



# THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

**WINTER 2015**

**VOLUME 42**

**NUMBER 1**

## TABLE OF CONTENTS

<b>PRESIDENT'S LETTER.....</b>	<b>2</b>
<b>MESSAGE FROM LAURENCE BECKER .....</b>	<b>3</b>
<b>VERMONT STATE GEOLOGIST'S REPORT .....</b>	<b>6</b>
<b>WINTER MEETING ANNOUNCEMENT, JANUARY 24 .....</b>	<b>7</b>
<b>ADVANCEMENT OF SCIENCE REPORT.....</b>	<b>7</b>
<b>TREASURER'S REPORT .....</b>	<b>8</b>
<b>CALENDAR .....</b>	<b>8</b>
<b>EXECUTIVE COMMITTEE .....</b>	<b>10</b>

**PRESIDENT'S LETTER**

One of the most memorable photos I have taken while working for the Vermont Geological Survey is above, which shows the Jeffersonville landslide scar after the second of two landslides in 1999. A house was perched precariously at the edge of a cliff above the Brewster River and fresh trees were still collapsing into the scar. The cliff is composed of Pleistocene glaciolacustrine deposits with light brown fine sands overlying gray varved clays. Larry Becker is the bottom right of the photo looking over the damage. As the Vermont Geological Survey prepares to celebrate Larry's retirement on January 24, 2015, we should pause to remember the path that he led the Vermont Geological Survey on over the past 20 years. Our mission has been to use intensive field-based geologic studies to build a detailed framework ("The Vessel" as he would say) for understanding and mitigating geologic hazards. In the traditional sense, "hazards" are thought of as physical, including only landslides, erosion, floods, and earthquakes. However, we have also worked extensively on geochemical hazards to human health, such as radionuclides, arsenic, and nitrates in groundwater. Our group (below) had a really good run under Larry.



From right to left, Larry Becker, Jon Kim, Marjie Gale, and George Springston, on a 2014 visit to the Lowell Wind Farm.

Respectfully submitted,  
Jon Kim, President

**MESSAGE FROM LAURENCE BECKER, VERMONT STATE GEOLOGIST,  
1995-2014**

An Honor to Have Served

It has been an honor to serve you as the Vermont State Geologist from 1995 -2014 and a privilege to direct the Vermont Geological Survey (VGS). The geological community is a strong one in Vermont and the VGS is an integral part of that community. We have accomplished much during the last 20 years through the work of the Survey and the work of all your respective organizations as individuals while often collaborating together. The line of State Geologists goes back to 1845 but the job continues to be reinvented with every new generation. I came in at the beginning of the digital mapping revolution and we have played this technology to the benefit of all. At our web site are multiple maps products – framework geology and a range of applied maps based on GIS technology. Today GIS is the everyday means to make maps, but not in 1995. Not only have we produced VGS products, but in cooperation with USGS partners, most notably Nick Ratcliffe, Greg Walsh, and the technical and cartographic teams, we produced the 2011 Bedrock Geologic Map of Vermont.

---

The partnerships have also been with the academic institutions in the State – the University of Vermont, Middlebury College, Norwich University, Johnson State and Castleton – their professors and students. The University of Vermont is our primary academic partner on the 2011 Bedrock Geologic Map of Vermont (Rolfe Stanley, Char Mehrrens, Barry Doolan). In recent years, UVM has provided structural geologic studies from Keith Klepeis and geophysics from Laura Webb. For geology and public health, Middlebury College and Pete Ryan, have been our primary partners. Ray Coish and his multiple geochemical studies contribute in a number of areas. The long standing partnership with Norwich gave us George Springston's work on surficial mapping and landslide considerations. Thanks to Dave Westerman for all his support. Helen Mango at Castleton and her work on arsenic and Leslie Kanat at Johnson State and his work on the Jeffersonville landslide brought cooperation with the State Colleges. Thanks to Peter Thompson and Thelma Thompson for their work on the bedrock map. Thanks to surficial mappers Stephen Wright from UVM and John Van Hoesen from Green Mountain College, and Rick Dunn, Norwich. John Lens and Mandar Dewoolkar of UVM engineering contributed seismic hazard maps in cooperation with George Springston. Thanks to Anne Clift for her work on a landslide mapping protocol. Numerous interns have made fine contributions. If I have missed any one please forgive, you all have done special work.

#### Special Thanks to the VGS Core

Please welcome *Marjorie Gale* as our next State Geologist. Marjorie received an MS in Geology from UVM and her thesis was about the bedrock and tectonic history of rocks at Belvidere Mountain. Marjorie started her career for the State in 1996 and is a co-author of the 2011 Bedrock Geologic Map of Vermont. She currently is working on mapping, till chemistry and groundwater projects.

Our next State Geologist is highly deserving of the honor. She has worked diligently to provide geologic information to the community in the form of her mapping and co-authorship of the 2011 Bedrock Geologic Map of Vermont. Her web site work delivers the geologic goods to our audience in fine style. At the web site are the maps and the groundwater studies she completed and much more. Recent Till studies which are underway are a new area for her science.

Our work together goes back to 1996 at the beginning of my tenure. We have worked together for many years and spent many hours of discussion to design and build programs and

---

working the grants that pay for them. I will very much miss our direct interactions. At every stage, Marjorie has shown much ability and willingness to plan and execute tasks. What stands out is the competence and quality of product that always results with the speed and agility to bring the work in on time. I could not have done the survey's work without her and if people think of our work kindly looking in from the outside, a key part is due to Marjorie's perseverance, science, and organization.

*Jon Kim* is our State's expert on Geology and Health, from work that began with an elevated radionuclide reading in a well in Colchester progressing to studies in Williston, Hinesburg and Bristol and other localities around the State. Arsenic studies with Middlebury College followed and all were intended to reveal information about the potential health hazard. The work led to passage of a bill to provide notification to homeowners to test for constituents of concern.

Before Jon joined us in Vermont he proposed a mapping project with an Adobe figure he built to illustrate the plan. He was ahead of his time in 1995 helping me see a visual presentation future for VGS when few knew how to use this tool. How successfully he has played this out. All the fine and very defensible science he has built from mapping projects, geochemistry, water samples, water well data, and geophysics always lands in a final product with visual panache. It tells the story and is key to having Vermonters respect our work and look to us for science. His publication record in peer reviewed journals is a very active one. He works closely with towns when a mapping project is underway. He has talent for collaboration with others and with the students to bring forward a strong and respected body of work in a legacy for Vermont.

*George Springston* of Norwich University has been integral to many projects here at the VGS for 15 years and made our partnership work so effectively over the years. The body of work he has brought us resides in the surficial mapping projects, landslide work, hydrogeologic coding and single year projects such as the highway study. All are outstanding benefiting from his methodical and careful approach. Because of that care we can always count on the results of the reports to be very well written and focused directed toward the essentials. His legacy is a very careful body of work very well considered and toward the applied. He has been a great support to the survey. He has a style that includes ideas presented and makes a fellow geologist really feel like a partner throughout any project.

---



Winter GMG bragging rights for 'Where's It, What's It?' go to Bruce Cox who identified the site as Rte. 106 in Weathersfield. "The location is on VT Route 106 just south of the intersection of VT Routes 106 and 131. The view is to the south. The stream is the Black River. The shot was taken in the aftermath of Tropical Storm Irene. This area was reported to be the last section of state highway to reopen."



Larry Becker, Vermont State Geologist, 1995-2014

Thank you all for your support and guidance. I have many fond memories of the field and the Northeast GSA meetings and all our interactions. It has been a great run and thank you for the opportunity.

