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Wheaton College
For Christ and His Kingdom

CONTACT

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

Petrography and Petrology class posing between the cliffs of Pennsylvanian sandstone at Giant City State Park, southern Illinois.

INSIDE THIS ISSUE:

From the Department Chair

STEPHEN MOSHIER

2018 was a year of change for the Department of Geology and Environmental Science. We celebrated the retirements of Jeff Greenberg and James Clark, said goodbye to our colleague Sam Smidt, and welcomed three new faculty colleagues who you will meet in this issue of CONTACT. Over the summer the Black Hills program hosted geology and environmental science majors and many visitors. During the fall, our new team reviewed the geology major curriculum. We submitted proposals for course changes for both majors that we are looking forward to offer starting next year. There were many notable alumni visits and interactions this year that encouraged us and provided another reminder of how God continues to bless our program here at Wheaton College. I invite you to read and enjoy this issue of our alumni newsletter.

ALL DRESSED UP FOR THE FACULTY BANQUET (L-R: ANDREW AND AUDREY LUHMANN, CHRIS AND MAUREEN KEIL, KATIE AND ANTHONY MANEIRO, GILLES TAGNE, CAROL AND STEVE MOSHIER)

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

STUDENT AWARDS

JEFFREY LEEBURN, 2018 HADDOCK AWARDEE

2018 Gerald Haddock Award to Outstanding Geology Senior Jeffrey Leeburn

Jeffrey Leeburn received the 2018 Haddock Award for his excellent academic work, service to the department and absolute enthusiasm for all things geological. Jeffery was raised in North Carolina and came to Wheaton College with interests in both science and piano performance. He readily took to Geographic Information Systems, which earned him two summer internships at The Johns Hopkins University Applied Physics Lab, working on the stratigraphy of Mercury by studying impact crater ejector. He contributed to papers presented at the annual Lunar and Planetary Science Conference in Houston. He continued to work on projects for APL during the academic year at Wheaton. He and fellow geology major Benjamin Hess spent many a weekend traveling to mineral and fossil collection sites throughout the Midwest. Jeffrey is now midway through his first year of graduate study at Penn State University.

KIRSTIE WHITE, 2018 MUIR AWARDEE

2018 John Muir Award to Outstanding Environmental Science Senior Kirstie White

The John Muir Award is given annually to the outstanding graduate of the year. The award is based academics, extracurricular activities, departmental involvement, internship / field course / research performance, and leadership. Kirstie White, our 2018 awardee, distinguished herself by the breadth of her participation while a student. Not only a very good student, Kirstie served as a teaching assistant for the Introduction to Environmental Science class. She spent the summer after her freshman year studying in the Black Hills where her natural positivity and energy helped build the community out there. She was also active in A Rocha and helped with leadership in a number of the club's initiatives. Kirstie completed a restoration ecology internship with Lake Forest Open Lands. In addition to the practical hands-on aspects of restoration ecology Kirstie got to interact with the public, governmental officials and donors.

As a top-level tennis player for three years on Wheaton's tennis team, Kirstie won over 75% of her matches. Despite the promise of a spectacular senior year season, Kirstie decided to spend that fall semester studying abroad at ISDSI in Thailand. Always a hard worker, she jumped into a part-time job upon her return from Thailand to finish out her senior year on campus. While discussing candidates for John Muir award, all of the faculty noted Kirstie's intangible positive effect around the department. From helping with singing at department chapel, to promoting the Environmental Science program to current and potential students, to bouncing up and down our hall, poking in her head to say "Hi!," Kirstie was a great blessing to the department. Perhaps someday, someone will endow a financial award. But until then, we hope the recognition and name on a plaque is a sufficient expression of our appreciation of the excellence of students like Kirstie.

GSA in Indianapolis: A Stepping Stone to the Future

ANDY MARGASON ’20

PHOTO: ANDREW MADSEN
EXCITED TO SEE FRESH CORE FROM THE STILLWATER MINE IN MONTANA.

“So, what do you want to do in geology?” said the graduate student from Kansas. It was the ninth time hearing that question after visiting nine consecutive graduate school booths, and quite frankly I didn’t have an answer. Before spending time as a Wheaton College student delegate and student volunteer for the GSA conference in Indianapolis, I was uncertain as to what my future held in geology. However, after several days surrounded by brilliant minds and like-minded peers, I began to understand what I wanted to pursue with my major in “rocks.”

As a student delegate from Wheaton, the GSA conference presented great opportunities for me and other undergraduates to meet professional geologists. On the third day of the conference I had the privilege to meet Deana, a geology consultant, in a mentoring session. Deana worked with me to figure out potential future options in the broad field of geology. Three months later I am still contacting her asking for her advice.

Furthermore, by working as a student volunteer for the conference, I was able to assist academic geologists representing all fields of research. My main job was to work as the right-hand in the technical sessions for those proctoring other geologists giving their research presentations. I learned about the evolution of knee bones through time and about teaching techniques in the classroom. However, the most fascinating subject to me was the memorial of University of Wisconsin Geology Professor Dr. Robert Dott, and the great life he lived as a stratigraphic geologist (he also wrote our Historical Geology textbook).

My time at the GSA conference in Indianapolis was well spent by meeting exciting new people and ascertaining more about the opportunities for up-and-coming geologists, like myself.

Granite Boulder Moved to Meyer Science Center

The Perry Mastodon may be our largest specimen, but the heaviest is surely the red granite boulder that sat beside Breyer Lab for sixty years. The six-ton boulder was excavated during a construction project not far from the campus and first identified by Dr. Donald Boardman. The landowner donated the boulder to the college and it was moved to campus in late 1958. Dr. Boardman recognized its educational value as a glacial erratic derived from the Canadian Shield. After the Meyer Science Center was built, numerous contractors were asked to move it from the Breyer location. No one wanted the job! Finally, with the impending demolition of Breyer Lab to make room for a new Concert Hall, the boulder was finally moved in November 2018 to where it now sits along Howard Street at the southeast corner of Meyer. Some of you will be happy to know that the famous Gravity Rock was also moved from the grounds near Armerding to the landscaping behind Meyer.

RED GRANITE GLACIAL ERRATIC IN ITS NEW LOCATION, DRESSED UP FOR CHRISTMAS.

GILLES' JOURNEY

GILLES TAGNE, VISITING ASSISTANT PROFESSOR OF ENVIRONMENTAL SCIENCE

Hi, my name is Gilles Tagne. I am one of the three new hires of the Department of Geology and Environmental Science at Wheaton College! It is a real blessing to embark in this journey as a faculty at Wheaton College, a blessing to being part of such an amazing cohort of young and dynamic faculty (within the department and at the college at large) who are so passionate in investing in God's kingdom through teaching and mentoring students.

Welcome to Wheaton… Transitioning into a new life's season
Embarking on this journey was not the easiest. In fact, as someone who has moved around 4 different countries in the last 8 years, I will admit that my transition to Wheaton College is among the hardest. As a new faculty, I was constantly challenged in understanding what it is that I am bringing as a person into the classroom, what is my mission and my God-given goals for this new season... But amidst all these questions, my life over the last 6 months can be summarized into a story of God's faithfulness through my doubts and my feelings of inadequacy, his patience and willingness to bless my weak and sometimes hesitant "yes-es" and bring fruitfulness to the work of my hands.

My day-to-day life at Wheaton
Last fall, I have been teaching one general education (Christ at The Core) class (Introduction to Environmental Science) and one GIS (Geographic Information System) course. I am also in the process of completing my PhD dissertation work at Ball State University where I worked in understanding recharge and contamination patterns in groundwater in Eastern Kentucky. My defense is rescheduled for March. As a new faculty, I am also taking part in a biweekly "Faith and Teaching" seminar. The seminar is an opportunity to mingle and fellowship with other new faculty, hold each other accountable, hear stories of success and failures, and learn how to apply successful teaching pedagogy into our classroom.

