QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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THE VERMONT GEOLOGICAL SOCIETY ANNUAL SPRING STUDENT PRESENTATION MEETING

April 30, 2016, 8:30 am

McCardell Bicentennial Hall 276 Bicentennial Way Middlebury College

Middlebury, VT

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PRESIDENT"S LETTER

Over the years, we have had a tough time planning and running our annual winter meeting in January/ February. Last year's meeting, which celebrated the retirement of Larry Becker (former Vermont State Geologist) at The Cider House in Waterbury with a barbeque buffet and three guest-speakers was a recent exception. The Cider House changed owners in the fall of 2015 and was not available as a venue this year. Research into other venues in the Montpelier/Waterbury area revealed room rental and group menu prices that were too high to consider. George Springston has volunteered to spearhead an effort to revive the VGS winter meeting. If you have any ideas or comments, contact George at gsprings@norwich.edu.

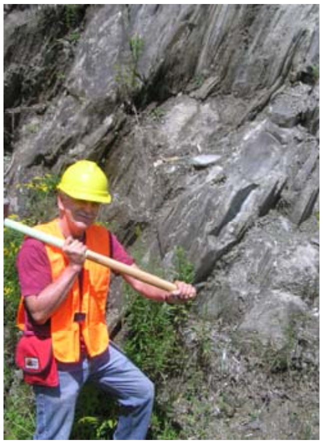
The Executive Committee and other interested members will hold a meeting after the VGS Spring Meeting at Middlebury College on Saturday April 30th. We will meet at a local restaurant after the student talks and awards conclude. Some topics to be considered include the fate of the VGS winter meeting, summer and fall field trips, new officers, and implications of the Professional Geologist certification in New York State for Vermont geologists (Dave Franzi from SUNY at Plattsburgh told me that the last date to be considered for "grandfathering" will be sometime in November 2016).

The Retirement of Ray Coish

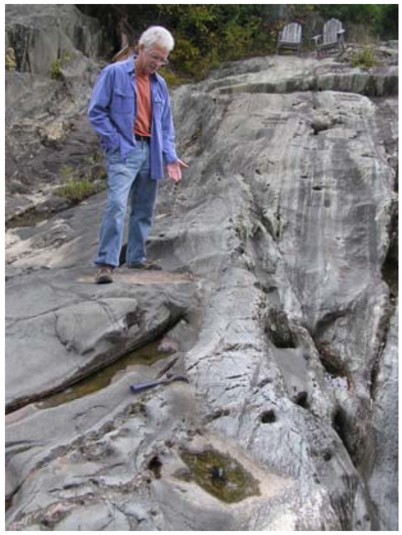
As most of you know, Ray Coish will be retiring from the Geology Department at Middlebury College at the conclusion of the spring semester. Ray has been a mentor, colleague, and friend to me over 20 years. Working with Ray and his students has certainly been one of the highlights of my career. Over the years, one of my favorite things to do was to "talk tectonics" with Ray in his office at Middlebury College. Ray and his students made many major contributions to the understanding of Vermont geology. I also have firsthand knowledge from his students what an outstanding teacher he is. He will be missed.

I first learned about Ray when I was doing preliminary research for a Ph.D. dissertation at SUNY at Buffalo in January of 1989, in part, by reading the papers that he and his students had written. Although it did not take much convincing, my soon-to-be advisors, Bob Jacobi and John Fountain, told me that if I just chose their tectonics project in the Rowe-Hawley Belt of northwestern Massachusetts, I could be "like Ray Coish". I first met Ray at the 1996 NEGSA in Buffalo, New York, where he chaired a symposium on Northeastern Appalachian igneous geochemistry that I participated in.

I moved to northern Vermont in May 1996 to work as a contract mapper for the new state bedrock map and cobbled together an existence through this, teaching as an adjunct instructor at Johnson State, and teaching skiing at Smugglers' Notch Resort. During the summer and fall of 1997, I worked with my first of many of Ray's students, Scott Applegate, mapping in the Worcester Mountains; Scott is the only Coish student that finished mapping in a foot of snow while camping at Mt. Elmore State Park. I started working full-time at the Vermont Geological Survey in November 1997. Other excellent Coish students that I worked with included Dave Johnson, Evan Twelker, Nate Morris, Mike Gleason, Claire Anderson, Melissa Whitehead, Scott Zolkos, Juliette Ryan-Davis, C.C. Connard, and Patrick Scott. Instead of writing further, I thought that some "greatest hits" pictures of Ray would be more appropriate:

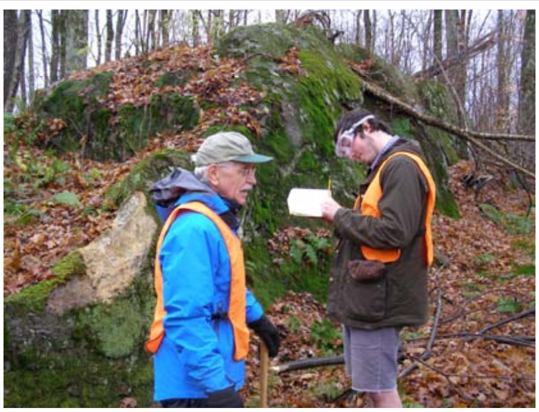


Ray with "The Whammer", a 14 lb. sledge that devastated rocks all over Vermont.

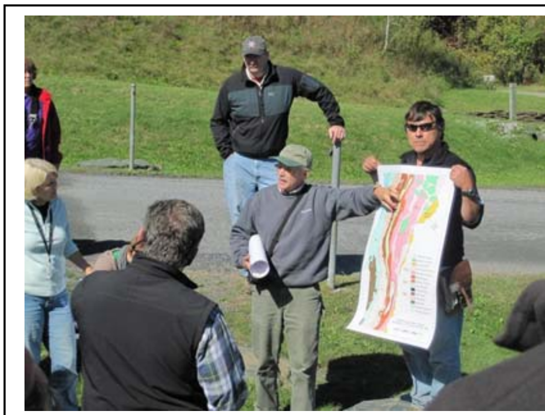


Standing at the contact between a metadiabase dike (left) and quartzites of the Moretown Fm (right) (2011).

The R(ay)-MC between rocks of the Cram Hill Fm to the west (left) and Waits River Fm to the east (right).



Sampling the Shaw Mountain Fm for detrital zircons with Patrick Scott during the late fall of 2015.



Explaining greenstones at stop 3 during a 2009 NEIGC trip in central Vermont (D. West photo)

TREASURER'S REPORT

Finances: The Society remains in excellent financial health. Since the last report, the only thing we have done is deposit more dues and as contributions to the Research Grant Program. Nearly all members have paid their 2016 dues, but a few stragglers will be granted another brief extension. Anticipated immediate expenses include the costs of operation for the spring meeting, student paper awards, and another round of student research awards.

Expenses:
None

Income:
$1,338 Dues for 83 members
$1,175 Contributions to the Research Grant Program by 32 members

Balance: Our current balance as of April 22, 2016 is $12,161.

