



CONTACT

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



CORE 325 Nature, Environment and Society, a new course taught in the Black Hills

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FROM THE DEPARTMENT CHAIR

Stephen Moshier

Our apologies, but we missed getting CONTACT out last year (2016–2017). The past two years have been crazy busy. Here's a brief summary. Summer 2016: The field mapping course in the Black Hills was enrolled with 14 students. Lab and Office Coordinator Jamie Fearon bid us farewell after two years of service to the department. She taught the 4-week gen ed geology course in the Black Hills on the way to her wedding in Montana at the end of the summer! Fall 2016: We welcomed Dr. Sam Smidt to our department as Visiting Assistant Professor of Geology & Environmental Science. His position was granted by the College to allow our faculty to teach first year seminars in the new Christ at the Core general education curriculum. Spring 2017: We welcomed Paige Wietelmann as our new Lab and Office Coordinator. Our Department hosted the annual Wheaton College Science Symposium featuring Columbia University Newberry Professor of Geology Wally Broecker, a pioneering climate scientist of international distinction. Dr. Broecker attended Wheaton through his junior year in 1952 before transferring to Columbia. Several geology and chemistry alumni preceded or followed Wally to Columbia for graduate studies from the 1940s to 1960s. The graduating class included four seniors in Environmental Science and six seniors in Geology. Summer 2017: The second biennial Student & Alumni Field Trip, this time to West Texas and New Mexico was enjoyed by 14 participants, including current students, alumni and family from the 70s, 80s, 90s, and 10s. Fall 2017: The search begins for two new faculty to occupy the offices of the irreplaceable Jeff Greenberg and Jim Clark. That's summary enough. More details are promised in the following pages. ■



CORE 325 Nature, Environment and Society, a new course taught in the Black Hills.

WANT TO SEE THE PHOTOS IN THIS ISSUE IN COLOR?
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JEFF'S JOURNALS

"Endings always come at last; endings always come too fast; they come too fast but they pass too slow". Words from Art Garfunkel have hurting, sad feelings conveyed. When I was finishing my doctorate at UNC, I got weepy over the tune of "So long, it's been good to know ya". We humans are made for relationships in community, but we are not designed to enjoy the breaking of those bonds. Of course, life itself is no real end. The bonds of love can't be broken, only stretched and strained for a while.

Brother Jim (Clark) and I have this last one-semester year to complete our full-time tenure with Wheaton College Geology. For me, it will conclude 32 years in this service. There are no real descriptions possible to do justice to the time and experiences. Maybe bits and small pieces of memory can offer some sense of it all.

I note up front, that not all of 32 years has been smooth or satisfying. Real life is not like the selection of high points remembered. Wheaton College is a most amazing, unique place. Its blemishes are as bold and blatant as its virtues. In 1986, as I left our Madison, WI area academic friends, I heard that WC was that "fundamentalist" school outside Chicago (good bye real science), and from our Christian friends, I was warned about WC "going liberal". This duality seems a lot like the grand divide of culture in the USA today. Both admonitions proved correct, and of course, also overblown. I found a place on a knife edge of society, trying to be all things to all people. It has been a valiant but impossible vision to make real. The people here, students, faculty colleagues, staff workers, and "bosses" have demonstrated the best of Christ-like sacrificial love in service. I can really never impugn the motives of anyone, beyond our flawed nature in general. This place is a nurturing center for the distribution of Kingdom agents throughout the globe. It is also therefore, under constant opposition by spiritual forces. Our flaws, our mistakes in failing WC as a light for Jesus, are because we are human. The College requires constant, intense prayer to balance out a true Jesus faith in the midst of cultural (including The Church) disintegration. Fear and a felt need to build walls and emotional-physical protection against the "World", must be resisted. Love, sacrificial love, through giving of our time, our skills, our future in service is the only way forward. We live in perilous and challenging times! Retirement for me is looking forward to new, invigorated servants that will step in and guide the Department of G&ES of Wheaton College.

I applaud our administrators for very quickly affirming the need to replace both my position and Jim's. With this year's addition of Sam Smidt, newly minted PhD, and Office Administrator, Environmental Scientist, Paige Wietelmann, we have a fine nucleus for the future of educating, research, mentoring, and service.

Diane, my life-wife of almost 47 years, hasn't had a full-time employment-job for many, many years. She has served in a multitude of family (oh our family!), church, and WC capacities. She was for several semesters a very wonderful lab instructor for our Gen Ed Geology courses. As I move away from the Faculty position and likely, away from Wheaton, the area is also losing Diane. Many of you alums and others know that Di has advanced

stomach cancer and a general prognosis of being incurable. She has endured harsh chemo therapy of two types over two years now. As of this writing, we are again confronted with scans that tell her doctor and us about the next stage in this hard journey. Her cancer is both growing in places and stable in other areas. Prayers for complete healing are golden, but so are prayers for all of us to be ready for anything the Lord allows. We find it difficult to plan any events more than a couple of months in advance. God willing, if she is up to it, we mostly intend to move to a better living environment in terms of natural beauty, etc. Our potential new venue might be in CO, FL (where we grew up), or maybe in the SD Black Hills where the very dear Wheaton College Science Station has been our second home. By the time you read this, many crucial things may have occurred to keep us here in Wheaton, or only-the-Lord-knows-where. In fact. Since I first drafted this note, we have decided to stay on in Wheaton over the 2018-2019 school year. I really must provide some help and training for the new "hard rock" geologist replacing my position. My work in curating samples and multitudes of other geological-departmental collections, leaves about 20% to be finished. It would be wrong to leave that work undone, possibly forever. I also should spend time with the new colleague in outlining classes, especially those at the Science Station. And so, the Provost is agreeable to me hanging around to complete chores other than teaching.

Please also offer prayers for our dear Provost, Dr. Margaret Diddams, as she has been temporarily (we hope) derailed by illness. In her brief time here as top administrator, she has shown great wisdom, compassion, and passion for the future of Wheaton College. Her position is close to impossible in meeting all the duties of running such a complex operation. Pray for her health, her refreshment, her continued positive trajectory, and for spiritual protection.

