QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

VGS Website: http://www.uvm.org/vtgeologicalsociety/

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THE VERMONT GEOLOGICAL SOCIETY ANNUAL SPRING STUDENT PRESENTATION MEETING

April 28, 2018, 8:30 am

McCardell Bicentennial Hall 276 Bicentennial Way Middlebury College Middlebury, VT

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PRESIDENT"S LETTER

With the passing of another freezing rain storm this week, I began looking forward to the upcoming field season. To me, there is nothing like getting the hiking boots laced up, the field belt buckled, and the backpack on my shoulders for the first time in the late spring. Right now, I am not sure where I'll be starting as I have ongoing projects in both central and southern Vermont. I use this talk of the field season as a segue into field trips for the Vermont Geological Society (VGS).

The VGS has traditionally run summer and fall field trips each year. During 2018, George Springston has volunteered to lead the summer field trip on "Greatest-Hit Landslides in Central Vermont" and Kristen Underwood has offered to lead the fall field trip on "Glacial and Environmental History of the Mad River Watershed". Stay tuned for dates, meeting places and meeting times in the Green Mountain Geologist.

If you would like to propose a field trip or other event, please contact me at jon.kim@vermont.gov or 802-522-5401. A short photo galley of selected past field trips follows.

Fall 2008- Woodbury granite quarry on a field trip led by Dave Westerman.

Summer 2012- Anticline in the Cheshire Quartzite on a field trip in Bristol led by Jon Kim, George Springston, and Everett Marshall.

Summer 2013- Lake Champlain field trip on the R/V David Folger led by Pat and Tom Manley.

Fall 2013- Surficial geology of Killington field trip led by Stephen Wright.

TREASURER'S REPORT

Introduction to New Treasurer

Thank you for the opportunity to serve as the society's new treasurer! I began working with outgoing treasurer Dave Westerman earlier this year to start the process of transferring duties and information. A little about me – I graduated from the University of Vermont with a MS in Geology in 2000. During my time at UVM, I concentrated my studies on Vermont Geology – assisting with a small amount of mapping for the new state map in the Underhill and Cold Hollow Mountains of Bakersfield and Enosburg, Vermont. Since my real interests were in igneous and metamorphic petrology, I honed my thesis research on the granites in the Northeast Kingdom Batholith – specifically the geochemistry and regional significance of the Averill Pluton. After graduating from UVM, I spend a few years working as an environmental consultant then landed at the State of Vermont, Department of Environmental Conservation first with positions in the Drinking Water Program and the Waste Management Division, an now in my current position managing all of the planning related responsibilities for the DEC. My current position doesn't allow much time to geology so I am thrilled to connect with all of you! My son, Jackson has also developed quite a passion for geology and rock collecting, even though he is only eight. Following his entrepreneurial spirit after a trip to the Rock of Ages quarry a few summers ago, he started a website (www.jacksonsgemstones.com) showing some of the rocks in his precious collection. It's been a fun hobby!

Treasurer's Report

The Society remains in excellent financial health. With the transition in Treasurer, we got the dues notice out a little but late. The payments are being processed and if your check has not been deposited yet, it will be very soon. One major change to the operation is that we changed our mailing address to a PO Box in Montpelier. We will inform you as soon as possible on the new address.

Paid expenses in 2018

$282.00	Invoice from Middlebury College for Doll Award plaque.
$96.00	US Postal Service for PO Box
$70.64	GMG Fall newsletter (payment pending bank account transfer)
$215.69	VGS Executive Meeting (payment pending bank account transfer)

2018 Dues

Checks are coming in! About 70 renewals received so far along with generous contribution to the research grant program, grand tally will be included in the next newsletter.

New Members

Ronald Parker, Sr. Geologist, Borehole Image Specialists, Denver, CO
Joanne Garton, Special projects Coordinator Forestry, VT Dept of Forestry, Parks and Rec, Montpelier, VT
Michael Moore, Hydrologist, DCR Services and Construction, Inc., Montpelier, VT
Kasey Kathan, Hydrogeologist, VT Department of Environmental Conservation, Montpelier, VT
David Mitchell, Science Teacher, Hazen Union School, Hardwick, VT

Please contact me directly if you have any questions: carey.hengstenberg@vermont.gov