New Members:
Jean & Mel Simmons, New Haven, Vermont

Contributors to the Research Grant Program:
Bruce and Cheryl Cox, Andrew & Laura McIntosh, Sharon Strassner, Peter J. & Thelma B. Thompson. Roger & Terry Thompson. Laurence R. Becker, Alice Blount, David Butterfield, Alex G. Czuhanich, Vincent DelloRusso, Brett Engstrom, Laurie Grigg, Timothy W. Grover, Barbara L. Hennig, Jefferson P. Hoffer, Leslie Kanat, Jon Kim, John Klimenok, Jr., Chris Koteas, Eric Lapp, John A. Malter, Donald M. Maynard, John Moore, Dagan Murray, Alexis P. Nason, Jeffrey Pelton, Peter Ryan, George Springston, Stuart Strife, Art Stukey, John G. Van Hoesen, Gregory J. Walsh, Laura Webb, David West, David S. Westerman, Stephen F. Wright

Respectfully submitted,
David S. Westerman, Treasurer

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

No research grant applications were submitted to the VGS AOS Committee by the April 1, 2016 deadline. The next deadline for these grants is October 1, 2016. Contact Jon Kim at jon.kim@vermont.gov if you have any questions.
We are still looking for volunteers to lead the summer and fall field trips.

Respectfully submitted,
Jon Kim, Chair

STATE GEOLOGIST'S REPORT

Our Geological Survey and collaborators continue to work on multiple projects focused on geology and health, hazards, and groundwater, all dependent on utilization of basic bedrock and surficial maps. Our priorities, however, took a dramatic turn this spring with the report of PFOA contaminated groundwater in North Bennington. The Department of Environmental Conservation mounted a major on-going effort to assist residents in North Bennington and Pownal. Jon Kim and partners are working to understand contamination at the site and surrounding areas, groundwater flow, and potential groundwater-surface interactions in the area. He will likely be focused on this project through the fall - winter. As for me, in my role on the Agency Science Advisory Committee, we were asked to form a sub-committee and review other contaminants of emerging concern. EPA's list of contaminants of emerging concern (unregulated) in public drinking water include roughly 100 disinfection products, chemicals used in commerce, waterborne pathogens, pharmaceuticals, pesticides and biological toxins. Our committee is looking at human and environmental health concerns associated with groundwater, surface water, waste water, drinking water, air, fish and wildlife. Our group began by discovering that there are more than 109 million substances in the Chemical Abstracts Service registry. We have since coordinated with other Agencies and hope to soon have a short list of high priority contaminants for Vermont. We never know where geology will take us, but it is always interesting and challenging. Now, back to highlights from our usual topics and projects.

Hazards

The Survey is funding rock fall and landslide hazard work in Highgate, Addison County and Jeffersonville through grants and contracts to Norwich University, Green Mountain College and Johnson State College, respectively. The town of Highgate is particularly concerned about slope instability issues at a closed landfill site, now a transfer station. The town has conducted several mitigation efforts thus far but has been unsuccessful in obtaining FEMA funds for mitigation of the site. As part of the landslide hazard map study, an opportunity became available to have a UVM School of Natural Resources drone flight provide detailed imagery and elevation data which will be used to the document slope, the present state of the site and the current extent of the erosion/failure sites. The Addison County project will complete a prototype Phase 1 assessment following protocols set out in the State Hazard Mitigation Plan. We hope to complete statewide Phase 1 assessments within a 5-8 year time frame, depending on lidar coverage, and use these assessments to identify areas for detailed studies and concentrated mitigation efforts. The Jeffersonville project continues monitoring of the landslide site downtown and of rockfalls in Smugglers Notch.

The National Transportation Safety Board (NTSB) contacted the Geological Survey for geologic assistance in their investigation of the train derailment site in Northfield, VT last fall. Tom Eliassen (VTRANS), George Springston (Norwich University) and I met with the investigators and discussed the geologic map, rock structures, rockfall and landslide types, and hazard rating systems. We visited the derailment site in the afternoon and provided NTSB with a preliminary assessment of the rockfall. The NTSB, an independent US Federal Agency, is charged with determining probable cause(s) of transportation accidents and making safety recommendations. Subsequently, WPTZ contacted the Division for information about rockslides. The aired story began with hazards related to the train derailment but moved to a discussion of rockslide hazards throughout the state. The hazard mapping project which was recently initiated in Highgate served as an example of the work we do to provide sound science for mitigation planning and to assist towns in hazard identification.

A one year study, conducted by Northeast States Emergency Consortium (NESEC) in association with the Vermont State Geologist, the Vermont National Guard and the Vermont Division of Emergency Management and Homeland Security, was delivered by NESEC in February 2016. The study evaluated buildings and their potential response to seismic events. Buildings were rated through ROVER* based on factors such as year built, type of building (unreinforced masonry, steel frame etc.), number of occupants, and plan irregularities. The building rating was then applied to estimate damage during a seismic event in HAZUS-MH, a computer program for risk assessment and damage estimates. NESEC recommended on-site assessments of 22/26 facilities.
The final report from NESEC is: Seismic Screening and Analysis of Selected Critical Facilities in Vermont Utilizing Two FEMA Methodologies (HAZUS & ROVER). The report is available on our web site.
*ROVER is the acronym for Rapid Observation of Vulnerability and Estimation of Risk.

This winter our office was contacted by the Shelburne News for information about ground shaking and noise in Shelburne on January 8 and 11. From the verbal descriptions and absence of any recorded earthquake, it is quite likely that cryoseisms or frost quakes, very shallow cracks which develop in frozen ground, caused the shaking and noise. Although Vermont does not track frost quakes, we discovered that the Maine Geological Survey does and we directed VPR to Henry Berry (MGS) who did a great job explaining the phenomenon on VPR. You can read the Shelburne News article at: http://www.shelburnenews.com/2016/01/15/mysterious-rumblings-in-the-night-wake-shelburne-residents/

Groundwater

The Geological Survey has many groundwater supply and water quality projects in progress including projects in Cabot, Kingsbury Branch, Calais, Woodbury, Monkton, Hinesburg, Sutton, Bennington and the Champlain Valley.

On March 30, Jon Kim testified before the House Fish, Wildlife, and Water Resources Committee on groundwater issues. He explained that Geology and Health is one of our major programs and involves detailed studies of groundwater chemistry throughout Vermont with partners from Middlebury College, SUNY at Plattsburgh, and UVM. These studies involve the testing of multiple private wells in each field area for 35 parameters, which include contaminants such as arsenic, radionuclides (gross alpha and uranium), manganese, lead, nitrate, and fluoride. Geologic mapping always accompanies these studies so that the geologic framework is well-defined. GIS maps that show areas where elevated levels of contaminants have been found in groundwater are regularly produced (i.e. west-central and southwestern Vermont). In addition, he reported on our collaboration with the Vermont Agency of Agriculture on nitrate contamination of groundwater around large dairy farms.

Jon Kim (Geology) and Jeff Comstock (AAFM) presented results of a collaborative study on nitrate contamination of groundwater and subsequent recovery associated with a dairy farm in East Montpelier to the Water Quality and Farm Inspection Program. The study integrated long-term nitrate monitoring of groundwater with the detailed geologic framework and is intended to help inform best management practices involving both point and non-point sources. The lessons learned from this study are being applied to nitrate contamination of a public water supply well in Sutton.

The Vermont Rural Water Association (VWRA), EPA, Rodney Pingree (Drinking Water and Groundwater Protection Division) and the State Geologist have been conducting workshops on groundwater protection and planning for regional planners. Rodney presents a case study of a local community "No Water Town, Vermont" and discusses planning for future public water supplies, loans and outreach, while I cover groundwater mapping studies, EPA discusses the Source Protection Collaborative, and Liz Royar of VRWA addresses planning for source protection at the local level. VRWA is also under contract with us to conduct an inventory of water use data retained at DEC and write a plan to upgrade data from baseline values to higher tiers which have been defined by the USGS. The USGS goal is to develop data which can be used by water managers, academia, and government to establish local and regional water budgets.