Besides my teaching, dissertation, and faculty development commitments, I am continuing a research project I started last summer with a Christian non-profit organization, aiming to improve access to clean water in rural parts of Sierra Leone. I spent 4 weeks of intensive sampling and meetings with staff and government officials there. As I took on this faculty position, reflecting on ways to involve students and the Wheaton College community in this project has been one of my top priorities. I was awarded a John Stott Faculty Internal Grant ($5,000) to cover part of the travel and lab expenses for my next sampling trip (summer 2019) in Sierra Leone. I have also applied to a larger external grant from the Society of Exploration Geophysicists (SEG) that could help cover additional summer research expenses and other analytical fees. Meanwhile, I presented some preliminary results from last summer at the Geological Society of America's Annual Meeting in Indianapolis last November (see abstract on page 10).

I designed the spring GIS Practicum class as a research-based course experience to involve students in the Sierra Leone study. Students will design a GIS project involving the formulation of a research question and use some of the water quality data I gathered last summer to map the groundwater resource in Sierra Leone. Besides the idea of familiarizing students with the research I am conducting abroad, this will be a great opportunity for them to present their findings in form of posters to the Wheaton Community and to a broader audience at a national conference.

Leaning on others throughout the journey
"For if they fall, one will lift up his fellow. But woe to him who is alone when he falls and has not another to lift him up! Again, if two lie together, they keep warm, but how can one keep warm alone? And though a man might prevail against one who is alone, two will withstand him—a threefold cord is not quickly broken." Ecclesiastes 4:10-12

I am very thankful for the support of my colleagues but much more for the help I have so kindly received from my student teaching assistants. Most of them helped me with a huge part of my workload, carrying the burdens of grading or preparing labs even beyond their normal student work hours. After my first GIS lab session of the semester (which was a disaster), one of my TAs came to me and gave me some tips on how to revise the way I was giving the lab instructions. The "magic" tip worked so well during the next lab that I have adopted it for the rest of the semester! TAs' participation during the lab sessions was extremely helpful. One of my TAs agreed to cover a GIS lab on his own while I was attending a conference in Indianapolis, which was a huge relief!

Update: Gilles passed his dissertation defense on March 14!

PHOTO: LAST DAY OF GILLES TAGNE'S INTRO ENVIRONMENTAL SCIENCE FEATURED IN THE WHEATON COLLEGE INSTAGRAM DAILY
CREDIT: LAYLA LANDEROS (STUDENT)

MANEIRO'S MUSINGS

KATHRYN MANEIRO, ASSISTANT PROFESSOR OF GEOLOGY

KATIE MANEIRO TEACHES STRATIGRAPHIC CORRELATION TO HER EXPLORING THE DYNAMIC EARTH STUDENTS

Hello Wheaton alumni and friends! I am pleased to introduce myself to you, and I look forward to meeting many of you face-to-face in the future. My name is Dr. Kathryn Maneiro, although I generally go by Katie. I officially joined the Geology and Environmental Science department as an Assistant Professor in July of 2018 and I have been tasked with trying to replace the irreplaceable Jeff Greenberg. I jumped right in by spending the entirety of July 2018 at the Wheaton College Science Station, participating in field instruction by Jeff's side. He enjoyed introducing me as the "new Jeff who has to try and fill my shoes," and I enjoyed reminding people that my shoes are quite different from Jeff's!

I earned a Bachelor's degree from Olivet Nazarene University in 2011 with a double major in Geology and Science Education, a minor in Biology, and an Illinois high school teaching license. I then entered directly into a PhD program in Earth Science at Boston University, which I completed in 2016. Following my PhD, I completed a one year postdoc at Boston College before teaching for a year as a Lecturer at Indiana University- Purdue University Indianapolis. My husband, Anthony, and I recently bought a house in Wheaton, although Anthony continues to work as an attorney in New York City for now.

This year I am focusing on course updates and establishing a research trajectory. Going forward, I will teach the upper-level "hard rock" classes in the department, and I started with Petrology and Petrography in Fall 2018. Work is underway to reorganize the sequence of the "hard rock" classes to ensure that Geology majors complete Mineralogy, Petrology, and Structure in a logical order prior to field camp. We have also proposed a reorganization of the existing Petrology course to become a semester-long course in igneous and metamorphic petrology with high-temperature geochemistry and a new, separate course in sedimentary geology to be taught at the Wheaton Science Station. I enjoy bringing my pedagogical training to the classroom and helping plan out how we can position our students for the job market and graduate school. If you have suggestions, we would love to hear them!

I consider myself an isotope geochemist, and my primary research interest is garnet geochronology. I have worked on method development for new techniques that allow us to date detrital garnet for the first time. I also currently hold the world record for dating the Earth's oldest garnet, which is 3.2 Ga from South Africa. I have worked with garnet from around the world, including the Acasta Gneiss from the Canadian Shield and near the Jack Hills site in Western Australia. You are always welcome to come hold some of Earth's oldest rocks and minerals if you visit my office.

I currently have two undergraduate students (Bradley Dowell and Luke Penney) working with me to compile a database of all garnet ages in the peer-reviewed literature. This project is intended to serve as a valuable community database and will allow us to assess whether the metamorphic record from garnet matches peaks seen in age distributions from zircon that have been interpreted as representing super-continent cycles. Planning is also ongoing for a lab renovation that will bring clean lab capabilities to Wheaton College. Stay-tuned for updates on the renovations!

BRADLEY DOWELL ’20 LECTURES ON HIS EXPERIENCE ON THE GSA/EXXONMOBIL BIG HORN BASIN FIELD SEMINAR

Bighorn Basin Field Seminar

BRADLEY DOWELL ’19

A week after the end of the field course at the Science Station, I returned to the Rockies for another field experience as a GSA/ExxonMobil Bighorn Basin Field Award recipient. This one-week short course in petroleum geology emphasized integrated basin analysis techniques including interpreting sedimentary structures and stratigraphy. The annual field seminar is sponsored by the Geological Society of America Foundation and led by ExxonMobil geologists with experience in hydrocarbon systems in northwest Wyoming. I unintentionally fell into this opportunity by applying for a different GSA program, but I am quite grateful for this opportunity which has provided me great value and worthwhile memories. The trip was impactful to my geoscience education by solidifying many classroom concepts in the field—utilizing skills I acquired from stratigraphy labs and lecture concepts like Walther’s Law, but this time with beautiful outcrop on all sides.

The program brought together both undergraduate and graduate students to interact with GSA representatives and ExxonMobil geologists. It was a fun opportunity to represent Wheaton College and be the only person pursuing a liberal arts degree in geology. My time at the Bighorn Basin field camp gave me a wonderful experience applying lab material in the field with unique people, but it also was an interesting time of reflection and marveling at the wonder of God’s created order. The method of science is a fascinating pursuit of knowledge based on reproducibility. It’s truly incredible that science broadly, and exploration geology specifically, can utilize established relationships to discover resources deep in the ground that most people would walk over without any thought. In many ways, this ability requires discernment with how it is utilized, but it’s predictive power ought to be a marvel.

