EARTH MATTERS

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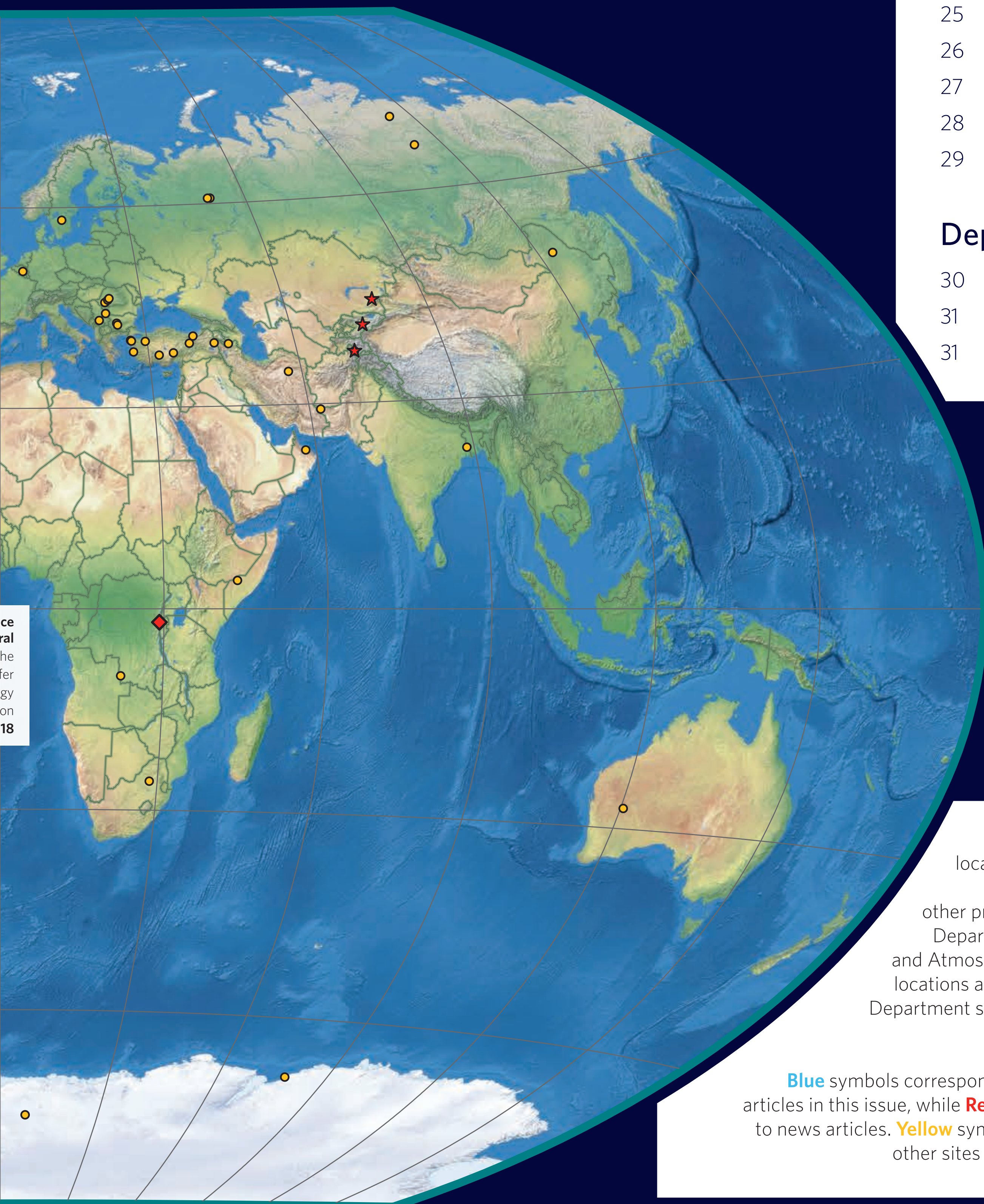

This map depicts locations of field research, sample collection, and other projects from across the Department of Earth, Ocean, and Atmospheric Sciences. These locations are taken from the 2017 Department survey and compiled by Colin Rowell.

Blue symbols correspond to sites from feature articles in this issue, while **Red** symbols correspond to news articles. **Yellow** symbols correspond to all other sites reported in the survey.

DESIGN Colin Rowell, Alan Shapiro

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COVER PHOTOS Front: Saba volcano, Peru by Colin Rowell. Back: Jellyfish bloom by Keith Holmes, Hakai Institute.

From the Head

EOAS Department Head Prof. Roger Beckie.

Earth Matters Editor-in-Chief Alan Shapiro.

Earth Matters Editor-in-Chief Alan Shapiro sat down with Earth, Ocean and Atmospheric Sciences Department Head, Prof. Roger Beckie, to review the past year and examine the year ahead.

How does EOAS fit and stand out in the Faculty of Science and UBC communities?

EOAS is a miniature version of the Faculty of Science. In addition to Earth science, we have biology, physics, math, and chemistry represented in the Department. We are doing leading research on both basic and applied topics.

We are also leaders in teaching at UBC, and recognized internationally by organizations such as the Bay View Alliance. Renowned science educator Carl Wieman, now at Stanford University, has highlighted UBC, and EOAS in particular, as doing great work. We have so many excellent people in our educational space, and we'd like to maintain that leadership for a long time.

Our alumni and community are known as the most engaged in the Faculty of Science. They are very generous with their time and financial support for EOAS at all levels, and we're hoping to find ways to maintain and enhance that.

What current job searches are underway, and are there plans for more hiring in the future?

We have two searches active: one in sedimentology and the other in hydrogeology and related disciplines. The Department will also be hiring 3 new faculty members within the next year. We will be posting other positions this fall. Less than a year from now, we will have new faculty members coming into the Department, which is very exciting.

In your foreword to the last issue of *Earth Matters*, you identified 2 key drivers in a world-class research department: building upon established disciplinary strengths and forging into emerging areas. How has EOAS continued pursuing both goals over the past year?

It's a balancing act – we have to do both to remain a vital research university and department. Ultimately, we want to do things to help understand our place in the world and the universe. Sedimentary geology is one discipline that's both an emerging area for EOAS and considered a core part of a geoscience department. Our current hiring is augmenting a long-standing need in the Department to bolster the soft rock area.

In terms of emerging areas, geomicrobiology – Prof. Sean Crowe's lab – is one example of a bet that paid off. He has been very successful working within two disciplines that until recently were largely independent – Earth sciences and microbiology.

Another good example to highlight is BRIMM (the Bradshaw Research Initiative for Minerals and Mining), led by Prof. Greg Dipple. Greg is a great example of a guy who started off in a core metamorphic petrology area and now has an environment and climate focus. As a department, we have that critical mass and those connections where people like Greg can flourish and take unorthodox career paths that follow those big questions.

What successes has the Department achieved in teaching over the past year, and how do you expect programs to change in the upcoming year?

Prof. Roland Stull's *Weather for Sailing, Flying & Snow Sports* (ATSC 113) course is one example of teaching success in our Department. The course has seen very strong enrollment and has brought a lot of students into the Department. It's delivered in an exciting way and has been tailored to match the proclivities of the new generation of students. I hope that we can roll out more of that into our other courses.

Department members received a number of teaching awards this year, including a Killam Teaching Award for Prof. James Scoates and Killam Graduate Teaching Assistant Award for Emily Scribner. We've also seen Sarah Bean

Sherman move into a permanent position as a Science Education Specialist, providing educational support to the Department. Sarah's appointment is a huge commitment by the Faculty Science and EOAS to excellence and innovation in instruction.

There are a couple of areas that we'd like to get involved in. One is the idea of data and visualization in geosciences contexts. We need to give our students and ourselves the ability to understand, extract value and information from data. We're looking into how we can partner and draw on existing strengths at UBC and within the Department.

The field schools are also something that we're still working on. The plan is to look at all the field schools and see how the skills map through the curriculum. Can we have a dedicated geological engineering field school? How does the second year field school relate to third year field school? Experiential learning is crucial. Many of our students need those skills to work in industry.

What other milestones stand out from the past year?

We're seeing a once-in-a-generation change in the Pacific Museum of Earth (PME), driven by generous funding from Wheaton Precious Metals. Wheaton, under the leadership of Geological Engineering alumnus Randy Smallwood, has committed one million dollars to the PME, 3 million dollars towards the Wheaton Precious Metals Atrium in the Earth Sciences Building, and another one million dollars towards the Beaty Biodiversity Museum. PME Director Dr. Kirsten Hodge is leading the design of several new installations. Stay tuned!

We're also waiting in great anticipation for the new Dean of the Faculty of Science, Prof. Megan Aronson, who will start in early September 2018. The former Dean, Prof. Simon Peacock, has returned to his home here in EOAS after 12 years leading the Faculty. He is using his well-earned 18-month leave to focus his energy on his research.

Sadly, the Department lost 3 former professors in the past year. Can you speak to that?

Former Professor Art Soregaroli and Emeritus Professors Paul Harrison and Oldrich Hungr died in the past 12 months. Art was a professor of economic geology in the early 1970s, and subsequently became a leader in the Canadian mining industry. Paul was a biological oceanographer who was known for his generous mentorship of his students. He died in December 2016 after a short illness.

Oldrich was a cornerstone of the Geological Engineering program, specializing in landslide hazards until his retirement in June 2016. He passed away unexpectedly in August 2017. Art, Paul and Oldrich were all down-to-earth people of strong character. Scholarships in the name of Art, Paul and Oldrich have been established to honour their many contributions to EOAS and the wider community.

See page 31 of this issue for information on the memorial scholarship funds. For information on the Bay View Alliance, visit http://bayviewalliance.org. Read about Randy Smallwood at https://www.bcbusiness.ca/lunch-with-randy-smallwood and about Prof. Megan Aronson's appointment at https://science.ubc.ca/news/texas-am-physicist-appointed-dean-ubc-science.

EOAS Department Head Prof. Roger Beckie (right), former Faculty of Science Dean Prof. Simon Peacock (second from right), UBC alumnus Ross Beaty (third from right, profiled in this issue), and others attend the unveiling of the Wheaton Precious Metals Atrium at the UBC Earth Sciences Building in June 2018. Photo credit: UBC Faculty of Science.

Research News

Sampling Honey

by David Zeko

Kate Smith, a PhD student in EOAS, is working with Prof. Dominique Weis and Dr. Marghaleray Amini from the Pacific Centre for Isotopic and Geochemical Research (PCIGR) to analyze honey from beehives throughout the Lower Mainland. The PCIGR is collaborating with Hives for Humanity, a nonprofit organization in Vancouver's Downtown Eastside that encourages community connections through beekeeping. Bees collect nectar and pollen from plants within a 3-kilometer radius of their hive. Honey from each hive therefore represents a sample of the local environment.

The concentrations of various metals (lead, zinc, arsenic, copper, and cadmium among others) in honey were measured at the PCIGR. In addition, lead isotope analyses were carried out to help fingerprint the sources of lead. Results from this sweet study show that, although detectable, the concentrations of trace metals in urban honey are very low and safe for human consumption. The data collected will help researchers to map the current distribution of metals across the Lower Mainland; understand the transport of metals through air, water, soil, and plants; and construct a baseline from which future pollution changes can be measured.