Respectfully submitted,

Laurence Becker

### STATE GEOLOGIST'S REPORT

The first order of business is to relay to you a brief history of Larry Becker's accomplishments over the past 20 years as State Geologist and celebrate his contributions. Larry began working at the State of Vermont in 1981 and has served since 1995 as the 13th State Geologist, the first being Charles Adams in 1845. For the past 20 years Larry has directed the activities of the Geology Division and Vermont's Radioactive Waste Management program. Prior to 1995 he served as Technical Services Chief for the VGS and as a groundwater planner for DEC. He developed the aquifer mapping protocols for Vermont's aquifer protection program and has managed the mapping programs, stream geomorphology studies, and advised the legislature on mineral industry issues and groundwater.

Larry served on numerous committees including: Chair of Education Committee, Association of American State Geologists; Chair, NESEC State Geologists - Northeastern States Emergency Consortium (NESEC); Vermont State Hazard Mitigation Committee; VT State Nuclear Advisory Panel; and the Groundwater Coordinating Committee.

Larry worked hard to connect the Survey and geology to other government Divisions, Departments and Agencies and made a constant and creative effort to apply geology to address issues in Vermont. He has excelled as a mediator of issues and advocate for science. His management style created a great workplace for all of us.

As I begin my new role at the Vermont Geological Survey, I want to express my appreciation to the geologic community and my co-

workers for their encouragement and to Larry, for his leadership, friendship and unwavering commitment to the bedrock map of Vermont and to the Vermont Geological Survey.

Respectfully submitted,

Marjorie Gale, Vermont State Geologist

### **WINTER MEETING, JANUARY 24**

The Vermont Geological Society will hold its annual winter meeting on Saturday January 24, 2015 at the Cider House Restaurant on Route 2 in Waterbury. This meeting will commemorate the retirement of Larry Becker, who was the Vermont State Geologist for the past 20 years. The program for this event is shown below:

4:00 – 5:00 PM: Beverages (cash bar and soft drinks) and Appetizers (chicken wings, spinach dip, and cheese and crackers).

5:00 – 6:00 PM: Buffet Dinner (\$20 per person will be collected at the door)

Entrees: Pulled Pork, St Louis Ribs, Grilled Chicken, Vegetarian Pasta Primavera

Side Dishes: Mac and Cheese, Black Beans and Rice, Green Beans

Desserts: Warm Apple Crisp and Maple Bread Pudding

6:00 – 7:30 PM: Guest Speakers on Applied Geology

Bob Marvinney (Maine State Geologist), “Arsenic in Maine groundwater and attitudes toward testing and remediation”.

Rick Chormann (New Hampshire State Geologist), “Changing Course: The Suncook River Avulsion and its Aftermath”.

Steve Mabee (Massachusetts State Geologist), "Massachusetts Enters the Shale Gas Wars: Facts vs Fiction"

Larry Becker (Vermont State Geologist Emeritus), to be announced.

I received 43 RSVPs by December 31, 2014. The *last possible day* to reserve a space at this meeting is Thursday January 15th, 2015 (Jon Kim: geojon710@msn.com).

---

## ADVANCEMENT OF SCIENCE COMMITTEE REPORT

There were two proposals submitted to the Vermont Geological Society Research Program and both received full funding. Please see the Treasurer's Report for details.

Respectfully submitted,  
Jon Kim, Chair

## TREASURER'S REPORT

**Finances:** The Society remains in good financial health. Since the last report we have awarded two research grants and covered Executive Committee meeting expenses, and no new income has been received.

**Expenses:**

- \$700 Nick Bachman, Middlebury College, "Uranium Bearing Phosphorite Breccia in the Clarendon Springs Formation Dolostone and the Implication for Aquifer Chemistry; Milton and Colchester, Vermont"
- \$700 Cynthia Connard, Middlebury College, "U-Pb Dating of Detrital Zircons in the Cram Hill Formation, Vermont: Implications for Paleozoic Paleogeography and Orogenesis"
- \$114 November Executive Committee meeting expenses

**Balance:** Our balance as of December 31, 2014 is \$10,158 as we await the new year.

**New Members:** None.

Respectfully submitted,  
David S. Westerman, Treasurer

## CALENDAR

**Middlebury College, Geology Seminar Series**

**Date:** February 27, 2015

**Time:** 12:30 pm

**Location:** Room 417, Bicentennial Hall, Middlebury College, Middlebury, VT

**Information:** Ryan McKeon of CalTech will present "Shouldn't the Appalachians be flatter by now? New perspectives on an old mountain range from low-temperature thermochronology"

**Middlebury College, Geology Seminar Series**

**Date:** March 13, 2015

**Time:** 12:30 pm

---

**Location:** Room 417, Bicentennial Hall, Middlebury College, Middlebury, VT

**Information:** Andrew Schroth of UVM will present a talk about the influence of glaciation on iron in fluvial and marine systems. Title TBA.

**2015 Northeastern Section Geological Society of America 50th Annual Meeting**

**Date:** March 23-25, 2015

**Location:** Bretton Woods, Mount Washington, New Hampshire

**Information:** For information, visit the web site or contact [Brian Fowler](#) (meeting chairperson) or [Gary Johnson](#) (chair, Tech Program).

**Middlebury College, Geology Seminar Series**

**Date:** April 24, 2015

**Time:** 12:30 pm

**Location:** Room 417, Bicentennial Hall, Middlebury College, Middlebury, VT

**Information:** Rich Goldfarb of USGS will present a talk about tectonics and ore deposits. Title TBA.

**2015 NGWA Conference on Groundwater in Fractured Rock**

**Date:** September 28-29, 2015

**Location:** Burlington, Vermont

**2015 Geological Society of America Annual Meeting & Exposition**

**Date:** November 1-4, 2015

**Location:** Baltimore, Maryland

**2016 Geological Society of America Annual Meeting & Exposition**

**Date:** September 25-28, 2016

**Location:** Denver, Colorado

**Host:** Geological Society of America

---

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
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*



# THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

SPRING 2015

VOLUME 42

NUMBER 2

***THE VERMONT GEOLOGICAL SOCIETY ANNUAL  
SPRING STUDENT PRESENTATION MEETING  
April 18, 2015, 8:30 am  
Room 219, Delehanty Hall, UVM, Burlington, VT***

## **TABLE OF CONTENTS**

<b>PRESIDENT'S LETTER.....</b>	<b>2</b>
<b>VERMONT STATE GEOLOGIST'S REPORT .....</b>	<b>3</b>
<b>ADVANCEMENT OF SCIENCE REPORT.....</b>	<b>5</b>
<b>TREASURER'S REPORT .....</b>	<b>5</b>
<b>ANNUAL STUDENT MEETING, APRIL 18 .....</b>	<b>6</b>
<b>CALENDAR .....</b>	<b>15</b>
<b>EXECUTIVE COMMITTEE .....</b>	<b>17</b>

**PRESIDENT'S LETTER**

The Vermont Geological Society held its annual winter meeting on Saturday January 24, 2015 at the Cider House Restaurant in Waterbury. This meeting, which was attended by 48, commemorated the recent retirement of Vermont State Geologist Larry Becker (1995-2014). The meeting started with a "happy hour" of appetizers and a cash bar, was followed by a buffet feast, and concluded with applied geology talks by Bob Marvinney, Rick Chormann, and Steve Mabee, the current state geologists of Maine, New Hampshire, and Massachusetts, respectively. Larry Becker spoke last and recapped the highlights of his career and thanked all the attendees. Because of this special event, the Vermont Geological Society covered the full cost of dinners for some special guests as well as ~50% of these costs for all attending members.

Respectfully submitted,  
Jon Kim, President



State Geologists (left to right): Steve Mabee (MA), Marjorie Gale (VT), Laurence Becker (retired VT), Rick Chorman (NH) and Bob Marvinney (ME)



Greg Walsh and John Van Hoesen enjoying the gathering at the Cider House.