Retirement Event Honors Jim Clark and Jeff Greenberg

On the evening of April 2, more than fifty people gathered from across the continent to honor Jim Clark and Jeff Greenberg on the occasion of their retirements from Wheaton College. A catered dinner and much joy was shared in the elegantly-decorated North Party Room of the Beamer Student Center. The two honorees and guests heard many testimonial stories told by alumni, current students, colleagues and friends. Wheaton alumni included Kyle Arney ’93, Lara Bell ’94, David Curtiss ’92 and Susan Carns Curtiss ’92, Alex Fojtik ’17, David Heidlauf ’82, Chris (’87) and Maureen (’88) Keil, Sammy Mallow ’16, Jeff Schloss ’75, Bethany Thornton ’06, Peter (’71) and Virginia (’73) Vagt, Kaitlyn Wallett ’14, Ruth Williams ’82 and Steve Geiser ’82, and Ken and Helen Wolgemuth ’65. By video, Peter Brice ’11, Katie Foltz ’13 and David Wheatley ’12 introduced a new endowed fund, The Jeffrey Greenberg-James Clark Student Research Fund, to encourage and enable student research. Graduating Environmental Science and Geology seniors were also feted at the event.

JIM CLARK SHARES ONE MORE “TRUE STORY” AT THE RETIREMENT EVENT. (CREDIT: PETER VAGT ’71)

JEFF GREENBERG POINT-TIFICATES AT THE RETIREMENT EVENT. (CREDIT: PETER VAGT ’71)

GUESTS AT THE RETIREMENT DINNER FOR JIM CLARK AND JEFF GREENBERG IN APRIL (CREDIT: PETER VAGT ’71)

The Amazing Glen Ellyn Fulgurite

BENJAMIN HESS ’19

“A meteorite fell in my backyard!” That’s what Mrs. Janet Tuscher told Physics Professor Dr. AJ Poelarends over the phone in May 2016. Dr. AJ consulted with Dr. Moshier, who requested a photo from Mrs. Tuscher. Based upon the photo, Doc Mo could tell it was no meteorite: it was a lightning strike! Dr. AJ and Doc Mo arrived on site to find a phenomenal glass structure embedded in the ground. With his archeological know-how, Doc Mo excavated this stump-sized (~20 cm diameter) glass tube called a fulgurite. It extended about 40 cm below the ground before branching out into several thinner limbs.

The fulgurite, generously donated to the college, formed in clay-rich soil making it a type 2, or “clay fulgurite,” a type which has been little studied. Fulgurites are important because they may represent analogue systems for mantle processes: they form at high temperatures under reducing conditions, and some papers demonstrate that they may also form under pressures equivalent those in the mantle! Others believe they may contain clues to early planetary atmosphere formation.

In the Fall of 2016, I worked with Dr. Greenberg and two other students, Jeff Leeburn and David Tillman, to characterize the bulk chemistry and mineral structure of this fulgurite. In Spring 2018, I furthered the research by studying the micro-structure using a Raman confocal microscope at the University of Chicago. Raman allows you to determine not only the mineral but also mineral polymorphs. I continued my research at the University of Leeds, England where I studied abroad in the Fall of 2018. I worked with two Leeds faculty members, Sandra Piazolo and Jason Harvey, to finish the fulgurite research. We made EDS (elemental) and EBSD (phase and phase orientation) maps.

The inside of the fulgurite is a mass of amorphous silica glass, amorphous graphitic carbon, and micro-silicon carbide. The abundant silicon carbide is intriguing because it is only known to naturally form in meteor impact sites and potentially the deep earth. Within the fulgurite center was a millimeter-sized spherule composed of copper, antimony, and iron, as well as other smaller iron-phosphide spherules. The origin of the antimony is unknown, but the metals suggest that under the high temperature, reducing conditions, the metals are highly mobilized and concentrate

The outer rim of the fulgurite is marked by a sharp transition to a more vesicular structure with crystalline grains. Here we identified TiO2 polymorphs rutile and anatase, feldspar, zircons, and several quartz grains. Lining the edges of some of the larger vesicles were spherules of native iron, demonstrating the reducing nature of the formation process. The EBSD data shows the quartz has been thermally shattered and not shocked; therefore, this fulgurite is high temperature and low pressure, unlike sand and rock fulgurites which appear to form under high pressures. One EBSD map showed a shattered quartz grain with normal alpha quartz cores surrounded by smaller bits of cristobalite (a high-temperature quartz polymorph), demonstrating the phase transition taking place.

These results will lead to one, possibly two publications: the first, discussing the results of this case study, and the second, dependent on the work of Sandra Piazolo, may be on the size-based kinetics that controls the phase transition from quartz to cristobalite and back.

BENJAMIN HESS AT THE CONTROLS OF THE RAMAN MICROPROBE SCANNER AT THE UNIVERSITY OF CHICAGO

Diversity of People and Rocks Makes Field camp Special

APRIL PHINNEY ’20

I distinctly remember my moment of realization while sitting on a quartzite outcrop at the base of Bear Butte. Between bites of roast beef sandwich and conversation with my work partner, the land below suddenly transformed in my mind from patches of colorful rock into a geologic formation. This shift from random details to a cohesive structure characterizes the academic, relational, and spiritual transformation I experienced this summer at the Wheaton College Science Station (WCSS).

Selecting individual highlights from the geology learning experience is nearly impossible since every day was an adventure. However, few members of our class will forget the Whitewood mapping project. On one day temperatures reached 101°, while the next day rain soaked through every layer of our clothing and we ultimately retreated to eat lunch inside a tractor garage. Not only did we learn how to identify synclines and anticlines, but also how to sweat/slosh through less than ideal conditions.

One highlight of our field explorations was touring the Stillwater Mine in Montana, which brought us through the core lab and up to an abandoned World-War-II-era chromite mine in this famous layered mafic intrusion. After fixing a flat tire and filling our arms and pockets with the maximum number of chromite chunks possible, we conversed with two Wheaton geology alumni who live in Red Lodge over pizza. This connection not only made it possible to learn from and explore the amazing mine, but also provided a valuable and encouraging glimpse into the post-Wheaton life of a

LUHMANN'S LETTERS

ANDREW LUHMANN, ASSISTANT PROFESSOR OF GEOLOGY

I was grateful to return to the department this fall as one of the new faculty members, having started my scientific pursuits here as a geology major ('06). For the past three years, I was an Assistant Professor of Hydrology in the Department of Earth and Environmental Science at New Mexico Tech. I spent nine years at the University of Minnesota – Twin Cities before that. My research focused on karst hydrogeology during the five years of my doctoral studies, and my postdoctoral research in the following four years focused on reactive transport in the context of geologic carbon sequestration and serpentinization.

In the fall I taught a general education course titled Water: The Essential Natural Resource, covering a wide variety of topics relevant to water resources. The highlight for the class was a field trip to the West Branch of the DuPage River to measure stream flow. One student, a Business-Econ major who frequently fishes locally, did not believe me that we would be spending class at the river. That is, until I asked him to carry a pair of waders to the vehicle at the beginning of class. Needless to say, he and the other students (from a variety of other majors) loved class that day. I am now teaching Hydrogeology this spring and am enjoying interacting with a lot of our upper division majors as well as a retired physician who is auditing the class; I was surprised to find out that he is the son-in-law of my namesake from Langdon, ND! (The world is small!) We have some very bright students and I am starting karst hydrology research projects with some of them.

A group of us from Wheaton attended the nearby Geological Society of America Annual Meeting in Indianapolis this year, including new faculty (Katie Maneiro, Gilles Tagne, and me) and students (Bradley Dowell, Aleks Glavnik, Andy Margason, April Phinney, Libby Quinn, and Michaela Sandeno). We all had dinner together one night with alumni Christina Richardson, Andrew Graber, and Sammy Mallow, and department friend Chuck Carrigan from Olivet Nazarene University. I gave a talk at the meeting about seismic responses to artificial and natural recharge events in karst aquifers and was heavily involved with the technical sessions in the Karst Division, having served as the division's Primary Representative for the Joint Technical Program Committee.

