



WHEATON
COLLEGE

For Christ & His Kingdom

CONTACT

The Alumni Newsletter of Wheaton College's Department
of Earth and Environmental Science



Geologists at Grand Teton National Park

INSIDE THIS ISSUE:

Graduating Seniors	2
Introducing Students to Interdisciplinary Landscapes	2
Field Camp Reflections	4
Keil's Corner	5
Beekeeping: Helping or hurting?	6
Katy's Kommentary	7
Luhmann's Letter	8
Department Publications	9
Student Articles	10
Department Updates	12
1965 Department Report	13
Doc Mo's Memoir	14
Maneiro's Musings	15

From the Department Chair

STEPHEN MOSHIER

What's new?

We are now the Department of Earth and Environmental Science.

What's in a name?

Borrowing from Bill Shakespeare, that which we called the Department of Geology and Environmental Science *by any other name would smell as sweet*. Like many other programs around the country, we decided that Earth and Environmental Science matches better with contemporary understandings of what we do here. For one thing, high school students generally don't take a course in geology, it's called Earth Science. More high school students are taking environmental science these days, even as an AP course. We hope our new name will invite people to discover how we approach earth and environment as an integrated system, with two options for focused study and professional preparation: geology and environmental science. We are NOT changing the name of the geology major.

How are we doing?

That is the question of the year for us. The college has a ten-year cycle for program self-study and this spring we welcomed a team of two visiting faculty and two local faculty to read our geology self-study

report, interview students, staff, administrators, and make their own report. Alumni from the past ten years were asked to fill out an online questionnaire as well. Thanks to those of you who contributed to this effort. We see the timing of this review as essential, seeing that programs at the college are under great scrutiny in this age of shrinking numbers of applications and corresponding revenue for operations. We hope the report will encourage our administration to continue to support and potentially enhance geo-science education at Wheaton, as it has since the first geology BS was awarded in 1935. Environmental Science is reviewed in a different ten-year cycle, with the next one scheduled for 2024.

Emerging from the pandemic

Or have we? Fall semester here was almost normal. Infection levels were manageable and the only real inconvenience was masking in the buildings. It has been wonderful to teach in-person labs, attend sporting events and musical performances, and even in-person faculty meetings (maybe I went too far on that last one).

How are you doing?

We always appreciate hearing from you with professional and personal updates. It's especially wonderful when you stop by the department. And, if you have a memorable story to tell about your college days as an environmental science or geology major, we would love to include it in the pages of our newsletter.

Want to see the photos in this issue in color? Download pdf versions of CONTACT at wheaton.edu/geology

GRADUATING SENIORS 2021-22

Environmental Science

- Siobhan Duba, August 2022
- Dianna Gagnon, May 2022
- Mariah Gascho, August 2022
- Jacob Harvey, August 2022
- Emily Kranendonk, August 2022
- Layla Landeros, May 2022
- Grayson Layne, August 2022
- Emily Park, May 2022
- Jiyoun Park, May 2022
- Gloria Rhee, August 2022
- Emma Sawyer, August 2022
- Grace Tate, August 2022

Geology

- Hasten Biddlecome, Dec 2021
- Calvin Block, May 2022
- Marc Borowski, Dec 2021
- Shayne Bower, May 2022
- Lauren Breederland Madsen, May 2022
- Daniel Morken, May 2022
- Jenna Paulsen, May 2022
- David Sandeno, May 2022



Congratulations to Andrew Madsen ('20) and Lauren Breederland Madsen ('22) on their New Year's Day Wedding. Their romance was born here in the department!

INTRODUCING STUDENTS TO INTERDISCIPLINARY LANDSCAPES: A CASE STUDY IN PROGRESS

STEPHEN O. MOSHIER AND CHRIS KEIL

Reprinted with permission, Christian Scholars Review Blog, August 13, 2021

<https://christianscholars.com/introducing-students-to-interdisciplinary-landscapes-a-case-study-in-progress/>

Established in 1935, the Wheaton College Science Station in the South Dakota Black Hills hosts the longest running off-campus program at the Illinois-based college and represents a pioneering effort for offering summer programs in field science for Christian higher education. Picture how different things were culturally and politically those 86 years ago. The year 1935 was only 67 years after the 1868 Fort Laramie Treaty, which affirmed Native American ownership of the Black Hills and over 100,000 square miles around them, only to be violated by and essentially nullified by the rush of eastern (white European) settlers after gold was discovered there in 1874. When the Science Station was established, Native Americans had only been permitted to vote for 11 years. Many of their cultural and religious practices were prohibited by law until 1978 with the American Indian Religious Freedom Act.

With the focus on natural science education, for decades there was little effort to consider the Native American heritage of the land we were using as our field laboratory and little effort was made to reach out to the local Native American community. That began to change about ten years ago. For one, it was obvious that some of the best places to map rocks or observe animals and plants were also areas considered sacred by the Lakota, Cheyenne, and other tribes of the northern Rockies and Great Plains. Growing recognition of these sacred sites, like Bear Butte and Devils Tower, led to the state and national parks to recommend moratoriums or limits on rock climbing and hiking during the month of June, considered a season of particular religious observance by Native Americans at those sites. Of course, June is when we conduct our program, as do other colleges around the country, and is the peak of summer tourism.

Secondly, we were beginning to feel that bringing our students to this amazing physical and ecological landscape should also include an introduction to the remarkable landscape of Native American culture and history. As is often the case in established institutions and programs, it took the eyes of newcomers to reveal our blind-spots. A Bible professor and an anthropology professor recognized the Science Station as a laboratory, not only for natural sciences, but for exploring the history and continuing effects of American westward expansion. The forceable relocation and colonialization of the Plains Indians is a black mark in European American history, especially for Christians who were active or complicit in implementing the racist policies. Bible, anthropology and art classes began to be taught delving into the Lakota experience. These classes and the efforts of artists in residence connected the Science Station with some Lakota leaders. A particular friendship developed with Woyatan Church and their Pastor Jonathan Old Horse. This relationship has flourished in recent years with students worshipping at Woyatan on Sundays and Pastor Old Horse and others visiting the Station.

