



Diamond Exploration and Research Training School

Winter 2020, Issue 3

Newsletter

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Last year we enrolled our largest student cohort to date: 14 new students joined the DERTS program. The DERTS students participated in a variety of internships and workshops, presented at national and international conferences, organized and led an international fieldtrip and continued to diligently work on their research projects and publish their results! Details of all our DERTS activities are summarized in our newsletter.

We are greatly indebted to all our internship partners who continue to provide excellent and rewarding internship placements for the DERTS students. The students were excited to share their internship experiences with their colleagues through presentations on DERTS Day. Thank you for your ongoing support!

The DERTS Team continues to make significant contributions to the knowledge about diamonds, kimberlites and the mantle with the publication of over 35 manuscripts in 2019!

Our first international fieldtrip to Guatemala was a huge success! The fieldtrip was organized and run entirely by the student cohort. The group visited two ophiolite terranes and climbed several volcanoes to examine volcanic deposits.

We look forward to future productive collaborations with all our research and industry partners!

Graham Pearson
DERTS Program Director



Funding provided by:



About the program

DERTS is a unique graduate studies program that brings together industry, government and academia to train students in the latest advances in volcanology, geochronology, indicator mineral analysis/ interpretation, and exploration geophysics as applied to diamond deposits.

The program provides fully funded scholarships for high-performing MSc and PhD that are interested in conducting research related to diamonds and/or kimberlites at the University of Alberta or the University of British Columbia. The DERTS program includes a highly successful industrial internship component that provides on-site experience at mines, on exploration projects, in laboratories and with geological surveys. Internships average 8 weeks per year over the course of the degree. These internships provide the students with the critical experience they need to successfully secure jobs in the mining and exploration industry upon graduation.

The DERTS research team is internationally recognised, with a broad spectrum of expertise ranging from diamond mineralogy and geochemistry, kimberlite petrography and volcanology, geochronology, theoretical and lab-based experimental studies, to exploration geophysics and hyperspectral techniques for mineral exploration.

The DERTS program is in the 4th year of a 6-year grant. The program is funded by a \$1.65 million grant from NSERC CREATE, with additional support from the University of Alberta of \$400,000. Funding to support the research portion of each project has exceeded \$600,000 since the inception of the program. Additionally, numerous DERTS collaborators have provided funding to support DERTS events including fieldtrips, conferences and internships, to date totaling over \$200,000.

For more information about the DERTS program, please visit: www.uab.ca/diamonds or contact us: derts@ualberta.ca.



2019 Program Overview

2019 Graduates

Five DERTS students successfully defended their theses in 2019! Ben Gruber kicked off the year by defending his MSc. in March and the remaining four students defended their theses in the fall of 2019. Their research projects (see below) covered a variety of topics including mineral chemistry of inclusions in diamonds, geochemistry of kimberlites, understanding kimberlite eruption processes and modelling mantle structure using MT data. If you would like a copy of any DERTS thesis, please contact us at derts@ualberta.ca. Recent DERTS graduates have secured jobs with industry or are enrolled in furthering their studies.



DERTS Students – Completed Theses



Ben Gruber, MSc.

Thesis: Temperatures and Heat Production in the Slave Craton Lower Crust: Evidence from Xenoliths in the Diavik A-154 Kimberlite.

Defended: March 2019

Current position: PhD candidate at Scripps Oceanographic Institute



Sean Bettac, MSc.

Thesis: A 3D Magnetotelluric study of the Slave Craton Lithosphere, NW Canada.

Defended: September 2019

Current position: Geophysicist with DeBeers



Marina Karaevanglou, MSc.

Thesis: Diamondiferous mantle beneath the Lace kimberlite in South Africa : evidence from mineral inclusions in diamonds.

Defended: October 2019



Dennelle Smyth, MSc.

Thesis: Petrology, chemistry, and geochronology of the Pikoo kimberlites, Saskatchewan.

Defended: November 2019



David Sasse, MSc.

Thesis: Attrition of mantle cargo during kimberlite ascent: Insights from analogue experiments.

Defended: December 2019

Internships

DERTS students participated in 11 internship placements with 9 DERTS partners in 2019. The interns were hosted by exploration and mining companies, commercial and national laboratories, and geological surveys. Through the internship placements the students learned to bridge academic scholarship with practical experience gaining invaluable hands-on work experience in a broad range of fields. In addition to the technical experience, they also participated in supplementary on-the-job training sessions including Wilderness First Aid, off road driving, field navigation, firearms training, field safety, helicopter safety and survival training. The interns were excited to share their internship experiences with the entire DERTS group during our annual meeting. The financial support provided by intern hosts to facilitate internships in 2019 exceeded \$85,000. We are extremely grateful to all the internship hosts for providing a very welcoming environment for the students and to all employees for taking the time to share their expertise and for making the students feel like they were part of the team.

Rio Tinto hosted **Christian Veglio, Brody Myers and Dylan Cone** over a period of 5 months during the summer of 2019. Christian and Brody spent most of their internship placements at the FALC project logging and sampling kimberlite core. During his placement Brody was fortunate to accompany Rio staff on a visit to the Diavik diamond mine. During his placement Dylan worked with the Rio team in Vancouver developing software related to kimberlite exploration.



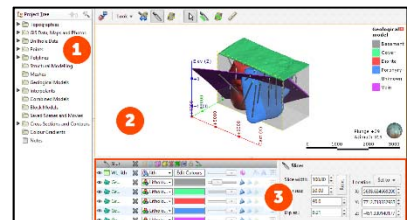
Christian logging core at the FALC Project.



Nicole at the SRC Geoanalytical labs.

Nicole Meyers held a 4 month internship at the Saskatchewan Research Council (SRC) in Saskatoon. Nicole worked on projects related to kimberlite and diamond processing with the team at the Geoanalytical Laboratories. She gained practical experience working as part of a multidisciplinary team and was introduced to the processing procedures for commercial samples.

Mei Yan Lai participated in an internship with Dominion Diamond Mines. She spent several months at Dominion's Calgary office working on geostatistical analysis and 3D geological modelling using Leapfrog Software. During her placement, she had the chance to visit the SRC Laboratories to observe some diamonds.



Mei gained experience using Leapfrog modelling software.

Tim McIntyre followed up on his successful 2018 placement with Anglo American with a second 5 month internship placement during the summer of 2019. Tim spent part of his time in Vancouver contributing to the planning and logistics for the summer field program and completing several required safety-training programs. Subsequently Tim spent several months working on a project in Greenland where he completed prospecting and aerial surveying as well as gained experience with project management.



Fieldwork in Greenland was helicopter supported.

The Alberta Geological Survey (AGS) hosted **Will Siva-Jothy** as an intern in 2019. Will spent several weeks at the AGS working with ArcPro to compile and construct a 3D model for Alberta kimberlites for inclusion in the AGS's 3D Geological Framework. He additionally continued with the work previous AGS intern Garrett Harris started with updating the kimberlite indicator mineral (KIM) microprobe data database for online publication.