Respectfully Submitted,
Carey Hengstenberg, Treasurer

SECRETARY'S REPORT

Introduction to New Secretary

Graham Bradley, PhD, FGS, CGeol

I am very pleased be a member of the Vermont Geological Society and to accept this position as Secretary. I am a hydrogeologist with the Department of Environmental Conservation. Previously, I taught hydrogeology, engineering geology, and geomorphology at SUNY Oswego. Having fallen in love with Vermont, my wife and I moved the Green Mountain State in 2017. We have embraced the lifestyle and live 4 miles up a dirt road in Marshfield, surrounded by farms, forests, poets & musicians! Coming from the northeast England, I developed a childhood passion for geology through fossil hunting on the Yorkshire coast and hiking in the Lake District of Cumbria. I studied joint geology and geography at the University of St Andrews. Upon graduating with a masters in engineering geology from the University

of Leeds, I spent 17 years working for Golder Associates, first in Nottingham and then Vancouver, Canada. During this time I worked on radioactive waste disposal, mining hydrogeology, and contaminated sites. A classic mid-life crisis in 2007 led me to University College London where I did doctoral research on landscape evolution and hydrogeology in southwest Uganda. In 2012 we moved back across the pond, and our journey has finally led us to Vermont where we hope to stay for many happy years to come. Here in the heart of the Acadian belt I am reminded of my undergraduate days in the Caledonides of Scotland. I look forward to meeting many likeminded geologists in our newly adopted home.

Report

Vermont Geological Society Executive Committee Meeting April 4, 2018

Present: Jon Kim (President); Graham Bradley (Secretary); George Springston (Boards of Directors); Leslie Kanat (Board of Directors); Marjorie Gale (Public Issues); Peter Gale (Publishing), Larry Becker (Member)
Apologies: Carey Hengstenberg (Treasurer); Keith Klepeis (Vice President)
Treasurers Report - presented by Jon Kim

- The Treasurer's report was prepared by Carey Hengstenberg
- Society account has a healthy balance ($9,541.37).
- New plaque purchased for the Charles G. Doll Student Award.
- Both new and old plaque will be kept at the 1st place student's college.
- The society has received about 50 membership renewals for 2018. There are about 150 recent members on record.

Field Trips

- Traditionally there is one summer and one fall field trip
- George Springston offered to lead a summer 2018 field trip on "Greatest-Hits Landslides of Central Vermont".
- Through an email to Jon Kim, Kristen Underwood offered to lead a fall 2018 field trip on erosion in the Mad River Valley.
- Suggestion was made to ask Roy Schiff of Milone and MacBroom, Waterbury to lead fluvial geomorphology field trip.
- Discussion of trying to combine fieldtrip with a barbeque social afterwards.
- Meeting titles will be forwarded to Peter Gale for the Green Mountain Geologist newsletter.

Meetings

- Graham Bradley conveyed recent experience of monthly dinner meetings with the Central New York Association of Professional Geologists (http://www.cnyapg.org/). Most talks were not applied but still attracted professional community. Professors also brought students. It is a regular networking, as well as social and educational, event. The character and continuity of the meetings is perhaps more important than subject of the talk to achieving good attendance. CNYAPG charge $20/$25 member/nonmember, $10/$15 student member/nonmember for dinner. It was acknowledged that VGS faces challenges to holding frequent meetings, including a small, dispersed membership, and rural driving making winter travel difficult.
- There was general agreement to stick to quarterly meeting program for now, but to keep considering the options for more regular events. While weekend meetings can impinge on family time they are often more practical to enable members to travel from further distances.
- This year's VGS Spring Student Meeting will be on Saturday April 28th at Middlebury College.
- There was a proposal to give a one-year free membership to Research Grant and Student Award recipients (*1st, 2nd, and 3rd?).* There was a unanimous vote by those present to go ahead with this if it is consistent with the Bylaws. A suggestion was made to create a membership category to enable this to happen if necessary.
- Jon Kim noted that the Vermont Geological Society Executive Committee agree last year to raise the maximum Research Grant award to $1000 from $700, if funds available (web site currently states $700 and must be updated).

Any Other Business

- Peter Gale has requested contributions to the winter/spring newsletter by April 20th. Student abstracts from April 28th meeting will be included in this issue.
- Les Kanat suggested holding a special lecture meeting in honor of David Westerman. Larry Becker and George Springston volunteered to work on this.

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

One application for the Vermont Geological Society Research Grant Program was received by the April 1st deadline.
Name: John Mark Brigham, M.S. student, Syracuse University
Address: 212 Heroy Geology Laboratory, Syracuse, N.Y. 13244-1070
Email: jbrigham@syr.edu
Title: Mineralogy and Petrology of the east Dover Ultramafic Body in Southern Vermont
Amount Requested: $1000

This proposal is currently being reviewed by two members of the VGS Executive Committee with the funding recommendation expected soon.

Hope to see you at the VGS Spring Student Meeting on Saturday April 28th at Middlebury College. Details can be found later in this issue. I need another judge (or two) for the presentations.

