Events and Happenings

Experimental Education: An Innovative Approach to Teaching in the Field

What happens when you task 25 graduate students with teaching a lesson in a field area they've never been to? A little bit of confusion of course, but it turns out you also get a lot of enthusiasm, creativity and most importantly, learning.

This is exactly what the Multidisciplinary Applied Geochemistry Network (MAGNET; www.magnet.eos.ubc.ca) set out to achieve in summer 2016. MAGNET is an NSERC-funded industrial stream Collaborative Research and Training Experience (CREATE) initiative led by Dominique Weis at UBC. The program connects trainees with leading scientists and state-of-the-art analytical laboratories across Canada to address challenges in analytical, environmental and exploration geochemistry. Our trainees come from diverse backgrounds – geology, oceanography, chemistry, archaeology and environmental science – which gives us a unique opportunity to draw on each other's strengths, create an integrated learning environment, and take a novel approach to geochemistry education and training in Canada.
At least once a year, MAGNET trainees and faculty from across Canada get together for an intensive week of technical training, networking and professional development. Each time, the workshop features a different theme, format and location. This year, we decided to head down to the US to explore three unique field sites in Montana and Wyoming: the Stillwater Complex, the Beartooth Mountains and Yellowstone National Park.

The concept of the workshop drew heavily on UBC's strength in geochemistry and expertise in teaching and learning initiatives, and particularly benefited from the guidance of co-organizer James Scoates. For the lessons, he came up with a somewhat unusual idea: why not have the students teach each other? The benefits of peer learning are well-known and the technique is widely gaining momentum.

Groups of trainees were responsible for designing and delivering half-day teaching modules that included field activities at each of the locations. Planning was carried out using Basecamp, a web-based project management and collaboration tool. Students were free to self-organize into groups of 2-4, with the one rule that each group should include participants from at least two universities. They were also encouraged to choose their own topic as long as it included geochemistry. Within 10 days, all trainees had found groups and defined their topics.

Over the course of two months, the students transformed their ideas into a formal lesson plan, complete with learning goals, a schedule of teaching

Students lead a group discussion on field relationships in the Beartooth Mountains, Montana. *Photo: J. Scoates.*

Co-organizer James Scoates provides an overview of the regional geology of the Stillwater Complex, Montana. *Photo: D. Hanano.*

activities, equipment lists, and plans for safety, environmental mitigation and archiving samples/data. Each group was assigned a mentor (postdoctoral fellow, faculty or staff member) who provided advice, feedback and recommendations throughout the process.

In August, 30 students and mentors flew from all over Canada, from Vancouver to as far east as Chicoutimi, down to the quaint, historic town of Red Lodge, Montana. The first evening we held a kick-off meeting that included pizza and a "snowball fight" – a fun icebreaker and get-to-know-you activity.

Day 1 we headed off to the Stillwater Complex, a large mafic layered intrusion that is actively mined for its extensive reserves of chromium and platinum group elements. After a comprehensive safety discussion (also led by the students), the first group took over. We began by exploring the Peridotite Zone of the Ultramafic Series near the base of the intrusion.

Students practiced identifying minerals, sketching outcrops and using a magnetic susceptibility meter to learn about the formation of chromitite layers. The next day, we completed the Picket Pin traverse, which took us on a transect through the Banded Series in the upper part of the intrusion. Student groups, each armed with a compass, GPS and base map, spent the day locating outcrops, classifying rocks and taking structural measurements. The exercise culminated with each student constructing a cross-section and a discussion of the overall structure and formation of the Stillwater Complex.

We switched gears on Day 3, and drove through the spectacular Beartooth Mountains near the border of Montana and Wyoming. This module was structured as a "jigsaw" activity (a cooperative learning technique) and was very successful, despite the sudden downpour and unexpected lack of outcrop. Each group was assigned a map unit that they had to describe, name

Students instruct their peers on how to make cross-sections at the end of the Picket Pin traverse, Stillwater Complex, Montana . *Photo: J. Scoates*

and match to whole rock major element data. New groups were formed consisting of one expert from each map unit to compile their observations and interpretations for the entire map area. The final discussion synthesized the regional geologic history and major concepts on metamorphism and geochronology.

The second half of the trip took place in the incredible natural laboratory of Yellowstone National Park. Day 4 was spent identifying the different facies of Mammoth Hot Springs on the basis of their physical characteristics, chemistry and microbial communities.

Teams work on a fun activity building the chemical reactions occurring at Mammoth Hot Springs, Yellowstone National Park, Wyoming. *Photo: D. Weis.*

Although we weren't able to directly sample the spring water, the students had fun using infrared thermometers to record temperature variations. At the end, students summarized their facies observations and learned about the biogeochemical processes at play.

The following day, the teaching group provided their peers with an overview of Yellowstone volcanism, including stops to observe the mineralogy and structure of rhyolitic and basaltic outcrops from each of the three volcanic cycles. Students were able to make connections between the different cycles and their geochemistry, and formulate their own interpretations about magma sources, relationships and processes. This module took us on a huge loop of the park, where we often had to stop for bison (and tourists) on the road, making for a long but rewarding day.

On Day 6, we went on a walking tour of the Norris Geyser Basin, an acidic hydrothermal system that provided a useful contrast with the alkaline hot springs we saw at Mammoth. Students completed worksheets consisting of thought-provoking questions and activities at each of the remarkable geothermal features, including geysers, fumaroles and hot springs. On the final day, we investigated the geology, geochemistry and archaeology of Obsidian Cliff. Unfortunately, we couldn't access the area due to construction, but the student leaders did an amazing job improvising. They

PhD student measures water temperature variations at Mammoth Hot Springs, Yellowstone National Park, Wyoming. *Photo: D. Weis.*

used a variety of active learning strategies including polls, think-pair-share, a gallery walk and even a crossword competition and human scatterplot.

We ended the workshop with a wrap-up activity designed to synthesize all of the concepts learned throughout the week. Teams of students drew conceptual maps incorporating all three field sites, and integrating aspects of time, chemistry and processes. The level of participation and the sheer variety and quality of the finished products were both impressive and inspiring.

The workshop was a huge success by several measures. In one week, we were able to explore ancient crustal rocks, mafic layered intrusions, supervolcanoes and modern geothermal systems, spanning four billion years of Earth history. The outdoor classroom and hands-on activities enhanced understanding of concepts introduced earlier in the year and gave students a sense of scale, context and perspective. The trainee-led format facilitated peer-to-peer knowledge transfer and provided professional skills development in project management, teamwork and communication. New friendships were formed during our (rare) free time at stops like Old Faithful and in the evenings over shared meals and campfires. These personal connections and memories will stay with them for years to come.

Time constraints and unforeseen field circumstances were the most difficult aspects the student instructors had to overcome. Keeping learners motivated, especially those with varying knowledge levels, was also a challenge. As one graduate student remarked in their post-trip reflection, “nothing goes according to plan, but it all works out somehow if your students are engaged and interested, regardless of their back-ground.” And at the end of the day, we saw more, did more and learned more than we could have ever imagined. We hope others will be inspired to take more risks in teaching and will use our positive experience with peer learning as a model for future field courses and workshops.

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Students sketch the sediments and basalts of The Narrows (Overhanging Cliff in background), Yellowstone National Park, Wyoming. *Photo: D. Weis.*