EARTH MATTERS

Newsletter of UBC Earth, Ocean and Atmospheric Sciences

Vol. 2 **2015**

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From the Editor

It is my privilege to present to you the 2nd edition of Earth Matters. This year’s edition has been expanded to feature some of our most outstanding PhD students, PDFs and RAs whose blood, sweat and tears power research programs. Four faculty members exemplary of the interdisciplinary inquiry Earth, Ocean, and Atmospheric Sciences members are capable of provided me and my team with personal insights and laboratory tours; we divulge all the details. Pride filled me as I reviewed the massive index of faculty members’ published research papers and the many accolades they have received over only the past few years.

The individuals featured in these pages are part of a larger cohort. More than 40 RAs/PDFs, 40 faculty members, and 200 graduate students call EOAS their home. So diffuse is the EOAS community, however, that you’d be lucky to shake hands with even a quarter of them. I’ve lamented to my colleagues that the single occasion I’ve personally observed anywhere close to that number of EOASers gather together was at the departmental welcome back barbeque on a bright September afternoon; summer field stories were shared, new students were welcomed, and potato salad was piled high. And then, we fell back into our designated spaces. Departmental initiatives to create shared lab spaces have been beneficial, but I believe that we have the potential to synthesize a higher order of community.

EOAS has more than enough aesthetically pleasing physical space to host its past and present members; so many other UBC university departments share ideas and praise their best in our atrium (looked on by graduate students hoping to scoop up a catered snack undetected). EOAS also has a share of individuals who organize poster sessions, formal talks, informal talks, intramural sports, and a biweekly departmental coffee hour. I know from personal communication that EOASers of all roles have ideas they would bring to the table, if not for their justified fears of low turnout. The regularly scheduled coffee “hour” is a 15 minute affair whose participants make their exit by indicating the amount of work that awaits them and the guilt they feel for socializing “too long”. We apparently don’t value descending the ivory tower.

Building community in EOAS requires a substantial change in how we prioritize leisure time by examining why we should. Spending time together just to socialize allows us to deepen our curiosity for others’ work, to recognize their strengths, and to initiate collaboration. Humble social connections are the foundation of, not a distraction from, the productive interdisciplinary research connections EOAS seeks. Social events need authority to become the immutable highlighted block in our schedule they need to be. That authority comes from departmental research role models considering—experiencing—the utility of pure socialization. It is my wish that this volume inspires you to come out for cup of coffee in the museum, ready to share.

Chuck Kosman
Earth Matters Editor-in-Chief
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From the Head

It is almost 20 years since the Departments of Geology, Geophysics and Astronomy, and Oceanography joined together to form EOS (renamed EOAS in 2006). These departments persist in our undergraduate programs, and many faculty members still identify themselves with their disciplinary communities: engineers, geologists, geophysicists, oceanographers or atmospheric scientists. While each discipline has its own vernacular, community and culture, and it is important to maintain our ties to them, it is also important to develop a distinct EOAS culture and community.

Why is an EOAS community important? And even more fundamentally, why EOAS? EOAS is here to fulfill the two core missions of education and research in the support societal needs. I am proud to say that we are world leaders in both missions, but if we do not maintain and build our EOAS community we will fall behind. We cannot be complacent.

The success of our alumni in their careers is the most obvious evidence of the past quality of our education. Building upon these successes, over that last eight years the quality of instruction in EOAS has measurably improved under the Carl Wieman Science Education Initiative. Scholars in EOAS have developed science-based methods of instruction and transformed how we teach, winning national and international acclaim for their achievements. Universities across North America and Europe are looking to follow the ideas implemented in EOAS. In my humble opinion, the rich context of the Earth sciences and our innovative pedagogy make EOAS one of the best places in the world to receive a science education.

Our scholars also continue to be recognized with numerous research awards and prizes. And while research funding does not directly correlate with research quality, it is a good measure of the esteem in which our investigators are held in the academy. By this metric we are doing well—EOAS has the largest research budget in the Faculty of Science at UBC.

How can we build upon our education and research successes and move EOAS forward? I believe the best way to do this is to support and recruit outstanding people and to develop a strong interdisciplinary EOAS community of students, staff, faculty and external partners.

There are a number of reasons to promote an interdisciplinary and collaborative community. Students with a broad perspective of the Earth sciences have advantages in their careers and are better citizens. Many of today's jobs could not have been imagined even a decade ago. A broad perspective allows our graduates to take advantage of these future opportunities. Many graduates will work on interdisciplinary teams in their careers. Exposure to the unity of the Earth sciences also makes our students more informed leaders, who can help society discuss and make decisions about how we manage our environment and resources.

Interdisciplinary collaborations are also an efficient way to transfer knowledge and techniques from one discipline to another in addition to a way to discover (or recognize) new research opportunities Interdisciplinary, team-based research allows one to tackle larger, complex problems such as resource development or climate change that are beyond the scope of a single discipline.

It is still a struggle to promote interdisciplinary research and collaboration—it is more comfortable and less risky to remain within our disciplinary silos. Recognizing this, research granting agencies often explicitly require multidiscipline proposals. While this deliberate approach can brings success, the business literature on innovation demonstrates the importance of unintentional casual interactions—the so-called watercooler talk—where two apparently disparate disciplines engage and spark ideas. Cognitive science tells us that just by articulating an idea to a colleague, we develop a more profound understanding of the idea. To be effective, we need collegial people, which we have by the bushel here in EOAS, and time and place for casual encounters—which are regrettably in shorter supply.

Indeed, most of us place a low priority on these casual encounters—we are "busy", which I translate to mean, we have other higher priorities. As Head, I struggle to create opportunities for collegial encounters. The more immediate demands of teaching and shorter-term research goals seem to take precedence. Furthermore, our merit structure in the academy most often rewards and recognizes the individual teaching or research star. However, we all know that individual success is built upon many unrecognized contributions by staff, graduate students, faculty and external partners.

A collegial, interdisciplinary community promotes the natural evolution of EOAS, allowing us to move forward and enhance our dynamic, world-class department by focusing on the most relevant and exciting problems. This does not imply that we dismiss traditional fields where we have established strengths. Any new area that we move into will be founded upon our accumulated canon of traditional knowledge. For example, I think of former Head, Greg Dipple who is a metamorphic petrologist now investigating the physical, chemical and biological processes that sequester carbon dioxide in minerals in mine wastes.

In the coming years, we will have the opportunity to bring new people with fresh ideas and skills into the department. We have invested considerable time and energy in the last 5 years discussing our vision and future hires. At our April 2015 retreat, EOAS faculty presented and discussed 19 faculty hiring ideas including: surface processes, a modern take on sedimentology; geobiology, the successor to paleontology; and natural hazards in mountainous terrains, a traditional strength that exploits the natural laboratory of British Columbia. To maintain our programs and ensure high-quality education for our students, we need people to teach our core courses. However, I believe our teaching capacity is not limited if we hire into new and emerging areas, since any new area will have almost always have roots in traditional skills and disciplines.

If the past is any guide to the present, we will soon have many opportunities to hire, and in future messages you will hear about them. Indeed, in the 12 years between 2002 to 2014 we hired 27 faculty, just over 2 per year on average. We have been exceptionally successful in recruiting the very best young people to our team and I fully expect this will continue—we are not being complacent. With your continued support and engagement, the future of EOAS is very bright.

Roger

Professor Roger Beckie
Head of Earth, Oceran and Atmospheric Sciences

News

Reinvigorating PDFs and RAs

PDF/RA Council

Research associates (RAs) and postdoctoral fellows (PDFs) play essential roles in many of the department's research groups and also contribute to student supervision, funding acquisition, lab management and other administrative tasks. We are highly skilled researchers and teachers that have much to offer to the whole department, yet, we have not been well integrated in department activities, as was recognized by the 2014 external department review. Addressing this issue is both a challenge and opportunity for EOAS, PDFs, and RAs.

After numerous thoughtful discussions with PDFs, RAs, and faculty members, we have formed the PDF/RA Council that will provide leadership and representation for these two groups within EOAS. The council was officially established in January 2015 and consists of six members: Nancy Soontiens (PDF), Dikun Yang (PDF), Mark Halverson (PDF), Murray Allan (RA), Marg Amini (RA), and Ian Power (RA).

We aim to build community and engagement among the PDFs and RAs by ensuring that these two groups are represented at department meetings and committees, and through organizing social and professional development events. To support these initiatives, the council has been granted an annual operational budget of $2000 from the department.

In its first few months, the PDF/RA Council has organized several events, including a social gathering at The Point Grill and a successful career panel in collaboration with the department's Graduate Student Council. We have also distributed our first survey to compile information about who we are as a group, the results of which were presented at the department retreat on April 27, 2015. We're excited by and appreciative of the level of support shown by PDFs, RAs, and faculty thus far.

Ultimately, our hope is that the PDF/RA Council can serve the department and PDF/RA communities by capitalizing on the diversity of skill sets inherent in these two groups. Although the department's research interests are broad and far-reaching, we will all benefit from cross-department collaborations and connections.

Undergraduate Research at UBC

Thomas Aubry

Undergraduate students, are you interested in research, but don't know how to start or how to develop meaningful connections with the UBC research community? Graduate students, do you want to share your research passions with young motivated minds and contribute to their development? Professors, do you want your graduate students to empathize with your challenging supervisory role? Undergraduate Research Opportunities (URO) has the solutions! Each year, hundreds of UBC undergraduate students connect with over a hundred graduate students in unique mentee-mentor relationships via the Research EXperience program (REX). From late September to early March, each participant has to either develop an original research question and the methodology to answer it, or directly work on a research question provided by their mentor. The program's climax is the Multidisciplinary Undergraduate Research Conference (MURC) where each group presents their work. This year was a great success, with 200 presenters and their truly impressive presentations with over 200 delegates.

Although REX is an amazing program, it has a major defect: only a few students and mentors come from Earth, Ocean and Atmospheric Sciences, about 8 this year! Undergraduates, don't miss out on this amazing research opportunity to sign up for REX in September. Graduate students, help represent our research community and remember that supervising young creative minds is an incredible learning experience, too. Mentor recruitment for next year starts in July!

For more information on URO, REX and MURC, visit:

http://www.uroubc.ca/

http://www.uroubc.ca/rex/

http://students.ubc.ca/career/murc

EOSC 515 Returns

Rhy McMillan

The ability to effectively communicate scientific ideas is paramount for both researchers and teachers. Students in the UBC EOAS Graduate Seminar Course (EOSC 515), a follow-up to Teaching and Learning in the Earth Sciences (EOSC 516), are provided with the opportunity to practice their presentation skills and to learn how to host speakers. After a short introduction to the necessary skills, students take turns presenting and hosting weekly seminars that are open to the general public. They present their research and receive feedback on their talk from their classmates. The feedback is based on a rubric that evaluates how they introduce their topic, the clarity and organization of their presentation, their content, their style/delivery, how they used visual aids, how they summarize their talk, and how they address questions. The presenter not only gets valuable feedback from their peers about their talk but also about their own research, both in the form of questions after the presentation and comments on their feedback forms. For the seminar, the hosts have the opportunity to invite a guest speaker, introduce presenters, and mediate question sessions. These are also valuable skills to obtain as it provides the framework for future hosting opportunities. The course is student-run, and is an ideal opportunity to obtain a single credit while learning, and more importantly, applying an extremely valuable skillset.

Chuck Kosman

EOAS Graduate Student Council (GSC) held two instalments of Earth Talks, a forum initiated in 2013 to promote research communication between EOAS graduate students of all disciplines. Graduate student speakers delivered non-competitive, 10-minute presentations to an exclusively graduate student audience with a touch of humour. The November 2014 instalment included:

Jason McAlister, PhD Oceanography – "Of space and time: an ocean odyssey". Jason showcased his work on the biogeochemistry of the Northern Pacific Ocean from the perspective of lead isotopes.

Anna Grau, PhD Candidate Geophysics – "Was Mars a warm, wet habitable world in the past?" By comparing Earth's fluvial structures to surface features of the red planet, Anna mounted evidence toward an abundance of water on ancient Mars.

Kathi Unglert, PhD Candidate Geophysics – "How to sit back and let the computer do all your work: volcanic tremor and machine learning". Kathi introduced her novel work on machine learning as it relates to seismic activity associated volcanoes.

