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DEPARTMENT OF EARTH & ENVIRONMENTAL SCIENCES

SPRING 2023 NEWSLETTER

MESSAGE FROM DEO DAVID PEATE

"We are truly appreciative of all the work the board does in support of the department..."

As I write this message, I have just got back from our inaugural "Earth Day Open House". Faculty, staff, and student volunteers set up activities around Trowbridge Hall that included various demonstrations (volcanoes, groundwater, streams, impact cratering, LIDAR); rock / mineral / fossil exhibits; a virtual tour of Mars geology) and displays by the Environmental Sciences student club and the Iowa Geological Survey. We had about 75 visitors of all ages who braved the unseasonably cold weather, so this was a very successful outreach event, explaining to the public about what the department does and its relevance, plus having fun at the same time.

This newsletter highlights the impressive array of analytical facilities now available on campus to faculty and students for research and teaching. Most of the instrumentation is housed in the Materials Analysis, Testing, and Fabrication (MATFab) Facility in the Iowa Advanced Iowa Advanced Technology Laboratories building (the 'shiny' Frank Gehry building next to the IMU), just a couple of minutes walk from Trowbridge Hall. Over the last decade or so, EES faculty have acquired funds for XRF (X-Ray Fluorescence), EMP (electron microprobe), FE-SEM (field emission scanning electron microscope), LA-ICP-MS (laser ablation inductively coupled plasma mass spectrometer), and HR-ICP-MS (high resolution inductively coupled plasma mass spectrometer) instruments. The shared facility also has X-Ray diffraction and Raman spectroscopy instruments.

As I mentioned in the last newsletter, the College of Liberal Arts and Sciences (CLAS) sees the broad area of Environment as a potential growth area, and we are in the process of developing a joint vision with the Department of Geography & Sustainability Sciences to present to CLAS. We should have more to report by the Fall newsletter.

I want to thank everyone who gave to the department during the One Day for Iowa event, which raised almost $10,000 for the Earth & Environmental Sciences Field Course Support Fund – and thanks again to the EES Alumni Advisory Board for providing a matching challenge. Some of these funds will be used immediately to buy satellite phones to have available for when field courses are in remote areas away from cellphone reception. Lee Phillips, the current Chair of the EES Alumni Advisory Board, told me that they are actively looking for additional alumni volunteers to serve on the board. We are truly appreciative of all the work the board does in support of the department and its mission to educate and train geologists and environmental scientists for their future careers. If you are interested or want to nominate other alumni to serve on the board, please contact us via the department e-mail (geology@uiowa.edu). More details about the board can be found at the "Alumni and Friends" link on our website (https://clas.uiowa.edu/ees/alumni-and-friends).

The Materials Analysis, Testing, and Fabrication (MATFab) Facility

By Tori Forbes, MATFab Director

The Materials Analysis, Testing and Fabrication (MATFab) Facility is an interdisciplinary multi-collegiate user facility managed by the University of Iowa Office of the Vice President for Research that provides instrumentation and infrastructure to support characterization of both natural and engineered materials and nanofabrication of innovative devices. Our facility houses instrumentation for chemical and elemental analysis, imaging, metrology, and micro and nanofabrication. Chemical and elemental analysis gives information about the composition of materials, while imaging capabilities allow us to, in some cases, map elemental and chemical composition spatially. The facility also supports workforce development through training undergraduate and graduate research assistants on highly sophisticated equipment and introducing undergraduate students to cutting edge techniques in the classroom. Our laboratories occupy 4500 square feet of research space in the Iowa Advanced Technology Laboratory and is staffed by professional scientists with backgrounds in chemistry, engineering, geoscience, and physical sciences that allows us to meet research needs across many disciplines. We also work together with faculty in the physical sciences and engineering departments to write competitive proposals to bring new, innovative equipment to the to enhance the research enterprise across the University of Iowa campus.

Chemical characterization and imaging capabilities at the MATFab Facility

By Kenny Horkley & Daniel Unruh

Kenny Horkley and Daniel Unruh are Core Facility Research Specialists at the MATFab Facility.

Elemental and isotopic characterization of samples is key to many geology and environmental science research questions. Electron, ion, X-ray and inductively coupled plasma analytical techniques are the standard for elemental and isotope analysis. The Materials Analysis, Testing, and Fabrication (MATFab) facility, hosts a range of low to mid sensitivity instruments for both in-situ and bulk chemical analysis.

