Kansas State University Department of Geology

Summary of Outputs and Achievements

Advisory Council Meeting

06 November 2020

Congratulations to Matthew Brueseke—promoted to Professor!

Dr. Matthew Brueseke was promoted from Associate to full Professor this year in recognition of his distinguished reputation in igneous petrology and outstanding record of contribution to the Department of Geology through teaching, research, and service. Matt joined K-State in 2007 and was promoted to Associate Professor in 2013. Matt is recognized by his colleagues for his impressive disciplinary range, which encompasses volcanology, geochemistry, petrogenesis, and tectonics. His students think he is 'amazing', 'influential', and 'inspiring'—and we do, too! He has served as Geology's Director of Graduate Studies for many years, and has been recognized by the University with a Big 12 Faculty Fellowship (2018-19), a Kansas State University Goals and Values in Science Faculty Fellowship (2019-20), and in 2018 was the Honorary Award recipient of the Rocky Mountain Federation of Mineralogical and Lapidary Societies for the AFMS Scholarship Foundation. Congratulations, Matt, and well done!

K-State Geology responding to COVID

Emergence of COVID-19, and the university decision to suspend all in-person classes halfway through the spring semester, meant that Geology faculty had to pivot all courses into an online format at a moment's notice. Unless you've ever had to do something like this yourself, it's hard to explain the amount of work involved to pull it off. Let me assure you, it was enormous, and I want to compliment the Geology faculty and graduate teaching assistants who went above and beyond to make it happen. Through their efforts, we ensured that our students received the highest quality educational experience possible. Yes, we had to cancel field trips, including a major excursion to Hawaii that was planned as part of our Regional Geology course this year! And some lab-based activities were also curtailed, but we did our best to limit the spread of the virus while meeting the educational needs of our students.

Some research activities also fell victim to COVID. Dr. Karin Goldberg and Dr. Pamela Kempton were scheduled to participate in International Ocean Drilling Program research cruises—Dr. Goldberg on Leg 388 (Equitorial Atlantic Gateway) and Dr. Kempton on Leg 390 (South Atlantic Transect)—but both cruises were cancelled. Leg 390 has now been rescheduled, but not until spring of 2022, and we're still waiting to hear what will happen to Leg 388.

The summer months of 2020 were spent developing strategies for how to deliver classes in the fall that would provide adequate protection for students and faculty while still meeting educational demands. Unfortunately, on top of all the other issues we had to deal with, we learned that most of the labs and classrooms in both Thompson Hall and the basement of Nichols Hall had inadequate ventilation, so these classrooms were taken 'offline'. This resulted in a mad scramble just weeks before classes were to start in the fall to find spaces from which to teach labs and classes that most needed an in-person component. We are currently teaching Intro Geology Lab (GEOL 103) from Willard Hall, and some upper-level labs, like Mineralogy, had to be split into two separate labs to stay within the COVID capacity of the room, which effectively doubles the workload for the faculty member and GTA. Work is now ongoing to improve the ventilation in both Thompson and Nichols Halls, but at the time of this writing, neither has been achieved.

Spring, and possibly even fall, 2021 look like they will be a continuation of the online and hybrid instructional modalities we have been using since March. But faculty have been working hard to continually improve the quality of our instruction in these formats. Some of the classes that are the most difficult to teach in the online format are those that require rock and mineral identification, either in hand sample or thin section. To meet this challenge Drs. Lacroix, Brueseke and Kempton submitted a proposal to the National Science Foundation to acquire the equipment to rapidly produce thin section scans that can approximate the experience of using a microscope in a virtual environment and Dr. Brueseke, in collaboration with Graham (Univ) submitted a proposal to facilitate provision of 3-D images of rocks and minerals that could be used for teaching Mineralogy and Petrology. Both proposals were successful, so we're looking forward to having a much better experience for our students.

You know what they say, when life hands you lemons, make lemonade!

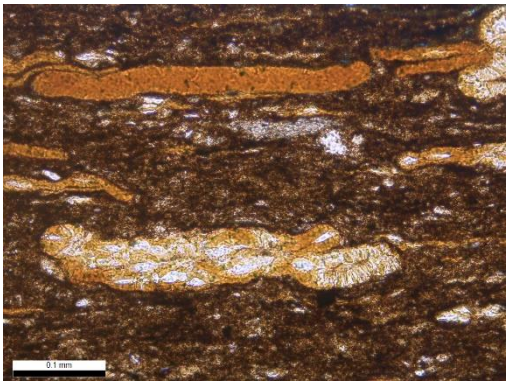
Research and Impact Highlights

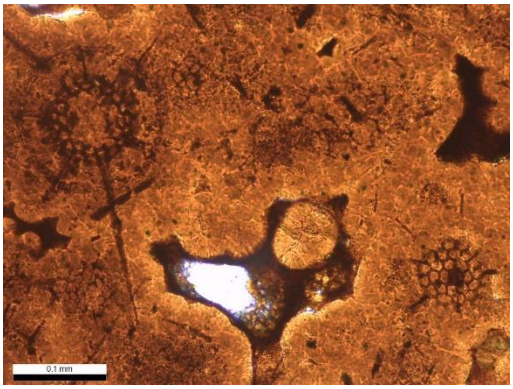
RAMAN spectroscopy of chlorite – preparing to explore Mars

Chlorite is a ubiquitous mineral found in sedimentary, metamorphic and magmatic settings. Its composition provides important clues about the pressure and temperature conditions under which it formed, the composition of the fluid from which it crystallized, as well as the oxidation state of its environment of formation. This makes chlorite an ideal candidate to study geological processes. Raman spectroscopy can provide a multitude of information about chlorite composition as long as calibrations exist. **Dr. Brice Lacroix** and his M.S. student, **Sarah Lamm**, are currently developing a calibration of chlorite composition using micro-Raman analysis. With the embarkation of a miniaturized Raman spectrometer (RLS) on board the next ESA ExoMars planetary mission, scheduled for launch in 2020, such a calibration could become an invaluable tool for exploring geological processes on Mars. Sarah recently presented her results at the virtual GSA meeting.

High-resolution sequence stratigraphy of the Chattanooga/Woodford Shale

Dr. Karin Goldberg and her students **Spencer Brower** (recent MSc graduate) and **Brayton Pew** (current MSc student) continues to focus on "High-resolution sequence stratigraphy in mudrock-dominated successions: the Chattanooga/Woodford Shale (Late Devonian, Midcontinent Basin)", which is a project funded by the American Chemical Society (Petroleum Research Fund). The purpose of this research is to better understand the nature of the depositional environments and paleogeographic settings that are most conducive for accumulation of high concentrations of organic matter in mudstones, in order to improve identification of viable source rocks, as well as which rocks can be most easily fractured to extract petroleum. The project compares drill core of Chattanooga/Woodford shale in northeastern KS with outcrops Oklahoma. Results to date show that the sedimentary successions in the two locations consist of different facies and have different organic matter contents. In KS core there are nine sedimentary facies, dominantly algal-rich silty and clayey shales, with abundant sand laminae and terrestrial organic matter that suggest proximity to the shoreline. Most samples have low overall concentration of organic carbon (less than 1% TOC), with a maximum of 12% TOC. In the OK outcrop, the studied unit is composed of only three facies: radiolarites and algal- and radiolarian-rich clayey shales, indicating deposition in deep-water settings. The concentration of organic matter is very high (>2%, average 11%), with TOC in most samples consistently higher than 10% and a maximum of 21%.

