. Umit has returned to Turkey to teach at the university level, and Andrew is currently employed with Chesapeake Energy Corporation in Oklahoma City, OK. Both Andrew and Umit completed petroleum related research, and the titles of their dissertation projects are as follows:

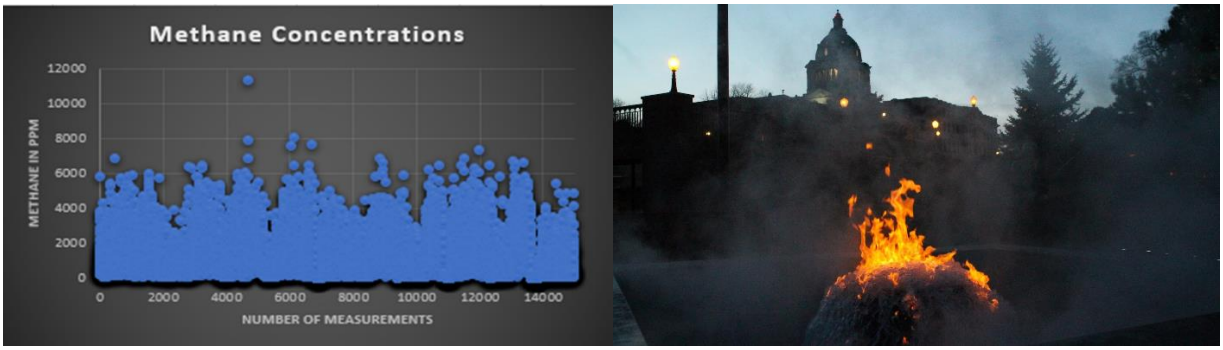
Clift, A.D., 2019, Stratigraphic architecture and facies mapping of the Late Cretaceous Niobrara interval of the lower Cody Shale in central Wyoming

Yildiz, U., 2019, Characterization of fault architecture and fault seal analysis at Cherokee Ridge, Greater Green River Basin, south-central Wyoming

Undergraduate student research continued to be a highlight for me this year within both the Pre-Engineering Education Collaborative (PEEC) program as well as senior thesis research projects within the department. The PEEC program focuses on reservation-based research on topics including ground water hydrology, affordable housing, sustainable food production, and other societally relevant issues. This year student research projects focused on a makerspace at Oglala Lakota College, a sustainable greenhouse at the He Sapa College Center in Rapid City, and a small (affordable) house project on the Pine Ridge Reservation. Poster sessions resulting from these summer research projects were held at Oglala Lakota College in August, 2019, and at the He Sapa College Center in Rapid City in September, 2019.

Left: Andrew Bieber presents his poster on affordable housing on the Pine Ridge Reservation. Right: Nayda Jones discusses her poster on a makerspace at Oglala Lakota College.

Senior thesis research projects which I advised within the department this past year included an assessment of geologic conditions underlying the "flaming fountain" at a veterans memorial in Pierre, SD, completed by Logan Kocab in May, 2019, and this year I am working with Garrett Fedora on his senior thesis modeling reservoir conditions and evaluating CO_2 injection potential at the Salt Creek Dome in central Wyoming. It is also my distinct pleasure to mention that the SDSM&T Society of Petroleum Engineers (SPE) Student Chapter was honored for a second year in a row with a national 2019 SPE Student Chapter Excellence Award for their exemplary accomplishments and activities.



Left: Methane concentrations measured at the "flaming fountain" over a ten-day period (data provided by Dan Soeder). Right: The flaming fountain in better days.

Additional highlights for me this year included teaching field geology in Turkey as well as the Petroleum Field Camp in South Dakota and Wyoming. Both of these field courses were

rewarding and enjoyable, however, Dr. Alvis Lisenbee formerly co-taught these courses with me and his presence was dearly missed by all.