The range of instrumentation for chemical analysis at MATFab is used to meet a variety of needs independently, but they can best be related by viewing them as part of analytical workflows. An in-situ analysis workflow at MATFab includes our Nikon Ci Pol research grade polarizing microscope for optical surveying of thin sections and locating target minerals or oxides. This survey is followed by mineral and texture survey, basic qualitative elemental analysis or imaging using our Hitachi S-3400N Scanning Electron Microscope (SEM) with Secondary Electron (SE), Backscattered Electron (BSE) and Cathodoluminescence (CL) imaging capabilities, as well as X-ray Energy Dispersive Spectrometer (EDS) analytical capabilities. Later this year MATFab will add a new Field Emission Scanning Electron Microscope (FE-SEM) which will include the techniques of our current SEM, but expand our capabilities by including nanometer resolution imaging, automated mineral and phase identification software, and potentially an Electron Backscattered Diffraction (EBSD) detecto. Further in-situ analysis takes place on our JEOL JXA-8230 Electron Probe Microanalyzer (EPMA), or microprobe, for quantitative major, minor, and trace element spot and map analysis (pictured below). Laser Ablation Inductively Coupled Plasma Mass Spectroscopy (LA-ICP-MS) on our Agilent 7800 quadrupole ICP-MS (pictured next page)

S-3400N Scanning Electron Microscope

with a 213 nm wavelength New Wave laser provides further minor, trace, and isotope analysis from an ablated in-situ spot. In the coming months MATFab will add a Thermo Fisher Scientific Element XR High Resolution Inductively Coupled Plasma Mass Spectrometer (HR-ICP-MS) capable of in-situ laser ablation trace element and isotope analysis at concentration levels critical for geochronological techniques and isotope studies.

Many of the above instruments, and a couple of additional ones, can also be viewed as part of a bulk chemical analysis workflow at MATFab. The EES department houses two portable X-ray Fluorescence spectrometers that are widely used in the field and lab for surveying major and trace elements and sample ID. The Rigaku Primus IV X-ray Fluorescence Spectrometer (WD-XRF)(next page top) at MATFab is the next step in major and trace element analysis, offering a wider range of available elements (Be-U), certified rock powders for calibration standards, lower detection limits and errors, and automated analysis. This instrument can also be set up to analyze powders and liquids in addition to the more common glasses and slabs. Similarly, the Varian 720 Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) at MATFab is best for analysis of major and trace elements, specializing in low dilution or high matrix solutions. Further bulk chemical analysis takes place on our Agilent 7800 ICP-MS with higher dilution, lower matrix samples for trace element and isotope analysis. As mentioned previously, MATFab will be adding a HR-ICP-MS which will allow for lower concentration bulk isotope analysis.

MATFab also houses a variety of other analytical techniques including surface area, pore space and adsorption characterization by Brunauer-Emmett-Teller (BET) analysis, characterization of carbon, nitrogen, hydrogen and sulfur by combustion Elemental Analysis (EA), and ellipsometry and profilometry for surface roughness and thickness, to name a few.

Crystallography and X-ray diffraction techniques have always had close ties with Geology and Environmental Science departments. When attempting to understand the mineral phases present in rocks, soils, sediments, or corrosion products, there is no better technique for quickly determining which phases are present in an unknown sample. In the MATFab facility, we host three diffraction instruments: a Bruker D8 Venture single crystal diffractometer with both molybdenum and copper radiation sources for determining the structure of single crystals (next page bottom left), a Bruker D8 powder diffractometer configured for analyzing multiple powder samples (next page bottom right), and a Rigaku SmartLab powder diffractometer with capabilities of analyzing small irregular shaped materials. Along with these instruments, our facility also hosts the ICDD PDF 4+ database for mineral and inorganic PXRD phase analysis, and the analysis software packages JADE, EVA, and TOPAS. With the analysis software packages and database, it is reasonably straightforward to quickly identify the mineral phases present in your sample and determine semi-quantitative concentrations of phases present within your powder samples.

Along with XRD techniques, our facility also hosts a Renishaw inVia confocal Raman microscope. The system currently has two laser options, 514nm, and 785nm, both of which can be used for studying mineral phases in thin sections. While this technique has historically been utilized by the thin film and single crystal users