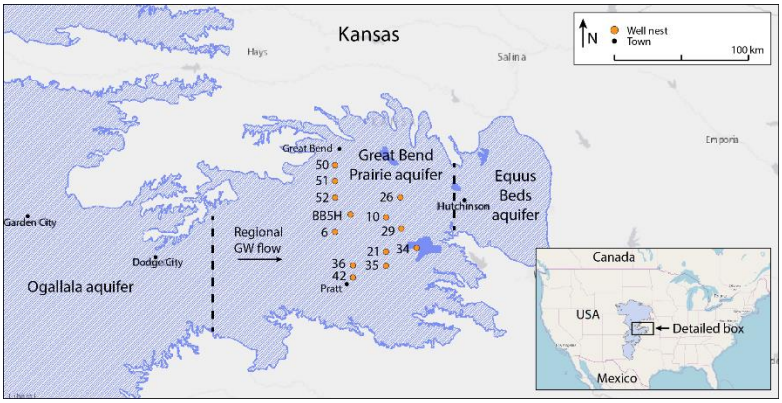




Chemical proxies have been identified using the department's Handheld XRF (HHXRF) to identify key stratigraphic surfaces and assess the controls on the accumulation of organic matter in the sediments. Key elemental ratios differentiate three sequences in the sedimentary succession on the basis of detrital input (Ti/Al, Zr/Al, Si/Al), primary productivity (P/Al) and anoxia (Mo/Al, Ni/Al). Basal Sequence 1 records relatively rapid changes between multiple facies during deposition. Sequence 2 is more homogeneous throughout, with low detrital input and primary productivity. The topmost Sequence 3 is similar to Sequence 1, with frequent facies changes and evidence for greater detrital input. The study will allow the assessment of whether (and how) a different paleogeographic position affects the accumulation of organic matter in the sediments.

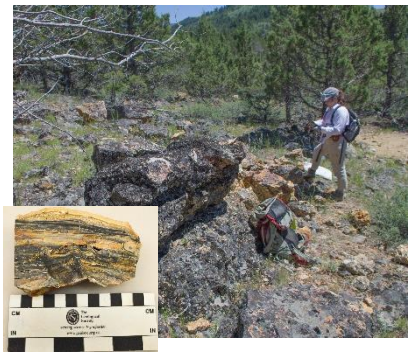
Rural water wells in High Plains Aquifer show large increase of nitrate levels

Groundwater levels are dropping at an alarming rate in portions of the High Plains Aquifer in western Kansas. However, groundwater quantity is not the only thing we need to be concerned about when it comes to the High Plains Aquifer. **Dr. Matthew Kirk**, **Alexandria (Allie) Lane** (recent MSc graduate), and collaborators recently published some of Allie's thesis findings, which showed that groundwater quality is also threatened. The research focused on the Great Bend Prairie Aquifer, a part of the High Plains

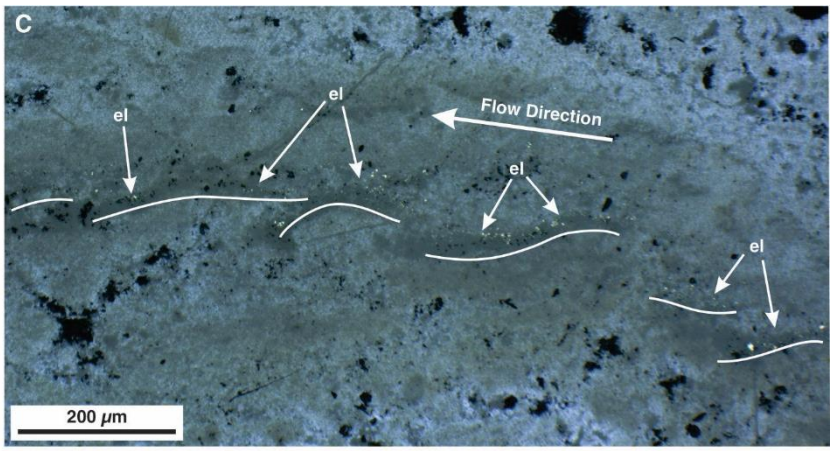


Aquifer in south-central Kansas where groundwater levels are relatively stable. By comparing their results from samples collected in 2016 to measurements made on samples from the same wells in the 1970s and 1980s, they demonstrated that nitrate concentrations have increased significantly during the past four decades as a result of fertilizer use. The amount of increase in nitrate is large relative to other aquifers and represents a major decrease in water quality. Seven of the 21 wells they sampled for the study had nitrate concentrations above the standard for drinking water (10 mg/L as N) compared to only one when the wells were sampled in the 1970s and 1980s. These results shed light on a growing problem in agricultural landscapes and raise questions about the quality of water produced from private drinking water wells in the study area. As such, the article received considerable attention when it was published. The press release from the article was picked up by at least 29 different media outlets, including media in the US and Europe. Dr. Kirk is now collaborating with a faculty member and students at Barton Community College to learn more about nitrate levels in private water wells and working on a second publication that considers microbial community composition in the aquifer and how it relates to land use and nitrate accumulation.

Professor Matthew Brueseke writes about 'staying alive and sane' in the age of COVID



In addition to trying to stay alive and sane in an ongoing global pandemic and an acute University budget crisis, **Prof Matthew Brueseke** and his students have continued work on a variety of research projects, including arc volcanism and terrane accretion; metal(loid) behavior in epithermal sinter deposits; and intraplate volcanism. He recently published a paper in the AGU journal *Tectonics* that provides constraints from igneous and sedimentary strata (field, physical, geochemical, and radiogenic isotope data) on a postulated volcanic arc associated with accretion of the Wrangelia