Science Advisory Committee

The Agency Science Advisory Committee (SAC), which I co-chair with Sandy Wilmot from Forest, Parks, and Recreation, was established by Charter in late fall. We reviewed Agency-wide recommendations for strengthening science and set priorities for the coming year. Several "just do it" items were initiated and we plan to initiate at least one mid-level project, and develop plans for long term projects and processes. The SAC has several priority items, including building the culture of science, increasing collaboration and communication among Agency of Natural Resources science staff, and data management. The SAC seems to be a good fit for the State Geologist Office since geology crosses all media (air, earth, water) and earth systems.

Association of American State Geologists (AASG) Liaison, Washington, DC

On March 21-23, I had the good fortune of attending the AASG Liaison meeting. 19 AASG members met with Directors and other representatives from 30 Federal Agencies, NGOs, and Senators, Representatives and staffers from Senate and House Appropriations Committees and Energy and Natural Resource Committees. AASG voiced for support of the National Cooperative Geologic Mapping Program (NCGMP) and the important groundwater and hazard maps which are derived from this basic work, the National Geologic and Geophysical Data Preservation Program (NGGDPP), Lidar and 3DEP mapping, and the National Groundwater Monitoring Network. AASG also supported a landslide hazard research and mapping bill introduced by Congresswoman Suzan DelBene (WA).

On a final note or two, this spring we received notification of our 2016-2017 STATEMAP award for surficial mapping in Weathersfield and the Joes Pond quadrangle. Groundwater resource maps will be developed from the basic surficial maps. Also, our web site has been completely re-designed to achieve consistency in the look and navigation across the Department of Environmental Conservation and Vermont government sites. Work was done throughout the fall, all content has been migrated, and the site is scheduled to go live on April 18. We hope you enjoy the new site at http://dec.vermont.gov/geological-survey.

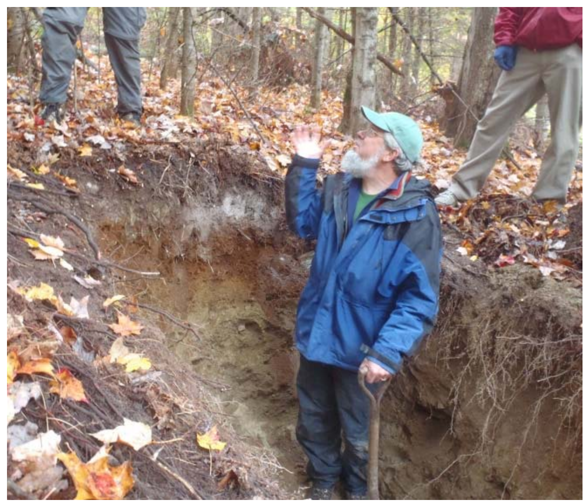
Happy Spring 2016 to all and thank you for all the support you provide to our geologic community.

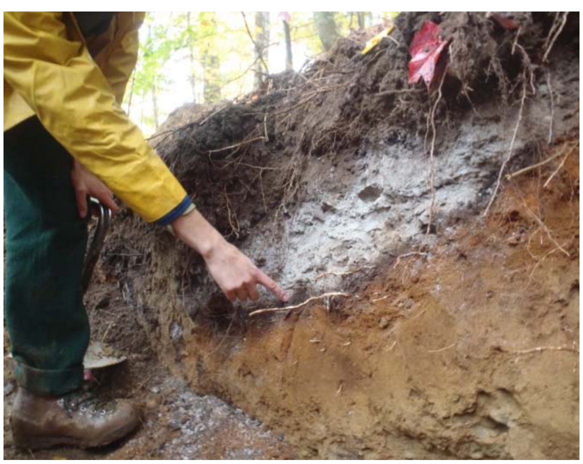
Respectfully Submitted,
Marjorie Gale, Vermont State Geologist

Fall Field Trip Report: Soil Genesis in Addison County—the Soil Profile in Context

On October 17, 2015 Larry Becker (retired Vermont State Geologist) and Caroline Alves (NRCS) led our group on a tour of sites in the New Haven River watershed to explore soil profile development on a variety of surficial geologic materials. We met at Lincoln Applied Geology and proceeded to examine soil profiles in a series of backhoe pits that Steve Revell kindly prepared for us. These gave us excellent views of soil profiles in glacial till. We then moved on to a landslide exposure on the west side of the New Haven River which exposed a thick sequence of sands (deltaic or ice-contact?) over lacustrine silt-clay over dense till. After a bag lunch in an increasing rain, we visited additional sites farther upstream. As I drove out of Lincoln that afternoon, a light snow falsely suggested that a snowy winter was on the way.

Photos upper left: Caroline enthusiastically describing spodosol development. Upper right: Craig Heindel in deep discussion. Lower left: a truly spectacular spodic profile. Lower right: a group photo (in driving rain).





Many thanks to Steve Revell of Lincoln Applied Geology for these excellent pits.

Trip report by George Springston.

2016 SPRING MEETING PROGRAM

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

9:00 AM -- JACK C. STEELE, Late Pleistocene Chronology of Lake Terreton, Southeastern Idaho

9:15 AM -- CAITLIN HAEDRICH, Lidar Ground Surface Classification in the Middlebury River Watershed

9:30 AM -- MICHAEL CHIRIGOS, Using Photogrammetry to Analyze Structures in a Tectonic Sliver in the Foot Wall of the Champlain Thrust, Shelburne, Vermont II

9:45 AM -- SAM COWAN, Analysis of Groundwater Quality in a Fractured Rock Aquifer Influenced by Black Shales in the Central Champlain Valley, Western Vermont

10:00 AM - STEPHAN NIKOLAS KOENIGSBERGER, Speciation of Uranium in Sedimentary Phosphorites Associated With U-Affected Groundwater

10:15 AM - INGRID EVANS, Does sample preparation impact carbon absorbance and fluorescence properties of soil leachate?

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

11:00 AM - AMANDA FISHBIN, Geochemical and Hydrochemical Analysis of a Quartzite-Dolostone Bedrock Aquifer in the Central Champlain Valley, Monkton, Vermont

11:15 AM - SAMUEL S. O'KEEFE, Using Lake Sediment Records to Reconstruct Post-Glacial Dust Delivery to High-Elevation Lakes in the Uinta Mountains, Utah

11:30 AM - AMY LEWIS, Decoding an Atypical Saprolite at Camel's Hump, Vermont

11:45 AM - PERRI SILVERHART, Utilizing Landslides on Lake Champlain as Paleoseismic and Paleohazard Indicators

12:00 PM - **BREAK FOR LUNCH**

12:45 PM - NOAH STONE, Geochemistry and Petrology of the Cuttingsville Igneous Stock

1:00 PM -- MARIAH SCHNEIDER, Geophysical Surveys of the UVM Green

1:15 PM -- ELISABETH McELWEE, The Origin of the Color Difference in Sandstones of the Lower Cambrian Monkton Formation

1:30 PM - WILL BURKE, Petrology and Geochemistry of Metamorphosed Cambrian-Ordovician Volcanic rocks of the St. Croix Belt, Western

Penobscot Bay, Maine

1:45 PM - PATRICK SCOTT, Detrital Zircon Ages of the Umbrella Hill and Shaw Mountain Formations, Vermont

2:00 PM – **BREAK, COFFEE & REFRESHMENTS**

2:15 PM - EDWARD BONNER, Vonsenite, 2FeO•FeBO3, A High-Temperature Mineral Occurring in Contact Metamorphic Deposits: Crystal Structure at Room and Liquid Nitrogen Temperatures

2:30 PM - C. MAEVE GRADY, Creating a Landscape-Scale Model of Soil Evolution on the Pacific Coast of Costa Rica