Respectfully submitted,
Jon Kim, Chair

STATE GEOLOGIST'S REPORT

First and foremost are mighty congratulations and a big thank you to the organizing committee, hosts and sponsors of the NEGSA meeting held in Burlington in March. I'm listing these colleagues and supporters below because they truly deserve acknowledgement and made Vermont proud!
Organizing Committee: Andrea Lini, Charlottte Mehrtens, Dave West, Craig Heindel, Jon Kim, George Springston, Dave Franzi, Larry Becker, Tony Fowler and Nico Perdrial.
Meeting Hosts: University of Vermont, Middlebury College, Norwich University SUNY Plattsburgh, and the Vermont Geological Survey (Geology Division, DEC).
Sponsors: GeoInsight, Inc., Isle LaMotte Preservation Trust, Milone & MacBroom, Rock of Ages, Roger Thompson, Jr., SEPM, Fitzgerald Environmental Associates, Lincoln Applied Geology, Carrara, Magic Hat Brewing Company, Chevalier Drilling, NRC, NIWR, U. of Pennsylvania, PA Water Resources Research Center, Vermont Geological Survey (DEC), VHB, and Waite-Heindel Environmental Management.

NEGSA technical sessions featured groundwater and contamination, private wells and health, tectonics of the Appalachians and Adirondacks, river restoration, engineering geology, lake studies, hazards and government issues. Staff from the Geology Division plus student interns, contractors and partners gave presentations, chaired and co-chaired several technical sessions, participated as mentors in student luncheon events with over 300 attendees and served on the organizing committee. The session on emerging contaminants and groundwater contamination in the northeast, a topic of relevance in Vermont and in the current legislative session, was particularly valued and included work to date in Bennington. Talks included results of bedrock and surficial mapping, geochemical fingerprinting of water, groundwater age dates, and flow in wells. Thanks again to the geologic community!

Association of American State Geologists Spring Liaison
The Association of American State Geologists (AASG) held the annual Spring Liaison in Washington DC on March 11-14. State Geologists met as a group with the US Geological Survey and discussed programs in water science, natural hazards, energy, minerals, environmental health, and climate and land use. The implementation plan for the National Cooperative Geologic Mapping Program and its re-authorization were significant topics of interest. The program is the source of funding for bedrock and surficial geologic maps in Vermont and has provided more than 1.6 million to support our state program over the past 24 years. Benefits of a new program to evaluate critical mineral resources using airborne geophysical surveys, Lidar and mapping were also discussed. Complete 3D data collected for critical minerals could also be applied to hazards and groundwater. We expect discussion surrounding geologic mapping and funding to continue at the annual meeting.

Mapping projects and Digital Mapping

The appropriations bill passed by Congress in March provided an increase in funding to the USGS with flat funding for Core Science Systems which includes the National Cooperative Geologic Mapping Program (NGCMP). NCGMP has supported our STATEMAP projects for more than 25 years and is a significant source of funding for the Vermont Geological Survey mapping program. This coming field season we will have contractors and partners mapping surficial geology in the Richmond, Huntington and Proctor quadrangles. These projects received letters of support from the local communities interested in hazards, groundwater and wastewater analyses. Surficial mappers have also been working on standardization of map units and George Springston is beginning the compilation of the Montpelier one-degree sheet.

The Digital Mapping Techniques Workshop (DMT), held annually since 1998, will be attended by Colin Dowey and should help us advance our digital mapping. Colin is providing GIS and database support for the map standardization effort, particularly as we move into alignment with national data standards and look towards national geologic map compilations. The DMT includes sessions on data collection, remote sensing, Lidar, GIS design, and data management.

Lastly, many of you have asked about Larry Becker and what he has been up to since retiring as State Geologist in 2014. Larry is providing an update for you in the next section.

Happy Spring!

Respectfully Submitted,
Marjorie Gale
Vermont State geologist

COMING FULL CIRCLE

As in the rock cycle, positions on the circle have a way of doubling back to prominence. Certainly, there is a renewed need for rational fact-based thinking and the hope that the next generation gets a strong encounter with science - our way of seeing the world. I too have circled back since leaving the State Geologist's job in 2014.

As a graduate student in the mid-1970s, I taught introductory geology labs at UVM and since January 2016 I've been teaching the same at Norwich University. With three sections a semester, I have had encounters with over 300 students most non-science majors. The hope is that these learners get a dose of scientific thinking to serve them later in life. A way to sift through the cacophony of information flow and the hurly-burly of false claims. Science as a touchstone for sound judgments made with a critical mind. More directly, I work with two students on soil studies that focus on soil horizon clay minerals and elemental chemistry to better understand cation exchange capacity and the nutrients that support the growth of food plants

Norwich is looking to internationalize. Future plans are to lecture for intro next fall and then design with Norwich Professor Chris Koteas an introductory geology class in Ireland (I visited last summer and the geology is spectacular). Toward that end Norwich is sending me overseas in July to a Council on International Educational Exchange seminar "Best Practices for Creating Successful Faculty Led Programs".