A general education science course taught at the Station titled Nature, Environment, and Society explores the interactions between the natural and human world. Black Hills regional issues such as land rights, wildlife management, earth resources, and water quality provided case studies for studying human interactions with creation. With our expanding awareness of Native American interests in these issues and our growing relationships we decided to be more explicit and intentional about the role of the Lakota people and the ongoing effects they experience. We would like to highlight one of the four weeks in this course from this past summer.

After two weeks of exploring ecosystems and water resources in the Black Hills and surrounding Great Plains, the focus of the course turned to land use issues, encompassing geological history and resulting mineral resources, mining, public lands, and solid waste disposal (landfills). Special attention was given to the troubled history of Native American land exploitation since the breaking of the 1868 Fort Laramie Treaty.¹ Fittingly, our Sunday evening vespers at the beginning of that week featured a visit and conversation with Pastor Old Horse. The pastor shared how the Lakota peoples viewed the land through the telling of their creation stories. Students discovered that many Native American principles of how to live sustainably on the land parallel Biblical principles from Genesis and instructions for care of the Promised Lands. Students read two articles detailing the history of relations between national and state park systems over the management of Bear Butte and Devils Tower, two sacred sites in the theological landscape of Great Plains native peoples. At Bear Butte, a South Dakota State Park, a Native American docent described for the students how he and his family had experienced vision quests on the peak and the reasons it is considered sacred. Later in the same day, we walked respectfully around the circumference of Devil's Tower (more appropriately and originally named Bear Lodge), observing multicolored prayer cloths tied to tree branches marking individual pilgrimages to the site.

We looked into four holes-in-the-ground that week, too. One was a natural depression, a sinkhole created by the collapse of shallow bedrock due to the dissolution of underlying soluble gypsum beds. There are many in the Great Plains surrounding the Black Hills, but the bottom of this sinkhole was filled with thousands of bison bones and stone tools used to butcher them. Just any sinkhole would not do. Archaeologists excavating at the Vore site, near Sundance, Wyoming, determined that between 1500 and 1800 AD, a succession of Kiowa, Apache, Shoshone, Hidatsa, Crow and Cheyenne hunters took advantage of the most optimal topography to skillfully guide herds of bison into the "jump."

Two other holes-in-the-ground we visited were dug to mine gold. The Open Cut at the Homestake Mine, in Lead, South Dakota, represents mining operations there between the discovery of the "mother lode" in 1886 and the cessation of mining activity there in 2001. This funnel-shaped crater is one half mile wide at the top and ranges from 800 to 1200 feet deep. Yet, all the gold produced from the open cut and underlying mines to a depth of 8000 feet below the surface would fill little more than two moving vans! Gold is strategic for electronic components, dentistry, and coinage, but 78% of gold consumed annually goes into jewelry.

Not far from the Open Cut, we ascended the bumpy dirt road to the top of Terry Peak, a vantage above the active Wharf gold mine. While Homestake employed traditional stamping and processing of gold in onsite mills, at Wharf the gold is leached out of heaps of rock using a toxic cyanide solution. The "pregnant" solution (that is, fluid now bearing dissolved gold) is drained from the base of the heap and moved to processing ponds and a chemical factory that produces solid gold bullion. We discussed the environmental consequences of mining operations, such as the two local Superfund sites, designated by the Environmental Protection Agency as polluted locations requiring long-term (and expensive) cleanup. At the end of the day, we visited a forested valley that is being proposed for



Pastor Jonathan Old Horse from Woyaton Church leading faculty and students in morning prayer, July 2021.

new underground gold mining. We considered how the landscape would change if development is permitted by the state.

At the end of the week, our last hole-in-the-ground to visit literally stunk, but not as bad as you might think. It was the Rapid City Landfill. Students were impressed by the exemplary program of recycling and solid waste disposal. The geology of the site is well suited to prevent groundwater contamination from fluids that might leak from the landfill and proper management has mitigated against other potential negative environmental impacts. Perhaps, this effort follows more closely the respect for land known to the ancient hunters of the Great Plains at their bison jump.

Students wrote summary essays at the end of each week, to review and critically reflect on their readings and travels. The issues we discussed were understood by all as deeply complex and deserving multiple perspectives and disciplines of study. One student reviewed our discussions at the two sacred sites on the nature of conflict and resolution. Other students continued to question our values regarding such diverse resources as gold and water. Many references were made to how our religious and cultural traditions shape our values, perceiving Native American passive interactions with nature in contrast to European mastery and exploitation over nature. One student compared the Native American belief that things the creator put in the earth were not meant to be dug up with Tolkien's *dwarves of Moria*. Their overzealous digging for precious *mithril* awoke the terrible Balrog of Morgoth. Another student recognized that moving to green technologies will actually require mining of strategic elements. She found published reports on more sustainable extraction technologies. In personal conversation (and course evaluations revealed), some students shared discomfort in our even visiting Bear Lodge (Devils Tower) during the month of June, or at least not observing silence in our walk about the perimeter (we had no plans to hike up Bear Butte).

Like any good course, this one will change and improve with experience, discovery of new readings, and especially with more direct interactions with people who live and work there, representing the diversity of the community. The course certainly attempts to capture the best of experiential and interdisciplinary learning.

¹In 1980 US Supreme Court ruled that the Sioux Nations were deserving of compensation for the act of breaching the treaty and subsequent actions.

FIELD CAMP REFLECTIONS

Reflections from Geology Field Camp, Summer 2021

Jenna Paulsen, GEOL '22

They say field camp is simultaneously the hardest and the most fun part about being a geology major, and it is that paradox that makes it one of the most transformative experiences for a geologist. From my experience this past summer at the Wheaton College Science Station, I would say I couldn't agree more with that statement! Over the course of 8 weeks, our class of 12 geo majors—10 juniors and seniors from Wheaton plus 2 students from SD School of Mines and North Carolina State—not only improved immensely in our field skills, but also grew so much closer as a team and in our awe of God's power and creativity, which are so evident in the environment of the Black Hills.

Because field camp was cancelled in the summer of 2020, we were especially excited to get out to the Science Station this past May. For the first week or so, unvaccinated students were required to wear masks in the dining hall and other common areas; after that, we created a "bubble" by limiting travel outside of campus so that we could unmask for the rest of the summer without fear of spreading the virus. For most people, it was the first time in over a year that community life felt somewhat normal again!

