



QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

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

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PRESIDENT’S LETTER

As another field season winds down, I look back on lots of field time on the Bennington PFOA, Rutland Airport PFAS, Champlain Valley fracture, and Irasburg and Bristol nitrate projects. In addition, I led field trips for the New England Intercollegiate Geological Conference (NEIGC) and American Institute of Professional Geologists (AIPG).

Over the past 20 years, Alain Tremblay of the University of Quebec at Montreal and I have arranged multiple field trips to look at the bedrock geology of southern Quebec and Vermont with participants from the Vermont Geological Survey, University of Vermont, University of New Hampshire, and Norwich University. The purpose of these multi-day trips is to share work that has taken place since the previous trip.

This August, Norwich University, University of Vermont, and University of New Hampshire geologists joined Alain and I to look at the Thetford Mines and Lac Brompton ophiolites, Ascot Complex, St. Daniel Melange, and Connecticut Valley Gaspé Trough in southern Quebec (2 days) and then faults, folds, and fractures in the Champlain Valley near Burlington (2 days).



Alain Tremblay explains the geology of southern Quebec.



Chris Koteas admires an ultramafic clast breccia in St. Daniel Melange near Thetford Mines.



Folds in Ascot Complex metarhyolite (white) and amphibolite (black) near Sherbrooke



Alain in “The Oven”, Monkton Quartzite, North Ferrisburgh, Vermont.



TREASURER'S REPORT

Finances: The Society is in sound financial health. My apologies for falling behind on dues collection and processing. I will be back on track for 2020!

Membership Renewal 2019: Member dues renewals notices and research grant donation forms were sent out extremely late this year, but you should be receiving a notice later this week.

Expenses:

Spring Conference Expenses:	\$288.49
Renewal printing & mailing supplies:	\$110.00
Student Research Awards	
Miranda Max De-Beer	\$300.00
John Mark Brigham	\$200.00
Bryce Belanger	\$100.00
VGS Research Grants	
Kristin Schnalzer	\$1000.00
GMG Printing/Mailing	<u>\$108.98</u>
Total	\$2,107.47

Income: \$0.00

Balance: Our current balance as of September 30, 2019 is \$7,794.30. No new members joined the society since our last newsletter.

Respectfully submitted,
Carey Hengstenberg, Treasurer

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The AOSC received 2 applications by the October deadline and both are under review.

Applicant: George Valentine (Middlebury College undergraduate)
Title: Montane Groundwater Movement in a PFAS-Contaminated Aquifer
Amount Requested: \$1050.00

Applicant: Alexandra Cobb (Middlebury College undergraduate)
Title: Fate and Transport of PFAS in Groundwater in Clarendon, VT
Amount Requested: \$1050.00

Proposals for the 2020 summer and fall field trips are currently being sought.

STATE GEOLOGIST'S REPORT

This fall featured several regional and national meetings in Vermont. Our geologic community stepped up to give presentations, lead field trips and serve on planning committees for all of these events. Summer/fall also featured the release of new Open File Reports, initiation of new mapping projects, a landslide in Waterbury and a change in staff. With fall in full swing, our projects are well underway and we are looking forward to moving to office space with windows in December!

Meetings and presentations

The American Institute of Professional Geologists (AIPG) held its 56th national meeting in Burlington in September. Jon Kim and Keith Klepeis (UVM) led a field trip to favorite outcrops in the Champlain Valley on Sunday and presented a talk about aquifer characterization as the plenary session headliners on Monday. Marjorie Gale, keynote speaker, discussed landslides at Cotton Brook, Smugglers Notch and Lake Willoughby at the luncheon on Monday and followed that with a field trip from Charlotte to Appalachian Gap on Tuesday. Thanks to AIPG for bringing this national event to Vermont. Immediately following AIPG, the National Groundwater Association held a fractured bedrock conference in Burlington. Jon Kim served as a panelist to discuss components of conceptual site models, the importance of understanding the geologic framework and some of the less well-known data such as age dates which can contribute to better site models for regional projects.

Norwich University hosted the annual NEIGC in October. Many thanks to NU and to Chris Koteas for a successful weekend of field trips and comradery. Thanks also to all the members of our geologic community who led field trips in Vermont and New Hampshire.

I attended the Association of American State Geologists annual meeting in Butte, MT in June and co-chaired the plenary session on national groundwater issues. Nine states presented talks on groundwater contamination, groundwater flooding (flooding from below due to rising groundwater levels), karst and chemistry, recharge characterization, injection of saline wastewater, management of large datasets, groundwater modelling and policy. The session was informative for the states and for our federal partners. In addition, the New England states, having recently formed an informal consortium, held a break-out session with USGS to identify geologic mapping priorities. We voiced the necessity of applied maps and the usefulness of an overburden thickness map for the region. An overburden map would be

useful for: 1) Planning and cost estimates for major engineering and transportation projects, 2) Assigning the correct soil classification for site response during an earthquake, 3) Groundwater resources and hydrogeologic model development, 4) Assessing temporary subsurface stormwater storage, and 5) Assessment of landslide hazard is dependent on material thickness. A top-of-rock initiative has been added to the USGS NE workplan and will begin with a data inventory.