On the personal front, our oldest daughter Sasha has come full circle and now lives in Brooklyn, NY where I grew up and is working toward a full-time career in graphic design. Our youngest, Alena, is a head start teacher in Asheville NC. A mountain home that is the source of the old-timey banjo style I play (Yes, there is time for other pursuits in "retirement"). And my marriage partner for 30 years, Kate Ross, just published a text book in her field of speech language pathology.

Thanks to the VG Society for the great send off in January 2015 and for all you do for our community – the student meeting a prime example. Thanks to the fine leadership of Marjorie Gale as our very able State Geologist; Jon Kim for all his detailed mapping with application to critical groundwater issues; George Springston at Norwich doing much vital work for Vermont; and the Department of Earth and Environmental Science at Norwich for the chance to teach. All in all, I am having a great time and hope all in the Society are continually circling back to your own version of the great times – both geological and personal.

Sincerely,
Larry Becker
Middlesex, VT

2018 SPRING MEETING PROGRAM

(Order of presentations is subject to change)

8:30 AM - **COFFEE & REFRESHMENTS**

9:00 AM -- GEOCHEMICAL APPROACH TO QUANTIFYING ATMOSPHERIC DUST INPUT TO ALPINE SOILS IN THE UINTA MOUNTAINS, USA
NORRIS, Emmet, Department of Geology, Middlebury College, Middlebury, VT 05753, USA

9:15 AM -- ANALYSIS OF THE EFFECT OF REGIONAL CLIMATE ON SOIL MINERALOGY AND CHEMISTRY IN THE TROPICS: A CASE STUDY FROM THE PACIFIC COAST OF COSTA RICA PISANO, Connor, RYAN, Pete, Geology Department, Middlebury College, Middlebury, VT 05753

9:30 AM -- QUANTIFYING STREAM PHOSPHORUS DYNAMICS AND TOTAL SUSPENDED SEDIMENT EXPORT IN FORESTED WATERSHEDS IN VERMONT
RYAN, Sophia, Department of Geography, University of Vermont, Burlington, Vermont WEMPLE, Beverley, Department of Geography, University of Vermont, Burlington, Vermont ROSS, Donald, Department of Plant and Soil Science, University of Vermont, Burlington, Vermont

9:45 AM -- THREE-DIMENSIONAL HYDRODYNAMIC MODELING ON THE EFFECTS OF CAUSEWAY REMOVAL AND RESULTING WATER QUALITY IN MISSISQUOI BAY, LAKE CHAMPLAIN
CHEN, Tina, MANLEY, T.O. and HERDMAN, L.M.M. Geology Department, Middlebury College, Middlebury, VT 05753, USA

10:00 AM - PRE-ERUPTIVE STORAGE AND EVOLUTION OF HIGH-MG BASALTS IN THE SOUTHERN CASCADE ARC
LEITER, Sophie, WALOWSKI, Kristina, Department of Geology, Middlebury College, Middlebury, VT 05753, USA

10:15 AM - ORDOVICIAN PROTOLITH HISTORY AND DEVONIAN DEFORMATION AND METAMORPHISM OF THE CASCO BAY GROUP, HARPSWELL, MAINE
PROCTOR, Atticus, and WEST, David P., Department of Geology, Middlebury College, Middlebury, VT 05753

10:30 AM - **BREAK, COFFEE & REFRESHMENTS**

10:45 AM - NEW DETRITAL ZIRCON AGES FROM MULTIPLE ACCRETED TERRANES IN SOUTH-CENTRAL MAINE: EVIDENCE FOR VARYING SOURCE REGIONS IN PRE-SILURIAN TIME
CARTWRIGHT, Samuel, WEST, David, Department of Geology, Middlebury College, Middlebury, VT 05753, USA

11:00 AM - THE EFFECT OF CALCITE-BEARING VEINS ON GROUNDWATER GEOCHEMISTRY IN A FRACTURED ROCK AQUIFER
BENINGSON, Nathan[1], RYAN, Peter[1], KIM, Jonathan[2], (1) Geology Department, Middlebury College, Middlebury, VT 05753, (2) Vermont Geological Survey, Montpelier, VT 05620

11:15 AM - UTILIZING MAJOR AND TRACE ELEMENT DIFFUSION MODELS IN OLIVINE AND CLINOPYROXENE TO DETERMINE ASCENT TIMESCALES OF CINDER CONE MAGMAS IN THE SOUTHERN CASCADES
HOLLYDAY, Andrew, WALOWSKI, Kristina, LEITER, Sophie, Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