Chuck Kosman, MSc Candidate Geology – "Your samples are now diamonds". Chuck presented his work on mineral inclusions trapped inside diamonds from central Africa as insight into the composition of the underlying mantle.

The most recent instalment in March 2015 included:

DJ Lake, MSc Candidate Geology – "Columbian emeralds: now 100% pegmatite free". Though much gem quality beryl is thought to form in geologic structures called pegmatites, DJ explained how the world's most famous emeralds are still a geologic mystery.

Anna Mittelholz, MSc Candidate Geophysics – "The external magnetic field of Mars". Anna showed how contributions to Mars' magnetic field as the result of its interaction with the solar wind comprise a significant portion of its total magnetic field.

Sarah Devriese, PhD Candidate Geophysics – "Imaging SAGD steam chambers using electromagnetic methods." Sarah modeled how changes in electromagnetic properties resulting from steam injection into oil sands as a means of extraction could be monitored from surface instrumentation.

Kaleb Boucher, MSc Candidate Geology – "Structural and paragenetic evolution of the Efemçukuru low- to intermediate-sulfidation epithermal gold deposit, western Turkey." Kaleb's mapping revealed how relay faults attributable to regional scale extension are the key to gold distribution within his section of MDRU's Western Tethyan Project.

GSC intends to hold a session of Earth Talks in the fall.

In the Field

Leaving the Cold for a Hotspot

Johan Gilchrist

Last February, the Dawson Geology Club at UBC organized a trip for a group of undergraduates to explore the big island of Hawai'i. On the way to the Hawai'ian Volcano Observatory, they saw vast areas of ropy-textured pāhoehoe lava and viewed fresh lava eeking out of the Halema'uma'u crater behind the observatory at night. Making the most out of the trip, they went to the dormant volcano of Mauna Kea, looked in awe at the green sand beach composed of olivine at Papakōlea, visited a turtle sanctuary and swam in the freshwater of a lava tube. Luana Yeung sums up her experience; "I think as geologists, we have a greater appreciation about what we do when we can see such great examples of *in situ* lava textures and flows." The students would like to thank Mike Poland for being an awesome tour guide of the observatory as well as Dominique Weis, Mary Lou Bevier and Lucy Porrit for helping to organize a fantastic trip!

Undergraduates in front of Halema'uma'u Crater. From Left to right: Mila Huebsch, Luana Yeung, Wanika Lai, Alain Boudreau, Byeong Kim, Tim Armitage, Denise Baker, Tierney Woods, Chris Moll, Harley Hoiles, Dom Walkling, and Sebastian Gerhard.

Oceanographic Methods

Muriel Dunn

Over reading week in February while other students were catching up on school work or off on a tropical vacation, the oceanography students at UBC were working harder than ever getting some hands on experience in their field. For many students this was a deciding moment, a week to find out if oceanography was the right choice.

The beautiful serene view upon arriving was soon just a distraction from all the work there was to accomplish. Every student, no matter their specialisation, had to go through the full process of chemical, biological and physical experimental oceanography. The first three days started on a boat with a crash course on the equipment and techniques of the specialisation of the day. Next came processing the morning's data in the lab in the afternoon, ending the day with analysis and a presentation in the evening.

The last two days were dedicated to a personal research project chosen by each student. Everything from coming up with a problem, to a presentation and writing a paper was all based on the next two days of data acquisition. Many groups were taking data around the clock and there were countless boat and equipment crises, and unpleasant seasickness. In the end, somehow everyone got the data they needed. Overall, I can say I learned more during reading break than any other week of the term and I am convinced that physical oceanography was the right choice for me!

Geologist Angelo Farci at the Rio Tinto Mine, Spain interprets the local and regional geology to the SEG-GAC field trip participants. Photo by R. Yarra.

Oliver Field School

Natalie Cook

This year's Oliver Field School (EOSC 328) had more than 40 students from Geology and Geological Engineering. At the beginning of May, students travelled to Oliver in British Columbia's Okanagan region where they stayed in Arctic trailers, bunkhouses and exploration-style tents. Over three weeks, students completed geological mapping exercises on either side of the Okanagan Valley detachment fault; one in sedimentary and volcanic rocks of the White Lake basin, the other in mylonitized granitic intrusions around Mt. Keogan. Professors Kenneth Hickey, James Scoates, Lori Kennedy, Kelly Russell, and Matthijs Smit instructed EOSC 328 this year. They were ably supported by TAs Jamie Cutts, Marie Turnbull, Chris Herron and Natalie Cook. Students navigated the field, took accurate structural measurements, interpreted geological relationships in the landscape, made geological maps and cross sections, and interpreted the geological history of an area from their maps and sections.

SEG Annual Field Trip

Anna Grau

The UBC Student Chapter of the Society of Economic Geology-Geological Association of Canada (SEG-GAC) welcomes students interested in economic geology and mineral deposits to participate in their annual field trip. This year's destination, the Iberian Peninsula, included active and historical mine sites and deposits in both Spain and Portugal.

The Iberian Peninsula is home to more than 10 world class deposits (that is, with over 50 million tons of ore) of which 8 are giant deposits that contain more than 100 million tons of ore. The trip consisted of a crew with eleven UBC students and eight industry sponsors that got the chance to visit some of these spectacular deposits including Rio Tinto (a copper, lead, zinc deposit) and Almadén, a deposit that contains over a third of the world´s mercury reserves.

Commencing in Madrid, the participants first visited Las Médulas in northwest Spain, the remains of a mountain that the Romans mined for gold using hydraulic methods nearly 2,000 years ago. The trip continued south to Portugal to visit the gold exploration project of Lagares and the tungsten mines of Los Santos and Panasqueira. Continuing to Spain through the world class Iberian Pyrite Belt, the participants toured the active mines of Aguablanca (a norite-hosted nickel deposit) and Las Cruces (a copper VMS deposit) and the historical mines of Rio Tinto and Almadén. The trip finished in the southern Mediterranean coast with a visit to the historical gold mine of Rodalquilar.

The trip also explored aspects of the rich culture and history of Spain and Portugal. Evidence of mining dates back to almost four millennia ago, which enhanced the growth and commerce of early Arabic and Roman settlements. Trip participants had the opportunity to explore some of the main Iberian cities, such as Porto and Lisbon in Portugal, and Madrid, Salamanca, Sevilla, Córdoba and Granada in Spain. Culture, history and gastronomy combined with world-class geological sites to make this trip a huge success.

Drilling and Discovery in the Bengal Fan

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Diane Hanano

For the past 2 months I've been onboard the scientific drilling ship JOIDES Resolution, surrounded by nothing but the deep blue Indian Ocean. We're on an expedition for the International Ocean Discovery Program, drilling at 7 sites spanning a massive accumulation of sediment that covers the entire floor of the Bay of Bengal called the Bengal Fan. We're studying sediment that has been eroded from the Himalayas to learn about connections between this mountain range and climate. The age and composition of these sediments will provide clues about the collision of India with Asia, the resulting uplift and erosion of the Himalayas, and the development of the Asian monsoon.

Although a geochemist by training, I'm sailing as part of the Education and Outreach Team. My job is to communicate the onboard science to audiences around the world. Every day, we hunt around for engaging scientific and personal stories for social media posts, blogs and videos. We connect with shore-based educators to provide resources and schedule live video events that include ship tours followed by Q&A. We've held 60 live broadcasts with over 3200 students in 17 countries, from Belgium to Bolivia, and Morocco to Malaysia.

Communicating with all of these schools in different time zones is no easy task. At first we were on the night shift to accommodate audiences in North and South America. I actually enjoyed night shift, which I hadn't expected. There is something wonderfully quiet and peaceful about starting your day at midnight. And then around 6 am, it's tradition to meet up on the top deck (a.k.a. "steel beach") to watch as the sky slowly begins to brighten and turn unimaginable shades of pink and orange. A few weeks ago, we made the difficult transition to the day shift so we could connect with other countries and cultures on the opposite side of the world.

Each classroom is a unique experience, watching how the students interact with each other and listening to their questions. Some of my favorite moments include the nine-year-olds from France politely asking their prepared questions in groups of four, the library packed full of inquisitive New Zealand students with their arms waving in the air, and the school in Nepal where the Internet wasn't working so the teacher invited the students (all 75 of them) to his home.

Above:
Photo by Lisa Strong.

Below: Diane describes a core for students in the lab onboard the JOIDES Resolution. Photo by Tim Fulton.

Above: Live broadcast with fourth graders at Sunnyside Elementary School, San Francisco. Photo by Gerrit Dekens.

Early on, a high school student asked us something that we quickly realized needed to be addressed during the broadcasts. If we're studying the mountains, why are we in the middle of the ocean? We explain that, despite being the highest mountains on Earth, much of the Himalayas have already been eroded away. About 80% of this material ends up in the Bengal Fan, giving us the most complete record of past climate and history of these ancient mountains.

This discussion often leads to another question: how do these pieces of the Himalayas get all the way out to the Bengal Fan, 3000 kilometers away? Students understand that rivers carry the sediment to the delta, but it isn't clear what happens next. We describe how the material is transported by fast-moving sediment-laden currents of water called turbidity currents, kind of like an underwater avalanche. To help illustrate this process, two of our resident scientists and technicians built a small tank to generate these currents, which we filmed to show the students, along with real examples of turbidite deposits in our cores.

Of course sometimes there are some funny questions like if we can see Mt. Everest from the ship, if we're allowed to go swimming, and my personal favorite, if we've found any light sabers. Older students tend to ask more insightful questions, like the Nepalese students who wanted to know how a landlocked country such as theirs benefited from an ocean drilling expedition, and the Bolivian students who asked why we weren't studying the Andes instead.

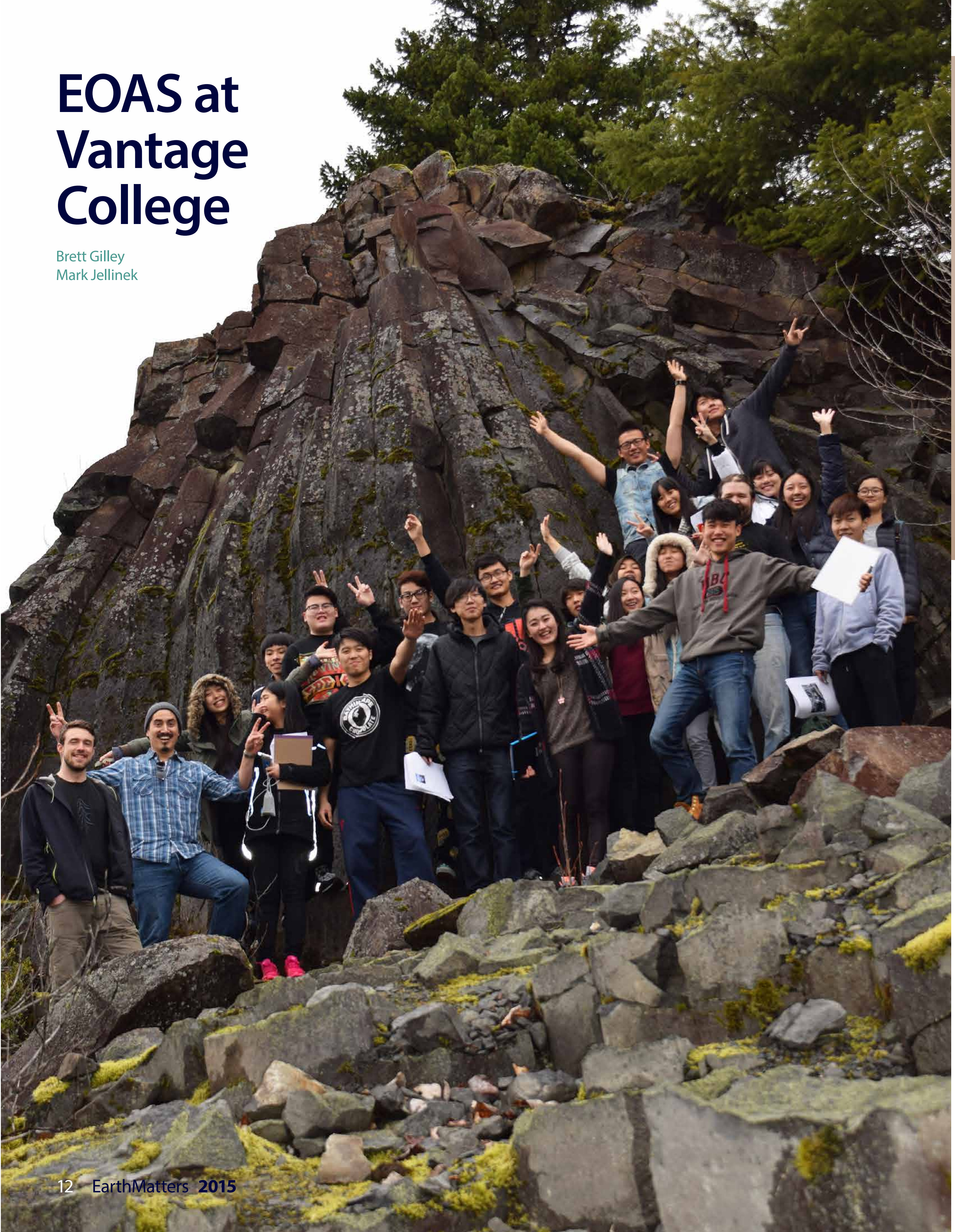
I consider myself lucky to have been given the chance to help tell this story and inspire a new generation of scientists. It's truly incredible that we can use the Earth's ancient magnetic field recorded in magnetic minerals to tell time, and how the tiny shells of foraminifera and nannofossils can tell us what ocean and climate conditions were like millions of years ago. It's a wonder that we can even study these materials in the first place, given that we're drilling below the seafloor in almost 4 kilometers of water. We've recovered over 1700 meters of core, full of turbidites, calcareous "oozes," plant fragments, woody debris, and even volcanic ash layers.