Of course, the greatest highlight of all is watching our students grow into competent, successful geoscientists who continue to amaze and impress me with their talents, enthusiasm, and accomplishments. I wish all of our students, alumni, friends, and colleagues a successful, healthy, and enjoyable year in 2020!

Sincerely,

Foster

Larry Stetler

I was on sabbatical leave during the fall 2018 semester so missed providing an update for last year's newsletter. I will try to include some highlights of the sabbatical and the past year.

During my semester leave, I was able to finalize three manuscripts and get them through the review process and finally see them published. The 1st of these was a paper that described the erosion research I have been working on at Badlands National Park. This paper discussed the basic erosion model for slopes at Badlands and resulted in erosion models for the Park based on 1) location within the Park, 2) geologic unit, and 3) slope angle and aspect. The average annual erosion rate for all regions, slopes, and units was 9.7mm. The erosion rate varied based on the three parameters and indicated that south-facing slopes were 1/3 less erosive than north-facing slopes. These results will provide a basic erosion model Park personnel can utilize in their fossil management program.

The 2nd manuscript was a paper describing the sedimentological history of the Hanford Site in south-central Washington, the site of much of the Nation's plutonium extraction activities. This research provided critical evidence that was used to redefine the environments of deposition for the surficial deposits. Early geologic investigation in the 1940-1943 (during the building of Hanford) ascribed an eolian origin to the ubiquitous sands that mantle to site. My investigations allowed these forms to be defined as glacio-fluvial megaripples, originating from glacial outburst floods between 16-12 ka. During the Holocene, winds have reworked the upper surface of the fluvial megaripples providing them with an eolian veneer.

The 3rd manuscript was a paper researched by my PhD student, Kyle Hazelwood during his dissertation research. This paper defines morphological landscape classifications for the Black Hills using geological data from the field and GIS analysis of watersheds. A new analytical routine, called 'watershed decomposition', was developed for this work and was used to ascribe non-channel elements into a river's long valley profile.

The Badlands paper was published in a special issue of the journal *geosciences: Mechanics of Erosion: Process Response to Change*, a compendium of global research in water and wind erosion processes and can be accessed at:
https://www.mdpi.com/journal/geosciences/special_issues/mechanics_erosion#published

The Hanford and Black Hills papers were part of a special issue of the journal *Geomorphology: Historic and paleoflood analyses: New perspectives on climate, extreme flood risk, and the geomorphic effects of large floods* and can be accessed at:
https://www.sciencedirect.com/journal/geomorphology/special-issue/10MBRN7RPB2

I can be contacted for a full electronic copy.

Research during the sabbatical period included two projects: 1) continued data collection on erosion at Badlands, and 2) data collection for a soil genesis project. I am currently working on a new manuscript for erosion processes and methodologies to measuring erosion in badlands environments. In 2018 I collected another set of erosion measurement at Badlands using digital 3-D photogrammetry. Current, I have 8 years of record and these photogrammetric data is now being analyzed in conjunction with data collected using other measurement methods as the topic of a new manuscript on erosion methods. Secondly, I collected several soil samples in the Black Hills across a slope that had a bedrock pegmatite granite outcrop at the top of the slope and was progressively buried under thicker soil regolith down the slope. Several trenches were excavated along the slope axis and soil samples collected from surface to the soil-bedrock contact. These samples were sieved and will be analyzed using X-Ray Fluorescence to determine compositional variation (if any) down the slope and vertically in any soil profile. The intent is to define soil pedogenesis as a function of compositional change in soil the further away from bedrock the soil occurs. I have presented this concept to the USDA/NRCS and they are interested in potentially funding a larger project based on these findings, when completed. The results will be written up and submitted as a journal paper.

In 2019 I taught 3 courses in the spring term (Geological Engineering Design, Drilling Engineering, and Geomorphology), 1 course in the summer (Engineering Field Geology), and 2 courses in the fall semester (Geological Engineering Design and Fluvial Processes). Currently I am advisor for 1 MS GeoE student (graduating in Dec 2019), 1 PhD GeoE student, and 1 PhD Geology student (graduating in Dec. 2019).