Alberta 3D Geological Framework (Image: AGS)



Sigma 300 VP SEM at

Kelsey Bulbuc spent several months in Copenhagen, Denmark working with the Geological Survey of Denmark and Greenland (GEUS). Kelsey gained experience analyzing samples using multiple analytical instruments including SEM and ICPMS. In addition to the technical training she enjoyed the cultural experience and learning to speak Danish!

Gabrielle Jones worked with the BC Geological Survey on their Hogem Batholith Mapping Project in Northern BC. After initial preparatory work in Victoria Gabi participated in several mapping campaigns including helicopter set-out mapping and working out of an alpine fly camp. The mapping entailed 5-10 km traverses through rugged terrain collecting all field data on tablets using Manifold software.



Photo: G. Jones

Completing a mapping traverse at the Hogem Batholith Project.



Photo: uni-bayreuth.de

Bavarian Research Institute of Experimental Geochemistry and Geophysics (BGI)

Margo Regier spent several weeks working a various laboratories across the globe including: the Advanced Photon Source synchrotron facility, Chicago, the Raman Laboratory at Northwestern University, the Geochemistry Laboratory at the University of Southampton and the XRD Laboratory at Bayreuth University. These opportunities allowed her to access and use instrumentation and novel

isotopic techniques not available at the University of Alberta. It also provided Margo with the opportunity to experience how different laboratories operate around the globe.

Natasha Barrett was awarded a prestigious research internship through the Exploration Science Summer Intern Program at the Center for Lunar Sciences and Exploration in Houston Texas. Natasha was part of team that mapped geological features on the moon using ArcMap tools in preparation for future crew-based lunar missions. During the internship was she was fortunate to tour many of NASA's facilities including the Neutral Buoyancy Lab, Lunar Rover yard and Lunar Landing Research Vehicle as well as observing lunar samples! The internship resulted in the publication of 2 geological maps of the Moon's South Pole.



Natasha (center) viewing lunar rocks at the Lunar Sample Laboratory.

Workshops

Indicator Mineral Workshop

Cristiana Mircea from the Saskatchewan Research Council (SRC) prepared and taught an Indicator Mineral Identification Workshop for the DERTS group in March 2019. The students learned to identify and sort indicator minerals from various size fractions of heavy mineral concentrate. The students enjoyed working with genuine exploration sample sets and learning about the indicator mineral selection processes and operations of a commercial laboratory. Thank you Cristiana for sharing your valuable knowledge with the students!



Kimberlite Petrology and Core Logging Workshop

Bruce Kjarsgaard from the Geological Survey of Canada returned to teach an updated Kimberlite Petrology and Core Logging Workshop for the DERTS program. The workshop ran between November 12 and 14, 2019 at the University of Alberta. The workshop included lectures by Drs. Kjarsgaard and Pearson covering topics ranging from mantle mineralogy to kimberlite volcanology and core logging techniques. In the laboratory the students had a chance to examine numerous

samples of mantle xenoliths and kimberlite both in hand samples and in thin sections. The practical portion of the workshop also included exercises on coarse and detailed line scans, heavy mineral scans and core logging. The University of Alberta has a broad collection of full drill holes of kimberlite core from across Canada. Additional representative samples of kimberlite core and mantle xenoliths from the collections of Drs. Kjarsgaard, Pearson and Stachel were also used during the workshop to provide the students with exposure to a broad range of kimberlite and mantle xenoliths from across the globe. Due to the positive feedback from the students we plan to offer this workshop every 2 years so that all students in the DERTS program will have a chance to complete it.

Thank you Dr. Kjarsgaard for once again teaching an excellent course, we look forward to running the next workshop!



Students completing the practical exercises and participating in lectures during the Kimberlite Petrology and Core Logging workshop.

DERTS 2019 Fieldtrip

In April 2019 a group of 10 DERTS students along with 2 faculty members participated in a student organized and led fieldtrip to Guatemala. The field trip was split into 2 parts: Part 1 focused on obducted arc assemblages from Cretaceous aged subduction in central Guatemala and Part 2 examined modern arc volcanism in eastern Guatemala. Thanks to all the DERTS students for organizing the trip which was a stunning success! Margo Regier and Tim McIntyre devoted a substantial amount of time and effort to immaculately planning the logistics of the trip which

ensured the trip ran very smoothly. The remainder of the fieldtrip participants researched and compiled the field guide and led the group at each of the outcrop locations.

The DERTS 2019 field trip by sponsored by NSERC, the University of Alberta, DeBeers Group and the Prospectors and Developers Association of Canada, we are gratefully for all your support!

For Part 1 of the trip we were joined by professor Sergio Moran and his students Carlos Ventura, Servin Aguilar, and Hugo Hernandez Cajas from the University of San Carlos, Guatemala. Dr.Moran and his students were invaluable guides leading the group to the best outcrop locations and giving the students a chance to practice their Spanish! This portion of the trip visited the Chaucus complex and 2 ophiolite complexes: El Tambor and Baja Verapaz which are sandwiched between the North American and Caribbean plates along the Motagua fault zone. The group had a chance to observe a variety of rocks in outcrop including eclogite, ultra-fresh orthopyroxene-rich massive harzburgite as well as orthogneiss with garnet amphibolite lenses which were interpreted to be retrogressed eclogites. Additionally, the group was fortunate to secure a visit to a Jadeite locality where several meter-plus scale jadeitite boulders are found as float in the serpentinite melange. Guatemala is second only to Myanmar (Burma) as a source of the rare form of jade known as jadeite.



Clockwise from top-left: The group at the El Tambor complex orthogneiss outcrops; Margo Regier, Kelsey Bulbuc and Graham Pearson closely examining minerals in an amphibolitized eclogite at El Chol; Eclogite specimen from the Chaucus complex; Group dinner at a local restaurant at Granados; DERTS students and our Guatemaln guides examining light green-white coloured meter-scale jadeite boulders; The group examining ultra-fresh orthopyroxene-rich massive harzburgite at a roadside quarry near Purulha.

The second portion of the trip (Part 2) included visits to the Acatenango, Fuego, and Pacaya volcanoes followed by a boat tour around the Lake Atitlan Caldera. The group participated in an overnight hike to the summit of Acatenango volcano where they were able to observe the active eruption of Volcan Fuego. Subsequently a hike up the Pacaya volcano offered the students the opportunity to closely observe active a'a flows cascading down the side of the volcano and recently cooled t a'a and pahoehoe flows. On the drive to Lake Atitlan the group saw the extensive pyroclastic flow deposits formed by the Los Chocoyos eruption - the latest eruption of the Lake Atitlan Caldera ~84mya. The pyroclastic deposits fill many of the valleys in Guatemala with ~200 m of non-welded pumice, crystals, ash, and lithic fragments. Lake Atitlan itself partially fills the caldera which formed during the Los Chocoyos eruption. The caldera is surrounded by 3 volcanoes: Volcan Toliman, Volcan Atitlan, and Volcan San Pedro.