11:30 AM – **JUDGING**

12:00 – 12:15 PM –**AWARDS CEREMONY**

ADJOURN and LUNCH

STUDENT ABSTRACTS

PRE-ERUPTIVE STORAGE AND EVOLUTION OF HIGH-MG BASALTS IN THE SOUTHERN CASCADE ARC

LEITER, Sophie, WALOWSKI, Kristina, Department of Geology, Middlebury College, Middlebury, VT 05753, USA

The Lassen Region in Northern California is dominated by cinder cones, small volcanic landforms that erupt once for a period of 1-10 years. Though cinder cones are small, they are capable of producing violent Strombolian eruptions, which could have potentially disruptive effects on air travel and infrastructure. However, magmatic storage and evolution of cinder cone systems is not well understood, especially when compared to larger volcanic systems. Thus, we seek to better constrain magmatic storage depths of cinder cone magmas in the southern Cascades.

Here, we present the whole rock and mineral (olivine and pyroxene) geochemistry from one tephra and nine lava samples of two Pleistocene high-Mg basaltic-andesite cinder cones, the Basaltic Andesite of Box Canyon (MBX) and Basalt of Bunchgrass Meadow (MBG). Lava samples from MBX and MBG are dark gray, aphanitic with phenocrysts of pyroxene and olivine and groundmass plagioclase. Large glomerocrysts of intergrown olivine and pyroxene are common. Whole rock major element data shows that the lavas sampled from MBX have higher MgO (~10 wt%) and SiO_2 (~ 52 wt%) than previously analyzed primitive basaltic products in the Lassen region compiled by Borg et al. (1997), while MBG samples have similar MgO and SiO_2. Clinopyroxene phenocrysts are Ca-rich augites and are not zoned with respect to major elements. Additionally, there is little to no compositional variability between clinopyroxene derived from tephra and lava samples, which may indicate a single storage depth prior to eruption. Composition differences within MBX and between MBX and MBG can be attributed to fractionation of pyroxene and olivine. Pressure conditions were determined by comparing calculations from the Neave & Piturka (2017) clinopyroxene-liquid barometer and experimentally derived phase diagrams from Blatter et al. (2013). Pressure conditions for MBX were likely between 8-9kbar, which returns depths of ~35km. MBG was likely formed under lower pressures (3kbar), placing them at depths around 10km. Although further work is still required, our initial results provide new insights into the storage and evolution of basaltic magmas in the Cascade Arc.

ORDOVICIAN PROTOLITH HISTORY AND DEVONIAN DEFORMATION AND METAMORPHISM OF THE CASCO BAY GROUP, HARPSWELL, MAINE

PROCTOR, Atticus, and WEST, David P., Department of Geology, Middlebury College, Middlebury, VT 05753

Rocks of the Casco Bay Group are continuously exposed in a narrow northeast striking belt in southern coastal and south-central Maine for a distance of nearly 150 kilometers (from just south of Portland to nearly Bangor). This Middle to Late Ordovician (≈ 460 to 475 Ma) sequence of metasedimentary and metavolcanic rocks has been interpreted to have initially formed outboard of Laurentia in an evolving Iapetus/Rheic Ocean basin and then subsequently accreted during the Silurian-Devonian Acadian

orogeny. This study is focused on a portion of the Harpswell peninsula in northern Casco Bay, where rocks of the lower portion of the Casco Bay Group (Cushing, Cape Elizabeth, and Spring Point formations) are spectacularly exposed. Detailed studies in this area focus on unraveling both the Ordovician pre-accretionary history of the protolith rocks, and the superimposed deformational and metamorphic events associated with their Acadian accretion.

This study involves the detailed mapping of a 9 km^2 area just south of Harpswell Center that was previously mapped by Arthur Hussey in his classic study of the bedrock geology of the Orrs Island 7.5' quadrangle (Hussey, 1971). The field site lies along the western limb of the Harpswell Sound syncline where rocks of the Cushing, Cape Elizabeth, and Spring Point formations have undergone low pressure amphibolite facies metamorphism (staurolite zone). The rocks exposed here provide an excellent opportunity to explore the transition between primarily felsic volcanism in the Cushing Formation, to sedimentation in the Cape Elizabeth Formation. At this transition lies the distinctive Wilson Cove Member of the Cushing Formation – a thin Fe-rich unit which may represent a mixture of hydrothermal exhalatives and sediment. Finally, above the metasedimentary Cape Elizabeth Formation, the Spring Point Formation hosts metamorphosed mafic and felsic volcanic rocks.

Major and trace element geochemical studies of all these rocks provides evidence of their aforementioned volcanic and sedimentary depositional environments and protolith rock types. Additionally, structural and petrographic work reveals the nature of Devonian-aged Acadian deformation and metamorphism, allowing for this field area to be placed in a broader geologic context.

