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 29, 2017, 8:30 am
Department of Geology, Delehanty Hall
University of Vermont, Trinity Campus
180 Colchester Ave.
Burlington, Vermont 05405-1758

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PRESIDENT"S LETTER

When the 2017 spring semester at Norwich University concludes this May, Dave Westerman, a pillar in the study and teaching of Vermont geology, will retire. Dave received his Ph.D. in Geology from Lehigh University in 1972 and, after teaching at a few universities in the northeast, came to Norwich University in 1982. During his tenure, he has been both a Professor of Geology and an Associate Vice President for Research.

I moved to Vermont in May of 1996 to map the bedrock geology of parts of the Lowell, Eden, and Albany quadrangles as a contractor to the Vermont Geological Survey. During the fall of 1996, Dave took me on an all-day field trip through the Northfield Quadrangle to look at the Moretown, Cram Hill, Shaw Mountain, and Northfield formations, all formations I was working with up north. I particularly remember the papery Shaw Mountain phyllitic conglomerates along the Dog River Fault Zone, the large amplitude isoclinal folds defined by the interbedded phyllites and quartzites of the Northfield Formation, and the eccentric landowner who had drilled a series of deep (some > 1000') bedrock wells in the Moretown Formation for amusement. I will always appreciate the time that Dave took to show his mapping to "a new kid on the block".

At the time of this field trip, Dave was primarily an Appalachian "hard rock" tectonics researcher, but if my memory is correct, he had just started to collaborate on the igneous petrogenesis of the Island of Elba with Italian colleagues. That research blossomed over the next two decades into a series of important publications.

Good luck to you Dave. I know that I will see you in the field somewhere in Vermont. As you told me last year, "there's still so much to do". Below are some photos from Rick Dunn of Dave in action, doing what he does best, TEACHING!

	
Connecticut River Course (2013): looking at Gile Mt. Formation turbidites	Southern California coast with students (2008)

Connecticut River Course (2013): explaining comingled magmas on Mt. Monadnock.

Respectfully Submitted,
Jon Kim, President

TREASURER'S REPORT

Finances: Active members continue to support The Society with both dues and contributions to our Research Grant Program. Nearly all members have paid their 2017 dues, but about 15 stragglers will be granted another brief extension (again). Anticipated immediate expenses in the near future include costs associated with an upcoming student research symposium and another round of student research grants.

Expenses:

$700.00	Research grant to Tucker Merideth
$700.00	Research grant to Evan Tam
$700.00	Research grant to Cheyne Aike

Income:

$2,973.00	Dues and Student Research Fund Contributions – not all dues are in, but 93 members have paid up for 2017. This is combined with donations in support of the Research Fund from: Dennis S. Albaugh, Laurence R. Becker, David Butterfield, Bruce and Cheryl Cox, Alex G. Czuhanich, Jeanne C. Detenbeck, Barry Doolan, Brett Engstrom, Barbara L. Hennig, Jefferson P. Hoffer, Keith & Gabriela Klepeis, John Klimenok, Jr., Chris Koteas, Ronald B. & Anita H. Krauth, Eric Lapp, John A. Malter, Andrew & Laura McIntosh, Dagan Murray, Alexis P. Nason & family, Jeffrey Pelton, Sharon Strassner, Ethan Thomas, Peter J. & Thelma B. Thompson, Roger & Terry Thompson, John G. Van Hoesen, Laura Webb, David S. Westerman and Stephen F. Wright (my apology for any omissions).

Balance: Our current balance as of April 22, 2017 is $12,296

New Members:
Cheryl Cormier, Sr. Project Manager, AECOM/TRC Solutions, Ashburnham, MA
Ken Cormier, Sr. Environmental Geologist, AECOM/TRC Solutions, Ashburnham, MA
Susan Smiley, retired, New Haven, VT
Ian Smiley, Bristol Bakery, N. Ferrisburgh, VT

Deceased Member: Mary Anne Mento

Respectfully submitted,
David S. Westerman, Treasurer

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

No Vermont Geological Society research grant applications were received by the April 1st deadline. Fall 2017 research grant applications must be postmarked by October 2nd and sent to Jon Kim, Vermont Geological Survey, 1 National Life Drive, Main 2, Montpelier, VT 05620.
We are looking for field trip leaders and proposals for the summer and fall of 2017. Please contact Jon Kim (jon.kim@vermont.gov).

Respectfully submitted,
Jon Kim, Chair

STATE GEOLOGIST'S REPORT

Help Us Complete a Landslide Inventory

The Landslide Inventory Geoform was launched on-line at: http://dec.vermont.gov/geological-survey/hazards/landlsides. Since past failures are an indicator of future slope instability, we are asking the public to help us locate existing landslides, including rockfalls, debris flows, gullying and other mass failures. Many thanks to Erik Engstrom of ANR IT for building the application for us. The data collected will be evaluated and used to create landslide hazard maps by county. Addison County was previously completed by John Van Hoesen (Green Mountain College); George Springston (Norwich University) is working on Washington County this year. The maps delineate possible areas of high, medium and low landslide susceptibility based mainly on geologic materials, steepness, proximity to streams and landslide history. The complete process is documented in the Landslide Hazard Mapping Protocol. Success of hazard analysis projects relies on the use of newly acquired Lidar, a remote sensing method which produces precise information about land surface characteristics and the shape of the earth's surface. Our regional maps are a means to provide generalized landslide susceptibility information/planning level maps to all of Vermont within a reasonable time frame.