Gokce Ustunisik

Dear Alumni and Friends,

Happy holidays to you and your families. I Hope 2019 was a great year and 2020 will be even more promising. It is hard to believe that I am already in the middle of my fourth year here at Mines. I joined the GGE faculty in Fall 2016 as an Assistant Professor in petrology. For all of you who either took Mineralogy and Petrology, or were GTAs in those classes, you will be

pleased to know that undergraduates still find both classes a transformational experience, and in many cases, Mineralogy represents the first time they really feel like geologists. I took over teaching GEOL212/L (Mineralogy and Crystallography) and GOL341/L (Igneous and Metamorphic Petrology) in 2016-7 and have found it a challenging and rewarding experience. In addition to those core classes, I have taught Advanced Igneous Petrology, Planetary Petrology, Volcanology and developed some graduate seminars in my field.

I was trained as an igneous petrologist; applied field, analytical, and thermodynamic modeling approaches to a variety of problems related to subduction zone volcanoes during my Ph.D. at the University of Cincinnati (2005-2009). During 2009-2012, I was a post-doctoral scholar at Stony Brook University where I extended this research to experimental planetary petrology. That research focused on the role of dissolved volatiles and halogens on the phase equilibria during degassing of Mare basalts as well as lunar and martian crust formation and differentiation. For the four years prior to moving to the School of Mines (2012-2016), I worked as a research scientist (Katherine Davis research fellow) at the American Museum of Natural History (AMNH) and Lamont Doherty Earth Observatory (LDEO) of Columbia University in New York. My lunar and martian research have evolved into to the study of chondrules - the earliest rocks in our Solar System found commonly in carbonaceous meteorites. This fellowship involved teaching as a member of the science faculty in the Master of Arts in Teaching (MAT) Earth Science program.

One of the advantages of having developed my research at places such as LDEO and AMNH is that I have been able to continue in my position as a research associate at those institutions. That has provided opportunities for me as a researcher, and for my students here at SDSM&T. I continue to work with my colleagues there by spending several weeks a year in New York. Being a "city girl", transition from Manhattan, New York to Rapid City was not an easy cultural change even though the moving process was remarkably smooth.

Upon my arrival, I built the Experimental Petrology laboratory by transforming MI 322 from a teaching to a research laboratory. My laboratory is equipped with one atmosphere quench and gas-mixing furnaces, and sample preparation and processing equipment. I have focused my research in 3 main areas, "petrogenesis and volcanology of arc magmas and mid ocean ridge systems"; "planetary petrology and cosmochemistry"; and "big data petrology with its applications to trace element experiments and numerical modeling" (https://webpages.sdsmt.edu/~gustunis/Research.html). This laboratory serves as the main research facility for my graduate students and myself. My research has been funded as a PI by the National Science Foundation (NSF) and SD-BOR Competitive Faculty Research Grant, and as a collaborator by National Aeronautics and Space Administration (NASA). Since Fall 2016, I have published 6 journal articles in high impact journals such as American Mineralogist, Geochemistry, Geophysics, Geosystems (G-cubed), Geochimica Cosmochimica Acta, and Chemical Geology; 6 white papers; and 11 conference proceedings in AGU, GSA, and LPS (Lunar and Planetary Science) meetings. I have been invited to serve in the program committee for the Lunar and Planetary Science Conference (LPSC) in addition to organizing 4 special sessions at AGU and LPSC meetings over the last 3.5 years.

I find myself very fortunate with respect to my graduate students. I have been primary advisor for 3 graduate students including Alexander Rogaski-B.S. University of Cincinnati, (began Fall 2017); Taran Bradley-B.S. SDSM&T, (began Spring 2018); and Kristen Lewis-B.S. Michigan Technological University, (began Fall 2018). I have enjoyed serving on the committees of 4 MS students from Geology and 2 PhD students from Civil and Environmental

Engineering and Nanoscience departments in addition, it was my privilege to have the experience of supervising a post-doctoral fellow (Jay Tung – until Spring 2019).