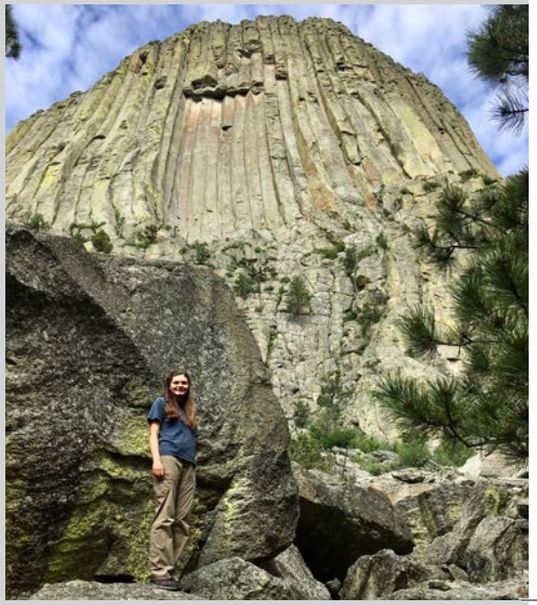
This past summer we started a research project funded by NSF monitoring geophysical responses to recharge events in a karst aquifer in north-central Florida to map conduits, characterize the subsurface architecture, and potentially monitor for flow. We are looking for small-scale deformation from flow processes in the conduits across a range of timescales. I am collaborating with a great group of colleagues from New Mexico Tech and the University of Florida. I am also still involved with carbon sequestration research, working with a few grad students at New Mexico Tech who are conducting experiments to explore various processes that result from CO_2 injection into the Farnsworth Field in Texas, part of the DOE-funded Southwest Regional Partnership on Carbon Sequestration.

When not working on teaching or research, my wife Audrey, also a 2006 Wheaton graduate, our children Benjamin, Samuel, Lucy, Nathan, Joshua, and Karena and I have been exploring our new neighborhood and working on house projects. Audrey and I have been reconnecting with classmates who are still in the area. I enjoyed lunch one day this past fall with Tim Bayley '05, who is a Principal Hydrogeologist at Montgomery & Associates in Tucson. I look forward to interacting with other alumni and friends of the department in the future. We are grateful to be here!

geology major. Truly, camp provided us with both a solid geology tool belt and a colorful variety of life skills.

The people at WCSS were just as varied as the rocks of the Black Hills. As the summer progressed the spectrum of personalities represented in the geology class became unified around jawbones in the badlands, soggy hiking boots, and victory cones (ice cream celebrating the end of each mapping project). It was a joy to learn from Dr. Carrigan and Dr. Moshier for the first half of the summer and then be the final class to experience Dr. Greenberg's excellent field tutelage, while meeting Dr. Maneiro for the first time. In spite of- and even because of- our differences, we to enjoyed and learned much together.

Those rocks and people pointed me to the beauty and wisdom of God. A stunning lightning show over Mount Wheaton, conversations with friends, and morning scripture reading and prayer lead me to more fully rejoice with the psalmist, "how majestic is your name in all the earth!" (Psalm 8:1). This combination of discovery, a dynamic team, and the beauty of God displayed through creation stimulated such a meaningful summer in the Black Hills.



APRIL PHINNEY '20 UNDER DEVILS TOWER, WYOMING

ABSTRACTS FROM RECENT PROFESSIONAL MEETINGS

GSA 2018

Modeling Irrigated Pumping Data for the High Plains Aquifer in Western Kansas

ALEKSANDR GLAVNIK, WHEATON COLLEGE;
SAMUEL J. SMIDT, UNIVERSITY OF FLORIDA

The High Plains Aquifer is a predominant resource for irrigated agriculture in Western Kansas. However, prolonged rates of pumping have depleted the supply faster than it can naturally be replenished. Here, we analyze pumping data from almost 5,000 wells from 1990-2013 to identify trends between water pumping and groundwater decline. We applied a water-balance sustainability model to extrapolate regional pumping rates to better inform water conservation strategies and end-user decision making. We found the correlation between pumping and water level change to be nonlinear, where a moderate amount of pumping led to the greatest water level decline. We then explore other degrees of complexity by applying a polynomial fit model to represent the data. Results from this study can be used as pilot data for research questions focused on water use decision making and aquifer sustainability.

GSA 2018 – BEST STUDENT POSTER AWARD – HYDROGEOLOGY DIVISION

Identifying Factors of Groundwater Consumption Across the High Plains Aquifer

LIBBY G. QUINN, WHEATON COLLEGE;
SAMUEL J. SMIDT, UNIVERSITY OF FLORIDA

The water level of the High Plains Aquifer (HPA) continues to decline due to irrigation practices, leaving farmers in a dire situation; choosing to irrigate results in the depletion of the valuable water resource, and choosing to reduce irrigation results in lost current crop productivity.In this study, we analyzed key socio-agricultural system elements(e.g., market prices, groundwater legislation, and local management strategies) to identify predominate drivers to irrigation water use across the HPA. We collected county-level data in 2012 for each element and ran a linear regression model against aquifer groundwater levels to derive key correlations leading to groundwater decline. We found that the driving factors of groundwater decline include: total number of farms, acres of farmland, average farm size, total crop sales, largest crop commodity, average rainfall, per capita income, management district, recharge, and saturated thickness. According to our results, many of the variables tested do not significantly influence groundwater decline. These variables include: total population, population served by groundwater, and groundwater withdrawal type (fresh, saline, total, domestic). The results of this study may assist experts in focusing management plans and water use sustainability strategies across the HPA to extend the life of the aquifer.

Water Quality Assessment of Alternative Drinking Water Sources in Urban and Suburban Areas, Sierra Leone, Africa

GILLES V. TAGNE, WHEATON COLLEGE

The assessment of water quality for drinking purpose in Sub-Saharan Africa has been widely done using numerous criteria that usually vary from one country to another. In Sierra Leone, the Ministry of Water Resources has established a list of 34 criteria including biological (bacteria and pathogens), chemical and physicochemical properties that are used to assess the suitability of water for human consumption based on WHO recommendations. However, following the recent Ebola outbreak and the need to prevent the spreading of water-borne diseases associated with poor sanitation, both government and humanitarian aid efforts have focused their attention addressing the bacteriological component (Lapworth et al., 2015). As major concerns have been raised regarding groundwater chemistry in particular (elevated iron in the Freetown metropolitan area; naturally-occurring arsenic around mines in the Northeast), it is becoming clear that a more comprehensive picture of the quality of drinking water sources in the country should take into consideration other variables besides the biology. Ten biological, chemical and physicochemical criteria were used to assess the quality of drinking water collected from 142 alternative sources including packet water (73), communal water tank (36), groundwater samples (9), municipal grill (8), and retail bottled water (3). Although packet water is the most widespread and economically viable among all the other drinking water alternatives, it raises the biggest concern for public health among the 5 alternatives based on both biological and chemical criteria: 23% of samples falling above the WHO recommendations for coliform content; 15% above the recommended limit for iron content; maximum E-coli, Total Coliform and nitrate levels. To address the threat to human

health presented by packet water, it is suggested a thorough assessment of its content (quality control) and a reinforcement of regulations and incentives to reduce their marketability.

Seismic Responses During Recharge Events in Karst Aquifers: Potential Records of Pressure Pulses?