2:45 PM - RYAN C. McELROY, Determining the Influence of Dust on Post-Glacial Lacustrine Sedimentation in Bald Lake, Uinta Mountains, Utah

3:00 PM - ANDREW GORIN, Paleoclimate Reconstruction from a Weybridge Cave Speleothem

3:15 PM - JENNIFER BOWER, Lead in Urban Soils: Observations from the Macroscale to the Microscale

3:15 PM - **JUDGING, REFRESHMENTS & AWARDS CEREMONY**

STUDENT ABSTRACTS

LATE PLEISTOCENE CHRONOLOGY OF LAKE TERRETON, SOUTHEASTERN IDAHO

STEELE, Jack C., and AMIDON, William H. Department of Geology, Middlebury College, Middlebury, VT 05753

A better understanding of Late Pleistocene climate change in the western US is important because it can help to calibrate climate models that are designed to predict future changes caused by global warming. Shorelines of closed lake basins provide excellent climatic records, which are particularly good at recording the timing of high stands caused by wetter and/or cooler conditions. Lake Terreton was a large lake situated on the western Snake River Plain, an area with relatively few direct climate proxies. The lake occupied the Mud Lake and Big Lost Trough sub-basins around the time of the last glacial maximum. 19 samples of shoreline-proximal sands were collected from outcrops and hand-dug soil pits. Optically Stimulated Luminescence (OSL) ages for five of the samples indicate that the lake rose to its highest level at roughly 23 ka and experienced smaller high stands near 8 and 13 ka. The oldest high stand at 23 ka matches the timing of the Big Lost River Flood, which flowed into the Terreton Basin. This suggests the flood may have filled the Terreton basin to the point of overflow, causing an exceptionally large high stand. The younger high stands tentatively correlate with known climatic anomalies in the North Atlantic although additional work is required to better constrain the ages and place them in a regional context.

LIDAR GROUND SURFACE CLASSIFICATION IN THE MIDDLEBURY RIVER WATERSHED

HAEDRICH, Caitlin[1], AMIDON, Will[2], (1) Geology Thesis Student, Middlebury College, Middlebury, VT, (2) Professor of Geology, Middlebury College, Middlebury, VT.

The rapidly expanding coverage of high resolution LiDAR-derived topographic datasets enables many new applications in geomorphology and related fields. In the northeastern U.S., LiDAR data allows researchers to see through the forest canopy and visualize the land surface in rich detail. This study aims to develop a semi-automated method to differentiate between ground surface types in northern New England such as bedrock, fluvial/alluvial terraces and glacial till, which appear texturally distinct in high resolution digital elevation models (DEMs). Using a $12km^2$ study area in the lower Middlebury River watershed in East Middlebury, VT, spatial statistics such as slope, roughness and variability are used to characterize the surface textures. Multiple training and classification methods were run in ArcMap and the resulting class maps were ground-truthed to assess the accuracy of the different statistic combinations and classification techniques in the study area. Although additional study is required to refine our approach, accurate classification of ground surface from LiDAR may ultimately be useful in geologic mapping, sediment budgets, and infrastructure planning.

USING PHOTOGRAMMETRY TO ANALYZE STRUCTURES IN A TECTONIC SLIVER IN THE FOOT WALL OF THE CHAMPLAIN THRUST, SHELBURNE, VERMONT II

CHIRIGOS, Michael[1], KIM, Jonathan[2], HOESEN, John Van[3], (1) Department of Geology, University of Vermont, Burlington, Vermont, 05405 (2) Vermont Geological Survey, Montpelier, VT (3) Green Mountain College, Poultney, VT

In the Champlain Valley Belt of west-central Vermont, the Champlain Thrust juxtaposed ferruginous quartzites and dolostones of the Lower Cambrian Monkton Fm (hanging wall) with calcareous shales of the Late Ordovician Stony Point Fm (foot wall = Parautochthon), during the Ordovician Taconian Orogeny. A tectonic sliver of dark gray limestone that probably correlates with the Cumberland Head Fm is internal to the Parautochthon in this area.

Structural analysis of a ~100 m long outcrop was completed through a combination of photogrammetric techniques and field measurements. We used photogrammetry to build photo mosaics of 1) the entire outcrop and 2) each of 5 fault-bounded structural packages. A preliminary synthesis is described below, and structures with the same relative age, determined using cross cutting relationships, developed diachronously across the outcrop from west to east.

The oldest planar structure in each package is bedding (S0), which is a millimeter-scale, dark and light, compositional banding. Superposed on S0 at high angles, is a penetrative spaced pressure-solution cleavage S1 that, where associated folds are absent, is thrust-related. Southeast-trending slickensides formed on fault-parallel zones of calcite veins in 3 of the 4 major faults.

In packages 1-3 (numbered west to east), S1 is truncated by, and/or rotated into parallelism with, the overriding east-dipping thrust faults. These faults (A+B) are deformed by open folds (F2) with a local axial planar spaced cleavage (S2). The fault C boundary between packages 3 and 4 truncates F2, and S2. East of fault C, S1 cleavage is openly folded (F2), and truncated by fault C'. Propagation of faults C'

and D, and the intensification of folding in packages 4 and 5 is interpreted to be in response to motion on an inferred decollement. In the western side of Package 4 , S1 cleavage fans until it shears out to the east to form a ~vertical fault contact (Fault D) with package 5, and an S2 fracture cleavage is formed axial planar to F2 folds. Within package 5, S1 is deformed by tight reclined F2 folds, with gently plunging axes. The axial planar S2 cleavage in eastern package 5 was truncated by a local S3 cleavage associated with backfolding. In an area characterized by foreland-propagating thrust sequences, we determined that hinterland-propagating processes also operated.

ANALYSIS OF GROUNDWATER QUALITY IN A FRACTURED ROCK AQUIFER INFLUENCED BY BLACK SHALES IN THE CENTRAL CHAMPLAIN VALLEY, WESTERN VERMONT

COWAN, Sam, Geology Department, Middlebury College, Middlebury, VT 05753

Residents of rural regions tend to rely on a largely unregulated water source, private groundwater wells. In Vermont, 40 % of the state's population obtains drinking water from private wells that are rarely tested for inorganic or organic contaminants. The focus of this study is the central Champlain Valley of northwestern Vermont, where a large portion of the population relies on private wells that produce drinking water from a shale-dominated aquifer. The Champlain Valley is comprised of Cambrian-Ordovician passive margin sediments with black shale as a common lithology in some areas. The shales are the youngest units in the sequence and were deposited in a downwarping, deepening basin related to convergence associated with the Taconian Orogeny. The Champlain thrust fault divides the bedrock aquifer system, placing allochthonous Hortonville Formation black shales structurally above parautochthonous black shales of the Stony Point Formation. Black shales tend to contain elevated trace element concentrations, particularly of redox-sensitive elements like arsenic and uranium, and recent studies in the northern Appalachians have identified black shales and black slates as sources of elevated arsenic in bedrock aquifers. Accordingly, this study is designed to examine the inorganic chemistry of black shales as well as groundwater produced from black shales in the hanging wall and footwall of the Champlain thrust. Preliminary results from 29 shale-dominated wells in the Stony Point Formation of the footwall document relatively low levels of arsenic – only one well exceeded the EPA MCL of 10 ppb As, although 5/29 (~17 %) exceeded 5 ppb As. Groundwater analyses paired with XRF, ICP-MS and SEM-EDS analysis of shale chemistry will provide insight into controls exerted by black shales on groundwater, including potential control exerted by paleo-redox environment present at the time of deposition. Additional comparison of the Champlain valley shales with Taconic shales highlights distinct paleoredox conditions, and differences in sediment source.