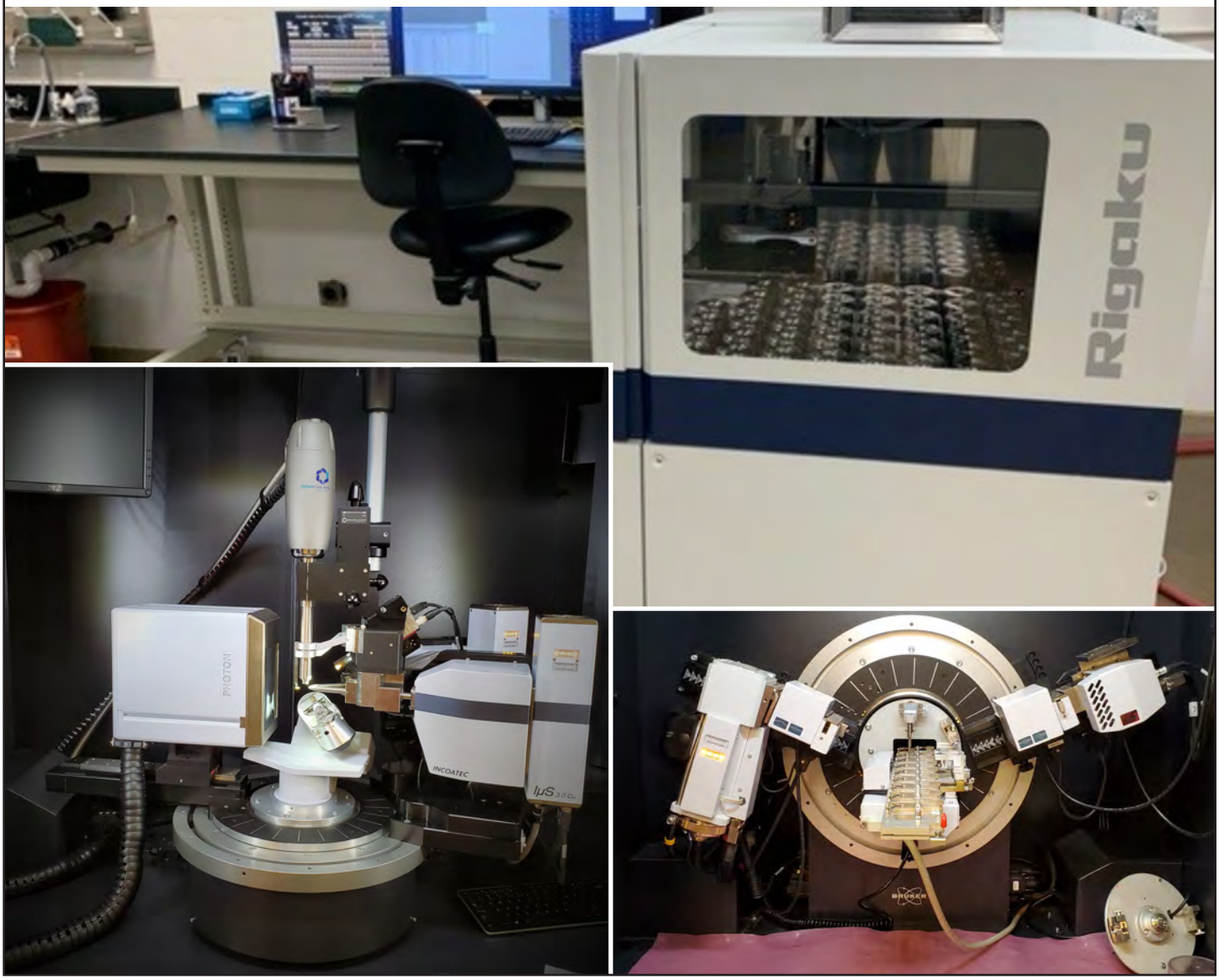
on campus, there has been some interest in studying and creating a database for heavy minerals with this technique. We are currently in the process of determining the viability of such an approach here at Uiowa.

Finally, we are in the process of moving the Bruker SkyScan 1272 (micro-CT) from the College of Dentistry to the MATFab facility (May 2023). With this technique, users can explore either the distribution of grains or fractures with core samples in-situ. Our hope is that once the instrument is reinstalled in the facility, interested users will have a chance to come by and take a look at the instrument and its possible applications.

If you have questions about the abilities or limitations of these techniques please feel free to contact the MATFab staff at matfab-staff@uiowa.edu and one of our staff scientists will be more than willing to discuss your questions further.

