# THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

| WINTER 2014 | VOLUME 41 | NUMBER 1 |
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# PRESIDENT"S LETTER

I would like to catch you all up on some of the latest business of the Vermont Geological Society. *Please read carefully* because I would like feedback on some of the items from the membership (jon.kim@state.vt.us).

Winter Meeting 2014: The VGS will not have a winter meeting in 2014. We will, however, pursue this meeting in future years. In the past, the winter meeting has been a conference with talks or a guest lecturer event with potluck meal. Do you have an opinion on what we should do for future winter meetings?

VGS Guest Lecturer: Marjie Gale is stepping down after giving eight lectures on the new Vermont bedrock geologic map. The VGS Executive Committee has proposed that, instead of a single lecturer, we have a rotating panel of three or more different guest lecturers that interested parties can choose from. If any VGS member would like to be on the guest lecturer panel, please let me know.

Sandy Partridge Gift: Before he passed away last year, long-time VGS member Sandy Partridge left the society $4000.00. The executive committee is in favor of using these funds to supplement the research grant program. Two additional ideas were put forth for some of these funds: a) give career service awards (plaques) to special retired or retiring geologists or b) use some of the money to promote/ enhance geology in Vermont (i.e. prepare new and collate existing educational materials that explain special field sites such as the Champlain Thrust at Lone Rock Point etc.). Do you have any ideas on how these funds should be used?

2014 Field Trips: We need volunteers to run the summer and fall field trips. If you have an idea, let me know. I reached out to the New Hampshire Geological Society about a possible joint trip in the next year or two

Elections: We need to have elections. A link to Survey Monkey can be found at the end of this issue of the Green Mountain Geologist as well as a paper ballot. Please vote.

Vermont Geological Society Publications: The executive committee discussed the possibility of producing a Vermont Geological Society Volume 9 in 2014. The last issue of Vermont Geology (Volume 8) was published in March 2001. Such an effort would solicit manuscripts on Vermont geology that would be reviewed externally and be published online and in hard copy. Would you support this publication?

The Vermont Geological Society will hold its Spring 2014 meeting on Saturday, April 26th, 2014 at Middlebury College. The Call for Abstracts is in this newsletter (p.3). Like last year, this will be a joint meeting with the Lake Champlain Research Consortium (LCRC).

Respectfully submitted,
Jon Kim, President

## TREASURER'S REPORT

**Finances**: The Society remains in good financial health. Since the last report when we had a balance of $10,606, we have spent received $430, with $310 income as dues and $120 income to the research fund. Expenses were high at $2,755, as follows:

- $700 Research award to Kevin Chu, Middlebury College undergraduate: Cartographic analysis of watershed scale surface and groundwater interactions in Bristol, Vermont
- $675 Research award to Julia Favorito, Middlebury College undergraduate: An analysis of the lithologic control on major elements, radionuclides, and other trace elements in groundwater south of Bristol, Vermont
- $696 Research award to Samuel Lagor, UVM Masters student: The relationship between magmatism, deformation, and metamorphism during the Acadian Orogeny: A case study from the Knox Mountain Pluton, Green Mountains, Vermont
- $335 Research award to Zach Perzan, Middlebury College undergraduate, Evolution and paleoclimatic history of Weybridge Cave, Weybridge, Vermont
- $101 Executive Committee meeting expenses
- $248 Dues mailing expenses

This leaves us a current balance of $8,281 with most of the 2014 dues and research fund gifts still to be received.

**New Members**: Please join me in welcoming a new member:
Cynthia Norman with the Lake Champlain Basin Program

Respectfully submitted,
David S. Westerman, Treasurer

## ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The Advancement of Society Committee funded four student research grant proposals that were submitted by the October 1, 2013 deadline. Please see the Treasurer's Report for the list of awards.

Please consider a gift to the Vermont Geological Survey Research Grant Program.

Respectfully submitted,
Jon Kim, Chair

## SPRING MEETING & CALL FOR ABSTRACTS

The Vermont Geological Society Spring 2014 meeting is on Saturday, April 26th, 2014 at Middlebury College. The meeting is dedicated to students conducting research in the geological sciences. Undergraduate and graduate students are encouraged to submit abstracts outlining the results of their research. Abstracts covering all aspects of the geological sciences are welcome and will be published in the Spring issue of the Green Mountain Geologist. The Charles Doll

Our fearless leader for the Fall Field Trip - Stephen Wright

At the crest of an esker

Award for the outstanding undergraduate paper will be presented. Cash awards for the top three papers will also be presented based on quality of the research, the abstract, and the presentation of the paper.

Abstracts should be prepared using the style employed for abstracts submitted to Geological Society of America meetings (maximum of 2,000 characters without spaces). We strongly encourage speakers to send their abstracts electronically as a Word file with a .doc extension attached to an e-mail message to Will Amidon at wamidon@middlebury.edu .

Presentations will be limited to 12 minutes with 3 additional minutes for questions. A computer projection system is available for PowerPoint presentations.

Like last year, the Lake Champlain Research Consortium (LCRC) will meet simultaneously.

Deadline for abstracts: Friday, April 4, 2014 at 5:00 pm

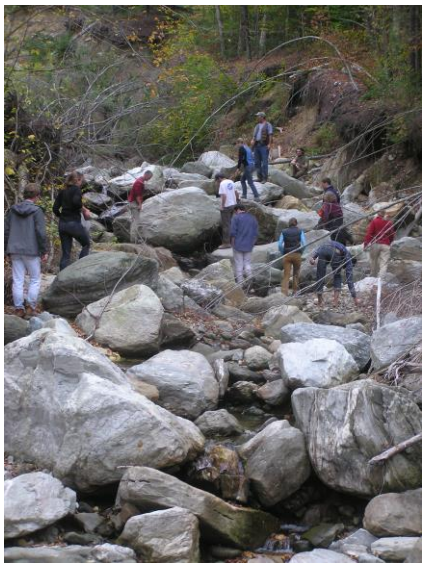
## FALL FIELD TRIP

On Saturday October 5, 2013, the Vermont Geological Society fall field trip was led by Stephen Wright of the University of Vermont and was entitled “Glacial Geology of the Pico Peak Quadrangle”. The attendance for this trip was 50, the largest in recent memory. The field trip description from Stephen follows with photos from Jon Kim.

The Pico Peak Quadrangle straddles the Green Mountains at the latitude of Sherburne Pass. The field trip began with visits to field sites along the Wheelerville Road (NE of Rutland) and the new sections exposed in the upper reaches of Mendon Brook (along Route 4) following the Irene floods. From there we drove up to the Inn at Long Trail and hiked a short distance south to look at outcrops depicting 2 different directions of ice flow. We then drove east into the upper Ottauquechee River valley where many alluvial fans were active during the Irene flood. Finally, we drove up to the drainage divide between the Ottauquechee River and the South Tweed River valleys to visit the outlet of a glacial lake that occupied the South Tweed valley as the ice sheet

retreated to the north.

Field trip overview for 50 participants (left); George Springston (left) and Larry Becker (right) examining high-level glacial lake clays along Mendon Brook (right).



Fall foliage at last stop (above); Boulders transported by Irene flooding in a tributary to the Ottauquechee River (left).

## VERMONT STATE GEOLOGIST'S REPORT

State Climatologist and groundwater as safequard against drought: UVM Professor and State Climatologist, Lesley-Ann Dupigny Giroux, combined with the State Geologist, Laurence Becker, and the Vermont Geological Survey (VGS) for a grant application to the National Oceanic and Atmospheric Association (NOAA). Through its Climate and Societal Interactions Program, NOAA maintains a National Integrated Drought Information System (NIDIS). The grant proposal is intended to support the NIDIS. Justification is through the Vermont State

Hazard Mitigation Plan that includes Action Item 5.1.10: "Develop groundwater resource maps for towns, and conduct ongoing statewide assessments to support community planning and identification of future water supplies, particularly for times of drought". As groundwater is a safeguard against drought, the proposed project will focus on locating water well data and hydrogeologic data coding to support the development of VGS groundwater favorability maps.

Radon and Geology – Multistate Group: A Center for Disease Control (CDC) multistate initiative for national environmental public health tracking (EPHT) is focusing on radon. The inhalation of radon gas above standards can be associated with elevated lung cancer risk. From the geology beneath, the gas can reach homes through several pathways. The Vermont Geological Survey is working with the Vermont Department of Health to integrate radon test data and geological information. A multistate subgroup held a series of video conferences to share each state's approach to data integration and presentation. The State Geological Surveys and the Health Departments from CO, KS, NH, NJ, OR, UT, and VT participated.

Geophysical Logs and Water Wells: Over the past two years, the Vermont Geological Survey partnered with the State University of New York at Plattsburg to log 17 bedrock wells in Vermont using modern geophysical logging techniques. Temperature, conductivity, gamma (~lithology), caliper (borehole diameter), and acoustic televiewer (radar imaging) data were acquired for each well. A presentation of a "Preliminary Hydrogeological Analysis of Selected Bedrock Wells in Vermont using Geophysical Logs" by Jon Kim to the State Groundwater Coordinating Committee (state and private sector membership) showed logs from selected wells with some preliminary hydrogeological analysis to stimulate discussion.

Media Interviews: The State Geologist appeared in a WCAX-TV story from the top of Mount Philo. The questions centered on the Green Mountains, Champlain Valley, Adirondacks, the White Mountains and the geologic history that explains the differences. The story aired during the 6:00 pm news on October 9, 2013. On December 31, 2013 and early January, 2014, the New England Cable Network and WCAX TV interviews focused on "Frost Quakes" also known as cryoseisms. When a cold snap freezes shallow groundwater, expansion can break rock or soil, releasing energy as booming sounds and/or ground shaking.

Geologic Map Advisory Committee: The STATEMAP geologic mapping grant applied for annually requires a meeting of an advisory committee to help set priorities. The committee met on Oct. 16. Bedrock and surficial projects to meet the Town of Calais's interest in groundwater resources is the highest priority followed by a compilation of surficial geologic map data at a scale of 1:100,000 for the Montpelier one-degree sheet. Surficial mapping for part of the Sleeper's River Research Watershed is the 4th priority. As a follow-up the State Geologist and Jon Kim of the Division visited the Calais Selectboard on Nov. 25 to explain the project and how the mapping will progress.

Geothermal: The VGS delivered the data collection portion of geothermal studies funded by the U.S. Department of Energy through the American Recovery and Investment Act. Marjorie Gale collected 40 rock samples and delivered complete geochemical analyses and thermal conductivity data. Temperatures from 17 water wells were collected by Jon Kim and Plattsburgh State. The VGS has additional funds from Central Vermont Public Service (now Green Mountain

The correct answer to Where's It, What's It came from John and Tina Cotton: *Photo is the Comerford Dam in Barnet, Vermont. This 170-foot hydroelectric dam spans the Connecticut River between Barnet, Vt and Monroe, NH, forming the Comerford Reservoir downstream of the larger Moore Reservoir.*

To learn about the Silurian Comerford Intrusives at the dam's spillway see: Rankin, D., et al, 2007, Silurian extension in the upper Connecticut Valley, United States and the origin of Middle Paleozoic basins in the Quebec embayment: American Journal of Science, vol. 307, p. 216-264.