It would be a delight to keep working with the Department in some capacity into the future, beyond my extra year of tinkering. I will never lose love for the students and their grand potential in training for Kingdom service. The geosciences are horribly underappreciated by society and await a boost in publicity-marketing to attract more caring, talented people. The

USA is in a terrible rut of political disdain for the ethical role of science in sustaining life and thus glorifying the Creator. That is a mission vision that requires prayer and much hard work. I can't retire from that. Perhaps my last physically productive effort at Wheaton, will be the publication of a book to recruit young Jesus-followers into Science as a vocation of Kingdom service. Along with this initiative are other cooperative ventures with Christian and non-theistic friends to make Creation care a priority.

We had a delightful recent visit from the non-alum son of WC. Geology's first graduate. Fred Rittgers '39 died suddenly in a farm accident in 1950. His son, Stan, was four years old and had few memories of his dad. Fred did leave behind a diary including his Wheaton College days, and that alone has attracted the Rittgers to find out more about this school that helped form their father. Professor Higley was the Geologist on duty in Fred's time. Apparently Higley had a great, positive impact in this man's journey. Fred spent a lot of time studying rocks from the Black Hills. Wheaton began its Science Station the same year, 1935, that the Geology major was initiated. Between the "lapidary" lab and the Black Hills, Fred grew a deep fondness for his experience at WC. This impression brought the Rittgers to see what

“
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the department is like today. I can convey with joy, that Stan, retired Engineering professor from Ohio State University, was very impressed with our facilities, our mission to serve globally, and our continuing devotion to the lives of our students, was very impressed with our facilities, our mission to serve globally, and our continuing devotion to the lives of our students. Yes friends, Wheaton College Geology & Environmental Science continues to distinguish itself as one of the best undergrad programs anywhere (no brag, just fact!)

I am into ten months of collecting profiles (three-page bios and brief stories) from Christians in science, in order to create the recruitment book of great need mentioned above. In summary, I was awarded a grant from the Templeton Foundation-Fuller Seminary STEAM (Science and Technology for Emerging Adult Ministries) Program to design and produce a unique volume. The theme is SCIENCE VOCATIONS FOR CHRISTIAN STUDENTS AS KINGDOM SERVICE. The goal is to inspire and attract young Jesus followers into college science programs. I have a super team of colleagues from all over the USA working on this. We emphasize the real need to recruit majors for the Physical Sciences (Chemistry, Earth Sciences, Physics, and all their subdisciplines). These majors are terribly under-elected by Christian students for various unfortunate reasons. The Bio-medical sciences and Engineering are booming in all university-college environments, and therefore require much less help in gaining majors. Again, the reasons for this imbalance are understandable but not justified. The book will have profiles from Christian medical, biological, engineering, and math professionals. However, the majority will be for the less popular and crucial areas of study. We pray that parents, clergy, counselors, teachers, and youth group leaders will be persuaded to help the vision find success among students. Organizing and lead-editing such a book is more than challenging. Don't try it!

As a direct result of co-editing a Special Paper volume for the Geological Society of America (Wessel and Greenberg, 2016, SP #520), I am now also co-convenor with friend Greg Wessel for an important workshop/forum being planned for September 2018 in Bermuda (a tough venue eh?). The mega-event is being staged by the world's top geoscience organizations. The theme is applying crucial (geo) scientific information in global policy making. Specific issues involved are among the most significant challenges confronting humanity now and in the future: Climate Change, Natural Hazards, Water Resources-Sanitation, Coastal Dynamics, Erosion, Land-Use Planning, Ocean Systems, Mining and Resource Exploitation, etc. This venue will bring Science, Ethics, Politics-Governance, and Economics together with the goal of cooperative problem solving. My main responsibility in this venture, is to arrange for adequate input from faith groups. It is invigorating to see respect for religious concepts and people among global scientific communities. Sadly, our own nation is out of line with almost all nations in addressing common environmental and resource concerns. I am overwhelmed to be an actor in this initiative and represent WHEATON COLLEGE GEOLOGY as the only educational institution, among such lofty geoscience societies, among the sponsors/organizers.

I missed participation in the annual GSA Meeting this year. Instead, I will join other Christians involved in Creation Care, in Pasadena, next April. This is for the second gathering in the USA for the Lausanne Commission. My presence as geoscientist and professor will be to encourage the employment of undergrad students for international service-research. God has blessed our department with many great examples of student scholars bringing the love of Christ into community development. These young people have so much to offer and so much to gain.

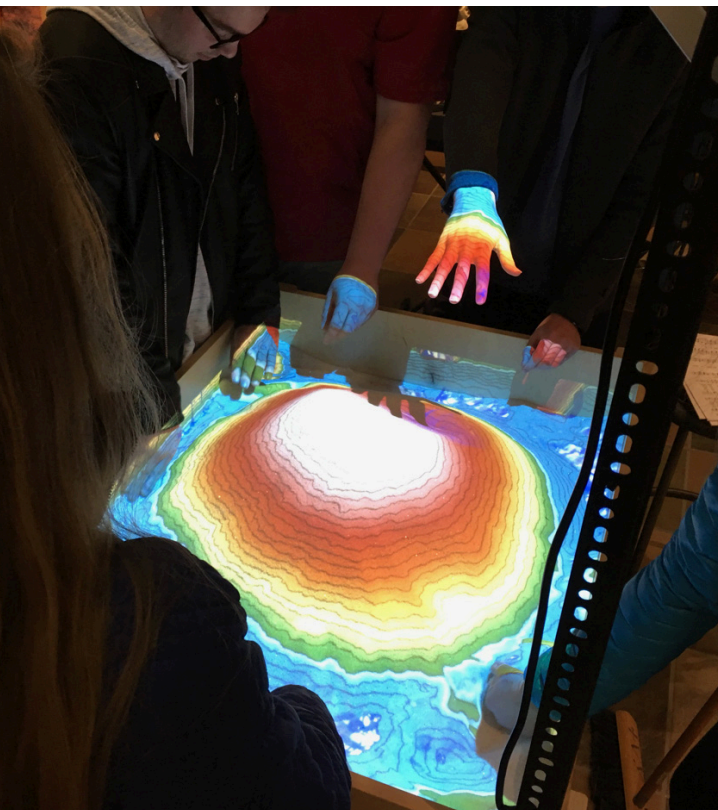
Please be praying for the two new G&ES faculty members. We reviewed applications this fall and invited people for interviews for early 2018. Replac-