ANDREW J. LUHMANN, WHEATON COLLEGE; SUSAN L. BILEK, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY; RONNI GRAPENTHIN, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

Seismic signals have been recorded during recharge events in karst aquifers, including responses to both anthropogenic injection experiments and natural recharge events. Here, we highlight records that were collected near Bear Spring in southeastern Minnesota, USA. Temperature and electrical conductivity monitoring during a natural recharge event suggest that the spring is sourced by at least a couple of conduit flow paths. During this natural recharge event, surface displacements of up to 2 µm were recorded. The largest displacement corresponded to a time when spring discharge underwent a significant increase. It is likely that this displacement was caused by a pressure pulse or surge signal within one of the conduits in response to the recharge event, either from the conduit transitioning from open channel to full pipe flow or by a flood wave arriving at an already, fully submerged conduit. While both velocity and discharge generally increase as water levels rise in a conduit with open channel flow, both decrease as water levels approach and reach full pipe flow conditions. If this transition happens quickly, pressure increases, potentially producing a pressure surge or a water hammer effect. Regardless of whether the measured displacement resulted from the transition of open channel to full pipe flow or from a flood wave reaching a conduit full of water, pressure perturbations would travel at ~1500 m/s in conduits full of water. This particular displacement was first recorded at seismometers near the spring and successively later at seismometers further from the spring and at higher elevations, potentially suggesting much faster signal propagation through the water in the conduit than through the thin overlying rock and soil. Another series of displacements were recorded during one of the artificial recharge events, but the order of arrival times at the seismometers was reversed, likely due to lower water levels and only portions of the flow path full of water that led to slower pressure transmission through the conduit. Environmental seismology enables monitoring of dynamic flow processes in karst aquifers, and ongoing research is assessing how this information may be used to improve karst aquifer characterization.

Unraveling the Age of HT Metamorphism in Eastern Senegal: Evidence from U-Pb in-situ Analyses on Monazite and Sm-Nd Garnet Geochronology

J. KONE, L. BARATOUX, K.A. MANEIRO, E.F. BAXTER, O. VANDERHAEGHE, S. DUCHENE, P.M. NDIAYE, P. PITRA, G. DUFRECHOU, O. BRUGUIER

Metasediments of the Paleoproterozoic Diale Dalema Basin are affected by a polyphase metamorphic evolution during the Eburnean Orogeny (2.25 - 2.00 Ga). The garnet-staurolite-sillimanite metapelites contain two generations of garnet. Garnet porphyroclasts wrapped in the S3 schistosity contain inclusions of chlorite, epidote, biotite, ilmenite, plagioclase, and quartz that delineate the S2 schistosity. The development of S3 is coeval with the growth of inclusion-free rims around the garnet porphyroclasts and by garnet neoblasts. Garnet porphyroclast displays a zoning pattern typical of prograde metamorphism associated with decompression from 9 to 6 kbar and an increase in temperature from 550 to 620°C. Monazite neoblasts in the S3 schistosity yield LA-ICP-MS U-Pb ages of 2052 ± 7 Ma and 2048 ± 8 Ma, whereas inclusions in staurolite yield an older age at 2090 ± 16 Ma. Sm-Nd garnet geochronology yields a bulk garnet age of 2080.2 ± 7.7 Ma on garnet porphyroclasts and 2049.1 ± 3.1 Ma on neoblasts. The results highlight an agreement between U-Pb ages from monazites and Sm-Nd ages from metamorphic garnets. The oldest ages are interpreted as the age of the prograde regional metamorphism during burial, while the youngest are attributed to the thermal peak.

GOLDSCHMIDT 2018 CONFERENCE

Earth's Oldest Garnet: 3.20 Ga Garnet Ages Robustly Constrain the Timing of Early Metamorphism

K.A. MANEIRO, K. CUTTS, E.F. BAXTER, AND G. STEVENS

Earth's earliest metamorphic stories have been told using zircon and monazite ages with thermodynamic modeling, but the Archean garnet record has remained largely untapped. Garnet's role as a rock-forming mineral directly tied to growth during metamorphic reactions provides an attractive target for direct determination of linked ages, pressures, and temperatures for Earth's earliest metamorphism.

Earth's Oldest Known Garnet Age

To our knowledge, the only location with published direct garnet ages exceeding 3.0 Ga is the Barberton Granite Greenstone Belt ("BGGB"). A previous study in the BGGB indicated the presence of garnet of extreme age, but Sm/Nd ratios were low, Nd concentrations high, and the garnet textures indicate polymetamorphism leaving room for speculation about the accuracy and

averaging of the age. This study provides robust, new Sm-Nd garnet ages for two samples from the Inyoni Shear Zone, bordering the Stolzberg and Badplaas blocks of the BGGB. Sample 115-13 is 3201.6 +/- 5.2 Ma (MSWD = 1.12), and Sample 21-13 is 3200.7 +/- 5.3 Ma (MSWD = 0.46). Both Sm-Nd garnet isochron ages yield relatively high Sm/Nd ratios (>0.6) and low Nd concentrations (<0.3 ppm) for garnet, mitigating concerns about age inaccuracy due to mineral inclusions. Garnet ages from the BGGB represent the oldest known garnet ages and provide a solid age constraint for the formation of the Inyoni Shear Zone at 3.20 Ga.

The Inyoni Shear Zone's Metamorphic Story

Updated thermodynamic modeling for the region yields metamorphism at approx 600° C and 8 kbar. The presence of 3.20 Ga garnet ties garnet growth conditions to a prominent Archean structural boundary and robustly constrains metamorphic timing. These P-T-t conditions support interpretation of the Inyoni Shear Zone as an early example of accretionary tectonics potentially tied to early subduction.

AGU 2018

Seismic Monitoring of Artificial and Natural Recharge Events in Karst Aquifers

ANDREW J. LUHMANN, WHEATON COLLEGE; SUSAN L. BILEK, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY; RONNI GRAPENTHIN, NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

Seismology is now being used to study a variety of Earth surface processes in rivers, hill slopes, and glaciers, leading to the new field of environmental seismology. We have begun to expand this field to the study of various processes that occur in karst aquifers, reporting on observations during artificial and natural recharge events near Bear Spring in southeastern Minnesota, USA. Artificial recharge experiments were conducted by injecting water directly into the conduit system via a dry overflow spring, whereas the natural recharge event involved seismic monitoring of a rainstorm that yielded more than two inches of rain over a couple of hours. We observe a variety of seismic signals associated with the different recharge events. The largest amplitude ground motions occurred during the rain of the natural recharge event, with multiple large amplitude pulses occurring within several seconds of each other and during the period of rapid discharge increase at Bear Spring. These pulses arrived first at the seismometers near the spring, which may be due to the details of the conduit geometry relative to the surface topography or a rockfall or collapse near the spring. We find different behavior for the artificial recharge events, with the large ground motion signals arriving first at the seismometers near the location of the water input, suggesting signals generated from or near the water fall into the conduit system. We also find differences in frequency content of the seismic signals, with peak power in the higher frequencies during time periods of subsurface flow and peak power in the lower frequencies during time periods of surface flow. Ongoing seismic monitoring of recharge events in karst aquifers will hopefully be used to locate the conduit network, to characterize the aquifer, and to monitor for flow and transport processes.