Power) through September 2014 and will continue to collect water well temperatures and investigate how to use models to project temperature at depth throughout Vermont.

Rockfall: George Springston of Norwich University and the State Geologist visited a home in Wells below a steep rock face and a talus slope. Rockfall events caused the family to vacate several times for fear of rocks reaching the domicile. A second field visit further mapped out the downslope extent of talus (some older rocks were found below the level of home) and a fresh boulder from one of the 2013 late spring or summer events was found in proximity to the home. The failed rock slope above displays a wedge of rock that appears to be unstable.

Seismic Studies Delivered to FEMA: The Vermont Geological Survey delivered reports, a map and powerpoint presentations to close-out an Earthquake Hazard Reduction State Assistance grant. Vermont receives funds due to earthquake hazards associated with the region from Southern Quebec to Ottawa and the Northern Adirondacks. The reports cover Seismic Hazard for the Burlington and Colchester, Vermont USGS 7-1/2 Minute Quadrangles and measurements of the shear wave velocity of soft soils as a measure of the potential for enhanced shaking. The map is titled: "Seismic Site Classification for Amplification Potential" for the two quadrangles. FEMA is happy that the studies have led to action items in the State's Hazard Mitigation Plan (SHMP). The SHMP strategies are: 1) Provide data to critical facilities on the impact of seismic shaking and landslides on their facilities 2) Identify the potential for enhanced shaking on soft soils and make outreach to critical facilities in these areas.

Respectfully submitted,
Laurence R. Becker, State Geologist

## CALENDAR

February 24: UVM Lecture Series, *Ophiolites and Global Tectonics* presented by Yildirim Dilek at 4:15 pm in Delehanty Hall, Rm 219

March 10: UVM Lecture Series, *Chemistry of Suspended Sediment* presented by Diana Karwan at 4:15 pm in Delehanty Hall, Rm 219

March 23-25: Northeastern Section Meeting, Geological Society of America, Lancaster, PA

April 26: Vermont Geological Society Spring Meeting, Middlebury College, Middlebury, VT

## EXECUTIVE COMMITTEE BALLOT

Please take a moment to vote in the Society's election of Executive Committee members. You may vote on-line via the Survey Monkey (ctrl, click) at:
https://www.surveymonkey.com/s/Q6XBNT9

If you are unable to use the online option, please fill out the ballot below and mail it to Will Amidon (Dept. of Geology, Middlebury College, Middlebury, VT 05753).

BALLOT
One vote per officer position

President
Jon Kim _____
Other member (write in)_____ _____

Vice President
Keith Klepeis _____
Other member (write in) _____

Secretary
Will Amidon _____
Other member (write in) _____

Treasurer
Dave Westerman _____
Other member (write in)_____ _____

Board Member (vote for three)
Les Kanat ____
Kristen Underwood _____
George Springston _____
Other member (write in) _____

The **Vermont Geological Society** is a non-profit educational corporation.
The **Executive Committee** of the Society is comprised of the Officers, the Board of Directors, and the Chairs of the Permanent Committees.

**Officers**

| | | | |
|---|---|---|---|
| President | Jon Kim | (802) 522-5401 | jon.kim@state.vt.us |
| Vice President | Keith Klepeis | (802) 287-8387 | keith.klepeis@uvm.edu |
| Secretary | Will Amidon | (802) 443-5988 | wamidon@middlebury.edu |
| Treasurer | David Westerman | (802) 485-2337 | westy@norwich.edu |

**Board of Directors**

| | | |
|---|---|---|
| Les Kanat | (802) 635-1327 | les.kanat@jsc.edu |
| George Springston | (802) 485-2734 | gsprings@norwich.edu |
| Kristen Underwood | (802) 453-3076 | southmountain@gmavt.net |

**Chairs of the Permanent Committees**

| | | |
|---|---|---|
| Advancement of Science | Jon Kim | jon.kim@state.vt.us |
| Membership | David Westerman | westy@norwich.edu |
| Public Issues | Laurence Becker | laurence.becker@state.vt.us |
| Publications | Marjorie Gale | marjorie.gale@state.vt.us |

**Vermont Geological Society**
**Norwich University, Dept. of Geology**
**158 Harmon Drive**
**Northfield, Vermont  05663**

***ADDRESS CHANGE?***
*Please send it to the Treasurer at the above address*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VGS Website: http://www.uvm.org/vtgeologicalsociety/

| SPRING 2014 | VOLUME 41 | NUMBER 2 |
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***THE VERMONT GEOLOGICAL SOCIETY ANNUAL***
***SPRING STUDENT PRESENTATION MEETING***
***April 26, 2014, 8:00 am***
***McCardell Bicentennial Hall, Rooms 219 &220***
***Middlebury College, Middlebury, Vermont***

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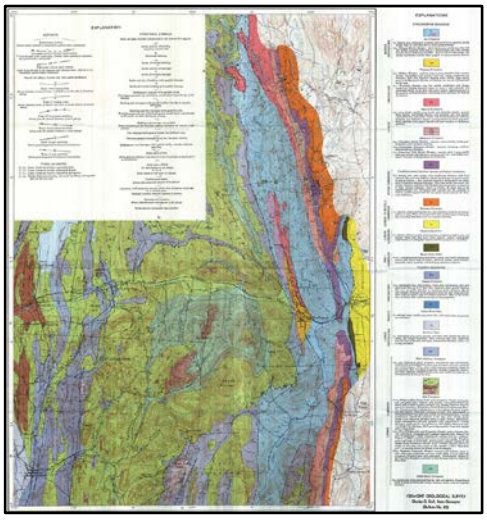
# PRESIDENT"S LETTER

A View of the Taconic Range along Lake Bomoseen

E-an Zen, formerly of the U.S. Geological Survey, died March 29, 2014. Although I never formally met E-an, I knew of his extensive work in the Taconic Mountains of southwestern Vermont through undergraduate and graduate field trips. We used his maps on these field trips and visited some of the famous associated outcrops such as the Scotch Hill Syncline along Lake Bomoseen. In my neo-geologist stage during the summer of 1980, I remember being in awe of Zen's maps, cross sections, and reports.

> From the US Geological Survey: "He joined the Survey in 1959 and retired in 1989. He did extensive mapping in Montana and New England, and his research in the latter area contributed substantially to a modern synthesis of the tectonic history of the northern Appalachians. In the early 1980s, he chaired a committee to review the research of Geologic Division programs, and the "Zen report" established standards and patterns that are still being followed today. E-an was a Fellow of the Geological Society of America and GSA President in 1991-1992; during his tenure he was instrumental in establishing the Geoscience Education Division of GSA. He was also a Fellow of the American Association for the Advancement of Science and of the Mineralogical Society of America. He had the great distinction of being elected to the National Academy of Sciences. E-an will be fondly remembered for his dedication to science and public service, his strong support of young scientists, and his great, dry sense of humor."



Bedrock Geology of the Castleton Quadrangle (Zen, 1964)

Scotch Hill Syncline in gray slates and dolomitic sandstones of the Poultney Formation.

The Vermont Geological Society Annual Student Presentation Meeting will be held jointly with the Lake Champlain Research Consortium (LCRC) on Saturday April 26, 2014 at Middlebury College. The meetings will be held in McCardell Hall, Rooms 219 and 220, so please check to see you are in the right room for the talks you wish to hear. Beverages and snacks will be served prior to the meeting from 8:00 – 8:30 am and at the morning break from 10:45 – 11:15 am. Come and support the students for their fabulous talks and a do little socializing with other VGS members. Please contact me if you are able to serve as a judge for the presentations.

An informal poster session will accompany the morning break. All members are encouraged to display posters they have made for previous meetings. The idea is to share more of our research with each other outside of the student talks. This is really a chance for people who won't be speaking to share what they have been up to over the past year.

We are currently working to identify leaders and topics for the VGS summer field trip, which we hope to run in August. The VGS fall field trip will be led by George Springston and Rick Dunn of Norwich University and is entitled "Unusual Late Pleistocene Stratigraphic Sections in Central Vermont". The trip will focus on surficial deposits in Great Brook in Plainfield and Honey Brook in Barre. We have not yet set a date for the fall trip.

Respectfully submitted,
Jon Kim, President

**2014 SPRING MEETING PROGRAM**

| | |
|---|---|
| 8:00 AM | COFFEE & REFRESHMENTS |
| 8:30 AM | LAURA CUCCIO: Hydrogeology of a fractured bedrock aquifer in strongly deformed and metamorphosed rocks of the Rowe-Hawley Belt, Central Vermont |
| 8:45 AM | JULIA FAVORITO: Lithologic and structural controls on radionuclides in groundwater in the Bristol Quadrangle, Vermont |
| 9:00 AM | MALAYIKA CINCOTTA: Fractured bedrock hydrogeology of a well field in the complexly deformed Connecticut Valley Trough of Central Vermont |
| 9:15 AM | KATIE SCHIDE: Investigating the role of bedrock weathering in the formation of alpine soils, Mount Monroe, White Mountains, New Hampshire |
| 9:30 AM | STEFAN CHRISTIE: Ground penetrating radar in saturated soils near Chesapeake Bay: Challenges and feasability |
| 9:45 AM | KRISTOFFER FALCONES: Rates of soil formation and tectonic uplift of marine terraces, Osa Peninsula, Costa Rica |
| 10:00 AM | DAPHNEE TUZLAK: Chemical and mineralogical evolution of arid tropical soils, Pacific Coast of Ecuador |
| 10:15 AM | BRENDAN MURPHY: An update of the mean water levels of Lake Champlain shows rising levels significantly |

10:30 AM ZACHARY PERZAN: A pre-Wisconsinan paleo-environmental record from Weybridge Cave, VT

**10:45 AM BREAK, COFFEE & REFRESHMENTS** (next abstracts begin on page 10)

11:15 AM DANIEL REED: Geochemistry and petrology of the Cretaceous Alfred Igneous Complex in southwestern Maine

11:30 AM SARINA PATEL: The magmatic history of the Mt. Herbert and Akaroa Volcanic Groups, Banks Peninsula, New Zealand

11:45 AM JACOB VINCENT: Microstructural investigation of the Richardson Memorial Contact: A case study from Hubbard Park, Montpelier, Vermont.

12:00 PM JEFFREY COLT: Comparing two high strain zones along the Norumbega Fault System in central coastal Maine

12: 15 PM TRAVIS DAWSON: Strike-slip fault patterns in the Winooski River gorge: tectonic significance and relationship to the Saint George fault, Essex Junction, Vermont

12:30 PM SEBASTIAN SCHELL: Mio-Pliocene erosion rates in the northwestern Argentina Andes

12:45 PM RYAN BRINK: Depositional environments and provenance of the Lower – Early Middle Cambrian Altona Formation (Potsdam Group)

1:00 PM EMILY ATTWOOD: Properties and origin of fine sediment within late-lying snowbanks in the Uinta Mountains, Utah, USA

**1:15 PM JUDGING AND REFRESHMENTS**

**1:30 PM AWARDS CEREMONY**

## ABSTRACTS

HYDROGEOLOGY OF A FRACTURED BEDROCK AQUIFER IN STRONGLY DEFORMED AND METAMORPHOSED ROCKS OF THE ROWE-HAWLEY BELT, CENTRAL VERMONT

Laura Cuccio (University of Vermont), Malayika Cincotta (University of Vermont), Jonathan Kim (Vermont Geological Survey), Edwin Romanowicz (SUNY Plattsburgh), Keith Klepeis (University of Vermont), William Norland (Otter Creek Engineering)

Over the past decade, the Harwood Union High School District, of Duxbury, VT, has struggled to meet increasing water demands. During the summer of 2013, two new bedrock public water supply wells (150 meters apart) were drilled to provide additional groundwater capacity. We used modern borehole geophysical well logging techniques on these wells (Wells N and O), including temperature, conductivity, gamma, caliper, and acoustic televiewer tools to better understand the hydrogeology of this well field.