Top-left to right: An eruption at Volcan Fuego seen from the top of Volcan Acatenango. The group at the summit of Volcan Acatenango;

Centre: Lake Atitlan partially fills the caldera which formed during the Los Chocoyos eruption. The caldera is surrounded by 3 volcanoes: Volcan Toliman, Volcan Atitlan, and Volcan San Pedro (left to right although obscured largely by the mist).

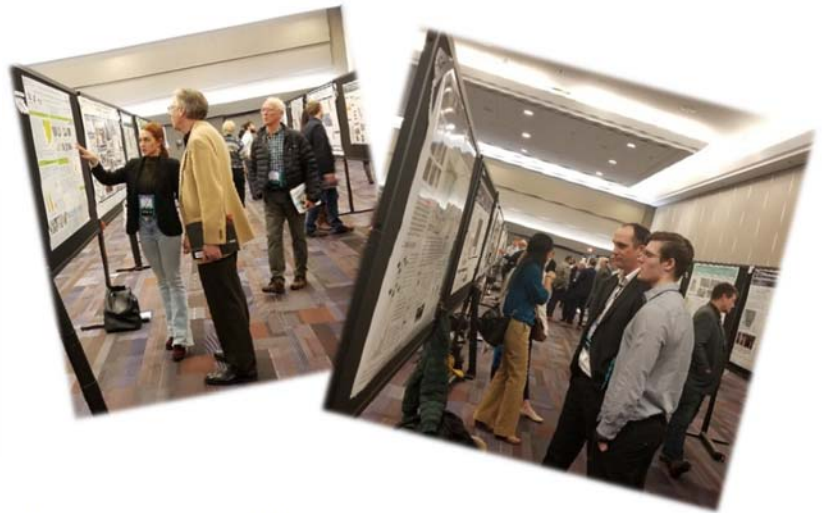
Bottom-left to right: Active a'a lava flows were observed during the hike up the Pacaya Volcano. Massive ash deposits several ten's of meters thick are exposed along roadcuts.

The DERTS 2019 Guatemala fieldtrip guide is available for download on our website www.uab.ca/diamonds.



Conferences

Exploration Roundup



DERTS students from both the U of A and UBC attended the AME Roundup conference in January 2019. We had a booth at the tradeshow to facilitate interaction between students, faculty and our industry partners. Marina Karaevnagelou (*center photo*) and David Sasse (*left photo*) both presented posters on their research projects.

PDAC Convention and GAC-MAC-IAH Conference

Christian Veglio attended and presented at both the PDAC Convention in March and the GAC-MAC meeting in Quebec City in May. The PDAC Convention is the most-attended event for the world's mineral exploration and mining sector and allowed Christian to interact with industry professionals. GAC-MAC is Canada's largest geoscience conference and gave Christian the opportunity to interact with renowned Canadian and international geoscientists.

The Diamond Conference

The DeBeers sponsored Diamond Conference is held annually in July at the University of Warwick, UK. The conference brings together scientists and industry professionals with a focus on the physical properties of diamonds. Margo Regier presented on her research relating to boron-bearing blue diamonds.



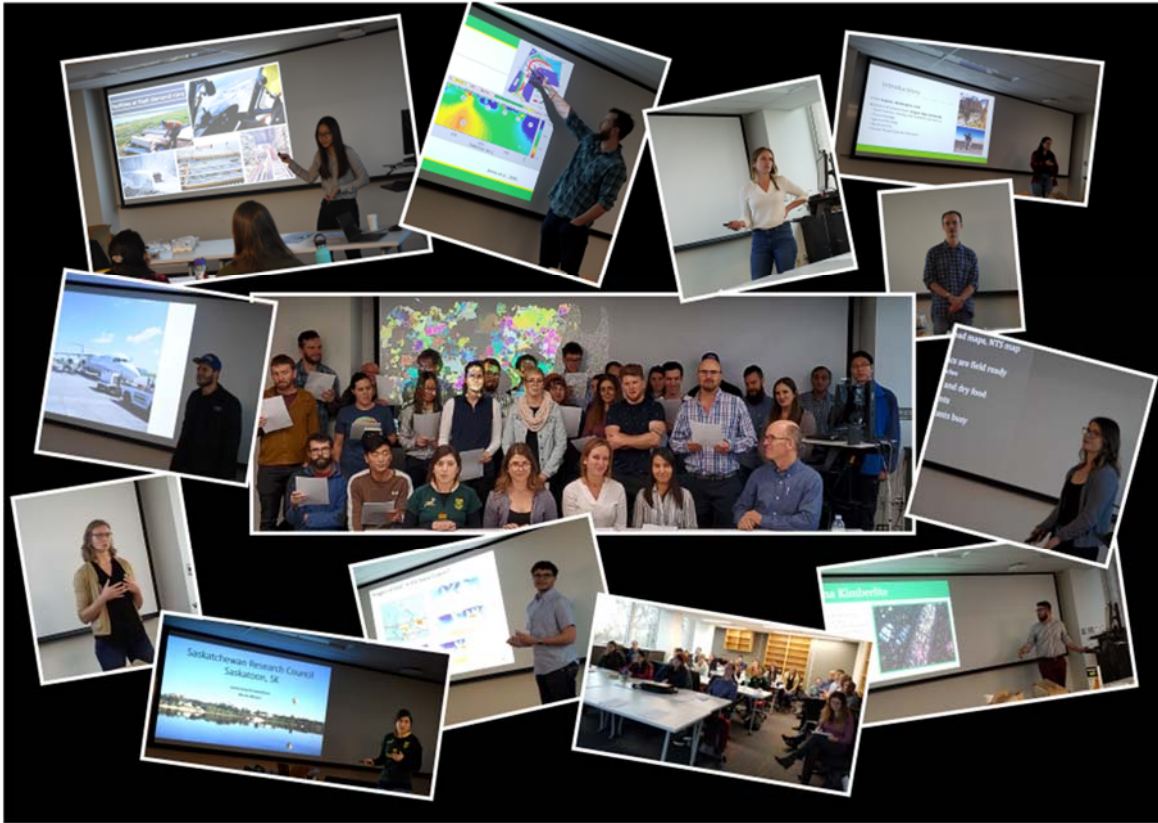
Margo (second from right) discussing her research after her presentation.

DERTS Day 2019!

On November 1, 2019 DERTS students and faculty gathered in Edmonton for the DERTS Annual meeting. The focus of DERTS Day was to introduce and integrate our 14 new students from U of A and UBC. The day was the perfect occasion for the new cohort of U of A and UBC students to meet and interact with the entire DERTS faculty and the previous student cohorts. The new recruits got a



to hear first-hand about the program through presentations by senior students about their internship experiences and research progress. Overall a very informative and constructive day!