SPECIATION OF URANIUM IN SEDIMENTARY PHOSPHORITES ASSOCIATED WITH U-AFFECTED GROUNDWATER

KOENIGSBERGER, Stephan, Geology Department, Middlebury College, Middlebury, VT 05753

Elevated alpha radiation and uranium occur in groundwater of a carbonate-dominated fractured rock aquifer in the Champlain Valley of NW Vermont, and geologic mapping indicates a strong spatial association with dolostones of the late Cambrian Clarendon Springs (Ccs) Formation. Of 131 wells tested within the 12 km2 area, 30 contained levels of alpha radiation exceeding the EPA's Maximum Contaminant Level (MCL) of 15 pCi/L. Of wells that exceeded the alpha MCL, 90% also exceeded the Vermont MCL for uranium of 20 mg/L. Uranium in the CCs occurs in sedimentary breccias and thin wispy bedding planes comprised of black phosphorite which contains up to 420 mg/kg U. X-ray

diffraction of the black phosphorites indicates that they are dominated by flouroapatite, a mineral which has the potential to host U(IV) substituted for calcium. SEM-EDS reveals that uranium is heterogeneously distributed within the black phosphorite clasts and layers and is marked by 5-10 micron "blebs" that contain stoichiometries consistent with meta-autunite. Many of these occur in conjunction with decomposing pyrite, suggesting that sulfuric acid generated by pyrite oxidation may trigger reaction of fluoroapatite (with reduced U(IV)) to meta-autunite (with oxidized U(VI)). Experiments designed to transform uranium bearing flouroapatite to autunite or metaautunite via reaction with solutions of sulfuric acid have been carried out. This approach was meant to simulate the acid produced by the oxidation of pyrite within the black chip phosphorite. While this experimentation has not produced any detectable amounts, if any at all, of autunite or meta-autunite, it nevertheless indicates that the oxidation of pyrite is capable of re-mobilizing uranium. Sequential chemical extraction of uranium bearing, flouroapatite-rich phosphorites has also been carried out to further explore the solubility and speciation of uranium in the Ccs. The progressive sequential extraction of the phosphorite samples has progressed through solutions of the following: potassium nitrate, acetic acid, hydroxylamine hydrochloride and hydrogen peroxide. Quantitative XRD and ICP-MS analysis following each extraction have revealed the solubility of the various minerals within the black phosphorite chips and their effect on the release of uranium into solution.

DOES SAMPLE PREPARATION IMPACT CARBON ABSORBANCE AND FLUORESCENCE PROPERTIES OF SOIL LEACHATE?

EVANS, Ingrid, HAMPSCH, Alyson, CINCOTTA, Malayika, PERDRIAL, Julia, Department of Geology, University of Vermont, Burlington, Vermont, 05405

Aqueous soil extracts are often prepared as an analogue for mobile soil solution for dissolved organic matter (DOM) studies, however, recent research indicates that slight differences in methods can produce very different results (Gabor et al. 2015). Specifically the type of extraction solution used was shown to strongly impact DOM absorption and fluorescence characteristics. Although this study tested various salt solutions, no natural solution was tested. Stream water is a natural solution leaching DOM from stream banks and was therefore included in our study. Furthermore, the impact on temperature changes on these types of extracts has not been investigated systematically. Our study bridges this gap and used two different types of soils (from an agricultural field and a forested plot from the Mad River Corridor) that were leached with 1) Winooski River water, 2) salt solution, and 3) deionized water and subjected to temperature changes (from 25°C to 40°C, and to -20°C to induce freezing). Soils were dried, sieved at 2mm, and mixed with the respective solution in replicates at a solid/liquid ratio of 1/5. The suspension was shaken and filtered to recover the dissolved fraction and subjected to one at 1) room temperature, 2) 40°C, and 3) frozen for a total of 18 treatments. The preliminary results show that salt solution yielded the lowest absorbance and fluorescence intensities. The temperature differences between samples were not significant, but freezing samples tended to decrease absorbance.
Gabor, Burns, Lee, Elg, Kemper, Barnard, McKnight (2015) Influence of Leaching Solution and Catchment Location on the Fluorescence of Water-Soluble Organic Matter. ES&T 49 (7), 4425-4432.

GEOCHEMICAL AND HYDROCHEMICAL ANALYSIS OF A QUARTZITE-DOLOSTONE BEDROCK AQUIFER IN THE CENTRAL CHAMPLAIN VALLEY, MONKTON, VERMONT

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Previous studies identified groundwater contamination from naturally occurring inorganic constituents in fractured bedrock aquifers in some areas of VT. Quartzites and phyllites of the hanging wall of the Hinesburg thrust fault are sources of elevated radionuclides (U and alpha radiation). This study aims to assess a fractured bedrock aquifer composed mainly of Cambrian Monkton Quartzite and Dunham Dolostone. The area is situated in the footwall of the Paleozoic Hinesburg thrust and is bisected by the Mesozoic St. George normal fault. No systematic information on groundwater quality, aquifer potential or bedrock composition has been collected from this part of the Champlain Valley. Groundwater from 28 wells and bedrock from representative rock outcrops were sampled for analysis of major and trace element composition.

Gross alpha radiation exceeds the VDH action level of 5 pCi/L in 11% of wells tested. Groundwater sampled from wells in the Dunham and Winooski Dolostone tends to have higher alpha radiation levels than other formations. Data indicates that 10% of wells contain > 5 µg/L U, and 5% contain > 10 µg/L U; none exceed the MCL (20 µg/L). Alpha radiation and U are positively correlated in groundwater, suggesting U is the source of alpha radiation. Calculations of residual gross alpha suggest that Ra is < 5 pCi/L in this aquifer system. Variation in reduction-oxidation potential of the aquifer system is indicated by varied abundances of Mn and Fe. Mn >100 µg/L in 20%, and Fe >100 µg/L in 35% of wells. In other cases, both are below detection limit. Pb exceeds the EPA MCL in one well. As is less than the EPA MCL in all wells. Results indicate the Monkton contributes lower amounts of radionuclides and other trace elements to groundwater than the Cheshire and Pinnacle quartzites. Well yields in the Monkton are greater than yields in the Cheshire or Pinnacle, implying lower residence time of groundwater in the Monkton limits the release of radionuclides into solution. The Monkton is relatively undeformed compared to the Cheshire and Pinnacle. Zircons and other potential radionuclide sources were not affected by shearing and grain size reduction to the extent that has been observed in the more deformed units. This may inhibit the release of radionuclides into solution. In addition, initial U and Th concentrations are lower in the Monkton.

USING LAKE SEDIMENT RECORDS TO RECONSTRUCT POST-GLACIAL DUST DELIVERY TO HIGH-ELEVATION LAKES IN THE UINTA MOUNTAINS, UTAH

O'KEEFE, Samuel S., MCELROY, Ryan C., and MUNROE, Jeffrey S. Geology Department, Middlebury College, Middlebury, VT, 05753

Dust is increasingly recognized as an important component of biogeochemical cycling, geoecology, and ecosystem function in mountain environments. The Uinta Mountains of northeastern Utah rise above arid lowlands of the southwestern US. Previous work has shown that delivery of dust to these mountains has influenced pedogenesis, soil nutrient status, and surface water chemistry. An array of passive and active samplers in the alpine zone of the Uintas provides detailed information about contemporary dust fluxes and geochemistry. However, reconstruction of changes in the dust system over time requires a continuous sedimentary archive sensitive to dust inputs. A radiocarbon-dated core collected from the subalpine Marshall Lake extends from the late Holocene back into the latest Pleistocene, providing a continuous record of sedimentation dating back to local deglaciation. Passive

dust collectors in the vicinity of the lake constrain the geochemical properties of modern dust, and samples of regolith constrain properties of the local surficial material within the watershed. Together these represent two end member sources of clastic sediment to each lake basin: allochthonous dust and autochthonous regolith. Geochemical analysis of the sediment cores from each lake allows the relative contribution of local and exotic material to the lake to be considered as a time series covering the post-glacial interval. XRF and ICP-MS analysis reveal that the abundance of Ca in dust is 2x that in local material. Conversely, the abundance of Al is higher in regolith than dust. As a result, the ratio Ca/Al is 2.5x greater in dust than in local material, potentially allowing this metric to be used as a signal of dust deposition over time. Plotting Ca/Al as a 12,000-year time series in Marshall Lake reveals that this ratio was relatively high during the middle Holocene, at the same time that water levels were notably low at Bear Lake and Blue Lake, suggesting that dust records from high-elevation lakes track regional aridity. Because the amount of dust entering the lake each year is likely small relative to the contribution from the local watershed, Sr/Zr and Ca/Zr, which show the same relationship as Ca/Al, potentially provide a more sensitive technique for identifying the influence of dust on lake sediment properties.