Kenny Horkley

Daniel Unruh



Examples of Cathodoluminescence Imaging of Zircon

By Bill McClelland

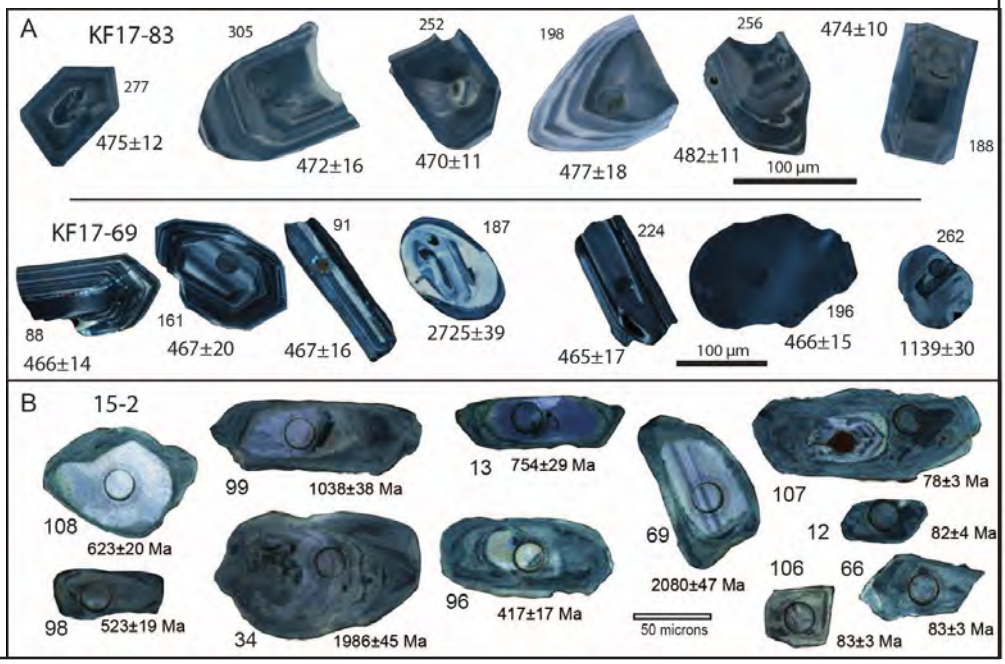
Cathodoluminescence (CL) imaging of zircon is a critical tool for identifying zoning and age domains prior to and after U/Pb analysis. CL imaging in the MATFAB facility is available using a Gatan ChromaCL system mounted on the Hitachi 3500N scanning electron microscope (SEM).

Examples are provided from (A) arc-derived volcaniclastic rocks from the Fire Bay assemblage, northwest Ellesmere Island, Canada (Koch et al., 2022, Canadian Journal of Earth Sciences) and (B) eclogite-facies paragneiss in the Eclogitic Micaschist Complex of the Sesia Zone, Aosta Valley, Italy (Gilotti et al., in review, European Journal of Mineralogy).

Zircon from a lithic tuff (KF17-83) shows oscillatory zoning characteristic of igneous zircon. The images guided spot location for laser ablation-inductively coupled mass spectrometry (LA-ICPMS) analysis at the Arizona LaserChron Center and later selection of 6 grains for chemical abrasion-isotope dilution-thermal ionization mass spectrometry (CA-TIMS) analysis. LA-ICPMS analyses defined a 206Pb/238U weighted mean age of 473 ± 1 Ma (n=186) that was improved by CA-TIMS analysis of 6 grains to 470.0 ± 0.2 Ma.