Surficial Mapping

This February we met with surficial geologists from Norwich University, Green Mountain College, University of Vermont, USGS, private companies and the chair of the STATEMAP Advisory Committee to discuss mapping techniques and standardization of mapping protocols. Based on lessons learned from the process of making the Bedrock Geologic Map of Vermont 2011, we hope to develop a common set of map units, nomenclature, and symbology to apply to future surficial mapping projects. The availability of Lidar has a significant impact on our surficial maps and allows us to capture and map units more accurately. The group reviewed maps recently published by the USGS plus maps from other states and the legacy maps produced in Vermont. We intend to have standards for our Vermont maps developed for the summer field season 2017. Surficial geologic maps provide information about the unconsolidated materials overlying bedrock and are used to evaluate such things as groundwater recharge, transmissivity and siting of septic systems.

Mapping is in-progress by George Springston in the Joes Pond Quadrangle and Stephen Wright in the town of Weathersfield. This coming field season we plan to map in the Bolton, Barre East and Proctor quadrangles and to initiate compilation of the surficial geology of the Montpelier one-degree sheet.

Upgrade of Digital Data and Portal
1:24000 scale geologic data from VGS Open File Reports were added to the VCGI and ANR Open GeoData portals, http://geodata.vermont.gov/ . Colin Dowey worked with Ryan Murphy (ANR IT) on the project to update metadata, export data to shapefiles, and include published maps as pdf in the zipped files. The new portals are more user friendly and should increase the visibility and accessibility of this geologic information. Colin is also working with Dave Soller at the USGS to contribute Vermont data as they upgrade the USGS NGMDB.

Presentations and publications
VGS staff and our university partners and students gave several presentations at NEGSA in Pittsburgh in March:

Meredith, T., Ryan, P, Koenigsberger, S. and Kim, J.: Synsedimentary phosphorite in late Cambrian dolostone of the northern Appalachians as the source of radionuclides in a fractured rock aquifer

Miers, M., Fisher, B., Maglio, S., and Wright, S., Evaluation of surface and groundwater hydrology in the Black River and North branch valleys, Weathersfield, Vermont

Remington, C., Kim, J., Klepeis, K., and VanHoesen, J.: Using drone surveys to interpret the geometry and kinematics of a Mesozoic fault zone in dolostones of the Champlain Valley belt, west-central Vermont.

Springston, G., Gale, M., and Ryan, P.: Distribution of major and trace element geochemistry of till, Montpelier 1:100,000 sheet, central Vermont.

Vincett III, W., Hazebrouk, G., and Wright, S.: Glacial history of the Black River and North Branch Valleys, Weathersfield, Vermont.

Wright, S., Vincett, W., Hazebrouk, Garrett, D., Miers, M., and Maglio, S.: Surficial geologic map of Weathersfield, Vermont: glacial history and implications for groundwater resources.

Two new (or re-formatted) open file reports have been posted on-line at
http://dec.vermont.gov/geological-survey/publication-gis/ofr

VG2017-2 Thompson, P. J., and Thompson, T. B., 2017, Bedrock Geologic Map of the Mount Mansfield 7.5 Minute Quadrangle, Vermont: VGS Open-File Report VG2017-2, (Plates 1 - 3), scale 1:24,000. Supersedes VG99-3. GIS Data.

VG2017-1 DeSimone, D. J., 2017, Surficial Geology of the Bennington Area, Vermont: VGS Open File report VG2017-1, (Plates 1 - 3), scale 1:12,000. GIS Data.

Lastly, I want to express gratitude to Dave Westerman for his support of the Society, Survey and our science and to wish him well in the years ahead.

Respectfully Submitted,
Marjorie Gale, Vermont State Geologist

2017 SPRING MEETING PROGRAM

(order of presentations is subject to change)

8:30 AM - COFFEE & REFRESHMENTS

9:00 AM -- GEOCHEMICAL AND PETROGRAPHIC ANALYSIS OF VOLCANIC ROCKS FROM NORTH HAVEN ISLAND, PENOBSCOT BAY, MAINE
BEST, Mackenzie, WEST, D. P., Geology Department, Middlebury College, Middlebury, VT 05753

9:15 AM -- USING REMOTE SENSING AND HIGH-RESOLUTION DIGITAL ELEVATION MODELS TO IDENTIFY POTENTIAL EROSIONAL HOTSPOTS ALONG RIVER CHANNELS DURING HIGH DISCHARGE STORM EVENTS
ORLAND, Elijah, AMIDON, William, Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

9:30 AM -- CHARACTERIZING PSEUDOTACHYLYTE VEINS IN THE ARROWHEAD THRUST FAULT ZONE, VERMONT
SULLIVAN, Patrick Department of Geology, University of Vermont, Burlington, VT