During the first few weeks at camp, we completed a 2-credit Sedimentary Petrology course with Dr. Moshier, visited two national parks/monuments (Badlands and Devil's Tower), hunted for fossils near the National Grasslands, and camped overnight through a thunderstorm. We started to get used to the daily routines of field work: tall socks and pants to keep the ticks out, sack lunch sandwiches in the field day after day, nights out on Inspiration Point looking up at the sunset and the stars... and the list goes on. Dr. Carrigan from Olivet Nazarene University joined us for the remaining six weeks and served as our incredible Field Geology professor, striking the perfect balance of walking us through new concepts and letting us fly on our own.

Probably one of the unanimous favorite parts of field camp was going on our week-long Western camping trip. We had the privilege of visiting two more national parks - Yellowstone and Grand Tetons - drove through the northern and southern portions of Bighorn National Forest and saw some pretty incredible rock formations along the way. (Oh, and lots of bison too!) From waking up at 4:50 am to watch the sun rise over the Tetons, to taking a random detour through Idaho just to see their famous potato fields, to jumping in the freezing river next to our campsite for a swim, so many unforgettable memories made.

After spending weeks creating cross sections, stratigraphic columns, and maps of the Badlands, Cowboy Hill, Whitewood, Bear Butte, and Nemo Quadrangle by hand, we were pretty exhausted. Though parts of me wanted the summer to last forever, we all knew it had to come to a close. With two seniors graduating at the end of the summer and two other geology friends going back to their respective colleges, goodbyes were not easy. But I left with a full heart knowing that it would be impossible to forget the summer we'd spent in the Black Hills. *"For from him and through him and for him are all things. To him be the glory forever!"* (Romans 11:36)



KEIL'S CORNER

CHRIS KEIL,
PROFESSOR OF ENVIRONMENTAL SCIENCE

In many ways late January 2022 feels a lot like late January 2021. We are teaching masked in classrooms and wondering when “normal” will arrive again. It is a bit better though. Some of the classroom restrictions have been eased. And we don't have to teach to students both in the classroom and online simultaneously. Well, not always anyway. A few students have gotten Covid since the semester started and we've had to do some quick work to get a low production quality video stream of the lecture to the ill students. So, while many of us are getting “used to” teaching in the covid environment now, it still is fatiguing.

But good things are happening too! I've had a research student, Layla Landeros, working with me all year. Last semester she did some great work with our XRF doing elemental analysis of road and soil dust. This semester Layla is working on organizing all our water quality equipment with instructions and sampling protocols to start up a long-term monitoring campaign of water bodies in the Wheaton area. We can't wait for above freezing temperatures so we can start that up. Another research student, Kaitlyn Imano is doing research on land acknowledgements with indigenous tribes so we can better pursue being good relations with our Lakota friends in the Black Hills.

And speaking of the Black Hills, we had a good community last summer out at the Science Station. It was the “fullest” summer since I've been at Wheaton. I'm sure it was in part driven by the pandemic preventing classes out there the summer of 2020. Taylor U had their class run in both June and July. And both sections of the biology track were full. Geology field camp was packed, again because the regularly scheduled camp was cancelled in 2020. We also had good enrollment in our general education courses.

Also, last summer was our inaugural “Sustainability Summer”, our track that is the core of the Certificate in Environmental Sustainability. The sustainability students learned principles and practices that will connect sustainability to their courses of study. None of the sustainability students major in science (the certificate is intended for non-science majors), but they did a phenomenal job learning about, designing, and installing some solar lighting at the Science Station.

I've also been able to gain some traction on a book project I've been working on. I started it during my sabbatical in the fall of 2019. The plan was to finish it up the spring semester of 2020. The pandemic had other ideas. I was able to get adjusted to my job during the pandemic enough to pick up the project again last August. The end is in sight if I can just get some co-authors to finish their parts.

It's a brave new world of finding internships and jobs. So, if you have any leads, we'd love to have them to pass on to our students. And we'd love to hear how you are doing too! Shalom!



Highlights from the Black Hills

Beekeeping: Helping or hurting? What happens when humans house non-native pollinators

Science Journalism project at the Marine Biological Laboratory, Woods Hole, MA

Dianna Gagnon, ENVR '22

There has been a mounting buzz surrounding the keeping of bees: according to data from the Food and Agriculture Organization, there has been a worldwide 45% increase in beekeeping over the last fifty years. In large part, this has been a response to the notion that abundance of any kind of bee is beneficial. The black and yellow mogul is seen everywhere from Hollywood's 2007 *Bee Movie* to the prints on boutique socks and notebooks. There is just one looming issue: the 'sustainability celebrity' is not all that sustainable.

"People want to save the bees, but they don't realize that they are dumping money into saving the wrong kind of bees," said Dr. Kirk Larsen, an entomologist from Luther College in Iowa. "Technically [the honeybees] are an invasive species." In fact, scientists are finding that, around the globe, installation of honey beehives is hurting local pollination networks.

Addressing what he calls the "pollination crisis," Dr. Alfredo Valido of the Spanish National Research Council and colleagues recently published a paper based on the impacts of honeybees on the plant-pollinator network located in Teide National Park of Tenerife (Canary Islands). There it was found that the honeybee surge demolished connectivity amongst flowers and their local pollinators. Studies in Barcelona, France, Brazil, China, and Denmark, amongst others, have sought to replicate Valido's protocol to assess the scalability of these findings. Across the board there has been wide scale concurrence that honeybees actually push out native species when they arrive.

Valido's comprehensive study was a three-year endeavor, beginning with observations in 2007, which served as a control year without any bee population in Teide. In the two years following, beekeepers supplied the park with a significant bee population of roughly 2,700 beehives. Then, the researchers began tallying. They sat in front of plants like fiery malpais and cone-shaped Teide catmint, to see how many pollinators visited them over one to two weeks. Interviewed from his office in the Canary Islands, Valido was adamant in advocating for the health of native pollinators. The truth, he counseled, is that the honeybee should not be given the opportunity to act as 'queen bee' when it comes to pollination networks.