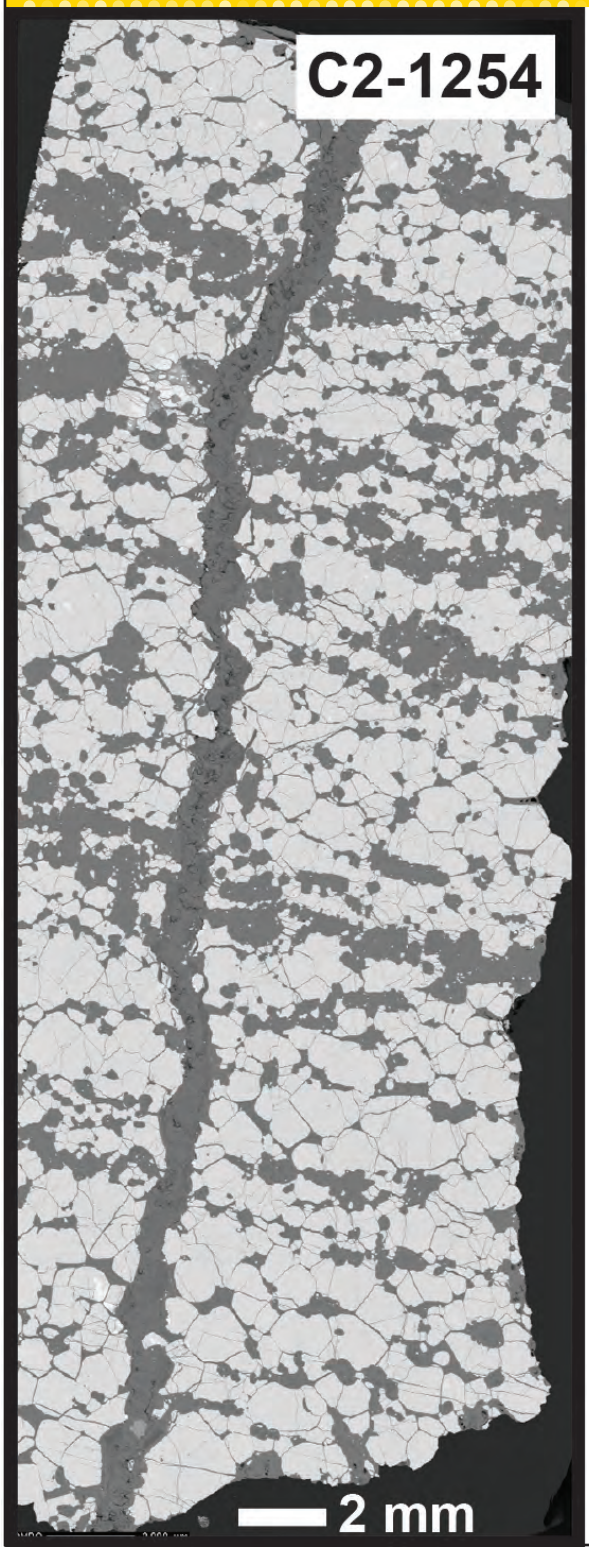
Detrital zircon from a volcaniclastic lithic arenite (KF17-69) varies from euhedral to well rounded and elongate to equant shape. Euhedral grains display well developed oscillatory zoning whereas rounded subequant grains typically have variable zoning patterns commonly truncated at the grain boundaries. Euhedral grains with oscillatory zoning analyzed by LA-ICPMS gave Ordovician dates that define a maximum depositional age of 466 ± 1 Ma (n=99). Rounded grains provided detrital ages ranging from ca. 497 to 3115 Ma.

Jadeite-bearing paragneiss (15-2) that hosts jadeite-bearing orthogneiss quarried near Tavagnasco in the lower Aosta valley contained abundant elongate to equant zircon with clear core-rim relationships. The euhedral to rounded and typically oscillatory zoned cores are overgrown by 1- to 30-micron-thick rims with coarse oscillatory and convolute zoning. CL images guided analysis of 105 cores for provenance and 5 rims or grains with CL zoning typical of the rims to determine the age of metamorphic overgrowths. The detrital ages range from 520 to 2610 Ma provide a maximum depositional age of ca. 570 Ma. The Neoproterozoic zircon population and Ediacaran depositional age are consistent with derivation from the Gondwana margin. The rim analyses combined with data from the adjacent orthogneiss define an age of 78 ± 2 Ma for the HP metamorphic rims and the timing of the oldest eclogite-facies event in the Sesia Zone associated with early Alpine continental subduction of Adria.



Chromite chemistry of the Otter Creek Layered Mafic Complex

By David Peate



The Otter Creek Layered Mafic Complex represents the oldest known rocks in Iowa, dated at ~2.7 billion years. This late Archean layered mafic intrusion was discovered by mineral exploration drilling in the 1960s into a positive magnetic anomaly near Matlock in NW Iowa. The first reconnaissance investigations of the Otter Creek complex were made by two department graduate students (Abdolmajid Yaghubpur and Timothy Tvrdik) in the late 1970s and early 1980s. A more detailed study was done in the late 1980s by Ray Anderson (IGS), Ken Windom (ISU) and Karl Seifert (ISU), who analyzed a suite of samples for major elements and select trace elements, and obtained a Sm-Nd age.

In the 30 years since these studies, analytical techniques have improved significantly, and we now have access to many of these methods on campus in the MATFab facility. So, current PhD student Trent Olson decided to work on the Otter Creek for his MS thesis, with analytical assistance from Kenny Horkley. Trent used a handheld pXRF instrument owned by the EES Department to get reconnaissance elemental data directly on the cores archived at the IGS. These data were used to collect 24 representative samples from throughout the intrusion that were crushed and powdered ready for chemical analysis by XRF (major elements) and ICP-MS (trace elements).