Alex's research involved the experimental investigation of the volatility of Germanium, Lithium, and Zinc deposits in Martian Basalts. The goal was to understand the observed Cl, Ge, Zn enrichments in Gusev Crater on Mars. Alex presented his research at GSA, AGU, and LPS conferences. His research was funded by SD Space Grant Consortium. In addition, he was selected as a summer intern at the NASA Lunar and Planetary Institute. He coauthored 2 papers in the Journal of Geophysical Research (JGR). His 3rd paper is in the process of publishing in Meteoritics and Planetary Science (MAPs). He is currently working as a research geologist at Avocet Environmental in Irvine, California.

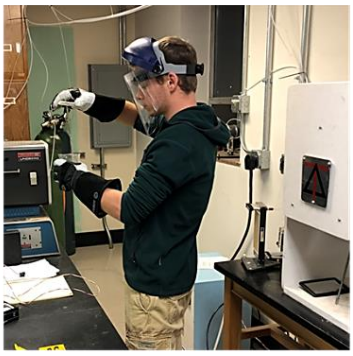
Taran's research involved the temperature and bulk composition controls on the observed variations in the Al-OH wavelengths of mica-bearing blue and green schist in Turkey and eclogites from Guatemala. Taran presented his research at the Fall 2018 and 2019 AGU conferences and received funding from two instrument (Goetz and TerraSpec) programs. Taran is graduating in Spring 2020 after publishing his research in American Mineralogist.

Kristen's research focuses on understanding the petrogenesis of plagioclase ultraphyric basalts (PUBs), a component of the array of mid-ocean ridge basalts (MORB). Specifically, she is working on understanding how to experimentally reconstruct the composition of plagioclase hosted melt inclusions – an increasingly important source of information on the early petrogenetic history of MORBs. Kristen presented her research at the Fall 2019 AGU conference in a special session and received funding from SD Space Grant Consortium and SD Boards of Region for her research. Kristen was accepted as a RA to University of Canterbury, New Zealand for her PhD. She will be graduating in Spring 2020.

The last 3 years has been a wonderful adventure, and I look forward to what is coming in the new year. Best wishes to you and yours for a happy and healthy holiday season and a great 2020!

Ustunisik Research Group - Meet the Team

Crustal Evolution of Planetary Bodies and their Volatiles: Linking Observations and Experiments

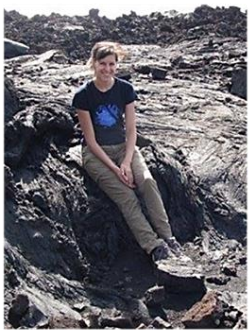


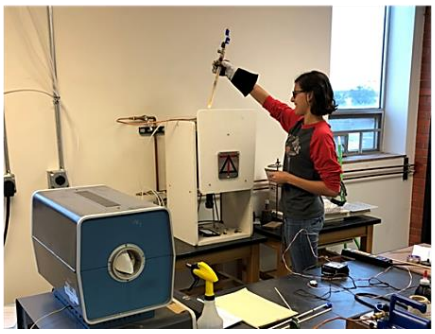
Alexander Rogaski
(MS GEOL, *graduated Spring 2019*)
NASA Lunar and Planetary Science Internship

Taran Bradley
(MS GEOL)
ASD Students Mining and Energy Instrument Support

South Dakota Space Grant Consortium

Kristen Lewis
(MS GEOL)
South Dakota Space Consortium Student grant





SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

AMERICAN MUSEUM OF NATURAL HISTORY

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

CEOAS

Oregon State University

Spring 2019 Commencement: Gokce Ustunisik, Alexander Rogaski

Left to right: Kristen Lewis, Taran Bradley, Gokce Ustunisik, Alexander Rogaski, Roger Nielsen