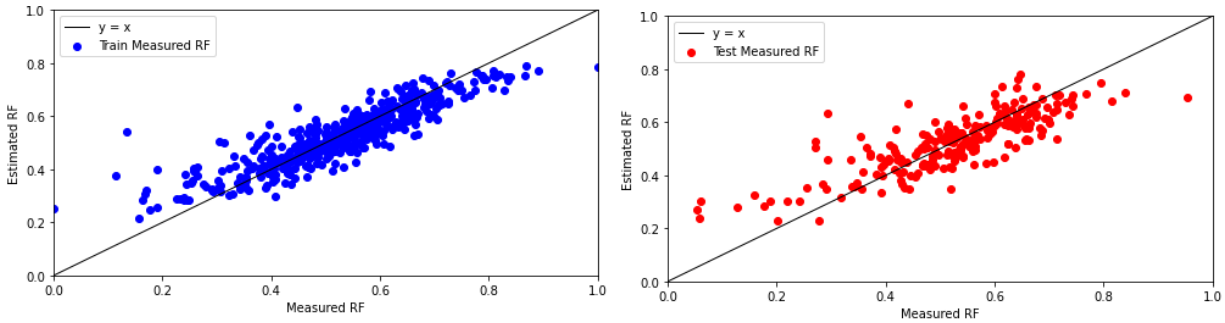


terrane, Alaska (one of the largest additions of allochthonous crust to the North American continental margin). Recent M.S. graduate **Emily Fenner** documented the occurrence of gold nanoparticles in a Miocene hot springs sinter (ID); this has significant implications for how epithermal gold deposits form and demonstrates that sinter, which

is historically considered “barren”, can provide mineable resources and also provide useful criteria for exploration of deeper gold and silver deposits.

Hydrocarbon recovery factor estimation via machine learning

Accurately estimating hydrocarbon recovery factor can save industry millions of dollars. Although recovery factor can be determined with relatively high accuracy at small core scales, its estimation at the reservoir scale is still a major challenge for oil and gas companies due to large-scale heterogeneities and complexities. Recently, with advances in machine learning algorithms, it is possible to analyze large databases even with missing data. **Dr. Behzad Ghanbarian** and M.S. student **Alireza Roustazadeh** are working to estimate the hydrocarbon recovery factor from reservoir characteristics, such as porosity, permeability and lithological properties using a large commercial database that includes more than 1,200 reservoirs from around the world. They have applied the Tree Based Gradient Boost model (XGBoost), one of the latest Gradient Boosting type algorithms available in the market, to train and test the machine-learning model. For the training and test samples (figures below), their model returned root mean square errors (RMSE) of 0.063 and 0.085 and correlation coefficients (R^2) of 0.78 and 0.64, respectively. Comparing the determined R^2 values with those reported for some existing models developed for databases with similar diversity showed a significant improvement in the estimation of oil recovery factor at the reservoir scale.



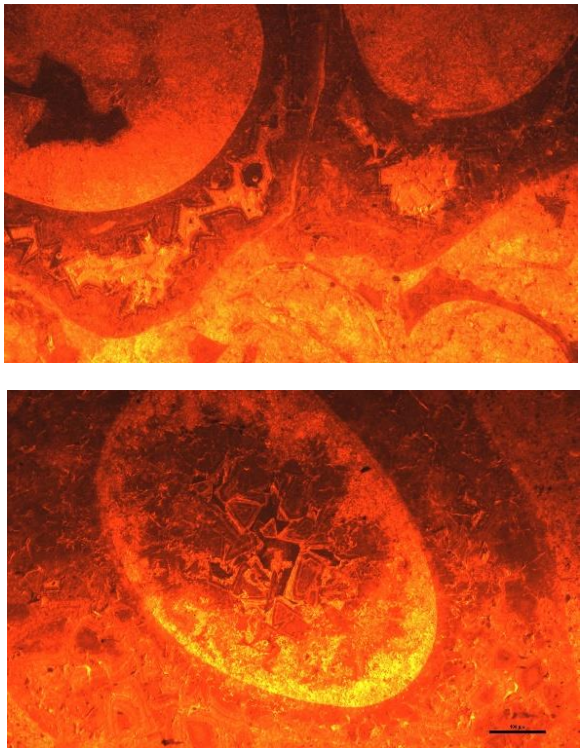
Estimated oil recovery factor vs. the measured one for the train and test datasets. Data are from the commercial database used in this study.

Constraining Turkish Tremors

For the past five years Dr. Joel Spencer has been collaborating with Professor Hasan Sözbilir and members of his research group at the Earthquake Research and Implementation Center (ERIC) at Dokuz Eylül University (DEU), İzmir, Turkey. Luminescence dating expertise from Kansas State University in collaboration with labs in Ankara, Turkey is being used in several paleoseismic projects to constrain past movement of a series of faults in and around the İzmir region, in western Turkey. Accurate chronology provided by luminescence analyses is critical to understanding Late Pleistocene to Holocene movement of these faults, to aid in predictive assessment for future earthquake hazard. These studies are leading to a series of publications, and to pending spin-off proposals submitted to Tubitak (Turkish equivalent to NSF) to study active tectonics in Antarctica and to the Marie Skłodowska-Curie Fellowship program (part of the EU Horizon 2020 funding initiative) to further study faults in the İzmir region. If successful, the latter proposal will support Dr. Mustafa Softa (ERIC, DEU) for two years of postdoctoral research at K-State to develop surface dating methods normal to the slip-surface of the fault plane using luminescence techniques.

Geology now has cathodoluminescence capability!

The Department of Geology now has a fully operational facility for cathodoluminescence (CL) microscopy. The ELM-2 luminoscope CL instrument is attached to a Nikon Eclipse polarizing microscope with a 5-megapixel color camera system. Cathodoluminescence, the analysis of light emitted by a mineral when excited by an electron source, can be an important petrologic tool for many types of rocks, although most work has been done on sedimentary rocks. General applications include, for example, (1) identification of minerals, mineral distribution, and quantification, (2) visualization of primary and secondary microstructures (growth zoning, deformation features, fluid flow, etc.), (3) crystal chemistry (trace element distribution, internal structures), (4) reconstruction of geological processes, and (5) characterization of technical products[1]. The color produced by excitation of electrons in specific chemical impurities (activators) within a crystal structure can be used in sedimentary petrology to determine texture, sediment source, degree of compaction, diagenetic history, ratio of authigenic and detrital minerals[2], stratigraphy, siliciclastic components, cementation history, and provenance[3], as well as to study structure and chemistry of fossils. Those interested in using the facility should contact **Dr. Karin Goldberg** to schedule training and analytical sessions.



photomicrographs of Aptian carbonate rocks from the Araripe Basin, Brazil, taken using the department's new CL equipment.