THREE-DIMENSIONAL HYDRODYNAMIC MODELING ON THE EFFECTS OF CAUSEWAY REMOVAL AND RESULTING WATER QUALITY IN MISSISQUOI BAY, LAKE CHAMPLAIN

CHEN, Tina, MANLEY, T.O. and HERDMAN, L.M.M. Geology Department, Middlebury College, Middlebury, VT 05753, USA

Missisquoi Bay, a uniformly shallow (<4 m) and eutrophic region in the northeast quadrant of Lake Champlain bordering Vermont and the Province of Quebec, has been experiencing nearly annual cyanobacterial blooms during the summer months. These blooms and the eutrophic status are a result of anthropogenic inputs (both current and historical) of phosphorus to the bay. Previous studies and local knowledge evaluations have suggested the role of the Missisquoi Bay causeway for potentially exacerbating pollution by limiting water circulation and preventing flushing of pollutants out of the bay. In order to assess possible management questions and provide feasible solutions, a fully developed atmospherically-coupled three-dimensional hydrodynamic model of the Lake Champlain has been developed. The three model output variables that are currently being used to compare to observations for calibration of the model are: water level, thermal structure, and water velocity. Validation of the model performance, with 2013 observations of temperature and velocity in Missisquoi Bay and 2005 observations of temperature and velocity data from the Inland Sea, will be used to provide insights in water quality related to the partial and/or complete removal of the causeways within the region.

NEW DETRITAL ZIRCON AGES FROM MULTIPLE ACCRETED TERRANES IN SOUTH-CENTRAL MAINE: EVIDENCE FOR VARYING SOURCE REGIONS IN PRE-SILURIAN TIME

CARTWRIGHT, Samuel, WEST, David, Department of Geology, Middlebury College, Middlebury, VT 05753, USA

The metasedimentary rocks of the Central Maine, Casco Bay, and Fredericton terranes in south-central Maine were accreted onto the Laurentian continent during the Silurian-Devonian Acadian orogeny. Metamorphism and deformation associated with this event erased primary features in the sedimentary protoliths of these terranes, leading to uncertainty about their pre-Acadian history. Presented here are findings from U-Pb geochronology carried out on detrital zircon grains sampled from these and other sub-units of uncertain origin (i.e., Benner Hill and Jam Brook formations) in south-central Maine.

Samples targeted for detrital zircon separation were collected across a ~40 km long, perpendicular-to-strike transect west of Penobscot Bay, Maine. Along this transect, metasedimentary rocks were collected from each of the following lithotectonic belts, described from northwest to southeast: (1) the eastern margin of the Late Ordovician (?)-Silurian Central Maine belt (Hutchins Corner Fm.), (2) the Middle to Late Ordovician Casco Bay belt (Cape Elizabeth Fm.), (3) the Silurian Fredericton belt (Appleton Ridge Fm. and Ghent Phyllite), (4) the Jam Brook sequence of uncertain protolith age, and (5) the Ordovician Benner Hill sequence (Hart Neck Fm.).

Crystallization ages were determined for detrital zircon grain populations from seven samples using U-Pb isotope ratios gathered by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) at Middlebury College (n = 62–164). Results vary considerably amongst the samples with some showing strong peri-Gondwanan source region signatures (i.e., ~600 Ma peaks), while others do not. The youngest detrital zircon ages from each sample provide maximum depositional ages for the respective units ranging from Neoproterozoic to Late Ordovician.

The considerable variability in detrital zircon age distributions from the different analyzed terranes strongly suggests a complex pre-Acadian tectonic evolution in and around the Iapetus and Rheic Ocean basins. Additionally, though the sampled terranes are currently juxtaposed in close proximity, variable contributions of inferred West African craton, peri-Gondwanan, and Cambro-Ordovician source regions indicate they originally formed in very different settings.

QUANTIFYING STREAM PHOSPHORUS DYNAMICS AND TOTAL SUSPENDED SEDIMENT EXPORT IN FORESTED WATERSHEDS IN VERMONT

RYAN, Sophia, Department of Geography, University of Vermont, Burlington, Vermont WEMPLE, Beverley, Department of Geography, University of Vermont, Burlington, Vermont ROSS, Donald, Department of Plant and Soil Science, University of Vermont, Burlington, Vermont