Diagenetic Capillary Heterogeneity Influences Multiphase Flow, Enhanced Oil Recovery, and CO_2 Storage in a Depleted Brownfield Reservoir

THOMAS A. DEWERS, LINDSEY RASMUSSEN, WILLIAM AMPOMAH, JASON E. HEATH, ERIC BOWER, ANDREW J. LUHMANN, MARTHA CATHER, AND PETER MOZLEY

Pennsylvanian Morrow Sandstones, part of the Southwest Regional Partnership on Carbon Sequestration's (SWP) Farnsworth Unit CO_2 injection project in the Texas Panhandle, USA, have been targets of decades of enhanced oil recovery with both water and CO_2 flooding. We investigate CO_2-brine relative permeability in core obtained through the SWP at both in situ residual oil saturation and cleaned via Dean-Stark extractions. SEM, optical microscopy, laser scanning confocal microscopy, and mercury porosimetry show that all core contain abundant diagenetic microporosity, and that most residual oil resides within the microporosity, commonly associated with abundant kaolinite and illite-filled pores. We classify the pore heterogeneity within the Morrow-B unit at well 13-10A in terms of five hydraulic flow units based on mercury porosimetry, gas permeability, and porosity of cleaned core. Using dual focused ion/scanning electron beam and micro-CT analysis, we quantity properties and three dimensional distributions of macro- and microporosity in the five units, and show via pore network modeling how micropore distribution, and not just extent of heterogeneity, controls effective stress-dependent absolute permeability and flow paths in and around hydrocarbon-containing micropores. A parallel experimental effort involves co-injection of brine and super-critical CO_2 into core at in situ conditions. Tests at capillary numbers near the viscous limit yield brine curves that follow a Corey-type relative permeability curve, whereas CO_2 curves during drainage do not. CO_2-flooding at similar injection rates near irreducible water saturation yield capillary numbers approaching the capillary limit, apparent flow-rate dependent relative permeability, and low end point CO_2 permeability related to the degree of capillary heterogeneity in the flow units. These observations are linked to influences of microporosity. We examine effects of extreme capillary heterogeneity with reservoir simulations of CO_2 injection into a model Farnsworth reservoir using a five-spot injection-producer well pattern. Relative permeability relationships derived from low capillary number data generally show poor sweep and storage efficiency compared to history-matched relative permeability models, corresponding to

much higher capillary numbers. We discuss the potential for fast paths, residual CO_2 trapping, and enhanced oil recovery in light of these results.

WHEATON GEOSCIENCE REUNION AT GSA 2018. CHUCK CARRIGAN (SECOND FROM RIGHT) IS OUR FIELD CAMP FACULTY (WCSS).

Three-Phase Compositional Simulation Modeling Coupled with Reactive Transport: Application to Farnsworth Field CO_2-EOR and Storage Project

EUSEBIUS J. KUTSIENYO, WILLIAM AMPOMAH, ROBERT S. BALCH, MARTHA CATHER, AND ANDREW J. LUHMANN

This poster presents field-scale numerical compositional simulations of CO_2 storage mechanisms in the Morrow B sandstone of the Farnsworth Unit (FWU) located in Ochiltree County, Texas. The study examines structural-stratigraphic, residual, solubility and mineral trapping mechanisms. The reactive transport modeling incorporated evaluates the field's potential for long-term CO_2 sequestration and predicts the CO_2 injection effects on the pore fluid composition, mineralogy, porosity and permeability.

The dynamic CO_2 sequestration simulation model was built from an upscaled geocellar model for the Morrow B. This model incorporated geological, geophysical, and engineering data including well logs, core, 3D surface seismic and fluid analysis. We calibrated the model with historical CO_2-WAG miscible flood data and used it to evaluate the feasibility and mechanisms for CO_2 sequestration.

We used the maximum residual phase saturations to estimate the effect of gas trapped due to hysteresis. In addition, gas solubility in the aqueous phase was modelled as function of pressure, temperature and salinity. Lastly, the coupled geochemical reactions, i.e., the characteristic intra-aqueous and mineral dissolution/precipitation reactions were assimilated numerically as chemical equilibrium and rate-dependent reactions respectively.

Additional scenarios that involve shut-in of wells were performed and the reservoir monitored for over 1000 years to understand possible mineralization. Changes in permeability as a function of changes in porosity caused by mineral precipitation/dissolution were calibrated to the laboratory chemo-mechanical responses.

The study validates the effects of Morrow B petrophysical properties on CO_2 storage potential within the FWU. Study results shows: EOR at the tertiary stage of field operations, total amount of CO_2 stored in aqueous-gaseous-mineral phases, evolution and dissolution/precipitation of the principal accessory minerals and the time scale over which mineral sequestration took place in the FWU.

This study relates the important physics and mechanisms for CO_2 storage in the FWU and illustrates the use of the coupled reactive flow. The study serves as a is benchmark for future field-scale reactive transport CO_2-EOR projects in similar fields throughout the world.

Students examining core and thin sections in the petrology lab

ENVIRONMENTAL SCIENCE SENIORS' REFLECTIONS

Chris Keil asked his Environmental Science Capstone Seminar students to write about their experience at Wheaton College. Here are three notable essays. They highlight the value of students taking advantage of off-campus learning opportunities, like the International Sustainable Development Studies Institute in Thailand, Wheaton in Chicago and Danish International Studies.

HYE-YOUNG YIM '19

Christian liberal arts education that I received at Wheaton gave me formative and impactful experiences that became great foundations for expansion of my academic horizon and deepening my personal faith journey with the Lord. Through liberal arts education, I learned wide range of subjects and draw connections from one to another although they seemed to be in different fields of studies. Moreover, the discussions that I had with the peers and the professors from different backgrounds who sometimes hold contradicting perspectives to mine challenged my perspectives in positive ways. Such education expanded my academic horizon tremendously.

But one thing that separates Wheaton from any other liberal arts college is that it builds all arts and science on the foundation of Christianity. Through my times at Wheaton, I realized that there isn't one single course that does not direct us to God and His nature. Yet, all these learnings would have not come to completion if all remained as just knowledge about God. The part where it truly impacted my characters and life as a disciple of Christ was the lives of people around me, professors, peers and staff that I met on campus. The professors gave us guidance that was full of wisdom and experience that came from their lives in Christ. Sometimes, the small 'droplets' in lectures that professors casually said or shared about their lives inspired me to see what it really means to live out the faith. Moreover, having friends who are no less devoted than any others, but full of passion for God and compassion for people, impacted my own faith as well.

These precious individuals that I met at Wheaton became the life role models of what it means to be a disciple of Christ. I think this is what separates Wheaton from any other liberal arts college because Wheaton's education is not just about transferring knowledge from one brain to another but also about giving holistic and formative education that equips young generation to live out the Kingdom.

I also went to a study abroad program called ISDSI (International Sustainable Development Studies Institute) in Thailand last fall. The program enabled me to live and experience the lives of people in rural villages of Thailand. Being fully emerged in their lives, I was accepted as a part of their family and came to obtain perspectives that outsiders could not perceive. I was able to see the immediate threats that the villagers faced in their daily lives, and how their voices were not included in the decision-making process of environmental policies in Thailand. This further led me to generate unique perspectives that extend beyond the governmental policies and scholarly articles through understanding people's stories on a personal level. Additionally, I learned practical skills of measuring changes in biodiversity, implementing organic sustainable farming, and acquiring account from the villagers about the changes that they tangibly feel over the periods of time.

Also, during this intensive, four months of academics, community living and personal struggles, my faith and my knowledge were tested to the very limit. I had to be challenged about what I thought I knew and was. This became a place like a furnace, where it enabled me to see the real essence of being a Christian and the reason for all the academic learnings from Wheaton. Although it was not easy, I wouldn't have been the same without the experience in Thailand.

KATE PANIZZA '19

I had never imagined myself studying abroad in Denmark with Danish International Studies (DIS) for four months my senior year of Wheaton. I was dead set on studying at Oxford or somewhere in France, where I knew I'd be able to speak the language. And yet, in the fall semester of 2018, I found myself living with a Danish host family in the Copenhagen suburbs and studying sustainable development in a Northern European context. Four months later and anxiously facing graduation in May, I feel like nothing could have better prepared me for engaging with and caring for the environment and the earth we live on.