The field area lies in the Rowe-Hawley Belt, a tectonic assemblage of rocks that was deformed and metamorphosed by the Ordovician Taconian and Devonian Acadian orogenies. Both wells were completed in the Stowe Formation, which consists of fine-grained, silvery green quartz-muscovite-chlorite-albite-magnetite schists. The dominant foliation in these rocks strikes ~N-S and dips steeply east, orthogonal to foliation. The dominant fracture set dips steeply and trends ~E-W, orthogonal to foliation. Well N is 185 meters deep, encounters the top of bedrock at 33 meters, and has a driller's yield of 196 liters per minute (lpm). Well O is 215 meters deep, encounters the top of bedrock at 23 meters, and has a yield of 76 lpm.

Important findings of this study are: 1) Potential correlations of major fractures and a high gamma zone between the two wells may indicate possible avenues of groundwater communication. These avenues may partly explain the drawdowns in Wells O and N during pumping tests, 2) A nearby brook (Dowesville Brook) potentially recharges the bedrock aquifer, either through fractures or along the surficial/bedrock interface. The slope of the surficial/bedrock interface revealed by a cross-section and the static water levels, support this interpretation, and 3) The recharge from the brook likely influences Well N more than Well O.

We correlated the geophysical logging data from both wells and then integrated these with pumping test data that were collected after the wells were drilled. We believe that this work will aid in other well siting efforts in the Rowe-Hawley Belt, where multiply deformed metamorphic rocks are the only available aquifer type.

## LITHOLOGIC AND STRUCTURAL CONTROLS ON RADIONUCLIDES IN GROUNDWATER IN THE BRISTOL QUADRANGLE, VERMONT

Julia Favorito (Middlebury College)

Bedrock aquifers are a significant water resource in Vermont because 40-50% of the population obtains drinking water from private bedrock wells. Previous hydrogeologic, geochemical, structural, and cartographic analyses in the Hinesburg-Williston area indicate that elevated radionuclides (U and alpha radiation) are associated with wells in the Pinnacle, Cheshire, and Fairfield Pond formations (36 % of wells producing from these units exceed EPA guidelines) – these formations comprise the hanging wall of the Hinesburg Thrust fault. The study area of this thesis is the Bristol quadrangle; it is located due south of Hinesburg, but the dip of the Hinesburg Thrust is much steeper than it is to the north. The goal of this project is to assess occurrence of radionuclides in bedrock and groundwater.

Bedrock data indicate elevated U and Th in the Pinnacle and Fairfield Pond formations, and strong correlations between U-Th and Th-Zr indicate that zircon is a possible source of radionuclides. Two samples with anomalously high Th (21.9 ppm and 81.6 ppm) skew the correlation between U-Th and Th-Zr. This may reflect varied abundances of U and Th in zircons, or that Th may be found in another mineral with high concentrations of Th compared to U. Th is strongly correlated with La, Ce and Nd even when the anomalously high Th samples are included. La, Ce and Nd are proxies for monazite, a phosphate mineral in which Th tends to be elevated. Another possible host mineral for Th is allanite, an epidote mineral that can contain up to 2% Th. XRD analysis is in progress to determine whether or not these minerals are present in samples at concentrations high enough to detect. Feldspars are another possible source for Th and U. Bedrock data shows that K proxies Rb and Ba have fairly strong correlations with both

Th and U. XRD analysis is in progress to determine if plagioclase and potassium are more abundant in samples with higher Th and U.

Preliminary groundwater data indicates that gross alpha levels in the Bristol area (all wells < 10 pCi/L) are lower than expected based on comparison to Hinesburg-Williston groundwater (mean = 18.3 pCi/L). Given that aquifer bedrock geochemistry is very similar to the Hinesburg-Williston area, this difference may be due to lower residence time of groundwater in the Bristol area. Groundwater compositional analysis is in progress.

## FRACTURED BEDROCK HYDROGEOLOGY OF A WELL FIELD IN THE COMPLEXLY DEFORMED CONNECTICUT VALLEY TROUGH OF CENTRAL VERMONT

Malayika Cincotta (University of Vermont), Laura Cuccio (University of Vermont), Jonathan Kim (Vermont Geological Survey), Edwin Romanowicz (SUNY Plattsburgh), Keith Klepeis (University of Vermont), William Norland (Otter Creek Engineering)

In 2009, the town of Berlin, VT drilled three bedrock wells in a triangular map pattern to serve as future public water supplies as development in Berlin expands. This study aims to better understand the hydrogeology of this well field by constructing detailed geologic and hydrogeologic cross sections between the field's three wells. Our study integrates recently collected temperature, conductivity, gamma, caliper, and acoustic televiewer data, with existing lithologic logs and pumping test data.

The well field area lies in the Connecticut Valley Trough (CVT), a Silurian-Devonian basin that was deformed and metamorphosed during the Devonian Acadian Orogeny. The wells were drilled within the Waits River Formation, which is comprised of interlayered marbles and phyllites of varying thicknesses. The dominant foliation in these rocks strikes N-S and dips steeply west. The structure pattern in the area is controlled by two asymmetric fold sets. The dominant fracture set dips steeply and trends ~E-W, perpendicular to foliation. The well depths range from 183-184 m and the long-term tested yields range from 182-189 liters per minute.

Findings of this study include: (1) gamma logs could be used to construct detailed stratigraphic columns for each well; (2) groundwater flow into the wells was indicated by abrupt changes in temperature and conductivity, which corresponds to lithologic changes or foliation surfaces; (3) the correlation of lithologies was strongest in the N-S direction due to control by gentle fold plunges, whereas the steep westward dip of the dominant foliation hampered correlation in the E-W direction; and (4) the thick marble horizons (>10 m), found at depths >135 m, are of particular interest as groundwater source zones. Pumping tests show greater drawdowns in the N-S direction relative to the E-W direction, consistent with groundwater flow being controlled by the N-S striking dominant foliation.

This study shows the importance of understanding the relationship between lithologies, fractures, and groundwater flow. Furthermore, hydrogeological models developed for the Berlin well field will also be broadly applicable to other wells situated in the CVT, a lithotectonic belt that encompasses approximately 25% of Vermont, and major parts of New England and southern Québec.

## INVESTIGATING THE ROLE OF BEDROCK WEATHERING IN THE FORMATION OF ALPINE SOILS, MOUNT MONROE, WHITE MOUNTAINS, NEW HAMPSHIRE

Katie Schide and Jeffrey Munroe (Middlebury College)

This study investigated the role of bedrock weathering in the formation and development of alpine soils on Mount Monroe in the White Mountains of New Hampshire. A recently published bedrock map (Eusden, 2010) identifies multiple formations in an area where other soil forming factors are otherwise constant (climate, biologic activity, relief, and time of deposition). Using this map as a guide, 72 soil samples and 5 rock samples were collected from 25 different locations in Monroe Col and analyzed for a variety of soil, chemical, and mineralogical properties. The soil profiles have distinct Oa, A, B, BC and one E horizon and weathering indices reveal an increase in weathering intensity upward from the bedrock. X-ray diffraction reveals biotite in the rock weathering to hydrobiotite in overlying soils and chlorite in soils above all bedrock formations. The presence of chlorite in soils over rocks that do not contain this mineral could indicate glacial origins from a homogeneous bedrock material deposited in the late Wisconsinan. Trace mineral concentrations are relatively uniform for all soils with no clear bedrock control. Differences in median grain size are significant in soils over different bedrock formations, while ammonium-chloride extractable cations, calculated cation exchange capacity, and exchangeable acidity in the soils show no significant differences. The similarity of soil chemical properties is inconsistent with the theory that Potentilla robbinsiana prefers the chemical properties of soils over calcium silicate bedrock. These preliminary results suggest that the soils in Monroe Col have developed in surficial deposits from the last glaciation with a modest amount of in situ weathering of the underlying bedrock. Soil properties, therefore, reflect a generally uniform parent material with some local variation.

## GROUND PENETRATING RADAR IN SATURATED SOILS NEAR CHESAPEAKE BAY: CHALLENGES AND FEASIBILITY

Stefan Christie (University of Vermont)

The Blackwater National Wildlife Refuge (BNWR) is located within a low-elevation landscape on the Delmarva Peninsula, the spit that borders the eastern shore of the Chesapeake Bay. According to tide gauge data from 1943-2006, relative sea level in this region rose approximately 3.48 mm/yr in that time period, nearly twice the rate of current eustatic sea level rise. Based on ages produced for Holocene stratigraphy, this discrepancy has increasingly been linked to glacio-isostatic adjustment (GIA). Preliminary research in the BNWR supports previous studies in the coastal plains of Virginia and North Carolina that indicate GIA during MIS-3 as well. Specifically, the age and lithology of the Kent Island Formation, the major surficial unit within the BNWR, indicate estuarine deposition when sea level was significantly lower than present according to multiple global sea level proxies. This unit is currently being mapped in the subsurface via boreholes, but due to the high cost of drilling, much of the subsurface extent remains poorly described. Here we test the utility of ground penetrating radar (GPR) as a potentially cost-effective and less invasive option for further constraining the Kent Island Formation, which is characterized by thick beds of loose, light-colored cross-stratified sand and massive silt, and ranges in thickness from 2-12 m. The GPR equipment used in this study consisted of a low-frequency (25 MHz), unshielded, rough-terrain antenna run through a MALA ProEx control unit. This equipment was chosen because the BNWR presents challenging

conditions for GPR data collection, including saturated soils and dense forest; our goal was to constrain the full thickness of the Kent Island Formation. Using stratigraphic information from boreholes as ground-truthing, GPR profiles were processed using Radan 7 software. Processing steps included the application of background removal, filtering, stacking and gain. The results of this study show that GPR imagery is capable of discriminating features and stratigraphic contacts to depths approaching 10 m and can significantly help in tracking stratigraphic units in the subsurface. GPR data were collected directly following an unusually wet season, resulting in particularly saturated soils; data obtained during a dryer season may provide better resolution at depth.