Globally the quantity of reactive phosphorus (P) in soils, streams and groundwater has greatly increased throughout the 20th and early 21st centuries. This phenomenon is problematic in Vermont, evidenced by the repeated cyanobacteria blooms in shallow bays in Lake Champlain. While many studies have focused on P dynamics in agricultural watersheds, there is limited information on P dynamics in forested

watersheds. Current remediation plans under the Lake Champlain TMDL call for substantial reductions in P loadings from forested areas of the basin. However, the lack of information and knowledge regarding forest P dynamics limits management and remediation plans. This study was conducted in three small forested watersheds, ranging in size from 2.5 to 8.3 square kilometers that have been managed under varying practices, including logging and maple sugaring. Both watersheds drain into Missisquoi Bay, a shallow bay in Lake Champlain that consistently has seasonal algal blooms. Streams were instrumented with pressure transducers to measure stage and turbidity sensors. A rating curve was developed during field visits to relate stage to discharge. Water samples were collected from May through November using ISCO Automated Samplers. A total of twenty storm events were captured, along with periodic baseflow sampling, and used to characterize P concentrations and calculate seasonal P loadings. Results indicate that there is a strong positive relationship between turbidity, total suspended sediment and total phosphorus concentrations (r2 ranging from 0.64 to 0.83). The results of this project provide insight into transport of P and total suspended sediment within forested catchments of Lake Champlain tributaries. In particular, the research shows that fluxes total phosphorus are linked to fluxed in total suspended sediment and that the overall monthly totals of P being exported from forested catchments is low.

THE EFFECT OF CALCITE-BEARING VEINS ON GROUNDWATER GEOCHEMISTRY IN A FRACTURED ROCK AQUIFER

BENINGSON, Nathan[1], RYAN, Peter[1], KIM, Jonathan[2], (1) Geology Department, Middlebury College, Middlebury, VT 05753, (2) Vermont Geological Survey, Montpelier, VT 05620

The effect of bedrock on groundwater geochemistry in fractured bedrock aquifers is well constrained, with a focus on how naturally occurring harmful trace elements like arsenic and uranium can be incorporated in drinking water resources. However, previous studies examining trace elements in groundwater in fractured bedrock aquifers have found anomalous concentrations of strontium in groundwater across thrust faults in the Champlain Valley, Vermont. The metamorphosed pelites in the hanging walls have lower concentrations of Sr (88 ppm) compared to the relatively unmetamorphosed carbonates in the footwalls (160 ppm), but hanging wall groundwater has very elevated levels of Sr (2363 ppb) compared to footwall groundwater (196 ppb). Calcite veins were theorized as the source of these anomalous Sr levels, as calcite veins have been shown to incorporate high Sr concentrations elevated above those of their host rock. For this study, calcite veins were sampled from the hanging walls of the Hinesburg Thrust and the Muddy Brook Thrust in western Vermont. XRD analysis revealed that veins primarily consisted of calcite and some quartz, with one vein comprised of palygorskite and calcite. ICP-MS analysis of trace element concentrations yielded hanging wall vein Sr concentrations significantly elevated above the host rock averaging 3,327 ppm, while footwall veins had Sr concentrations averaging 341 ppm. This indicates that the calcite-bearing veins are a likely source of the elevated Sr in the hanging wall groundwater, and suggests that calcite-bearing veins can affect the trace element geochemistry of fractured bedrock aquifers.

ANALYSIS OF THE EFFECT OF REGIONAL CLIMATE ON SOIL MINERALOGY AND CHEMISTRY IN THE TROPICS: A CASE STUDY FROM THE PACIFIC COAST OF COSTA RICA

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As compared with understanding of pedogenesis in temperate regions, evolution of soil properties in the tropics is not particularly well understood. Previous studies on the development of tropical soils have primarily examined the effect of soil age on factors such as bulk density and chemical composition, however the rate at which soil evolution in the tropics occurs due to variations in climate (particularly precipitation) has not been well documented. Largely, this gap of knowledge is due to a lack of sufficient empirical data needed to create an effective predictive model. The aim of this study is to add to existing results of several tropical soil studies conducted throughout Costa Rica by analyzing thirty-three new soil samples collected during December 2016 from sequences of Quaternary-aged (0-120 ka) fluvial fill terraces around the largely smectite-dominated Western Nicoya Peninsula and kaolinite-dominated Ojochal. The two locations differ from others that have already been studied across the region primarily with regards to precipitation, which is 2200 mm/yr and 3500 mm/yr respectively for the two sites. Samples were analyzed using both X-ray diffraction (XRD) and X-ray fluorescence (XRF) methods, while chemical weathering rates were determined using bases:alumina, bases:R_2O_3, and Parkers weathering index methods (Birkeland, 1999). Results were incorporated into an effective age model established by Pincus et al. 2017 in order to continue efforts to predict the future development of soils throughout the global tropics.