ing Jim is of course, impossible. His breadth in course offerings is unlikely to be available in any one person. My replacement will need to cover the "hard rock" required classes for majors, *Fundamentals of Mineral Science* (half semester plus lab), *Petrology and Petrography* (2/3s of a semester's igneous and metamorphic lecture and lab with Moshier doing the sedimentary petrology), and the semester of *Structural Geology* and lab. We have great hopes for a new and innovative geochemistry course to be developed as well. I have also covered most of the mapping instruction, including all of the hard-rock exercises for the summer practicum at the Science Station. Beyond those, I have taught the intro Physical Geology course multiple times each year. By estimation, I have taught well over 4000 (closer to 4500) students in that class at Wheaton. Other elective and general education, and majors' classes I have taught bring the grand total to 22 different courses. Too many of those were really beyond my expertise, but don't tell anyone. It is almost humorous that I began the first classes in GIS at the College. It is truly miraculous that, a) I learned enough to convey basics to the students, b) we got two different GIS programs loaded and "working" on our earlier mismatched computers, and c) that anyone actually gained something from my bumbling about. In fact, three of those in the earliest classes went on to become GIS specialists with government and industry. My greatest accomplishment was in not ruining these fine people. Later, Jim Clark would turn our GIS curriculum and research capabilities into an excellent mini-program.

This issue of CONTACT is likely the finale for Jim and myself. We both desire to stay with the family and available to all of you as friends. Geoscience as knowledge base and service is far more important than the vast majority of people recognize. I pray that alumnae and friends of the department will uplift the mission of G&ES in prayer and consider ways to provide financial support. Most of us are not blessed with great sums of money beyond what is needed to get by. However, many of us also know others who might be enlightened about the department and contribute to its future. We offer the type of education and pre-professional training that industry and government most desire. We have unfortunately, never tapped into the kind of support enjoyed by public universities. Our undergraduates deserve more scholarship support as well as increased internship and research opportunities. Please keep that in mind and prayer. The department's biggest challenge remains the recruitment of students into "the family" as Geology and Environmental Science majors. It shouldn't be so difficult to "sell" what we offer to students. As you probably know, it is a stressful barrier to overcome in competition with all the other major programs on campus. ■



Jeffrey Greenberg introducing Wally Broecker at the Annual Science Symposium, Spring 2017.



Dr. Clark and students built this augmented reality sandbox that projects elevation contours on landforms shaped by hand in real time and fills depressions with virtual water.

CLARK'S CAPERS

As always, Jeff is the eloquent spokesperson for the department. I agree with his comments about Wheaton College and the need to pass the baton from our weary bodies and minds to fresh and enthusiastic new faculty in hard-rock and no-rock specialties. The program will look very different next year and it will undoubtedly be better prepared and rejuvenated for the next lap. After 17 years at Calvin College and 17 years at Wheaton College I can truthfully say that Christian education in geology is rewarding and strongly needed in a world that is hurting. Christian geologists and environmental scientists, especially, are well prepared to address the resource, pollution and ethical issues that now fuel global concerns and tensions.

This summer was filled with travel for Sue and me. First stop was Rwanda where I led a workshop attended by 9 African brothers in Christ representing 5 different nations. We used my little cheap seismic refraction units and my accompanying free software to interpret near surface bedrock profiles. They took that knowledge back to their respective countries as they use it to explore for water. We then spent some time on the French Riviera at the A Rocha preserve, Domaine des Courmettes. Dr. Chris Walley, who now lives there and directs A Rocha research, showed off the fine geological features of the Maritime Alps in anticipation of a possible future Wheaton Geology post-commencement field trip. Spectacular Alps, beautiful Mediterranean coastlines, and amazing geology would be hard to pass up on a 10-day trip for students and alumni. Next Sue and I took a whirlwind trip through 10 different European countries in about as many days. Then we flew to Israel, our first time in the Holy Land. We stayed one week with a childhood friend of mine who immigrated to Israel 45 years ago and has since become an Orthodox Jew. Our time with Ted was very interesting as we learned the orthodox customs (e.g. do not flick a light switch during the Sabbath), lived in his home in a "settler" village on the West Bank and attended his synagogue. We then went to Tel Shimron, Israel where we helped implement the geophysical surveys of that new Wheaton/Univ of Tel Aviv archaeology site. We used my little resistivity and seismic refraction instruments to determine the thickness of the "cultural" layer of the Tel. We also experimented with "seismoelectric" methods. After two weeks we left the completion of the geophysical survey in the capable hands of Steve Moshier and senior David Gates. David presented a nice poster at the annual GSA meeting summarizing the results (see abstract on p. 8).

I am looking forward to retirement near Sacramento, California where Sue and I bought an older house which Sue has laboriously renovated. Eight of our 10 grandchildren are in California and 6 of them live just a short 300 yards away from our house. My daughter is homeschooling her children (oldest is 8 years old) so I am looking forward to being retrained as a homeschool professor. We also made one small room into an electronics shop that I can use to develop further my little cheap geophysical instruments.

In December I gave my last lecture in Process Geomorphology class. I always end the semester with a lecture about "my life as a geomorphologist" and this year I realized that I was still in high school when I spent a summer helping a geomorphologist map glacial features in the high Colorado alpine. That was exactly 50 years ago and I decided after that summer that geology would be my life's work. I have never regretted that decision. At that time I did not know Christ but when I finally yielded my life to the Lord when a post-doc at Cornell University I witnessed how God can use our passion, whatever that is, for his kingdom. I was very nervous giving my testimony at Wheaton College chapel a few years ago and some of you might be interested in hearing it online (<https://www.youtube.com/watch?v=u5rtL8PoqJs>). Of course it is my students who have always motivated and challenged me through their enthusiasm and creativity. It has been a joy to learn of the exploits of many of them as they continue in their geology careers and in service to our Lord. I will miss them and their boundless energy. ■

IN THE CLASSROOM & FIELD



2016 GEOL senior seminar: Sara Hahne, Teddy Miller, David Huizenga, David Gates, Sarah Ostertag, Leah Blobaum, Susan Lamb.