Chromite is virtually the only primary igneous mineral left in these highly altered samples, and where chromite occurs in thin seams (chromitite layers), their compositions are a more reliable recorder of the original magma that formed the intrusion. Electron microprobe analyses of polished core sections of the chromitite seams, showed that the chromite compositions are very different from chromites found in the contemporaneous Stillwater layered mafic intrusion in Montana. Instead, the Otter Creek chromites are similar to chromites in the late Archean Great Dyke and Inyala mafic intrusions in Zimbabwe. Whole rock compositions of the dunite units and the chromite compositions indicate that the Otter Creek Layered Mafic Complex formed from a crustally-contaminated komatiite parental magma.

1st Annual Earth Day Open House

The Earth & Environmental Sciences and Geographical and Sustainability Sciences departments hosted a free Open House Earth Day celebration. The day's events included hands-on-exhibits and demonstrations. Highlights included an augmented reality sandbox, stream tables, rocks and minerals, Devonian and Ice Age fossils, making impact craters, a virtual tour of Mars, LiDAR demonstrations, and groundwater contaminant models.

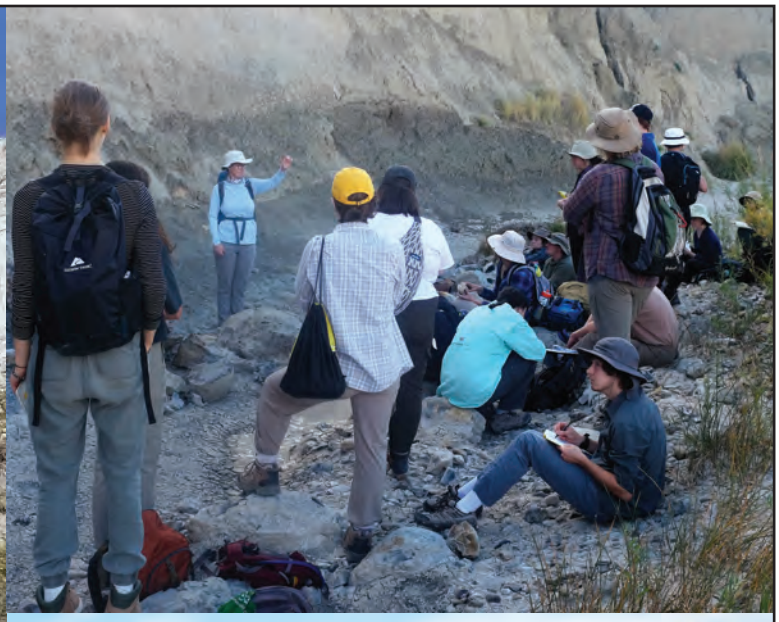
Previous page: (top left) Brad Cramer mans the welcome table. (top right) Kids playing in the augmented reality sandbox. (bottom left) Visitors looking at microfossils. (middle right) Representatives of the Environmental Sciences Club. (bottom right) Visitors learning about LiDAR from Adam Skibbe from the Geographical and Sustainability Sciences Department.

This page: (top left) Alyssa Bancroft and Ryan Clark at the Iowa Geological Survey table with undergraduate Samantha Eberly. (top right) Valerie Payré showing participants how to control a Mars rover. (bottom left) A visitor looking at mineral specimens through a miscroscope. (bottom right) Visitors looking at mineral specimens that display fluorescence uder a black light.

EES:2001 Second Year Field Trip

Badlands National Park, South Dakota

(top left) Ciara Gallen, Sydney Rayburn, and Claire Bruce at Yellow Mounds. (bottom left) Sadie Richter, Meghan Kroeger, Sam Eberly, Dr. Kate Tierney, and Ian Ray examining a cephalopod fossil at Sage Creek. (top right) Claire Bruce, Sam Hudziak, Emma Holesinger, and Ian Ray contemplating ash deposits in the Brule Formation. (bottom right) Anna McNally, Dr. Ben Swanson, and Henry Frederick discussing fluvial terraces in the Sage Creek Valley.



(top left) Emma Holesinger waiting to climb the ladder to the Notch. (bottom left) Bob the Bison strolling through the campsite at Sage Creek Campground. (top right) Dr. Kate Tierney lecturing about fossils and marine shale, Sage Creek. (middle right) Tosh Klever, Sydney Benton, and Rachel Walenceus discussing depositional patterns along Sage Creek. (bottom right) Class photo at Badlands National Park.