With so many cores to describe, analyse and interpret, life onboard is busy. Everyone works a 12-hour shift, 7 days a week. Considering this international endeavour has been 10 years in the making, there's no time to waste. But it's not all work, we find ways to relax and have fun. We've watched Bollywood movies in the lounge, translated by our Indian colleagues when the subtitles were missing. We recently wrapped up our pool tournament, where despite my best effort, I was no match for the ship's chief mechanic. We even had a "hump day" celebration, complete with camels taped around the ship, at the halfway point of the expedition.

That seems like a long time ago now. The last core of the expedition was recovered today, March 28th. This much anticipated event was marked by cheering, clapping and an overwhelming sense of accomplishment. Next stop: Sri Lanka. We have a short 2-day transit to Colombo, and then everyone will go their separate ways. From labs around the world, we'll continue to piece together this ancient puzzle of continents colliding, land rising, mountains crumbling, and climate changing.

EOAS at Vantage College

Brett Gilley
Mark Jellinek



@modernhydra

If you know a current UBC student they have probably taken EOSC 114 - The Catastrophic Earth: Natural Hazards. The various iterations of EOAS's flagship course reach almost 3000 students per year. Ask students who've take the course about it or the instructors; odds are they love it and them. The current lead instructor of EOSC 114 is Brett Gilley, EOAS's newest tenure-track Instructor. Though Brett was recently hired in the Instructor role he has been in EOAS since 2007 as part of the Carl Wieman Science Education Initiative (CWSEI). For the past seven years Brett has helped faculty in EOAS improve their courses, taught some classes of his own (such as EOSC 114), and performed geoscience education research. His new role however, is to teach EOAS's portion of the curriculum at UBC's new Vantage College.

Vantage College is a brand new college at UBC, created for international students who have the same excellent grades expected of all UBC students, but whose English skills are slightly below what is required for direct entry. When people hear about Vantage College they are sometimes skeptical. Some have the impression of wealthy students trying to find a back door into a prestigious institution, or of foreign students taking away resources from local students. Others are concerned that these foreign students are exploited for their much higher tuition fees (and some institutions do treat these programs as cash cows and farm out the teaching to private companies). At UBC however things are different.

Vantage College is an academic unit within the structure of the University, students are UBC students, and the subjects are taught by the faculty of the University. The college is self-funding, with excess money going to supporting other programs at UBC. Students are international students from a wide variety of backgrounds. All meet the academic requirements to get into UBC, and a scholarship program is in place to help students in need. Each course in Vantage is paired with a dedicated Academic English tutorial that helps students learn the language and prepare them for second year. To make it into the second year, students must pass 70% of their course and maintain a 60% average to remain at UBC, the same academic requirements as students who change from one faculty to another.

There are some challenges that come with teaching in Vantage College. Though the students are able to communicate, their English skills are often lacking when they first arrive. Success in an environment like Vantage College has a lot to do with an instructor's ability to listen to, disarm, and engage students in ways they can understand. Students arrive into the program with distinct world views and skill sets, a complicated mix of excitement, motivation, and fear, all combined with a non-trivial and varied understanding of what school, and even culture, means. To get the most out of these students—to enable them to do more than they themselves can imagine—is a monstrous challenge and a wonderful opportunity.

Finally, in the first year, a majority of the students come from China. This homogeneity makes it more difficult for those students to learn English as they can easily speak in their native language in most situations. However, if the experience of Simon Fraser University's "Fraser International College" is anything to go by, these numbers will change over the first few years and students from other countries will gradually increase in number.

With these challenges are several opportunities. For example, Vantage allows us to continue offering an excellent education to our direct entry students at UBC, but Vantage is good for UBC in other ways as well. It exists as a test bed for direct entry classes. The instructional team at Vantage is made up of several people, like Brett, who are leaders in the immerging field(s) of discipline-based-education research. They try out innovative methods and hone them in our Vantage sections before trying them in our, sometimes very large, direct entry classes. Techniques include Brett's two-stage exams, recently featured in Maclean's magazine: http://www.macleans.ca/education/multiple-choice-multiple-students/.

The first cohort of Vantage students recently completed their first academic year. After months of intensive English instruction even the lowest performing students now speak and write better than many ESL students in direct entry classes. The students perform like any first year class. Some excel beyond our wildest expectations; some struggle at first and then improve; some are mediocre; and some do not put in the effort required. Several students will not make it into their second year of study, those who do will enter second year indistinguishable from international direct entry students except for improved English skills. Next September, several of these students will transfer into EOAS and Brett is very excited to be there with them as they begin their new careers as geoscientists.

Above: Brett Gilley, EOAS's newest tenure-track instructor.

Opposite: An Earth Science Vantage College class at columnar basalt in the field with, lead by teaching assistant D.J. Lake (far left) and Brett Gilley (2nd row, third from right)

New Faculty

Matthijs Smit

Jason McAlister, PhD Oceanography

Continental configurations on our modern earth are but a snapshot within a billion year ballet orchestrated by plate tectonics. Imagine India 80 million years ago as an island crossing the equator, on a collision course with Asia to form the mighty Himalaya. While the sedimentary record and plate motion paths suggest that India collided into Asia 55 million years ago, dating techniques applied to rocks suggest the event occurred less than 25 million years ago. This discrepancy lies at the core of debate on Himalaya formation and evolution. Matthijs Smit seeks to reconcile these dates by analyzing a mineral called garnet.

Garnet forms within deep crustal layers when they first become buried or heated, triggered by the collision of continents. Matthijs explains that these garnet "act as little packages of information, revealing the time and temperature when they formed". Matthijs measures the radioactive decay of the lutetium isotope ^{176}Lu to the hafnium isotope ^{176}Hf within garnet. Pairing ^{176}Lu and ^{176}Hf provides an atomic clock, recording time radioactive decay. As a new researcher at UBC, Matthijs establishes only the sixth lab in the world with the ability to conduct high precision measurement of Lu and Hf to radiometrically date garnet.

Matthijs revolutionized Lu-Hf dating of garnets by showing that these elements remain within the mineral. This evidence is vital to establishing that the Lu-Hf clock in garnet faithfully records the time since the mineral grew. Matthijs applied his Lu-Hf dating method to garnets from the Himalaya, demonstrating these minerals are indeed exactly 55 million years old. Matthijs' ability to date garnet is instrumental in unravelling Himalaya history, settling a debate that hampered progress in Himalayan tectonics research for decades.

Research in the Himalaya allows Matthijs the opportunity to collaborate in large interdisciplinary projects, including working with botanists, geophysicists, and anthropologists. Matthijs' method of Lu-Hf dating of garnet is in high demand by researchers, as it places an ultimate date on reactions occurring in the crust and upper mantle. Matthijs explains passionately, "For me, my work gets its validation from being placed in a framework of multidisciplinary research, that's where I find motivation".

In addition to the Himalaya, Matthijs' research team travels around the world, including places such as Norway and Greenland to, "find where nature has brought rocks to the surface so we can look at the past". In these unique locations, research can be conducted on rocks that originated 10–100+ kilometers beneath the Earth's surface. Investigating these geologically diverse areas provides research opportunities for Matthijs to ponder "the history and evolution of our continents, our home, where life diversified".

Matthijs works to continuously add to an ever-developing toolkit to analyze geologic samples, developing versatile and efficient methods that collectively reveal processes shaping our planet. He emphasizes, "I'm not just dating garnet to date garnet. It really has to answer a question that comes out of a larger research question. I'm intrigued by the most diverse of questions and I link my own research into that framework. That is what really makes it worthwhile". Matthijs sees himself as a great fit to the department, as he explains that his research "links with what others are doing, but does not overlap with what is already here. I am another piece in the puzzle that found its way home."


Photo by C. Kosman

Tara Holland

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Anna Grau Galofre, PhD Geophysics

Many people wish they could merge their everyday work and their lifelong passions. Tara Holland, a new Science Teaching and Learning Fellow (STLF) at UBC, has succeeded in this—twice.

Tara started her early career as a biological scientist with an interest in ecology, and switched to biophysical geography for her PhD. In particular, she was interested in the potential impacts of climate change on wine production. *Vitis vinifera*, the species of grapes from which all high quality wine is produced, can only grow in regions with a temperature average of 20 to 22 °C with no extreme variations. These sensitive requirements narrow the areas where the production of high quality wine is possible to the Mediterranean, Australia, California, Chile, Argentina and some mild areas in the US and Canada.

Hence, a small increase in average temperatures would cause a major impact in the wine industry. Even the mildest Intergovernmental Panel on the Climate Change (IPCC) scenario forecasts temperatures to rise more than 1 °C in those areas, forcing wine producers to adapt to these changes by, for example, moving the crops to higher elevations or growing grapes adapted to warmer climates. "Vines take a long time—up to decades—to start producing quality grapes, so now is the moment to start thinking about climate change for wine producers."

But not everything is bad news, particularly for Canadian producers. In fact, the major wine producing regions in Canada, now mainly limited to the Okanagan Valley and the Niagara Peninsula, will potentially extend to additional regions. For example, Tara studied the newest official wine-producing region in Canada, Prince Edward County in Ontario, and found that climate change has already allowed for high quality wines to be grown there.


Photo by C. Kosman

Prior to and throughout her PhD, Tara's passion for teaching lead her to teach multiple Earth Science and environment courses in several universities across Canada, including Bishop's, Mount Royal, Quest and Guelph. "I have always been a teacher at heart," she says in her e-portfolio. It is this passion that led her to her current position at UBC as a Student Teaching and Learning Fellow (STLF), sponsored by the Carl Weiman Science Education Initiative at UBC. As a part of a team under Dr. Sara Harris' direction, she works to develop and foster evidence-based teaching practices in the EOAS curriculum. She also supports a co-teaching project in which instructors who have experience with active learning strategies are paired with less experienced instructors. Tara has so far worked with instructors in EOSC 220 Introductory Mineralogy, EOSC 240 Site Investigation, ENVR 200 Introduction to Environmental Science, ENVR 300 Introduction to Research in Environmental Science, and ATSC 303 Methods in Atmospheric Science.

Active learning techniques consist on displacing the attention focus from the lecturer to the students by engaging them in group activities, discussion, peer instruction and feedback, and adopting a Socratic approach whenever possible. "I see myself as a facilitator of learning," Tara says. Her teaching philosophy reflects this by focusing on providing a welcoming class climate that encourages students to discuss and participate, respecting the students by valuing their voice, and keeping a professional relationship in and out of the class.

Thanks to Tara's and other teaching and learning research, the role of a teacher is becoming more adaptable to the students' needs and the focus is switching from a class of passive listeners to a group of active learners. From her new STLF position, Tara can merge both her main interests: learning through research and teaching.

Graduate Students

Kathi Unglert

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Muriel Dunn, BSc Oceanography

Photo by C. Kosman

In 2013, Kathi received a Vanier Canada Graduate Scholarship to study how volcanic tremor can be used to improve eruption forecasting. This award is designed to identify and enable ambitious future world-class leaders of their field in Canadian Universities.