My core class in Copenhagen was focused on sustainable development, which I took in conjunction with classes on environmental policy, urban ecology, and GIS. What was so special about taking these classes in Denmark was the personal

JOYFUL AND BURRITO-STUFFED ENVIRONMENTAL SCIENCE MAJORS AT THE CHRISTMAS DINNER

connections and practical experience that all of my professors there had. I got to tour the Danish Parliament with a MP from the Alternative Party (a very "green" party) and learn how environmental policy is practically created, visit permaculture farms that offered new types of community and lifestyles, and meet with members of a shareholder-owned wind farm in Copenhagen Harbor. It was refreshing and inspiring to see how sustainability can really work in the world and is being implemented in real-life, especially in a place so similar and yet so different in culture and politics from the United States. I was challenged again and again in how I can practically live a sustainable life and how I could transfer what I learned in Denmark to the current political and cultural climate in the United States.

One of the biggest things I learned through my time at DIS was just how much of a difference Christ and a Christian faith makes in looking at the environment. When discussing environmental ethics or sustainable lifestyles, most of my classmates would bring up meditation routines or animal cruelty (as the reason for vegan diets) or a vague respect for nature. They spoke with an almost religious view about their life, but in the end, many of our conversations ended up being hopeless and fruitless. It was encouraging to see how many people care so deeply about the environment and are willing to lead correspondingly low-impact, sustainable lifestyles, but at the same time, there was little discussion of the poor and those who didn't come from a wealthy, educated background or the influence of a personal religion in how a person treats the environment. Living with the promise of a new heaven and a new earth and the promise that God will end the groanings of creation, I was constantly reminded of the blessings of a Christian education and faith. We are lucky in living with the hope of Christ's coming again and having a deep connection and responsibility to His creation that goes beyond the rote metaphysical zen-type connection that my fellow students at DIS practiced.

CINDY HU '19

Wheaton in Chicago has been a highlight of my college experience. I was interning at a non-profit organization called Center for Neighborhood Technology, which devotes its work on urban sustainable development. I was assigned to the water department. The latest project that we received was to come up plans to assess and improve the water quality and infrastructure in the cities around the Great Lake Basin. According to the researched information, there are obviously water-related issues and space for better management. However, we got stuck. Most of the city environmental administrators shut us down right away when we interviewed them. Some admitted the issues, but they also did not want us to intervene and said they already came up with strategies to cope with the problems. The story was different when we contacted engineers who worked in the facilities directly. Many told us that they wanted to improve the efficiency and knew exactly how, but somehow their communication never reached municipal government officials. There are people who desire change, there are also others who want things to remain the same, because that is the easier, cheaper, least risky way.

Most of these tragedies occur because of misunderstandings, miscommunication, or ignorance. I want to respond by three actions that Wheaton College's education has challenged me daily—slow down, listen, and pay attention. Wheaton College has taught me to take time to listen to the unheard or underrepresented voice in order to grasp a wholistic picture. It involves repentance and humbling. Policy makers should not just discuss ideas around a table in a confined room. They need to get in contact with the people who experience the issues firsthand. People in higher authority usually assume they have the best knowledge to make a difference for the best of the community. Christians, on the other hand, understand that they are not better than anyone else, because all have sinned against God; they also understand that everyone is created by the image of God with an inherited dignity. Learning from the people on ground, listening to what they have to say, seeing their potential, is a long, effortful process, but it is where true, sustainable transformation grows. Christ could have destroyed everything and already recreated the earth as the salvation plan. Instead, He humbled down himself to enter human history and continued this history to include everyone in his salvation plan through His death on the cross. Should not Christ followers' step into the mess of others and wrestle the issues with the community together rather than seeing themselves as saviors to a problem?

KEIL'S CORNER

CHRIS KEIL, PROFESSOR OF ENVIRONMENTAL SCIENCE

Environmental Sampling and Analysis Capacity Expands!

One of the things that drew me into the environmental field is the enjoyment I get out of measuring things. It's just part of who I am. My first job in the sciences after graduation from Wheaton was working in a toxicology lab. While college prepared me with theory and some application, it was there that I was first exposed to the detailed ins and outs of sampling and analysis, documentation, chain-of-custody, calibration, etc. As a teacher I try to give my students as much exposure as possible to the quantitative aspects of working in the environmental field. This, of course, includes doing environmental measurements in classes, labs, and independent studies. Over the past six years we've been able to expand the department's collection of equipment for air and water sampling and analysis. A big acquisition was the XRF spectrometer for elemental analysis. The capacity for measurement in student research and independent projects has steadily increased.

With the development of the Environmental Pollution and Toxicology course and its inclusion in the Environmental Science major curriculum, the need for additional equipment became more acute. In this new course we hope give students more than just a passing familiarity with some types of pollution measurement equipment. The first two times I taught the course, we had a few of each type of instrument. But I wanted every student to get extended, up-close time with each technique. So, I set up a progressive, round-robin of five different activities in five weeks that the students rotated through. This required coming up with detailed instructions for each activity, which were never as good as I wanted. And during each lab session, I was moving around from one group to another, all doing different activities. One group might be doing organic vapor analysis, another carbon monoxide sampling, another measuring particles, and so on. The lab worked pretty well. But it never fully was the experience I wanted for the students.

The spring however, we are teaching "Pollution and Tox" lab with a whole new energy! We managed to secure funding for new equipment so that this year we purchased multiple sets of the instruments needed for our lab exercises. Now all of the lab groups (of 2-3 students each) are working on the same techniques at the same time. We work through procedures and supporting theory together as students are all working hands-on with the instruments and materials. Questions arise and everyone can benefit from the discussion. And all the data the class collects can then be looked at together for statistical analysis and interpretation relative to regulatory levels. We also moved the lab into Meyer 049, the laboratory that has dedicated utility service and access to a fume hood in the adjacent prep lab.

I'm excited to give students even more hands-on experience with environmental sampling, analysis and data interpretation. This is a great step toward our goal of preparing students for careers post-college with a balance of practical and applicable skills grounded in theory connect with a Biblical-based creation care ethic.

JEFF GREENBERG POINTS AT ROCKS (OR MAYBE JUST SNOW) IN WISCONSIN. COMBINED EARTH HISTORY AND STRUCTURAL GEOLOGY FIELD TRIP

Alumni to the Black Hills and Other Field Trip News

We are committed to a biennial cycle of Alumni-Student Field Trips (odd numbered years) and Black Hills reunions (even numbered years). With all our new faculty this year, we decided to not schedule an Alumni-Student Field Trip for 2019. However we do plan to have a Black Hills Reunion at the Science Station during the summer 2020 while our field course is in session. The next Alumni-Student Field Trip is planned for May 2021. We invite you to suggest locations for the trip and help with organization and logistics

Giving to the Department of Geology and Environmental Science

Anyone wishing to give to the ongoing work of the Department is invited to consider donating to any of the listed funds. Please clearly indicate which fund or funds for which your gift is designated. Many employers match gifts. We thank you for your consideration.

- **Boardman Black Hills Scholarship**
  An endowed fund providing scholarships for geology majors attending our field course in the Black Hills

- **Geology Major Scholarship**
  An endowed fund providing financial aid for geology majors.

- **Jeffrey Greenberg and James Clark Endowed Research Fund**
  Promoting faculty-student research, such as expenses primarily related to collaborative geoscience research, or interdisciplinary research, for undergraduate geology or environmental science majors, including conference costs for students who have been selected to represent Wheaton College at professional conferences to present their findings.

CLASS OF 2018 ENVIRONMENTAL SCIENCE AND GEOLOGY SENIORS

Environmental Science

WESLEY AHRENS
Employment with Synergine, a values-based multidisciplinary consultancy whose mission is to help create a more livable, just and sustainable world) in New Zealand. Participated in Wheaton in Chicago, Wheaton in the Black Hills (student and staff).