ENVR 221 class working a "prescribed burn" to restore a local prairie.

DOC MO'S MEMOIRS

This fall I have been preoccupied with teaching two courses in our Christ at the Core Curriculum. For the second year, Jeff, Chris and I have led our own sections of First Year Seminar for freshmen. We have been challenged to lead discussions of Shusaku Endo's novel *Silence*, Augustine's *Confessions*, NT Wright's *Simply Christian*, a number of articles on various topics and some of our own selected readings. The second course is an Advanced Integrative Seminar on the topic of Humanitarian Disasters and Recovery. This is a full semester update of my gen ed Natural Disasters quad course, adding the social science of recovery to an overview of the natural science of disasters. I got lots of help from social science colleagues, as well as a Skype lecture from Torrey Olsen '77, who is a director with World Vision. In November, I was invited to the Evangelical Theological Society annual meeting in Providence, Rhode Island to give a presentation during a special session, Creation, Evolution & the Age of the Earth. The session was motivated by the release of *Grand Canyon- Monument to an Ancient Earth* (Kregel, 2016) including many Wheaton geoscientists among the co-authors.

During the summer, Carol and I joined the Tel Shimron Expedition, a new archaeology project led by Daniel Master, Professor of Biblical Archaeology and sponsored by the Museum of the Bible. Carol was an integral member of the excavation team, serving as the Student Volunteer Coordinator. Jim and Sue Clark were there for the initial two weeks, as Jim trained senior David Gates and me on the use of his low-cost geo-

physical instruments. We applied seismic refraction, electrical resistivity and seismoelectric methods to probe the subsurface of the tel. At the same time, I taught a Science of Archaeology course with three students who were participating in the dig. Essentially, the students participated in the geophysical surveys and practiced a number of scientific methods, such as botanical floatation and zoological analysis, that were part of the daily work at the excavation. David and senior Valerie Tewell took a poster based upon our summer results to the Geological Society of America meeting in Seattle.

I was unable to participate in the Black Hills during summer 2016. After a few years of anticipation, I underwent open heart surgery at the Mayo Clinic in Minnesota to correct my hypertrophic obstructive cardiomyopathy. I was so "prayed up" that I experienced virtually no anxiety, despite the invasive procedure and uncomfortable recovery. By late October, I was leading the Petrology field trip to Southern Illinois and Missouri. By Thanksgiving, Carol, my two sons, daughter in law and I participated in the 4-mile gobble gobble gobble race in Somerville, Massachusetts. Can't say that I ran the whole way, but I did not let the woman dressed as a banana beat me.

This year I have been serving as President of the American Scientific Affiliation. A highlight was participating with Jeff Greenberg in the annual ASA meeting on the campus of Colorado School of Mines in Golden, Colorado. We met with recent Wheaton geologists who are enrolled in the graduate program there: Anna Ryken, Mark Hansford and Andrew Graber. ■



PERRY MASTODON CONTINUES TO INSPIRE CHILDREN

Every year hundreds of school children visit our exhibits and the Perry Mastodon. We provide brief programs for public, private and home schools and scouts. Many children return letters of thanks. Here are excerpts from three elementary students writing from Clapham School (Wheaton College Church).

"I had a joyous time learning about Perry. The slide show was very interesting. Perry must have had a wonderful life. If you are going to send me a letter back, please tell me things I didn't get to hear."

"Thank thee for letting me see photos of Perry's bones and letting me feel Perry's bones. I also thank thee for letting me see Wheaton College's rock collection. Me thinks that thee is a good professor."

"Thank you so much for giving us an amazing tour. I'm sure nobody could give a better tour than you! I learned many new things and a few of my favorite parts were looking into Perry's brain and the slideshow." ■

KEIL'S CORNER

Things are always hopping down on the lower level of the Meyer Science Building! There's more to do than we have a chance to fully engage in. Environmental interests seem currently to be growing in the Wheaton College students. It's been an up and down cycle, but I'd say interest is strong based on the number of requests everyone in the department gets to participate in environmental panels, activities, class sessions, community involvement and the like. The whole department is heavily involved in the new general education program so many non-science majors are getting good exposure to earth and environmental science. This isn't necessarily translating into an explosion of new majors, but earth and environmental science across the curriculum is something we all believe in. It is an exciting and opportunity filled time.

One of the highlights of the year for me was developing and teaching ENVR/CORE 325 Nature, Environment, and Society at the Science Station. The CORE designation indicates that it is an Advanced Integrative Seminar (AIS). In the new Christ at the Core general education curriculum, all students have to take and AIS course. This new course meets both the upper divisional science requirement for non-science majors and is an AIS course. The class was a lot of fun to prepare and deliver and the students were great. Four weeks is what I've always wanted for teaching a general education environmental science course out in the Hills, but we still didn't get to everything I wanted to do and cover. Some of the highlights of the class included: a trip to Wyoming stopping at Devils Tower and visiting a coal mine and power plant outside Gillette, a joint field trip with the biology track out to the Black Fox Valley and Bee Draw, getting a tour of the lumber mill outside Hill City, and the always popular visits to the sewage treatment plant and landfill. Some photos of our adventures are featured on page 1.

Studying off campus continues to be a theme in the Environmental Science Program. This fall four of our majors did the Wheaton in Chicago program, part of which was doing internships in a variety of environmental workplaces. The International Sustainable Development Studies Institute (ISDSI) in Chiang Mai Thailand continues to be a program that gives environmental science students training in sustainability in the two-thirds world. Three of our students have spent a semester there over the past year. Another one of our students is studying sustainability in Scandinavia this semester.

Internships remain an important part of the Environmental Science curriculum. Students regularly provide feedback on the great value of their internship experiences. And the supervisor evaluations we get back from their internship site are unanimously positive. So if your organization wants to host a intern, contact me and let me know.