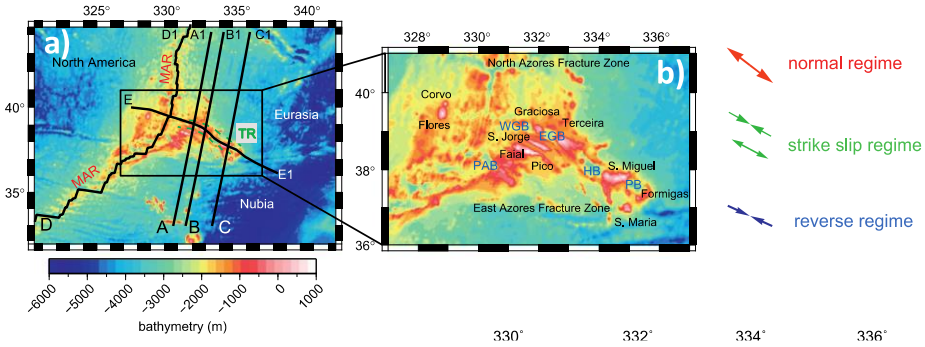
Δ47/U-Pb thermochronometry

Resolving the temperature history of sedimentary basins and their tectonic history is challenged by the lack of accurate thermometer and chronometer. However, the recent emergence of newly developed techniques, namely, clumped-isotope thermometry and U-Pb geochronology on carbonates, have significantly improved our understanding of the diagenetic history of carbonate reservoirs and increased our understanding of past diagenetic alteration. **Dr. Brice Lacroix,** M.S. student **Hallie Bruce** and undergrad students **Madeline Akers** are currently applying these techniques to unravel the history of fluid flow due to different tectonic phases of the Arbuckle Mountains uplift. The project is funded by the American Chemical Society Petroleum Research fund.

[1] Gotze, J. 2012. Microscopy and Microanalysis, 18(6):1270-1284.
[2] Sippel, R.F. 1968. Journal of Sedimentary Petrology,38(2):530-554.
[3] Owen, M.R. and Carozzi, A.V. 1985. Geological Society of America Bulletin, 97:110-115.

Modelling the stress field along continental rifts from tomography models

Passive margins created by rifting of the continental lithosphere are economically important, because they are prolific sources for oil and gas. Better understanding of the tectonic phenomena that have shaped them is required for conducting broad, integrative thinking in basin analysis. It may therefore facilitate our efforts to explore for these valuable natural resources. Despite the tremendous progress that has been made during the last 40 years through data acquisition and the design of complex analogical, analytical and numerical models, the role played by the mantle during rift initiation and propagation is still debated. **Dr. Claudia Adam** has recently been funded by the American Chemical Society to use highly resolved tomography models to model the instantaneous mantle flow under three regions: the Baikal rift, the central East African rift, and the Afar triple junction. This modeling allows the



Example of the stresses induced by mantle dynamics in a oceanic rift (Terceira Rift in the Azores) (a) and (b) Bathymetry and names of the bathymetric and topographic features

computation of the dynamic topography, the geoid/gravity anomalies, the stresses induced in the lithosphere, and the inferred tectonic regimes. Model outputs will be compared to surface observations in order to calibrate them and to quantitatively infer the role of the mantle on the observed surface deformation. The project will support the research of three undergraduate students for three years.

Investigating the early history of Europe's most active volcano, Mt. Etna.

Mount Etna in NE Sicily occupies an unusual tectonic position in the convergence zone between the African and Eurasian plates: it is situated in an extensional environment close to the northern end of the Malta escarpment, as well as near the Quaternary subduction-related Aeolian arc AND above the down-going Ionian oceanic slab. Phew! Could things be any more complicated? **Prof Pamela Kempton**, along with colleagues in the UK, France, Germany, the Netherlands and the USA, are working to understand the early history of Europe's most active volcano. Etnean magmatism only started about 500,000 years ago, but most of the research has focused on historic and recent eruptions (i.e. ~ 200 years or less), because most of the oldest lavas are buried beneath the young eruptive products. In this study, alkalic lavas have been


Image from NBCnews.com

sampled from the southern wall of the Valle del Bove, a massive slump feature that exposes older lavas representing a time span of Mt. Etna's prehistoric magmatic activity from >85.6 to <15 ka. They lavas exhibit geochemical variations that distinguish them into six separate lithostratigraphic and volcanic units. The new Sr-Nd-Pb-Hf isotopic data indicate that several isotopically distinct sources have been available in the magma generation process since prehistoric times. To better understand the magmatic evolution of the VdB lavas, we have modelled isobaric fractionation and isentropic melting (20-8kb) using MELTS. Results suggest that the VdB has a 'plum pudding' style mantle source consisting of a mix of lherzolite and pyroxenite. The proportion of pyroxenite appears to be less in VdB lavas than in historic / recent Etna. Fractionation occurred in a magma chamber at moderate depths (~10-12 km) and is dominated by olivine and clinopyroxene. The degree of fraction of VdB lavas is similar to that of recent/historic Etna, but with distinctive parental magmas, i.e. recent Etna lavas are more silica undersaturated. Differences may be a function of degree of partial melting but are more likely due to different source composition and particularly different proportions of pyroxenite in the source.

Sound bites:

- **Dr. Brice Lacroix** has been investigating the role of deformation in the emplacement of Au-deposits worldwide (Canada, USA, East Africa, Europe, Morocco, South America). This research integrates field-based structural analysis, petrography (fluid inclusion, Raman spectroscopy) and geochemical (C, O, C and H isotopes) methods. He is leading research on the structural control of Au-deposits in French Guiana, Bay James area (Canada), East Africa and California.
- **Dr. Abdelmoneam Raef** has developed a new research partnership with Metropolitan Water Reclamation District of Greater Chicago, aiming at subsurface geophysical characterization to support groundwater quality monitoring of the Tunnel and Reservoir Plan (TARP) in the greater Chicago area.
- **Dr. Matt Totten** is working on identifying Mississippian reservoir well-log facies in the Bindley field, Hodgeman County, KS, using artificial intelligence.
- **Dr. Ghanbarian,** director of the Porous Media Research Lab (www.pmrlab.org) at K-State, recently signed a non-disclosure agreement (NDA) to start joint university-industry projects with Saudi Aramco. He will be working with them to extend research and collaboration between K-State and industry to address challenges in unconventional reservoirs and their production.
- **Dr. Abdelmoneam Raef** continues his research into understanding CO_2 effects on elastic properties of the Mississippian Carbonates in Sumner County and the implications for CO_2 sequestration and enhanced EOR. A new seismic facies map of the Wellington-Anson Bates Fields is a highlight of this research effort that is of interest for both reservoir development and CO2-Sequestration programs in the study area. He has also been pursuing a new collaboration with Al-Azhar University, Cairo, Egypt, with a focus on the Western Desert Petroleum System and seismic reservoir characterization and modeling. The research findings have recently been published in Journal of Petroleum Science and Engineering (see Peer-Reviewed Publications below).

Publications (peer reviewed)

Abdelwahhab, M.A. and **Raef, A. (**2020) Integrated reservoir and basin modeling in understanding the petroleum system and evaluating prospects: The Cenomanian reservoir, Bahariya Formation, at Falak Field, Shushan Basin, Western Desert, Egypt. *Journal of Petroleum Science and Engineering, 189*, 107023.

Bayer da Silva, D., Cronin, B.T., Çelik, H., **Goldberg, K**., Kneller, B.C., Gürbüz, K. (2020). Evolution of two overlapping sand-rich clastic submarine fans in the Lower Miocene Adana Basin, southern Turkey: Contribution from a new palaeocurrent analysis. *Turkish Journal of Earth Science, 29*: 764-784.