Kathi Unglert is indeed determined beyond measure. She found her passion for volcanoes in her second year at the University of Munich while on a field trip to the Canary Islands. The islands were a significant departure from the limestone and glacial deposits of the European Alps to which she was accustomed. Kathi pursued her passion in volcanology with an MSc at the University of Wellington, New Zealand. After much deliberation between universities on the west coast of North America, Kathi came to EOAS to investigate volcanic tremor under Dr. Mark Jellinek's supervision.

Volcanoes have complex subterranean plumbing systems; scientists are interesting in monitoring how magma is pumped through these networks to drive eruptions but can neither see nor image them. “There a is specific type of earthquake that happens on volcanoes called volcanic tremor that is often thought to be related to moving fluids, maybe magma, so is there a direct link with eruptions? There is a debate to whether that is true or not,” Kathi notes. Tremor is type of low frequency (0.5 to 10 Hz) earthquake that lasts from minutes to weeks and is one of many seismic signals associated with active eruptions. In traditional monitoring studies, this type of earthquake is studied by comparing its emergence and character to other parameters including ground deformation, changes in gas emissions and infrasound (sounds waves at very low frequencies). Kathi compares the tremor signals from volcanoes with different types of magma. Volcanoes with runny magma (like Kilauea in Hawaii) are distinct from volcanoes with sticky magma that produce explosive eruptions (like Mount St. Helens). Characterizing the tremor associated with different magma types will potentially provide better forecasting of volcanic eruptions and therefore mitigate hazards.

The largest obstacle for Kathi is creating an appropriately rich and detailed database of seismic and other geophysical observations because of the rarity of repeated eruptions and the limited resources for monitoring capability, especially in developing nations. However, when the data is available for a volcano, it comes in overwhelmingly large amounts. Kathi has been working on machine learning to process the massive data sets. One form of machine learning Kathi uses is self-organizing maps (SOMs), a method that is capable of processing large amounts of data quickly as well as identifying key patterns diagnostic of eruptions within the data. Using the Hawai'ian dataset, with which she is already very well acquainted, and a synthetic dataset, within which she decides the input, she can test whether the SOMs are able to recover the input patterns she has determined. Once this is established, she can detect patterns in the tremor that are common to a wide range of volcanoes and relate it to the external factors of magma composition and types of eruptions. However, Kathi keeps in mind that no two volcanoes are the same.

Marina Martindale

Johan Gilchrist, BSc Geophysics

Photo by C. Kosman

We cannot see what goes on inside the Earth so how do we know so much about the inner workings of our dynamic planet?

Marina Martindale is a PhD candidate in geochemistry at UBC studying the crust and upper mantle below western British Columbia. Hailing from the East Midlands of England, her interest in geochemical research attracted her to the world class facilities of the Pacific Centre for Isotopic and Geochemical Research (PCIGR) at UBC. More specifically, she is interested in determining the sources of melt that generated the Cascade mountain range.

With the precise instruments of the PCIGR and the Cascadia subduction zone as a natural laboratory, British Columbia is the perfect place for Marina to apply her trade. The Cascadia subduction zone involves the Juan de Fuca (JDF) and Gorda tectonic plates, which are subducting under the North American (NA) plate. This generates molten rock that rises through the overlying mantle and crust to form the Cascade volcanoes, extending from Northern California to BC. BC hosts most of the Garibaldi Volcanic Belt (GVB), the northern section of the Cascades volcanic chain, running parallel to Vancouver Island. Marina and her colleagues have discovered that the chemistry of the volcanic rocks changes significantly along the belt, becoming more enriched in alkali elements from South to North.

Unfortunately, we cannot simply put a camera in the Earth to see what is going on so this is where geochemistry comes into play. Marina uses the instruments of the PCIGR to analyze the various elements present in rock samples. The abundance ratios of trace elements give clues as to where the original melt came from. Each potential source has a certain distribution of elements, known as a “fingerprint”, and Marina tries to determine what combination of fingerprints gives rise to the geochemistry of her samples. For example, lead isotopic compositions can be determined using one of the mass spectrometers of the PCIGR and these have distinct values, or fingerprints, for various parts of the crust and mantle under the Cascadia range. Thus, the chemistry of a rock can reveal its journey through the Earth.

Using samples collected by Marina and her colleagues from the subducting oceanic plate, GVB volcanoes and local basement rock, she characterizes their sources by precisely measuring their elemental composition. Sometimes the fingerprints for two sources are very similar, like continental crustal rocks and the sedimentary layers on top of the JDF plate, making it difficult for her to distinguish one from the other. To solve this problem, she has to carefully prepare samples in the clean labs of the PCIGR to avoid contamination. She then separates and counts the elements present in them with highly sensitive mass spectrometers. With great care and patience throughout this process, she can reduce the error in the measurements, which helps her to discern the fingerprints of similar crustal sources.

The results of Marina and her colleagues suggest that the rocks of the GVB and the southern High Cascades originate from distinct sources and have undergone differing degrees of crustal assimilation during their ascent. As you move northward along the GVB the fingerprints indicate a progression from shallow to deeper mantle source. They interpret this as a variation in tectonic processes along the arc, and an indication that the JDF plate has been torn apart below the Nootka fault and is allowing deep mantle material to rise and contribute to the volcanic rocks in this part of the GVB. These results will help scientists learn the history of the Cascadia subduction zone and potentially reveal what it will do in the future.

Marina is using geochemistry like a precise microscope to look inside our dynamic planet. The more we know about our planet, the better prepared we can be for what it will do next.

Corey Wall

Johan Gilchrist, BSc Geophysics

We always want to know how long something will take and this is no different for geologists studying the history of the Earth. To understand the history of geologic formations, PhD student Corey Wall applies a specific radiometric dating technique, uranium-lead (U-Pb) geochronology, to zircon and other minerals to ascertain their age. Corey puts it more simply, "It's a dating technique; uranium decays to lead so we can use that time clock to determine the rates of different things." For example, the age of the Earth has been determined precisely to be 4.54 billion years old using a form of U-Pb geochronology.

U-Pb geochronology is the gold standard of radiometric dating. Carbon dating, a perhaps more well-known radiometric dating technique, is useful for dating artifacts from thousands of years back; U-Pb dating can go back billions of years. This technique is especially powerful when applied to zircon, a robust mineral that incorporates uranium into its crystal structure as well as the lead produced during radioactive decay. Since the rate at which the decay occurs is known, measurements of the amount of both elements within just a single crystal as small as 1/25th of a millimetre in length yield the precise age at which it formed. By using zircon, Corey can calculate a two-million-year age estimate with less than 0.01% error; minimizing this error in measurement is one of the goals of his research. In addition, he can date some of the oldest rocks on Earth while maintaining high temporal resolution. Now let's see how he applies his trade to learning about our planet.

Ever heard of Platinum Group Elements (PGEs)? These are some of the rarest and most precious metals on Earth with applications in the automotive, aerospace and agricultural industries, among others. PGEs are concentrated within geologic formations called mafic layered intrusions. One of them, the Bushveld Complex in South Africa, hosts more than 80% of the of worlds PGE resources. These were formed when magma intruded between layers of rock in the Earth's crust and then solidified. Corey wants to know how these formations originated and evolved. The prevailing theory has been that these intrusions solidify from the bottom to the top, however the time between layer emplacement and solidification is largely unknown. If Corey can find zircons in each layer, he will be able to date them to test the prevailing formation theory.

So what is the challenge for Corey? The rocks in these formations are normally devoid of zircon, but he was able to go to the field in South Africa, and to the Stillwater Complex in Montana, to find pockets in the rocks where zircons had formed, a novel sampling method in geology. Now he is back at the Pacific Centre for Isotopic and Geochemical Research (PCIGR) applying U-Pb geochronology to these samples with the goal of revealing their story of formation and evolution.

Many of the age estimates in geology owe their origin to U-Pb geochronology. Applying it to rare and valuable mineral deposits, like PGEs, allows Corey to understand their origin. Geologists can then use this information to find more rare deposits around the world so that you and I can enjoy the wonders of technology that rely of these rare elements.

David Siuta

Rhy McMillan, PhD Geology

We are all influenced by the weather, but for some of us it is a fundamental part of who we are. David Siuta, PhD Candidate at the University of British Columbia, turned his childhood passion into a career trajectory that is, quite literally, a breeze; David studies the wind. More specifically, he conducts research on how to better predict the wind for applications in power generation.

"I'm from a small town in New Jersey, where nor'easters and snowstorms are a regular occurrence," says David, describing where he first found his passion for studying the atmosphere. He took his first meteorology course via correspondence in high school and then went on to study Earth System Science as an undergraduate and Atmospheric Sciences during his master's at the University of Wyoming in Laramie, WY. He is now completing his doctoral degree under the supervision of EOAS Professor Roland Stull while also modelling for UBC's Geophysical Disaster Computational Fluid Dynamics Center. "Our models create different representations of how we think the atmosphere is going to evolve in the future," says David. At the center they operate 14 of these models and he is in charge of maintaining, upgrading, and running 6 of them.

Because of the increasing demand for cleaner energy sources, David's research focuses on more accurately forecasting the wind at the hub-heights of power-generating wind turbines. David's work builds on our understanding of the dynamics that govern complex wind patterns near the ground and has the potential to make power production both more efficient and environmentally friendly. Wind power is 'green' energy; after the initial implementation of the infrastructure, carbon emissions are next to zero. However, forecasting favourable wind patterns from day to day is challenging. This makes consistent power production more difficult compared to other conventional power sources, such as hydrocarbon, nuclear, and hydroelectricity and even other weather-dependent energy sources, like solar energy. "Wind speeds are highly variable, often changing with short notice, and forecasts of wind speed are still quite uncertain. Since wind power is, by nature, only available when the wind blows, forecast uncertainty complicates power management," explains David. Thus, accurately forecasting when supplementary power will be needed is crucial, and predicting the wind at hub-height is extremely important for allowing energy planners to optimally balance energy resources from multiple sources to continuously match supply with demand. Regions with large variations in topography have particularly complex wind patterns near the surface. In places such as British Columbia,where David studies, extreme topographic changes also occur near a coastline making the challenge of predicting wind-driven energy resources particularly acute.

The combination of life-long passion, excellent computational skills, and motivation to improve how we power our lights is leading David to a bright future in Atmospheric Science. He plans to continue following his passion by either inspiring others through a career in teaching at a university or by continuing his current modelling work, allowing us to better plan our outdoor adventures, or simply decide if we need to bring an umbrella to work.

Photo by C. Kosman

David Turner

Thomas Aubry, PhD Geophysics

David Turner's research is a real hidden gem. After graduating from the University of Victoria, with a double major in Earth Sciences and Physical Geography, David started an MSc at UBC studying a deposit of aquamarine, in the Yukon territory. David kept looking for gemstones in the field as a consultant for Archer Cathro & Associates and True North Gems. His search eventually led him Greenland where he discovered a true gem, one of the largest rubies ever found in the Northern Hemisphere. David's success led, in turn, to the current construction of a ruby mine there called the Aappaluttoq project. How do you find such a big gem? "Basically, you need to have a good idea of what you are looking for, and use a combination of geological maps and models to narrow the area where you search," says David, not mentioning the flair and intuition he has honed over years of fieldwork, something he particularly enjoys!

However, David has another passion that is challenging to combine with months of hard work all over the world: his children. David recently finished writing his PhD thesis just a few days before his third child arrived. The other two were born during his wife Darcie's MA and his PhD. "It's like a rule, one of us has to be completing graduate studies for a child to be born." Five years ago, David slowed down his field work and went back to UBC to start his PhD and to spend more time at home.

David's research involves hyperspectral imaging of rare earth element (REE) bearing minerals and rocks. REEs are a set of 17 trace elements, with concentrations in the parts per million or less. REEs, such as europium and neodymium, are key for the development of green and modern technologies, including hybrid cars, wind turbines, solar panels, electronic screens. Hyperspectral imaging exploits differences in the way individual minerals reflect, absorb or scatter light to produce coordinate maps of their distribution in a rock. Each pixel of the map contains information on how the minerals in that spot interact with select spectra of light. By knowing how each individual mineral interacts with those wavelengths, mineralogic maps down to a remarkable 1 mm spatial resolution are possible. David has also used hyperspectral imaging to investigate the mineralogy associated with sapphire deposits of Baffin Island. As David still loves travelling, he is analyzing his samples' mineralogy at UBC, performing spectral analysis at the University of Alberta and analyzing the data back home in the Comox Valley.