## RATES OF SOIL FORMATION AND TECTONIC UPLIFT OF MARINE TERRACES, OSA PENINSULA, COSTA RICA

Kristoffer Falcones (Middlebury College)

The goal of this project is to determine uplift rates in the tectonically-active Osa Peninsula of Costa Rica by studying temporal changes to the mineralogy and geochemistry of soils developed on marine terraces. In the humid tropics, soils become increasingly enriched in Al and Fe and kaolinite over time, while simultaneously becoming depleted in base cations and early-formed smectite. However, other factors, rainfall especially, also affect the maturation process. Higher precipitation will cause soils to mature more rapidly. In this thesis I seek to test three main hypotheses: 1) that the mineralogy of tropical soils in a rainy environment (5000 mm/yr) evolves rapidly from Holocene smectite-dominated to late Pleistocene kaolinite-dominated; 2) that the mineralogy and geochemical fingerprint of the Osa terrace soils can be used to identify and correlate distinct terraces; and 3) that point 2 will reveal spatial relationships that exhibit consistent terrace characteristics (i.e. uplift from sea level, soil mineralogy, soil geochemistry, age, and elevation). X-ray diffraction (XRD) and transmission electron microscopy (TEM) were used to analyze soil clay mineralogy. Results indicate that < 10 soils are dominated by smectite, but that 40 ka soils (the oldest soils collected) are predominantly composed of kaolinite; this contrasts soils in less rainy regions such as the Nicoya Peninsula (~2200 mm/yr) where 50-80 ka soils contain interstratified kaolinite-smectite, and the transition to kaolinite-dominated soils requires ~120 ka. TEM analysis of three Ca-saturated samples (5 ka, 10 ka, 40 ka) reinforce the XRD results: the 5 and 10 soils are dominated by pedogenic smectite whereas the 40 ka sample is dominated by single crystals of kaolinite and halloysite crystals. These results show that clay mineral formation within tropical soils in the extremely rainy Osa Peninsula undergoes rapid evolution from smectite-dominated to kaolinite-dominated, in about half the time required in the drier Nicoya Peninsula, due to the increased chemical weathering provided by higher precipitation rates in Osa. Current research is applying GIS analysis to assessment of terrace correlation and Holocene to early Pleistocene uplift across the Osa Peninsula.

## CHEMICAL AND MINERALOGICAL EVOLUTION OF ARID TROPICAL SOILS, PACIFIC COAST OF ECUADOR

Daphnee Tuzlak (Middlebury College)

Understanding rates of chemical reactions and mineralogical pathways in tropical soils is important as they typically undergo intense leaching due to tropical conditions and also support approximately three-quarters of the world’s population. This study examines changes in soil

chemistry and mineralogy of arid tropical soils formed on marine terraces (120 ka to early-middle Pleistocene) along the Pacific Coast of Ecuador. Given that this region is very arid compared to most of the tropics; this study provides the opportunity to compare soils in dry tropical climates to more-frequently studied soils in the humid tropics. An additional goal is to determine whether or not temporal changes in soil mineralogy/geochemistry are effective in correlating terraces to aid in tectonic interpretation, as has been done with terrace soils in the humid tropics. XRD, ICP-AES, SEM, TEM, grain size and pH were used to study mineralogy, chemistry and physical characteristics. Results show that smectite is the dominant pedogenic clay in nearly all soils, and that it only begins to transform to interstratified kaolinite-smectite in soils > 330 ka. Pedogenic calcite and aragonite are present at depths > 30 cm in soils > 120 ka — the presence of pedogenic aragonite was verified by XRD, and its occurrence is notable because it is rarely observed in soils. Pedogenic aragonite may reflect rapid crystallization from saturated solutions that kinetically favor aragonite over calcite. Parker and Reiche weathering indices as well as base cations plotted against $SiO_2 + Fe_2O_3 + Al_2O_3$ show trends of increased leaching with age although rates of reaction appear to be much lower than in moister terrace soils in Costa Rica and Colombia. Formation of kaolinite is prohibited by high evaporation and low precipitation, and this, combined with slow rates of change in soil chemistry over time, makes it difficult to correlate terraces for tectonic interpretation.

## AN UPDATE OF THE MEAN WATER LEVELS OF LAKE CHAMPLAIN SHOWS RISING LEVELS SIGNIFICANTLY

Brendan R. Murphy (Champlain Valley Union High School)

For the past four decades the primary source of data for the mean water levels of Lake Champlain has been a 1971 paper entitled “Vermont Water Resources Research, Extreme Mean Daily Annual Waters Levels of Lake Champlain”, June, 1971, by Richard N. Downer, a professor at the University of Vermont. His study analyzed water level data records from 1907 to 1971 measured at the Burlington waterfront. His determination of the mean low water level, the mean water level, and the mean high water level became and has remained the accepted basis of property ownership and the starting point for the jurisdiction of various regulatory programs on the Vermont shore of Lake Champlain. This study re-analyzed the water level data using daily measurements from 1907 to 1917 and analyzed new data from 1971 to 2013. The analysis showed the original Downer study, which used a more limited data set, provided lower levels than when the data was re-analyzed using all the daily levels for the studied period. In addition, the study showed that since 1971 the low, mean and high levels of Lake Champlain have increased significantly. The data shows that the mean water level over the past 40 years was nearly 0.9 feet higher than the mean calculated by the Downer study in 1971. In addition to the increase of the mean levels of the lake, the frequency of high water events has also increased. The maximum recorded water level prior to 1971 was 101.51 feet. Since 1971, that mark has been surpassed 58 times, with a new high water mark of 103.19 in 2011. Some of the increase in mean levels of the lake is the result of changes of the outflow on the Richeleau River in the early 1970s; however the remainder may be the result of other physical factors and not necessarily climate change.

## A PRE-WISCONSINAN PALEO-ENVIRONMENTAL RECORD FROM WEYBRIDGE CAVE, VT

Zachary Perzan, William Amidon, and Jeffrey Munroe, (Middlebury College)

A complex latest-Quaternary history has been reconstructed for the Champlain Valley in western Vermont including a series of proglacial lakes in front of the retreating Laurentide ice sheet, submergence beneath a marine embayment during a period of high relative sea level, and establishment of the modern-day Lake Champlain. However, very few records of climatic conditions exist for northern New England prior to the retreat of ice ~14 kyr ago. To begin filling this gap, we are conducting a detailed chronological, sedimentological and geochemical examination of clastic sediment within Weybridge Cave, in the central part of the Champlain Valley. This cave, developed in Ordovician limestone with over 450 m of passage, is one of the larger known solution caves in this region. Passages of the cave closer to the surface are floored with erratic cobbles washed in from the glacial till and proglacial lake sediment that mantles the surrounding landscape. In contrast, the deepest level of the cave (~35 m below surface) is partially filled with fine, laminated sediments. The majority of this sequence (>2 m) consists of silty clay (mean grain size of 10 μm) with mm-scale and sub-mm scale laminations. Several exposures contain local concentrations of rip-up clasts and a mélange containing intact blocks of finely laminated clays, indicating that deposition of this fine-grained unit was punctuated by higher-energy discharge events. Optically Stimulated Luminescence (OSL) evidence from fine sand at the base of the section suggests that the laminated fines were deposited before the Last Glacial Maximum. Ongoing work comparing paleomagnetic declination, inclination and intensity variations to existing, dated records may help to narrow the age estimate for the fine-grained sediment and support correlation between outcrops within the cave. The sediments described here offer a paleoenvironmental record that could aid further interpretation of New England landscape evolution prior to the most recent glaciation.

## GEOCHEMISTRY AND PETROLOGY OF THE CRETACEOUS ALFRED IGNEOUS COMPLEX IN SOUTHWESTERN MAINE

Daniel Reed (Middlebury College)

The Alfred Complex in SW Maine is one of many Cretaceous-aged igneous plutons in northern New England and adjacent Quebec. The magmatic origin of these widely distributed plutons is unknown and is of interest because the region is generally considered to have been tectonically quiescent during the Cretaceous period. This is the first study to address this question though employing modern petrologic and geochemical studies on Alfred Complex rocks.

Previous mapping (Hussey, 1961) and the results of this study classify the Alfred Complex into three major rock types. In map pattern, these rocks form a generalized circular “target” pattern, with rocks from outside to inside: biotite-bearing noritic gabbro, monzodiorite, and granodiorite. Rocks are composed of plagioclase, alkali feldspar, biotite, orthopyroxene, clinopyroxene, hornblende, quartz, and opaque minerals, with minor amounts of apatite and zircon. A porphyritic texture is common, with plagioclase phenocrysts up to 9mm across. Phenocrysts are sodic, and are compositionally zoned with sodic rims relative to cores. Phenocryst An content in gabbro ranges from An24 – An62, in monzodiorite from An15 – An43, and in granodiorite from An10 – An36. This represents a general shift to more sodic composition towards the center of

the complex. Orthopyroxene, which is only abundant in the gabbro, has an average Mg# of 61. Clinopyroxene composition in the gabbro is Wo44En38Fs18; in monzodiorite: Wo45En31Fs24.

Rocks are geochemically classified on a standard alkali-silica diagram as syenodiorite and gabbro. Harker diagrams show an increase in K, Na, and Al and a decrease in Ca, Fe, Mg, Mn, P, and Ti with increasing Si. Bivariate plots of trace elements against Si show strong positive correlations of Si with Hf, Lu, Rb, Th, U, and Zr, and strong negative correlations of Si with Ni, Sr, and V. Samples are light rare earth element (LREE) enriched, and plot with a generally flat trend. An extended REE diagram shows negative anomalies for Sr and Ti.

Initial results suggest that rocks are comagmatic and of within-plate origin, and that variation in rock type is a result of fractionation processes. Ongoing research will continue to interpret the origin of these and related rocks to increase understanding of the tectonic origin of the magma series and of anorogenic igneous processes in general.

## THE MAGMATIC HISTORY OF THE MT. HERBERT AND AKAROA VOLCANIC GROUPS, BANKS PENINSULA, NEW ZEALAND

Sarina Patel (Middlebury College)

Banks Peninsula, situated SE of Christchurch, New Zealand, is comprised of a massive accumulation of 5.8-12 million year old volcanic rocks of ambiguous origin. These volcanics erupted in the center of the Zealandia tectonic plate, but existing literature is conflicted on the driving mechanisms of magma production. Twenty rock samples were collected from two co-erupted formations, the Mt. Herbert and Akaroa Volcanic Groups, and have been analyzed to produce all-new petrographic and geochemical data for the Mt. Herbert region of the peninsula.

Based on an alkali-silica geochemical classification scheme, samples collected for this work fall on the more mafic end of the spectrum observed overall on the peninsula, classifying as tephrite, alkali basalt, and hawaiite. Whole-rock Mg#s range from 59.9-37.8. High wt.% TiO2 values (2.73-4.09) are consistent with published trends. Samples are LREE enriched ([La/Ybn] range = 7.57-15.87) with a slight positive Eu anomaly. An extended REE diagram shows slight positive Nb, Ta, and Sr anomalies and a small negative K anomaly for all samples, consistent with an intraplate-source signature. The abundance of minerals as phenocrysts and matrix grains varies by sample, but generally includes some combination of plagioclase, olivine, clinopyroxene, titanomagnetite and ilmenite, and rare occurrences of alkali feldspar as matrix grains. Plagioclase and olivine phenocryst chemical compositions are generally more calcic and Mg-rich respectively than those found in the matrix (An60-70 vs.An~50; Fo70 vs. Fo50). Plagioclase demonstrates a variety of zoning textures, including oscillatory and patchy, and spinels show occasional exsolution into ilmenite and titanomagnetite. Some plagioclase phenocrysts have more sodic cores (An~50) than rims (An62).