DECODING AN ATYPICAL SAPROLITE AT CAMEL'S HUMP, VT.

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An extensive exposure of deeply weathered rock (i.e. saprolite), with profiles at least 5 m thick underlain by greenschist, was recently discovered at Preston Brook, near Huntington, Vermont- roughly 2 km from the Winooski river confluence. Such a saprolite is atypical in New England as ice-sheet erosion during the recent Wisconsinian glaciation removed pre-glacial material. We formulated two hypotheses for the outcrop formation: (1) It was formed over geological time and preserved against erosion and (2) It is the result of localized extreme acidic weathering. Combining mineralogical and geochemical characterization of the saprolite with groundwater and stream water geochemical analysis, we tested these hypotheses.

Six river and seeping water samples were collected and analyzed for pH and major element concentrations (ICP-MS). Twenty-three solid samples were collected throughout the weathered outcrop and along a 3 m profile. After grinding, these samples were analyzed for total elemental concentration by XRF and mineral composition by quantitative XRD. Additionally, the fine fraction (<70 μm) of five samples were extracted, and treated for precise clay mineral characterization.

Water analyses show near-neutral pH and major element concentration dominated by Si, Na & Mg which suggests current environmental conditions at Preston Brook are not extreme. Mass balance plots based on elemental concentration showed enrichment of Si, Zn & Ca, and depletion of Fe, Ti, Mg, Mn & Al upward in the saprolite. The clay mineral evolution throughout the 3 m profile shows weathering from chlorite to smectite to kaolinite.

Together these are indicators of hydrolyzing weathering typical of tropical systems. This study concludes that the Preston Brook saprolite is a pre-glacial remnant that was developed under a developed tropical-like weathering regime in an interglacial period. This outcrop is a rare instance of a pre-glacial feature shielded from glacial erosion.

UTILIZING LANDSLIDES ON LAKE CHAMPLAIN AS PALEOSEISMIC AND PALEOHAZARD INDICATORS

SILVERHART, Perri, MANLEY, Patricia, MANLEY, Thomas, Geology Department, Middlebury College, Middlebury, VT 05753

In Lake Champlain, many landslides have been identified via Mutlibeam and CHIRP (compressed high intensity radar pulse) seismic profile imagery. Previous studies (Ghosh, 2012, Rosales-Underbrink, 2015, Manley and Manley, 2015) have shown that these landslides are coeval and were most likely triggered by a large earthquake ~4500 – 5500 years ago. These landslides also correlate with surficial landslides in Ottawa, for which a M6.5 earthquake trigger has been determined (Brooks, 2015). It has also previously been recognized that older landslides have also occurred, but no further investigation has been done. This study focuses on a series of overlapping landslide deposits in an area between the Bouquet River Delta and Essex, NY in the main section of Lake Champlain, where nearly the entire slope has had failure, with the exception of a few locations where blocks of sediment remain intact. Core studies show that sedimentation rates are much higher on the west side of the lake than the east side because of sediment flux from the Bouquet River. Using this sedimentation rate and the thickness of sediment accumulation above slumped material in seismic imagery, we have identified four failure events on the west side of the study area and five on the east side, and have approximated the date of failure for each.

GEOCHEMISTRY AND PETROLOGY OF THE CUTTINGSVILLE IGNEOUS STOCK

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The Cuttingsville igneous suite, located ten miles south of Rutland VT, is one of several plutons emplaced during the Mesozoic in the New England Quebec region. Despite the abundance and longstanding study of these intrusions, their origin is still a subject of debate. Two explanations currently exist for this intraplate magmatism; one arguing that melting occurred due to a mantle plume, the other that the intrusions are a result of extensional tectonic forces. Studying the Cuttingsville complex aims at shedding light on this debate. Composed of five distinct lithologies, the Cuttingsville pluton contains both mafic and felsic silica-undersaturated and oversaturated rocks. For this study, multiple samples have been collected from each rock type and have undergone a suite of analyses, resulting in in a complete whole rock, trace, and rare element geochemistry dataset for the Cuttingsville suite. Initial data interpretations suggest that the five rock types of the Cuttingsville suite formed via fractional crystallization of a parent magma with a similar composition to the monzogabbro type. The data supports early crystallization and fractionation of pyroxene, plagioclase feldspar, k-spar, ilmenite, and apatite.

GEOPHYSICAL SURVEYS OF THE UVM GREEN

SCHNEIDER, Mariah, Department of Geology, University of Vermont, Burlington, Vermont, 05405

The UVM Green in Burlington, Vermont has undergone a number of geologic and archaeological processes that can be studied using Geophysical data. By using the Geophysical survey methods of Ground Penetrating Radar (GPR), Electromagnetic Induction (EMI), and Seismic Refraction, said processes can be revealed in the subsurface. We used GPR grid surveys to target locations of old

foundations on the UVM Green on the south and north sides. Three grids were surveyed on the south side, and four grids that covered 30 by 20 meters total were surveyed with more detail on the north side of the UVM Green. EMI surveys were taken to overlap the GPR grids. Seismic refraction was completed in lines that crossed the GPR survey grids. Once all the Geophysical Survey data was collected and analyzed, it was mapped out and correlated to known geological and historical data in order to discover the spatial locations of subsurface disturbances. Comparing seismic refraction data with GPR data will confirm layer depths in the ~2.5 meters of GPR data collected, along with the presumed sandy soil composition of the material. Subsurface disturbances revealed by the GPR data include two locations of possible foundations, a trench, and a potential grave site. EMI data reveals correlations with known above ground structures including the UVM sign on the north side of the UVM Green, and light posts on the south side of the Green. The EMI data also reveals a subsurface region of high conductivity on the north side of the Green. The GPR data that is of potential Archaeological significance will be of interest to UVM's Consulting Archaeology Program as further validation of the archaeological sensitivity of the northern end of the UVM Green, and for further knowledge of the north and south end of the UVM Green.