David in Greenland up near the ice sheet. The very large crystal longer than David's leg is kornerupine, a rare and complex borosilicate mineral. Red and green hues in the gravels are spinel and pargasite.

One may find looking at a spectrum of light less exciting than hiking the world looking for amazing gemstones. However, a spectrometer tuned to spectra of interest may be set up an airplane or a satellite, where David's gem and ore deposit knowledge could pinpoint the right places to look for interesting rocks. Besides shortening David's future hikes, this might also help to significantly reduce the land surface area damaged by a mining exploration operation. Hyperspectral imaging could also help in selecting only those rocks that are rich in rare elements from the large volumes extracted from the ground, which would reduce the volume of chemicals used to actually extract precious material from the rocks. David's seeks to apply his PhD results to industrial problems in the future as a postdoctoral fellow.

Fabien Rabayrol

in linkedin.com/in/fabienrabayrol

Jason McAlister, PhD Oceanography

Since the beginning of human civilization, people have been searching for metals such as gold and copper for industrial and economic purposes. Today, mining companies use modern exploration techniques and employ geoscientists like Fabien Rabayrol, PhD candidate in the Mineral Deposits Research Unit (MDRU) in EOAS, to travel the world in search of gold and copper deposits.

Fabien moved from his native France to Quebec, then to Turkey to work for Vancouver-based exploration mining companies, and has now parlayed this experience to a PhD program with the industry-sponsored Western Tethyan Metallogeny Project in Turkey. Here, Fabien and MDRU "combine research metallogeny, explaining how and why a deposit is formed, and mineral exploration geology, determining where a mineral deposit occurs and how much precious (gold and silver) and base metals (copper, lead, and zinc) it contains".

Beneath Fabien's research area in Turkey, the collision of Eurasian, African and Arabian tectonic plates has been swallowing up the ancient Neotethys Ocean, and more recently the Mediterranean Sea, for the last 100 million years. Convergence of these plates has created the Tethyan orogen, an area of mountain building extending from the Alps to the Himalaya via Turkey. The Anatolian microplate in Turkey occupies the central segment of this orogen and "was affected by a widespread collision-related magmatism hosting both precious and base metals, now targeted by exploration mining companies," explains Fabien.

Fabien's research seeks to reconstruct the metallogenic evolution of the Anatolides through the study of the complex interaction between tectonics and magmatism during the evolution of the Tethyan orogen, and its influence on the formation and distribution of gold and copper mineralization.

Fabien classifies magmatic rocks hosting gold and copper mineralization on the basis of differing ratios of elements and isotopes as revealed by mass spectrometry. Such geochemical fingerprints enable him to identify distinct magmatic suites and understand their evolution from their original source to their final emplacement and crystallization in the crust. However, magmatism does not occur continuously and it evolves through space and time along this complex orogen.

To determine when and where magmas were produced, when they started crystallizing and how long it took to freeze, Fabien measures changes in the isotopic composition of minerals resulting from radioactive decay in systems such as U-Pb, Ar-Ar, and Re-Os. Each system undergoes radioactive decay at a different rate. Thus, ages determined from different decay schemes can constrain distinct epochs in the production, cooling and crystallization histories of a given magma.

Each type of mineral has a specific closure temperature at which it captures elements produced through and thus begins counting time. The suite of atomic clocks that Fabien applies constrains the age of the magmatic rocks and mineral phases associated with gold and copper mineralization. Combination of these dates is crucial to understanding when and for how long magmatism and mineralization peaked during the major tectonic stages of the orogen evolution.

Finally, Fabien's research also aims to use low-temperature geochronology to assess the post-crystallization cooling history of the gold- and copper-bearing magmatic bodies and exhumation from their emplacement depth to the surface. This exhumation rate is perhaps most important, dictating if economic gold-copper deposits are presently available as outcrops at the surface or buried at depth. Alternatively, erosion may have long since carried riches away; lost to the forces of tectonics, wind, water, and the inevitability of time.

Photo by R. Yarra

PDFs and RAs

Photo by C. Kosman

Cheryl Chow

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Anna Grau Galofre, PhD Geophysics

Scientists calculate that there are around 5×10^{30} bacteria and around 10^{24} viruses in the world, less than 1% of which are fully characterized. They both play crucial roles as the base of food chains and for the ecological sustainability of Earth's oceans. Improving this understanding is the main interest of the post doctoral fellow Cheryl Chow at the Centre for Microbial Diversity and Evolution in the Biodiversity Research Centre. And she is good at it, with more than 10 publications in the last 4 years.

Even though bacteria and viruses are found in all habitats on Earth, we tend to care only about the ones that interact with us. But it is in the rest where most of the diversity of species, metabolisms, and functions occur. "It is not the 1% known of virus and bacteria species that I am interested in, but about the rest, the 99%, that mostly live in the oceans," Cheryl states.

Viruses and bacteria play a key role in the oceans. Phytoplankton, the microscopic photosynthesizing organisms inhabiting the surface oceans, constitute the base of marine food chains. Despite their small size, the biomass bacteria represent in the ocean is the equivalent of 30 million blue whales. The roles of viruses are fundamental: they infect bacteria and break their cells, releasing nutrients into the ocean in the process known as viral shunt. By doing so they control the microbial population and prevent runaway growth.

As a PhD student Cheryl worked in the San Pedro Ocean Time Series (SPOT) project. Over fifteen years, she and her collaborators identified variations in the amount, types, functions and roles of bacterial communities on a daily, seasonal and annual basis. This research is key to understanding what the roles of bacteria and viruses are at the base of support for the food web, when they appear en masse and why. Blooms of phytoplankton attract predatory fish. Consequently, knowing when a bloom will occur has major implications for the management of coastal fisheries.

But what Cheryl has in her plate now is even more exciting and fundamental. She is interested in understanding the functioning of marine viruses by surveying them and sequencing the DNA they carry as individuals. "It is like figuring out how a watch works by disassembling it and studying the pieces, the machinery," she notes. Such insulation has never been done before, not even in human-affecting viruses. These viruses have had their DNA sequenced before from large samples, but individual viruses have never been insulated from environmental populations. Isolation of single viruses would allow for a profound study on how they act, which populations they infect and what their role is in the ocean as recyclers of key elements for life such as nitrogen and phosphorous.

"The hardest part is going from a 10 mL sample of seawater that contains up to ten million viruses to just one without contaminating the sample in the process". It is certainly a challenge, but by achieving it she will provide science with a methodology to understand and study individual viruses. Application of this method could bring to light the great diversity and function of the myriad microorganisms yet unknown and potentially reshape the study of viral ecology.

Lydia Philpott

Chuck Kosman, MSc Geology

Lydia Philpott's studies have taken her on her own orbit. From her studies in her home of New Zealand at University of Auckland, to an honours degree in Astronomy and Astrophysics at the Australian National University, a Master's of Advanced Study at the University of Cambridge and a PhD in Theoretical Physics at the Imperial College, to programming planetary research software at the Institute of Geophysics and Planetary Physics, University of California, Los Angeles (UCLA), Lydia is no stranger to travel. Yet Lydia's current Research Scientist role at UBC under Dr. Catherine Johnson concerns travel about another planet entirely: Mercury, the planet closest to the Sun.

If you've ever used a magnetic compass on a hike, you've come to appreciate the utility of Earth's magnetic field. Much like the needle in the compass itself, Earth's magnetic field can be approximated as that of a bar magnet whose north and south ends are offset slightly from Earth's rotation axis. Mercury too has its own approximate dipole magnetic field.

"It's easy to measure Earth's magnetism from its surface," explains Lydia. Not so when it comes to the other celestial bodies. NASA's MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) satellite launched in 2004 continuously collected data on, among other things, the magnetic field of Mercury starting in 2011. Placed in a highly elliptical orbit about Mercury, MESSENGER frequently passed through Mercury's magnetopause, a dynamic boundary defined by where the tension of Mercury's magnetic field exactly balances the pressure of the continuous and vigorous bombardment of charged particles emitted from the Sun. Due to this elliptical pathing, Lydia is able to differentiate between the magnetism attributable to Mercury from that of the Sun in MESSENGER's collected data. After two mission extensions, MESSENGER ran out of fuel and crashed into Mercury's surface on April 30th, 2015.

Lydia welcomed the change from theoretical to planetary physics. Indeed, her experience at UCLA with planetary mission data set her up for success at UBC. "I've plotted all the magnetic field data and looked at every single orbit of MESSENGER", Lydia smiles. "I know immediately if something is strange about an orbit because I've looked at all of them." In contrast to Earth's nearly centered dipole, Mercury's is shifted 475 km, or about 20% of Mercury's radius, towards its north pole; the reasons for this offset are as of yet unknown.

Photo by C. Kosman

Lydia examines Mercury's magnetic field as just one piece of a larger planetary puzzle: "I'm interested in planets and how the solar system developed. The magnetic field is just one way of looking at one small part of that big question. Venus and Mars don't currently generate intrinsic magnetic fields but aren't that far from Earth, so different things must have happened in their histories. That must say something about the developmental history of the solar system, why planets are cooling at different rates. Have the planets moved from somewhere else in the solar system? The questions you can ask are endless."

With MESSENGER's recent mission termination, Lydia hopes to continue working with Catherine on two other early stage NASA missions; 1) OSIRIS-REx, which will sample asteroid Bennu and return to Earth; and 2) the InSight Mars lander, which aims to perform the first seismic studies of a planet other than Earth including the first picture of the structure of Mars' interior. Who knows where Lydia's orbit will take her next.

Nicolas Estrade

Chuck Kosman, MSc Geology

Nicolas in front of the Nu Plasma 1700, an instrument critical to his measruement of Si isotope abundance. Photo by D. Weis.

Nicolas Estrade isn't a detective, but he's looked at quite a few fingerprints. And he's not necessarily a financial guru, but he can tell you all about balancing a budget. As a postdoctoral fellow working with Dr. Dominique Weis and Roger François, Nicolas studies the way in which elements move between minerals, organisms, and their ecosystems—a complex task uniquely suited to an environmental isotope geochemist.

Not all atoms are created equal. Isotopes, or atoms of the same element with differences in their number of neutrons and consequently minute differences in mass, exist for all the elements of the periodic table. Silicon, for example, the second most abundant element of Earth's crust, naturally occurs with three different masses. As the continents are continuously weathered over millions of years, rivers transport particulate matter whose silicon isotopic composition is nearly that of the minerals and vegetation from which they were sourced. This matter is eventually spread over the submarine shelves at the margins of the continents. However, isotopic fingerprints aren't quite perfect records; many chemical and biological processes on Earth, including weathering, fractionate stable isotopes according to their slight differences in mass. Heavier silicon isotopes preferentially dissolve into water during weathering whereas the minerals left behind hold onto the lighter silicon isotopes.

When it comes to balancing the account of silicon in the oceans, something just doesn't add up. Considering all known its sources and sinks to the oceans, along with the processes that partition it between organic, particulate and dissolved phases, the predicted silicon budget of the ocean is lower than what is measured. All elements that dissolve into ocean water and remain there for up to thousands of years, in fact, have imprecisely balanced budgets to differing degrees. "For many elements, biogeochemical and isotopic balances are not even close," he stresses, smiling. Nicolas postulates that those sediments left out on the continental shelf are dissolving to balance the budget. "Calculations indicated that even if 1% of silicon coming from the continent dissolved, it could close the budget," he notes, though even that tiny amount is only dissolved over geologic timescales.

Fortunately, a natural laboratory exists right in Nicolas' backyard for him to test out his hypothesis. "My goal here at UBC is to trace the dissolution of silicon from the Fraser River into the open ocean in the Pacific," he states. By characterizing the isotopic composition of sediments discharged from the Fraser River and the ocean water overlying the continental shelf past Vancouver Island, Nicolas hopes to determine the extent to which dissolution of silicon from the continental shelf sediment figures into the budget.

Nicolas examines silicon isotopes in particular for direct evidence of his hypothesized dissolution. Isotopes of the elements samarium (Sm) and neodymium (Nd) have long been used to trace a wide variety of surface processes in the Earth sciences, including the potential contribution of continental margin sediment dissolution to the oceanic geochemical and isotopic budget. However, the low abundance of Sm and Nd only allow for indirect, low resolution field investigations of potential dissolution. The abundance of silicon on the continental shelf allows Nicolas to more directly quantify the magnitude of dissolution at the interface between continental shelf sediment and ocean.