The new data from this study have been integrated with previously published geochemical datasets from the region and, for the first time, allows for a comprehensive evaluation of the nature of volcanism on Banks Peninsula. This work focuses on identifying the factors which differentiate the two co-erupted volcanic groups, Mt. Herbert and Akaroa, modelling their late-stage development, and ultimately generating a petrogenetic model for the region which can be

compared to previous published models based on a more fragmentary record.

## MICROSTRUCTURAL INVESTIGATION OF THE RICHARDSON MEMORIAL CONTACT: A CASE STUDY FROM HUBBARD PARK, MONTPELIER, VERMONT

Jacob Vincent (University of Vermont)

The Richardson Memorial Contact (RMC) has been extensively studied throughout Vermont for many decades although there are very few places to physically see the contact. The RMC is a geologic boundary between rocks to the west that were affected by the Taconic and Acadian orogenies and rocks to the east that only record Acadian and younger deformation. This study investigates the RMC in Hubbard Park Montpelier, Vermont. While there is general agreement about the RMC being a fault in and south of Hubbard Park, this is the first study to examine both outcrop and microstructural deformation in this location. The goals of this study are to: 1) Document the geology and collect oriented samples along a transect perpendicular to the RMC; 2) Conduct microstructural analyses; 3) Synthesize field and thin section information, and to place constraints on fault kinematics and the metamorphic conditions attending different stages of deformation. I was able to measure 41 different outcrops around the RMC and collect six oriented samples in a 1.75 kilometer perpendicular transect across the fault zone. Preliminary observations are that samples furthest away from the fault on both sides are dominated by crenulation cleavage. Samples taken from the fault zone also display porphyroclasts and quartz ribbons that have been further folded, indicating an episode of folding postdating mylonitization. The constraint of the relative timing of ductile shearing in thin section in relation to the other microstructures around the fault zone can help us in understanding the relative timing of faulting along the RMC with respect to the development of multiple generations of Acadian folds.

## COMPARING TWO HIGH STRAIN ZONES ALONG THE NORUMBEGA FAULT SYSTEM IN CENTRAL COASTAL MAINE

Jeffrey Colt and Dave West (Middlebury College)

Strain localization displacement structures such as shear zones and faults occur at any type of tectonic regime and are important manifestations of plate tectonic activity. This study focuses on two high strain zones (Ray Corner zone and Hill 806 zone) within the central portion of the Norumbega fault system in Maine (a 450km long and up to 30km wide dextral transcurrent fault system) and provides a multipronged approach to comparing the rocks within each of these zones. Understanding and differentiating between the various types of high strain rocks in the Ray Corner and Hill 806 zones provides insight to their timing, conditions of deformation and displacement history. Despite being in close proximity to one another (within 2 km), results thus far indicate significant differences in these two zones at a variety of scales. The Ray Corner high strain zone is characterized by many episodes of deformation and a variety of fault rocks including mylonite, fault breccia, deformed pseudotachylyte, later cross cutting injections of pseudotachylyte, and cross cutting epidote veins. Hill 806 is a zone best described by varying mylonite (from coarse grained to ultramylonitic fabric) with notable similarities to surrounding host rocks but no evidence of reactivation. These observations lead to the following conclusions: Rocks within the Ray Corner zone most likely formed close to the brittle-plastic transition (10-15km deep) while rocks within the Hill 806 zone formed deeper in the plastic regime (>15km deep). These results can be used to expand the story of the Norumbega fault system and are a

useful analog for the processes of active transcurrent faults elsewhere.

## STRIKE-SLIP FAULT PATTERNS IN THE WINOOSKI RIVER GORGE: TECTONIC SIGNIFICANCE AND RELATIONSHIP TO THE SAINT GEORGE FAULT, ESSEX JUNCTION, VERMONT

Travis C. Dawson and Keith A. Klepeis (University of Vermont)

This study was performed to collect and analyze structural data on arrays of superposed strike-slip faults that occur in the Winooski River gorge, in Essex, VT. The goal of this study was to understand the genesis and the regional significance of strike-slip faulting near the St. George fault, to infer geometries of regional stress fields and fault motion, and assess their compatibility with geometries from the St. George fault, as determined in previous studies within the Champlain Valley. Characterizing the nature of these faults establishes controls on the hydrology of the Winooski River in Essex.

The faults in the study area occur within the Clarendon Springs Formation, which has undergone heterogeneous brittle deformation, brecciation and strike-slip faulting. The study area is defined by two major NE-SW trending vertical faults that bound a brittle area of deformation, subject to shear zone processes. In this shear zone are fracture populations interpreted as synthetic and antithetic faults within a sinistral strike-slip system. Conjugate faults, Riedel shears, and strike-slip step-overs with local transtensional fracturing are common. The area encompassed by the faults exhibits two distinct domains. The SW region between the major bounding faults is dominated by offset conjugate R and R' shears cut by young, tensile veins. In the NE region the northern bounding fault curves and strikes NNE to form a horsetail splay. This latter area shows dextral right stepping echelon arrays where tensile quartz veins have developed between en echelon fault segments.

Topographic lows that influence the flow of the Winooski River are a result of localized extension within the bounded shear zone as a result of fault bending and horsetail splay fault termination subject to a sinistral sense of shear. The fracture sets observed in this study are compatible with Mohr-Coulomb failure criterion. Stress inversions using this failure criterion suggest a regional stress field characterized by principal compressions orientations: NE-SW-trending sub horizontal max ($\sigma 1$), and NW-SE-trending, sub horizontal min ($\sigma 3$). These stress orientations are representative of several, but not all, examples of high angle Mesozoic faults from previous studies near the St. George strike-slip fault system.

## MIOCENE-PLIOCENE EROSION RATES IN THE NORTHWESTERN ARGENTINA ANDES

Sebastian Schell (Middlebury College)

Climate and tectonic activity are known to be the two main controls on erosion rates. This project seeks to produce a long term erosion record for the Andes of Northwestern Argentina, and relate these erosion rates to known climactic and tectonic events occurring in the Central Andes over the past 8 million years. Erosion rates are determined by measuring cosmogenic 10Be in quartz, a rare isotope that is produced in the upper 3m of Earth's crust through bombardment by cosmic rays. The Rio Iruya Canyon is a perfect site to implement this

technique, not only because it has been incised over the course of the past 100 years, ensuring minimal post-burial cosmogenic production, but the strata has been independently dated through paleomagnetostratigraphy. Dating of zircons from ash layers interbedded with the sedimentary strata provide further age control for the erosion by dating. Thus far 6 ash beds have been successfully dated using the U-Pb dating method. The ages of 4 of these beds correlate directly to the ages of the Atana (3.96 ma), Chaxas (4 ma), Puripicar (4.09 ma), and Guacha (5.65) ignimbrites, which were all produced by eruptions on the Puna Plateau.

## DEPOSITIONAL ENVIRONMENTS AND PROVENANCE OF THE LOWER - EARLY MIDDLE CAMBRIAN ALTONA FORMATION (POTSDAM GROUP)

Ryan A. Brink and Char Mehrtens (University of Vermont)

The Altona Formation represents the oldest Cambrian unit in northern New York, recording cyclic deposition in shallow marine and fluvial environments under both fair-weather and storm conditions. Five outcrops and one well log were measured and described at the centimeter scale and the top and bottom contacts of the Altona were identified. Based on the recognition of sedimentary structures such as hummocky cross stratification, oscillatory ripples, graded bedding, trough and tabular cross stratification, and bioturbation, as well as subtle lithologic changes, six lithofacies representing non-marine, middle to upper shoreface, offshore, and carbonate ramp environments were identified. The top contact with the overlying Ausable Formation is characterized by inter-tonguing marine to non-marine siltstones and cross stratified medium sandstones with the cross stratified non-marine Ausable Formation. The lowermost Altona is found to lie only one meter above Precambrian basement and is interpreted to be the only non-marine facies in this unit. Throughout the 84-meter thick section, stratigraphy records a transition from non-marine/marginal marine deposits and carbonate ramp deposition to upper/middle shoreface, carbonate ramp, and offshore mud depositions before grading into the non-marine Ausable Formation.

Thin section analysis from each lithofacies quantified grain size and composition and identified a possible source. Modal analysis data from clastic lithofacies identified subarkose to arkose sandstones with an accessory mineral suite including ilmenite, apatite, rutile, and zircon. Integrating the compositional data, particularly the accessory mineral suite, with detrital zircon dates of 1000-1300 Ma (Chiarenzelli et al., 2010) suggests that ancestral Adirondacks as a possible source.

## PROPERTIES AND ORIGIN OF FINE SEDIMENT WITHIN LATE-LYING SNOWBANKS IN THE UINTA MOUNTAINS, UTAH, USA

Emily Attwood and Jeffrey Munroe (Middlebury College)

Interest in modern dust deposition has risen as the effects of anthropogenic modification of the landscape have been brought to the forefront of climate change discussions. Increased atmospheric dust deposition is a key consequence of landscape disruption due to both human activities and transitions within climate regimes. In particular, deposition of atmospheric dust within alpine environments has strong implications for soil development, vegetation growth, nutrient cycling, surface water chemistry, and snowpack properties. In the Uinta Mountains 60% of annual precipitation falls as snow, much of which persists into the summer season.

Concentrations of dark, fine-grained sediment are commonly observed at the surface of snow banks and typically assumed to be of eolian origin, however this interpretation has not previously been tested. This study analyzes dirty snow samples from 14 late-lying snow banks and 14 samples from the soil surface in the vicinity of these snow banks. The primary objective was to determine whether the fine-grained sediment in the snow is exotic eolian sediment or more locally sourced material. While grain size distributions are different between the two sets of samples, with abundant very fine sand and coarse silt in snow samples (mean GS of ~90 μm), and medium to fine sand in samples of soil near snow banks (mean of ~150 μm), a mixing model using dust and soil samples as end-members reveals that the fine-grained sediment in the snow is composed of both of these sediment types. X-ray diffraction analysis of the fine-silt fraction from both sets of samples reveals that the sediment within the snow, and the surrounding soil, contain amphibole and plagioclase. Neither of these minerals are present in the local bedrock or in soil B horizons, yet both are present in modern dust samples collected directly from the air, suggesting an eolian source. Comparisons of immobile trace element ratios, Ti/Zr, Ti/Nd, Th/La, and Ce/Y, across dust, soil, and snow samples further support this mixing theory. In addition, snow bank analysis was conducted regarding possible correlations between certain topographic positions and relative dust content. Results of this study indicate that the fine-grained sediment within the snow banks is a mix of both exotic eolian particles and locally derived soil inputs.

## STATE GEOLOGIST'S REPORT

Northeastern Geological Society of America – Hydrogeology Presentations

The Vermont Geological Survey was involved in four groundwater-related poster presentations at the Geological Society of America - Northeastern Section conference held in Lancaster, PA in March. Posters 1-3 involved the detailed hydrogeology of public water supply well fields in Hinesburg, Berlin, and Moretown (Harwood Union School); this research will be given to these towns. Undergraduate students from the University of Vermont and the State University of New York at Plattsburgh strongly participated in this research. Poster 4 showed results of *10 years of statewide groundwater data analyses* and the integration of bedrock and surficial geology with a) water well data, b) a water-use study conducted by the US Geological Survey and c) an ANR-funded water well interference study. Statewide planning maps integrating all data sets were proposed.