9:45 AM -- GEOCHRONOLOGY AND MICROSTRUCTURES OF THE TILLOTSON PEAK COMPLEX IN LOWELL, VERMONT
PIDGEON, Elizabeth Department of Geology, University of Vermont, Burlington, VT

10:00 AM - USING DRONE SURVEYS TO INTERPRET THE GEOMETRY AND KINEMATICS OF A MESOZOIC FAULT ZONE IN DOLOSTONES OF THE CHAMPLAIN VALLEY BELT, WEST-CENTRAL VERMONT II
REMINGTON, Connor1, KIM, Jonathan 2, KLEPEIS, Keith1, and VAN HOESEN, John 3
1 Department of Geology, University of Vermont, Burlington, VT
2 Vermont Geological Survey, 1 National Life Drive, Main 2 Montpelier, VT
3 Department of Environmental Studies, Green Mountain College, Poultney, VT, USA

10:15 AM - RECONSTRUCTING A POSTGLACIAL MINERAL DUST RECORD IN THE EASTERN UINTA MOUNTAINS, UTAH: CONSTRAINTS FROM THE TAYLOR LAKE WATERSHED
WASSON, Luna, MUNROE, Jeff, Geology Department, Middlebury College, Middlebury, VT, 05753

10:30 AM - BREAK, COFFEE & REFRESHMENTS

11:00 AM - APPLICATION OF GEOSTATISTICAL AND GEOCHRONOLOGICAL METHODS TO STRATIGRAPHIC PROBLEMS IN THE LOWER CAMBRIAN MONKTON FORMATION
MAGUIRE, Henry, MEHRTENS, Charlotte. Department of Geology, University of Vermont, Burlington, Vermont 05401, USA

11:15 AM - CAN BLOOD AND SOIL PB LEVELS BE PREDICTED IN BURLINGTON, VT?
CZYZYK, Katelyn, ROSSI, Amanda, University of Vermont, Geology, Environmental Mineralogy and Chemistry, Burlington, VT

11:30 AM - IGNEOUS PETROGENESIS AND OVERPRINTING DEFORMATION AND METAMORPHISM OF THE EDGECOMB GNEISS, MID COASTAL MAINE
CHEN, Jessica, WEST, D.P, Geology Department, Middlebury College, Middlebury, VT 05753

11:45 AM - U-Pb DATING OF CALCITE VEINS IN THE CHAMPLAIN VALLEY: CONSTRAINTS ON POST-PALEOZOIC REJUVENATION IN THE EASTERN NORTH AMERICAN MARGIN
BARR, Matthew, AMIDON, Will, Department of Geology, Middlebury College, Middlebury, VT, 05753

12:00 PM - COMPARISONS OF DETRITAL MINERAL ASSEMBLAGES IN THE BALTIMORE CANYON TROUGH WITH MODERN RIVER SEDIMENTS: CONSTRAINTS ON POST-RIFT TECTONISM IN THE NORTHERN APPALACHIANS
STANLEY, Milo and AMIDON, W. H. Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

12:15 PM -- LABORATORY SYNTHESIS OF SERPENTINES TO ASSESS POTENTIAL FOR ARSENIC INCORPORATION
PAINTER, Will Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

12:30 PM – LUNCH, JUDGING

1:15 PM –AWARDS CEREMONY

STUDENT ABSTRACTS

GEOCHEMICAL AND PETROGRAPHIC ANALYSIS OF VOLCANIC ROCKS FROM NORTH HAVEN ISLAND, PENOBSCOT BAY, MAINE

BEST, Mackenzie, WEST, D. P., Geology Department, Middlebury College, Middlebury, VT 05753

The fault-bounded volcanic rocks on North Haven Island in Penobscot Bay, Maine have been largely overlooked, leaving their age, relationship to other volcanic rocks in the region, and the tectonic environment responsible for their eruption unclear. Previous work by Gates (2001) shows that the North Haven Formation is pre-Silurian in age and includes a wide variety of rock types which are dominated by weakly metamorphosed basalts with lesser amounts of felsic volcanics, tuffs of varying composition, and sedimentary rocks. This research is focused on the volcanic rocks on North Haven Island and includes petrographic analysis, whole rock geochemistry, and U-Pb geochronology.
The greenstones display well-preserved pillow structures and a porphyritic texture dominated by fine-grained matrix chlorite with plagioclase phenocrysts. The felsic units (<10%), show euhedral phenocrysts in a fine-grained matrix of plagioclase laths. Thirteen samples representing a range of volcanic rock types in the formation were analyzed for major and trace element geochemistry. Classification diagrams based on these results reveal eight of the samples are sub-alkaline basalts (45-51 wt% SiO_2) and five are intermediate to felsic in compositions (58-68 wt% SiO_2). Chondrite normalized rare earth element (REE) plots for the mafic rocks reveal flat patterns, while the more felsic samples show more light REE enrichment and steeper slopes. Extended trace element diagrams also reveal significant differences between the rock types with the mafic rocks showing no individual element anomalies, while the felsic rocks show greater relative abundances and pronounced negative Sr, P, and Ti anomalies.