In addition to examining silicon isotope geochemistry, Nicolas studies nickel isotopes for its similar discrepancy in its biogeochemical and isotopic budget. On top of these projects, Nicolas is also conceptualizing ecosystem resilience, the ability to recover from contamination. He examines isotopes of mercury, a metal notorious for its ability to accumulate within aquatic organisms and cause adverse health effects, in the bodies of fish kept frozen within worldwide environmental sample banks to do so. By characterizing sources of elements and how their isotopes are transformed in the environment over short time scales, Nicolas is part forensic scientist, part accountant, full-time geochemist.

Faculty Research

Photo by C. Schoof

Susan Allen

@sallen_sada

Thomas Aubry, PhD Geophysics and
Rhy McMillan, PhD Geology

Ocean processes are extremely complex and greatly impact the viability of life on the coast. Susan Allen is developing a cutting-edge model to forecast phenomenons ranging from storm surges to phytoplankton blooms of utmost interest to the many industries and communities who live and work near the Salish Sea.

Photo by C. Kosman

Susan contemplating different stations with two observationalists, Richard Dewey and Jody Klymak from the University of Victoria, on the Falkor.

Do you like to work with numbers? Do you find yourself contemplating between a career in banking and Earth Science? Dr. Susan Allen found herself in this exact situation not so long ago. Susan grew up in Kingston, on the coast of Lake Ontario. As an undergraduate, she studied physics at Queen’s University, where she made a decision that would forever change the trajectory of her career. “In about third year I lost interest in math for math’s sake and became interested in math that I could use to explain physical things,” says Susan.

Susan’s love for physics and the ocean have grown from two separate passions of hers: working with models and sailing. Her parents were both scientists, so science was a part of her life from a young age. Her family members were also sailors, and she even sailed competitively some time ago. “I raced a lot as a kid; it was a family thing,” Susan explains, “but I wasn’t terribly good at it.” With being a professional sailor off the table, Susan combined two of her interests and decided to study fluid mechanics during her PhD at Cambridge University.

After receiving her doctorate, Susan was not sure if the academic route was the best path for her. She decided to test her luck in industry, where she worked at Seakem Oceanography, Ltd. with an NSERC Industrial Post-doctoral Fellowship. This is where, again, the passion for her work showed: Susan did not enjoy how quickly she had to move from project-to-project in industry. When she starts something she wants to have the opportunity to finish it before moving on, even when working on a number of projects simultaneously.

After her enlightening post-doctoral work, Susan came to UBC where she is able to conduct research, spread her passions, and inspire her students as a faculty member in the Earth, Ocean, and Atmospheric Sciences (EOAS) Department. “I realized could not just do one thing,” Susan says, “and right now I have three quite distinct projects. I have a group that is doing a model of the Salish Sea, which includes the Strait of Georgia. I have another group that is pretty theoretical and trying to understand the flow dynamics of how water moves over submarine canyons. That one is not running in real-time like the Salish Sea model and is quite different. My other project is part of a big group in the department working with GEOTRACES, which is all the chemical oceanographers who are going on a big cruise later this year, while I am staying home modelling,” Susan says happily.

Susan’s team is working on the first high-resolution NEMO (Nucleus for European Modelling of the Ocean) model of the Salish Sea, which will lead to forecasts of everything from plankton blooms to the sea level height during storm surges. The predictions of their models are useful for many different individuals, ranging from fishermen, who rely on plankton blooms for fishing herring, to those that live near the beach, who can experience property damage during storms. Modelling such a complex system requires a wide range of expertise, such as how to model the fluid dynamics of ocean currents and parameterize the biology, as well as an understanding of small-scale mixing processes and the ability to efficiently and effectively communicate with those both involved and impacted. Learning the NEMO dynamical model took months of training and collaboration at other universities. Communicating the output in a comprehensible language is also challenging and requires a unique skill set, one that is fundamental to the model’s longevity.

The Salish Sea is on a different level than Susan’s team’s theoretical work on submarine canyons. These features are not only exciting places to explore, they are essential to marine life on the shallow continental shelf, which is the submerged part of a continent that extends out away from land. They also contribute greatly to atmospheric carbon removal. Earth’s rotation and the incline of the continental slope, which is where the shelf ends and drops off to the abyssal depths of the open ocean, cause a current that separates the shallow water teeming with marine life from the nutrient-rich depths. In some locations this current is overcome by the flow of water both up and down the slope, forming a conveyor belt that connects these two extreme environments. This flow occurs in submarine canyons. It brings carbon incorporated into life by the consumption of carbon dioxide into the deep ocean where it is sequestered, while also moving nutrients that are essential to life up from the depths where they can be consumed. Thus, understanding the movement of ocean water is paramount to resolving how this exchange affects both marine life and the climate. Additionally, Susan’s research on the flow of water in submarine canyons has similarities to how wind travels on the surface, and her methods have been used in modelling of the movement of air packages along mountain slopes.

The applicability of Susan’s work is much broader than submarine canyons or the Strait of Georgia. Although her expertise ranges from theoretical fluid mechanics and modelling to lab work (which she still considers to be modelling), much of the pertinence of her research comes from the interdisciplinary environment the department offers. Susan has the ability to collaborate with colleagues from different study areas and within her field, including outstanding ocean observationalist Dr. Rich Pawlowicz. “I work with observationalists, but am not an observationalist myself,” Susan says. “I have had many opportunities to add new skills during my sabbaticals, but have never chosen to add observation because of the great collaboration at UBC.” Because of the wide impact of her work, she considers herself lucky to have a network of students, post-doctoral fellows, and colleagues to help with the range of applications of her research.

Susan also teaches a number of classes at UBC, whose topics include atmospheric science, oceanography, and climate studies. Susan’s enthusiasm for teaching extends beyond her own classrooms; she is also an active participant in the movement to improve teaching campus-wide. As chair of the Peer Review Teaching Committee, she is involved in a peer review process for teachers, where she observes, evaluates, and gives feedback to colleagues in a holistic evaluation of the classroom. “The peer review is interesting because it can connect what is seen in the student evaluations to what we see in the classroom”, says Susan.

In the near future Susan intends to keep improving and enhancing the capabilities of her model of the Salish Sea in order to make the Strait more productive, safer, and better understood. Because of her passion and the applicability of her research, Susan is a wonderful example of someone who does not just study the world around her, she lives in it.

Raymond Anderson

Rhy McMillan, PhD Geology and
Johan Gilchrist, BSc Geophysics

The natural world is full of variation beyond the human imagination. Raymond Andersen taps into this reservoir to provide the building blocks on which new and exciting pharmaceutical drugs are established, ranging from those that help with asthma to those that fight cancer.

Above:
Photo by C. Kosman

How do you go from farm supply to supplying cancer medicine? One way is to follow the path of Dr. Raymond Andersen. From the dry badlands near Drumheller, AB to the wet kindness of Vancouver, BC, Raymond has taken his product supply knowledge to the cutting edge of pharmaceutical drug development. Currently, Raymond occupies a unique joint-position in the Departments of Earth, Ocean and Atmospheric Sciences (EOAS) and Chemistry at the University of British Columbia (UBC). He has also co-founded several companies in the pharmaceutical industry and received multiple, highly coveted awards for his academic contributions. So how did he do it?

Raymond grew up during the space-race era, an exciting time for science when the Soviet Union and USA were pushing the boundaries of space exploration. In his spare time, he would read the *Encyclopædia Britannica* and its supplements that arrived in the mail containing updates on the latest scientific developments. This and a desire for life in the big city served as motivation to leave the badlands and pursue a career in science.

Raymond successfully completed his high school science requirements, many of them through correspondence, and was accepted into the University of Alberta in Edmonton, enrolling in an honours physics program in his first year. It soon became apparent to him that he did not enjoy physics as much in university and switched into honours chemistry. He went on to start a Ph.D. at the University of California (UC) at Berkeley during the Vietnam war era, having a number in the draft lottery but luckily never called upon. At the time, his work involved the development of chemical lasers whose main application was related to shooting down missiles, something he was not very interested in, much less the war itself. Some of his good friends were in the field of oceanography, sparking his interest in the field., At the same time, he learned about a new professor at the Scripps Institute of Oceanography at UC San Diego, Dr. John Faulkner. Dr. Faulkner was focusing on discovering chemical compounds produced by organisms in the ocean, known as marine natural products, and accepted Raymond as his first Ph.D. student. At the forefront of marine natural products, they learned how to scuba dive and began collecting samples off the coast of California to compare their chemistry to that of terrestrial plants. It turned out that marine natural products contained new chemistry that no one had ever seen before.

So what are marine natural products and why study them? "About 50-60% of drugs that are used in human medicine are based on natural products. These are small, unique, organic molecules produced by living organisms. Many of them have properties that are useful for treating diseases, such as antibiotics, cytotoxins for treating cancer, all kinds of things," Raymond explains. He is interested in the secondary metabolites of marine organisms, molecules made by the organism that are not involved in keeping the organism alive and have some secondary purpose, like defense. While these may be found throughout the ocean, the incredible biodiversity of tropical reefs has proven to be the largest source of secondary metabolites, coming mostly from sponges. Sponges are some of the oldest living organisms on the planet and known as "nature's best fermenter" due to the variety of symbiotic relationships they have with the microorganisms they host. These microorganisms produce the secondary metabolites Raymond looks for and their hosts, sponges, are extremely difficult to culture in the laboratory, hence the need to find them in their natural habitats.

Raymond and Dr. Faulkner were in the process of discovering a massive reserve of natural products that had yet to be studied. They began building a database, focusing on antibiotics, which were relatively easy to isolate via a biological assay. This method is one that you might have encountered at the doctor's office when you have an infection. "They take your bug, then grow it on a plate and try a whole bunch of different types of antibiotics and see which one will kill it," explains Raymond.

From one well-known natural products chemist to the next, Raymond went on to secure a Postdoctoral appointment at the Massachusetts Institute for Technology (MIT). From there, he finally landed at UBC. As a pioneer of marine natural products chemistry, he was jointly appointed to the Chemistry department and the Institute of Oceanography, which was later absorbed by the EOAS department in 1996. With the history of research in EOAS driving towards two main goals, resource development and traditional research, his work bridges the gap between the two. Concerning natural products, he has "always been interested in the fundamental chemistry of these molecules, what are their structures, how can you synthesize them, how are they made biosynthetically by their producing organisms. But once [he] got to UBC, [he] really got focused on using these molecules as potential drugs," pointing out that many people do not realize the vast resource of potential drugs awaiting discovery in the ocean. The hope is that they will save human lives.

Since Raymond first ventured into the ocean, technology has progressed rapidly leading to great advancements in his field. In particular, methods for extracting and isolating the desired molecules have been invented and improved. Add to this the advancements in computers and the result is a huge database of the marine organic molecules that he and his colleagues have discovered over three decades. With such a massive supply, there may still be molecules with drug potential in the database that have yet to be put through the trials. With powerful computers, why can we not simply sidestep nature and have computers find all the possible molecules for us? "We discover chemical diversity that was created in nature through trial and error and evolution that no one would have ever imagined," says Raymond, adding that all computer based methods start from an idea conceived by humans. Though intelligent and creative, our imagination cannot compete with billions of years of evolution producing unimaginable biodiversity.

Delving into the business side of his work, Raymond has co-founded two Vancouver-based drug companies developing drugs inspired by marine natural products discovered in his lab. The first is developing a safe drug for asthma prevention, with ideal properties for kids who like the simplicity of taking a pill instead of using an inhaler. The second company is developing a drug for treating the last stages of prostate cancer, which have no current treatment options. Both companies are publicly traded on the NASDAQ and TSX, respectively, and Raymond believes that "trying to get one or both of these drugs approved and actually used in a clinic would kind of be the culmination of 30 some years of working on academic drug discovery."

From the big sky to the big ocean, Raymond took his childhood experiences to the world of marine natural products research. With his ultimate goal of finding a drug that helps people beat their illness close at hand, Raymond continues to be fully committed to his work, admitting that, "when I get up in the morning and think about what I would like to do, it's usually interesting things at work."