I still squeeze in some time to move forward in my long time research program on modeling indoor air pollution transport focused on workplace environments. I don't get out into factories as much as I used to, but in collaboration with students my research moves ahead. Just this fall I published a paper with a student as a co-author "Interzonal airflow rates for use in near-field far-field workplace concentration modeling", Chris Keil & Yuxi Zhao, *Journal of Occupational and Environmental Hygiene* 14:10, 2017. I hope to be able to continue making progress in this line of research. There are so many good things to do! ■



The GSA crew with Dr. David Wheatley ('12), Claire Browning, David Gates, Becky Thielman and Valerie Tewell

SAM SMIDT, VISITING PROFESSOR OF ENVIRONMENTAL GEOLOGY

Hello everyone! As this is my first update, I figured I would quickly introduce myself and interests. I joined the department as a visiting professor in the fall of 2016 as part of the new Christ at the Core gen-ed initiative, and I have been teaching classes in both the geology and environmental science majors. My PhD is in Environmental Geoscience from Michigan State University, and I have a doctoral specialty in Environmental Science and Policy. I am an interdisciplinary hydrogeologist by training, and most of my background involves resource use and planning, particularly around the sustainability of freshwater systems. My wife, Sarah, and I live in St. Charles, and we are expecting our firstborn this March!

My first two years in the department have been focused on student recruitment and undergraduate research. I currently am working with 7 students on research projects, covering field applications, computer modeling, and geoscience education. Most recently, five students and I made our way to Seattle for the GSA Annual Meeting to present the work we have been conducting for the past year. The conference was a huge success and was capped by senior geology major, David Gates, winning the best poster award for his topical session, "A Showcase of Undergraduate Research in Hydrogeology".

The GSA crew with Dr. David Wheatley ('12), Claire Browning, David Gates, Becky Thielman and Valerie Tewell

(above).

I have also been working to develop a research relationship with nearby Campton Township Parks and Open Space (about 35 minutes west of campus; <http://campton-parks-and-open-space.com/>). The township has made available ~1,500 acres of open space for student education and research. The area includes wetlands, groundwater fens, streams, long and short grass prairies, oak savannahs, woodlands, and Native American mounds. So far, we have had around 100 students conducting research at the property as part of service-based field trips, and several have worked on the property during summer research opportunities. An interesting note that we discovered this semester – the original landowner of their main property was a Wheaton College graduate from the early 1900s; the archives group on campus is now involved with the Wheaton College artifacts still left in the original farm house.

I have appreciated every opportunity to connect with department alumni, and I am looking forward to meeting more and developing relationships in the future. As a friendly non-native (Olivet Nazarene University, '12), it has been fun learning about the history of the department and observing the impact that alumni have on our department. Your connection with the department is extremely valuable, and current students are very grateful for relationships and interactions. ■



Participants in the Alumni-Student Field Trip, May 2017 at El Capitan, Guadalupe Mountains National Park. (L to R): Stewart Dykstra, Jeffrey Leeburn, Katy Foltz, Austin Patrick, Alec Fojtik, Jonathan Williams, Benjamin Hess, John Patrick, Stephen Moshier, Lisa and David Heidlauf, Rich Aram (Brenda Aram photographer).

STUDENT AND ALUMNI FIELD TRIP: FAR WEST TEXAS AND SOUTHEASTERN NEW MEXICO May 8-13, 2017

by Jonathan Williams '80

I enjoyed reading about the Great Basin student and alumni field trip in the April 2016 CONTACT and thought that sort of vacation might be fun to consider some day. Less than a year later, my brother Christopher, also a geologist and Wheaton College alumnus, alerted me about a similar field trip being planned by Dr. Stephen Moshier to explore the Franklin Mountains, Guadalupe Mountains, McKittrick Canyon, Carlsbad Caverns, White Sands, and more. We signed up.

Besides the geologic itinerary, and rooming with one of my brothers for a week, I was looking forward to meeting the other people who would choose this type of adventure. As anticipated, I enjoyed the mixture of students and graduates who participated. Life was shared in the van, at meals, on the trail, and at the outcrop. Students and alumni took the initiative to ask probing questions of each other.

This was a collegial trip. Unlike a traditional college field trip, the college professor was not the only expert. Dr. Moshier prepared a mixture of sharing his considerable expertise and asking field trip participants to share theirs. He also arranged for us to be led by a local hydrogeologic researcher, New

Mexico Tech Professor Lewis Land, for a day focused on gypsum karst processes.

The breadth of geologic experience and geographic diversity amongst the alumni made for great discussions both professionally and personally.

Professionals on the trip were from the states of Washington, Texas, Illinois, Michigan, and Florida. Professional experience included petroleum exploration and production, managing hazardous waste site cleanups, producing state geologic maps, teaching college, and a variety of consulting projects.

Two field trip participants had not been formally trained in geology. They enjoyed themselves, and often inquired about an outcrop or landscape. Although amateurs in the field of geology, they were equally appreciated participants who helped shape the group dynamic.

I'm grateful to the Geology Department for offering this opportunity, to my brother who joined me in the adventure, and to God Almighty for creating an amazing world worthy of our study and stewardship. ■



Alumni and student hikers at McKittrick Canyon Trail, Guadalupe Mountains National Park.

STUDENT ABSTRACTS FROM RECENT PROFESSIONAL MEETINGS

GSA Annual Meeting in Seattle, Washington, USA - 2017

ESTIMATING IRRIGATION ENHANCEMENT ACROSS THE CONUS

GATES, David J. and SMIDT, Samuel J.

Irrigation applications are a common farming strategy for maximizing annual crop yields, yet farmers looking to introduce a new irrigation system do not have a reliable data source that estimates the yield increase expected when compared to dryland regimes. Irrigation use is also a notable stress on water systems, making the management of both food and water a challenge in agriculturally intensive areas. A comprehensive understanding of irrigation enhancement compared to dryland practices is needed to couple sustainable water use with increased food production. This study uses a dual end-member linear regression model to estimate yield enhancement for major row crops across the continental United States (CONUS). We constructed the model using both observed yield data and common drivers to crop production (e.g., seasonal precipitation, air temperature, soil characteristics, and geographic location). We then interpolated this county-level data to generate a spatially complete yield enhancement map. Irrigation enhancements across commodities identified general East-West trends, with little effect in the east to roughly doubling yields in the west. This data can be used to influence farmer decision making at the regional level and establish a baseline for food production and water use in agricultural systems.