PhD student Kate Smith (left) and Julia Common (right) of Hives for Humanity sample bee bread (pollen) from a rooftop hive in Vancouver's Downtown Eastside. Photo credit: Hives for Humanity.

Prof. Matthijs Smit conducting fieldwork in the Western Gneiss Complex, Norway.

Crustal Evolution

by David Zeko

Research professors Matthijs Smit of EOAS and Klaus Mezger of Universität Bern have discovered a possible link between the long-term evolution of the Earth's crust and the emergence of Earth's oxygen cycle 3.0 billion years ago. Although ancient photosynthetic bacteria known as cyanobacteria may have produced oxygen as early as 3.7 billion years ago, it took almost a billion years for that oxygen to start accumulating in the shallow oceans and atmosphere. To better understand this apparent delay, the researchers investigated links between the emergence of the oxygen cycle and the chemical evolution of the continental crust.

Their findings show that approximately 3.0 to 2.4 billion years ago, Earth's continental crust changed from a magnesium-rich composition to the silica-rich composition of today. Matthijs and Klaus suggest that this dramatic shift caused a decline in the concentration of "oxygen scavenger" molecules in the continental environment. This allowed oxygen to accumulate in the early oceans and atmosphere, ultimately setting the stage for the evolution of complex life.

These findings are part of a collaborative research initiative called *Earth's codependent siblings: studying dynamic interactions between crust and mantle in ancient and modern continents.* Through this initiative, Smit, students, and collaborators are studying the formation and evolution of Earth's earliest continents using the world-class analytical facilities at PCIGR.

Read the publication: Smit, M.A. & Mezger, K. (2017). Earth's early O_2 cycle suppressed by primitive continents. Nature Geoscience.

Ocean Watch

by Karina Ramos Musalem

EOAS professors Stephanie Waterman, Roger Francois, and Philippe Tortell, along with scientists at the University of Victoria and the Institute of Ocean Science, have received 9.5 million dollars to create the Canadian Pacific Robotic Ocean Observing Facility (C-PROOF). Funds for the project were awarded by the Canada Foundation for Innovation ($3.8 million), the Province of British Columbia ($3.8 million), and several project partners ($1.9 million).

C-PROOF is designed to support ecological managers and meteorologists in planning for the future and to drive the development of ocean-driven renewable energy technologies. The state-of-the-art facility will monitor the coastal and offshore waters of BC using autonomous ocean observation platforms such as ocean gliders and mooring arrays. As the world's oceans become warmer, more acidic, and deoxygenated, these instruments will help scientists track and understand changes in ocean currents, weather, and marine ecosystems.

Much of the data produced in conjunction with C-PROOF will be publicly available. The facility's strong network of partnerships includes government organizations, NGOs such as Pacific Salmon Foundation and the Hakai Institute, local industries engaged in ocean sensor development, and stakeholders in the wind and wave energy sectors.

For more about ocean observation platforms in EOAS research, see Oceans in Motion on page 16 of this issue.

Spill Prediction

Given the prospect of a proposed new pipeline and an increase in tanker traffic in the Strait of Georgia, community concern regarding oil spills and their impacts has been on the rise. The Marine Environmental Observation, Prediction, and Response Network (MEOPAR) and Ocean Networks Canada awarded Professor Susan Allen $500,000 to develop a prediction and risk assessment system to study the impact of oil spills in the Salish Sea. Fisheries and Oceans Canada (DFO) and North Shore Emergency Management will complement the funding with in-kind support worth $392,000. The project will initially run for 3 years, starting in April 2018.

The project aims to improve our understanding of the dispersion and transport of diluted bitumen (dilbit), the primary pipeline product coming from Alberta's Oil Sands, as its fate in marine environments is poorly understood compared to conventional crude. "The idea is that it can inform policy and also be something that risk management people and regulators like the Port of Vancouver will use," says PhD candidate Ben-Moore Maley, co-author of the proposal. The project draws on numerical models developed by Susan's research group (SalishSeaCast), along with researchers at DFO, Dalhousie University, and the UBC School of Community and Regional Planning (SCARP).

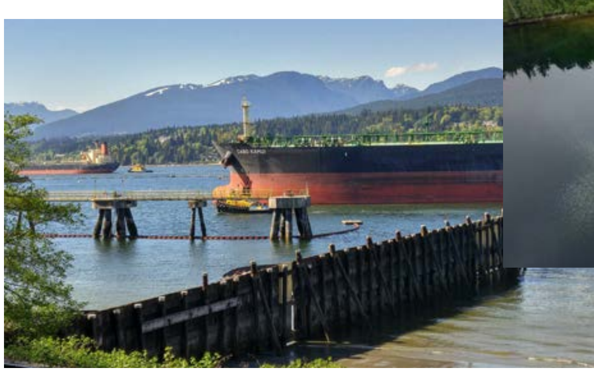
Jellyfish Blooms

Blooms or clusters of jellyfish are very common in coastal environments. Scientists are interested in understanding the characteristics of these blooms to better assess their impacts on sensitive ecosystems. Using drone technology, assistant professor Brian Hunt and recent BSc alumna Jessica Schaub are one step closer to understanding moon jellyfish blooms in waters around Pruth Bay, off Calvert Island, BC. Their research has generated widespread interest and was featured in a February 2017 CBC news article.

The use of drones has revealed new information on how moon jellyfish clusters move, how they respond to river runoff, and how they are aggregated by ocean currents. Brian and Jessica were able to combine aerial images from drones with samples from net tows and underwater cameras to calculate the mass of the clusters. These results set the stage for further studies on the effects of jellyfish on the food web.

Read the publication: Schaub, J. et al. (2018). Using unmanned aerial vehicles (UAVs) to measure jellyfish aggregations. Marine Ecology Progress Series.

Read more about Jessica Schaub in her profile on page 27 of this issue.



An oil tanker docks at a Port of Vancouver terminal. Photo credit: Karina Ramos Musalem.

Jellyfish bloom viewed from the air. Photo credit: Keith Holmes, Hakai Institute.

Teaching News

Mountain Learning

by Arran Whiteford

Driving on a tortuous dirt road from Khorog to Dushanbe, Tajikistan, Francis Jones recalls being surrounded by mountains “more spectacular than anything I’ve seen in BC, the Rockies, or the Alps.” He had just visited one of 3 University of Central Asia (UCA) campuses, all deliberately nestled in wild, remote, mountainous locations.

With campuses in Tajikistan, Kazakhstan, and Kyrgyzstan, UCA’s core mission is to develop the communities that neighbour the campuses. At a foundation-laying ceremony, Aga Khan IV, the University’s principal funder announced that "by creating intellectual space and resources, the University will bring the power of education and human ingenuity to the economic and social challenges of mountain societies in Central Asia and elsewhere." The goal is to develop local expertise for sectors including resources, energy, infrastructure, ecotourism, environment, and water.

In 2017 UCA announced a partnership with EOAS to design an internationally reputable, Central Asia-specific BSc in Earth and Environmental Sciences, under the leadership of EOAS’ Francis Jones. Drawing on proven pedagogy, each of the 22 courses is being developed by a UBC Science Education Specialist with the support of undergraduate students. UCA’s first cohort of Earth scientists is expected to graduate in 2021.

The process of designing the curriculum has been rewarding but challenging. “Ideally,” shares Francis, “we should work closely with the faculty who will teach these courses, but most have not yet even been hired. Therefore, we must balance rigour and flexibility so instructors can take ownership in ways that reflect their interests, passions and priorities.” Francis hopes that this partnership will support the development of these remote communities without forcing students to leave the rugged mountain regions they call home.

Residences at the University of Central Asia campus in Khorog, Tajikistan. Photo credit: Francis Jones.

Teaching Together

by Alan Shapiro

When it comes to excellence in teaching, EOAS is recognized as a leader not just within UBC but around the world. Since the launch of the Carl Wieman Science Education Initiative at UBC in 2007, the Department has become a proving ground for a range of initiatives to support evidence-based education. The Paired Teaching Initiative (PTI) is the newest of these programs, launched as a pilot in 2014 with funding from the Harris family.

The program pairs instructors new to student-centered teaching with instructors experienced with that pedagogy. These instructor pairs co-teach courses that have already been transformed with the help of EOAS’ dedicated team of Science Education Specialists (SESs) to integrate active learning practices. In addition to co-teaching the course, instructors meet weekly over the course of the term to discuss and reflect on teaching strategies. A SES helps to facilitate discussions between instructors and provide ideas and feedback as needed.

Currently a SES with EOAS’ University of Central Asia project, Dr. Tara Holland has supported and studied the PTI program since its inception. Through instructor interviews, written reflections, and teaching observations, Holland assessed teaching practices and monitored how they changed over time. “Paired teaching,” shares Tara, “offers many benefits, particularly for new instructors.”

Within EOAS, the program has now been run with 8 instructor pairs over 3 years. Feedback has been very positive, with both paired members reporting getting a lot out of experience. Tara notes that even “more experienced instructors appreciated having someone to share ideas and learned a lot through the process." The Faculty of Science hopes to continue to expand the program across all departments, offering mentorship opportunities for all new faculty.

Read the publication: Holland, T., Sherman, S.B., & Harris. S. (2018). Paired teaching: a professional development model for adoption of evidence-based practices. College Teaching.

Expert Educators

by Arran Whiteford

EOAS is rich with talented science educators. Prof. Stuart Sutherland, who along with Prof. Sara Harris was awarded EOAS Undergraduate Instructor of the Year in 2017, and Brett Gilley, who won the prestigious faculty-wide 2016-17 Killam Teaching Award for Science Instructors, share their thoughts on what makes an excellent instructor.

On what they love about their jobs:

Stuart: I am basically a science nerd who loves talking about rocks and fossils. I also get a lot of energy from seeing other people getting turned on to some of the science stuff that I find cool.

Brett: In general, I really like interacting with the students, but being able to help others learn how complicated, connected, and cool the Earth is is pretty fun too.

On what makes a good instructor:

Stuart: #1 is enthusiasm for what you are teaching. If you are enthusiastic, some of that excitement for science will filter into the classroom.

Brett: I think one important thing is to have empathy for the students' situation. Being a student is difficult and much more complicated than when I went through school. I try to remember that I am only one of 5 or more demands on their time.

On how their teaching has evolved over time:

Stuart: It can be a challenge to let go of "delivering content" in a course, but in recent years my classroom has become much more active. I have handed responsibility for more course content to the students and then explored that material in online tests and more significantly during in-class activities.

Brett: In the last decade my teaching has changed rapidly. As a Science Teaching and Learning Fellow, I got to learn about effective teaching as part of my job. I read many papers, observed many classes, and measured how students learned. This has given me an excellent foundation for my teaching skills.

On what advice they would share with their past selves:

Stuart: Don't beat yourself up. Some things are not going to work. Learn from them and move on (still trying to apply that one today). Question why you are delivering content and strip away that which isn't needed. "That's what I had to learn when I was an undergraduate" is not a logical way to create a curriculum.