UTILIZING MAJOR AND TRACE ELEMENT DIFFUSION MODELS IN OLIVINE AND CLINOPYROXENE TO DETERMINE ASCENT TIMESCALES OF CINDER CONE MAGMAS IN THE SOUTHERN CASCADES

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While geophysical and U-series isotopic methods have robustly characterized pre-eruptive histories of major composite volcanoes, timescales of magmatic crustal transit and pre-ascent deep mixing remain poorly constrained for monogenetic cinder cones. As the most abundant volcanic landform on earth, cinder cones have relatively simple conduit systems but can produce violent strombolian eruptions (Pioli et al., 2008; Wood, 1980). Diffusion modelling of major and trace element zones in olivine and clinopyroxene allows us to study the timescales of early magma generation, mixing, crustal storage, and ascent for systems that are young and unable to be monitored in real-time. We utilize the finite difference approximation of Fick's Second Law to calculate diffusion timescales of primitive olivine and pyroxene phenocrysts (~52 wt% SiO_2) from a southern Cascade Arc cinder cone that erupted during the Pleistocene: the basaltic andesite of Box Creek (MBX). Bimodal internal reverse and normal core zoning populations within ~150 tephra-derived clinopyroxene phenocrysts indicate both a deep pre-eruptive mixing event as well as a later growth-dominated ascent event, respectively. Diffusion models of the internal zone recorded by rare earth elements along c and a/b crystallographic axes yield timescales on the order of several hundreds to ~2500 years , which can be used as a conservative

maximum timescale of ascent prior to eruption. These results may provide new constraint on timescales of mafic magma crustal transit and the complexity of cinder cone magmatic histories.

GEOCHEMICAL APPROACH TO QUANTIFYING ATMOSPHERIC DUST INPUT TO ALPINE SOILS IN THE UINTA MOUNTAINS, USA

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Geochemical and isotopic comparison of atmospheric dust and local bedrock allows for the quantification of exogenous versus endogenous inputs to alpine soils. We applied this approach in the Uinta Mountains, part of the Rocky Mountain system in the western USA. Largely homogenous, quartzite-dominated bedrock of the Uinta Mountains is depleted in key environmental nutrients, and thought to be insufficient to support the productive ecosystem of high alpine tundra meadows. Wind-transported mineral dust is known to be a significant contributor of nutrients in other alpine regions. A network of passive and active dust collectors has sampled contemporary dust deposition in the Uinta Mountains since 2011. This dust is notably enriched in calcium, strontium and rubidium relative to bedrock. Samples of surface soil and deeper soil horizons, from four locations at the eastern end of the Uinta range, were collected in 2016, providing a perspective on the dust content of alpine soils in this region. Grain size analysis of 41 samples reveals that soil A-horizons are composed of 42.3 to 87.0% silt (mean of 67.2%), whereas B-horizons contain 13.0 to 68% silt (mean of 38.8%). This difference, which is significant (P=0.000), supports previous observations of a ubiquitous loess cap averaging 18 cm thick at the eastern end of the Uinta Mountains. XRF analysis of soil, dust and bedrock samples from the four locations demonstrate A-horizon enrichment in strontium of 450-480% relative to bedrock. A simple mixing equation is employed to categorize dust and local bedrock as elemental endmembers in the composition of soil. Analysis of the average neodymium values in soil horizons demonstrate that A-horizons are composed of 78% dust, with just 22% local material. In contrast, deeper soil horizons are composed of 69% dust and 31% bedrock. XRD analysis shows that muscovite and feldspar dissolution from dust is the likely source of dominate soil clays minerals. Chemical, isotopic and mineralogical analysis demonstrate that exotic dust is the most important parent material to high alpine soils in the Uinta Mountains.

ANNOUNCEMENTS

Please send announcements that are pertinent to our membership to the VGS publications manager as listed below.

CALENDAR

Vermont Geological Society Student Meeting
Date: April 28, 2018
Location: McCardell Bicentenial Hall, Middlebury College, Middlebury, VT
Contact: For more information contact Jon Kim at 802-522-5401

2018 Resources for Future Generations - Energy, Minerals, Water, Earth
Date: June 17-21, 2018
Location: Vancouver, Canada
Host: International Union of Geological Sciences, Geological Association of Canada, Mineralogical Assoc. of Canada, Canadian Institute of Mining, Metallurgy and Petroleum, and Canadian Federation of Earth Sciences
Joint Field Conference of the New York State Geological Assoc (NYSGA) and New England intercollegiate Geologic Conference (NEIGC)
Date: October 5-7, 2018
Location: Lake George, New York
Geological Society of America Annual Meeting
Date: November 4-7, 2018
Location: Indianapolis, Indiana
Solar Eclipse (NASA site)
Date: April 8, 2024
Information: In Vermont we will see a total eclipse with the maximum in Burlington around 3:27 pm

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