From Black Hills Natural Sciences Field Station (BHNSFS) and Nuri Uzunlar:

The BHNSFS is the world's largest field school offering summer and winter camps in earth science and related engineering fields including geology, geological engineering, environmental geology and engineering, volcanology and geomorphology six continents. In 2019, 256 students from 87 institutions across the USA mapped geological environments ranging from volcanoes to fault zones in Hawaii, Turkey, France, Spain, Morocco, New Zealand Iceland, Nepal, Ecuador, and the Black Hills of South Dakota. We are getting ready for the winter camps in Hawaii, New Zealand, Arizona and Death Valley. All four camps will start after Christmas.

In addition to traveling from camp to camp I have been very active in departmental committees and the department's graduate recruiting efforts. I attended GSA in Phoenix and AGU in San Francisco, where the field station and the department had an exhibit.

For additional information about upcoming field station activities please visit: http://geologyfieldca mp.sdsmt.edu, call me at (605) 394–2494 or write to nuri.uzunlar@sdsmt.edu

There are two separate scholarships set up in Dr. Lisenbee's honor.

1. One can send checks to the Foundation (https://foundation.sdsmt.edu/) with a note designating which fund is to be supported.
2. Alternatively, one can make a donation online at (https://foundation.sdsmt.edu/lisenbee-memorial-gifts). After clicking on this link, look for the pull-down menu under "Designation" to direct your gift to either the scholarship or the Turkish field camp. (See image of this below.)

<u>The Alvis Lisenbee Scholarship</u> is *awarded to a full-time SD Mines student majoring in geology. Recipients are outstanding, top-performing juniors or seniors selected by a scholarship committee within the Department. This scholarship already exists, so gifts made to this fund will augment the amount of the scholarship.*

<u>Turkish Field Camp "scholarship"</u> *is a new fund being established to support SD Mines students in attending a summer field camp in Turkey. How the funds will be allocated depends upon the amount raised, but all funds will go to SD Mines students. Nuri Uzunlar will be the responsible party for managing gifts to the field camp until or unless inter-department structures are established for this.*

Kevin M. Ward

Greetings and happy New Year! I am finally beginning to settle in as I start my second year here at SDSMT. It has been a busy year with even more activity on the horizon for 2020. In February/March of 2019, one undergraduate and one graduate student from our department traveled with me to Alaska where we deployed and recovered over 400 seismometers. This is the largest passive source study of its kind (at least until 2020). The field work involved working long hours in cold conditions snowshoeing between sites and digging through the snow to deploy the seismometers. Despite the cold weather, both students had a great time and the dataset we collected is amazing. Taking advantage of the warm summer months, I also led a deployment of 85 seismometers centered on the Lassen Volcanic Center in northern California. This is a really unique volcano as it is the only Cascade volcano that has hydrothermal features similar to the ones found in Yellowstone National Park. In early September, I also co-led a field trip to Yellowstone National Park following in the footsteps of Dr. Alvis Lisenbee. In total, 23 students, staff, and faculty from our department spent four days in the park looking at the main tourist

features but also exploring some of the lesser known stops with spectacular geology building a stronger understanding of the story of Yellowstone.

Looking forward, 2020 is going to be an even busier time for me and SDSMT. We are putting the final touches on a huge multi-institution project that will image the Cascade Subduction Zone in a way never before done along the margin. The effort will include a 40-day offshore cruise with a multichannel wide-angle seismic study across the margin from Northern California to Canada. The study will also have an ocean bottom seismometer deployment. Our group will focus on extending the offshore lines onshore with 11 dense lines across the forearc. This effort with give us some of the best trench to arc seismic images as well as looking at the 3-D effects of segmentation along the plate interface. The science of this work is truly cutting edge, but we will also be recruiting about 30 undergraduates to help with the deployment and recovery from a nation-wide call. Indeed, it is an exciting time to be a seismologist!