By the sheer amount of honeybees per hive, Valido has found that large-scale human installations of beehives have sent communities of plants and pollinators, developed over thousands of years, spiralling. The nature of honey beekeeping operations is that hives house between 40,000 and 70,000 individuals at a time. Comparatively, native species tend to congregate in small pods. The overwhelming honeybee populations push native species out, taking local nectar and pollen captive, despite native species' adaptations that should give them an advantage.

Indeed, the honeybee surge in Teide National Park proved to slash connectivity within the local pollination networks, Valido's team found. "The impact of the beehives is so dramatic that you can see interruption between plants and pollinators within a day of the beehives' installation," he said. Modularity and nestedness also suffered accordingly. These are a pair of gauges that are frequently used to assess ecosystem resilience: modularity refers to species' tendency to group up, while nestedness describes the interactions between generalist and more specialized species in plant-pollinator networks. The teams also observed that these structural changes impacted potential for pollination; researchers noticed decreased seed counts in the honeybees' favorite plants.

Effective plant-pollinator networks should instead "remain reliant on the native pollinators that have long supported these systems," said Valido. In other words, honeybees will only be helpful if their presence supplements, rather than replaces, ongoing work by native pollinators.

Yet giving native pollinators space may also prove challenging, given the commercial appeal of honey and honeybees. The reality is that honey is far too rich a nutritional and economic resource to leave by the wayside; Larsen noted that a single hive can produce up to 100 pounds of honey, selling at five dollars per pound. In addition, many agricultural areas rely on imported honey bees to pollinate important commercial crops, from almonds to apples.

Entomologist Larsen emphasized how honeybee density is an important factor in the pollination crisis. "Personally, I have two beehives behind my house, but the native bees still are abundant," he said. "I've had Rusty Patched bumblebees six feet from my house on some of our native plants with honeybees present."

The honeybee is no fix to the pollination crisis, Valido said, but rather the opposite. We need to "stop using honeybees as a quick solution," he continued. In addition, he said, humans can help struggling native pollinators by planting native plants. Ultimately, humans' ability to do so well hinges on supporting and training devoted managers and ecologists for natural areas.

Another problem? People know the honeybee. People love the honeybee. So, Valido ruminated, "they are using the 'prop' to solve their problems." — with "they" referring to the agroindustry at large. Though unsurprising in many ways, these findings on the honeybee are still quite novel. Valido expects that his findings will take some time to gain traction with the public, thanks to the honeybees' public image. The next time you get caught up in the buzz around honeybees, just remember: the makers of honey aren't always as sweet as you'd expect.

KATY'S KOMMENTARY

KATY FOLTZ, LAB AND OFFICE COORDINATOR

Year One at this role has certainly been a rollercoaster for me but like all good rollercoasters, the adrenaline and endorphins keep you going. I am often asked, "What is it that you actually do at your job?" and I find that I struggle to comprehensively describe my day-to-day schedule because it is always different. But for this Kommentary, I thought I might give it a go.

I usually arrive on campus around 9:00 am, depending on how fast I complete my morning routine and if I am teaching night lab that evening. After opening the Geology Museum, I head to the office, where I spend most of my morning resetting our student coffee bar, answering emails, tracking applications for Wheaton in the Black Hills, or paying bills. Students and faculty will filter through the office as they shift from class to class, dropping by for a visit, grabbing chocolate or a hot beverage, or to print off labs. As I co-instruct our Intro Lab sections with Lisa Heidlauf, I'll also be reviewing the labs for the week, begin prep for next week, and approve timecards for our fantastic TAs.

Many of our major classes are clustered around the lunch period, so I usually have a large influx and exodus of students between 12:30-2:00. At times, there can be 8-10 students in the office in addition to a faculty member printing or heating up lunch. I really love these times because the energy is palpable and permeates through the department.

The afternoon is back to the computer but with more interruptions as people drop by with questions or just to chat. As I run around the department bossing both faculty and students, organizing and cleaning up



Prof Heidlauf and Prof Katy enjoying a well-deserved field trip to Matthiessen State Park in Ottawa, IL.

the labs, and opening study spaces for students, I'm reminded of my own time as a student and how much this department felt like home. This is where I feel like I can contribute to the department community best.

My day usually ends as the department grows quiet. I reset my To Do list, revisit the calendar to prep the next day's meetings or upcoming department events, and then head home. As opposed to my last job, I appreciate that I can usually leave work at work, that it does not overly linger as I decompress at home. It's a blessing to be around these amazing students and supportive faculty, who make this role worth it.



Wheaton Geologist at the Helm of Brunton Compasses

Last year, Lauren (Powell) Heerschap '01 and her husband David became the owners of Brunton, the company that manufactures the essential geological field tool, the Brunton Transit Compass. Lauren's role is CEO and majority owner. They have been employed by the company since 2014, after their successful pitch to manufacture their patented Axis Transit Compass. The company is based in Riverton, Wyoming, where it was founded by W. D. Brunton in 1894. Lauren was a double Bible and Geology major and spent the spring semester after her December graduation as a field assistant to Dr. Moshier in the North Sinai, Egypt. While the other essential geological field tool is the rock hammer, there is no indication that the Heerschaps will be taking over Estwing in the near future.

LUHMANN'S LETTER

ANDREW LUHMANN, ASSISTANT PROFESSOR OF GEOLOGY

It has been another year, and Covid is still with us. I felt like I was on fumes while finishing last spring; the pandemic has made an impact on us all. This past semester, it was good to be able to hop in a bus or van with students and return to more normal field trips. This semester, I am blessed with a parental leave, as my wife Audrey just gave birth to our daughter Ruby Spring. I know, this is quite the name for a father who loves earth and environmental science; we also love that Ruby Bridges, whom our Ruby is named in honor of, lived her life so bravely as a little girl to bring about good change, and there are numerous reasons for her middle name, one of which is the work of the Holy Spirit in our lives.

We completed the data collection portion of my karst aquifer project in Florida this past May. Senior Geology major Calvin Block joined me and our team during the demobilization trip. We initially planned to monitor for seismic and tilt changes that result from recharge events over a two-year period of time, but this was extended to three years with the traveling restrictions brought on by Covid. Students at the University of Florida were critical in keeping our instrument network downloaded and maintained during the final year, giving us a rich dataset.