Cheryl Marvinney and Kate Ross

Heartfelt Thanks for the Event

With admiration for the Society, I want to thank the Executive Committee and the Membership for the sendoff at the VGS winter meeting. The Executive Committee put time and energy into the event with many arrangements made by Jon Kim, Society President. The gifts are special: The 2011 bedrock state map framed; the glass version of the simplified 1961 map of

---

---

On March 13, 2015 the House and Senate adopted S.C.R. 10 honoring the work and contributions of Laurence R. Becker as Vermont State Geologist.

---

---

Larry is working as a temporary employee in our office through June. He is working on a special project for strengthening the role of science in ANR. Work groups are discussing “Asking and Answering Natural Resource/Environmental Questions” and “Personnel and Science Expertise” and working towards recommendations for processes to be established in ANR.

---

---

Many thanks to Jon Kim for organizing a wonderful retirement celebration for Larry Becker.

---

---

Vermont and the plaque from USGS. My state geologist colleagues from Maine, Massachusetts, and New Hampshire ably supported the geology and public-policy theme – the applied geology our surveys all perform. For those that attended and to the membership, we have a special group that continues to show how a vibrant community meets, greets, and shares the joys of our science. All in all, a very gratifying evening.

Sincerely,  
Larry

### STATE GEOLOGIST’S REPORT

From water chemistry to tectonics, Lidar and drones, there were 52 Vermont-specific presentations by our geoscience community at the Northeast Section Annual Meeting of the Geological Society of America in Bretton Woods, NH this past March. Jon Kim, George Springston, and our soon-to-graduate student intern Christina Strathearn were co-authors on several abstracts:

Connard, C., Coish, R., Kim, J., and Amidon, W., 2015, U-PB dating of detrital zircons in the Cram Hill Formation, Vermont: implications for paleogeography and orogenesis.

Dunn, R.K., Springston, G.E., Hermanson, T., and Thomas, E., 2015, Interbedded subaqueous debris and turbidity flows; a thick and laterally extensive ice-proximal facies preserved in isolated proglacial basins.

Kanat, L.H., Springston, G.E., and Sevi, A., 2015, Complex earth slide-flows in glaciolacustrine deposits over the past 100 years in Jeffersonville, Vermont.

Kim, J., Romanowicz, E., Dorsey, M., and Strathearn, C., 2015, Hydrogeological analysis of a complexly folded and faulted bedrock aquifer in the Champlain Valley of west-central Vermont.

Kim, J., 2015, The along-strike context of the Richardson Memorial Contact (RMC) in the town of Craftsbury, north-central Vermont.

Ryan, P., Kim, J., and West, P., 2015, Along strike variation in arsenic and other trace elements in metapelites of the Connecticut Valley/Gaspe sequence (NE Vermont and SE Quebec).

Springston, G.E., and Underwood, K.L., 2015, Landslide and alluvial fan activity due to Tropical Storm Irene: Examples from Money Brook, Black River watershed, Vermont.

Springston, G.E., and Kim, J., 2015, Surficial features and bedrock structures revealed by lidar in western Vermont.

Strathearn, C., Klepeis, K., Kim, J., Gombosi, A., Langworthy, M., Johnson, E., and Schachner, B., 2015, Detailed analyses of structures in the footwall of the Champlain Thrust at Lone Rock Point, Burlington, Vermont.

In the meantime, I have been transitioning to my new role as State Geologist, a role significantly different than bedrock mapping. I'm working on how to best explain and deliver our science and its applications to the public, particularly within 3-5 year time constraints and in tight budget years. We developed results-based accountability measures (RBA) and in that context our focus is earth science as applied to environmental and human health, hazards, and groundwater. We are now tying the RBAs to our Strategic Plan and developing specific annual goals and strategies to address how Vermont is better off due to our work and to illustrate our contributions to ANR. "Actionable research" and "timeliness" needs for policy makers are terms recurring in conversations.

Other items on our radar are Act 250 applications for both sand and gravel pits and rock quarries, re-design of the Environmental Conservation (includes the Geological Survey) web site, landslide hazard mapping, and planning for the ROVER (Rapid Observation of Vulnerability and Estimation of Risk) analyses of selected critical facilities in Vermont this summer. That work, conducted in coordination with NESEC and FEMA, is focused on an evaluation of buildings and their potential response to seismic events. NESEC hopes to employ ROVER at National Guard facilities, the DEMHS building in Waterbury, and are possibly the Vermont Statehouse. A trained group of volunteers, the FEMA Volunteer Corps, will conduct the facility evaluations.

Lastly, with Spring finally upon us we are planning for STATEMAP-funded surficial geology projects in Cabot and Monkton. Also, George Springston and I will collect more till samples for geochemical analyses and mineralogy (Pete Ryan and students) in the Montpelier one-degree sheet before the end of June. Jon Kim will be in the field focused on groundwater in fractured bedrock projects in conjunction with his powerhouse informal consortium of Keith Klepeis (UVM), Pete Ryan (Middlebury), and Ed Romanowicz (SUNY Plattsburgh).

Respectfully submitted,  
Marjorie Gale, Vermont State Geologist

---

**ADVANCEMENT OF SCIENCE COMMITTEE REPORT**

The committee did not receive any applications to the Vermont Geological Society Research Grant Program by the April 1<sup>st</sup> deadline. However, recent discussions by the VGS Executive Committee recommended that the spring deadline be extended to May 1<sup>st</sup> to better accommodate students, who have recently been selected for upcoming field projects, but are not “up to speed” enough yet to write a research grant. Because of the late notice of this extension, **I will accept research grant applications for the new May 1<sup>st</sup> deadline that are postmarked by Monday May 11<sup>th</sup>.** Send grant applications to Jon Kim, Vermont Geological Survey, 1 National Life Drive, Main 2, Montpelier, VT 05620-3902.

**REQUESTS** - 3 judges are needed for the VGS Student Meeting on Saturday April 18<sup>th</sup>. Last year, Craig Heindel, Larry Becker, and Peter Gale were judges so I would appreciate some other volunteers. Please contact me if you are willing to judge ([jon.kim@state.vt.us](mailto:jon.kim@state.vt.us)). Also, please let me know if you have an idea for the summer field trip.

Respectfully submitted,  
Jon Kim, Chair

**TREASURER’S REPORT**

**Finances:** The Society remains in good financial health. Since the last report we have not incurred expenses, but Spring Meeting expenses are pending. These will include cash prizes to the winner of the Doll Award and to the second and third place finishers, as well as upcoming expenses from the next round of Student Research Awards.

**Expenses:**

Dinner guests and member subsidy	\$1220.88
Speaker expenses	\$411.99
Gift expenses	\$427.82

**Balance:** Our balance as of April 1, 2015 is \$11,758, with most of 2015 dues having been received. To date for 2015, we have received \$1,648 in dues and \$1,112 in gifts toward the Research fund.