Trace element compositions of the basaltic rocks plotted on various tectonic discrimination diagrams consistently plot in fields for MORB and Ocean Island within-plate tectonic settings. This is consistent with high TiO_2 concentrations, and the absence of Nb anomalies in trace element plots strongly suggests the volcanic rocks of the North Haven Formation were not generated through subduction processes. These findings are consistent with a previously proposed correlation with Middle Cambrian rocks of the Ellsworth Terrane on the mainland. U-Pb geochronology on zircons separated from felsic units will further test this proposed correlation.

USING REMOTE SENSING AND HIGH-RESOLUTION DIGITAL ELEVATION MODELS TO IDENTIFY POTENTIAL EROSIONAL HOTSPOTS ALONG RIVER CHANNELS DURING HIGH DISCHARGE STORM EVENTS

ORLAND, Elijah, AMIDON, William, Department of Geology, Middlebury College, Middlebury, Vermont 05753, USA

As global warming intensifies, large precipitation events and associated floods are becoming increasingly common. Channel adjustments during floods can occur by both erosion and deposition of sediment, often damaging infrastructure in the process. There is thus a need for predictive models that can help managers identify river reaches that are most prone to adjustment during storms. Because Vermont rivers flow over a mixture of bedrock and alluvial substrates, the identification of bedrock vs. alluvial channel reaches is an important first step in predicting vulnerability to channel adjustment

during flood events, especially because bedrock channels are unlikely to adjust significantly, even during floods. This study develops a semi-automated approach to predicting channel substrate using a high-resolution LiDAR-derived digital elevation model (DEM). The study area is the Middlebury River, a well-studied watershed with a wide variety of channel substrates, including reaches with well documented channel adjustments during recent flooding events. Multiple metrics were considered for reference—such as channel width and drainage area—but the study utilized channel slope as a key parameter for identifying morphological variations within the Middlebury river. Using data extracted from the DEM, a power law was fit to selected slope and drainage area values for each branch in order to model idealized slope-drainage area relationships, which were then compared with measured slope-drainage area relationships. Differences in measured slope minus predicted slope (called delta-slope) are shown to predict river channel morphology. Compared with field observations, higher delta slope values correlate with more stable, boulder rich channels or bedrock gorges; conversely the lowest delta-slope values correlate with flat, sediment rich alluvial channels. The delta-slope metric thus serves as a reliable first-order predictor of channel substrate, which in turn can be used to help identify reaches that are most vulnerable to channel adjustment during large flood events.

CHARACTERIZING PSEUDOTACHYLYTE VEINS IN THE ARROWHEAD THRUST FAULT ZONE, VERMONT

SULLIVAN, Patrick Department of Geology, University of Vermont, Burlington, VT

Pseudotachylyte is a glassy rock that often forms due to frictional melt and can be injected into the walls of a fault. This study investigates pseudotachylyte veins identified near the mapped southern termination of the Arrowhead thrust fault that formed during the Taconic Orogeny. The thrust fault strikes NNE and dips shallowly to the east. The pseudotachylyte is observed in the Cheshire Quartzite formation, which was thrust over the younger Skeels Corner formation. The veins are typically thin, black veins with wispy, flame-like injection veins coming out of the main vein; locally veins were found to be up to 1 cm thick. Structural data was collected from the thrust, fractures, and pseudotachylyte veins, along with two hand samples for petrographic observations: 1) an undeformed pseudotachylyte vein; and 2) a hypothesized deformed pseudotachylyte vein. The undeformed vein was also prepared for 40Ar/39Ar geochronologic analyses. Petrographic analysis revealed a dark amorphic matrix with inclusions from the host rock and injection veins typical of pseudotachylyte as well as sigma clasts, which show these veins were reworked by mylonitic deformation associated with an east-west transport direction. The 40Ar/39Ar apparent age spectrum generally shows a hump-shaped spectrum with Mesozoic minimum ages and Late Devonian maximum ages. Structural analyses reveal that the deformed pseudotachylyte veins have a dominant orientation that strikes north and dips east. Based on the integrated data set, I interpret that the pseudotachylytes are Acadian, and thus resulted from reactivation of the Taconic age thrust fault.

GEOCHRONOLOGY AND MICROSTRUCTURES OF THE TILLOTSON PEAK COMPLEX IN LOWELL, VERMONT

PIDGEON, Elizabeth Department of Geology, University of Vermont, Burlington, VT

The Tillotson Peak Complex of Northern Vermont is an area of complicated and unique geologic history. The area has been subject to the Taconic and Acadian Orogenies that shaped Vermont, but maintains a higher metamorphic grade than surrounding areas. The goal of this research is to integrate microstructural analysis with geochronological data in order to determine the age of peak

metamorphism. Data was collected by thin section analysis, field work along the Frank Post Trail, Long Trail, and Eclogite Brook in Lowell, Vt., and 40Ar/39Ar geochronology. The rocks examined in this study record evidence for peak metamorphism at blueschist-facies conditions and greenschist-facies retrograde metamorphism. Peak metamorphic paragenesis includes rutile, glaucophane, garnet, quartz, and white mica. Retrograde facies contain actinolite, chlorite, epidote, quartz, and white mica. An 40Ar/39Ar step-heating analysis of white micas from a blueschist-facies metapelite yields a Mid-Ordovician age of 462.8 ± 1.4 Ma. This plateau age provides a best estimate for the timing peak metamorphism.