GEOPHYSICAL AND GEOLOGICAL SURVEY OF TEL SHIMRON, ISRAEL

GATES, David J., James A. Clark, Stephen O. Moshier, Valerie Tewell, Daniel Master, Mario Martin, and John Sheffer

Tel Shimron is an archaeological site in the Lower Galilee region of northern Israel. The tel is located on the northern margin of the Jezreel Valley and was inhabited from the Early Bronze Age to Islamic Period. Summer 2017 marked the first season of excavation and the start of this research. This study's purpose was to provide the archaeological team information on the local geology as it pertains to settlement patterns and ancient resources through both surficial mapping and geophysical prospection of the bedrock. The regional geology includes Eocene chalks of the Avedat Group with localized pedogenic alteration to calcrete (known regionally as nari) as well as Miocene basalt. The substantial exposure of basalt adjacent to the tel is of poor quality and was not used for tools, but rather extensively quarried for rampart construction and paving material. Hard nari was used for building stone and both chalk bedrock and nari are a local source of flint for tools.

Three geophysical methods were used to construct a partial subsurface model of the tel: electrical resistivity, seismic refraction and seismoelectric. Processed data revealed varying thickness of cultural "fill" over bedrock and suggested that the original topography beneath the tel may have influenced development patterns and

rampart construction. Shallow buried structures, such as walls and broad floors were revealed in transects on the southwestern edge of the tel. This information will be used to influence archaeological decision-making and promote a multifaceted approach to site excavation in future seasons.

A CONDUCTIVITY AND DISSOLVED OXYGEN SUITE FOR IDENTIFYING SURFACE WATER-GROUNDWATER INTERACTIONS

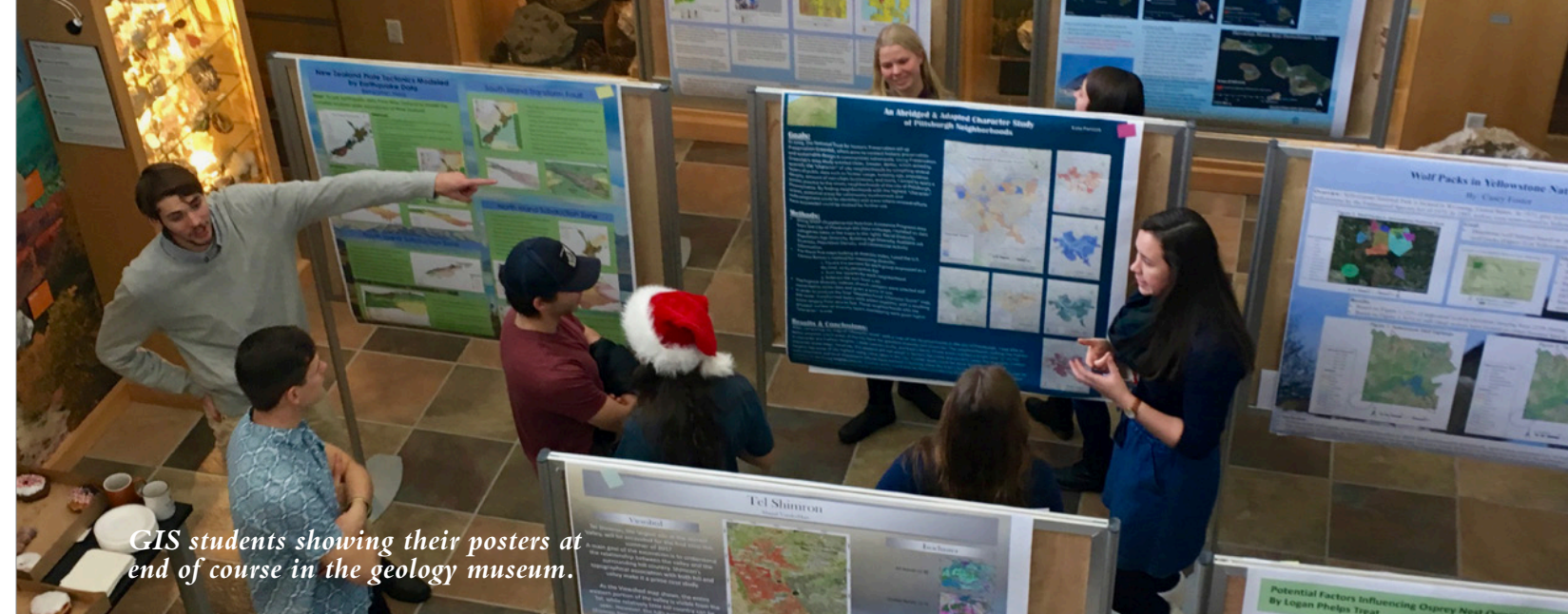
THIELMAN, Rebekah, MADSEN, Andrew and SMIDT, Samuel J.

Surface water-groundwater interactions are critical for overall stream health, but identifying the locations of these interactions often requires expensive or intensive field equipment. Moreover, field sampling is often site-specific and identification at multiple locations along a stream reach is limited. Streamlining the identification of surface water-groundwater interactions along a stream reach is a necessary step to large scale restoration projects, particularly in ungauged or unstudied areas. Here, we used a preliminary solute mass balance approach to efficiently estimate the magnitude of downstream surface water-groundwater interactions. We injected an in-stream saline tracer and simultaneously monitored for conductivity and dissolved oxygen adjacent to the stream channel using several groundwater monitoring wells. We then quantified the magnitude of surface water present in groundwater flow paths using a solute mass balance approach. Dissolved oxygen was then used as a proxy for conductivity to identify the location of downstream surface water-groundwater interactions and to quantify the magnitude of surface water present in groundwater flow paths. Results from this study can be used in watershed restoration projects or site assessments as a way to identify the locations of key flow paths that benefit overall stream function.