**New Member:**

Chris Koteas, Department of Earth and Environmental Sciences, Norwich University

Respectfully submitted,  
David S. Westerman, Treasurer

---

### 2015 SPRING MEETING PROGRAM

**8:30 AM COFFEE & REFRESHMENTS**

9:00 AM RILEY EBEL: Colloidal sediment in the Uinta Range, Utah

9:15 AM BRENT NIXON: A study of salinization dynamics on a ranch in eastern Montana: characterizing the source, production and transport of dissolved sodium and sulfate in surface water in three first-order catchments

9:30 AM JENNIFER BOWER: Impacts of competitive sorption processes on Pb bioavailability in urban soils

9:45 AM NICHOLAS BACHMAN: Origin and speciation of uranium in the Clarendon Springs Formation, Milton and Colchester, Vermont

10:00 AM CYNTHIA CONNARD: U-Pb dating of detrital zircons in the Cram Hill and Umbrella Hill formations, Vermont

10:15 AM SAM LAGOR: The relationship between magmatism, deformation and metamorphism during the Acadian Orogeny: evidence for syntectonic intrusion of the Knox Mountain Pluton in the Connecticut Valley-Gaspé Trough, Central Vermont

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

11:00 AM LOGAN MILLER: Stratigraphy, structure and volcanic rock geochemistry in the Little Jarvis area of the Palmer Property, southeast Alaska

11:15 AM ABRA ATWOOD: Cosmogenic <sup>3</sup>He paleo-seismology of an active normal fault, northern California

11:30 AM CHRISTINA STRATHEARN: Detailed analysis of structures in the foot wall of the Champlain Thrust at Lone Rock Point, Burlington, Vermont

11:45 PM PIPER ROSALES: Analysis of multiple slumps in Lake Champlain, Vermont from Juniper Island to Quaker Smith Point

12:00 PM ELLEN TAYLOR: Palynological analysis of a Champlain Sea peat layer, St. Albans Bay, Vermont

**12:15 PM JUDGING, REFRESHMENTS & AWARDS CEREMONY**

---

---

**2015 ABSTRACTS****COLLOIDAL SEDIMENT IN THE UINTA RANGE, UTAH**

Riley Ebel and Jeff Munroe, Middlebury College

Weathering of earth materials in high alpine environments is usually considered a slow process because rates of chemical reactions are known to be inhibited by low temperatures. However, physical weathering driven by freeze/thaw oscillations is efficient at reducing rock to fine sediment, and most chemical weathering processes continue to operate as long as liquid water is present. Thus at high elevations above the reach of alpine glaciers the combination of physical and chemical weathering could be expected to produce pedogenic minerals over long time periods. The Uinta Mountains of northeastern Utah provide a setting in which this prediction can be tested. Alpine uplands of the Uintas were not directly impacted by glacial ice during the Pleistocene, and soils in these landscape positions presumably began forming long before the current interglaciation. Previous studies have noted that clay minerals and colloidal (submicron) material are abundant in these soils. Other work has documented the presence of abundant colloidal material in sediment cores from lakes in landscape positions below the unglaciated alpine uplands. This project was designed to test the inter-related theories that a) the submicron material in the soils is pedogenic, reflecting long-term weathering during the Quaternary, and b) the submicron material in the lakes was derived from the alpine soils by erosion. Linking the colloidal sediments identified in alpine soils with those in lacustrine records may provide valuable information about chemical and physical weathering in alpine settings, as well as the source and fate of alpine sediment on both short and long term scales. Submicron material was isolated from previously collected soil and lake sediment samples through centrifuging. Results of XRD analyses indicate that the submicron material is predominantly composed of clay minerals. Lake sediment samples are strikingly monomineralic, containing only illite, whereas alpine soil samples contain both illite and smectite in varying amounts; some soils contain solely illite, some contain solely smectite, and some are a mixture. Illite-rich soils are more abundant in the eastern Uintas, with smectite-rich samples dominant to the west. SEM analysis demonstrates the presence of platy crystals, in some cases with wavy or curled edges, that are consistent with a pedogenic origin. Variation in K from 0.3 to 0.7 atoms per unit cell reflects smectite and illite end-members. Ubiquitous presence of secondary minerals in upland soils supports the theory of active pedogenesis in the uplands; in addition, similarities between lake and soil illites support the initial hypothesis that there is likely a connection between lake and soil material via erosion. Geochemical results from ICP-MS will be used to evaluate the similarity between the submicron material from the soils and lakes using ratios of immobile trace elements and rare earth element abundances.

**A STUDY OF SALINIZATION DYNAMICS ON A RANCH IN EASTERN MONTANA:  
CHARACTERIZING THE SOURCE, PRODUCTION AND TRANSPORT OF  
DISSOLVED SODIUM AND SULFATE IN SURFACE WATER IN THREE FIRST-**

---

---

**ORDER CATCHMENTS**

Brent Nixon, Middlebury College

Salinization in the Northern Great Plains (NGP) of North America has been studied both in the context of saline seeps in cultivated farmland and in high solute content in rivers. The study area, three first-order catchments on a ranch in a semi-arid, sparsely vegetated prairie landscape in eastern Montana, is underlain by gently dipping marine and non-marine Cretaceous and Tertiary sedimentary rocks, including black marine shales, sandstone, and coal/lignite. The locally derived surficial sediment incised by ephemeral streams fed by seasonal precipitation.

To test the hypothesis that Cretaceous marine shales are the source of sulfur and sodium in dissolved reservoir water, the geochemistry of water and non-water materials was studied. In general, the objective was to determine the original geologic source and production/transport dynamics of sulfur and sodium within these catchments.

Within three different catchments on a 160 km<sup>2</sup> ranch, three reservoirs with high, medium, and low salinity were the main study sites. Samples of overland storm flow were taken once, and reservoir water samples were taken twice, once when the reservoir was freshly filled with spring runoff and then two months later after significant evaporation and seepage loss. Non-water samples were bedrock, alluvium, and evaporite deposits from reservoir margins. Detailed geochemistry of all samples was determined using ICP-MS and XRD.

ICP shows reservoir waters to have very high levels of sulfate (1050 – 6900 mg/L) and sodium (400 – 2900 mg/L) and elevated concentrations of trace elements such as arsenic, strontium and uranium. ICP reveals a near one-to-one positive correlation of sodium with sulfate in shales, alluvium, coal, and evaporites in these watersheds. XRD indicates presence of thenardite (NaSO<sub>4</sub>), smectite, calcite, pyrite, chlorite, illite, quartz, and feldspar. Together with the high levels of sulfate and sodium, the presence of calcite, smectite, and pyrite suggests a geochemical model of production and release of sulfate and sodium from rock and sediment to shallow groundwater and surface water. In this model, calcite weathering produces calcium ions, which exchange with sodium ions adsorbed to smectite, releasing Na into solution. Oxidation of pyrite produces sulfate ions, which go into solution. This mechanism appears to be responsible for the dominance of sodium sulfate waters and thenardite in reservoir evaporite deposits.

**IMPACTS OF COMPETITIVE SORPTION PROCESSES ON Pb BIOAVAILABILITY  
IN URBAN SOILS**

Jennifer Bower, Chandler Noyes, and Nicolas Perdrial, University of Vermont

The presence of contaminant metals in soils is a worldwide and widespread issue of concern, but in-situ remediation efforts are often hindered by the complexity and heterogeneity of soil systems. Through multiscale analysis of column experiments, this project aims to model

---

competitive sorption dynamics, using Pb as an element of concern, with the goal of constructing a quantitative, predictive tool for soil competitive sorption to be applied toward soil remediation. Representative soil samples containing as much as 12,000 mg kg<sup>-1</sup> Pb were sourced from a Burlington, VT site contaminated with legacy Pb from exterior paint. A series of column experiments is then conducted, testing the mobility of Pb as a function of the pH of rainwater, before beginning column experiments investigating multiscale expressions of competitive processes influencing Pb speciation and bioavailability. Next, amendments of goethite (FeO[OH]) and PO<sub>4</sub> in specific ratios are added to soil columns and leached with synthesized rainwater in order to examine the speciation and bioavailability of Pb using molecular, micro- and macro-scale tools (XAS, XRD, SEM, XRF and elemental analysis). Coupling the experimental evaluation of Pb bioavailability as a function of the presence of competitive sorbents with numerical prediction of sorption behavior using the reactive transport model CRUNCHFLOW will contribute to the development of a quantitative, predictive tool relevant to the remediation of Pb-affected systems. Eventually, the goal of this research is to help generate sustainable Pb remediation techniques that are effective in a diversity of soil types.