Brett: There are things that I still do poorly. I tend to speak quickly when I'm excited, for example. Probably the best advice is to avoid thinking you have it "right" and to seek opportunities to improve your teaching skills. That's probably good advice for now too, honestly.

A New Face

by Alan Shapiro

Meet Dr. Alison (AJ) Jolley, the newest addition to the EOAS teaching and learning support team. AJ joins Science Education Specialist Dr. Sarah Bean Sherman and a dedicated team of teaching professors and curriculum designers supporting the faculty and designing student-centered learning experiences across the department. Here are 4 things you need to know about AJ and her role:

UBC Connection. AJ completed her BSc in Geological Sciences at UBC in 2011. She began her involvement with Earth science education early on through a summer research project that examined student views on Earth and ocean sciences. The project eventually led to an honours thesis with Prof. Sara Harris and Francis Jones on student perceptions of landscapes.

Science Teaching and Learning Fellow (STLF) Dr. Alison Jolley.

Educational Adventures. During AJ's Master's degree in Sheffield, England, she developed lesson plans to introduce high school students to geoarchaeology and highlight interdisciplinary connections between archaeology and other fields. Her PhD in Geology took her to Christchurch, New Zealand, where she studied how students develop a sense of place on undergraduate geology field trips and how this differs based on field trip style and student background.

The Role. The Science Education Specialist (SES, formerly STLF) program emerged in 2007 through the Carl Wieman Science Education Initiative. Its goal was to embed discipline-based science education experts within Faculty of Science departments. The role of the education specialists is to support other faculty in designing active, student-centered teaching and learning experiences. Of the departments involved, EOAS has had the most faculty members take part in teaching and learning reform.

Full Circle. AJ was an EOAS student in the early days of the STLF program and observed first-hand how classes evolved. She recalls how the 3rd year field school (EOSC 328) was re-designed by professors Ken Hickey and James Scoates and former STLF Josh Caulkins to address gaps in students' prerequisite knowledge. For example, a pre-field boot camp was added to refresh students' field skills, such as measuring strike and dip and making cross-sections.

Undergraduate

Environmental Storytelling

by Meghan Sharp

Through a creative event designed to highlight the environmental responsibility of every member of society, the UBC Environmental Science Student Association (ESSA) brought together "3 generations" of environmentalists to tell their personal stories. The 3 Stages event marked ESSA's first keystone talk open not only to the UBC community, but also to the general public.

The "young" generation was represented by speaker Grace Hermansen. She told the story of UBCC350, a UBC-based political climate action group that aims to use the power of collective action to promote climate justice. Award-winning writer, educator, and activist Dr. Briony Penn spoke on behalf of the "intermediate" generation. She invited the audience to learn about the forces of nature by reliving her radical environmental protection campaigns, such as riding down the streets of Vancouver dressed as Lady Godiva.

The "mature" generation was represented by Grand Chief Stewart Phillip, President of the Union of BC Indian Chiefs since 1998, and environmental activist Joan Phillip, the former Land Administrator for the Penticton Indian Band Council. The couple has been married for 30 years, and together has dedicated their lives to protecting BC's land and water. Their story guided the audience through Stewart and Joan's own experiences and outlined the important role that today's generation must play in environmental protection.

These speakers' unique yet complementary personalities shone through on an October evening at UBC's Chan Centre. ESSA's event successfully captured a holistic perspective on environmentalism, providing inspiration and guidance for the UBC and community members in attendance.

Speakers share their stories at UBC Environmental Science Student Association's 3 Stages event.

Rose Gallo in a tree cast at Tseax Cone.

Volcanic Adventures

by Meghan Sharp

The 18th century eruption of Tseax Cone, a volcano located in northwestern BC, is thought to be one of Canada's most deadly natural disasters. According to the legends of the Nisga'a First Nations, the eruption was responsible for the destruction of 2 villages and the mysterious deaths of 2000 people. It is unclear how the inhabitants died, as they were located far from where the tephra (material released by the eruption) reached.

Rose Gallo, who graduated from UBC's BSc (Hons) Geology program in 2018, devoted her thesis research to solving a piece of this puzzle. Under the supervision of Prof. Kelly Russell, Rose investigated the eruptive dynamics of the explosive phase of Tseax Cone. Field measurements of tephra depth, location of ballistics (volcanic projectiles), and observations of stratigraphy allowed her to constrain parameters such as the height of the eruption column, the extent of deposits, and the order of eruption events. Rose's research may allow us not only to expand on the oral history of the Nisga'a, but also to predict whether similar events can occur elsewhere in BC.

Members of the Dawson Club trek across a cooled lava flow in Hawai'i. Photo credit: Dylan Spence.

Textbooks Come to Life

by Meghan Sharp

Members of the G.M. Dawson Club spent their mid-term break exploring beaches and lava flows in every Earth scientist's dream location: Hawai'i. The aspiring geologists and geophysicists arrived in Kona and headed to "Snuggle Pie Cottage," their invitingly-named temporary home in the small town of Pāhoa. Students experienced first-hand the many dimensions of Hawai'i: the iconic shield volcano, Kīlauea; the diverse marine life in Kapoho tide pools; the home of ancient Hawaiian kings in Waipi'o Valley; and the role of astronomy in Hawaiian culture at the 'Imiloa Astronomy Center.

The trip was guided by 2 EOAS professors - mineralogist Lee Groat and volcanologist Lucy Porritt - and organized by Dawson Club Vice President Zina Boileau. Students rented budget-friendly mountain bikes that were practically falling apart, rode down a 5-kilometer gravel road, and trekked across a cooled lava flow until they reached active lava, where they saw the formation of new rock up close. The photos in their textbooks had come to life right in front of their eyes!

Making the trip possible, however, was no simple task. The dedicated Dawson Club members spent countless hours planning the trip and raising money, running samosa sales and a garage sale in the atrium of the Earth Sciences Building between classes to help fund the trip. The Dawson Club's hard work paid off as they experienced Hawai'i from the ocean to the stars, with the fascinating volcanoes in between.

Geophysics Recognition

by Alan Shapiro

EOAS undergraduate students Kevin Fan and Meghan Sharp received the 17th annual Canadian Exploration Geophysical Society (KEGS) Foundation scholarship, sponsored by the BC Geophysical Society. Recipients were selected based on their passion for geophysics, academic record, career goals, and a short essay describing experiences in the field. The scholarship not only provides support for Kevin and Meghan's future studies, but also offers valuable student-industry connections and opens doors to future opportunities in geophysics.

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Members of the UBC Oceanography Club attend the Sunset Beach cleanup. Photo credit: Eugenie Jacobsen.

Cleanup Curse

by Meghan Sharp

The UBC Oceanography Club gathered at Sunset Beach on a rainy April afternoon in their ongoing effort to keep our local beaches trash-free. Every year, the Club uses Vancouver Aquarium's Great Canadian Shoreline Cleanup website as a tool to select a site for their cleanup. The Club intentionally tackles locations that have not been recently cleaned, and The City of Vancouver provides support by donating necessary supplies such as bags, gloves, and garbage pick-up tools. A high traffic False Creek location, Sunset Beach offered an opportunity for Club members to protect and rehabilitate an integral component of the local environment.

Their mission included facing the "Cleanup Curse" – the inevitable rain and cold weather that plagues the event every year. Oceanography Club president Eugenie Jacobsen emphasizes the dedication of the participants who came out to the cleanup as they were "slipping and tripping on algae rocks" while trying to pick up garbage. Sharing the burden of the legendary curse never fails to lighten the mood and invoke laughter. These dedicated undergraduate students are on a mission to protect the ocean environment they study and love... and no Cleanup Curse will stop them!

Graduate News

The Graduate Sustainability Council's Jericho Beach cleanup.

PhD student Céline Michiels.

Sustainability Spotlight

by Catherine Armstrong

What stands out to PhD student Melanie Chanona, 2 years into the graduate student-led initiative to divert soft plastics from the trash in EOAS buildings? “Something that surprised me is how heavy soft plastic is!” Melanie should know – she and fellow graduate students Alysia Herr, Robert Izett, and Julia Soares have taken turns every week lugging two large bags of plastic to the University Services Building for recycling. The students are part of the Graduate Sustainability Council (GSC), which spearheaded the installation of 4 plastic collection bins throughout EOAS facilities. The initiative has been successful in addressing plastic waste generated both by individuals and labs, where wrappers that protect sterile materials can rapidly add up.

Other investments include the addition of a new Styrofoam disposal bin and the switch to printer paper made of 30% recycled materials. The GSC welcomes new ideas for measures to reduce waste and use resources more efficiently. According to Melanie, the solutions they’ll consider are limited only by the creativity of members of the Department! Melanie looks to other groups around UBC for information and inspiration, such as UBC’s Green Labs Program, which provides guidance and financial support to research labs interested in upgrading to more efficient equipment. As Melanie puts it, “Our privilege of free time and of money gives us a responsibility to be at least doing the little things… It sets up a foundation to solve harder problems in the future.”

Another goal of the GSC is organizing environmental-themed social events. Participants might even learn a new skill, such as zero-waste living, which was taught at a workshop hosted by Melanie in February. A social highlight from 2017 was the Department’s participation in the Great Canadian Shoreline Cleanup in September. A team of students and professors worked together to comb Jericho Beach for garbage, while persevering through inclement weather to boot. Ideas for future social events include a movie night and plogging – the picking-up-trash-while-jogging phenomenon out of Sweden that’s been sweeping across Canada. Plogging seems tailor-made for EOAS, a perfect way to harness the talents of the environmentally-conscious athletes that abound in the Department!

For feedback or ideas, reach out to the Graduate Sustainability Council at green.council@eoas.ubc.ca.

Ancient Microbes

by Kohen Bauer

For the majority of Earth’s history, oceans have been free of oxygen and rich in dissolved iron, a state referred to as “ferruginous.” Today, ferruginous conditions in the ocean are rare due to generally well-oxygenated waters, which prevent dissolved iron from accumulating. Consequently, much of our information on the activity and evolution of life in the oceans comes from studying modern ferruginous analogues: lakes.

PhD student Céline Michiels and supervisor Prof. Sean Crowe explored one such lake, Lake Kivu in the Democratic Republic of Congo, where the deep waters have geochemical properties reminiscent of Precambrian eons. Céline discovered that microbes living in the water column of Lake Kivu are efficient at recycling nitrogen, a nutrient essential for microbial life. Moreover, she found that the ability of these microbes to recycle nitrogen is highly iron-dependent, linking these organisms’ way of life to reactions that likely took place in the iron-rich oceans of the past.

By studying this ancient ocean analogue, Céline was able to develop a framework for how microbes living in ancient ferruginous water columns may have overcome nitrogen limitations. By recycling nitrogen, these microbes provided nutrients not only for themselves, but also for other microbes in the environment, and played a key role in the evolution of multicellular life and Earth surface chemistry.

Read the publication: Michiels, C.C. et al. (2017). Iron-dependent nitrogen cycling in a ferruginous lake and the nutrient status of Proterozoic oceans. Nature Geoscience.