DERTS students presenting at the 2019 DERTS Annual meeting. Center: The DERTS Team including students and faculty which now numbers 32! Presenters Clockwise from top left: Mei Yan Lai, Brandon Chase, Margo Regier, Katherine Landoni, Dylan Cone, Gabrielle Jones, Nikita Kepezinskas, Sean Bettac, Nicole Meyer, Kristi Kublik, and Brody Myers.

Connecting with Industry Partners

Along with meeting with our collaborators and supporters at numerous conferences throughout the year we welcome visiting DERTS supporters at the University of Alberta. These visits provide the opportunity to share our recent research, gather feedback about the program, strengthen relationships and discuss future collaborations. Additionally, these visits provide the students with a chance to interact with, and present to, industry professionals and visiting scientists in a relaxed setting. During your visit we are happy to arrange tours of our state-of-the-art laboratory facilities on campus and discuss potential research projects. If you are interested in visiting, or are passing through Edmonton, let us know and we would be happy to arrange a tour.

Seminar Series

Two seminar series are incorporated into the DERTS program to provide an opportunity for visiting industry professionals and scientists to present recent approaches/advances in exploration and evaluation techniques and cutting-edge research.



The DERTS Seminar Series is hosted at the University of Alberta in Edmonton. The series provides an opportunity for discussion and networking among industry and academic visitors and students. It additionally, provides a forum for developing collaborative research projects. Over the past year we have hosted numerous presenters including: Dr. Herman Grutter (SRK Consulting), Dr. Timmerman (Banting Fellow, University of Alberta), Dr. Jeff Harris (University of Glasgow), Dr. Ingrid Chinn (DeBeers Group) and Jon Carlson (Dominion Diamonds).

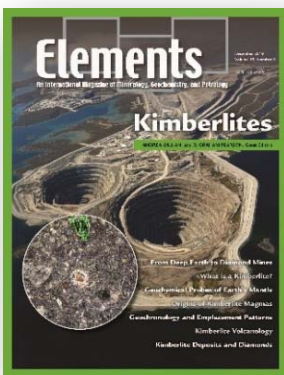


The Vancouver Kimberlite Cluster (VKC) Seminar Series is hosted by UBC and SRK Consulting, and held in downtown Vancouver, BC. The series provides an opportunity to share ideas and stories from diamond exploration, kimberlite geology, and related topics. A YouTube channel: **Vancouver Kimberlite Cluster Streams** has been set up that showcases recorded VKC seminars (with presenter consent). Check it out for any talks that you've missed: <https://www.youtube.com/channel/UCTRqX6g1nvGz5jmT8whUG9g>

DERTS Publications and Awards

In 2019 the DERTS research team, including the students, did a great job of disseminating their research results at numerous conferences and in publications. In total the DERTS team authored over 35 manuscripts related to diamonds, kimberlites and the mantle which were published in high impact, peer-reviewed journals. DERTS students and alumni were co-authors on 12 of these publications. DERTS students additionally presented their research at 5 national and international conferences. A comprehensive list of publications authored by DERTS students and researchers is appended at the end of the newsletter. If you would like to receive a copy of any of these publications, please contact us: derts@ualberta.ca.

Highlights



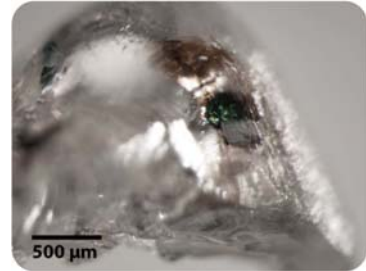
Dr. Pearson was a guest co-editor of a recent Elements Volume specifically dedicated to Kimberlites released in December 2019. DERTS researchers were co-authors on over half the manuscripts published in this volume.

This thematic issue includes review papers on:

- kimberlite formation, including key aspects of petrology, geochemistry and volcanology;
- kimberlite dating and the links between the temporal and spatial distribution of kimberlites and known geological events
- diamond exploration and resource evaluation methods that brought together modern advances in kimberlite and diamond geology with historical exploration knowledge to aid in target selection and resource evaluation.

DERTS Director Graham Pearson was named a Fellow of the American Geophysical Union (AGU)! An honor bestowed on AGU members who have made exceptional scientific contributions and gained prominence in their respective fields of Earth and space sciences. Additionally Graham was awarded the AGU's Bowen Award in recognition of outstanding contributions to the fields of volcanology, geochemistry, and petrology.

Nicole Meyer received the Departmental Research award from the Department of Earth and Atmospheric Sciences at the U of A for her discovery of the new mineral Goldschmidtite. Named in honor of Victor Moritz Goldschmidt, the founder of modern geochemistry, goldschmidtite has an unusual composition for a mantle mineral: it contains high concentrations of niobium, potassium, and rare earth elements such as lanthanum and cerium (Meyer et al., 2019).



Goldschmidtite (green) in a diamond. Photo: N. Meyer

A second new mineral was discovered by Garret Harris within a pyroxenite xenolith in a kimberlite from the Darby Kimberlite Field. Post-doctoral Fellow Chiara Anzolini concluded the detailed work required to get the new mineral approved. It has recently been published as Nixonite named after Peter H. Nixon, a renowned scientist in the field of kimberlites and mantle xenoliths. Nixonite: $\text{Na}_2\text{Ti}_6\text{O}_{13}$ is interpreted to have been produced by a fractionated Na-rich kimberlitic melt that infiltrated a mantle-derived garnet pyroxenite and reacted with rutile during kimberlite crystallization (Anzolini et al., 2019).



The Journal of International Kimberlite Conference Abstracts has been fully updated and contains the extended abstracts for all past kimberlite conferences. Thanks to all the hard work of DERTS students Nicole Meyer and Natasha Barrett and the financial support of the I1IKC and the University of Alberta Libraries that have made this possible. Paper copies of abstracts from past conferences are becoming increasingly more difficult to obtain and the Journal of International Kimberlite Conference Abstracts will ensure that all IKC extended abstracts are archived in digital format for posterity. The Journal is open access and all abstracts are available for download at:

<https://journals.library.ualberta.ca/ikcabstracts.com>.



Our Team

The DERTS Students

In 2019/2020 we enrolled our largest cohort of students to date! With 14 new students joining the DERTS team this year we have 23 graduate students enrolled in the program. Each student's research project is briefly summarized below. For additional information about the students, their research projects and DERTS alumni please visit our website: www.uab.ca/diamonds. DERTS students continue to have success in securing funding from numerous external sources including the U of A Faculty of Graduate Studies and Research, U of A Faculty of Science, and the Government of Alberta to help offset the cost of conference attendance.