LIGHTWEIGHT, LOW-COST PERISTALTIC PUMP FOR STREAM TRACER INJECTIONS

THIELMAN, Rebekah and SMIDT, Samuel J.

Constant rate tracer injections typically rely on a peristaltic pump, but few pumps are adapted to extreme field conditions. Pumps used by researchers generally fall into two categories: (1) lab-based designs implemented in a field setting or (2) do-it-yourself pump designs constructed by the researcher. Lab-based designs are often expensive (>\$1,000) and sensitive to damage and moisture common in a field setting, and both pump categories often require large and heavy batteries to drive long injections at high flow rates (>1 L/min). The purpose of this study was to develop a cost-effective, do-it-yourself alternative ideal for robust field conditions. We used a bipolar stepper motor (12V-36V, 1.5A) connected to a microstep driver (40V, 4A) to create a continuous peristaltic rotation. The pump is controlled by an Arduino Uno microchip processing board, allowing for variable pump rates to be defined by the user. Waterproof housing was constructed using a Pelican 1200 case (7.29" x 4.78" x 3.33"), which can support up to 2 motor systems per case, allowing for dual tracers or double flow rate. Each motor system only draws ~2A of current,



CIS students showing their posters at end of course in the geology museum.

allowing for extended battery life using only a small sealed lead acid 12V battery. Batteries can also be stored in an adjacent Pelican 1200 case for a complete weather-proof system. Our maximum flow rate was ~1 L/min per pump, or 2 L/min per housing case. Total cost of the design was \$300 for a dual pump set-up.

American Geophysical Union Fall Meeting in New Orleans, Louisiana - 2017

Understanding the evolution of S- and I-type granitic plutons through analysis of apatite

HESS, Benjamin Levi, Adrian Fiege and Nicholas Tailby

The major and trace element composition of apatites from the Lachlan fold belt (LFB) S- and I-type granitoids (Australia) and the Central French Massif (CFM) S-type leucogranites (France) were analyzed to investigate their compositional and redox variation. Apatite is a common accessory mineral in magmatic systems that can incorporate a variety of trace elements, including the polyvalent elements sulfur (S), iron (Fe), and manganese (Mn). It was recently discovered that apatite can incorporate three oxidation states of S (S6+, S4+, S2-) into its structure as a function of oxygen fugacity. However, the oxidation states of Mn and Fe in apatite are essentially unknown (2+ and/or 3+).

In this study, we collected many electron probe line transects across apatites in several different host phases from a variety of S- and I-type plutons. The F-H-Cl contents of the S- and I-type LFB samples were similar (~2.9 wt% F, ~0.4 wt% Cl, ~0.5 wt% OH). The CFM S-types contained virtually no Cl and ranged from near-endmember OH-apatite to near-endmember F-apatite. The apatites of all studied the S- and I-type plutons are characterized by similar ranges of Fe content (<1.5 wt% Fe), while Mn reaches much higher concentrations in the S-type when compared to I-type apatites (<6.5 wt% Mn). The S content of the apatites varies significantly, from <50 ppm S in the LFB S-types, up to 2,000 ppm S in the LFB I-types, and reaching 1,650 ppm S in the CFM S-types.

The elevated S contents in the LFB I-type and CFM S-type apatites allowed us to measure the S oxidation states by using X-ray absorption near-edge structure (XANES) spectroscopy. The spectra show variability in S oxidation states ranging from mostly sulfate down to nearly equal S6+/S2- ratios, indicating redox variations during apatite formation. The S-type Mn + Fe content plots in a 1:1 ratio against calcium (Ca) in atoms per formula unit, while the

I-type apatites have too low Mn and Fe to show a clear trend. Thus, divalent Mn and Fe probably replace Ca2+ in the S-types' apatite structure, while the incorporation of trivalent Mn or Fe in apatite is rather unlikely. We suggest that Mn and Fe contents in apatite may become a useful tracer of melt evolution once the distributions coefficients are experimentally calibrated.

Lunar and Planetary Science Conference XLVIII in Houston, Texas - 2017

THE STRATIGRAPHY OF MERCURY'S CRUST AS EXPOSED BY IMPACT CRATERS: A GLOBAL CLASSIFICATION

LEEBURN, J. M., B.W. Denevi, C. M. Ernst, and R. L. Klima

Understanding the origin and evolution of Mercury's crust was a key goal of the MESSENGER mission. Prior to MESSENGER's exploration of Mercury, a leading hypothesis for the formation of the planet's crust was through crystal-liquid fractionation of a magma ocean, leading to a plagioclase flotation crust analogous to that of the Moon. However, reflectance observations and elemental abundance data make it clear that Mercury's crust is very different from the Moon's, and interpretations based on the planet's geomorphology and crater size-frequency distributions imply widespread resurfacing occurred, likely through a combination of volcanism and impact cratering. This geologic activity complicates an examination of Mercury's early crust. Here we investigate Mercury's stratigraphy as exposed by impact craters >20 km in diameter in order to evaluate the mode(s) of formation of a key crustal unit, the low-reflectance material (LRM). LRM has been documented to be mainly exposed from depth, and proposed to be at the bottom of the stratigraphic column, either as a component of the lower crust or upper mantle. The reflectance of LRM is up to ~30% below the global mean, and it has a shallower (bluer) spectral slope, with a broad absorption-band-like feature at ~600 nm. These properties together with thermal neutron measurements have led to the interpretation that LRM is rich in graphite (up to 5 wt.%). Geochemical modeling has also shown that graphite is the only mineral that would have been buoyant in a magma ocean, suggesting it may have been a component in the earliest-forming crust. We explore whether the global occurrences and regional variations of LRM are consistent with this scenario, and investigate the role of early volcanism in the formation of Mercury's crust. ■



Dakota Skies is a new 4-week course offered in the Black Hills. Half astronomy and half meteorology with the highlight of launching a balloon instrument package to the stratosphere (100,000 feet).



Stephen Moshier and Sarah Ostertag at Wheaton College Honor Society Induction. Sarah was awarded the Gerald Haddock Outstanding Geology Senior Award for 2017.