Killam Award

by Alan Shapiro

EOAS PhD student Emily Scribner has been awarded the 2017/2018 Killam Graduate Teaching Assistant Award. The prestigious award is presented to graduate students who have made outstanding contributions to teaching and learning at UBC. Only 5 graduate students from the Faculty of Science are awarded the prize each year.

PhD student Emily Scribner.

Emily has been active as a teaching assistant since starting her Master's degree in EOAS in 2014, splitting her teaching time between EOAS and Integrated Sciences. "Whichever class I was TA'ing, I always looked for opportunities to suggest new activities, bring new techniques into classes, and wiggle in that role as much as I could. The instructors here are really great. They notice people who are keen and give them opportunities to do other things." In addition to TA'ing courses, she has also held non-traditional TA'ships through the Carl Wieman Science Education Initiative, working on course development with EOAS' team of Science Teaching and Learning Fellows.

Emily met Science Education Specialist Dr. Sarah Bean Sherman through her first TA role. Bean approached Emily with the idea of including a geoscience education component in her thesis. Since then, Emily's thesis has evolved to include the creation of a validated assessment for use in undergraduate mineralogy courses. "Bean has become a real mentor for me. She tells me when I'm doing well and what I can improve on. She has pointed me to tons of opportunities. If anything happens in my course that I've never dealt with previously, I go down to her office and ask for advice."

Emily was recently hired as a sessional instructor, teaching the popular online course *Earth's Treasures: Gold and Gems* (EOSC 118). She's brought several changes to the course, including sending out recorded video messages every week. "I wanted to bridge the anonymity gap that comes with teaching an online course. Overwhelmingly, students say that the videos make them more familiar with me, and more comfortable asking for help."

MAGNET workshop participants examine geological maps while Mauna Loa looms in the background. Photo credit: Dominique Weis.

From Sea to Mountains

by Catherine Armstrong

Thirty-two student, alumnus, and faculty geochemistry researchers from across Canada gathered in Hawai'i in February 2018 for a field-based meeting of the Multidisciplinary Applied Geochemistry Network (MAGNET) training program. Since 2012, the program has fostered research partnerships between industry and 5 participating Canadian universities, with major support from NSERC's CREATE program. MAGNET was inaugurated through the efforts of Program Director Prof. Dominique Weis, with the 2018 workshop organized by Prof. James Scoates.

The Big Island of Hawai'i has a diverse landscape that presents an inviting natural laboratory for geochemists. MAGNET trainees took advantage of this by planning field activities for their fellow students. Over the course of the 6-day trip, activities highlighted concepts around MAGNET's core areas of inquiry: Fragile Ecosystems, Hidden Resources, and Windows into the Earth.

One of the group's tasks involved identifying the geological source of stone tools used by ancient Hawaiians. Trainees measured the concentrations of trace elements in basalt samples collected at stops throughout the field trip using a portable X-ray fluorescence spectrometer loaned by REFLEX. Because each of the 5 volcanoes on the Big Island produces basalt with a unique trace element signature, compositional analysis of a stone tool can single out its most likely source. After ruling out natural transport, stone artifacts can be analyzed with geochemical methods to help unravel historical trade and travel patterns.The data collected by the MAGNET group yielded zirconium-rubidium signatures distinct enough to identify the volcanic source for each sample studied.

The MAGNET program officially concluded in March 2018, with Hawai'i serving as the capstone to its history of successful workshops.

Features

Visualizing Education

The OmniGlobe showing satellite imagery of Earth. Photo credit: Colin Rowell.

by David Zeko & Colin Rowell

Walking into the Pacific Museum of Earth (PME), located in the Earth and Ocean Sciences Main Building, you are greeted with a wide selection of mineral and fossil displays from around the world. Perhaps the most striking tenant is George, the 75 million year old fossilized skeleton of a Lambeosaurus that dominates the wall on your right.

Hidden behind the door on your left is a smaller room that houses the PME's most dynamic exhibit. Through the door and in the center of this room is the OmniGlobe – a large spherical projection screen on a raised pedestal, glowing with the light of internal projectors and fronted by a touch screen display that awaits curious museum visitors.

Designed for visualizing spatial imagery and data sets, the OmniGlobe can display a variety of projected images and animations on its surface. Using the touch screen interface, visitors can view an assortment of maps depicting global phenomena, such as the configuration of tectonic plates or the circulation patterns of dust carried on atmospheric winds. Topographic maps of Mars and visible light imagery of the moons of Jupiter and Saturn are among the many solar system features that can be explored.

Where the OmniGlobe truly shines is in its use of animations – the flow of ocean currents, the annual melting of sea ice, or the rise in global temperatures due to climate change – giving viewers a vivid illustration of the complexity, scale, and interconnectedness of global processes.

EOAS graduate student Mehrnoush Javadi leads a tour of the Pacific Museum of Earth's main gallery.

Two students enjoy a guided tour of the PME gallery.

MUSEUM OUTREACH

Installed during major PME renovations in 2013, the OmniGlobe was designed as a powerful visual tool for teaching both visitors and students. The exhibit has great applicability to engaging audiences of various levels, from kindergarten students to adult visitors, allowing them to make connections between science and the world around them. An entire class can observe the OmniGlobe simultaneously, allowing educators to guide students on what to look for and explain the significance of what the students are viewing.

According to Dr. Kirsten Hodge, Director of the PME, the OmniGlobe sees use primarily by school and tour groups, with PME volunteers and staff providing personal tours of the exhibit. For the average visitor, however, it can be easy to miss the darkened room tucked away in the side of the museum. Fortunately, this is expected to change.

Plans for new renovations to the PME over the next year are currently in development and include relocating the OmniGlobe to the front of the main museum, making it immediately visible as visitors enter. An exciting new collaboration with the UBC Faculty of Education is also underway, which will expand the exhibit's potential as a teaching and learning tool for both the UBC community and for museum visitors.

EDUCATION RESEARCH

Spearheading this interdepartmental collaboration is Prof. Marina Milner-Bolotin, an associate professor with the Faculty of Education's Department of Curriculum and Pedagogy. Marina uses novel technologies to enhance learning experiences in STEM (Science, Technology, Engineering and Mathematics). "We have a lot of tools to represent data," says Marina, "but do our students learn better now as a result of having these tools?"

One of her concerns is that virtual or augmented reality interfaces like the OmniGlobe are often underutilized. "When I was first shown the OmniGlobe, I was initially very excited. But upon observing how students interacted with it, I noticed that the lack of teaching materials was a big obstacle."

Marina and colleague Sharon Hu recently received a Teaching and Learning Enhancement Fund grant to design, implement, and evaluate learning resources for 3D technologies. Using this funding, they have begun a collaboration with the PME to design effective teaching activities for UBC teaching students, science students, and school groups.

Kirsten Hodge, along with PhD candidate Anna Mittelholz, will be working with Marina and Sharon to design the new OmniGlobe activities. "I am positive that as a result of our collaboration, we will create exciting educational pathways to engage museum visitors, our teacher candidates, and UBC guests during their visits to the PME … as well as open up new opportunities to research how students learn with the OmniGlobe technology."

For more information on Marina's research, visit http://blogs.ubc.ca/mmilner. For information on the PME, visit http://pme.ubc.ca.

UBC alumni use the OmniGlobe to explore Io, one of Jupiter's moons.

A young PME visitor touches a real dinosaur bone!

A glider at rest communicates turbulence measurements to its operator via a satellite or radio connection.

Oceans in Motion

by Arran Whiteford

Collecting data across the vast breadth and depth of our oceans poses an extraordinary challenge. Even massive international research networks can only skim the surface of the knowledge that the oceans hold. But as robotic technologies develop, so does our ability to study the oceans. The underwater glider is one such robot: an efficient autonomous submarine drone that cruises the water column, collecting data along the way.

EOAS oceanographer Prof. Stephanie Waterman and her group use ocean gliders to study physical ocean processes, particularly turbulence. Characterizing these processes is critical to understanding the larger ocean system, from melting sea ice to whale migration.

A glider is deployed off the CCGS Amundsen's "Science Barge" to measure turbulence in the Beaufort Sea.

MEASURING TURBULENCE

To sample the deep ocean, oceanographers typically string weighted sensors overboard and haul them back to the surface. The process is laborious and slow, and recovers only sparse, discrete measurements. In contrast, an ocean glider samples continuously, delivering a large number of measurements with excellent resolution in space and time. In a single 11-day Arctic mission, the glider recovered around 400,000 independent estimates of turbulent mixing rate, "the same order as all measurements of turbulence in the Arctic Ocean before," says Stephanie.

The glider traverses the ocean diagonally in a zig-zag profile. By enlarging or contracting a flexible bladder, the glider changes its buoyancy to sink or rise. Its wings direct this motion into a forward glide both as it dives and climbs through the water column. While underwater, the glider is entirely autonomous, acting on a pre-programmed mission plan. Between each dive, it surfaces to receive updated mission parameters and beam data back to base via a satellite link. At 1 kilometer per hour, the glider moves slowly but can travel up to thousands of kilometers in a single mission, zig-zagging as deep as 1000 meters. Its tranquil glide makes the drone a perfect low-noise platform for turbulence measurements, which are the focus of the EOAS glider group.

"Turbulence is the thing that you see when you pour milk into your coffee and watch the two liquids mix," explains Benjamin Scheifele, a PhD student in Stephanie's group. Tendrils of each liquid wrap around the other, swirling and intertwining to rapidly combine the milk and coffee into a single mixture. Benjamin looks at a similar process in a much bigger mug – the Arctic Ocean – with seawater as the coffee and ocean heat as the milk. "People are very interested in how quickly heat in warm subsurface water is transported to the surface and mixes with the cooler surface waters, and in whether or not that's a contributor to why we are losing so much sea ice." Turbulence plays a key role. If you can transport heat to the surface, you can melt a lot of sea ice.

A glider is well suited for turbulence research, where a large dataset of near-continuous measurements is ideal. "Turbulence is an intermittent, patchy, sporadic, chaotic process. You really can't just take one measurement. You have to take a whole sweep of measurements and talk about the distribution or the average," explains Stephanie. When turbulence levels are barely detectable and patchy – like in the Arctic Ocean – a large data set is even more important. Robust statistical characterizations of ocean turbulence are nearly impossible with traditional data collection techniques, but through the use of drones, Benjamin's research has already made significant progress in understanding turbulence in the Arctic Ocean.

While the glider excelled in recording data from the Arctic Ocean, it struggled to dive and climb in the highly stratified environment. "The more stratified the water column is, the harder it becomes for the glider to travel," says Benjamin. Larger density changes in the water column mean that the glider must make greater changes to its own buoyancy, and surface layers of fresh water can even trap the glider underwater. "In the Arctic, we were working at the very limit of what the glider was capable of doing."

PhD student Tara Howatt (left), technician Chris Payne (middle), and PhD student Benjamin Scheifele (right).