Below:
A member of Raymond Andersen's field team scuba dives in Papua New Guinea to collect samples for natural products research.

A picturesque view of the research and survey vessel being loaded with supplies before a sample collecting expedition by Raymond Andersen's field team in Papua New Guinea.

Kelly Russell

Jason McAlister, PhD Oceanography and
Anna Grau Galofre, PhD Geophysics

Kelly Russell has complemented his own research success by establishing a state-of-the-art research space benefiting researchers and international collaborators in Earth sciences, adaptable to the needs of his many affiliates and graduate students working on cutting edge problems in volcanology and petrology.

Kelly is a great example of a researcher that goes with the flow. Kelly came to EOAS as a new professor working on the application of theoretical geochemical thermodynamics to volcanic systems. His team conducts both laboratory and field-based research on fundamental problems in volcanology and petrology and also applied research on volcanic processes in collaboration with the diamond industry. Kelly's research spans many fields: "I don't have one expertise, the best part of my job is that I can go where I want". Kelly's intellectual flexibility has led him to establish collaborations as close as Canada and the US and as far as Italy and Germany.

Kelly is equally passionate coordinating collaborations among researchers at UBC. As Co-Director of the High Headspace Laboratory (HHL) in the new Earth Sciences Building (ESB), he facilitates research opportunities for colleagues across EOAS. The HHL stands proud within the new ESB atrium, a 100 foot long room with 5 ton cranes hanging from a 30 foot high ceiling. This massive space allows Earth science researchers to ask research questions that require specialized instruments to reproduce conditions of high pressures and temperatures. In building the concept for the space Kelly traveled the world to interview colleagues at institutions with similar dedicated research space, allowing EOAS to incorporate the best attributes in creating this unique new research asset at UBC. The HHL is a flexible space designed to accommodate cutting edge experimental research in the earth and ocean sciences for the next 50 years.

Kelly is proud of "the diverse faculty from across the EOAS department who use the HHL for applications and research questions of importance across society". Dr. Erik Eberhardt's research group studies, for example, mining safety in the HHL by investigating the stability of rocks forming the walls of mine shafts at increasing depths and pressures. To do this, cranes hanging from the ceiling load rock samples into a piston capable of producing high pressures found deep within mines. As increasing pressures crush the rocks microphones measure sound waves produced as the rocks crack. Analysis of these sound waves determines how rocks fail under pressure, helping researchers ensure mine stability and helping keep miners safe. Dr. Oldrich Hungr's research team is working to protect your travels from landslides. Rather than tumbling down a mountainside, in the HHL rocks crash harmlessly down a slide while being captured by high speed photography. This unique data is applied to researcher providing protection from landslide hazards. Dr. Ulrich Mayer's group use the HHL to study CO_2 sequestration in groundwater flows to mitigate climate change. The HHL is a profound success: many other faculty members and graduate students in EOAS use the flexible space and myriad instruments to conduct research into the optimization of hydraulic fracturing, geothermal energy, improving earthquake safety, and into groundwater remediation.

The HHL also hosts Kelly's experimental volcanology research program. Purpose-built devices allow Kelly to conduct experiments on rocks and magmas at temperatures found in volcanic systems. A major focus of Kelly's work is to build understanding of the rheology, or flow behaviour, of natural magmas with an aim of producing powerful and practical theoretical descriptions that can constrain key dynamics of volcanic eruptions.

As Kelly will attest, science often benefits from serendipity. Such an opportunity came with a phone call from a diamond exploration company looking for a volcanologist. An international search was on for experts in volcanology to study kimberlites, the rocks that host diamonds. Soon Rio Tinto was funding Dr. Russel's research group to study their diamond-bearing kimberlites in the Lac de Gras area of NWT. In addition to supporting exceptional graduate students now working in industry, this applied research produced several new scientific ideas and concepts important to understanding transport of magma and diamonds from the deep mantle to the Earth's surface.

Diamonds, one of the hardest known minerals and most prized gemstones, form deep in the Earth where high temperature and pressure stabilize carbon as diamond. Kelly explains that "kimberlite magmas are simply the vehicle for transporting diamonds to the Earth's surface where the diamonds can be mined". However, during transport, diamonds are expected to become unstable and turn into graphite, and who wants a pencil mine? How is it that kimberlite magmas can be transported hundreds of kilometers, from temperatures greater than 1000 °C, fast enough to avoid diamonds being turned into graphite?

Kelly explains that "logically, kimberlite ascent rates needed to be fast to explain diamond survival". Prior researchers suggested that H_2O or CO_2 bubbles in the magma expanded as pressure was released, analogous to the acceleration of a cork from a bottle of champagne. However, describing how bubbles form deep in the Earth was a puzzle as high pressures are expected to maintain the gas in solution, similar to the bubbles in champagne. Kelly provided an answer to this enigma with a quantitative model for diamond ascent and bringing him, as he puts it, his "two minutes of fame".

With colleagues, Kelly showed how CO_2 solubility can decrease dramatically as the magma becomes more silica-rich, forming bubbles in the original carbonate-rich magma carrying the diamonds. Expansion of these 2 bubbles reduces the density of the magma and accelerates the diamond-rich magma upwards. According to Kelly's estimates, kimberlitic lavas could travel 100 km in about 3 hours, a rate that would keep the diamond from turning into graphite. It is only thanks to this fast process that we can find diamonds at the surface, with applications in industry, mineral collections, and according to Marilyn Monroe, as a girl's best friend.

Flexibility and opportunism have characterized and stimulated Kelly's research for 30 years. Kelly has built collaborations both globally and with industry partners; and has now built the High Headspace Lab in the new ESB building. Kelly's passion is reflected in the HHL, where he aspires to the "creativity of future graduate students that will continue to change the space to incorporate their new ideas and experiments".

Katie Huang removes a crucible from a 1000 °C furnace, mimicking the volcanoes studied by Kelly's research group. Photo by A. Wilson.

Mark Johnson

@ecohydrologist

Chuck Kosman, MSc Geology and
Muriel Dunn, BSc Oceanography

Human land use dramatically affects how water moves through soil. Mark's novel interdisciplinary approaches study how the quantity of and compounds of carbon in groundwater are linked to these changes, providing directions for more sustainable land use practices.

You may have thought about taking a raft adventure Huckleberry Finn-style to leave your cares behind. UBC Professor Mark Johnson certainly dreamt of it as he grew up just inside the watershed of the Mississippi River in Virginia. However, Mark's interest in rivers took him on different journey across North America, from a PhD and postdoctoral studies at Cornell University, to further postdoctoral studies and ultimately an Associate Professorship at UBC. Straddled in a joint appointment between the Institute for Resources, Environment, and Sustainability and the Department of Earth, Ocean and Atmospheric Sciences, Mark is investigates how water moves throughout the landscape from the interdisciplinary perspective of ecohydrology.

Ecohydrology is an emerging field that explores how ecological and biological processes participate in and alter the hydrological cycle. Mark focuses on the coupling of the carbon cycle and the water cycle. In building an understanding of how carbon naturally moves through the soil, Mark also establishes a baseline for remediation efforts of all kinds. “CO2 has always been moving through these pathways; the degree to which it has been changed through human activities is of interest to get a better sense of anthropogenic impacts on our world,” Mark notes.

Observing how human activity changes the movement and composition of water in soil requires long term measurements over large areas in real time. Mark's research programs consequently require technologies that can continuously measure concentrations of trace gases, like CO2, without having to send researchers out on costly periodic sampling campaigns. “If you're only going every week or so to collect samples, you'll miss a lot of what's happening.”

Deforestation near the Campbell River. Anthropogenic land use changes the pathways that water takes through the soil and alters the carbon species it transports.

One such demanding research project is the assessment of how deforestation near the Campbell River changes the way in which carbon compounds move through the landscape, both above and below ground. As part of this project, Mark collaborates with Professor Andy Black of the Faculty of Land and Food Systems. Andy oversees the British Columbia network of flux towers, instruments that continuously measure the concentration of trace gases in the air, aptly named the BC FLUXNET. “At the same time, water is moving through the soil and taking carbon with it,” Mark points out. Mark's network of infrared gas analyzers installed into the soil provides subsurface chemical data complementary to Andy's atmospheric data. Importantly, Mark has found that deforestation not only fundamentally changes the pathways along which water travels through soil, but the types of carbon compounds that are transported as well.

You need not go to a forest to observe human impact on the water cycle. The abundance of dissolved organic carbon (DOC) in water is directly affected by changes in land use; water treatment plants seek to remove DOC because of its potential to form substances hazardous to human health. Last summer, Ashlee Jollymore (a PhD student) and Morgan Haines (an undergraduate student) began a project with Mark to collect data on DOC content in water from the Lower Mainland, the Sunshine Coast, Galiano Island – but not with their own hands. As part of the “Waterlogged” project the team sent calls out via social media requesting ordinary hikers and citizen scientists to take water samples from over 100 different locations. A map and description of the samples is publicly available at http://blogs.ubc.ca/waterlogged.

Another project of Mark's was inspired by an unsolved mystery of the Amazon. Black, anthropogenic soil containing unusually high charcoal content was discovered within the forests of the Amazon basin. Mark comments that this soil “violated essentially all the basic laws of soil science, in that they were highly enriched in organics yet located in the humid tropics where organic matter breaks down very rapidly.” Part of the enigma comes from trying to reason out why these soils are there: did people intentionally engineer them many years ago or were they a consequence of routine human activities? In either case, they inspired the production of biochar, created by heating organic waste products in the absence of oxygen to convert it to charcoal. This biochar can retain water and nutrients within soil, which promotes new growth.

The beauty of biochar is that it can be created from a wide variety of local industrial waste products. In BC for example, leftovers from the forestry industry are a potential source material for high quality biochar. “Following forest harvest, there's a lot of things that don't make it into the forest product stream that are left behind and gathered into piles termed ‘slash’ and often burned, which is probably not their best use. We're thinking if we could turn them into charcoal and enhance the soil properties for the next generation of trees, that might be a good thing for nutrient retention and carbon sequestration,” explains Mark. As part of this project, Mark collaborates with the UBC Farm to test biochar produced under a variety of pyrolysis conditions. Preliminary studies have shown that biochar is comparable to compost and that it is most beneficial when used in poor, sandy soils, as opposed to already healthy soil.

Not all of Mark's research takes place so close to home. To assess the effect of climate on ecohydrologic processes, Mark compares the wetlands of Brazil to the modest Burns Bog, just outside of Vancouver in Delta, BC. “The Pantanal is a wetland ecosystem in central South America which is quite seasonal in nature, it's about 6 months wet, 6 months dry. We're looking at the role of hydrology and the carbon cycle in the Pantanal”. Mark explains that studying our own smaller, less extreme scale wetland could help understand the ecological processes of methane formation, a significant greenhouse gas. With the easily accessible Burns Bog he can fill the knowledge gap of the balance between natural variability and human impact on methane production and one of its largest contributors, wetlands. Mark is currently collaborating with The Burns Bog Conservation Society and Dr. Andreas Christen, an associate professor in the Department of Geography at UBC, who are looking into the different stages of recovery of the bog and their relation with methane dynamics.

Water is our most precious resource. From food to forests and all life in between, living organisms, including humans, depend on its availability. In the consumption of water and the resources derived from it, landscapes and the water that moves through them are fundamentally changed. Mark's ecohydrological research characterizes how water moves through soils before and after anthropogenic land use changes. Through this characterization, directions for more sustainable land use practices and remediation efforts will emerge.

Waste timber in slash piles like these has the potential to be transformed into biochar.

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2012 – 2013*

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Barling, J., & Weis, D. (2012). An isotopic perspective on mass bias and matrix effects in multi-collector inductively-coupled-plasma mass spectrometry. Journal of Analytical Atomic Spectrometry, 27(4), 653-662.

Awards and other distinctions

Allen, Susan

Francois Saucier Prize in Applied Oceanography, Canadian Meteorological and Oceanographic Society (CMOS). For her application of fluid dynamics to better understand biological and chemical processes in the ocean and, in particular, for her recent groundbreaking work in developing a robust method for forecasting spring blooms in the Strait of Georgia.

Andersen, Raymond

Chemical Institute of Canada (CIC) Medal. This is the top award for chemical research in Canada for all branches of chemistry.

Francois, Roger

Killam Fellowship, UBC.

Hungr, Oldrich

The Thomas Roy Award of the Engineering Geology Division, awarded by the Canadian Geotechnical Society "for contributions to engineering geology in Canada".