USING DRONE SURVEYS TO INTERPRET THE GEOMETRY AND KINEMATICS OF A MESOZOIC FAULT ZONE IN DOLOSTONES OF THE CHAMPLAIN VALLEY BELT, WEST-CENTRAL VERMONT II

REMINGTON, Connor1, KIM, Jonathan 2, KLEPEIS, Keith1, and VAN HOESEN, John 3
1 Department of Geology, University of Vermont, Burlington, VT
2 Vermont Geological Survey, 1 National Life Drive, Main 2 Montpelier, VT
3 Department of Environmental Studies, Green Mountain College, Poultney, VT, USA

The Champlain Valley Belt of west-central Vermont consists of Cambrian- Ordovician, weakly-metamorphosed, carbonate and clastic sedimentary rocks and is informally subdivided into 3 east-dipping lithotectonic slices, which are (from east to west): 1) the hanging wall of the Hinesburg Thrust (HWHT), 2) the hanging wall of the Champlain Thrust (HWCT), and 3) the Parautochthon. These thrust slices were juxtaposed during the Ordovician Taconian Orogeny and later modified by Acadian (Devonian) folding and Mesozoic extension. Our field area lies in the HWCT in a sliver of the Clarendon Springs Formation dolostone. This sliver is bounded by the Ordovician Muddy Brook Thrust (east) and the Mesozoic down-to-the-east St. George Fault (west).

The field area consists of a 100m x 200m rectangle of continuous outcrop in a bedrock channel of the Winooski River at the Williston/Essex border. The northeast striking (~067) and steeply-dipping fault zone was first identified in 2014-2015 through detailed field mapping and structural analysis, however, drone surveys from altitudes of 41m (base map) and 26m (2 subdomains) were necessary to evaluate the geometry of this zone. Field mapping of fractures and bedding were conducted at multiple scales using scangrids, scanlines, and pace and compass techniques.

Photolineaments (n=715) were digitized using imagery captured by a UAV. The dominant azimuths are 067° (30%), 028° (29%), and 295° (14%). Photolineament lengths are shortest within the fault zone (2m) with longer lineaments occurring on either side (4m). Dividing the field area into six domains shows 067° as the dominant orientation with a subordinate 028° set. The fault zone is defined by en echelon fractures with sub-horizontal slickensides that strike 067° and step to the NW. Meter-scale scangrid arrays of the major fracture sets corroborate this stepover direction. Bedding strikes NW and dips moderately eastward suggesting minimal displacement by the fault. The Riedel model for development of strike-slip faults does not adequately explain the development of 067° and 028° fracture sets.

Detailed mapping in other areas of west-central Vermont identified other en echelon fault zones that strike ~067° and cut across Paleozoic ductile structures. We suspect they are related to motion on the St. George Fault.

RECONSTRUCTING A POSTGLACIAL MINERAL DUST RECORD IN THE EASTERN UINTA MOUNTAINS, UTAH: CONSTRAINTS FROM THE TAYLOR LAKE WATERSHED

WASSON, Luna, MUNROE, Jeff, Geology Department, Middlebury College, Middlebury, VT, 05753

Atmospheric mineral dust is recognized as an important part of ecosystem function in alpine environments, as it supports biogeochemical cycling and is a source of primary nutrients. Past research on dust delivery to the Uinta Mountains of northeastern Utah has shown dust to be essential in pedogenesis, soil fertility, and surface water buffering against acidification. Modern dust deposition has been tracked through active and passive dust collectors in the field, confirming the accumulation of dust in the alpine zone and providing geochemical dust composition data. History of dust deposition is less easily accessible, and must be reconstructed from collected material. Past dust deposition is recorded in alpine lakes, which provide an archive of undisturbed sediment accumulation over a long period. Geochemical properties of local sediment are constrained by watershed surficial material, while data from nearby dust collectors constrain geochemical properties of the modern dust. These are representative of two end member sources of sediment into the Taylor Lake basin. Geochemical analysis of a radiocarbon-dated core from Taylor Lake enables comparison of exotic and local material contributions to the lake over time. This analysis indicates high concentrations of calcium in the dust, while watershed material contains high levels of aluminum. A high Ca/Al ratio in the lake core in combination with radiocarbon ages suggests time intervals since the last glaciation of increased relative dust contribution compared to watershed material. The intervals of Holocene aridity that the Taylor Lake core highlights span ~10-8.2 ka BP, ~6.5-2.3ka BP, and ~2.1-1 ka BP, representing periods of increased relative dust contribution that show correlation with other records of aridity across the Great Basin and southwestern United States. This relationship suggests that high elevation dust records such as the Taylor Lake core are able to track low elevation aridity and dust source availability.