STUDYING WHALE HABITAT

The same glider was used by another PhD student in the group, Tara Howatt, as part of the Canada-wide Whales, Habitat and Listening Experiment (WHaLE) project, which pilots coordinated multi-glider missions on both the east and west coasts of Canada. The goal of the project is to better monitor whale locations and understand whale habitat so that shipping channels can minimize disturbance and mitigate vessel strikes.

To better predict the location of baleen whale feeding grounds, Tara studies the physical mechanisms that aggregate zooplankton. Using a range of data from multiple gliders in the project – conductivity, temperature, oxygen content, and pressure – Tara can identify local currents, upwelling, and downwelling. She compares these circulation features to zooplankton distributions mapped using a glider-mounted echo sounder to better understand the influence of ocean physics on zooplankton. Tara also plans to use her group's measurements to learn how turbulence impacts zooplankton. It is believed that limited turbulence can improve the chances of encountering prey and therefore increase feeding rates. Too much turbulence, on the other hand, can be disruptive.

Tara's glider missions have been exciting at times. One of the missions involved guiding the glider through a submarine canyon with powerful currents. Between each dive, Tara had to quickly learn and figure out the pattern of currents and where to direct the slow-moving glider. In these conditions, waypoints were "more of a guideline" and the glider would surface far away from where it was sent each dive. Good glider piloting therefore requires some intuition of the glider's path. Stephanie adds that "you often play games, trying to stay deep where the currents are weaker to try and break free."

A glider equipped with a hydrophone is deployed to listen for and identify whale songs.

Members of the EOAS glider group agree that the wealth of unique and interesting data that comes from a glider does not come for free. Gliders are at the forefront of technology, and so are complex to run and require active debugging. Benjamin says that the modern glider is "not always a user-friendly instrument. It requires a lot of work, a lot of understanding, a lot of problem solving skills. You really need to know what's going on behind the scenes." Collaboration and teamwork between technicians and scientists in the EOAS group and in the larger glider community is crucial to surmounting the challenges that come with the new technology.

As gliders become commonplace, the group hopes that these challenges will be worked out. "Hopefully, in 10 years, anyone will be able to take the instrument, put it in the water, tell it where to go, and simply push a start button," Benjamin shares. In the meantime, as the deep ocean remains largely unexplored, even limited technological advancements allow us to learn more about this "final frontier" than ever before.

For more information on Stephanie Waterman's research group, visit www.stephaniewaterman.ca/work.

Earth Science Goes Viral

A view of the Arctic Ocean from icebreaker CSGS Louis St. Laurent.

by Meghan Sharp & Catherine Armstrong

You could easily swallow as many of "these" while swimming in the ocean as there are people in Canada. Aligned end-to-end, the number of "these" in the sea would span 10 million light years. "These" are viruses. Prof. Curtis Suttle, head of the Suttle Laboratory at UBC, studies viruses in the environment. He was one of the first to grasp the incredible abundance of viruses in the ocean and is a pioneer of the specialized research field of marine virology.

Curtis and his team have collected samples from some of the harshest environments on the planet, from brine pools at the bottom of the ocean to a restricted-access cave in Mexico where temperatures reach upwards of 50°C. "That's the fun thing," Curtis shares. "There is just so much that we don't know as we explore these different kinds of environments. It's incredible in terms of what life is there."

As a researcher, Curtis takes a "follow-your-nose" approach to science, diving into whatever area of expertise is needed to answer questions as they arise. Naturally, this has attracted a multidisciplinary team of researchers to his lab, including oceanographers, geneticists, biologists, and many others.

The Suttle Group's research focuses on 3 areas. The first is the isolation and characterization of new life forms, which includes the sequencing of genomes of previously unknown viruses. The second is the study of biodiversity and deep evolution through a practice known as "metagenomics." In this approach, researchers look at all of the genetic material in a sample of seawater and work backwards to reconstruct what viruses are there.

The third focus explores the impacts of viruses in the environment and their role in biogeochemical cycles. Together, the group manages a diverse collection of projects from aquaculture-driven questions, such as the effects of viruses on oysters and salmon, to projects with astrobiological implications.

VIRUSES IN THE ATMOSPHERE

Curtis set his sights on atmospheric viruses after he and collaborators discovered viruses in meltwater in the Arctic Ocean that were similar to those found in the subtropical waters of the Gulf of Mexico and a lake in Germany. Viruses require a host organism to reproduce, and it seemed unlikely that the same host organism could be found in such vastly different environments. This indicated that viruses must be widely dispersed by

Professor Curtis Suttle.

some mechanism independent of their hosts.

In order to explain their findings, Curtis and colleagues at the University of Granada and San Diego State University explored the possibility of virus entrainment from land and sea, transport through the atmosphere, and finally deposition to a new environment.

In Spain's Sierra Nevada mountains, the researchers found tens to hundreds of millions of viruses settling down to Earth each day. Their work supports the hypothesis of an atmospheric virus transport mechanism and suggests that viruses may be present in the atmospheres of other planets. Their findings may aid astrobiologists in the search for extraterrestrial life.

STUDYING ANCIENT LIFE

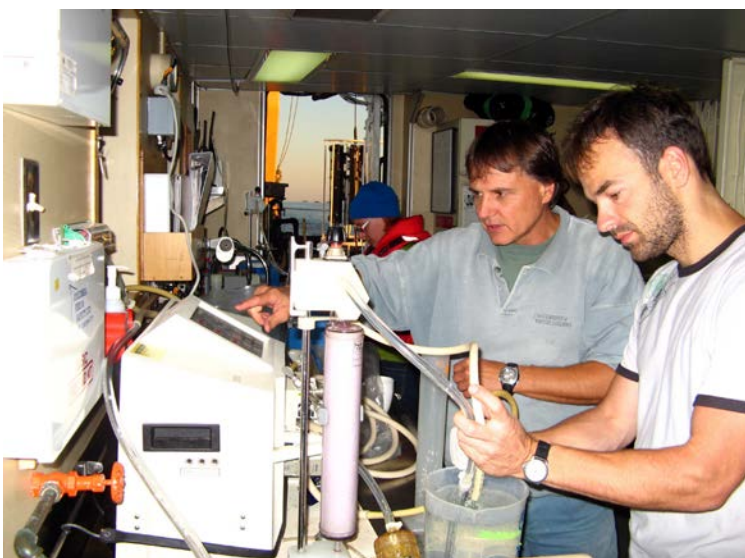
An important component of searching for new life involves exploring the origins of life itself. Prior to the emergence of multicellular life, the Earth was likely a very extreme environment, suitable only for bacteria, archaea, and viruses. In an effort to study some of the most extreme environments that exist today, Curtis has collected genetic material from pools of dense, unmixed, hypersaline brine trapped at the bottom of the Red Sea. Samples of unknown viruses in these environments may be ancient and could provide a window back in time, shedding light on what conditions were like for ancient life. They may also offer clues to how organisms can survive with little available organic matter, a possible analogue for other planets.

Curtis' research has taken him to a place on Earth that most people will never be allowed to visit – Mexico's Cave of Crystals. The cave is highly protected, but Curtis was granted permission to collect samples as part of a National Geographic documentary expedition. Due to the cave's proximity to a magma chamber, air temperatures can reach 58°C with up to 99% humidity. This posed the first difficulty for the scientists, as they could only withstand minutes of access at a time.

In addition to the extreme environment, much of the cave was unwittingly contaminated by the miners who discovered it. This significantly limited the area that was suitable for virus sampling. In the challenging field conditions, the team was only able to collect a 10 millilitre sample of material. Its analysis required a careful research plan, as there would never be a chance to return to the cave again. Fifteen years following the expedition, Curtis is now preparing to test the valuable material using a new tool capable of sequencing the genome of a single virus.

Conducting research at the leading edge of science poses many challenges. For instance, asks Curtis, "How do you find life if you don't know what you're looking for?" As they delve into new and more difficult questions, Curtis and his team continue to advance our knowledge of viruses, both on Earth and on other planets.

Read the publication on viruses in the atmosphere: Reche, I. et al. (2018). Deposition rates of viruses and bacteria above the atmospheric boundary layer. The ISME Journal.



Concentrating microbes from the waters of the Salish Sea aboard the CCGS Vector.

Sampling Mexico's Cave of the Crystals with former post-doc Danielle Winget.

Earth Sciences Building.
Photo credit: Faculty of Science.

Catching carbon

by Kohen Bauer & Karina Ramos Musalem

The influence of carbon dioxide (CO_2) emissions on Earth's changing climate is an issue of global and scientific importance. Prof. Greg Dipple, director of the Bradshaw Research Initiative for Minerals and Mining (BRIMM) is a leader in the field of carbon sequestration research, exploring new ways to capture and use CO_2. Through his work, Greg is changing the way we think about mining and mining-related processes.

Interested in seeing his work for ourselves, we met Greg in his office, where he showed us a small sensor connected to his laptop. As we watched, the sensor measured the CO_2 concentration in the room and graphed it in real time. Like a heart rate monitor, his computer screen tracked the room's carbon "pulse" as we chatted, stabilizing around 400 parts per million (ppm). Greg then pulled out a small beaker containing mine tailings – the crushed waste rock that every mining operation produces. He sealed the sensor inside the sediment-filled beaker, capturing the room's atmosphere along with it.

Our conversation continued. After only 10 minutes, the impressive results of his experiment were ready. The graph on Greg's computer screen revealed a significant reduction in the CO_2 concentration within the beaker over the brief time in which the air was in contact with the tailings. The change was stark. Over a span of 10 minutes, the concentration had been cut in half, falling to 200 ppm.

ATMOSPHERIC CAPTURE

The principle at work in Greg's demonstration is a central theme in his group's research – fluid-rock interaction. CO_2 from the atmosphere reacts with minerals found in ultramafic rocks – igneous rocks with low silica and high iron and magnesium content

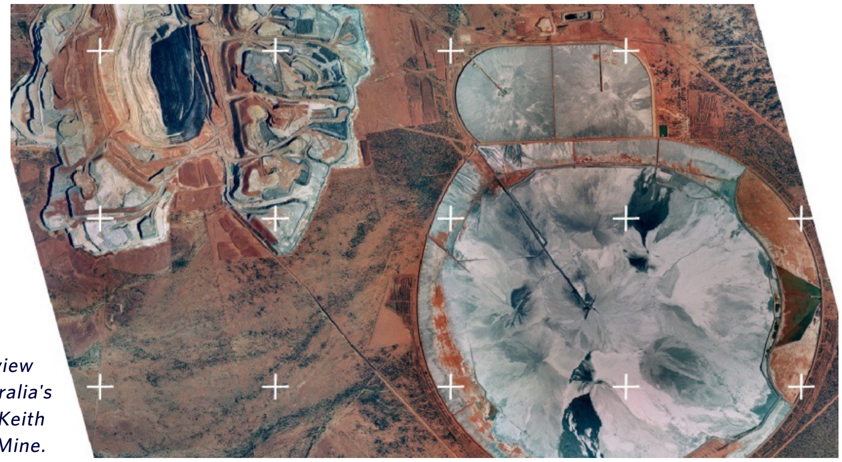
Sensor measuring ambient carbon dioxide concentration.

commonly found in the Earth's mantle – and is converted into new carbonate minerals. These reactions effectively absorb CO_2 from the atmosphere and turn it into rock, stable on geologic timescales. Mined deposits commonly hosted in ultramafic rocks included platinum, nickel, and diamond.