Ivanochko, Tara

UBC Sustainability Teaching and Learning Fellowship.

Jellinek, Mark

Named Senior Fellow, Canadian Institute for Advanced Research.

Reviewer of the year, Geophysical Journal International.

Johnson, Mark

Fullbright Research Fellowship, U.S. Fullbright Commission, Science and Technology Research (Brazil).

Special Visiting Researcher, Brazilian Ministry of Science and Technology, Brazilian Science Without Borders Research Fellowship.

Oldenburg, Doug

Distinguished Lecturer for SEG (Society of Exploration Geophysics).

J. Tuzo Wilson Medal: Presented by Canadian Geophysical Union. The Union gives this award annually to recognize scientists who make outstanding contributions to Canadian geophysics. Factors taken into account in the selection process include excellence in scientific or technical research, instrument development, industrial applications and/or teaching.

Scoates, James

EOAS Undergraduate Instructor of the Year Award.

Steyn, Douw

Elected Fellow of Canadian Meteorological and Oceanographic Society

Weis, Dominique

European Consortium for Ocean Research Drilling, ECORD Distinguished Lecturer. ESSAC selects three Distinguished Lecturers per series, one in each of the three main thematic areas of IODP research. Dominique was selected in the “Solid Earth Cycles and Geodynamic” theme.

2013 – 2014*

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Andersen, Raymond

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Haber, Eldad

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*Academic year spans March 31st - April 1st.

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Hungr, Oldrich

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Ivanochko, Tara

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*The NICOPP working group is a group of 40 people of which Tara is one.

Jellinek, Mark

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Orians, Kristin

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Russell, Kelly

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Tortell, Philippe

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Waterman, Stephanie

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Weis, Dominique

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Awards and other distinctions

Allen, Susan

Invited speaker of the Canadian National Committee (CNC) of the Scientific Committee of Oceanographic Research (SCOR) Eastern Lecture Tour.

Bostock, Michael

Edwin Allday Lectureship, University of Texas at Austin.

Bustin, Marc

Stanley E. Slipper Gold Medal, awarded by the Canadian Society of Petroleum Geologists (CSPG) for outstanding career contributions to oil and gas exploration in Canada.

Eberhardt, Erik

John A. Franklin Award, Canadian Geotechnical Society. Bi-annual award for an individual who has made outstanding technical contributions in the fields of rock mechanics or rock engineering applied to civil, mining or petroleum engineering).

Hickey, Ken

EOAS Undergraduate Instructor of the Year Award.

Hungr, Oldrich

Elected Fellow of the Geoscientists, Canada.

Johnson, Catherine

Elected Fellow of the American Geophysical Union.

Oldenburg, Doug

Elected Fellow of the Royal Society of Canada.

Pawlowicz, Rich

Canadian Meteorological and Oceanographic Society's President's Prize: "To Richard Pawlowicz of the University of British Columbia for his outstanding contribution in developing the new seawater standard TEOS-10. His novel contributions provide greater accuracy in estimating the physical properties of seawater.

Scoates, James

Awarded an International Research Chair at the Université Libre de Bruxelles in Brussels, Belgium.

Steyn, Douw

US EPA Scientific and Technological Achievement Award (Honorable Mention).

Suttle, Curtis

Elected as a Fellow of the American Academy of Microbiology.

Elected Chair of the Gordon Conference on Molecular Ecology.

Tortell, Philippe

Distinguished Scholar in Residence, Peter Wall Institute for Advanced Studies, UBC.

Waterman, Stephanie

Australian Research Council Discovery Early Career Researcher Award.

Weis, Dominique

Médaille André Dumont, career award Geologica Belgica 2014.

Chair of the International Program Committee for Goldschmidt 2014 (North America, Sacramento).

2014 – 2015*

Publications

Allen, Susan

Spurgin, J.M. & S.E. Allen, (2014). Flow dynamics around downwelling submarine canyons. Ocean Sci., 10, 799-819.

Snauffer, E. L., Masson, D., & Allen, S. E. (2014). Modelling the dispersal of herring and hake larvae in the Strait of Georgia for the period 2007–2009.Fisheries Oceanography, 23(4), 375-388.

Andersen, Raymond

Sriyatep, T., Siridechakorn, I., Maneerat, W., Pansanit, A., Ritthiwigrom, T., Andersen, R. J., & Laphookhieo, S. (2015). Bioactive Prenylated Xanthones from the Young Fruits and Flowers of Garcinia cowa. Journal of natural products, 78(2), 265-271.

Piotrowski, J. S., Simpkins, S. W., Li, S. C., Deshpande, R., McIlwain, S. J., Ong, I. M., ... & Andersen, R. J. (2015). Chemical Genomic Profiling via Barcode Sequencing to Predict Compound Mode of Action. Chemical Biology: Methods and Protocols, 299-318.

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Centko, R. M., Steinø, A., Rosell, F. I., Patrick, B. O., de Voogd, N., Mauk, A. G., & Andersen, R. J. (2014). Indoleamine 2, 3-Dioxygenase Inhibitors Isolated from the Sponge Xestospongia vansoesti: Structure Elucidation, Analogue Synthesis, and Biological Activity. Organic letters, 16(24), 6480-6483.

Du, Y. L., Williams, D. E., Patrick, B. O., Andersen, R. J., & Ryan, K. S. (2014). Reconstruction of Cladoniamide Biosynthesis Reveals Nonenzymatic Routes to Bisindole Diversity. ACS chemical biology, 9(12), 2748-2754.

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Awards and other distinctions

Andersen, Raymond

Elected Fellow, American Society of Pharmacognosy.

Eberhardt, Erik

Mann Redmayne Medal for best paper published in the Transactions of the Institution of Mining and Metallurgy: Ahmed, H.M., Eberhardt, E. & Dunbar, W.S. (2014).

Gilley, Brett

EOAS Undergraduate Instructor of the Year Award.

Harris, Sara

Society for Teaching and Learning in Higher Education (STLHE) 3M National Teaching Fellowship.

Herrmann, Felix

Selected for the EAGE Distinguished Lecture Programme: Felix Herrmann, "Wavefield Reconstruction Inversion – a New Perspective on FWI".

Jellinek, Mark

UBC Killam Teaching Prize.

Canadian foundation for Innovation John R. Evans Leaders Fund "Center for Geophysical Mixing in the Earth System".

Johnson, Catherine

Bullard Lecture, Geomagnetism and Paleomagnetism section named lecture.

Schoof, Christian

Killam Faculty Research Fellowship.

Smith, Paul

Fulton Award for service to students and the community of UBC. This recognized: a) his fundraising for the ESB; b) his central role in the UBC decision to found Vantage College; c) his support of the Wieman teaching initiative both as former Head of EOAS and as a board member.

Geological Association of Canada's Billings Medal for outstanding contributions to Canadian Paleontology.

Stull, Roland

EOAS Undergraduate Instructor of the Year Award.

Suttle, Curtis

Appointed as a Fellow of the Institute for Advanced Study at Hong Kong University of Science and Technology.

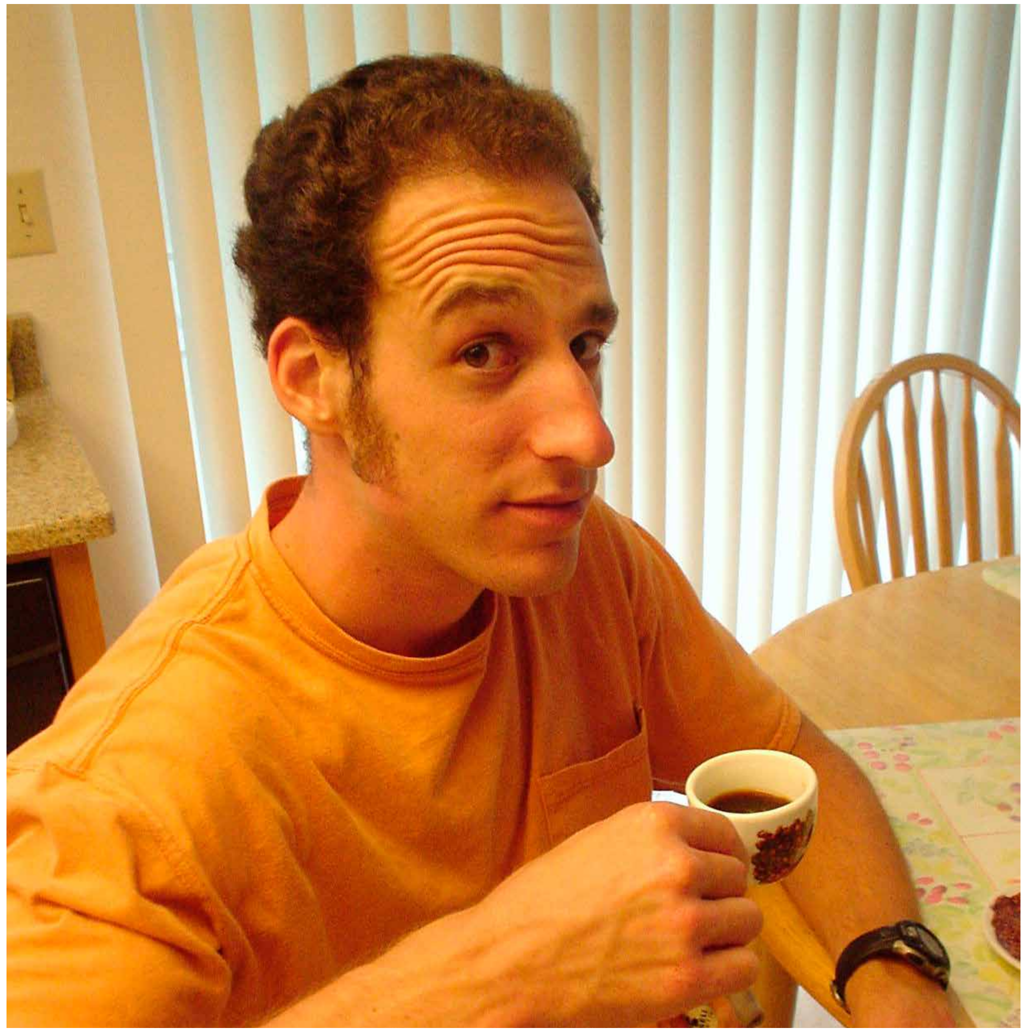
Weis, Dominique

Médaille André Dumont, career award Geologica Belgica 2015

Invited scientist for the Integrated Ocean Drilling Program (ODP) Expedition #357 (Atlantis Massif) .

In Memoriam: John "Ernie" Esser

May 19th 1980 – March 8th 2015



Felix Herrmann

John "Ernie" Esser was a post-doctoral fellow at the Seismic Laboratory for Imaging and Modelling. Ernie was a fantastic researcher working on a wide variety of problems. Beyond being an extremely enthusiastic and talented scientist, he was above all immensely generous with his time and ideas. This made him a key figure in our group and the ideal "go-to guy" for anybody who wanted to learn about large-scale optimization and scientific computing.

Ernie earned his PhD in Mathematics from UCLA in 2010 and joined UBC back in 2013. Over the relatively short time Ernie was at UBC, he made major contributions to two main areas. He came up with a new method for automatic delineation of high-velocity unconformities from seismic data using a technique known as full-waveform inversion. Ernie also made a major breakthrough in blind deconvolution, one of the classic problems in seismology. What made Ernie so special was his ability to turn recent developments in the mathematical and computer sciences towards breakthroughs in computational seismology.

Ernie also had a fantastic sense of humour, never complained, and was always in for a double espresso. He biked everywhere, played soccer, hiked, flew boomerangs and made wine and mead to share with friends. He returned each spring to his *Alma mater* the University of Washington to give his presentation "Why Boomerangs Come Back" at the Math Day program for high school students.

On March 8, 2015, Ernie passed away tragically. Following this news, our group received a major outpouring of shock and sadness from Ernie's friends, collaborators, and from different groups in academia and industry with whom he had been interacting. Ernie has had and will continue to have an enormous impact on the fields of scientific computing and image processing and on the UBC Seismic Laboratory for Imaging and Modelling. He was an exceptional researcher who really got it, with the ability to learn a new field and contribute. It was a privilege to have Ernie work with us. His family, everybody he interacted with at UBC, our sponsors, and the scientific community at large will dearly miss him.

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