1) Kim, J., Romanowicz, E., and Dorsey, M., 2014, The subsurface expression of a faulted and folded bedrock aquifer in the west-central Vermont foreland: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, #2, p. 48.

2) Cincotta, M., Cuccio, L., Kim, J., Romanowicz, E., Klepeis, K., and Norland, W., 2014, Fractured bedrock hydrogeology of a well field in the complexly deformed Connecticut Valley Trough of central Vermont: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, #2, p. 49.

3) Cuccio, L., Cincotta, M., Kim, J., Romanowicz, E., Klepeis, K., and Norland, W., Hydrogeology of a fractured bedrock aquifer in strongly deformed and metamorphosed rocks of the Rowe-Hawley Belt, central Vermont: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, #2, p. 49.

4) Gale, M., Springston, G., Van Hoesen, J., and Becker, L., 2014, A GIS-based approach to characterizing Vermont's groundwater resources: GSA Abstracts with Programs, NE Section (49th annual meeting), v. 46, No. 2, p. 47.
Please view on-line at:
http://www.anr.state.vt.us/dec/geo/pdfdocs/GaleNEGSAsmWater.pdf

Landslides and the Vermont Mitigation Approach

With the Washington State landslide in the news, the Division is receiving questions about landslide hazards in Vermont. Previously scheduled but after the Washington event, the Vermont Geological Survey, Norwich University, and Johnson State College met on Monday March 24 before the Jeffersonville Hazard Mitigation Committee to answer questions about a 1999 landslide and the hazards posed today.

The Lamoille County Regional Planning Commission is helping the committee to address the issue in a Mitigation Plan. There are analogies between the Washington slide and what happened in Jeffersonville as a high bank with a previous landslide on the outside of a river bend failed with a run out onto a floodplain. Luckily in 1999 no one was in harm's way but the slide did reach a home and there are concerns to the north and south of the 1999 slide. Our plan is to work with regional planning commissions to use a landslide mapping protocol we developed for the state hazard mitigation plan. The intent to identify areas of potential slope instability and use the maps for land use planning.
Please view on-line at:
http://www.anr.state.vt.us/dec/geo/pdfdocs/HazRpts/JeffLandslide2014.pdf

Forest Health and Soil Parent Material Chemistry

The Vermont Geological Survey is in cooperation with the UVM Field Naturalist Program, the USDA Forest Service Northern Research Station and the USDA Green Mountain National Forest (GMNF) to understand spatial patterns in calcium supply to aid the Forest Service in predicting basic tree nutrition and forest productivity, identifying rare plant habitat, assessing the impacts and recovery of forests from air pollution, and in evaluating potential impacts of harvesting and other land management activities on forest health and productivity. On April 10, 2014, we met with the partners to hear the results of Gus Goodwin's (UVM Master's candidate) research project which focused on a geochemical database, sampling, analyses, and GIS models of till composition in the GMNF. Several different models were presented along with a discussion of the next steps towards till model development.

Respectfully submitted,
Laurence Becker, Vermont State Geologist

## ADVANCEMENT OF SCIENCE COMMITTEE REPORT

One application to the Vermont Geological Society Research Grant Program was received by the April 1, 2014 deadline, which is entitled "Structural Analysis of the Richardson Memorial Contact in Woodbury, Vermont" by Christopher Defelice of Norwich University.

Please consider a gift to the Vermont Geological Society Research Grant Program, which partially funded two of the students that are presenting at the meeting on April 26.

Respectfully submitted,
Jon Kim, Chair

## ELECTIONS

Elections of Society Officers and Board members were conducted via Survey Monkey and optional paper ballot. 15 members voted. Thanks to those who volunteered to serve the Society this year. Officers elected are:

| | | | |
|---|---|---|---|
| President | Jon Kim | (802) 522-5401 | jon.kim@state.vt.us |
| Vice President | Keith Klepeis | (802) 287-8387 | keith.klepeis@uvm.edu |
| Secretary | Will Amidon | (802) 443-5988 | wamidon@middlebury.edu |
| Treasurer | David Westerman | (802) 485-2337 | westy@norwich.edu |

Respectfully submitted,
Keith Klepeis, Vice President

## ANNOUNCEMENTS AND MEMBER NEWS

*Judges are needed* for the student meeting on April 26. Please consider volunteering (no law degree required). Contact Jon Kim at 802-522-5401 if you can help.

*John S. Moore*, CPG, after 8 years of retirement, returned to work to serve as the National (Chief) Geologist in Washington, DC for the USDA, Natural Resources Conservation Service. His last position with the agency was National (Chief) Hydrogeologist. He has 36 years of experience at all levels within the agency, with about half his time spent in the field and half developing new, practical technology for investigating earthen dams and spillways, ground water development and protection, and erosion and sedimentation. He has worked in 35 states and 6 foreign countries in a wide variety of geologic terranes. John is "an old-time Vermonter from St. Johnsbury, with a camp at Joes Pond in Danville (since 1953)" and was a charter member of the VGS in 1973.

*In Press*: Roni, E., Westerman, D. S., Dini, A., Stevenson, C. and Rocchi, S., Feeding and growth of a dyke-laccolith system (Elba Island, Italy) from AMS and mineral fabric data: Journal of the Geological Society, London

*Please* send us your member news for inclusion in the Summer GMG.

## CALENDAR

April 26: Vermont Geological Society Spring Meeting, McCardell Hall, Middlebury College, Middlebury, VT; 8:00 am

The **Vermont Geological Society** is a non-profit educational corporation.
The **Executive Committee** of the Society is comprised of the Officers, the Board of Directors, and the Chairs of the Permanent Committees.

**Officers**

| | | | |
|---|---|---|---|
| President | Jon Kim | (802) 522-5401 | jon.kim@state.vt.us |
| Vice President | Keith Klepeis | (802) 656-0247 | keith.klepeis@uvm.edu |
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**Board of Directors**

| | | |
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| Kristen Underwood | (802) 453-3076 | southmountain@gmavt.net |

**Chairs of the Permanent Committees**

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| Advancement of Science | Jon Kim | jon.kim@state.vt.us |
| Membership | David Westerman | westy@norwich.edu |
| Public Issues | Laurence Becker | laurence.becker@state.vt.us |
| Publications | Marjorie Gale | marjorie.gale@state.vt.us |

**Vermont Geological Society**
**Norwich University, Dept. of Geology**
**158 Harmon Drive**
**Northfield, Vermont  05663**

***ADDRESS CHANGE?***
*Please send it to the Treasurer at the above address*

# THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

| SUMMER 2014 | VOLUME 41 | NUMBER 3 |
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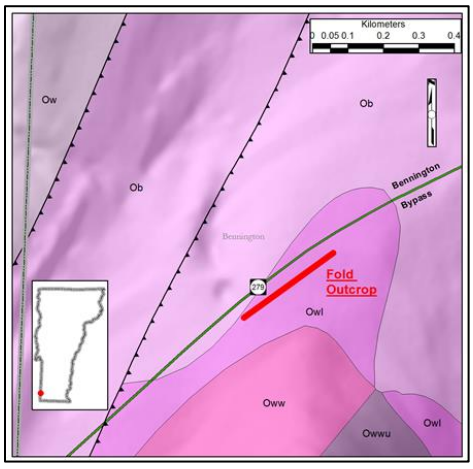
## PRESIDENT"S LETTER

Asymmetric anticline with steeper western limb (right). The syncline is out of the photo to the right.

The old adage says that geologists can be distracted drivers in the presence of spectacular roadside geology and…… it is true. I have driven past the new outcrop on the Bennington Bypass (Route 279) a number of times in the past few years and thus only observed the huge folds while swerving slightly at 65 mph. Last weekend, while returning from a family gathering in eastern New York State, I decided that I had to stop the car and gawk at the tight, asymmetric, and west-verging folds at the pulloff/ weigh station in the northbound lane (see map below). The outcrop itself is about ~200 meters long. The folds form an anticline and syncline pair in the limestone member of the Upper Ordovician Walloomsac Formation (Owl). Presumably, these folds are related to the thrust fault immediately to the west (see map). I recommend that you take the time to look at this outcrop whenever you are in the Bennington area.




Bedrock geologic map of the Bennington Bypass area modified from Ratcliffe et al. (2011).

Owl = limestone member of Walloomsac Fm.
Oww = Whipstock Breccia member of Waloomsac Fm.
Ow = shales with limestone and quartzite interbeds of the Walloomsac Fm.

Respectfully submitted,
Jon Kim, President

## SUMMER FIELD TRIP ANNOUNCEMENT

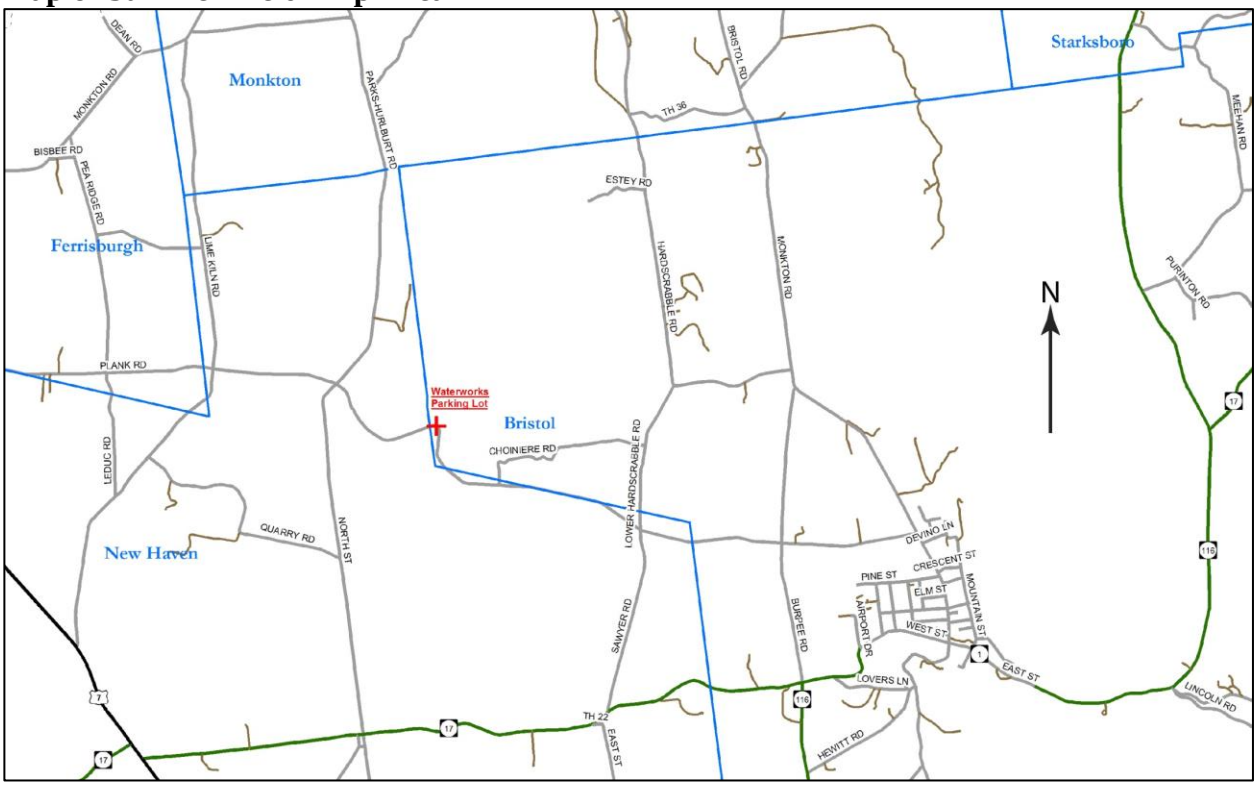
The Vermont Geological Society summer field trip will be held at the Bristol Waterworks property on Saturday August 9 (see map below).