Greg and his team have put much time and effort into understanding and optimizing these reactions. "Now with some strategic planning on how a mine organizes its tailings, interaction between atmospheric CO_2 and the tailings minerals can completely sequester and offset the entire CO_2 budget generated by the mining operation," says Greg. The beauty of this approach is the almost unlimited capacity of the Earth's crust for carbon mineralization. "It is absolutely fascinating that the collective CO_2 storage capacity of ultramafic rocks on the continents is actually large enough to completely alter Earth's atmospheric composition at the global scale."

Much of Greg's research has focused on identifying the factors that make the interaction of ultramafic rocks and CO_2 a viable carbon mitigation option. One important key is that ultramafic rock types form deep within the Earth, out of chemical equilibrium with the atmosphere. This makes them inherently reactive at the Earth's surface. In fact, these rocks react so strongly with CO_2 that the tailings of a large mine on an ultramafic deposit can store up to 10 times more CO_2 than the mining operation emits.

Only a fraction of ultramafic rock tailings, however, reacts easily with CO_2 in the atmosphere. This reactive fraction is known as "labile tailings". If 10% of a mine's tailings are labile, the mine can become carbon neutral by reacting only this comparatively small fraction of their total tailings. Preliminary work suggests that some operational mines produce enough labile tailings to completely offset their entire CO_2 emissions.



Aerial view of Australia's Mount Keith Nickel Mine.

REDEFINING MINE WASTE

To complement the carbon sequestration process, Greg's team is also investigating innovative uses for reacted tailings. The reaction with CO_2 transforms tailings into a harder, stronger material than the original finely crushed waste rock. Greg's team is exploring how to control this mineral transformation process in the lab.

In an experiment, Greg and his team exposed fresh tailings to a stream of gas similar in composition to the emissions of a mine power plant. Once the reaction was completed, the tailings adopted new mineral structures and strengths similar to or exceeding those of construction cement, creating an environmentally-friendly building material.

"We have started to stabilize this waste material, and this has value for the safety of the site, even after the mine has been closed and remediated," explains Greg. "The idea that CO_2-reacted tailings can now be used to build mine infrastructure may change the way we design mining storage facilities in a way that makes them safer, more energy efficient and less expensive." In this way, the reaction between CO_2 and tailings not only works towards reducing a mine's environmental footprint, but also produces a byproduct that can be used for construction of mine infrastructure, transforming a waste stream into a commodity.

Mining companies have welcomed the findings of the UBC Tailings Initiative and BRIMM. "After communicating the positive impacts of our research to mining companies, we already have partnerships in the works to create the world's first carbon neutral mine." Research has progressed rapidly in the past two years, moving from preliminary laboratory tests and numerical simulations to full-scale partnerships with active nickel and diamond mines.

At the moment, Greg's team is busy conducting baseline studies at several mine sites. Once these studies are completed, the team will be able to deploy their new strategies in the field. Greg is convinced that his team's research will enable operating mines to become not only carbon neutral but also carbon negative, removing more CO_2 from the atmosphere than they emit. This promises to change the way we think about mining, and offers a timely glimpse of hope for our environment.

For more information on BRIMM and the UBC Tailings Initiative, visit http://brimm.ubc.ca and https://ubctailings.ca.

Sampling tailings at Mount Keith Nickel Mine, Australia.

Profiles

Mark Jellinek

Professor, EOAS

When you receive an email from Mark Jellinek, the signature reads "Find What Matters," a fitting sign-off from the man who founded *Earth Matters* in 2014. In a way, these 3 words also summarize Mark's research as he aims to find what matters in a range of geological processes. In our interview, Mark discusses his research into Mars' climate and tectonic history.

by Kohen Bauer

Why does Mars' climate history matter?

In contrast to Earth, which has a clement climate improbable for its longevity and stability, Mars is an archetype of failed habitability through a catastrophic atmospheric collapse. Building our knowledge of Mars' climate, and specifically its early climate evolution, is important because it provides a framework for learning about how planets grow and maintain their atmospheres. We gain insight into the fragile dynamics of planetary habitability - how volcanism and surface processes such as water erosion or glaciation emerge, evolve, and modulate climate in turn.

How do you gain insight into these processes?

I use many approaches, but the technique I am most excited about is being developed and tested by my very innovative PhD student Anna Grau. We use pattern recognition methods and physical models to classify the ancient valley networks that sculpt Mars' surface in a statistically meaningful way. We characterize the surface geomorphology of Mars in terms of relative contributions of erosion by rain-fed rivers, glaciers (akin to Antarctica or Greenland), and runoff from springs. For decades, valley networks on Mars have been attributed to rain-fed rivers because they are visually similar to river valleys on Earth. This picture underpins the popular "warm and wet" early Mars hypothesis. Our story is very different: the geomorphology requires that Mars was never much warmer than modern day Antarctica.

What is the role of fieldwork in your research?

Fieldwork is fundamental for tethering our physical models to observations of the natural world. It is also deeply inspiring. Anna and I went to Devon Island, Nunavut to study the geomorphology of both fluvial and subglacial channels. Our goal was to distinguish channels generated by glaciers from those created by rivers. Interestingly, we found that subglacial channels can actually drive water uphill against gravity. Now we had a way of calibrating our models of Mars by applying our physical field observations. We discovered that a lot of the channels on Mars' surface were actually formed subglacially, ultimately leading us to the conclusion that Mars' early climate was a lot like modern day Antarctica.

BC is a great place to get inspired about geomorphology. How does being in Vancouver influence your work?

Similar to the raw inspiration I get from fieldwork, almost all the papers I've written or contributed to have emerged from ideas I've gotten while playing outside. I tend to be intense, and I bring that same intensity to my down time, which is when I'm most creative. It's something I teach my students – the importance of down time in fuelling creativity. With regards to EOAS, a very special quality is its diversity. It's the reason I started *Earth Matters* – to connect people to the amazing work being done by scientists in our department, who come from a plethora of different backgrounds.

Sara Harris

Associate Dean Academic, Faculty of Science and Professor of Teaching, EOAS

Professor Sara Harris has enjoyed an adventurous and teaching-focused career in science. An oceanographer by training, she has spent much of her career studying geoscience education and is particularly interested in understanding how people learn about climate science. Here, Sara shares how she became involved in Earth science education at UBC and what excites her about science.

by David Zeko

How did you become interested in earth science?

I started out as an undergraduate at Wesleyan University in Connecticut studying Russian, until I decided to try something completely different. I enrolled in a structural geology course that involved weekly field trips. This was a fun experience, and I particularly enjoyed the spatial puzzle solving. So, in my third year, I enrolled as a geology major.

During my undergraduate degree, I met someone who turned out to be very influential to my career, Suzanne O'Connell, who encouraged me to spend a summer working at the Scripps Institute of Oceanography in San Diego. That summer was such a fantastic experience that upon completion of my undergraduate degree, I began a PhD in oceanography at Oregon State University.

What brought you to UBC?

After completing my PhD, I accepted a job in Woods Hole, Massachusetts with the Sea Education Association. Here, we led undergraduate students on six-week research voyages while teaching them concepts in oceanography. I was the chief scientist on these voyages and spent a lot of time out at sea – about 2 years in total.

Although my time out at sea was exciting as well as personally and professionally rewarding, it was an unusual lifestyle. Spending prolonged periods of time in this environment can affect the continuity of your relationships onshore, so after 7 years I was looking for a change. I came to UBC in 2005 as part of the educational leadership stream. The job grew into studying the effectiveness of geoscience education and helping to spread teaching knowledge and lessons to other people at the University.

What does your current role involve?

In my current position as Associate Dean, I am in charge of the curriculum across the Faculty of Science and the Teaching and Learning Centre (Skylight). I also oversee programs such as Science One, Integrated Sciences, and SCIE 113. I am starting to look at student backgrounds and outcomes on a variety of levels, such as "Where do our students come from", "Where do they go", and "Are we gaining or losing people and why?"

What does science mean to you?

Broadly speaking, I think science is a series of activities that people undertake to answer questions with repeatable and defensible evidence. It is a human endeavour that is inherently coloured by our individual biases and socialization. These biases run through everything we do in science, including the questions we ask, the research that gets funded, the methods we decide to employ, and ultimately how we interpret results.

What science question would you most like to answer the most?

I am working with others to ask questions like "What are the students' risk perceptions of climate change", "How intensely do they perceive climate change as a risk", and "Does education about climate science shift students' perceptions of climate change risk at all?" We have done some work with university students, and it appears that education does shift perceptions of climate change risk. However, an individual's worldview and values appear to play a more dominant role. So if we want to have an impact, do we need to try to influence people's values instead?

Rachel Simister

Postdoctoral Fellow, EOAS

"You just keep finding puzzle pieces," shares Dr. Rachel Simister, offering an elegant summary of both her path to academia and her current research. A postdoctoral fellow in the Crowe Lab, Simister spends much of her time studying microbial life to better understand Earth processes. Here, Rachel talks to us about her research, her career path, and her love for oceans.

by Alan Shapiro

What brought you to UBC?

I had finished up my post-doc at Haverford College and Woods Hole Oceanographic Institution and felt like I wasn't quite ready to take on a faculty position. I wanted to expand what I was doing and hone in on what the focus would be if I had my own research group. There was a project advertised at UBC – the Towuti Drilling Project – and I was attracted by the project, the people, and the expertise that I could come here to learn.

What excites you most about your work?

I really just like answering questions. Sometimes there's a lot to manage, but you have to be inquisitive and want to know the answer to something. For me, it's microbes. Microbial life extends into virtually every imaginable habitat and can thrive under powerful extremes. Microbes evolved billions of years ago and are the most abundant organism on the planet. They have been the engines of biogeochemical cycles throughout Earth's history. They transformed the chemistry of our planet to make it habitable for plants, animals, and us!

How do microbes connect to Earth science?

The idea is that microbes are the best and fastest catalysts. The goal is to link microorganisms to their geochemical functions and explore how these communities react to changing conditions on Earth. Let's use an example from a current project I'm working on with MDRU (the Mineral Deposit Research Unit): discovering mineral deposits using soil microbial communities.

Soil microorganisms have evolved over billions of years to interact with and sense their environments and are very finely tuned to changes in chemical gradients. There are upwards of 10 million microbial cells comprising thousands of different species in a single gram of soil. We have been testing out a new analysis to uncover anomalies in the distribution of microorganisms related to buried ore mineralization, making mineral deposits easier to detect.

How did you become interested in science?

I think I've always been scientifically minded. When I was 8, I had a series of books called How My Body Works, and every month I would get a different organ to put together. I wasn't sure what I was going to do in my career, but everything just seemed to naturally fit together. I did my BSc – that was really interesting. Then I did a PhD. I guess you just keep finding puzzle pieces!

What do you love most about the Earth?