Chen, P., Wang, X, Luan, Y., Zhe, F, **Lacroix, B**., Lei, S., Das, S. (2020) High-Field Electromagnetic Radiation Converts Carbon Nanotubes to Nanoribbons Embedded with Carbon Nanocrystals. *Journal of Applied Physics.* doi.org/10.1063/5.0012016

Evans, S.G., *Yokeley, B., Stephens, C., and Brewer, B. (2020) Potential mechanistic causes of increased baseflow across northern Eurasia catchments underlain by permafrost: *Hydrological Process*, *34*, 2676-2690, doi:10.1002/hyp.13759.

Farough, A. and *Karrasch A. (2019) Correlation of Elastic Moduli and Serpentine Content in Ultramafic Rocks, *Geosciences 9 (12), 494*, https://doi.org/10.3390/geosciences9120494

Ghanbarian, B. (2020) Applications of critical path analysis to uniform grain packings with narrow conductance distributions: I. Single-phase permeability. *Advances in Water Resources, 137,* 103529.

Ghanbarian, B. (2020) Applications of critical path analysis to uniform grain packings with narrow conductance distributions: II. Water relative permeability. *Advances in Water Resources, 137*, 103524.

Ghanbarian, B., Lake, L. W., Sahimi, M. (2019) Insights into rock typing: A critical study. *SPE Journal, 24,* 230-242.

Ghanbarian, B., Liang, F., Liu, H. H. (2020) Modeling gas relative permeability in shales and tight porous rocks. *Fuel, 272*, 117686.

Ghanbarian, B., Torres-Verdín, C., Lake, L. W., and Marder, M. (2019) Gas permeability in unconventional tight sandstones: Scaling up from pore to core. *Journal of Petroleum Science and Engineering, 173*, 1163-1172.

Hoareau, G., Crognier, N., **Lacroix, B.**, Aubourg, C., Roberts, N., Niemi, N., Branellec, Beaudoin, N., Suarez-Ruiz, M. (2020) Combination of Δ47 and U-Pb dating in tectonic calcite veins unravel the last pulses related to the Pyrenean Shortening (Spain). *Earth and Planetary Science Letters*. 10.1016/j.epsl.2020.116636

Hunt, A. G., Faybishenko, B., and **Ghanbarian, B.** (2020). Predicting the water balance from optimization of plant productivity.*GSA Today 30*, 2.

Hunt, A. G., Faybishenko, B., **Ghanbarian, B.**, Egli, M., and Yu, F. (2020) Predicting water cycle characteristics from percolation theory and observational data. *International Journal of Environmental Research and Public Health, 17*, 734 (*Featured*).

Lacroix, B., Hughes*, J., Lahfid, A., Spangenberg, J., Putlitz, B., *Ward, C., **Kempton, P.** (2020). Structure and Origin of the Gold Mineralization in the Nacimiento Block: The Los Burros Deposits (Central California). *Ore Geology Review*. doi.org/10.1016/j.oregeorev.2020.103668

*Lane, A.D., **Kirk, M.F.**, Whittemore, D.O., Stotler, R., Hildebrand, J., Feril, O. (2020) Long-term (1970s-2016) changes in groundwater geochemistry in the High Plains aquifer in south-central Kansas, USA. *Hydrogeology Journal*, *28*, 491–501.

*Manselle, P., **Brueseke, M.E.,** Trop, J.M., Benowitz, J.A., Snyder, D.C., and Hart, W.K. (2020) Geochemical and stratigraphic analysis of the Chisana Formation, Wrangellia terrane, eastern Alaska: Insights into Early Cretaceous magmatism and tectonics along the northern Cordilleran margin. *Tectonics*, *39*, https://doi.org/10.1029/2020TC006131.

Mirzaei-Paiaman, A., and **Ghanbarian, B.** (2020) A new methodology for grouping and averaging capillary pressure curves for reservoir models. *Energy Geoscience, 2*, 52-62.

*Rijfkogel, L. S., **Ghanbarian, B.**, Hu, Q., and Liu, H. H. (2019) Clarifying pore diameter, pore width, and their relationship through pressure measurements: A critical study. *Marine and Petroleum Geology, 107*, 142-148.

Rostami, A., **Raef, A**., Kamari, A., Totten, M.W., Abdelwahhab, M. and Panacharoensawad, E. (2020) Rigorous Framework Determining Residual Gas Saturations During Spontaneous and Forced Imbibition Using Gene Expression Programming. *Journal of Natural Gas Science and Engineering*, *84*, 103644.

Saunders, J.A., Burke, M., and **Brueseke, M.E.** (2019) Scanning-electron-microscope imaging of gold (electrum) nanoparticles in middle Miocene bonanza epithermal ores from northern Nevada, USA: *Mineralium Deposita*, *55*, 389-398, DOI: 10.1007/s00126-019-00935-y

Scherer, C.M.S., Mello, R.G., Ferronatto, J.P.F., Amarante, F.B., Reis, A.D., Souza, E.G., **Goldberg, K**. (2020) Changes in prevailing surface-palaeowinds of western Gondwana during Early Cretaceous. *Cretaceous Research 116*: 104598.

Spencer, J.Q.G., Huot, S., Archer, A.A., Caldas, M.M. (2019) Testing luminescence dating methods for small samples from very young fluvial deposits. *Methods and Protocols*, 2(4), 90. https://doi.org/10.3390/mps2040090.

Trexler, C.C., Cowgill, E., **Spencer, J.Q.G.**, Godoladze, T. (2020) Rate of active shortening across the southern thrust front of the Greater Caucasus in western Georgia from kinematic modeling of folded river terraces above a listric thrust. *Earth and Planetary Science Letters*, 544, p. 116362. https://doi.org/10.1016/j.epsl.2020.116362

** denotes K-State Geology student or post-doc*

Invited Lectures

Brueseke, M.E. 16 to 14-million-year-old gold and silver deposits in the northern Great Basin (U.S.A.): epithermal bonanza ores linked to the Yellowstone hotspot. *Topeka Gem and Mineral Society*, 10/31/19.

Brueseke, M.E. Investigating the lostarc: geologic constraints on ~30 Million years of diachronous magmatism along an arc-transform junction, Wrangell Arc, southern Alaska. *Scheduled for April 2, Oklahoma State University, but cancelled due to coronavirus pandemic, 2020.*

Farough A., Mulvey B. K. Navigating the Transition to Virtual Education: Collaboration to Develop Accessible Virtual Hydrogeology Field Experiences, *American Geophysical Union, Fall Meeting* abstract [ED009-06], 2020

*Fenner, E. and **Brueseke, M.** Field evidence for the paragenesis of the Miocene Milestone Hotspring Sinter. *Topeka Gem and Mineral Society*, 10/31/19.