2019/2020 Cohort

Melissa Bowerman (*UofA*) PhD with Thomas Stachel



Melissa will undertake a geochemical investigation of the fluid and mineral inclusions and diamonds from the George Creek kimberlite, State Line District Colorado. Previous studies have identified the presence of CO₂ bearing fluid inclusions from fibrous diamonds at George Creek. CO₂ bearing fluid inclusions are extremely rare and have only been reported from a handful of localities worldwide.

Brandon Chase (*UofA*) PhD with Martyn Unsworth



Brandon's research focuses on using Magnetotelluric (MT) and Potential Fields methods to study lithosphere structure and architecture associated with kimberlites and diamond deposits. Brandon's study aims to provide additional information on how kimberlites are emplaced and what pre-existing structure(s) might guide, assist, or be exploited by them during eruption.

Dylan Cone (*UBC*) MSc. with Maya Kopylova



Dylan is investigating the origin of megacrysts within kimberlite through the analysis of megacryst samples from the Muskox kimberlite pipe in the northern Slave craton. Dylan is trying to model interactions between mantle rocks and metasomatic fluids that occur prior to kimberlite emplacement.

Connor Elzinga (*UofA*) MSc. with Robert Luth



Connor's research focuses on expanding the useful range of the single grain clinopyroxene thermo-barometer for use in diamond exploration. Connor will conduct experiments to synthesize clinopyroxene at mantle conditions using the multi-anvil press.



Jason Hinde (*UofA*) MSc. with Graham Pearson



Jason is investigating a range of metasomatized mantle xenoliths from the Kaapvaal Craton to characterize their ability to concentrate precious metals in the mantle.

Gabrielle Jones (*UofA*) MSc. with Graham Pearson and Luke Oates (BCGS)



In collaboration with the British Columbia Geological Survey Gabi's study aims to constrain crystallization ages and to develop a better understanding of the petrogenesis of the Hogem batholith of the Quesnel terrane. Gabi's project will involve analyzing a suite of samples using mineral-scale isotope geochemistry, including U-Pb, Lu-Hf, oxygen-isotope, and trace element analyses.

Nikita Kepezinskas (*UofA*) MSc. with Graham Pearson



Nikita is working on the characterization and timing of emplacement of the Dharma kimberlites in the Woopmay Orogen and Mel kimberlites in the Rae Craton. Samples have been provided by Santana Resources and North Arrow Minerals, respectively.

Kristina Kublik (*UofA*) MSc. with Claire Currie and Graham Pearson



Kristi is using geodynamic models to investigate how craton formation and stabilization influences topography and basin development. Her research aims to gain insight into the formation of Precambrian basins that host significant ore mineral deposits.

Katherine Landoni (*UBC*) MSc. with Kelly Russell



Katherine is studying olivine from melt/fluid inclusions, rims, and cracks to gain geochemical insights into the compositional evolution of kimberlite.

Sophie Leiter (*UBC*) MSc. with Kelly Russell



Sophie's project will focus on xenolith transport in kimberlites from the deep mantle. She will be primarily working with olivine to determine the mechanics and dynamics of xenolith ascent.

Skylar Massey (*UBC*) MSc. with Maya Kopylova



Skylar is using geochemical and mineralogical modeling to test the hypothesis that carbonatite melts react with the mantle by producing halos and reaction zones of pyroxenite and megacrysts.

Sarah Milne (*U of A*) PhD with Thomas Stachel



Sarah is working on diamond inclusions from the Juina kimberlites (Brazil) with the aim of establishing the proportion of superdeep diamonds (sub-lithospheric) relative to lithospheric diamonds in that area.

Daoheng Wang (*U of A*) MSc. with Graham Pearson



Daoheng's research is focused on understanding the evolution of the mantle beneath Zealandia. He will study major and trace elements and isotopes of peridotites and their melting residues using experimental petrology and geochemistry.

Ji Zhang (*U of A*) PhD. with Long Li & Graham Pearson



Ji is integrating mathematical and statistical perspectives to assess how to apply geochemical tools including stable/radioactive isotope and major/trace elements, to explain deep earth evolution.

2018/2019 Cohort

Tim McIntyre (*U of A*)
PhD with Graham
Pearson &
Larry Heaman



Tim is conducting a dating and tracer isotope study of the Coronation Gulf kimberlites and is examining the impact of heat producing elements (K, U, and Th) in mantle xenoliths on geothermal modelling. Additionally, he is working on understanding the evolution of the lithospheric mantle underlying the North Atlantic Craton using Re-Os isotopes and PGE's in crustal hosted peridotites of West Greenland.

Internship: *Anglo American 2018 & 2019*

Christian Veglio (*U of A*)
MSc with Graham
Pearson &
Chris Lawley (GSC)



Christian has analyzed mantle xenoliths from the Jericho and Muskox kimberlites to assess the presence, spatial variability and mobility of gold and other precious metals in the mantle. The goal is to determine the role of the lithospheric mantle on ore deposit genesis. Christian's project is co-funded by the Geological Survey of Canada.

Internship: *DeBeers Group (Canada); Rio Tinto*

Mei Yan Lai (*U of A*)
PhD with Thomas
Stachel



Mei is working on the first systematic study of diamonds and their inclusions from Sierra

Leone. She will complete carbon and nitrogen analyses (both isotopic and contents) on the diamonds and complete a full characterization of the inclusions.

Internship: *Dominion Diamonds*

Kelsey Bulbuc (*U of A*)
MSc with Thomas
Stachel & Graham
Pearson



Kelsey is in the midst of completing a detailed, comprehensive examination of diamonds from the former Snap Lake Mine, Southern Slave Craton. She aims to analyze $\delta^{13}C$, $\delta^{15}N$ and N-content on polished diamond plates. As well as analyzing the major and trace elements on all recovered mineral inclusions. This study aims to provide constraints on the characteristics of the diamond-forming fluid below the Southern Slave. Kelsey's project is supported by the DeBeers Group.

Internship: *GEUS – Geological Survey of Denmark and Greenland*

Natasha Barrett (*U of A*)
PhD with Graham
Pearson



Natasha's research focuses on how mantle evolution in younger, sub-oceanic lithosphere relates to conditions for continent growth and stabilization. She is working on mantle xenoliths from Fiji and ophiolite peridotites from Papua New Guinea.

Internship: *Center for Lunar Science and Exploration*

Brody Myers (U of A)
MSc with Robert Luth



Brody is studying a unique collection of melt-bearing mantle xenoliths recovered from the Chidliak kimberlites. He is trying to understand the nature of the metasomatic event that affected the mantle beneath the Chidliak kimberlite field and the effect of this event on the preservation of diamonds in the area.

Internship: *Rio Tinto*

Margo Regier (U of A)
PhD with Graham Pearson
& Thomas Stachel



Margo is using Raman spectroscopy, and synchrotron methods in conjunction with stable and radiogenic isotopes to trace the mantle sources of, and deep mantle processes recorded by, super-deep diamonds from Kankan (Guinea) and Juina (Brazil).