THE ORIGIN OF THE COLOR DIFFERENCE IN SANDSTONES OF THE LOWER CAMBRIAN MONKTON FORMATION

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The Lower Cambrian Monkton Quartzite is heterolithic, the two prominent lithologies are red and white cross-bedded sandstone that are interbedded with one another. This research project investigates the origins of the color differences between the sandstones. Thin sections of both sandstone types were made and using petrographic microscopy the grain size and sorting were determined. The white sandstone is a medium-grained sand ranging from 1.14 and 1.50∅ with standard deviations between 0.62∅, (moderately well sorted) and 0.76∅ (moderately sorted). The red sandstones are fine-grained sand ranging from 2.85 and 2.60∅ and are poorly sorted (1.40 and1.06∅). These results suggest that the color difference is related to grain size and sorting properties of the sandstone. In order to see why the grain size and sorting influences the coloration of the sandstone, thin sections were analyzed further using SEM and EDX both of which allow for an accurate analysis of the rock's mineralogy. Preliminary results from the white sandstone indicate that iron-bearing accessory minerals, such as ilmenite and magnetite are common in the white sandstones, along with zircon, rutile and apatite. Compositionally, the white sandstone ranges from quartz arenite (Q90F10L0) to subarkose (Q78F22L0). The mineralogy of the red sandstones are arkoses (Q54F46L0, Q31F69L0). The red sandstone, which is finer-grained and more poorly sorted, also differs in composition from the white sandstone in 4 important ways, possessing: (1) more iron-rich carbonate-cement, (2) a greater amount of ilmenite, and an absence of magnetite, (3) more plagioclase, and (4) iron-rich clay. We reject differences in climate, intensity and duration of transport, and source area as explanations for the color difference in the sandstones. Likewise, the presence of iron-bearing minerals is not unique to either sandstone. We propose that differences in hydraulic conditions in the Monkton tidal to subtidal environment controlled the color of the sandstone because depositional processes controlled sandstone textures. Textural differences, in turn, controlled the diagenetic history of the sandstones, including early diagenesis of feldspar weathering to clay, oxidation of iron-bearing minerals, and precipitation of iron-bearing cement.

PETROLOGY AND GEOCHEMISTRY OF METAMORPHOSED CAMBRIAN-ORDOVICIAN VOLCANIC ROCKS OF THE ST. CROIX BELT, WESTERN PENOBSCOT BAY, MAINE

BURKE, Will, WEST, D. P. and COISH, R. A. Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

The northern Appalachian orogen contains several peri-Gondwanan terranes that were accreted onto the continental margin of Laurentia during the Paleozoic. The Penobscot Bay region of mid-coastal Maine is composed of a number of these lithotectonic terranes, including the Cambro-Ordovician St. Croix and Ellsworth Belts, and the enigmatic Jam Brook complex of uncertain age. Preserved within all of these belts are metamorphosed volcanic rocks that contain information important in determining tectonic environment of formation. The purpose of this contribution is to present new petrologic and whole rock geochemical data from meta-volcanic rocks in the St. Croix and Jam Brook belts.

Within the St. Croix Belt, metamorphosed volcanic rocks are found at the base of the Penobscot Formation (Gushee Member). These volcanics are best exposed in a 30km long belt up to 1.5km wide extending from Union to Belfast, ME. In the field, rocks display features such as relict pillows and amygdaloidal scoria consistent with formation in an eruptive setting. Thin sections reveal a range in mineralogies and textures, including amphibolite with relict vesicles, and fine-grained felsic rocks with relict quartz and feldspar phenocrysts. Bulk rock geochemistry of the Gushee meta-volcanics (n=25) yields a range of compositions from 44 - 76 wt. % SiO2. Preliminary trace element geochemistry displays flat REE patterns with a distinct niobium anomaly suggestive of a source region influenced by subduction.

Immediately west of the St. Croix Belt are metamorphosed volcanic and sedimentary rocks of the Jam Brook complex. Within this unit, metamorphosed volcanic rocks are exposed along a 0.5km wide horizon extending 5km north of Sennebec Pond. In the field and in thin section, the rocks contain textures and structures consistent with a volcanic origin. Limited bulk rock geochemistry from these rocks (n=5) yields a bimodal distribution of chemical compositions with mafic samples ranging from 49 - 52 wt. % SiO2 and a felsic sample containing 76 wt. % SiO2. Trace element geochemistry displays flat REE patterns, also with distinct niobium anomalies.

Analysis of these rocks is on-going, and the data collected will be compared with volcanic rocks of similar age along strike (e.g., Ellsworth and Annidale belts) and integrated into tectonic models of the area.

DETRITAL ZIRCON AGES OF THE UMBRELLA HILL AND SHAW MOUNTAIN FORMATIONS, VERMONT

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U-Pb ages of detrital zircons have played a major role in our understanding of tectonic models of the Appalachians, including the Vermont part of the belt. Recently, a major suture, formed during closing of the Early Paleozoic Iapetan Ocean, has been postulated to exist within the Rowe-Hawley Belt of central Vermont. The Hawley slices within this belt in Vermont include the Cambro-Ordovician Moretown, Cram Hill and Umbrella Hill formations. Recent work has shown that the provenance of metasediments within the Moretown Formation and Cram Hill is Gondwanan. In a continuation of this work, we focus here on the Umbrella Hill Formation, a distinctive conglomeratic unit within the Rowe Hawley Belt. The stratigraphic relationship of the unit to the Moretown and Cram Hill formations is a subject of continued discussion. The Shaw Mountain Formation, a basal conglomerate of the Connecticut Valley Sequence east of the Rowe-Hawley Belt, is also part of this study. Detrital zircon ages of both units are correlated to known magmatic period signatures of potential source terranes. Through LA-ICP-MS analysis of isolated zircon grains of the Umbrella Hill and Shaw Mountain formations, a series of age peaks have been determined. Data based on ~300 grains from the Shaw Mountain Formation and ~150 grains from the Umbrella Hill Formation show intriguing, albeit tentative, results. Age peaks produced for the Umbrella Hill sample are centered around 460-500 Ma, 600 Ma, and 1000 Ma, suggesting possible Shelburne Falls Arc, Peri-Gondwanan, and Peri-Laurentian provenances, respectively. A single prominent peak was produced for the Shaw Mountain sample, centered around 460 Ma, suggesting a Shelburne Falls/Bronson Hill Arc provenance. As part of this ongoing study, more samples from both units will be analyzed for detrital zircon ages. These results will be used to shed further light on our understanding of the northeast Appalachian orogenic and tectonic model.

VONSENITE, 2FeO•FeBO3, A HIGH-TEMPERATURE MINERAL OCCURRING IN CONTACT METAMORPHIC DEPOSITS: CRYSTAL STRUCTURE AT ROOM AND LIQUID NITROGEN TEMPERATURES

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Swinnea and Steinfink (1983) postulated that in the mineral vonsenite (Fe2+2Fe3+BO5), limited Fe-Fe charge delocalization occurs at lower temperatures due to a change in the distance between Fe-Fe pairs. However, their assertions may be incorrect because the low-temperature structure of vonsenite had not been determined at the time of their conjecture and crystals used for their experiment were of poor quality.

This paper reports the atomic arrangement of vonsenite at room temperature (RT) and at -125K (LN) to investigate if the difference found in Mössbauer spectra can indeed be explained by a change in distance between Fe-Fe pairs. X-Ray diffraction data were collected with a Bruker ApexII CCD single-crystal diffractometer. The results of the structure solution yielded very similar RT and LN values for atomic position, bond valence and site occupation (〖R1〗_RT=0.0136 and 〖R1〗_LN=0.0137).

Because there is little difference in structures of vonsenite at room temperature and -125K, the conjecture about the low-temperature Mössbauer spectrum is not supported and we cannot explain differences in Mössbauer spectra from structural changes at different temperatures.