Shortly after I returned from Florida, I headed to the Black Hills with a caravan from Wheaton. I was at the Science Station for the first two weeks of the summer session, where I team-taught Nature, Environment, and Society with Dr. Keil and Doc Mo. During the first week, I joined Dr. Keil, (the newly minted Dr.!) Ben Lowe ('07, who was teaching the sustainability courses with Dr. Keil), and the students in their classes field trips and class discussions and planned a couple of other field trips for the following week. In week two, I led the students by focusing on water resources, and it was great to have Provost Karen Lee and Dean Becky Eggmann join our class for a day in the field. We had a great group of people in the Black Hills this past summer, and many memories were made in our Covid-free bubble.

I have had opportunities to engage with many people over the past year on fun and engaging research projects. I was able to work with Paul Isihara (Wheaton Professor of Mathematics) and Lucy Henneker (current Wheaton math major) on a paper that explores the use of complex analysis in the characterization of relatively simple groundwater contamination plumes. I have also been collaborating with Alireza Kavousi and other colleagues in Europe on flow and transport modeling in karst aquifers, which is using a dataset that I collected during my PhD studies. There are also several papers that I continue to work on with colleagues at various writing, review, or revision stages that explore physical-chemical-mechanical impacts in geologic carbon sequestration environments (with colleagues at New Mexico Tech, including Jason Simmons, who completed his MS thesis) or geophysical responses that result from recharge events in karst aquifers (with colleagues at New Mexico Tech; the University of Alaska Fairbanks; the University of Florida, including Han Byul Woo, who completed his PhD thesis; and the University of Arkansas). In addition, one of the tenure requirements at Wheaton is to write a faith and learning paper. I am currently working on mine, which explores scientific and theological connections between water and life.



Dr. Luhmann's students can usually be found playing in the water. Here are some of his Geomorphology students measuring stream flow of the DuPage River.

Finally, I am continuing to work on the karst aquifer museum exhibit with Ethan Emerson (Environmental Science major), Julia Baer (Philosophy integrated with French major), and Samuel Dunbar (Geology and Applied Physics double major) that I mentioned in last year's update. Custom work takes a lot of time and trial and error, but we are currently working with foam board to create 3D intricate cave passages. The students have great ideas and are going to make this a much better product that I initially anticipated.

Peace to you all, and please do keep in touch!



It was great visiting with our Wheaton Science Station alumni this past Homecoming at the Annual Black Hills Alumni Breakfast.

Publications

Wheaton people in bold

Isihara, P., L. Henneker, A. Luhmann, N. Bowden, D. Bremner, J. Higgins, S. McKay, and J. Reyes. 2022. A groundwater contaminant extraction model using complex potentials. *Journal of Undergraduate Mathematics and its Applications (UMAP Journal)* 43 (1), 39-76.

Maneiro, K.A., Jordan, M.K., and Baxter, E.F. (2022). Detrital Garnet Geochronology: A New Window into Ancient Tectonics and Sedimentary Provenance. In K.W. Sims, D.P. Schrag, and K. Maher (Eds.), *Isotopic Constraints on Earth System Science, Geophysical Monograph*, 273. John Wiley and Sons, Inc. DOI: 10.1002/9781119595007.ch09

Abstracts

Wheaton people in bold

Simmons, J., S. Wang, **A.J. Luhmann**, A.J. Rinehart, and J.E. Heath. 2021. Coupled chemomechanical feedbacks from experimental CO₂-rich fluid-rock interaction in uncemented lithofacies of Morrow B sandstone. Abstract MR52A-05 presented at the 2021 Fall Meeting, AGU, New Orleans, LA, 13-17 Dec.

Otu, S., A.J. Rinehart, **A.J. Luhmann**, and P. Mozley. 2021. Exploring the link between petrographic characteristics and chemically enhanced creep deformation in carbon sequestration reservoir conditions: An experimental study. Abstract MR55A-0004 presented at the 2021 Fall Meeting, AGU, New Orleans, LA, 13-17 Dec.

Gochenour, J.A., A.J. Rinehart, **A.J. Luhmann**, R. Grapenthin, and S.L. Bilek. 2021. Finite element modeling of poroelastic response to karst conduit pressurization and subsequent change in groundwater storage: Toward the use of high precision tiltmeters in karst aquifer monitoring applications. Abstract H35B-1044 presented at the 2021 Fall Meeting, AGU, New Orleans, LA, 13-17 Dec.

Kavousi, A., T. Reimann, T. Wöhling, S. Birk, **A. Luhmann**, J. Kordilla, T. Noffz, M. Sauter, and R. Liedl. 2021. Toward more realistic representation of discrete conduit features in discrete-continuum flow and transport models of karst systems. *Geological Society of America Annual Meeting Abstracts with Programs*, Vol. 53, No. 6, Paper No. 72-3, doi: 10.1130/abs/2021AM-369323.

Kavousi, A., T. Reimann, T. Wöhling, S. Birk, **A.J. Luhmann**, J. Kordilla, T. Noffz, A. Hartmann, M. Sauter, and R. Liedl. 2021. Dynamic controls on hydro-physico-chemical signal transmission in karst systems. Abstract presented at the 48th IAH Congress, Brussels, Belgium, 6-10 Sept.

for Awolayo, A.N., J. Byng, **A. Luhmann**, R. Lauer, B.M. Tutolo. 2021. Investigation of accessible reactive surface area for improved prediction of CO₂ mineralization in basaltic aquifer rocks. Abstract presented at the 2021 ACS Spring Virtual Meeting, 5-16 Apr.