EES:3160 Spring Break Field Trip

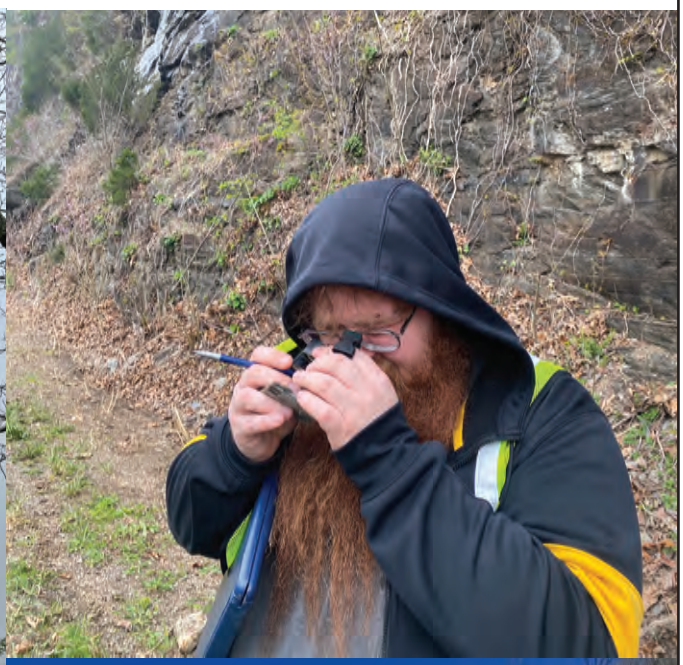
San Salvador Island, Bahamas

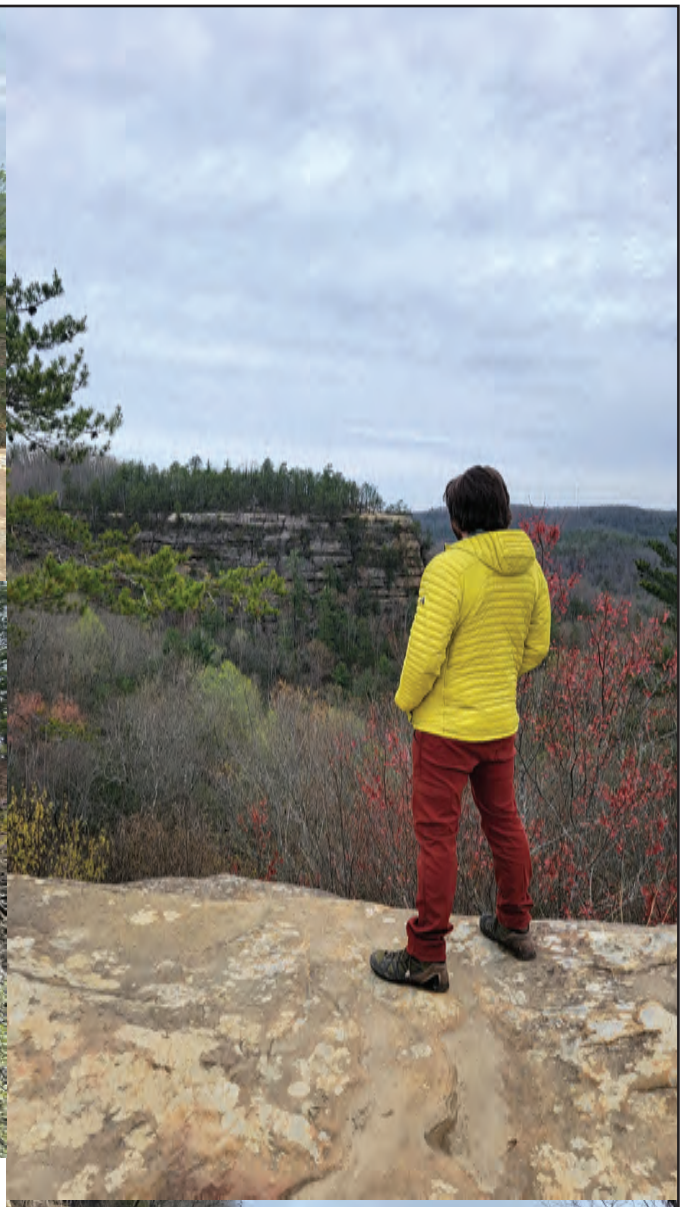
(top left) Spring Field Trip students and gear en route to Gerace Research Center. (middle left) Emma Holesinger and Talia Hill at Barker's Point. (bottom left) Iowa students volunteering to clean and maintain Gerace drinking water catchment. (top right) Emma Holesinger enjoying the bright blue waters at French Bay. (bottom right) Max Collins, Lauren Haefs and Emily Copple observing a quarry face cut by enslaved people in the early 1800s.