Ghanbarian, B. Effective-medium theory: Applications to upscaling soil moisture and remote sensing. *2019 National Soil Moisture Workshop, Kansas State University, 2019*

Ghanbarian, B. Hydraulic conductivity in soils: Challenges and opportunities, *1st International Congress on Iranian Irrigation and Drainage, University of Urmia*, Iran, 2019

Ghanbarian, B. Rock typing and its applications to petroleum geology, *Kansas Geological Society*, 2019

Ghanbarian, B. Rock typing in petroleum geology: Past and future, *Bureau of Economic Geology*, 2019.

Ghanbarian, B. Scaling analysis and its applications to flow and transport in porous media, University of Tehran, Iran, 2019

Goldberg, K. Diagenesis and reservoir quality in deep Cambrian carbonates of the Tarim Basin, China, *AAPG Chapter webinar,* Jun. 9th, 2020(140 attendees)

Goldberg, K. Climate change, *K-State's Sustainability Club*, Feb. 3rd, 2020

Kirk, M.F. Changes in groundwater quality in the Great Bend Prairie aquifer and their implications for rural water use. *North Central Region Water Network webinar series, The Current*, Mar 11th, 2020

Kirk, M.F. Connections between land use, soil microbiology, and groundwater microbiology in an agricultural landscape. *University of Texas at San Antonio*, Department Seminar. Oct 23rd, 2020

Lacroix, B. Understanding Faults: A Geochemical Approach. **University of Oklahoma**. October 15th, 2020.

Mulvey, B. K., and **Farough, A.**, "Go With The Flow": Adaptive Collaboration For Accessible Virtual Hydrology Field Experience Resources, *Geological Society of America Abstracts with Programs. Vol 52, No. 6, 2020. doi: 10.1130/abs/2020AM-355488*

Spencer, J.Q.G. Invited Keynote. 73rd Geological Congress of Turkey, Ankara, Turkey, April 6 - 10, 2020, "Constraining sedimentary dates and rates of the Anthropocene using OSL geochronology". Postponed due to Covid-19 pandemic.

** denotes K-State Geology student or post-doc*

Conferences: Presentations, Abstracts, Session Chairs, and Field Trip Leaders

*Fenner, E, **Brueseke, M.E.,** Deatherage, A. (2019) Field constraints on the paragenesis of a mid-Miocene sinter-hydrothermal vent complex, Silver City District, Owyhee Mountains, ID: *American Exploration & Mining Association 2019 annual meeting*, 12/4/19.

Adam C. and *Pandit B. (2019) Characterization of secondary mantle convection from geophysical data and models, *Geological Society of America*, Phoenix, Arizona, September, T48:205-7

Adam C., Ichihara M., Vidal V., Grosse P. (2019) Anomalous arc volcanism and subduction of linear topographic features. *American Geophysical Union*, San Francisco, USA

Brophy, T. M., Griffith, E., Nguyen, E., Schmidt, A., **Farough, A.** and Smidt, S. (2020) Relating Land Cover Change To Runoff Distribution Using NASA Earth Observations In Riley County, Kansas, *Geological Society of America Abstracts with Programs. Vol 52, No. 6, 2020. doi: 10.1130/abs/2020AM-355523*

*Esmaeilpour, M. and **Ghanbarian, B**. (2019). Effect of scale on porosity and permeability in homogeneous porous media: A pore-network modeling study. *AAPG Mid-Continent Section Meeting*, Wichita, KS, Oct. 3-8.

*Esmaeilpour, M., and **Ghanbarian, B**. (2019). Scale dependency of petrophysical properties in homogeneous porous rocks. *American Geophysical Union*. San Francisco, CA, Dec. 9-13.

Evans, S.G., *Yokeley, B.A**.**, and Stephens, C. (2019) Potential mechanistic causes of increased baseflow across northern Eurasia rivers underlain by permafrost: *American Geophysical Union Meeting*, San Francisco, CA, 9-13 December, Abstract C13E-1365.

Evans, S.G., *Yokeley, B.A., Stephens, C., and Brewer, B. (2020) What causes increases in baseflow across Northern Eurasian catchments underlain by permafrost? *Geological Society of America Meeting*, 26-30 October.

Farough, A., **Kempton, P. D.,** Spears, J., and Allen, D. (2020) A Novel Approach to Improving Geoscience Diversity and Participation in Kansas: The Geoscience Career Ambassador Training (GEOCAT) Workshops. *Geological Society of America Abstracts with Programs. Vol 52, No. 6, doi: 10.1130/abs/2020AM-358423*

Fuhara, G., Nahimana, L., Nimpagaritse, G., Delvaux, D., Dewaele, S., **Lacroix, B.,** Lahondes, D. (2020). First Attempt on the Structural and Lithostratigraphic control of Sn-Nb-Ta-W and Au mineralization in the Karagwe-Ankole belt (NE Burundi, East Africa). Geological Society of America Annual meeting, Montréal (virtual)

Ghanbarian, B. (2019). Hydraulic conductivity in soils: Challenges and opportunities. *1st International Congress on Iranian Irrigation and Drainage*. Urmia, Iran, Nov. 13-14. *Keynote speaker*

Ghanbarian, B. (2019). Wetting-phase relative permeability in multi-scale porous media. *American Geophysical Union*. San Francisco CA, Dec. 9-13.

Goldberg K., Adam C. and *Brower S. (2019) Automatic interpretation of the depositional conditions in black shales: application to the Chattanooga Formation in Kansas. *AAPG Mid-Continent Section Meeting in Wichita, Kansas*, October

Griffith E., Brophy T., Nguyen E., Schmidt A., **Farough A.** and Smidt S. J. (2020) Relating Land Cover Change to Runoff Distribution Using NASA Earth Observation in Riley County, Kansas, *American Geophysical Union, Fall Meeting,* abstract [H038-0017]

Hunt, A. G., M., Faybishenko, B. and **Ghanbarian, B.** (2020). Scaling approaches to geochemistry and ecology linked to the water balance. *Geological Society of America* annual meeting. Oct. 26-30.

Kempton, P.D., Downes, H., Spence, A., Blichert-Toft, J., Bryce, J., Hegner, E., and Vroon, P.Z. (2020) Prehistoric lavas from Valle del Bove (Etna): I. MELTS modelling results. International Goldschmidt Conference. https://doi.org/10.46427/gold2020.1275

Kempton P., **Brueseke M**., *Rogers K. and **Adam C**. (2019) The mystery of kimberlites in Kansas, GSA, Phoenix, Arizona, September, T17:55-1

King S., Liu, S. and **Adam C.,** Large and Small-Scale Structures within the Marble Cake Mantle. American Geophysical Union, San Francisco, USA, December.

Kirk, M.F. (2020) Connections between land use, soil microbiology, and groundwater microbiology in an agricultural landscape. *Kansas State University Global Food Systems Microbiome Workshop*, April 30th.