Internships: *Advanced Photo Source, University of Padua, Bayreuth University, University of Southampton*

2016 & 2017 Cohorts

William Siva Jothy (U of A) MSc with
Thomas Stachel/Graham Pearson



Will is finalizing his work on diamonds from the Gacho Kue Mine. His study included the characterization of diamond forming fluids through nitrogen and carbon isotopes as well as analysis of their mineral inclusions. Samples for Will's research were provided by DeBeers Group.

Internship: *DeBeers Group (South Africa); Alberta Geological Survey*

Matthew Wudrick (U of A) MSc with Graham
Pearson/Thomas Stachel



Matt is finishing up his thesis on Re-Os dating of garnet and spinel peridotite xenoliths from the Karowe Mine to determine the age and the chemical evolution of the lithospheric mantle in that area. Matt's thesis samples were provided by Lucara Diamond.

Internship: *Saskatchewan Research Council*

Associates

Matthew Hardman (U of A)
PhD with Graham Pearson/ Thomas Stachel



Matthew has defined a new, robust graphical classification scheme for low-Cr crustal and mantle garnet. The classification is based on a compilation of published data and new analyses of samples that were provided by industry and academia. Matthew has immersed himself in geo-statistics and mentors all the DERTS students on the use and application of statistics with their datasets.

Nicole Meyer (U of A)
PhD with Thomas Stachel/ Graham Pearson



Nicole is working on inclusions in diamonds from the Koffiefontein Mine to provide improved inclusion-based geothermo-barometry. During her research, she discovered a new IMA-approved mineral: goldschmidtite. Goldschmidtite ($K,REE,Sr)(Nb,Cr)O_3$ is a new perovskite supergroup mineral found as an inclusion in diamond. The samples for Nicole's study were provided by Jeff Harris and Petra Diamonds.

Post-Doctoral Fellows

Chiara Anzolini (U of A)
Post Doctoral Fellow with Graham Pearson



Chiara is working on Raman spectroscopic measurements of inclusions in Type II diamonds from Brazil and southern Africa. She has recently published detailed data on a new mineral "Nixonite": $Na_2Ti_6O_{13}$. Chiara mentors graduate students and is our group expert on Raman spectroscopy and X-ray diffraction.

The Researchers

The DERTS research team has internationally recognised expertise in a broad spectrum of geoscience fields ranging from diamond mineralogy and geochemistry, kimberlite petrography and volcanology, geochronology, theoretical and lab-based experimental studies, to exploration geophysics and hyperspectral techniques for mineral exploration. The DERTS research team includes 7 professors from the University of Alberta and 2 professors from the University of British Columbia. Additionally, several collaborative projects are co-supervised by researchers at the University of Alberta and Geological Survey partners. Current co-supervisors include: Claire Currie (U of A), Christopher Lawley (GSC), Long Li (U of A), and Luke Oates (BCGS). Please visit our website (www.uab.ca/diamonds) for additional information about research areas and projects currently run by each faculty member.



Top row: Graham Pearson, Thomas Stachel, Robert Luth, Kelly Russell
Bottom row: Larry Heaman, Martyn Unsworth, Maya Kopylova, Tom Chacko, Benoit Rivard

The Program Coordinator

Anetta Banas M.Sc., P.Geol



Anetta coordinates the DERTS program including all workshops, fieldtrips, meetings and internships. She is the primary contact for all information related to DERTS programming and admission requirements. Anetta liaises with our DERTS collaborators to ensure the success of the program. She is an alumnus of the University of Alberta where she completed her MSc thesis on the characterization of diamonds and their inclusions. She has over 10 years of experience working as a consultant to the diamond exploration industry.



Upcoming Events

A brief look at what we have planned for 2020:

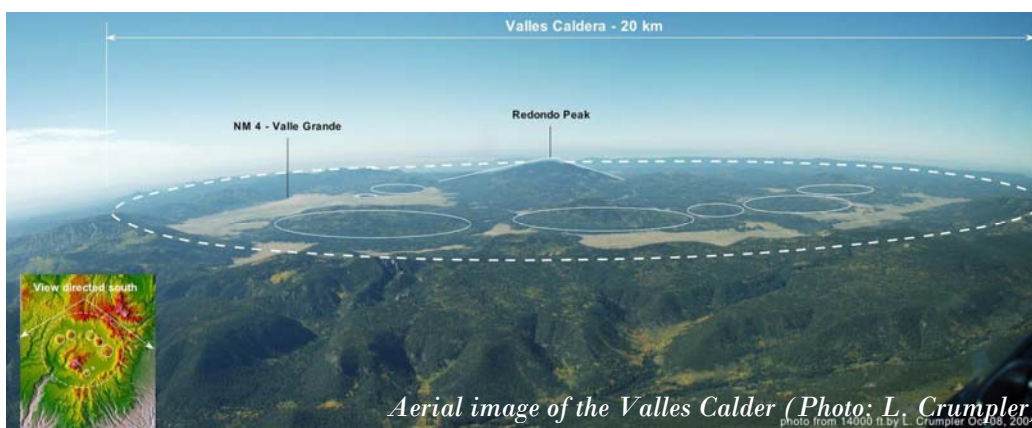
AME Round-Up Conference, Vancouver BC, January 20-23, 2020

We will be at the AME Round-Up Conference in Vancouver in January 2020. Come by and visit us at our booth #127 University of Alberta on Monday and Tuesday (Jan 20 -21) to learn more about the program and meet the DERTS students. Additionally we will be hosting a DERTS Appreciation Event on Monday January 20, 2020 at Lion's Pub from 5 – 7pm. Please join us if you are in Vancouver!

Indicator Mineral Workshop

The Indicator Mineral workshop held in 2019 was a huge success! We are happy to welcome Cristiana Mircea back in March to share her expertise with our new cohort of students.

Fieldtrip 2020 – Volcanic Fields and Deposits in Arizona – New Mexico – Colorado April 14-24, 2020



Planning for the DERTS 2020 fieldtrip is in full swing. This year we are going to explore the volcanic fields and deposits of the southwestern United States. The trip will begin with a visit to the peridot deposits of the Peridot Mesa - the type locality of the San Carlos olivine standard. Subsequently, we plan to visit several volcanos in the Navajo and Jemez volcanic fields including the Valles Caldera and associated deposits. The Valles Caldera is one of the largest young calderas on Earth with a diameter of over 20 km and is considered an active volcano. The caldera floor is dotted with hot springs, streams, fumaroles, natural gas seeps and volcanic domes. In the nearby Frijoles canyon lava and ash deposits of up to 1000 feet in thickness can be observed. These were deposited by the last eruption of the Valles volcano over a million years ago. Heading north we plan on exploring parts of the Colorado gold belt including the Cripple Creek mine. The last few days of the trip will be spent exploring kimberlites located in northern Colorado including the Green Mountain and Chicken Park kimberlites and potentially other kimberlites in the State Line district.