### **ORIGIN AND SPECIATION OF URANIUM IN THE CLARENDON SPRINGS FORMATION, MILTON AND COLCHESTER, VERMONT**

Nick Bachman<sup>1</sup>, Peter Ryan<sup>1</sup>, and Jonathan Kim<sup>2</sup>

<sup>1</sup>Middlebury College, <sup>2</sup>Vermont Geological Survey

The purpose of this thesis is to (1) determine the origins and diagenetic history of the phosphoritic material within the Clarendon Springs Formation, (2) model the uptake and fixation of uranium within Clarendon Springs Formation with specific focus on the phosphoritic horizons, and (3) identify the hydrological and mineralogical weathering processes causing the uranium to mobilize into groundwater. The background and impetus for this study are that groundwater produced from the Clarendon Springs Formation in Milton and Colchester is known to contain elevated uranium and alpha radiation. Radioactivity is high enough that the average alpha radiation from 131 domestic bedrock wells tested in a 12 km<sup>2</sup> area is 32 picocuries per liter (pCi/L) and 22 % of these wells produce concentrations of alpha radiation above the EPA's maximum contaminant level (MCL) of 15 pCi/L. Furthermore, the three most contaminated wells, which occur within a kilometer of each other, average 841 pCi/L, and the bedrock of this sub-area is the focus of this study.

Dark grey to black phosphorites are sporadically distributed throughout the region that contains elevated radionuclides in well water. Phosphorite-rich beds are interbedded with massive dolostone beds that lack phosphorite. The phosphatic material typically occurs as subangular, pebble-sized clasts in a dolostone matrix, and wispy beds of dark grey phosphorite (possibly "hardground") are also observed. These textures are consistent with a syndepositional origin of the phosphorite. Rock samples collected from outcrops up-dip of the most highly contaminated

wells were categorized based on structure and composition and analyzed for mineralogical and chemical content using ICP-MS, XRD and SEM-EDS. ICP-MS analysis shows that the phosphorites contain 80-210 mg/kg uranium while the dolostone matrix contains less than 10 mg/kg U. XRD indicates that the phosphorite mineral is fluoroapatite. SEM-EDS element maps show that phosphorite clasts and layers lacking significant post-depositional deformation contain the highest levels of uranium; U appears to occur diffusely in cryptocrystalline fluoroapatite, but perhaps more importantly, U is concentrated in microcrystalline pyrite (with associated Fe-hydroxide) scattered throughout the phosphorite. This may suggest that uranium was substituted into Ca sites in fluoroapatite upon crystallization on the seafloor (consistent with literature reports), but also that U was also incorporated into sulfides during very early diagenesis or during recrystallization associated with dolomitization. The role of pyrite as uranium host is significant because it weathers much more rapidly than apatite, and this may be an important factor controlling the high amounts of U and alpha radiation in well water.

**THE RELATIONSHIP BETWEEN MAGMATISM, DEFORMATION AND  
METAMORPHISM DURING THE ACADIAN OROGENY: EVIDENCE FOR  
SYNTECTONIC INTRUSION OF THE KNOX MOUNTAIN PLUTON IN THE  
CONNECTICUT VALLEY-GASPÉ TROUGH, CENTRAL VERMONT**

Sam Lagor and Laura Webb, University of Vermont

The Silurian–Devonian metasedimentary rocks of the Connecticut Valley-Gaspé trough (CVGT) were subjected to multiple fabric-forming deformational and metamorphic events throughout the course of the Acadian orogeny. Plutons intruding the metasediments have been considered post-tectonic, but microstructural studies of the intrusions and their metamorphic aureoles indicate some of these plutons have intruded syntectonically. This study investigates the relationship between Acadian deformation and intrusion of the Knox Mountain pluton (KMP) of central Vermont via an integrated structural and geochronological study along a transect across rocks of the CVGT. The transect begins at the western limit of the CVGT at a faulted unconformity, the Richardson Memorial Contact, and passes into the margin of the KMP in the east. Our observations confirm previous findings of three documented Acadian foliations (S1-S3) in the CVGT, where S1 fabrics typically dominate and closely parallel original bedding, S2 is a crenulation cleavage, and S3 is only locally apparent. However, we have also identified localities where S2 is associated with compositional banding in outcrop, S3 defines a strong crenulation cleavage, and S1 is preserved only in S2 microlithons. Field and microstructural observations indicate that the KMP intruded syntectonically. Evidence includes folded and boudinaged granitic dikes at the margin of the KMP, and microstructures such as flame perthite, myrmekite, deformation twins, and textures associated with grain-boundary migration recrystallization in the granite. In the metamorphic aureole, biotite porphyroblasts overgrew S1 and were deformed during S2 crenulation cleavage development. Pluton crystallization has been dated at  $371 \pm 4$  Ma using U-Th-total Pb dating of monazite, an age concordant with the published age of the nearby

Barre Granite. The timing of S2 fabric development in the CVGT is constrained by  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronology at ~365 Ma, consistent with microstructural evidence that suggests the KMP intruded just prior to S2 development. Plateau and weighted mean ages from across the transect, as well as minimum ages from argon loss profiles, show a general trend of younging towards the east, suggesting these rocks have been affected by Alleghanian and Mesozoic deformation and exhumation.

### **U-PB DATING OF DETRITAL ZIRCONS IN THE CRAM HILL AND UMBRELLA HILL FORMATIONS, VERMONT**

Cynthia Connard and Ray Coish, Middlebury College

The tectonic history of the Vermont Appalachians can be further understood with the aid of geochronological data from detrital zircons. The Rowe-Hawley Belt in central Vermont is a critical tectonic zone because it contains a major suture formed during closure of the Early Paleozoic Iapetan Ocean. The Hawley slices within this belt in Vermont include the Moretown and Cram Hill formations. These formations have been interpreted as metamorphosed fore-arc sediments of a late Cambrian - early Ordovician volcanic arc (the Shelburne Falls Arc) in the Iapetan Ocean. Recent data have identified the provenance of metasediments within the Moretown Formation as Gondwanan, contrary to previous work which suggested a peri-Laurentian source. To follow up on this work, the current study focuses on the Cram Hill Formation, which lies immediately above the Moretown and just below Silurian-aged rocks. In particular, we use detrital zircon ages to provide new information on the provenance of the Cram Hill metasediments by comparing those ages to known age signatures of possible source regions. Zircons from samples of the Cram Hill near Montpelier and Craftsbury, Vermont have been separated and analyzed on the LA-ICP-MS at Rensselaer Polytechnic Institute. Preliminary results show a prominent age peak at ~600Ma, which suggests a Gondwanan zircon source, and several less prominent peaks around 1,000-1,200 Ma, which imply a Laurentian zircon source. Another peak at 1,500-1,600 Ma is of uncertain origin. These data suggest that there were several available sources, consistent with deposition of the Cram Hill sediments as western parts of the Iapetan basin closed. A sample of the Umbrella Hill Formation near Craftsbury was also analyzed to give the first-ever detrital zircon ages for this unit. Results for this sample show prominent peaks at ~460-500 Ma, which suggests an Ordovician arc source. All results are used to further refine our understanding of the northeast Appalachian orogenic model.

### **STRATIGRAPHY, STRUCTURE AND VOLCANIC ROCK GEOCHEMISTRY IN THE LITTLE JARVIS AREA OF THE PALMER PROPERTY, SOUTHEAST ALASKA**

Logan Miller, Middlebury College

The Little Jarvis area of the Palmer property is located approximately 55 kilometers northwest of Haines, Alaska and is host to several distinct occurrences of volcanogenic massive sulfide

mineralization. The approximately 1.5 km<sup>2</sup> study area is within the Alexander Terrane which contains accreted, arc-related rocks of Precambrian to Triassic age. This relatively unstudied field area is separated from more extensively explored and locally mineralized portions of the property by what has been interpreted to be a large east-west striking, north-dipping normal fault (LJ fault).

Detailed bedrock mapping of the field area has resulted in the delineation of the following lithologic units (described from north to south): (1) a thick sequence of deformed calcareous argillite, (2) mafic lapilli tuff interbedded with argillites and deformed basalt, (3) massive to fragmental, strongly foliated basalt, (4) a thick deformed sequence of amygdaloidal pillow basalt, intercalated with thin beds of argillite, tuff, and limestone, and (5) a generally undeformed gabbro that intrudes and thus post-dates movement on the LJ fault. Numerous thin dykes and sills ranging from mafic to felsic in composition are found throughout the study area.