APPLICATION OF GEOSTATISTICAL AND GEOCHRONOLOGICAL METHODS TO STRATIGRAPHIC PROBLEMS IN THE LOWER CAMBRIAN MONKTON FORMATION

MAGUIRE, Henry, MEHRTENS, Charlotte. Department of Geology, University of Vermont, Burlington, Vermont 05401, USA

The Monkton Formation has been described by Palmer and James (1980) as a Lower Cambrian regressive sandstone unit containing shallowing up cycles and representing tidal flat progradation. Spatial variation and limited outcrops of continuous stratigraphy have made it difficult to characterize the cycles through the entirety of the Monkton Formation. This study seeks to identify stratigraphic trends in the cycle architecture and thickness, information that will clarify how the sea level is changing and impacting accommodation space.

This research project explores the stratigraphy of the Monkton at higher levels of resolution than previously achieved using geophysical data. Outcrops of the Monkton containing shallowing-upward cycles (parasequences) are being characterized by their gamma ray spectra signatures. Dolostone horizons that cap some cycles are recognizable by their low gamma ray signals while clastic horizons have variable gamma ray spectral signatures based on their grain size and amounts of dolomite cement. The gamma ray spectra produced by cycles are being statistically analyzed to produce an “idealized” pattern and this will be compared to the gamma ray data recorded in well logs. Using zonation software well logs will be subdivided to aid in cycle identification and correlation. Initial statistical study of gamma ray data from a well through the Monkton described by Kim et al. (2013) suggests that meter-

scale parasequences are identifiable in geophysical logs. Work continues to try and identify the lithologies and thicknesses of cycles in well log data based on gamma ray patterns obtained from outcrop data and to identify trends in cycle thickness through the Monkton. These results can be regionally applied to biostratigraphically correlatable rocks in New York, Quebec and Ontario.
An additional aspect of this study was to see if the detrital zircon populations in the Monkton and Danby Formations yield any data that would aid in correlating this unit to other Cambrian strata. Previously, there were no radiometric age determinations were completed on rocks of Cambrian age in the Champlain Valley of Vermont, so for this project, samples have been collected and processed for zircon dating to help constrain the age and provenance of this stratigraphy. Zircon population distribution shows dominate age peaks of 1.05-1.09 Ga for the Monkton and Danby suggests either a continuity of provenance source or the cycling of the Monkton's sandstones. This dominate age peak is similar to the 1.16 Ga age peak seen in the Altona and Ausable Formations of the lower Potsdam Group of NY. The complex age distributions described by Lowe (2016) in the younger members of the Potsdam are not seen in the Vermont Stratigraphy.

CAN BLOOD AND SOIL PB LEVELS BE PREDICTED IN BURLINGTON, VT?

CZYZYK, Katelyn, ROSSI, Amanda, University of Vermont, Geology, Environmental Mineralogy and Chemistry, Burlington, VT

Lead (Pb) is one of the most toxic chemical elements on Earth, causing severe neurological disorders in children. Exposure associated with older homes (pre-1978) is a concerning issue due to the historic use of Pb paint and low environmental mobility of Pb. This issue is especially prevalent in Burlington, VT. While abatement and remediation remain the only efficient ways to eradicate Pb, its prohibitive cost prevents large scale remediation. Our project investigates lead concentrations and bioavailability in Burlington soils. Based on previous work, we test two hypotheses in our investigation: (1) that Pb levels in Burlington soils are indeed linearly correlated to bioaccessible Pb and (2) that the predictive geospatial model previously developed in the UVM Environmental Mineralogy and Chemistry group accurately predicts areas and units of elevated risk.

Fifty two top-soil samples were collected from six residential properties in Burlington and subjected to XRF spectroscopy to determine total Pb concentrations. In parallel, gastric digestion was simulated in the laboratory and samples were analyzed to determine in-vitro Pb bioaccessibility using ICP-OES. Comparison between total Pb and Bioaccessible Pb allowed us to refine the threshold limit for Pb in Burlington soils. To further address Pb impact on communities, we used the EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model to predict blood Pb levels (BLL) for individual sites. A previous geospatial predictive model, based on 101 local soil samples, was reverse tested for accuracy. For this purpose, we carried a comparison between predicted and measured Pb values for the tested soils.
The data shows total Pb levels ranging from 0 to 2,410 mg/kg across the six properties. The locations exhibiting no Pb are homes built post-1978. Locations built prior, with or without exposed paint, show the highest levels of Pb, with many exceeding the EPA's guidance limit for residential play areas of 400 mg/kg. Painting over Pb paint helps reduce further contamination of the soil. Addition of these samples to the existing database further refined the previously determined relationship between total Pb and bioaccessible Pb, adding to the linear trend for which ca. 46% of total Pb is in bioaccessible form in Burlington soils. Inclusion of specific site samples into the IEUBK model highlighted the lack of mobility of Pb as well as its heterogeneous distribution at the site-scale. At the city scale, the addition of these samples into the predictive geospatial model and reverse modeling suggests that the framing

processes used to develop the model, namely co-kriging between housing age and total Pb, is accurate while sampling randomization is key to improving spatial accuracy. The combination of multiscale, targeted analysis and accounting for the EPA's lowered Pb BLL allowed us to propose a revised threshold for soil Pb in Burlington, VT or 360 mg/kg, 40 mg/kg lower than the national value. Our approach highlights the necessity for local investigation and determination of site-specific regulation for Pb contamination in soils.