*Rocks, Dirt, and Plants: A Natural History Tour of the Bristol Waterworks*

Leaders: Jon Kim- Vermont Geological Survey
George Springston- Norwich University
Everett Marshall- Vermont Dept. of Fish and Wildlife

The Vermont Geological Survey and Norwich University have recently completed bedrock and surficial geologic maps of the Bristol area. Join us for a hiking tour of the Bristol Waterworks where Jon and George will present key elements of the geology of the area and Everett will give the holistic view of how the geology and plant ecology fit together. Wear sturdy shoes and bring a lunch. Be prepared for a round-trip hike of ~2 miles. Meet at the main parking lot for the Waterworks on Plank Road at 9:45 am, which is on the north side of the road (see map). The trip will leave promptly at 10 am and will return approximately at 2 pm. We will be joined by a local group from the Bristol area. Please RSVP to Jon Kim at jon.kim@state.vt.us (802/522-5401) if you plan to attend.

**Map of Summer Field Trip Area**



## TREASURER'S REPORT

**Finances**: The Society remains in good financial health. To date this year we have received $2,809 as income in the form of dues and contributions to the research fund. Expenses were $725, as follows:

| | |
|---|---|
| $500 | Catering for Student Paper Meeting – Middlebury College |
| $100 | Sarina Patel, Middlebury College – Best student paper |
| $75 | Julia Favorito, Middlebury College – 2nd best student paper |
| $50 | Zach Perzan, Middlebury College – 3rd best student paper |

Our balance as of June 30, 2014 is $11,645 with most of the 2014 dues and research fund gifts already received.

**New Members**: None, but one application pending.

Respectfully submitted,
David S. Westerman, Treasurer

## SECRETARY'S REPORT

Award winners for the best talks given at the Vermont Geological Society Spring Meeting were from left to right, Zach Perzan (3rd place), Julia Favorito (2nd place), and Sarina Patel (1st place).

The Vermont Geological Society Meeting was held at Middlebury College on April 26th, 2014 and was widely hailed as a great success. First prize and the Doll Award went to Sarina Patel for her talk "The magmatic history of the Banks Peninsula, New Zealand", second prize to Julia Favorito for her talk "Lithologic and structural controls on radionuclides in groundwater in the Bristol Quadrangle, Vermont", and third prize to Zach Perzan for his talk "A pre-Wisconsinan paleoenvironmental record from Weybridge Cave, VT." The meeting was followed by lunch at Mr. Upps with VGS members, Middlebury, and UVM students. Thanks to Larry Becker, Peter Gale and Craig Heindel for serving as judges for the student presentations. Thanks to everyone who participated for making it such a fun and successful event!

Respectfully submitted,
Will Amidon, Secretary

## ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The Advancement of Science Committee for the Vermont Geological Society received one research grant proposal by the April 1, 2014 deadline. This proposal, which was submitted by Christopher Defelice, a Norwich University undergraduate student, was entitled: "Structural analysis of the Richardson Memorial Contact in Woodbury, Vermont". The committee decided to fund this grant proposal in-full for $555.00.

The research grant proposals are due on October 1, 2014 and must be postmarked by this date. Application details and an application form are posted on-line at
http://www.uvm.org/vtgeologicalsociety/grantpolicy.html

Respectfully submitted,
Jon Kim, Chair

## STATE GEOLOGIST'S REPORT

Geologic Maps

The Vermont Geological Survey and Norwich University partner submitted bedrock and surficial geologic maps of the South Mountain Quadrangle to the U.S. Geological Survey to fulfill our STATEMAP grant obligations. These maps comprise the basic geologic framework for the Town of Bristol and will be integrated with well log data to assess the groundwater and gravel resources of the town. The results of this study will be presented to Bristol town officials and residents in late 2014. A collaborative study with the Middlebury College Geology Dept. on the groundwater chemistry of the Bristol area, which involved testing for arsenic and radionuclides, was completed in May. Map link and references below:
http://www.anr.state.vt.us/dec/geo/ofreps.htm

Kim, J., Gale, M.H., Chu, K, Cincotta, M., and Cuccio, L., 2014, Bedrock Geologic Map of the northern two-thirds of the South Mountain Quadrangle, Vermont: Vermont Geological Survey Open File Report VG14-1, scale 1:24,000.

Springston, G.E. and Thomas, E., 2014, Surficial Geologic Map the northern two-thirds of the South Mountain Quadrangle, Vermont: Vermont Geological Survey Open File Report VG14-2, scale 1:24,000.

Seismic Hazard – Vermont Approach Presented at National Meeting

The Northeastern States Emergency Consortium (NESEC) supported the VT State Geologist to attend the National Earthquake Program Managers meeting in Denver, Colorado on May 21-22, 2014. FEMA headquarters representatives were also in attendance. The State Geologist presented seismic hazard maps developed by the Vermont Geological Survey (VGS) in cooperation with the UVM Engineering Dept. and the Norwich University Geology Dept. with FEMA funds for the Burlington/Colchester area. The maps are used as educational tools to help inform critical facilities of the hazard. Critical facilities must plan for all hazards. NESEC and the VGS are planning for another presentation to critical facilities in Chittenden County

sometime in September of 2014 that will also include a FEMA presentation on non-structural earthquake mitigation.

Association of American State Geologists (AASG) – Landslides
The Vermont State Geologist attended 106th annual meeting of the Association of American State Geologists in Lexington, KY. The Washington State Geologist presented his experience at the Oso landslide and how he and his geologists fit into the Incident Command Structure during the recovery phase and the work they accomplish as technical experts informing recovery safety. A discussion between AASG, the USGS, and others focused on how Congress should be informed and approached about the landslide issue to improve our understanding and make information available for managing the problem nationwide. (See next related topic)

Congressional Briefing – American Chemical Society (Public Policy Communications)
The VT State Geologist is asked to participate in a Congressional briefing on "Water Hazards". Based on discussions about the Jeffersonville landslide and the "Protocol for Identification of Areas Sensitive to Landslide Hazards in Vermont" as an appendix to the State Hazard Mitigation Plan, he is to cover the landslide issue. The presentation to Congressional staffers in Washington DC is planned for September.

Vermont Public Radio
On July 1, the State Geologist and Professor Charlotte Mehrtens of UVM appeared on Vermont Edition to cover geology topics and take questions. Web link: http://digital.vpr.net/post/nice-gneiss-geology-vermont

Respectfully submitted,
Laurence Becker, Vermont State Geologist

## AD HOC INTERNSHIPS COMMITTEE

Internship Committee members Marjorie Gale, Helen Mango, Michelle Nucci and Miles Waite met on June 25 to discuss initial fact-finding and planning. Discussion focused on the role of VGS and on preliminary tasks to assess demand and partnerships. Our goal is to determine the number of students who may participate, understand possible obstacles, then generate a list of potential intern employers or volunteer sites, contact those potential employers, and be able to transfer the internship information to a department contact person. The tasks we plan to complete by December 2014 are: 1) Michelle – develop a set of questions for a survey of our membership and eventually prepare the Survey Monkey; 2) Helen – develop a set of questions to assess student demand for internships and the types of internships; goal is to have the survey ready in the Fall of 2014; 3) Miles – generate a preliminary list of potential companies and the contacts for each; step 2 will be to contact the employers; 4) Marjie – generate a list of departments and contacts; contact the departments to see if they'll participate in the student survey and also assess interest in department participation.

## ANNOUNCEMENTS AND MEMBER NEWS

*Please* send us your member news for inclusion in the Fall GMG.

# WHERE'S IT, WHAT'S IT?

Send an e-mail to Marjorie.gale@state.vt.us with the Vermont town name and a brief description of what's in the picture. What do you win? Bragging rights. Look for your answers in the Fall Issue of the GMG. Also, feel free to contribute some photographs of your own to use in the next puzzler. Photo taken by Jon Kim.

# CALENDAR

May 17 – Sept 17: A T. Rex Named Sue, Montshire Museum of Science, Norwich, VT; http://www.montshire.org/exhibits/featured-exhibitions/a-t.-rex-named-sue/

August 9: VGS Summer Field Trip, Bristol Waterworks (see page 3)

Oct 1: VGS Student Research Grant Applications are due. Contact Jon Kim at jon.kim@state.vt.us for more information.

Oct 10-12: New England Intercollegiate Geologic Conference (NEIGC), hosted this year by Wellesley College, Wellesley, MA; http://w3.salemstate.edu/~lhanson/NEIGC/Conference.html

Oct 12-18: Earth Science Week, Earth's Connected Systems

Oct 17: Earth Science Week, Geologic Map Day; http://www.earthsciweek.org/geologicmap/

Oct 19-22: Geological Society of America Annual Meeting, Vancouver, BC; http://community.geosociety.org/gsa2014/home/

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The **Executive Committee** of the Society is comprised of the Officers, the Board of Directors, and the Chairs of the Permanent Committees.

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**FALL 2014** **VOLUME 41** **NUMBER 4**

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## PRESIDENT"S LETTER

When I moved to Vermont in 1996, my first mapping project was in the Eden, Lowell, and Albany area and took me a field season and a half to complete. During this project, I regularly consulted with Rolfe Stanley of UVM on this map because he (and his students) had worked along-strike to the north and west. The eastern part of this field area had me doing traverse after traverse over the Lowell Mountains and back. The last time I walked over the Lowell range was in the spring of 1997.

On August 27 of this year, I returned to the top of the Lowell Mountains on a tour of the Kingdom Community Wind Farm operated by Green Mountain Power with State Geologist Larry Becker and Marjorie Gale of the Vermont Geological Survey. Wow, how things had changed! I encourage you to take a tour of a wind farm sometime.

Respectfully submitted,
Jon Kim, President

*Lowell Wind Farm*

## FALL FIELD TRIP ANNOUNCEMENT

Date: Saturday October 18, 2014

Title: Unusual sedimentary sequences from a dynamic ice sheet, Great Brook and Honey Brook, north-central Vermont"

Meeting Place and Time: 9:30 AM at the Town of Plainfield Park and Ride. The site is on the north side of Main Street Extension, about 0.25 miles east of U.S. Rt. 2. As it is an official Park and Ride site, there is a sign out on Rt. 2. The Vermont Agency of Transportation website has specific information on this park and ride location (PLAINFIELD, TH3) at http://parkandrides.vermont.gov/.