The units in the Little Jarvis area have been subjected to both ductile and brittle deformation, and metamorphism to greenschist facies conditions. Deformation in the area north of the LJ fault is characterized by a sequence of gentle to open, upright folds with wavelengths of several hundred meters, as well as numerous small-scale north-west dipping normal faults. Foliation in the stratified rocks is variable depending on rock type, but locally well-developed.

Whole rock geochemical analyses of basalts in the study area reveal relatively consistent sub-alkaline compositions. Trace element analyses show primarily MORB-type signatures, confirming previous work that suggests a back-arc rift tectonic environment. Although it is difficult to directly correlate stratigraphic units from the field area with previously studied units south of the LJ fault, this work does not preclude correlations. The characterization of stratigraphy and structure in the field area provides a valuable contribution to the development of a regional model that will guide future economic mineral exploration in the area.

### **COSMOGENIC <sup>3</sup>HE PALEO-SEISMOLOGY OF AN ACTIVE NORMAL FAULT, NORTHERN CALIFORNIA**

Abra Atwood and William Amidon, Middlebury College

Over 100,000 earthquakes are felt each year around the world, 100 of which can cause significant damage to people; the human and financial cost of earthquakes underscores the need for improved understanding of how earthquakes on normal fault systems work. The Hat Creek Fault in northern California is a world class example of a segmented normal fault that cuts through a 24 ka basalt with an estimated slip rate of 2.2-3.6 mm/yr (Blakeslee and Kattenhorn, 2012). It is part of a system of normal faults that threatens local infrastructure, including a hydroelectric dam on the Pit River. Very little is known about its seismic hazard, although estimates based on the characteristic earthquake model have predicted a ~Mw 6.7 event with a

recurrence interval of ~700 years (Blakeslee and Kattenhorn, 2012). A better understanding of its paleo-seismic history will inform regional seismic hazard models, while also providing a test of common assumptions used when applying the characteristic earthquake model to normal faults. One major assumption is that a fault will rupture at a consistent magnitude and recurrence interval over time. Another assumption, used by previous seismic analyses, is that all sections rupture in tandem, which would lead to over-estimates of earthquake magnitude. This study develops a paleo-seismic history by using cosmogenic  $^3\text{He}$  in pyroxene and olivine to date exposure ages of co-seismically toppled blocks and corresponding scarp faces to determine the timing of major seismic events. Three of the eight fault sections were sampled in this study to assess whether the sections rupture in tandem or separately. Preliminary results suggest that different segments may have ruptured in distinct events, an emerging chronology that will be clarified by forthcoming results.

**DETAILED ANALYSIS OF STRUCTURES IN THE FOOT WALL OF THE  
CHAMPLAIN THRUST AT LONE ROCK POINT, BURLINGTON, VERMONT**

Christina Strathearn<sup>1</sup>, Keith Klepeis<sup>1</sup>, Jon Kim<sup>2</sup>, Anne Gombosi<sup>1</sup>, Max Longworthy<sup>1</sup>, Eleanor Johnson<sup>1</sup>, and Ben Schachner<sup>1</sup>,

<sup>1</sup> University of Vermont, <sup>2</sup> Vermont Geological Survey

Between Burlington, VT and the Quebec border, the Champlain Thrust (CT) juxtaposed massive dolostones of the Cambrian Dunham Fm (hanging wall) with calcareous shales of the Ordovician Iberville Fm (foot wall), during the Ordovician Taconian Orogeny. After this orogeny, the CT was deformed by open folds of possible Devonian (Acadian) age. In southern Quebec, the CT maps continuously into the Rosenberg Thrust/ Logan's Line. South of Burlington, the CT cuts up section into red quartzites of the Cambrian Monkton Fm via a presumed lateral ramp, and continues into New York. Published estimates of displacement along the CT range from 60-100 km.

Although the CT has been studied previously at Lone Rock Point, the multiple generations of ductile (low, moderate, high strain) and brittle structure in shales of the footwall have never been systematically defined. We present the following relative chronology of structures:

- 1) Formation of bedding planes (S0), characterized by thin layers of carbonate within black shale.
- 2) Formation of rootless isoclinal folds (F1) of brittle carbonate layers and the development of a spaced pressure solution cleavage (S1) that parallels the axial planes of the folds.
- 3) The S1 cleavage is deformed into asymmetric S-C shear bands that merge into parallelism with, and are cut by, intraformational thrusts. The thrusts form oblate, eye-shaped structures that are stacked on top of one another forming horse duplexes. A second cleavage (S2) defines a part of the S-C fabric and is intensified in thrust zones.

Calcite slickenlines on fault surfaces plunge to the SE and NW and slip directions fan up to 40 degrees with respect to one another.

4) Formation of sets of upright, north (F3) and east-striking (F4) folds of S2 warping the CT.

5) Formation of conjugate sets of normal faults that record top-down-to-the-north and -south kinematics.

6) Formation of the steeply-dipping fracture sets (N-S and E-W striking) that cut across competent lithologies.

Preliminary interpretations suggest that simple and pure shear components of deformation in the foot wall are partitioned into thrusts and SE-plunging isoclinal folds, respectively. Ongoing research seeks to correlate this relative structural chronology along strike.

### **ANALYSIS OF MULTIPLE SLUMPS IN LAKE CHAMPLAIN, VERMONT FROM JUNIPER ISLAND TO QUAKER SMITH POINT**

Piper Rosales, Patricia Manley, and Tom Manley, Middlebury College

Lake Champlain has three depositional layers that occurred as this body of water went from a proglacial lake to a saline oceanic extension and back to a freshwater lake. Marine debris flows are mass wasting events where the sediment is transported down slope and does not retain its original composition. Marine debris flows, when studied, have been known to give insight into the regions past natural disasters, temperature changes, and sediment distribution. Recent analysis has shown multiple debris flows as well as slumps east of the Four Brother's Islands and west of Juniper Island. This large cluster of debris flows in Lake Champlain is unusual because of their size and frequency. The size of the debris flow and location was deduced through seismic profiles gathered with the CHIRP sub-bottom profiler. Multibeam sonar generated a new bathymetric map allowing for location of failed scarps where the debris flows originated from. In addition three core samples of the three main debris flows in the study area were used to determine the sediment type and age of these debris flows. This thesis was focused on discovering the size and number of the debris flows, the direction and orientation of the debris flows, the different origins, and the time of failure. These processes help in the understanding of the layers of weakness in the region and give us a possible seismic history of the region.

### **PALYNOLOGICAL ANALYSIS OF A CHAMPLAIN SEA PEAT LAYER, ST. ALBANS BAY, VERMONT**

Ellen Taylor, Patricia Manley, and Tom Manley, Middlebury College

Palynology can provide information about past climates by revealing how vegetation changed over time. This thesis uses the pollen record from a St. Albans Bay, Lake Champlain, sediment core to study climate and vegetation succession approximately 8-9 kya. After the Laurentide Ice Sheet receded from Vermont 13.4 kya, the isostatically depressed land allowed the Atlantic

Ocean to flow into the Champlain Valley, creating the Champlain Sea. As the glacier's isostatic influence on the land receded into the past, the land rebounded, severing the Atlantic Ocean's connection to the Champlain Sea. Rain and river water freshened the Champlain Sea into modern-day Lake Champlain. This project seeks to understand how the vegetation and climate changed as the Champlain Sea transitioned into Lake Champlain. Core sediment samples were processed by a lab at the US Geological Survey, where the pollen was extracted and made into slides. At least 300 pollen grains (with a minimum of 100 non-pine grains) were counted per slide and identified to the lowest possible taxonomic level. Preliminary analysis indicates that St. Albans Bay may have become fresh much earlier than the rest of the lake, and that the early pine-dominated community became a hemlock-northern hardwood-dominated community, then returned to a pine dominated community.