CREATING A LANDSCAPE-SCALE MODEL OF SOIL EVOLUTION ON THE PACIFIC COAST OF COSTA RICA

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Geographic soil models are valuable for any kind of land use planning and are most important in agriculture, transportation, community development and conservation planning. Soil mapping in particular is essential in addressing a host of other questions relating to geomorphic processes, environmental concerns, public health, as well as food, water, and energy security. In tropical regions, available soil data may be antiquated, often dating back more than thirty years and the "kaolinite-dominated, nutrient-depleted" paradigm only describes about one third of tropical soils. This study synthesizes research conducted in three sub-regions of Costa Rica's Pacific coast and analyzes soil properties from a fourth sub-region to create a soil model along the entire coast (spanning 400 km and 2 degrees of latitude). Each sub-region was characterized using X-ray diffraction, bulk soil geochemistry by XRF, ICP-AES and ICP-MS as well as soil pH and cation exchange capacity. These data were used to create soil weathering classifications applicable across climatic sub-regions.

Ranging from dry (1500 mm/yr) to wet (4800mm/yr) environments, the four sub-regions differ appreciably in weathering rates. Previous studies conclude that soils in tropical wet forest environments (4800mm/yr) evolve to a nutrient-depleted, kaolinite-rich Oxisol mineral assemblage in half the time required for soils in a drier tropical forest (1500 to 2200 mm/yr) to do the same (and these drier soils never become as nutrient depleted as the 4800 mm/yr climate zone). To model the spatial variability of soil weathering, this study employs a cokriged interpolation model to weigh climatic, temporal and topographic data with pH, CEC, soil geochemistry and mineralogy. In a country dependent on agricultural exports and a region with active tectonic uplift, soil data and accurate methods for acquiring such data contribute to fundamental knowledge of the land thus influencing current land use and future planning. Furthermore, a spatial model of this type can be applied to questions of terrace correlation in interpreting landscape evolution over Holocene to Pleistocene time scales.

DETERMINING THE INFLUENCE OF DUST ON POST-GLACIAL LACUSTRINE SEDIMENTATION IN BALD LAKE, UINTA MOUNTAINS, UTAH

McELROY Ryan C., Geology Department, Middlebury College, Middlebury, VT, 05753

Dust is increasingly recognized as an important component of biogeochemical cycling and ecosystem function in mountain environments. Previous work has shown that delivery of dust to the Uinta Mountains of northeastern Utah has influenced pedogenesis, soil nutrient status, and surface water chemistry. An array of passive and active samplers in the alpine zone of the Uintas provides detailed information about contemporary dust fluxes, along with physical and geochemical properties of modern dust. Reconstruction of changes in the dust system over time, however, requires continuous sedimentary archives sensitive to dust inputs. A radiocarbon-dated 3.5 m core (spanning 12.7 kyr) collected from subalpine Bald Lake may provide such a record. A passive dust collector in the vicinity of the lake constrains the geochemical properties of modern dust, whereas samples of regolith constrain properties of the local surficial material within the watershed. Together, these represent two end member sources of clastic sediment to Bald Lake basin: allochthonous dust and autochthonous regolith. Ba, Sr, and Eu are found in higher abundances in the dust than in the watershed regolith. Zr, Hf, and Th are found to be lower in the dust than in the watershed. Geochemical analysis of the sediment cores allows the relative contribution of exotic and local material to the lake to be considered as a time series covering the post-glacial interval when ratios of these indicator elements are plotted. Early findings suggest dust records from high-elevation lakes track regional aridity and may correspond to low-stands of large lakes in the south-western United States.

PALEOCLIMATE RECONSTRUCTION FROM A WEYBRIDGE CAVE SPELEOTHEM

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Understanding future climate change may prove to be one of the most important scientific endeavors of this century. Studying past climate change allows scientists to place valuable parameters on global models that simulate and predict future climate patterns. This project focuses on the climate of Weybridge and the surrounding area over the past 5,000 years by studying the geochemistry of a speleothem taken from Weybridge Cave. This involves two primary tasks. The speleothem itself was sampled and analyzed for stable isotopes of oxygen and carbon, and a hydrology study was conducted on the cave. The speleothem oxygen isotope chemistry provides insight into past precipitation quantity, source, and sometimes temperature, while the carbon isotope chemistry provides insight into vegetation changes. The speleothem was dated with U-series dating, and spans between 4.8-1.5k BP. Our data suggests that d18O fluctuations are have historically been controlled by precipitation source and changes in seasonal precipitation distribution. As the precession orbital variation has created warmer northern hemisphere winters, changes in the North American Winter-Vortex and in the Bermuda have profoundly influenced the precipitation balance in the region. This study is particularly interesting because there have been very few speleothem paleoclimate reconstructions done in the Northeastern United States.

LEAD IN URBAN SOILS: OBSERVATIONS FROM THE MACROSCALE TO THE MICROSCALE

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Lead is a highly toxic contaminant that achieved notoriety for its impact on the community of Flint, Michigan. Environmental lead (Pb) is not limited to water; cities with aging housing stock such as Burlington, Vermont, continue to struggle with the persistence of soil Pb as a result of its use in house paint, a problem that is expensive and difficult to remediate due to the complexity of Pb behavior in soils. With this complexity in mind, the goal of this study is to constrain Pb behavior across scales, as its toxicity depends on the translation of geochemical conditions from the micro to the field scale.

To frame this research at the macroscale, we established the relationship between soil Pb and bioaccessible Pb in over 100 urban soil samples. A sample with high Pb content (~11,250 mg kg-1) was characterized for Pb speciation at the microscopic and molecular scale. By leaching this soil with acidified and amended (phosphates and nano-goethite) synthetic rainwater in column experiments, we assessed the efficiency of remediation techniques on Pb transport and bioavailability. Observations at the macroscale are complimented by microscale interpretations of Pb behavior, performed with state-of-the-art techniques, including scanning electron microscopy and energy dispersive spectroscopy (SEM-EDS, Middlebury College), and microfocused x-ray techniques (µXRF, µXRD, Advance Photon Source).

Combining µXRF maps of elemental distribution and µXRD scans pre- and post-leaching allows us to characterize microscopic changes in response to changing geochemical conditions. In this system, lead paint is associated with titanium oxide (a primary constituent of modern paint), and adsorbs onto microns-thick clay and oxide minerals as it weathers, eventually becoming incorporated into heterogeneous aggregates. By linking these microscale observations with macroscale expression, we can use predictive reactive transport modeling to constrain field-scale Pb remediation strategies.

ANNOUNCEMENTS

NEGSA IS COMING TO BURLINGTON!

After a 17 year hiatus, the 2018 Northeast GSA meeting is returning to Burlington Vermont. Co-Chairs Andrea Lini and Char Mehrtens (UVM) are looking forward to involving as many members of the Vermont and northern NY geology community as possible in the planning and implementation of the event, which will be held between March 17, 2018 and Tuesday, March 20, 2018. We'll need technical session Chairs, field trip leaders, poster session judges, and volunteers to help host, and VGS is a perfect organization to help. Formal announcements will go out shortly, but we wanted everyone to start thinking.

VERMONT GEOLOGICAL SURVEY NEW WEB SITE

Please add a bookmark to our new site at http://dec.vermont.gov/geological-survey. You can find us through the Department of Environmental Conservation's main page or through bookmarks.

CALENDAR

Middlebury College, Geology Lecture Series
Date: Friday, May 6
Time: 12:30 pm
Location: 417 Bicentennial Hall
Information: Friday, May 6 - Jack Loveless, Smith College
Understanding forearc deformation above subduction zones, examples from Chile"

2016 Geological Society of America Annual Meeting & Exposition
Date: September 25-28**,** 2016
Location: Denver, Colorado
Host: Geological Society of America

2016 NEIGC New England Intercollegiate Geological Conference
Geology of the Maine Coast from Maquoit Bay to Muscongus Bay
Date: October 14-16, 2016
Details: http://w3.salemstate.edu/~lhanson/NEIGC/index.html

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