*Koenigsberger, S., **Kirk M.F.,** Latta, D.E., Sikes, B.A., Loecke, T.D., Sarto, M.M., *VanderPutten, M., Hansen, P (2019) Variation in soil redox conditions with land use across the Kansas precipitation gradient. *Annual meeting of the American Geophysical Union*, San Francisco, California, December 10th

Lacroix B., *Keast R., Bidgoli T., **Abdelmoneam R**., **Adam C.**, Leclere H., Guillaume D. (2019) Assessing Fault Reactivation Potential Related to Increased Fluid Pressures within Wellington and Anson-Bates Fields, Sumner County, Kansas, *AAPG Mid-Continent Section Meeting in Wichita, Kansas*, October.

Lacroix, B., Lahfid, A., *Ward, C., Niemi, P., **Kempton, P.**D. (2020) Structure and Origin of the Gold Mineralization in the Nacimiento Block: the Los Burros Deposits (Central California). Geological Society of America Annual meeting, Montréal (virtual)

Lacroix, B., *Ward, C., Lahfid, A., Niemi, N., **Spencer**, **J.Q.G**., **Kempton, P**. (2020) Dynamics of the Post-Subduction Thermal Anomaly of the Nacimiento Block revealed by RSCM and (U-Th/He) Thermochronology. *Geological Society of America, Cordilleran Section*, Vol. 52, No. 4, ISSN 0016-7592, doi: 10.1130/abs/2020CD-347351

*Lamm, S., **Lacroix, B., Kempton, P.D.,** Gasda, P. (2020) Calibration of Chlorite Composition using Micro-Raman Analysis. *Geological Society of America Annual meeting*, Montréal (virtual).

Lipovetsky, T., **Ghanbarian, B**., Moriconi, L., Pontedeiro, E. M. B. D., Raoof, A., Santo, M., van Genuchten, M. Th., Alves, J. L. D. and Couto, P. (2019) Petrophysical characterizations of carbonate reservoir rocks. *American Geophysical Union*. San Francisco CA, Dec. 9-13.

*Rogers K., **Kempton P.D., Brueseke M**., and **Adam C.** (2019) In situ LA-ICP-MS trace element data on perovskite: implications for original melt compositions from kimberlites in Kansas. *Geological Society of America*, Phoenix, Arizona, September, T17:237-2

*Smith M. and **Adam C.**, Temporal evolution of buoyancy and volcanism fluxes along the Louisville hotspot, *Geological Society of America annual meeting*, Phoenix, Arizona, September, D10:107-12

Spencer, J., *Ataee, N., **Lacroix, B.,** Owen, L. (2020) Development of Luminescence Dating Methods in Tectonically Active and Arid Regions: Dating Fanglomerates from Alluvial Fans, Coachella Valley,

Southern California. *Geological Society of America, Cordilleran Section*, Vol. 52, No. 4, ISSN 0016-7592, doi: 10.1130/abs/2020CD-347539

*Yokeley, B.A., **Ghanbarian, B.** and Sahimi, M. (2020) A new approach for two-phase rock typing: Evaluation with pore network simulations. *American Geophysical Union Fall Meeting*, San Francisco CA, Dec. 1-17.

*Yokeley, B.A., **Ghanbarian, B.** and Sahimi, M. (2020) Scale-effect in the simulation of two-phase flow in porous media. *Interpore*, Aug. 31–Sept. 4.

** denotes K-State Geology student or post-doc*

Grants and Contracts

New

Adam, C. *American Chemical Society Petroleum Research Fund*, Modelling the stress field along continental rifts from tomography models, 2020 – 2023, $70,000

Brueseke, M. *Kansas State University Small Research Grant*, Investigating links between <5 million yr. old basaltic volcanism in the Centennial Valley Region and the Yellowstone hotspot. 5/1/2020-4/30/2021, **$4,428.**

Brueseke, M. (co-PI) *National Science Foundation* RAPID: Collaborative Proposal: Development of Digital Models of Minerals and Rocks for Online Geoscience Classes. G. Andrews (PI, West Virginia U.), 8/1/2020-7/31/2021. **$16,864.**

Brueseke, M. *National Science Foundation*, Collaborative Research: Investigating out-of-sequence magmatism and mantle plume-lithosphere interactions adjacent to the Snake River plain (U.S.A.). J. Benowitz (co-PI, UA-Fairbanks) 9/1/2020 – 8/31/2023**, $240,385**

Farough, A. (co-PI), *National Science Foundation* Improving Undergraduate STEM Education (IUSE)- IN: SOARING: Sharing Opportunities, Approaches, and Resources in New Geo-teaching

Farough, A. Lead proponent, NASA DEVELOP-Riley County Water resources-Langley Research center

Lacroix, B. *USGS EDMAP* Detailed Bedrock Mapping and dating in the Cape San Martin/Alder Peak/Villa Creek/Burro Mountain Quadrangles, Monterey and San Luis Obispo Counties, California, 2020, $17,500.

Lacroix, B. (PI), Kempton, P.D. and **Brueseke, M**. (co-PIs) *National Science Foundation* – RAPIDPetCAT-Scan: A high definition scanning tool for geoscientists in the COVID-19 pandemic and beyond, 2020-2021, $169,220

Lacroix, B. *American Chemical Society Petroleum Research Fund* Refining Syn-Tectonic Diagenetic History of Carbonates from the Arbuckle Mountains using delta47/(U-Pb) Thermochronometry, a new and Emerging Geochemical Technique, 2020-2023, $70,000

Active

Farough, A. (PI), **Kempton, P.D.** (co-PI), Spears, J. (co-PI). GP-IMPACT: *GeoCAT Workshop: Geoscience Careers Ambassador Training Workshop,* NSF- IUSE-Geopaths, 2019-2022, $153,000.

Ghanbarian, B. (co-PI) National Science Foundation of China, *Multi-scale and mechanistic studies of fracture-matrix interaction and hydrocarbon movement in lacustrine tight oil*. 2019-2023, $433,000.

Goldberg, K. (PI). *American Chemical Society, Petroleum Research Fund* (PRF), *High-Resolution Sequence Stratigraphy In Mudrock-Dominated Successions: The Chattanooga/Woodford Shale (Late Devonian, Midcontinent Basin)*, 2019-2021, $70,000

Kirk, M. (PI), Lydia Zeglin (Co-PI), Qusheng Jin (Co-PI) *National Science Foundation* Geobiology and Low-Temperature Geochemistry Program. Title: Collaborative Research: Biogeochemical drivers of interspecies electron transfer from iron reducers to methanogens. Total funding $310,748 with $196,330 to K-State.