## CALENDAR

### **Middlebury College, Geology Seminar Series**

**Date:** April 24, 2015

**Time:** 12:30 pm

**Location:** Room 417, Bicentennial Hall, Middlebury College, Middlebury, VT

**Information:** Rich Goldfarb of USGS will present a talk about tectonics and ore deposits. Title TBA.

### **78<sup>th</sup> Reunion of the Friends of the Pleistocene**

**Date:** June 5-7, 2015

**Location:** Dinosaur State Park, Rocky Hill, CT

**Host:** FOP, Geological Society of Connecticut, and the Connecticut Geological and Natural History Survey

**Information:** This year's fieldtrip is "Glacial Lake Hitchcock and the Champlain Sea" led by Janet Stone, Jack Ridge, Ralph Lewis and Mary DiGiacomo-Cohen.

For information visit the web site: <http://www2.newpaltz.edu/fop/>

### **2015 EarthScope National Meeting**

**Date:** June 14 - 17, 2015

**Location:** Stowe Mountain Lodge, Stowe, Vermont

**Information:** The main meeting program will have 5 themes as plenary sessions: Dynamics and evolution of the North American continent: crust, lithosphere, and deep mantle; From Groundwater to the Ionosphere; Active tectonics and modern earth processes of North America; Advances in understanding and forecasting hazards; and EarthScope innovations and looking into the future.

### **66<sup>th</sup> Highway Geology Symposium**

**Date:** September 14-17, 2015

**Location:** Sturbridge Host Hotel and Conference Center, Sturbridge, MA

**Host:** Massachusetts Dept of Transportation and the UMASS Amherst.

**Information:** There will be a half day TRB session titled "Geotechnical Risk Assessment and Performance Management" on Monday afternoon, September 14th. Technical sessions of the Symposium will start on Tuesday morning, September 15th.

More information is at: <http://www.highwaygeologysymposium.org/>

**2015 NGWA Conference on Groundwater in Fractured Rock**

**Date:** September 28-29, 2015

**Location:** Hilton Hotel, 60 Battery St., Burlington, Vermont

**Host:** National Ground Water Association

**Information:** Visit the web site: <http://info.ngwa.org/servicecenter/Meetings/Index.cfm>

**2015 Geological Society of America Annual Meeting & Exposition**

**Date:** November 1-4, 2015

**Location:** Baltimore, Maryland

**2016 Geological Society of America Annual Meeting & Exposition**

**Date:** September 25-28, 2016

**Location:** Denver, Colorado

**Host:** Geological Society of America

---

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
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*



QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

<b>SUMMER-FALL 2015</b>	<b>VOLUME 42</b>	<b>NUMBER 3-4</b>
-------------------------	------------------	-------------------

**TABLE OF CONTENTS**

**PRESIDENT’S LETTER.....2**  
**TREASURER’S REPORT .....3**  
**ADVANCEMENT OF SCIENCE REPORT.....3**  
**VERMONT STATE GEOLOGIST’S REPORT .....4**  
**ANNOUNCEMENTS .....5**  
**CALENDAR .....5**  
**EXECUTIVE COMMITTEE .....8**

**PRESIDENT’S LETTER**

This summer, my wife and I took the Lake Champlain ferry from Burlington to Port Kent, N.Y. to visit Ausable Chasm- a visit I had always planned to make during my 20 years in Vermont. The walking tour takes you along the chasm rim as well as down within and “the curse of the geologic mind” took over immediately, which seeks to explain everything in three-dimensions, rather than just admiring the beauty.

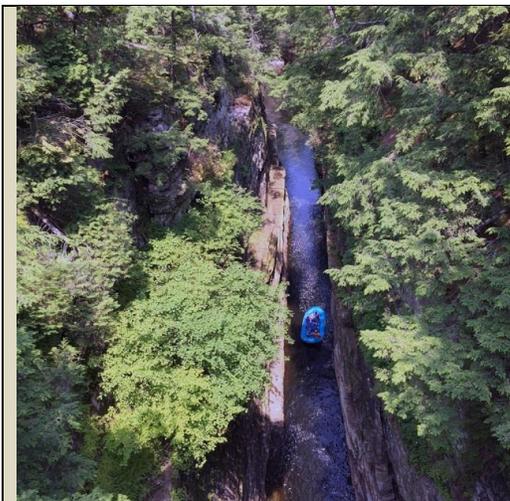


Ausable Falls from the rim trail.

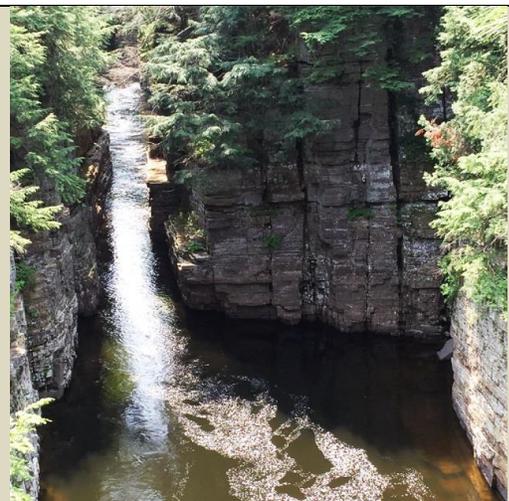


Right angle bend in the Ausable River as seen from the bridge.

The chasm itself is cut into the Late Cambrian Potsdam Formation, which is a light gray well-bedded quartzite. The downcutting (hundreds of feet) that produced the chasm, like that of



Raft following the dominant fracture set.



Wide river channel formed at the intersection of orthogonal fracture sets.

Niagara Falls, is actually post-Pleistocene. Within the chasm, the Ausable River channel follows a spectacular rectangular course that is controlled by two right-angle fracture sets. I left wondering if we have analogous fractures in Vermont.

The Vermont Geological Society fall field trip is entitled “Soil Genesis in Addison County - the soil profile in context” and will be led by Larry Becker and Caroline Alves on Saturday October 17<sup>th</sup>. Details will follow in a dedicated e-mail.

Respectfully submitted,  
Jon Kim, President

### TREASURER’S REPORT

**Finances:** The finances of the Society remain strong, still buoyed up by our major gift bequeathed to us from “Sandy” Partridge. Overall, however, our annual expenses remain approximately equal to our annual income.

**Expenses:**

Doll Awards (\$100, \$75, \$50)	\$225.00
Research Award	\$700.00

Jenny Bowers, UVM Graduate Student: *Impacts of Competitive Sorption Processes on Pb Bioavailability in Urban Soils*

**Balance:** Our balance as of July 1, 2015 is \$10,7786. An additional \$85 was received as dues, and \$100 as gifts to the research fund, bring our annual totals to \$1,733 and \$1,212, respectively.

**New Member:**

None

Respectfully submitted,  
David S. Westerman, Treasurer

### ADVANCEMENT OF SCIENCE COMMITTEE REPORT

Applications to the Vermont Geological Society Research Grant Program for the fall award period are due on October 1<sup>st</sup>. Applications should be sent to Jon Kim, Vermont Geological Survey, 1 National Life Drive, Main 2, Montpelier, Vermont 05620 and **post-marked no later than October 1<sup>st</sup>**.

Respectfully submitted,  
Jon Kim, Chair

## STATE GEOLOGIST'S REPORT

### AASG Annual Meeting

The Association of American State Geologists meeting was held in Flagstaff, AZ in June and was an opportunity to meet colleagues from across the country. There were sessions on groundwater, hydraulic fracturing, and survey sustainability, plus a trip to the Grand Canyon. Laurence Becker, retired State Geologist, was inducted as an Honorary Member of AASG.