ELIZABETH HOSSINK
Pursuing employment in Environmental Science. Participated in Wheaton in Mexico, Wheaton in the Black Hills, Wheaton in Chicago, Scholastic Honors Society.

LUCIA LARSEN
Employment with Topco Associates LLC. Participated in Wheaton in the Black Hills, International Sustainable Development Studies Program (Chiang Mai Thailand), Sustainability internship in Panama.

BRITTANY SCHULZ
Toxicology Research Support, Oak Ridge Associated Universities. Participated in Wheaton in the Black Hills, Wheaton in Mexico, NSF-REU at Grand Valley State's Annis Water Resources Institute.

CASEY FOSTER
Seeking Environmental Employment. Participated in Wheaton in the Black Hills, International Sustainable Development Studies Program (Chiang Mai Thailand), internship as Field Technician at V3 Companies.

JAKE STONER
Environmental Health Specialist at DuPage County Health Department: Wheaton in the Black Hills, water quality internship with Campton Township Open Spaces, research on water quality trends in Fersun Creek.

REBECCA THIELMAN
University of Connecticut, Water Resources Engineering. Wheaton Cross Country, Wheaton in the Black Hills, Wheaton Summer Research Program.

KIRSTIE WHITE
Candidate for M.A. in Sustainable Urban Development, DePaul U. McMaster-Carr, Industrial Supply Enthusiast. Varsity Tennis, Wheaton in the Black Hills, International Sustainable Development Studies Program (Chiang Mai, Thailand), Lake Forest Open Lands Restoration Internship, W.A.S.T.E. research project, John Muir outstanding Environmental Science Senior (p.2).

Geology

MATTHEW DEEKS
Recipient of Wheaton College Geology Major Scholarship and member/leader of Men's Glee Club.

DAVID GATES
Attending University of Arkansas to pursue an MS in Geoscience (with supervisor Glenn Sharman '08). Wheaton Summer Research Grants with projects on agricultural modeling (Smidt) and geophysical investigation of Tel Shimron (Clark/Moshier). Both projects resulted in presentations at Geological Society of America conference, including "Best Student Poster" in Hydrogeology.

ELLEN GIESER
Participated in dinosaur expedition sponsored by Carthage College summers 2015 and 2016 and Eocene Fossil Lake expedition sponsored by Field Museum of Natural History. Student volunteer at Tel Shimron Expedition, summer 2017.

SUSAN LAMB
Attending University of Florida to pursue an MS in Geoscience (with supervisor Sam Schmidt). HNGR intern to Nicaragua (Clark). Three-year participant in Honduras Project culminating in being director.

JEFFREY LEEBURN
Attending Penn State to pursue an MS in Geoscience. Internships at Applied Physics Laboratory, The Johns Hopkins University, summers 2016 and 2017 resulted in publications on craters and stratigraphy of Mercury and presentations at Lunar and Planetary Science Conference and American Geophysical Union. Gerald Haddock Outstanding Geology Senior Award (p.2).

VALERIE TEWELL
Attending Texas Tech University to pursue an MS in Geoscience. Double major in Biblical Archaeology. Student volunteer and staff for Tel Ashkelon and Tel Shimron expeditions, summers 2014, 2015 and 2017.

STUDENTS IN THEORIES OF ORIGINS CLASS AT THE FIELD MUSEUM UNDER ONE OF THE MOST FAMOUS QUOTES IN THE HISTORY OF GEOLOGY: "NO VESTIGE OF A BEGINNING, NO PROSPECT OF AN END (JAMES HUTTON)."

Doc Mo's Memoir

STEPHEN O. MOSHIER,
PROFESSOR OF GEOLOGY

I got rather philosophical last year about my career as a college professor. It started when children of alumni from my "early days" of teaching here started showing up in my First Year Seminar! They include *Joshua Dunbar*, son of Tim Dunbar (Chemistry '92) and nephew of Steve Dunbar (Geology '95), *Thomas Everest*, son of Nancy Palm Everest (Geology '94) and Michael Everest (Chemistry '94), and *Jena Paulsen*, grand-daughter of Richard Haugen (Geology '67) and niece of Chris Haugen (Geology '95). To further visualize the march of students through my life, I gathered all of the photos taken on Earth History field trips to Baraboo, Wisconsin over the past 25 years, mostly standing in front of the iconic Van Hise Rock (p.19). Among the class lists, starting in 1992, I counted 305 students (probably 2/3 of them geology majors). Advanced degrees earned in this group include some 25 PhDs and 50 MS. Several are active duty military officers and veterans, including a colonel or two.

Last year, I wrote up some remaining research from field work in the North Sinai, Egypt for Volume II of reports from the Tell el-Borg expedition 2000-2007. In September, I was invited to participate in a documentary for the National Geographic Channel, titled *Buried Secrets of the Bible*. The London-based production company flew me to Cairo for three sleepless days, with one day of filming around Ismailia, a city next to Lake Timsah along the Suez Canal. I was expecting to be interviewed about how I used satellite imagery and field work to reconstruct the geography of the Late Bronze period and its implications for the Exodus route. Unfortunately, they didn't ask me specifics about my research. Apparently, my job was to help the documentary host pronounce place names and describe what is already on most Bible maps. The program debuted in March. Spoiler alert: the Israelites eventually do make it to the Promised Land!

After five years of hard work, the textbook project for our Theories of Origins course was published in early December. *Understanding Scientific Theories of Origins: Cosmology, Geology, and Biology in Christian Perspective* is a 688-page tome, illustrated in full color, and published by Intervarsity Press. The work was supported by a grant from the BioLogos Foundation to the authors, Robert Bishop (Physics), Larry Funck (Chemistry), Ray Lewis (Biology), John Walton (Bible), and me. Joshua Olsen '16 contributed many original maps, cross sections, graphs and photographs. Drew Kulpecz '02 contributed a photograph of the famous stromatolites of Shark Bay, western Australia. I understand that some of you found the book under the Christmas tree!

I was honored to contribute a chapter to *The Lost World of the Flood*, by Tremper Longman III and John Walton (another IVP book, this one released in April), providing an "old earth" perspective on the lack of evidence in the geologic record for a global flood as envisioned by the "young earth" creationists.

The past five years I served on the Executive Council of the American Scientific Affiliation, including two years as Council President. I enjoyed the opportunity to meet so many members of this largest North American organization of Christians in the sciences, especially by regularly attending the summer meetings in venues including McMaster University, Oral Roberts University, Colorado School of Mines, and Gordon College. The ASA provides fellowship with Christians in the sciences and the organization's journal, web magazine and online resources are a tangible contribution to faith-science dialog around the world. It has been exciting to observe the recent growth of a more youthful and diverse membership, with increasing attendance at each successive annual meeting over the past five years. If you don't belong, check out <asa3.org> and see what you are missing! The 2019 annual meeting is at Wheaton College, July 19-22.

WHEATON GEOLOGY AT VANHISE ROCK, WI

MISSING: 1993, 1994, 1995, 1998, 1999, 2000, 2007

Wheaton College

For Christ and His Kingdom

Department of Geology
& Environmental Science

501 College Avenue
Wheaton, IL 60187

STUDENTS IN THE FIELD

LEFT: STUDENTS HAVE DINNER ON A LOG AT DEVILS TOWER, WESTERN FIELD TRIP
TOP RIGHT: YELLOWSTONE NATIONAL PARK
BOTTOM RIGHT: GEO-MAJORS LEAD WORSHIP WITH SONG AT SCIENCE STATION VESPERS SERVICE.