Probably the oceans. It comes from an obsession with David Attenborough and *Blue Planet*, a PhD spent scuba diving to study marine microbes, and a trip in a submarine! You know that old quote that we know less about the bottom of the ocean than we know about the surface of the moon? The fact that there is so much left to discover is fascinating to me. The oceans drive current cycles and heat transfer. We rely on them for food. You can even see phytoplankton blooms from space! The seas are a vital part of the global ecosystem, and they are under threat from humanity's actions.

In the words of James Honeyborne, executive producer of the *Blue Planet* series, "I would love to think that more and more people would have access to the ocean, would fall in love with the ocean, would engage with the ocean, because the more that happens, the better."

Manar Al Asad

Research Scientist, EOAS

Manar Al Asad does not like to confine her research to one specific question. Having followed her curiosity from planetary interiors to plasma physics, she is currently supporting the operation of OSIRIS-REx, a sample-return mission to the asteroid Bennu. When she isn't working, you can find Manar in the climbing gym or on a kayaking trip surrounded by marine wildlife.

by Meghan Sharp

What are you most excited for when you wake up in the morning?

I divide my time between the OSIRIS-REx mission and Mercury research, but I don't normally work on both in one day. I declare every day as either a "Mercury day" or an "OSIRIS-REx day". OSIRIS-REx days mainly consist of telecom meetings, writing reports, and doing the research behind the reports. Right now, I get most excited for Mercury days.

For a long time on Mercury days, I had a hard time matching my observations with my understanding because I don't have a background in plasma physics. I initially intended to approach my research from a geophysics perspective, but it naturally required me to understand how individual particles behave around magnetic field lines. I never thought that I would enjoy it, but I do. I am the type of person who will become interested in something and pursue it regardless of what my background is. I think I had unintentionally posed my questions from a plasma physics point of view all along, and now I'm excited to continue learning in new ways.

What was your childhood dream job?

I wanted to work for NASA, that was my dream. I envisioned myself dressed in a white lab coat – the stereotypical "nerdy" scientist. I had always thought of geophysics as an Earth and resource-based field until I was inspired while calculating the trajectory of rockets in Prof. Catherine Johnson's class. I approached her and began to work as her undergraduate research assistant. My relationship with Catherine led me into my current position, a unique opportunity as I have not yet proceeded on to graduate school. Somehow I've ended up working on NASA projects, which was my dream all along.

What do you find most frustrating about your field of study?

There are 2 things that frustrate me about planetary sciences. The first is the underrepresentation of women in STEM. I don't observe this directly on a day-to-day basis, as I am fortunate to work in a group of very intelligent and hardworking women, but I do notice this at conferences and during telecoms. The new generation includes many more female scientists than older generations, and I'd like to see this continue to grow.

The second is Canada's current minimal involvement in the international space program. Funding is scarce for future projects, and this discourages a lot of Canadians from entering the field of planetary sciences.

Why should we care about other planets?

If we limit our exploration to things we already know the applications of, we limit our development. Why is there plate tectonics on Earth? Why is there life on Earth? These are questions that cannot be answered without looking at other planets. The OSIRIS-REx mission, for example, aims to discover the precursors for organic compounds that exist in the solar system. Understanding other planets is required to understand the evolution of our own planet.

If you could have any superpower, what would it be?

I would choose unlimited wavelength vision so that I can see the interiors of planets. Although that's not what I'm currently focusing on in my research, I am very interested in interior processes.

Elliott Skierszkan

PhD Student, EOAS

In 2017, Elliott Skierszkan cycled all the way to Mount Baker with skis strapped to his bike, climbed the 3,286m heavily glaciated peak, then skied and cycled back home to Dunbar. The same year he also ran a marathon without training and spearheaded the production of a coffee-table book celebrating the rich 100-year history of UBC's Varsity Outdoor Club. Meanwhile, his PhD research looks at the behaviour of trace metals in mining waste rock and mine tailings. Between final thesis edits, Elliott takes some time to tell us a little about himself.

by Arran Whiteford

If you were an isotope, what would you be?

Let's keep things simple: I would be hydrogen-1. One proton, no neutron (who needs them anyway?) Plus I would be stable, light, and nimble, and a critical component in H_2O – the most important molecule to life on Earth!

What was the most exciting part of your PhD research?

Working with state-of-the-art mass spectrometers has been a privilege, and so has the travel to field sites and conferences to conduct and present the work. I had the good fortune of getting to visit the Antamina Mine in Peru and the Thompson Creek Mine in Idaho, USA to collect samples of water, waste rock, and tailings for geochemical analyses. Both of these field trips were wonderful opportunities to work with great people and connect me to the motivation behind my research, which broadly speaking aims to improve environmental management of mine waste. I would also add that making new scientific discoveries is hard to beat as a job description!

How did you get into geochemistry and hydrology?

During my undergrad in environmental science at the University of Ottawa, I became interested in pursuing work that improves our relationship with Mother Earth. Geochemistry and hydrology are means to understand, prevent, and remediate environmental contamination, and so I pursued those fields.

I also vividly remember some very inspiring lecturers at the University of Ottawa. Prof. Claude Farley wowed us in his first-year introductory geology lectures with stunning photos of unique natural features of the planet and opened our eyes to the Earth-building processes around us. Prof. Ian Clark told captivating stories about studying very unique environments where extreme water chemistry can be found. It was hard not to become fascinated with the Earth with lessons from these instructors!

What are your secrets to a productive day?

There is so much to productivity that is not part of "official" grad school training! My top 3 are: sleep well, exercise, and take breaks. It's hard to check out in this day and age of communication technology, but it's important. A well-rested mind and a healthy body do wonders to achieve deep focus and concentration. Good science is often creative work, and an inspired and well-rested mind is key to being creative.

Describe your favourite scene on Earth in 2 sentences.

It could be paddling a canoe on flat water under a silent autumn morning fog, or it could be watching an alpenglow sunset from some mountaintop. Both of those places give me perspective and inspiration.

Peru's Antamina Mine.
Photo credit Roger Beckie.

Jessica Schaub

UBC Alumna, BSc (Hons) Biology and Oceanography (2018)

Thalassophile (sea lover) Jessica Schaub has a contagious passion for the ocean and for jellyfish in particular. Her undergraduate research, which helped develop a novel method to study jellyfish clusters using drones, was recently published in a peer-reviewed journal and has been featured in the media. Between her academic success and her community involvement with the Vancouver Aquarium and the Vancouver Diving Locker, Jessica is ready to take the world by the horns, or more accurately by the tentacles.

by Karina Ramos Musalem

What motivates you to do science?

I have always been a very science-oriented person. I like learning new things, and I find that in science I learn things literally every day. My motivation is to be able to contribute to that learning, to give back and teach other people, and hopefully to inspire them to be interested in science as well.

This past November, I travelled to the Yukon as part of an award to promote interest in science, geared towards Aboriginal students. I spoke about the role of fieldwork as a motivator to get into science. I showed them a lot of pictures of what I have done in my fieldwork, and that seemed to light a spark. My professors lent me material to bring with me, like a rectangular tank to show how fresh and salty water mix in an estuary or dried starfish and other molluscs from the intertidal zone. It was really cool to bring that to students who had probably never seen the ocean at all.

How did you get interested in oceanography, and jellyfish in particular?

Ever since I was little, I've been super interested in the ocean even though I didn't grow up near it. In high school I watched a documentary on jellyfish, and it was then that I decided that I wanted to study jellyfish.

I started doing volunteer work in Prof. Evgeny Pakhomov's lab in my second year. During my third year, I talked to Evgeny about my interest in doing jellyfish-related work. I remember very distinctly that I was in the lab one day, and Evgeny came running in. He was very excited and told me that he and his colleague Prof. Brian Hunt from the Hakai Institute had a project that would be perfect for me to work on – using drones to study jellyfish.

What geoscience question would you like to answer?

I would like my career question to be: why are there blooms of certain jellyfish in some areas but not in others? Some species of jellyfish that live around coastal BC form large blooms in other areas like Europe, but they don't form blooms around here. Sometimes, there will be blooms forming in some areas, and in others there won't be. That is something that is not well understood.

What do you like most about Earth science?

I like the diversity – no two places are exactly the same. For example, I grew up in Northern Alberta, and it is so much different than BC. I spent a few years in Nova Scotia and the two coasts are so different from each other. I like the way that geography, topography, climate, biodiversity, and all these things come together to define each place.

Photo credit: Jessica Schaub.

Alicia Warkentin

Senior Program Coordinator, Undergraduate Programs, EOAS

If you've never stopped to think about the internal workings of EOAS undergraduate programs, it's because Alicia Warkentin makes sure they run like a well-oiled machine. From online to classroom to field courses, Alicia coordinates all 7 undergraduate programs within the Department. In our interview, Alicia talks about her background, her work, and the Vancouver Summer Program.

by Alan Shapiro

What brought you to EOAS?

I previously worked in the tourism industry for 11 years and was looking for a career change. When I first joined UBC, I worked in the Department of Art History, Visual Art & Theory and fell in love with UBC and its campus. I wanted a position that still allowed me to work with the public and assist people, so I applied for the EOAS Office Support position in 2012. I was hired not too long after that, and it was one of the best career moves I ever made!

What does your current role involve?

I coordinate all 7 EOAS undergraduate programs. This includes scheduling undergrad and grad courses, helping to organize field schools, compiling information for online and classroom-based courses, organizing a variety of student events (2 graduation receptions, Imagine Day, and more), providing support for the student academic fund and travel fund, and overseeing the delivery of the Vancouver Summer Program. I sit on the Undergraduate Prizes and Scholarships committee, the Timetabling committee, and the Public and Internal Relations committee.

How do you start your work day?

I begin my day by answering inquiries from students and faculty. I want to provide excellent service to everyone I come into contact with, especially our students. It can be a stressful time for them, and I want them to feel supported.

Can you tell us about the Vancouver Summer Program?

The Vancouver Summer Program (VSP) is a 4-week academic program offered by various faculties at UBC for students from partnered universities. The program provides the opportunity for students to take 2 academic courses while learning about Canadian practices and culture. I oversee the planning and execution of the VSP and supervise 4 amazing International Student Assistants. Our 2 programs (*The Dynamic Earth and Its Beautiful Treasures*, and *The Earth's Oceans, Atmosphere and Climate*) run in July and August.

What do you find most exciting about your work?

I really enjoy working the Vancouver Summer Program. It takes months of planning, but is so rewarding. Most of our students have never been away from home before, so to watch them become more independent is pretty special. It's great to see how happy the students are during the program, especially when enjoying our beautiful city.

What do you love most about Vancouver?

I was born and raised in Vancouver, so I'm a little biased. What I love most about Vancouver is its natural beauty. We are surrounded by mountains, forests, and beaches. I can immerse myself in nature or take a walk up Main Street, get a coffee and relax. I'm pretty lucky to call Vancouver home!

Saltspring field school 2018.