### Staffing and Budget

Amid budget cuts and a staff reduction, Jon Kim and I are working to define where our work has the largest impact and to maintain or expand the valuable partnerships we have with the geologic community and the Society membership. We have some stellar student interns and dedicated partners at Norwich University, University of Vermont, Middlebury College, SUNY Plattsburgh, Green Mountain College, and the Vermont State Colleges. The Survey is focused on groundwater quality and supply, reducing public exposure to physical hazards and meeting our statutory obligations to provide sound and timely advice, educate the public and inform decision making.

### Groundwater

Jon Kim, in partnership with the Agency of Agriculture, is investigating an issue of nitrates in the Sutton public and private water supplies. Jon, Keith Klepeis, Ed Romanowitz, and Pete Ryan (aka the groundwater consortium) are involved in regional studies and prepared field trips for the New York State Geological Association and the National Groundwater Association fractured bedrock conference. The field trip guidebook article for fractured bedrock studies in the Champlain Valley is posted on our web site.

This September we received a USGS grant to review water use data collected by the State of Vermont, and to write a plan to upgrade the data to USGS tier one and improve the data distribution system.

### Hazards

Geologic hazards continue to be a focus of the Survey. George Springston (Norwich University partner) is conducting a landslide hazard mapping project for the Town of Highgate following the State Hazard Mitigation Plan protocols.

We are working with the Northeast States Emergency Consortium (NESEC) to complete a ROVER (rapid observation of vulnerability) assessment for some critical facilities in Vermont and combine the information with surficial materials to produce seismic hazard information for planning.

### Mapping

Mapping projects funded through STATEMAP during 2015-2016 are surficial geologic mapping by George Springston in the Cabot Quadrangle and by John Van Hoesen in the Town of

---

Monkton. Groundwater resource maps will also be produced for these areas. Monkton provided in-kind match through the water well location project, contacting landowners and working on GIS data.

### One More Note

I've recently given presentations at the Plymouth Historical Society, Craftsbury Church, National Guard, Northern Rivers Land Trust, and the Country Club of Vermont and more are on the schedule. The interest in geology shown by so many Vermonters is amazing and fun. In some cases, the audience even came prepared with geology songs ("Gonna take a sedimental journey, gonna turn the rock to sand..."). Can't beat that!

Respectfully submitted,  
Marjorie Gale, Vermont State Geologist

## ANNOUNCEMENTS

Save the date – October 17<sup>th</sup> is the Fall Field Trip. "Soil Genesis in Addison County - the soil profile in context" will be led by Larry Becker and Caroline Alves. Details TBA – watch for an e-mail closer to the date.

Thanks to Peter Gale for volunteering as the next Editor of the Green Mountain Geologist and Chair of the Publications Committee.

New open-file reports posted on the Vermont Geological Survey web site are:

Kim, J. and Springston, G., 2015, Report on Aquifer and Aquifer Recharge Mapping in the Town of Bristol, Vermont: Vermont Geological Survey Open File Report VG2015-1, scale 1:24,000.

Kim, J., Gale, M., Springston, G., Koteas, C., Defelice, C., and Saitta, N., 2015, Bedrock Geologic Map of the Southern Two-Thirds of the Woodbury Quadrangle, Vermont, Washington County, Vermont: Vermont Geological Survey Open File Report VG2015-2, scale 1:24,000.

Springston, George, Thomas, E., and Kim, J., 2015, Surficial Geologic Map of the Southern Two-Thirds of the Woodbury Quadrangle, Vermont, Washington County, Vermont: Vermont Geological Survey Open File Report VG2015-3, scale 1:24,000. Digital data (geodatabase) also posted.

## CALENDAR

**University of Vermont, Geology Seminar Series**

**Date:** Sept 14, 2015

---

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdril, 802-656-0665 or Julia.Perdril@uvm.edu

**Information:** Christopher Sinton, Department of Environmental Studies and Science, Ithaca College, NY: "Seamounts and Drowned Islands of the Galapagos Region"

### **66<sup>th</sup> Highway Geology Symposium**

**Date:** September 14-17, 2015

**Location:** Sturbridge Host Hotel and Conference Center, Sturbridge, MA

**Host:** Massachusetts Dept of Transportation and the UMASS Amherst.

**Information:** There will be a half day TRB session titled "Geotechnical Risk Assessment and Performance Management" on Monday afternoon, September 14th. Technical sessions of the Symposium will start on Tuesday morning, September 15th.

More information is at: <http://www.highwaygeologysymposium.org/>

### **University of Vermont, Geology Seminar Series**

**Date:** Sept 21, 2015

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdril, 802-656-0665 or Julia.Perdril@uvm.edu

**Information:** Aaron Thompson, Department of Crop and Soil Science, University of Georgia, GA: "Coupled iron-carbon dynamics across the Luquillo and Calhoun Critical Zone Observatories"

### **Middlebury College, Geology Lecture Series**

**Date:** Sept 25, 2015

**Time:** 12:30 pm

**Location:** Bicentennial Hall

**Information:** Katharine North, Chevron Corporation: "Contaminant hydrogeology from California to Kazakhstan"

### **2015 NGWA Conference on Groundwater in Fractured Rock**

**Date:** September 28-29, 2015

**Location:** Hilton Hotel, 60 Battery St., Burlington, Vermont

**Host:** National Ground Water Association

**Information:** Visit the web site: <http://info.ngwa.org/servicecenter/Meetings/Index.cfm>

### **2015 Vermont Geological Society Fall Field Trip**

**Date:** October 17, 2015

**Location:** Addison County, Vermont

**Information:** "Soil Genesis in Addison County - the soil profile in context" will be led by Larry Becker and Caroline Alves. Details TBA – watch for an e-mail closer to the date.

### **University of Vermont, Geology Seminar Series**

**Date:** October 26, 2015

---

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdrial, 802-656-0665 or Julia.Perdrial@uvm.edu

**Information:** Rachel Gabor, Department of Geology and Geophysics, University of Utah, UT:  
"From soil to surface water: using organic matter fluorescence and other tracers to identify catchment controls on stream water chemistry"

**2015 Geological Society of America Annual Meeting & Exposition**

**Date:** November 1-4, 2015

**Location:** Baltimore, Maryland

**University of Vermont, Geology Seminar Series**

**Date:** November 9, 2015

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdrial, 802-656-0665 or Julia.Perdrial@uvm.edu

**Information:** Jon Kim, Vermont Geological Survey, VT: "Recovery of a Fractured Bedrock Aquifer from Nitrate Contamination in the Central Vermont Appalachians"

**University of Vermont, Geology Seminar Series**

**Date:** November 16, 2015

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdrial, 802-656-0665 or Julia.Perdrial@uvm.edu

**Information:** Seth Kruckenberg, Department of Earth and Environmental Science, Boston College, MA: "Mantle heterogeneity, deformation, and controls on olivine crystallographic texture: a record from xenoliths in West Marie Byrd Land, Antarctica"

**University of Vermont, Geology Seminar Series**

**Date:** November 30, 2015

**Time:** 4:15 pm

**Location:** Delehanty Hall, Room 219

**Contact:** Julia Perdrial, 802-656-0665 or Julia.Perdrial@uvm.edu

**Information:** Michael Schindler, Department of Earth Science, Laurentian University, ON CA:  
"Confined pore spaces in mineral surface coatings: environmental processes recorded at the nanoscale"

**2016 Geological Society of America Annual Meeting & Exposition**

**Date:** September 25-28, 2016

**Location:** Denver, Colorado

**Host:** Geological Society of America

---

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@vermont.gov
Vice President	Keith Klepeis	(802) 656-0247	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@vermont.gov
Membership	David Westerman	westy@norwich.edu
Public Issues	Marjorie Gale	Marjorie.gale@vermont.gov
Publications	Marjorie Gale	marjorie.gale@vermont.gov

**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*