Industry partners/researchers are welcome to join us on this trip. If you would like additional information please contact Anetta Banas (abanas@ualberta.ca).

Seminars

The first 2020 VKC seminar will be presented by Barrett Elliot from the NTGO. On January 23, 2019 Barrett will present on “**A Summary of the Slave Geological Province Exploration Development Initiative – Revitalizing Mineral Exploration and Facilitating Sustainable Development in a Key Economic Region**”. If you are in Vancouver please join us at 6pm PST UBC Robson Square Room c400. Please check the YouTube channel if you miss the talk!

Internships

We are proactively seeking internship opportunities for our students in 2020. If you are interested in hosting an intern in 2020 or in the future please contact us for more information.



Connect with us!

www.uab.ca/diamonds

Program Director: Graham Pearson gdpearso@ualberta.ca

Program Coordinator: Anetta Banas abanas@ualberta.ca



The DERTS group atop the Pacaya Volcano in Guatemala.



2019 Publications

DERTS authors in bold

- Abersteiner, A Kamenetsky, VS; Goemann, K, Golovin, AV, Sharygin, IS, **Pearson, DG**, Kamenetsky, M, Gornova, MA (2019) Polymineralic inclusions in kimberlite-hosted megacrysts; implications for kimberlite melt evolution. *Lithos*, V. 336-337, p. 310-325
- Anzolini, C., Wang, F.; **Harris, G.A.**, Locock, A.J., Zhang, D., Nestola, F., Peruzzo, L., Jacobsen, S.D., **Pearson, D. G.** (2019) Nixonite, Na₂Ti₆O₁₃, a new mineral from a metasomatized mantle garnet pyroxenite from the western Rae Craton, Darby kimberlite field, Canada. *American Mineralogist*, V. 104, p. 1336-1344
- Aulbach, S, Symes, C, **Chacko, T** (2019) Elemental and radiogenic isotope perspective on formation and transformation of cratonic lower crust: Central Slave craton (Canada). *Geochimica et Cosmochimica Acta* doi.org/10.1016/j.gca.2019.05.044.
- Aulbach, S., Woodland, A.B., Stern, R.A., Vasilyev, P., **Heaman, LM**, Viljoen, KS (2019) Evidence for a dominantly reducing Archaean ambient mantle from two redox proxies, and low oxygen fugacity of deeply subducted oceanic crust. *Scientific Reports* 9, doi:10.1038/s41598-019-55743-1
- Bussweiler, Y., Giuliani, A., Greig, A., Kjarsgaard, B.A., Petts, D., Jackson, S.E., **Barrett, N.**, Luo, Y, **Pearson, D.G.** (2019) Trace element analysis of high-Mg olivine by LA-ICP-MS – Characterization of natural olivine standards for matrix-matched calibration and application to mantle peridotites. *Chemical Geology*, V 524 p. 136-157,
- Czas, J., Pearson, G., Stachel, T.**, Kjarsgaard, B., Read, G.H. (2019) A Palaeoproterozoic diamond-bearing lithospheric mantle root beneath the Archean Sask Craton, Canada. *Lithos* DOI: 10.1016/j.lithos.2019.105301
- De Hoog, J. C. M., **Stachel, T.**, Harris, J.W. (2019) Trace-element geochemistry of diamond-hosted olivine inclusions from the Akwatia Mine, West African Craton: implications for diamond paragenesis and geothermobarometry. *Contributions to Mineralogy and Petrology* 174(12) DOI: 10.1007/s00410-019-1634-y
- Ghent, ED, Edwards, BR, **Russell, JK** (2019) Pargasite-bearing vein in spinel lherzolite from the mantle lithosphere of the North America Cordillera. *Canadian Journal of Earth Sciences*, V. 56, p. 870-885
- Giuliani, A., **Pearson, D.G.** (2019) Kimberlites: From Deep Earth to Diamond Mines. *Elements* V. 15, p. 377–380
- Heaman, L.M.**, Phillips, D., **Pearson, D.G.** (2019) Dating Kimberlites: Methods and Emplacement Patterns Through Time. *Elements* V. 15, p. 399-404



- Jones, T.J, **Russell, JK**, **Sasse D** (2019) Modification of Mantle Cargo by Turbulent Ascent of Kimberlite. *Frontiers in Earth Science* V 7 DOI=10.3389/feart.2019.00134
- Krebs, M.Y., Pearson, D.G.**, Fagan, A.J., Bussweiler, Y., Sarkar, C. (2019) The application of trace elements and Sr–Pb isotopes to dating and tracing ruby formation: The Aappaluttoq deposit, SW Greenland. *Chemical Geology*, V 523 p. 42-58
- Lai, M.Y.**, Breeding, C.M., **Stachel, T.**, Stern, R.A. (2020) Spectroscopic features of natural and HPHT-treated yellow diamonds. *Diamond and Related Materials*, Volume 101
- Lawley, CJM, **Pearson, G.**, Waterton, P., AlexZagorevski, Jean H.Bédard, Simon E.Jackson, Duane C.Petts, Bruce A.Kjarsgaard, ShuangquanZhang, Wright, D. (2020) Element and isotopic signature of re-fertilized mantle peridotite as determined by nanopowder and olivine LA-ICPMS analyses. *Chemical Geology*, In press
- Lawley, CJM, **Pearson, G.**, Waterton, P., Wright, D. (2019) Element and isotopic signature of re-fertilized mantle peridotite as determined by nanopowder and olivine LA-ICPMS analyses. *Chemical Geology* DOI: 10.1016/j.chemgeo.2020.119464
- Li, K., Li, L., **Pearson, D. G.**, **Stachel, T.**, (2019) Diamond isotope compositions indicate altered igneous oceanic crust dominates deep carbon recycling. *Earth and Planetary Science Letters*, V. 516, p. 190-201
- Luguet, A., **Pearson, G.** (2019) Dating mantle peridotites using Re-Os isotopes; the complex message from whole rocks, base metal sulfides, and platinum group minerals. *American Mineralogist*, V. 104, p. 165-189
- Liu, J., Cai, R., **Pearson, DG.**, Scott, JM (2019) Thinning and destruction of the lithospheric mantle root beneath the North China Craton: A review. *Earth-Science Reviews*, V 196, doi.org/10.1016/j.earscirev.2019.05.017.
- Liu, J, **Pearson, DG**, Shu, Q, Sigurdsson, H, Thomassot, E, Alard, O (2019) Dating post-Archean lithospheric mantle: Insights from Re-Os and Lu-Hf isotopic systematics of the Cameroon Volcanic Line peridotites. *Geochimica et Cosmochimica Acta* <https://doi.org/10.1016/j.gca.2019.07.010>.
- McIntyre, T., Pearson, D.G.**, Szilas, K., Morishita, T. (2019) Implications for the origins of Eoarchean ultramafic rocks of the North Atlantic Craton: a study of the Tussaap Ultramafic complex, Itsaq Gneiss complex, southern West Greenland. *Contributions to Mineralogy and Petrology* 174(12):96
- McCanaan, K, Animireddi, VSK, **Barrett, N**, Boazman, S, Gawronska, A, Gilmour, C, Halim, SH, Shah, J, Kring, DA(2019) Topographic Contour Map of the Moon's South Pole Ridge. <https://hdl.handle.net/20.500.11753/1326>