(top left) Al Zukowski pointing out high angle large scale aeolinites at North Point. (bottom left) Gwen Rogers descending into Lighthouse Cave. (top right) Columns in Lighthouse Cave with Sydney Benton for scale. (bottom right) Lauren Haefs enjoying Lighthouse Cave.

EES:4750 Exploration Field Trip

A transect across the southern Appalachian Mountains





Left page: (top left) Samanthe Aberly, Sydney Rayburn, and Matt Brodale trying to catch a view on a foggy day in the Smoky Mountains. (bottom left) Brennan Hill taking a break with the help of the outcrop. (top right) Trent Olson getting a close look at some metamorphic minerals. (bottom right) A roadside outcrop along Hwy TN 31 with excellent exsposure of the Copper Crfeek fault.

This page: (top left) Samson Bruxvoort, Sydney Rayburn, and Manny Murillo taking in the view at the Red River Gorge Geological Area. (bottom left) Students examning the overturned Pennsylvanian strata in the Pine Mountain thrust footwall. (top right) Shay Ridl standing atop the Sky Bridge in the Red River Gorge Geological Area. (bottom right) Matt Brodale walking along outcrop exposures on the Bule RIdge Parkway.

(top left) Talia Hill, Manny Murillo, and Sydney Rayburn in fron of the Smoky Mountains. (bottom left) Taking a close look at an armored mudball. (top right) Students looking very closely for indicator minerals. (middle right) Group photo near the Smoky Mountains. (bottom right) Sam Hudziak and Shay Ridl getting a good look at the outcrop.

Earth & Envrionmental Sciences Alumni Board News Briefs

by Kate Tierney, EESB Faculty Liason

EES ALUMNI BOARD: SELF NOMINATION CALL

Calling all graduates of EES: we are seeking new candidates for the EES Alumni Board and invite recent and senior graduates to self-nominate for a seat on the committee. Board members offer networking opportunities, mentor current students and advise for future academic and professional pursuits, and provide valuable input to the EES department. No matterwhen you graduated, we value your involvement and contributions to the department board.

If you are interested in serving on the EES alumni board, please note the following requirements and responsibilities:

· Graduate of EES (recent or senior)
· Serve for a term of three (3) years
· Visit campus/Iowa City at least once, or during the triannual meeting (Fall 2024)
· Availability to volunteer time and engage with current students and faculty both in-person and virtually (Zoom, Skype, email, etc.)

If you have any questions or would like more information, please contact EES Alumni Board President Lee Phillips (plphilli@uncg.edu) or EES faculty liasion Dr. Kate Tierney (kate-tierney@uiowa.edu). We appreciate all the support our alumni provide to the department and look forward to working with you!

EESB MENTORY PROGRAM: ALUMNI-LED MENTORING OPPORTUNITY

Our alumni board is offering career mentoring opportuniUes for all EES current and recent undergraduate and graduate students. Our diverse group of department alumni have a wealth of expertise about many types of careers available to Geoscience and Environmental Science students.

The goals of this mentoring program are to:

1. Provide career advice and input for life ader graduation.
2. Help with building a resume.
3. Give assistance with expanding networking skills.
4. Provide technical expertise where appropriate.
5. Help with understanding importance of ethics, safety, and profession certification issues.

If you are interested, please send the following information to Ali Geraets, EES Academic & Office Coordinator TH 115 (alexandra-geraets@uiowa.edu): Name, Email, Year in School or Graduated, Major & Degree objective, Prospective post graduate plan/career. The alumni mentoring committee will match you up with a suitable alumni mentor who will contact you by e-mail to start the mentoring process.

Wilderness First Aid Course

This version of the American Red Cross (ARC) Wilderness & Remote First Aid (WRFA) certification was held on February 4-5 and is a fast-paced, 18 hour advanced first aid course designed to prepare field trip leaders and research scientists for the range of medical emergencies they are likely to encounter in uncontrolled, wilderness or remote environments. This course involves lectures integrated with case studies, skills practice sessions, and outdoor practical scenarios designed to provide participants with opportunities to demonstrate skill mastery, exercise leadership and sound judgment during simulated emergency situations.

(top left) Led by graduate students Sam Hudziak and Shay Ridl, we attempt a deadlift of Dr. Jessi Meyer. (bottom left) The group showing off their ankle-wrapping skills. (top right) Dr. Jessi Meyer with an improvised arm sling using triage bandages. (bottom right) Dr. Emily Finzel in a emergency blanket and tarp burrito while practicing hyperthermia rescues.

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EARTH & ENVIRONMENTAL SCIENCES SPRING 2023

Anything you would like to see in the newsletter? Please send an email with suggestions or requests to clas-ees@uiowa.edu!