Kirk, M. *National Science Foundation RII Track-1 EPSCoR*: Microbiomes of Aquatic, Plant and Soil Systems (MAPS) Mediating Sustainability: An Observational and Experimental Network across Kansas ($20 million, $2.65 million to KSU, M. Kirk is one of the group leaders in the project team)

Spencer, J.Q.G. *USGS-STATEMAP/KGS*, Geologic mapping in Kansas; Role: Collaborator wirh Tony Layzell (KGS) and others, *2018-2021*, $21,600

Spencer, J.Q.G. *UWM/Harvard*, 2019-2021, "Luminescence dating of Bronze Age terraces, Sardis, Turkey", $9,900

Spencer, J.Q.G. *UMKC*, 2018-2020, "Luminescence dating of loess samples from Kansas"; Role: Co-I with Caroline Davies, UMKC, $1,648

Spencer, J.Q.G. *UMKC*, 2018-2020, "Luminescence dating of dune samples from Jordan"; Role: Co-I with Caroline Davies, UMKC, $2,884

Donations in Kind

Kirk, M. Isotech Laboratories: Gas Chromatography Isotope Ratio Mass Spectrometry (GC-IRMS) analysis of 100 samples for our NSF Geobiology study. The commercial value of this analytical work is $31,500.

Raef, A. Data donation in support of seismic methods interpretation and processing PacSeis 3D seismic data donation (Tiger Bayou 3D) valued at $1,345,000.00.

Raef A. OpendTect Seismic interpretation Sofware, $32,000.

Raef, A. RokDoc Seismic interpretation and rock physics modeling software, $50,000

Totten, M. and **Raef, A.** Co-PI Schlumberger second year of three-year contract 1-1ESYJ6T, which is valued at $18 million per year and provides the university access to the Petrel* E&P software and Techlog wellbore software platforms; PetroMod petroleum systems modeling software; and GeoX exploration risk, resource and value assessment software.

Faculty Awards and Professional Recognition

Brueseke, M. Page Twiss Faculty Development Award for Excellence in Graduate Advising and Teaching (inaugural award), Kansas State University Department of Geology, 2019.

Bruseke, M. Kansas State University Goals and Values in Science Faculty Fellowship, 2019-2020

Brueseke, M. Invited Review Editor, *Frontiers in Earth Science – Petrology*

Farough, A. May 2020 Recipient of Charlie Award in Advising

Farough, A. Geology of Department Faculty Development Award for Excellence in Undergraduate Advising and Teaching (inaugural award), Kansas State University, Department of Geology, 2019

Ghanbarian, B., 2020 Soil Physics and Hydrology Division Early Career Award, Soil Science Society of America (SSSA)

Student Grants, Awards and Recognition:

Alireza Roustazadeh (B. Ghanbarian, advisor) AGU Fall 2020 meeting travel Grant ($1000)

Alireza Roustazadeh (B. Ghanbarian, advisor) Awarded Free Registration for AGU Fall Meeting 2020 from AGU Hydrology Section and CUAHSI

Alireza Roustazadeh (B. Ghanbarian, advisor) Robert Cowdery - KGF Scholarship ($1000)

Barnabas Adeyemi (B. Ghanbarian, advisor) Awarded Free Registration for AGU Fall Meeting 2020 from AGU Hydrology Section and CUAHSI

Barnabas Adeyemi (B. Ghanbarian, advisor) Consortium of Universities for the Advancement of Hydrologic Science ($100)

Barnabas Adeyemi (B. Ghanbarian, advisor) Kansas Geological Foundation ($500)

Barnabas Adeyemi (B. Ghanbarian, advisor) Kansas State University Graduate Student Council Travel Award ($400)

Barnabas Adeyemi (B. Ghanbarian, advisor) National Association of Black Geoscientists ($550)

Ben Walters (A. Farough, advisor) Kansas Geological Foundation ($500)

Brandon Yokeley (B. Ghanbarian, advisor) Awarded Free Registration for AGU Fall Meeting 2020, AGU Hydrology Section and CUAHSI (2020)

Emily Fenner (M. Brueseke, advisor), Second Place, Student Poster Contest (American Exploration & Mining Association annual meeting, 2019)

Erik Parker (A. Farough, advisor) K-State Arts and Sciences Research Travel Award ($400)

Josh Ford (S. Datta, advisor; M. Brueseke, advisor after Datta left K-State) K-State Arts and Sciences Research Travel Award ($400)

Luke Rijfkogel (A. Raef, advisor) K-State Arts and Sciences Research Travel Award ($400)

Mikaela Rader (P. Kempton, advisor) Kansas Geological Foundation ($500)

Misagh Esmaeilpour (B. Ghanbarian, advisor) Awarded Free Registration for AGU Fall Meeting 2020, AGU Hydrology Section and CUAHSI (2020)

Misagh Esmaeilpour (B. Ghanbarian, advisor) College of Arts and Sciences Travel Award ($ 336), Kansas State University (2019)

Misagh Esmaeilpour (B. Ghanbarian, advisor) Graduate Students Council Travel Award ($ 450), Kansas State University (2019)

Nick Warren (A. Farough, advisor) K-State Arts and Sciences Research Travel Award ($400)

Public Outreach

Adam, C. Science café, March 10th 2020: Presented a lecture on *Volcanoes and plate tectonics* , followed by a two-hour-long activity based on maps (maps of seismicity, volcanoes, topography and seafloor age).

Adam C. KAWSE GROW event for for middle school students, October 2020, *Volcanoes and plate tectonics*. KAWSE (K-State Office for the Advancement of Women in Science and Engineering works to increase the participation, retention and advancement of girls and women in STEM; GROW (Girls Researching Our World) is an interdisciplinary program that supports the interests of girls of middle school age in Science, Technology, Engineering, and Mathematics (STEM).

Brueseke, M. Mineral and rock identification for the general public

Bruseke, M. 2019: Participant, NSF, NAGT, and ExxonMobil sponsored "Focusing the lens on field safety: a workshop for field trip leaders "(November, U. Iowa)

Bruseke, M. 2020*:* Participant, NSF-NAGT-IAGD sponsored "Designing remote field experiences" zoom-based workshops in response to the COVID-19 pandemic.

Ghanbarian, B. Presentation entitled "Fractal geometry: Concepts and applications" at the GROW workshop, a program for women in

Ghanbarian, B. Presentation entitled "Water consumption by plants" at the GROW workshop, a program for women in STEM, 2020

Goldberg, K. K-State's GROW EXPLORATION STEM Virtual Event, with activity 'A virtual field trip to a 300-million-year-old ocean in Kansas' (Oct 2020)

Goldberg, K. and Kirk, M., Organized a K-State GROW/EXCITE workshop for middle school girls with a "Career Chat" (29 students attended Zoom session on June 3rd, 2020)

Kempton, P., Speaker and panel member for Leadership Manhattan, sponsored by Manhattan Area Chamber of Commerce.

Kirk, M., Collaborated with a faculty member from Barton Community College to develop a groundwater quality monitoring project for BCC students. The project will involve new students each semester and focuses on water quality in private domestic water wells in south-central Kansas.