IGNEOUS PETROGENESIS AND OVERPRINTING DEFORMATION AND METAMORPHISM OF THE EDGECOMB GNEISS, MID COASTAL MAINE

CHEN, Jessica, WEST, D.P, Geology Department, Middlebury College, Middlebury, VT 05753

The Edgecomb Gneiss is an elongate deformed and metamorphosed igneous intrusion exposed near Wiscasset in mid-coastal Maine. The intrusion is found adjacent to the Boothbay Thrust Fault, which juxtaposes two regionally extensive lithotectonic terranes; the Ordovician Casco Bay Group, and the Silurian Fredericton belt. Previous maps have shown conflicting contact relationships between the Edgecomb Gneiss and this major terrane bounding fault structure. Structural, petrologic, and geochemical analyses of the Edgecomb Gneiss, in concert with radiometric age dating of its igneous protolith, will help construct a relative and absolute geochronology of the area, and lend insight into the tectonic setting of magma generation.

The Edgecomb Gneiss is a medium to coarse grained porphyroblastic gneiss containing large grains of light colored feldspar within a dark gray strongly foliated matrix dominated by biotite and lesser amounts of amphibole. Fieldwork shows that the Edgecomb Gneiss is contained solely within the Fredericton Belt, and does not cross cut the Boothbay thrust fault (D1 deformational event). Detailed structural and petrographic analysis reveals the intrusion has been overprinted by upright isoclinal folding and associated steeply dipping foliation that is consistent with D2 regional deformation. Additionally, the Edgecomb Gneiss has been subjected to regional amphibolite facies metamorphism. Whole rock geochemistry shows that the Edgecomb Gneiss is intermediate in terms of SiO2 content (55 to 62 wt.%), but has somewhat unusual trace element signatures. Specifically, it is relatively primitive with high concentrations of MgO, Ni, and Cr, but also relatively rich in alkali elements, like K, Rb, and Ba. Chondrite normalized REE plots show a pronounced enrichment in light REEs, and extended trace element (spider) plots show a pronounced negative niobium anomaly.

Geochemical analysis suggests that the magma that formed the igneous protolith of the Edgecomb Gneiss crystallized in a shallow subduction zone tectonic setting. The unusual geochemical signatures of the Edgecomb Gneiss are similar to the Late Silurian-Early Devonian Lincoln syenite and Turner Mountain syenite exposed along strike to the northeast. U-Pb zircon geochronology is in progress and will test this tentative correlation. Additionally, an igneous crystallization age of the Edgecomb Gneiss will provide absolute age constraints on the timing of regional deformation (D2) and metamorphism as the intrusion clearly pre-dates these events.

U-Pb DATING OF CALCITE VEINS IN THE CHAMPLAIN VALLEY: CONSTRAINTS ON POST-PALEOZOIC REJUVENATION IN THE EASTERN NORTH AMERICAN MARGIN

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Geologists have long been puzzled by the mountainous topography of New England. The last known large-scale tectonic event to impact the region was the opening of the Pangean supercontinent and the opening of the Atlantic Ocean in the Early Mesozoic time. However, several lines of evidence suggest that more recent tectonic events may have caused surface uplift and rejuvenated topography. For example, pulses of sediment into the Baltimore Canyon Trough near 115, 80, and 15 Myr suggest tectonic uplift in the adjacent Appalachians at those times. Regional apatite fission track and U-Th/He cooling ages also point to tectonic uplift and cooling from 85-65 Ma.

This study argues that post-Paleozoic tectonism is recorded by brittle fractures in presently exposed bedrock of New England. We use U-Pb dating of calcite veins to constrain the timing of bedrock fracturing in the Champlain Valley. Calcite samples were collected from brittle fractures that crosscut Paleozoic metamorphic fabrics in bedrock exposures. LA-ICPMS U-PB results from calcite collected from the veins fall into three age ranges: (1) 120-95 Ma, (2) 85-70 Ma, and (3) 20-0 Ma. We interpret these ages to reflect the timing of brittle fracturing in the Champlain Valley and believe these findings indicate periods of post-Paleozoic tectonic activity during the Cretaceous and Miocene. This paper supports previous work, which suggest post-Paleozoic tectonic activity in the Champlain Valley during the Early-Late Cretaceous and Miocene.