David Kapel '56, attended Geneva, IL High School and was a volunteer for the Geneva Young Life club as a Wheaton undergraduate. David was invited to the Kane County Young Life, 75th anniversary celebration in October 2017



Jeffrey Greenberg and Maddie LeMar review metamorphic rocks

TRIBUTE TO DR. JEFFREY K. GREENBERG

by Stephen Moshier

Dr. Jeffrey K. Greenberg joined the faculty of Wheaton College in 1986 at a time when the Geology major was in danger of being eliminated. In fact, the department had been moved under the leadership of the Chair of the Department of Physics. Jeff was charged with increasing the number of geology majors or be content with teaching nothing but general education earth science for the rest of his career! By 1990, the major was viable enough that another professor could be recruited to restore the department.¹ Jeff developed the Environmental Studies major in 1995, motivated by his interest in, and commitment to, creation care as a meaningful Christian vocation. He led the Geology and Environmental Science Department from the time he joined the faculty until December 2005. Jeff has contributed to teaching or leadership at the Wheaton College Science Station every summer since 1986, putting him in the Mount Rushmore of longest-serving faculty at our Black Hills campus. Another record for Jeff must be the number of semesters in which he taught our introductory geology course, often three to four sections per year. In this role, he has shared his enthusiasm for geology and environmental stewardship with probably more than 4,000 students. Jeff loves teaching in the field, and some 300 geology majors share vivid memories of wild adventures with him chasing outcrops and enjoying landscapes. He invested countless hours in the curation of a remarkable Department Collection of Rocks and Minerals, including the Arthur Smith Mineralogical Collection (received in 2012). Jeff embraced the new Christ at the Core curricula even late in his career, now in his third semester offering of the First Year Seminar. He has served on virtually every standing committee in faculty governance. Jeff's scholarship has been focused on appropriate technology and the use of geological knowledge for sustainable development. Co-editing the recent Geological Society of America Special Paper 520 *Geoscience for the Public Good and Global Development: Toward a Sustainable Future* is a fitting capstone for his career. He is co-organizer of an international conference dedicated to this theme, coming up in the spring. Jeff coined the term *geophilanthropy*, which he defines as "service rendered by education/training of others, by volunteering one's time and expertise in problem solving, or by materially supporting geology-related projects."² Jeff has been the heart and soul of the Department of Geology and Environmental Science for 31 years. The 82-year legacy of the Geology major (first granted in 1935) might have ended at less than 50 years without his passion, effort and leadership. ■

¹ I am grateful for those efforts, because that is when I was hired to join the department!

² Jeffrey K. Greenberg, 2016. "Geophilanthropy, personal and public", *Geoscience for the Public Good and Global Development: Toward a Sustainable Future*, Geological Society of America Special Paper 520, eds. Gregory R. Wessel, Jeffrey K. Greenberg

TRIBUTE TO DR. JAMES A. CLARK

by Stephen Moshier

Dr. James A. Clark joined our department in 2000 after serving 17 years on the faculty at Calvin College. Jim's reputation preceded his inquiry for the open position and we were ecstatic that he would consider joining us. After his inquiry, there were no other serious candidates for the position. Jim was able to transfer funding from NSF and NASA for research here at Wheaton College with our students, at a time when Wheaton faculty were not permitted to seek government supported research funding (Calvin College was gracious to continue accepting the grants from the agencies and transfer them to Wheaton College). His various projects resulted in numerous peer-reviewed articles with student collaborators. These were important contributions to the understanding of post-glacial sea level rise. His work in the past ten years was largely focused on developing inexpensive geophysical tools for groundwater exploration. For this work, he received the Gieser Award for contributions to missions. Some of his Wheaton College mentees are professors at flagship state universities and many others are involved in work ranging from water resource development in the majority world to domestic environmental management to energy exploration. He and his wife Susan traveled with the Honduras Project team during a spring break and he has made numerous visits to HNGR interns over the years. His teaching serves both the Geology and Environmental Science majors, as well as general education. Students understand that Dr. Clark's courses are challenging, but worth the effort for practical professional development. He delivers a devotion before each lecture that integrates the scriptures and Christian teachings with course material in imaginative ways. Students light up when he says, "True story..." because they know it signals the beginning of some amazing adventure in his past. As a colleague, Jim is always willing to pitch in with entertaining guest to the department, encouraging prospective students to accept offers of admission, or build just about any experiment or gadget that will advance our educational mission. Jim will be missed, but his legacy of teaching and mentoring will continue with his students in their vocations to advance Christ's Kingdom on the good Earth. ■



Sue and Jim Clark at Tel Shimron, Israel testing Jim's DIY electrical resistivity equipment



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"THE Department of Geology and Environmental Science at Wheaton (IL)"

DEPARTMENT NEWS

PAUL H. RIBBE '56 (1935-2017)

Paul Ribbe passed away on June 24, 2017, only eight weeks after Elna, his wife of 59 years. Paul was among the most distinguished geoscientists of our Wheaton family. He served as President of the Mineralogical Society of America (1986-1987) and was awarded both the MSA Distinguished Public Service Medal (1993) and the Schlumberger Award from the Mineralogical Society of Great Britain and Ireland (1995). Ribbeite, a Mg-Mn²⁺-orthosilicate, honors his contributions to mineralogy. Paul joined the faculty of Virginia Tech in 1966 where he mentored many future leaders in mineral and material science. He was a founding elder of the Blacksburg Christian Fellowship where he and Elna were much loved for their encouragement and spiritual leadership. A wonderful tribute to Paul was published in the recent Elements magazine <<http://elementsmagazine.org/2017/07/26/tribute-to-paul-h-ribbe-1935-2017/>>



DONUT FELLOWSHIP

We started a new intra-department gathering to promote fellowship and give students the chance to let other students know about their summer research experiences. On selected Thursday mornings, during the open "chapel" hour, we meet in the museum for snacks and coffee or tea.



DEPARTMENT OF GEOLOGY
& ENVIRONMENTAL SCIENCE

501 College Avenue
Wheaton, IL 60187



STUDENTS IN THE FIELD

Left: Students participating in the "March for Science" in April 2017. Top right: ENVR 221 class field trip. Bottom Right: Water quality testing on ENVR 221 field trip