Description: George Springston and Rick Dunn (Norwich University) will lead a trip examining fairly unusual sedimentary sequences related to the ice sheet margin and proglacial lake depocenter. With only 3-4 stops the trip is intended to give participants a lot of time to explore the sections and develop their own hypotheses regarding sedimentary processes and the glacial stratigraphy. The trip should be especially interesting for students as they can hone their interpretive skills!

The first 2-3 stops do not involve hiking, the final stop has a ~500 m walk up a valley. Viewing the complete stratigraphy at each site requires some steep slope scaling but they can all be examined from below. If it has rained participants may want to wear footwear for shallow stream wading. The trip should end by mid-afternoon, near Barre. There will be no store stop for lunch; participants please bring your lunch.

**VGS SUMMER FIELD TRIP**

Introduction to the field trip.

Jon shows how the Dunham Dolostone is folded over the Cheshire Quartzite.

**VGS Summer Field Trip**

On August 9, 2014, Jon Kim (Vermont Geological Survey), George Springston (Norwich University), and Everett Marshall (Vermont Dept. of Fish and Wildlife) led a field trip entitled "Rocks, Dirt, and Plants: A Natural History Tour of the Bristol Waterworks".

The purpose of this trip was to integrate bedrock and surficial geology with plant ecology for the 40+ participants. The trip involved seven stops spread over 2 miles of trails and roads. The calcium-poor Cheshire Quartzite and the calcium-rich Dunham Dolostone, which are the bedrock formations in this area, support markedly different plant communities. In addition, there are surficial deposits preserved from three major glacial lake levels.

See photos at left and below.

*Reminder - Fall Field Trip is October 18th, 9:30 am, Plainfield Park and Ride, Rt. 2.*

"The Anticline" in the Cheshire Quartzite.

George uses a LIDAR slope map to explain the multiple glacial lake levels in the area.

Everett explains plant communities that grow in the soils overlying the Dunham Dolostone.

## ADVANCEMENT OF SCIENCE COMMITTEE REPORT

There were two proposals submitted to the Vermont Geological Society Research Grant Program by the October 1st deadline. These proposals will be evaluated in the near future.

1) Nick Bachman, Middlebury College undergraduate student: Uranium-bearing phosphorite breccia in the Clarendon Springs Formation dolostone and the implication for aquifer chemistry; Milton and Colchester, Vermont
   Amount Requested: $900

2) Cynthia Connard, Middlebury College undergraduate student: U-Pb dating of detrital zircons in the Cram Hill Formation, Vermont: Implications for Paleozoic paleogeography and orogenesis
   Amount Requested: $900

Respectfully submitted,
Jon Kim, Chair

## STATE GEOLOGIST'S REPORT

Please look to the next State Geologist's report for a full thank you to all who made the Vermont Geological Survey what it is today. The full time, the partners, and the many have all contributed so much over the last 20 years, leaving a deep geologic legacy for Vermont. It certainly has been an exciting and rewarding time for me. Hopefully by the next GMG, the next State Geologist will be known and introductions to the community can be made (the position announcement is open until Oct 16).

Science and Congressional Briefing, Washington DC, September 12, 2014

The American Chemical Society (ACS) and the Society for Risk Analysis sponsored a "Water-Based Hazards: Risk Mitigation" briefing on Capitol Hill in the Rayburn House Office Building. The Vermont State Geologist presented "Landslide Hazard Mitigation" and the landslide mapping protocol developed in Vermont as an integral part of Vermont's landslide mitigation strategy. Adam Parris, an interdisciplinary expert on Social and Environmental Change at the National Oceanic and Atmospheric Administration, presented on "The Role of Science in Resilience: Lessons from Hurricane Sandy". Mr. Parris has a Vermont connection. He holds a Master's Degree in Geology having studied with Professor Paul Bierman. The two other talks were: "Lessons from the Elk River, West Virginia Chemical Spill" by a John Hopkins University Professor in Environmental Health Sciences and a presentation on "Disaster Mitigation Funding: Pre-Event vs Recovery"

Nov 12 Earthquake Meeting

As there exists low to moderate seismicity in northern Vermont, seismic hazard mapping projects for the Burlington, Colchester, and the Williston areas are complete (Lens, Dewoolkar, Springston and Becker, 2013). In addition to Burlington, Colchester and the Town of Williston, parts of Milton, Winooski, Essex Town and Village, South Burlington and Shelburne fall within the study areas. The Vermont Geological Survey will co-sponsor with the VT Division of Emergency Management and Homeland Security a briefing to Vermont Essential and Critical Facilities Managers on the seismic hazard maps accompanied by a FEMA Presentation titled "Earthquake Hazard Mitigation for Nonstructural Elements." The FEMA and the Northeastern States Emergency Consortium logos will be on the flyer as well. The event is planned for Nov 12, 2014 at the Double Tree in Burlington.

National Geologic and Geophysical Data Preservation Program
The State Geologist joined a USGS review panel in Denver, Colorado, June 16-19, 2014. Thirty states applied for funds to preserve geologic and geophysical data. There are four categories for consideration: inventorying what a state has, metadata creation, paper conversion/digital data preservation, and rescuing samples that are in need of better protection. The Vermont Geological Survey is working under its first grant to inventory our paper and digital data.

Regional Planning Commissions and Landslide Mapping Protocol
A Department of Environmental Conservation strategic plan strategy is to work with regional planners and local government to implement the "Protocol for the Identification of Areas Sensitive to Landslide Hazards in Vermont". On July 15, the State Geologist and George Springston of Norwich University met with the Central Vermont Regional Planning Commission (CVRPC) in Montpelier and a Local Emergency Planning Committee in Guilford administered by the Windham Regional Commission (WRC). We gave examples of the kind of landslides we see in Vermont and discussed the use of the protocol. Both the CVRPC and WPC are interested in going further and we talked about forming a consortium of RPC's to work with the Vermont Geological Survey.

Respectfully submitted,
Laurence Becker, Vermont State Geologist

## AD HOC INTERNSHIPS COMMITTEE

The Vermont Geological Society is trying to help connect students with internship opportunities. To this end, we need to assess how much demand there is for internships, and what limitations there might be for students accessing internship opportunities. We developed a questionnaire for students, a questionnaire for VGS members, and are working on connecting with businesses and organizations in Vermont who may hire interns.

We also contacted Geology and Environmental Science departments in hopes of establishing a contact person who could distribute information about a survey monkey student questionnaire and enlist students to participate. The contact person will also receive a listing of internship opportunities and be the key person to connect their interested and qualified college/university students with the opportunities. The VGS plan is to make the initial discovery and pass information on to departments.

Thus far the University of Vermont, Castleton State College, Johnson State College, and Middlebury College all plan to participate. We are waiting to hear from other colleges.

Please look for a Survey Monkey in your membership e-mail soon.

Respectfully Submitted,
Marjorie Gale, Helen Mango, Michelle Nucci and Miles Waite

# ANNOUNCEMENTS AND MEMBER NEWS

Fall GMG bragging rights for *'Where's It, What's It?'* go to all those who correctly identified the picture: Ron Krauth, Chuck Ratte, Greg McHone, Thomas Villars and Kent Koptiuch!


"*I can't resist taking a guess at the photo in the recent Green Mountain Geologist. This looks like the southern end of Lake Willoughby, up in the Northeast Kingdom in Westmore."*

*"Where's it, What's it? is pretty easy. Mount Pisgah cliffs along the east shore of Lake Willoughby in town of Westmore. Have ridden my bike along the shoreline on Route 5A many times, and always hoping that some huge boulder doesn't pick that exact moment to come tumbling down the cliffs. From the photo, looks like I had more of a margin in the talus slope area than I realized."*

For more pictures of Lake Willoughby, Mt. Pisgah, rockfalls and landslides, follow this link: http://www.anr.state.vt.us/dec/geo/hazmap.htm

## TREASURER'S REPORT

**Finances**: The Society remains in excellent financial health. As of September 30, 2014 we had $11,602 in the bank.

**New Members**: Please join me in welcoming a new member: Sara Lott with Impala Networks.

Respectfully submitted,
David S. Westerman, Treasurer

# WHERE'S IT, WHAT'S IT?
## (Contributed by guest photographer Thomas Villars)

Send an e-mail to Marjorie.gale@state.vt.us with the Vermont town name and a brief description of what's in the picture. What do you win? Bragging rights. Look for your answers in the Winter Issue of the GMG. Also, feel free to contribute some photographs of your own to use in the next puzzler.

## CALENDAR

Oct 10-12: New England Intercollegiate Geologic Conference (NEIGC), hosted this year by Wellesley College, Wellesley, MA; http://w3.salemstate.edu/~lhanson/NEIGC/Conference.html

Oct 12-18: Earth Science Week, Earth's Connected Systems

Oct. 13, 4:15 pm, Room 219, Delehanty Hall, UVM, 180 Colchester Ave., Burlington. UVM Geology Seminar: Laurel Goodwin, U of Wisconsin-Madison: Quantifying the mechanical behavior of shear zones.

Oct 17: Earth Science Week, Geologic Map Day; http://www.earthsciweek.org/geologicmap/

Oct 19-22: Geological Society of America Annual Meeting, Vancouver, BC; http://community.geosociety.org/gsa2014/home/

Oct. 27, 4:15 pm, Room 219, Delehanty Hall, UVM, 180 Colchester Ave., Burlington. UVM Geology Seminar: Frank Magilligan, Dartmouth College: Lessons learned from Hurricane Irene: Going from field impacts to fluvial theory and river management.

Oct. 31, 12:30 pm, Room 417, Bicentennial Hall, Middlebury College, Middlebury: Amy Leventer, Hamilton College: Interdisciplinary exploration of the East Antarctic margin. The public is warmly welcomed.

Nov. 3, 4:15 pm, Room 219, Delehanty Hall, UVM, 180 Colchester Ave., Burlington. UVM Geology Seminar: Marjorie Gale, Vermont Geological Survey: The 2011 Bedrock Geologic Map of Vermont: Highlights, transitions and notes about the journey.

Nov. 10, 4:15 pm, Room 219, Delehanty Hall, UVM, 180 Colchester Ave., Burlington. UVM Geology Seminar: David Singer, Kent State University: Speciation and distribution of trace metals associated with iron sulfides in the Marcellus Shale.

Nov. 14, 12:30 pm, Room 417, Bicentennial Hall, Middlebury College, Middlebury: Julia Perdrial, University of Vermont: How does critical zone carbon respond to global change: examples from the northeastern and southwestern US. The public is warmly welcomed.

Nov. 17, 4:15 pm, Room 219, Delehanty Hall, UVM, 180 Colchester Ave., Burlington. UVM Geology Seminar: Ken Ridgeway, Purdur University: TBD Cenozoic flat-slab subduction processes and the tectonic deevlopment of southern Alaska.

Dec. 5, 12:30 pm, Room 417, Bicentennial Hall, Middlebury College, Middlebury: Ray Mitchell, Principal Carbonate Sedimentologist, ConocoPhillips (retired): Microporous ooids in a Middle East sour gas reservoir. The public is warmly welcomed.

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