Madsen, L., Maneiro, K.A., Brown, A., Dragovic, B. and Stevens, G. (2022). Bulk Lu-Hf Garnet Geochronology in the Southern Marginal Zone, Limpopo Belt, South Africa, Joint GSA North-Central & Southeastern Section Meeting, Cincinnati, OH

Maneiro, K.A. (2022). "Surviving" an Introductory Geology and Environmental Science Course during Pandemic Teaching, Joint GSA North-Central & Southeastern Section Meeting, Cincinnati, OH

Research Grants

- GSA North-Central Section Undergraduate Research Grant (Lauren Breederland Madsen)
- SCIO/CCCU Supporting Structures Grant for Wheaton College Natural Science Division (Co-written by K.A. Maneiro)
- Wheaton College Summer Research Fellow for Summer 2022 (A.J. Luhmann)

STUDENT ARTICLES

Lauren (Breederland) Madsen, GEOL '22 Geochronology Research Project

I began my research with Dr. Maneiro in the summer of 2020 as a research assistant working on a compilation of garnet ages and dating methods from across the globe. Before COVID, my plan had been to attend the Black Hills in Summer 2020 and spend the summer of 2021 in Boston working with Dr. Maneiro on garnet geochronology for 2 months. I would then write the first senior honors thesis of the Department of Earth and Environmental Science, since the department had recently gained approval for the departmental honors program at Wheaton. However, COVID threw a few wrenches into my plan for success, or so I thought. Despite the challenges of rescheduling plans and working around the unpredictability of COVID, I continued my research assistantship in the summer and fall of 2020 and began searching out a research project with Dr. Maneiro for the spring of 2021. As new opportunities opened for Dr. Maneiro's research, I followed suit and focused on a research project that serves as a pilot study for her current research. This project was a pilot run of a Lu-Hf bulk age on a garnet sample from the Southern Marginal Zone of the Limpopo Belt, South Africa, and I have continued this research into my honors senior thesis. While the Limpopo Belt is widely studied, there has been little metamorphic geochronology work done in the Southern Marginal Zone. My study provides an age for the metamorphic story as well as more clarification for the area by using updated and more precise garnet dating techniques.

As part of my thesis, and to learn to do the actual work of getting an age out of a garnet, I spent 5 weeks in the summer of 2021 dedicated to my garnet research as a part of a Wheaton College Summer Research Fellowship, which surrounded the 9 weeks I spent in the Black Hills that same summer. For the last 3 weeks of my summer research, I traveled directly to the University of South Carolina from the Black Hills of South Dakota and worked in the lab facilities there to go through all the steps necessary to get an age out of my garnet sample. I am so thankful for everything that I learned while I was there, from what it's like to work with dangerous acids in a clean lab almost every day, to what it looks like to do lab work in graduate school, to how important it is to enjoy working alongside your advisor as well as their other students, to receiving advice on applying to graduate school, and the list could go on! My experience at USC was extremely valuable not only for conducting real-life garnet geochronology research, but also for confirming my desire to attend graduate school in the next year and experiencing a little of what it might be like to be a graduate student. I learned that I want to be able to participate in some field work while in graduate school, and that working in the lab really isn't as bad as I thought it would be! It was pretty fun! Independent research has also been teaching me discipline and stretched me in ways I could never have

imagined. As I sit down this semester to write my thesis and prepare to present at the 2022 Joint North-Central & Southeastern GSA Section Meeting, I am very grateful for the opportunities God has provided for me here at Wheaton and for the opportunity to work alongside Dr. Maneiro, who has been an incredible advisor and mentor for me. I have had a wonderful experience in the Department of Earth and Environmental Science during my time at Wheaton and wouldn't want to have it any other way! Additionally, if you are interested in reading my research abstract, the citation is included on the publications page of this issue (p. 9).

Mariah Gascho, ENVR '22 Semester in Thailand

Before coming to Wheaton, I had never expected that I could spend four months traveling around Thailand while receiving a full semester's worth of credits. But that is exactly what I, fellow senior Grace Tate, and junior Ethan Emerson had the opportunity to do in the Fall of 2021 through the International Sustainable Development Studies Institute (ISDSI). This program, started by Wheaton alumni Mark Ritchie ('86), focuses on teaching sustainable development and conservation through three main courses: (1) Sustainable Food Systems, (2) Marine Ecology of the Andaman Sea, and (3) Political Ecology of the Forests.

After an amazing, albeit intense, summer of studying biology and ecology in the Black Hills at the Wheaton College Science Station, the three of us met the rest of our cohort in Los Angeles and boarded a plane to Thailand. COVID-19 complicated our trip drastically since Thailand was still entirely locked down. So, all 31 students spent the first 14 nights and 15 days in quarantine in a government facility in Bangkok. While in quarantine, we began Thai language lessons in the mornings and culture lessons in the afternoons, both of which began preparing us for the transition of living in a different country.

Once out of quarantine we flew to Chiang Mai where the ISDSI campus is located. The campus is constructed of old shipping containers and contains classrooms, offices, a library, a coffee shop, and a CrossFit gym. We spent the next two weeks finishing our Thai society course in which we discussed religion, sociological context, history, and politics of Thailand. We did several day excursions around Chiang Mai in which we visited a few religious institutions including a church, mosque, and Sikh temple. We had the opportunity to talk with a monk about Buddhism in Thai culture and visited many temples and stupas around Chiang Mai. We also noticed the underlying animism that is still a large part of Thai culture, especially through Spirit Houses.



Lauren Breederland Madsen ('22) extracting garnet ages at the University of South Carolina.



(L to R) Mariah Gascho ('22), Grace Tate ('22), and Ethan Emerson ('23) exploring Doi Inthanon National Park in Thailand.

In Sustainable Food Systems, we learned about several farming practices: sustainable, regenerative, polyculture vs. monoculture, organic vs. chemical (fertilizers/pesticides), agroforestry, and cash crops. We spent a week working on an organic farm in Chiang Rai and visiting other farms in the area. We also spent three days at the Nine One Coffee farm and two days at UHD, which is an organization focusing on development through agroforestry. During the last week of this course, our cohort did day trips to visit a few cash crop farms, including cocoa, cannabis, coffee, and tea.

The Marine Ecology course focused on studying ecology and conservation practices on the Thai coast of the Pacific and Indian Ocean. We studied the conservation practices of coral reefs, sea grass, and mangroves while also getting a first-hand view of sustainable fishing practices. We learned to make fish/seahorse houses and learned about the conservation efforts for the Blue Swimming Crab, all while kayaking and snorkeling for three weeks!

Last was the forestry unit. In Political Ecology of the Forests, we studied political dynamics surrounding the forest and the land. We visited both Karen and Hmong villages and learned about their sustainable, traditional farming practices, mainly rotational farming. We also researched stream health and forest types at varying elevations. Our last week was spent in Doi Inthanon National Park, the highest point in Thailand.