COMPARISONS OF DETRITAL MINERAL ASSEMBLAGES IN THE BALTIMORE CANYON TROUGH WITH MODERN RIVER SEDIMENTS: CONSTRAINTS ON POST-RIFT TECTONISM IN THE NORTHERN APPALACHIANS

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Much of the elevated topography of the northern Appalachian Mountains was originally formed in a series of orogenic events during the Paleozoic era, from 450 to 230 Ma. Rocks exposed in the Adirondack massif to the west of the northern Appalachians are much older, having formed during the Grenville orogeny over 1,000 Ma. Conventional wisdom dictates that the Appalachians have been devoid of tectonism since the rifting of Pangea during the Jurassic period, and instead have been slowly denuded through the gradual processes of weathering and erosion. However, a growing body of evidence suggests that the northern Appalachians have experienced tectonic rejuvenation in the intervening time, as recently as the Mio-Pliocene.

Perhaps the most compelling evidence for post-rift episodic tectonism in the ENAM is a study by Poag and Sevon (1989) of sediment accumulation in the Baltimore Canyon Trough (BCT), showing strong peaks in the accumulation rate that could be explained only by drastic increases in sediment supply, and thus tectonic rejuvenation. This study attempts to place geographical constraints on post-rift tectonic uplift by identifying the source regions of sediment in the BCT through zircon geochronology. U-Pb dating of detrital zircons was performed on samples of Lower Cretaceous and Miocene sediments from a northern BCT drill core, COST B-2, and samples of modern river sediments from eight different watersheds across New Hampshire, Vermont, Massachusetts and New York. Results show that each

watershed has a unique distribution of zircon ages, representative of the geologic provinces drained by that watershed that differentiates it from the rest. Likewise, age distributions of detrital zircons in the COST B-2 samples show distinct variation with depth, suggesting a shift in the location of sediment sources over time. Further analysis of the COST B-2 data reveals some of the patterns of detrital zircon age distribution seen in the river sediment data, providing an indicator of provenance.

LABORATORY SYNTHESIS OF SERPENTINES TO ASSESS POTENTIAL FOR ARSENIC INCORPORATION

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Recent studies have identified arsenic as an elevated trace element in serpentinite, reaching concentrations of 450 ppm. Arsenic-bearing serpentinites have been identified as the primary source of arsenic groundwater contamination in north-central Vermont and elsewhere. Understanding the capacity for serpentines to incorporate arsenic is a crucial next step.

Previous studies have shown arsenic incorporation within the serpentine chemical structure, however the details of arsenic incorporation are not well understood. Previous studies have shown evidence for As(III) and As(V) substituting for Si(IV) and As(III) substituting for Mg(II).
The use of laboratory synthesis in this study allows for the testing of hypotheses through fine manipulation of variables such as concentration and oxidation state of the initial arsenic and aluminum. Samples were generated by combining appropriate ratios of aqueous $Mg(NO_3)_2$ and Na_2SiO_3 with variable concentrations of $Al(NO_3)_3$, $As(III)NaO_2$, and $HAs(V)NaO_4$ at a controlled pH. The solution was sealed in an airtight Parr 4744 reactor at 200°C for 7 days. After separation and drying, this method consistently produced approximately 20 mg of white powder. Samples were analyzed by powder XRD, FTIR, and ICPMS.

XRD indicated the synthesis consistently produced a hydrous 1:1 Mg-silicate with a d(001) at 7.5-7.9Å, a d(002) at 3.65Å, but no resolution of non-001 peaks, data consistent with disordered serpentine. FTIR confirmed hydrous serpentine formation with peaks at 3688 and 3400 associated with free OH bonding, peaks at 1640 associated with H_2O, and peaks at 1070 and 800 associated with Si-O bonding. ICPMS was performed on samples dissolved in aqua regia after washes of KCl and dilute acetic acid to remove adsorbed arsenic and disordered serpentine. Using [As](ppb) / ([Mg](ppb)*2/3) to reflect the ratio of incorporated arsenic to tetrahedral positions capable of accepting arsenic, every trial exhibited a rate between 2.9-12.1%. Furthermore in direct comparisons between 5 otherwise identical trials, As(III) consistently showed a higher rate of arsenic incorporation, an average increase of 52.1% over As(V).

ANNOUNCEMENTS

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

CALENDAR

Vermont Geological Society Annual Student Meeting
Date: April 29, 2017
Time: 8:30 am
Location: University of Vermont, Delehanty Hall, Burlington, VT
Information: For information contact Jon Kim at (802) 522-5401 or e-mail jon.kim@vermont.gov .

New England Intercollegiate Geologic Conference (NEIGC)
Date: Sept. 29 - Oct. 1, 2017
Location: Bethel, Maine
Host: Bates College
Information: For information about 3 days of field trips in western Maine and the White Mtns of New Hampshire, contact Dyk Eusden at deusden@bates.edu

NGWA Conference on Fractured Rock and Groundwater
Date: Oct. 2-3, 2017
Location: Burlington, Vermont

Earth Science Week
Date: October 8-14, 2017
Information: Please visit the AGI web site for suggested activities and special events and contests such as International EarthCache Day and Map Day.

Geological Society of America Annual Meeting
Date: October 22-25, 2017
Location: Seattle, Washington

2018 Northeast Geological Society of America Annual Meeting
Date: March 18-20, 2018
Location: Burlington, VT

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

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