Ross Beaty

UBC Alumnus, BSc Geology (1974) and Honorary DSc (2018)

Geologist and entrepreneur Ross Beaty is an EOAS alumnus with more than 4 decades of experience in the mining and renewable energy sectors. He has founded many successful companies, including Pan American Silver and Alterra Power Corp, and has been widely recognized for his philanthropy work. Ross is a strong supporter of UBC and the Patron of the Beaty Biodiversity Museum. Among his many awards, Ross was appointed to the Order of Canada in 2017 and received an honorary degree from UBC in 2018. Here, Ross recalls his start in geology and shares some advice for young geoscientists.

by Alan Shapiro

How did you choose geology?

I started in geography of all things. I had an interest in physical geography, but I did take first year geology. The professor, Dr. Danner, was a fabulous teacher. He made it come to life. The more I learned about geology, the more I realized that this was something that really spoke to me. Geology would allow me to find a job that would keep me outdoors, and I'd have a lot of opportunities to be an entrepreneur in the mineral exploration business, which is exactly what I ended up doing.

How did you go from your BSc in Geology to starting your first company?

After finishing my BSc, I got my MSc in Mineral Exploration from the Royal School of Mines in London. Then I travelled for a year in Asia, but I wasn't finished learning. I thought: what is the exact opposite of geology and would allow me to better understand how human societies function? Law is it. It's a completely man-made field, and most geologists have no clue how it works. So I did a law degree, articled for a year, and qualified to be a lawyer. I never planned to practice, and the day I was called to the bar, I got on a plane, flew to the Yukon, and started my very first company – Beaty Geological. It's been a wonderful career and life since then.

Where does the process of turning an idea into a successful company start?

My whole career and my entire life have been a succession of being lucky. It sounds odd to say that, but one example was being brought up in Vancouver, where we had something called the Vancouver Stock Exchange. This allowed young guys like me with effectively no capital to start with to form a company, list it on the stock exchange, and raise money from investors. All this simply from the idea: I think I know where I can find gold. I started my first company in 1985, took it public on the Exchange, and we raised $145,000. That was the springboard to all my other successes.

Much of your current focus is on philanthropy, including through your foundation – The Sitka Foundation. What is Sitka's goal?

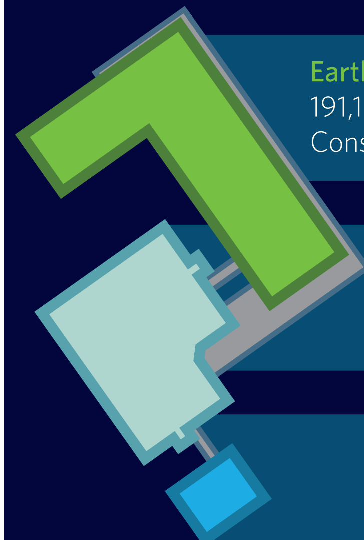
We're exclusively focused on the millions of species that don't have voices. We fund groups that are interested in the preservation of the environment and protection of biodiversity. There are many ways to do that. The 4 broad areas we fund are land conservation, scientific research, education, and public policy. Currently we're funding 74 environmental groups doing great things across the board.

What advice would you give to young geoscientists?

Everyone should pursue their areas of strength. For some that means entrepreneurship and for some that means being a really good geologist. Focus on your strengths and try to overcome your weaknesses. Try to live a full life – travel a lot and understand what's happening in the world. Read a lot, be informed, be active, be involved in the world, and in that way you can help shape it. Beyond that, follow your nose and try to take advantage of opportunities when they come by.

The Department of Earth, Ocean, and Atmospheric Sciences

2017/2018



Earth Science Building
191,115 ft²
Constructed in 2012

- 4 Computational Research Labs
- 9 Basement Research Labs
- 3 Wet Labs
- 4 Clean Labs
- 2 Lecture Theatres

Earth and Ocean Science - Main
98,000 ft²
Constructed in 1970

Earth and Ocean Science - South
18,000 ft²
Constructed in 1972

- Laser Lab
- Microbeam Facility
- X-Ray Diffraction Facility
- 14 Wet Labs
- 5 Clean Labs
- Pacific Museum of Earth
- 8 Teaching/Computer labs
- Student Resource Centre
- 49 Offices

Research Funding
$11.5 M

Courses Taught
155

POPULATION

= 10

Faculty		Staff	
Professor Stream	39	Research Staff	34
Teaching Faculty	14	Admin Staff	28
Post-doctoral Fellows	29		
Research Associates	19		
	101		**62**

Graduate **174**

Undergraduate **583**

16 Graduated 123

STUDENTS

Demographics by percentage

Graduate: 47 % 53 (female/male); 52 % 48 (Canadian/international)

Undergraduate: 51 % 49 (female/male)

Graduate %		Undergraduate %
7	Atmospheric Science	2
	Environmental Science	31
	Earth and Ocean Sciences	10
10	Geological Engineering	26
43	Geology	15
22	Geophysics	4
17	Oceanography	12

Awards and Distinctions

Mark Johnson	Charles A. McDowell Award for Excellence in Research	2018
Roger Francois	Fellow of the American Geophysical Union	2017
Doug Oldenburg (+ UBC Geophysical Inversion Facility)	SEG Distinguished Achievement Award	2017
Curtis Suttle	Distinguished University Scholar Award	2017
Curtis Suttle	Sustaining Fellow of the Association of the Sciences of Limnology and Oceanography	2016
Dominique Weis	Tier I Canada Research Chair in the Geochemistry of the Earth's Mantle (renewed)	2016
Mark Johnson	Tier II Canada Research Chair in Ecohydrology	2016
Kelly Russell	Fellow of the Mineralogical Society of America	2016
Philippe Tortell	Elected to the College of New Scholars, Artists, and Scientists of the Royal Society of Canada	2016
Dominique Weis	Fellow of the Royal Society of Canada	2016

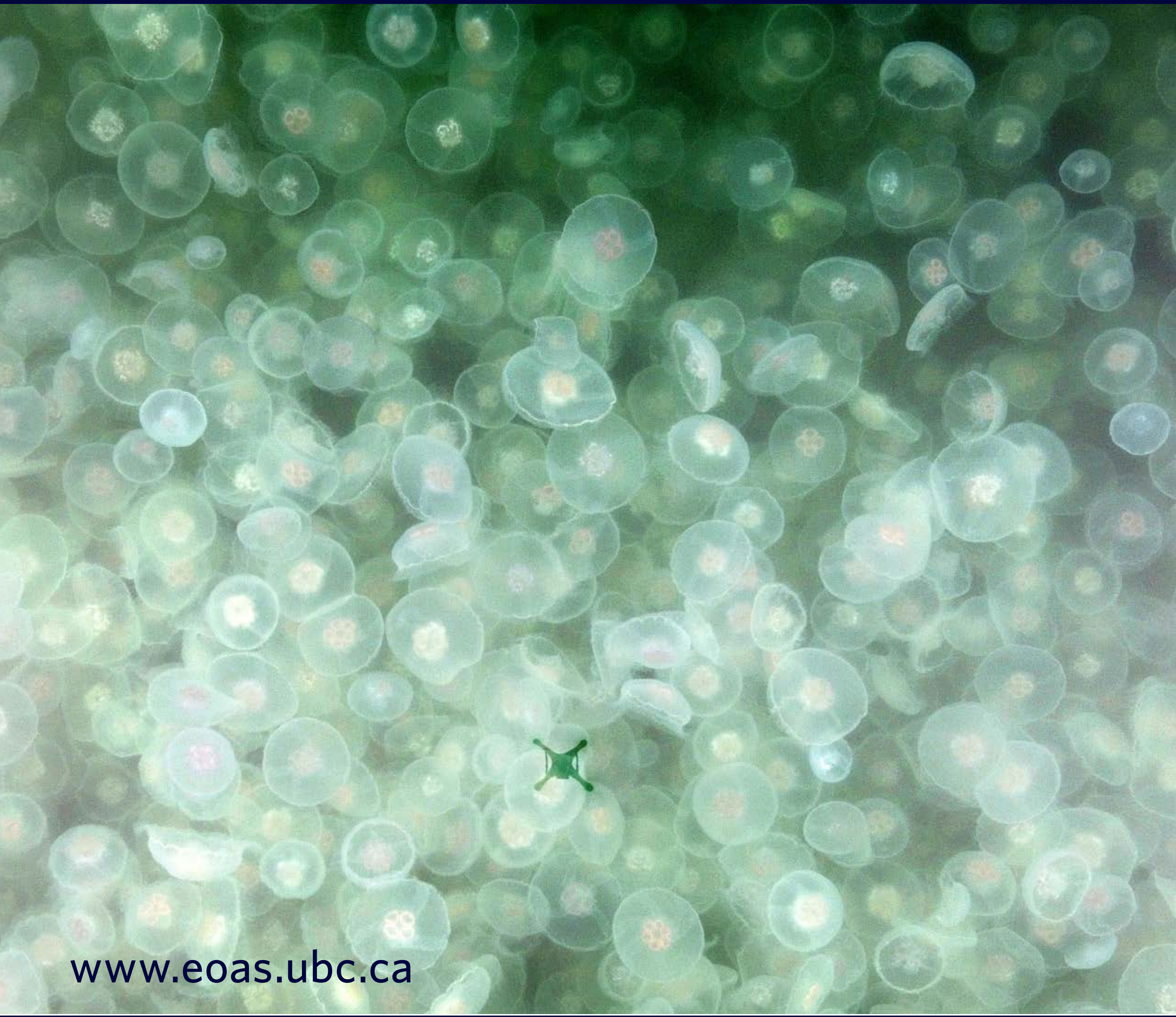
James Scoates	2017/2018 Killam Teaching Prize	2018
Sara Harris & Stuart Sutherland	EOAS Undergraduate Instructors of the Year	2017
Brett Gilley	2016/2017 Killam Teaching Prize	2017
Brett Gilley	EOAS Undergraduate Instructor of the Year	2016
Mark Jellinek	EOAS Undergraduate Instructor of the Year	2016

Kimberly Low & Sara Jenkins	EOAS Award for Excellence in Administration and Technical Services	2017
Greg Dipple	EOAS Leadership and Service Award	2017
Sukhi Hundal	Faculty of Science Excellence in Service Award	2016
Alicia Warkentin	EOAS Award for Excellence in Administration and Technical Services	2016
Charles Krzysik	EOAS Award for Excellence in Administration and Technical Services	2016

Evelyn Freres	Winner of Data Speaks Competition, Resources for Future Generations conference	2018
Emily Scribner	2017/2018 Killam Graduate Teaching Assistant Award	2018
Thomas Aubrey, Natalie Mahara, & Manuel Columbo	EOAS Outstanding Teaching Assistant Award	2017

In Memoriam

Arthur (Art) Soregaroli	EOAS Professor; A UBC scholarship has been created in his memory to support students pursuing economic geology and mineral exploration. (https://memorial.support.ubc.ca/art-soregaroli/)	2017
Oldrich Hungr	EOAS Emeritus Professor; A UBC scholarship has been created in his memory to encourage future generations of geotechnical engineers. (https://memorial.support.ubc.ca/oldrich-hungr/)	2017
Paul Harrison	EOAS Emeritus Professor; A UBC scholarship fund has been created in his memory to recognize outstanding graduate students in the Oceanography program. https://memorial.support.ubc.ca/paul-j-harrison/	2017



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Faculty of Science