This program changed my life in many ways. Not only did it open my eyes to see and understand perspectives entirely different than my own, but it also gave me a deeper understanding into the realities that some people face. Our attitudes towards sustainability and environmentalism in the United States can be ignorant in the sense that we often don't see the effects of our actions. In Thailand, many farmers are incredibly dependent on their land and weather patterns for survival. As Christians, we have a responsibility to love and take care of the earth God has made, not only because it is an expression of who He is but also because taking care of the earth is taking care of those who depend on the earth for survival.

New Wheaton Aequitas Sustainability Fellows Program Launching in Fall 2022

Wheaton's Aequitas program, which provides multi-disciplinary, cohort experiences organized around a central theme to high-achieving students admitted to Wheaton, is expanding! In Fall of 2022, Wheaton will welcome the first cohort of Aequitas Sustainability fellows, with Dr. Maneiro serving as the coordinator for the new theme. Each year, approximately fifteen newly admitted Wheaton students will begin a four-year exploration of sustainability in a Christian context. Designation as an Aequitas Fellow allows students to receive additional merit-based scholarship support, partial funding to participate in the Sustainability Summer program in the Black Hills, and the benefits of many social, co-curricular, and curricular events and activities designed just for cohort students. Over their four years, students with majors from across campus will engage together in exploration of the principles of sustainability, will undertake hands-on sustainability proposals and projects, and will develop into leaders that advance sustainability on campus and with global partners. We are excited about how this new program will expand opportunities for Wheaton students to explore a critical global issue no matter what they decide to major in and for the energy it will bring to sustainability efforts on campus and in our classrooms.

Jenna Paulson GEOL '22 Appointed to USGS Internship

Wheaton College participates in a cooperative program between the National Association of Geoscience Teachers and the United States Geological Survey that awards outstanding field course students USGS summer internships. Established in 1965, this is the Nation's longest continuously running geoscience internship program. The objective of the NAGT/USGS collaboration is to provide exceptional professional development to the next generation of geoscientists while helping to build a diverse and inclusive workforce. More than 2,400 students have participated in the program since its inception, with many continuing on to distinguished careers with the USGS, in academia, or industry. USGS will hire approximately 50 of this year's outstanding field camp students.

Our nominee from the Summer 2021 Wheaton field course is senior Jenna Paulsen. Jenna has been appointed to Pennsylvania Water Science Center, New Cumberland PA. The station works in cooperation with numerous federal, state, and local agencies to collect scientific data and conduct scientific studies of the source, quantity, quality, ecology, and use of Pennsylvania's water resources.

Jenna is a second-generation recipient of an NAGT/USGS summer internship, following her father, Sean Paulsen, who attended Northern Illinois University. Jenna also has deep Wheaton College Geology roots, following her grandfather Rik Haugen (GEOL '67) and uncle, Chris Haugen (GEOL '95). The nomination is by no means a rubber stamp for acceptance. Jenna completed extensive applications and interviews resulting in two invitations from USGS offices.

WAYS TO FINANCIALLY SUPPORT WHEATON GEOLOGY

It's possible to specify the following endowed funds as part or all of your giving to the College that will directly support Geology majors:

- 1. Dr. Donald C. Boardman Black Hills Award** - provides partial program fee scholarships for geology majors to attend their required summer field course at the Wheaton College Science Station.
- 2. Wheaton College Geology Scholarship** - provides merit-based financial aid to geology majors for regular semester tuition.
- 3. Jeffrey Greenberg and James Clark Endowed Research Fund** - provides funds to enable faculty-student collaborative research and cover costs for field and conference travel.

We thank all the recent donors to these funds, which provide tangible and substantial assistance and encouragement to our students.

1965 Wheaton College Tower Yearbook Report on the Geology Department Author unknown

Tucked neatly away atop Breyer Laboratory, the corridors of the Department of Geology boast the pictorial biography of a local mastodon and the largest number of majors in recent years. A new fiberglass encased stream table came as a damp and solemn reminder of the soft rock orientation of the faculty.¹

Though numerically few, department majors have a puzzling and impressive record of professional success upon graduation. The emphasis on student responsibility and research, though often disconcerting, quietly prepares the chisel swinging undergraduate for the library demands of advanced training.

Immersed in unimaginative Illinoisan topography, the department squirms amid the limitations of indoor laboratories. In autumn, introduction classes jammed into busses and sang their way across moraines to the Ottawa Silica Company. Second semester, after studying fossils with scissors, a busy weekend was spent at the Wisconsin Dells running from the rickety Helland Hotel to follow Dr. Boardman and Mr. Block as they raced across the countryside pointing out drag folds and ripple marks, or watching cross-bedded reflections on a mirror river. Each claiming credit, majors and Dr. Boardman finally got away from glacial

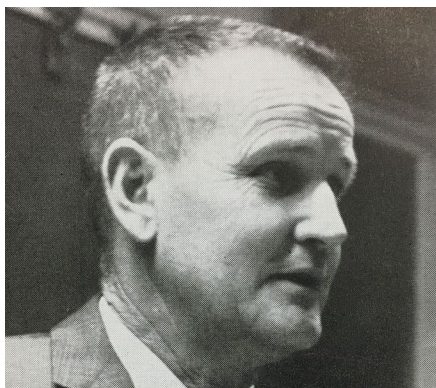
till and plundered the geologic library of the Grand Canyon during spring vacation. Geology all but jumps out from Wheaton's western campus in the Black Hills of South Dakota for summer students.

The glamor having worn thin, this year continued the patient reconstruction of the Perry mastodon. Junior zoologist Larry King sculptured missing bones and prepared others for fiberglass casting.² True to form, the department unearthed reconstruction assistance from a Chicago firm interested in manufacturing mastodons.

The synthesizing conclusions of the geologic sciences find Wheaton students less than defensive about the implications of their work to faith. Instead, the data with which they deal adds depth to their reflections about the Creator.

¹ The stream table was built by Larry Benson '66. He recently wrote Dr. Moshier about it: "I had been employed by DCB since my freshman year for anywhere between 12 and 15 hours a week, teaching labs, mounting his colored geologic map collection, making a stream table, etc. in order to pay my tuition. I also finished off the cabins at the S. Dakota field site when taking field geology one summer, and taught field geology the summer after my graduation."