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Pernet-Fisher, JF, Barry, PH, Day, JMD, **Pearson, DG**, Woodland, S, Agashev, A, Pokhilenko, L., Pokhilenko, N (2019) Heterogeneous kimberlite metasomatism revealed from a combined He-Os isotope study of Siberian megacrystalline dunite xenoliths. *Geochimica et Cosmochimica Acta* V 266, p. 220-236

Russell, JK, Stephen, R, Sparks, J, Kavanagh, JL (2019) Kimberlite Volcanology: Transport, Ascent, and Eruption. *Elements* V. 15, p. 405-410

Scott, J. M., Liu, J.; **Pearson, D. G.**; **Harris, G.A.**; Czertowicz, T. A.; Woodland, S. J.; Riches, A. J. V.; **Luth, R. W.** (2019) Continent stabilisation by lateral accretion of subduction zone-processed depleted mantle residues; insights from Zealandia. *Earth and Planetary Science Letters*, V. 507, p. 175-186

Shirey, S., Smit, K., **Pearson, D.**, Walter, M., Aulbach, S., Brenker, F, Bureau, H, Burnham, A, Cartigny, P, **Chacko, T**, Frost, D, Hauri, E, Jacob, D, Jacobsen, S, Kohn, S, **Luth, R**, Mikhail, S, Navon, O, Nestola, F, Nimis, P, Palot, M, Smith, E, **Stachel, T**, Stagno, V, Steele, A, Stern, R, Thomassot, E, Thomson, A, Weiss, Y (2019). Diamonds and the Mantle Geodynamics of Carbon: Deep Mantle Carbon Evolution from the Diamond Record. In B. Orcutt, I. Daniel, & R. Dasgupta (Eds.), *Deep Carbon: Past to Present* (pp. 89-128). Cambridge: Cambridge University Press.

Shu, Q, Brey, G, **Pearson, DG**, Liu, J, Gibson, S, Becker, H (2019) The evolution of the Kaapvaal craton: A multi-isotopic perspective from lithospheric peridotites from Finsch diamond mine. *Precambrian Research*, V 331
<https://doi.org/10.1016/j.precamres.2019.105380>.

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Tappert, R., Foden, J., **Heaman, L.**, Tappert, M., Zurevinski, S.E., Wills, K. (2019) The petrology of kimberlites from South Australia: Linking olivine macrocrystic and



micaceous kimberlites. *Journal of Volcanology and Geothermal Research*. V 373, p. 68-96

Timmerman, S., **Krebs, M.Y., Pearson, D.G.**, Honda, M., (2019) Diamond-forming media through time; trace element and noble gas systematics of diamonds formed over 3 billion years of Earth's history. *Geochimica et Cosmochimica Acta*, V. 257, p. 266-283

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Wenz, MD, Jacobsen, SD, Zhang, D, **Regier, M**, Bausch, H, Dera, PK, Rivers, M, Eng, P, Shirey, SB, **Pearson, DG** (2019) Fast identification of mineral inclusions in diamond at GSECARS using synchrotron X-ray microtomography, radiography and diffraction. *Journal of Synchrotron Radiation* V 26, p. 1763-1768

Wilson, AM., **Russell, JK.**; Ward, BC. (2019) Paleo-glacier reconstruction in southwestern British Columbia, Canada: A glaciovolcanic model. *Quaternary Science Reviews*, V. 218, p. 178-188

Woodhead, J., Hergt, J., Giuliani, A., Maas, R., Phillips, D., **Pearson, D.G.**, Nowell, G. (2019) Kimberlites reveal 2.5-billion-year evolution of a deep, isolated mantle reservoir. *Nature* 573, 578–581 doi:10.1038/s41586-019-1574-8

Student Abstracts and Conference Presentations

Karaevangelou, M., Kopylova, M.G., Loudon, P. (2019). Cretaceous diamondiferous mantle of the Kaapvaal craton: Evidence from mineral inclusions in diamonds from the Lace Kimberlite, South Africa. Poster Presentation at AME Roundup 2019, Vancouver Convention Centre, 28-31 Jan, 2019

Regier, M. (2019) Subduction signatures in lower mantle, boron-bearing blue diamonds. Diamond Conference, Warwick, Abstract, 3p.



Regier ME, Chalk TB, Stern RA, Smit K, Smith EM, **Stachel T**, Foster GL, Bussweiler Y, Harris JW, **Pearson DG** (2019) Isotopic Evidence for the Coupled Recycling of Carbon and Boron to Lower Mantle Depths. 2019 Goldschmidt Conference Abstract

Sasse, D., Jones, TJ., **Russell, K.** (2019) Experimental milling of Olivine: Implications for ascent and eruption of kimberlite. Poster Presentation at AME Roundup 2019, Vancouver Convention Centre, 28-31 Jan, 2019

Veglio, C., Pearson, G.D., Lawley, C, (2019) Behavior of Ore Forming Elements in the Sub-Continental Lithospheric Mantle Below the Slave Craton, PDAC Abstract and Poster Presentation, March 5, 2019

Veglio, C., Pearson, G.D., Lawley, C, (2019) Behavior of Ore Forming Elements in the Sub-Continental Lithospheric Mantle Below the Slave Craton. GAC-MAC Abstract and Poster Presentation, May 13, 2019

Theses

Bettac S. (2019) A 3D Magnetotelluric study of the Slave Craton Lithosphere, NW Canada. MSc. Thesis, University of Alberta

Gruber, B. (2019) Temperatures and Heat Production in the Slave Craton Lower Crust: Evidence from Xenoliths in the Diavik A-154 Kimberlite. MSc. Thesis, University of Alberta, <https://doi.org/10.7939/r3-mxym-n231>

Karaevangelou, M. (2019) Diamondiferous mantle beneath the Lace kimberlite in South Africa : evidence from mineral inclusions in diamonds. MSc. Thesis, University of British Columbia, <https://doi.org/10.14288/1.0384587>

Sasse, D. (2019) Attrition of mantle cargo during kimberlite ascent: Insights from analogue experiments. MSc. Thesis, University of British Columbia, <https://doi.org/10.14288/1.0387458>

Smyth, D. (2019) Petrology, chemistry, and geochronology of the Pikoo kimberlites, Saskatchewan. MSc. Thesis, University of Alber Lunar and Planetary Institute ta