² Larry King '66 retired from his medical practice in New Jersey and moved south to warmer weather. His work identifying the mastodon bones and determining how to put them together was essential to the reconstruction effort.



DOC MO'S MEMOIRS

STEPHEN O. MOSHIER, PROFESSOR OF GEOLOGY

Last spring, I wrote my annual CONTACT “memoir” from the central Texas hill country. Carol and I had a delightful sabbatical there, despite the notorious winter freeze and power blackout that forced us into a hotel for ten days! COVID closed the U Texas archive that owns the Frederick Barker diary that I was depending upon for one of the projects (Barker was the first natural history instructor at the college in 1861). However, I devoted most days to work on the Perry Mastodon book project. I have completed seven of eight chapters and should have a good draft of the whole thing by May. Corresponding with alumni involved in the excavation and restoration has been a highlight: Larry Benson, Jim Gill, Gaylon Lee, Dan Brinkman, Don Boardman’s daughters, and Larry King. Other correspondence includes Judge Perry’s grandson and Richard Rush’s daughter (Rush was the exhibit designer) as well as other eye witnesses.

We were only back from Texas for two weeks when we headed out again, this time to South Dakota and the Wheaton College Science Station. I introduced a new course for geology majors: GEOL 345 Sedimentary Geology. We pulled sedimentary rocks out of the petrology course to give Dr. Maneiro more time to cover the “hard rocks” and add a dose of high temperature geochemistry and geochronology to the course. I collected a suite of sedimentary rocks from the region in 2019, so we had thin sections for all of the units we studied in the field. The format was lectures in the morning, field trips in the afternoon, and thin sections study in the evenings. I think the students slept on the weekends. The two-week intensive was followed by the regular six-week geologic mapping course with “western trip” to Yellowstone country. After the sedimentary rock course, I stayed an additional week to contribute to a gen ed course: Nature, Environment and Society. My week with the students focused on natural resources and land use. We visited abandoned, working, and prospective mining sites on one day, including the Open Cut at Lead. Another day we visited Bear Butte, the Vore Buffalo Jump, and Devil’s Tower, with focus on the significance of the sites in Native American history and culture (see article on pg. 2).

I have now taught GEOL 308: Energy and Climate Change twice after inheriting the course from Jim Clark. While I touch on climate science in other courses (especially Earth History) and have a pretty solid background in traditional energy, I had to catch up on renewable energy. I really appreciate the contributions of Scott Tinker’s Switch Energy Alliance at U Texas/Texas Bureau of Economic Geology and the copious output from Climate Scientist Katharine Hayhoe, among other sources of good material. A highlight included a class session with **Craig Gordon** ’95 who is currently Senior Vice President for Government Affairs at Invenery LLC, North America’s largest privately held renewable energy company. He eloquently described projects and more importantly, how students (from a number of majors) can prepare for a career in this growing industry.



Congratulations to Dr. Moshier on his 30-year anniversary at Wheaton College!

MANEIRO'S MUSINGS

KATHRYN MANEIRO, ASSISTANT PROFESSOR OF GEOLOGY



It has been another year full of unexpected challenges and new ways to watch God at work. In Spring of 2021, I was diagnosed with a rare form of cancer. Despite being rare overall (and even more atypical for my demographic), it is considered highly treatable with long and durable remissions, and I was quickly referred to an experienced oncologist. Praise God! God also provided for field camp instruction while I was on medical leave for treatment in Summer of 2021 by allowing Dr. Charles Carrigan from Olivet Nazarene University to take over, with Sophia Becker ('20) as a field assistant for a couple weeks. I was able to return to work in August 2021. In one additional major twist for the year, in the Fall of 2021 we found out that we are expecting a miracle baby, due in June 2022. Maternity leave coming Fall of 2022!

Wheaton has returned to fully in-person learning this year. In Fall of 2021 I taught Igneous and Metamorphic Petrology for our majors and a section of our combined geology/environmental science introductory course. Although this was the third time I have taught Petrology at Wheaton – it was a third totally new course overhaul as we have finalized the shift to a full semester of Igneous and Metamorphic Petrology by removing Sedimentary Petrology from the course to be covered between two weeks in the Black Hills and Earth History and Stratigraphy. In Spring of 2022 I am teaching two sections of our intro course. We have good enrollment for both sections this semester, so we are hopeful that some new majors may join the department. Meanwhile, I am working to keep up with 110 intro students!

Over the past year, I have also been working on an expansion of Wheaton's Aequitas program. I will serve as the theme coordinator overseeing the new Aequitas Sustainability theme, which you can read about in

the Wheaton College article announcing the new program. I am also continuing as the faculty adviser to the Student Government Executive Vice President of Sustainability and co-advising the Garden and Prairie Project, which oversees the new campus garden and helps fight local food insecurity.

Finally, research continues. I am working with student researcher Lauren (Breederland) Madsen ('22) on the preparation of the department's first honors thesis. During the Summer of 2021, Lauren visited the University of South Carolina to complete a bulk garnet age on rocks from the Limpopo Belt in South Africa to help resolve tectonic timing in a critical Archean craton. She will present this work at the Joint GSA North-Central & Southeastern Section Meeting in Cincinnati, Ohio, in April. I also helped Wheaton submit a grant application to the SCIO/CCCU Supporting Structures grant competition, and we were awarded the grant! As part of the grant, I will be given a full semester of research leave in Spring of 2023 to continue the project Lauren has started and will also travel to Oxford to participate in science and faith integration training. You can read more about the grant here: <https://www.wheaton.edu/news/recent-news/2021/june/cccu-and-scio-grant-for-natural-sciences/>. Finally, I have submitted final proofs for publication of an invited chapter in an AGU Monograph sometime in 2022 following pandemic delays.

Between maternity leave in Fall 2022 and research leave in Spring 2023, this upcoming year will take me away from the department physically. However, it means there will be a lot to report in next year's CONTACT!



DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCE

501 College Avenue
Wheaton, IL 60187

NON-PROFIT
U.S. POSTAGE
PAID
CAROL STREAM, IL
PERMIT #122



SEND IN YOUR BEST CAPTIONS TO GEOLOGY@WHEATON.EDU BEFORE MAY 8.
WINNER WILL RECEIVE A FREE BLACK HILLS 2021 JACKET!