New publications

Kim, J., Young, P., and Peterson, N., 2019, Bedrock Zones in Vermont and Radon in Air Test Points and Statistics: Vermont Geological Survey Open File Report VG2019-2.

Springston, G., 2019, Surficial geology and hydrogeology of the Huntington 7.5 Minute Quadrangle, Vermont: Vermont Geological Survey Open File Report VG2019-3, scale 1:24,000, Report plus 1 plate.

Van Hoesen, J., 2019, Surficial geology and hydrogeology of the northern half of the Proctor 7.5 Minute Quadrangle, Vermont: Vermont Geological Survey Open File Report VG2019-4, scale 1:24,000, Report plus 9 plates.

Wright, S., 2019, Surficial geology and groundwater hydrology of the Richmond quadrangle, Vermont: Vermont Geological Survey Open File Report VG2019-1, scale 1:24,000, Report plus 5 plates.

Also, be sure to check the Vermont Open Data Portal for all our GIS data. GIS data for 1:24,000 scale quadrangle projects and for the statewide landslide inventory are posted at: <http://geodata.vermont.gov/>

New mapping and projects

Three projects are underway with funding through the USGS STATEMAP program, a program which has contributed nearly 1.8 million to mapping in Vermont during the past 25 years. Stephen Wright and students at UVM are mapping the surficial geology of the Stowe quadrangle. Stephen previously completed projects in Richmond and Bolton Mountain. His maps include the area of the recent landslide in Waterbury and of public water supply in Bolton. George Springston is mapping the surficial geology of the Groton quadrangle and editing and compiling existing data on the Northfield, Cabot and Joes Pond quadrangles.

Jon Kim is completing work in Bennington (PFOA in groundwater) and beginning work at the Rutland airport. David DeSimone is mapping surficial geology in the area as part of the aquifer characterization project. These projects are conducted with the Waste Management Division in DEC and our university partners at SUNY Plattsburgh, Middlebury and UVM. Julia Boyles, a new hire at the Survey, is continuing work on the Water Use grant and plans to complete updates of well locations for three remaining counties: Rutland, Addison and Orleans.

Landslide Hazards

Since past failures are indicators of future slope instability, our landslide inventory maps identify existing and relict landslides, including falls, topples, slides and flows. The maps, drawing heavily from Lidar, also incorporate river corridor assessment data for gullies and mass failures. Our statewide GIS database with 43 attributes is at <http://anrgeodata.vermont.gov/datasets/landslides>. Data is distributed as point data although companion maps at 1:24,000 show polygons. With four out of 14 counties completed, the inventory contains over 2000 points and spans all major physiographic regions of the state. The goal of the inventory is to provide guidance for hazard avoidance. The inventory was incorporated in the new USGS national landslide inventory.

In late May, a major landslide occurred on state lands at Cotton Brook in Waterbury, VT (Figures 1-4) and we were asked to assess the site since it included a popular mountain bike trail. Based on field visits, Lidar analysis and a preliminary analysis of drone imagery supplied by VTrans, the area of the landslide scar and the landslide deposit at the base were estimated at 12.0 acres and volume estimate is 200,000 cubic meters. The landslide deposit blocked Cotton Brook, leading to an impoundment upstream of approximately 1.8 acres. The slope, roughly 25° , is composed of fine-grained silt and sand which are lake bottom sediments deposited in Glacial Lake Winooski. A grooved and striated slide surface of very fine silt to clay was visible. The slide was active as of this report in early November. The landslide also resulted in massive sedimentation downstream to the mouth of the brook at Waterbury Reservoir. The resulting delta of sediment encompasses about 2.8 acres.

The area was mapped by Wright (2018) who documented two other landslide deposits upstream. At this time, we interpret factors for failure to include saturation of unconsolidated material above less permeable clay-silt layers, dipping beds which formed the slide surface, type of material (sand over clay), height (109 m), load balance, groundwater level, and steepness of slope.



Figure 1. Drone image of the 12-acre landslide at Cotton Brook, Waterbury, VT (image from VTRANS). Figure 2. 2.5 acre delta formed in the Waterbury Reservoir due to sediment from the landslide.



Figures 3,4. View downstream across toe deposit on 6/4 and 10/8.

Comings and goings

Colin Dowe left us in August to become a systems developer at the Agency of Digital Services. He's a few floors up, but we can still tap into his GIS expertise. Colin made significant progress on the Water

Use grant, database development of our surficial geologic maps and the Montpelier one-degree sheet compilation, and helped with our web site, 3D visualization projects and assorted geologic projects. In October, we welcomed Julia Boyles to the Survey. Julia received her BA from SUNY Plattsburgh in 2014 and is nearing completion of her MS from San Jose State. She dove right in and is working on the Water Use project as she acclimates to her new job. She will also work on the wide variety of surficial and bedrock projects, landslides, and digital data for the Vermont Geological Survey.

As we close out 2019, I want to extend my thanks to all of you who support our work and use the geologic maps and services we provide. Our annual STATEMAP meeting was held in October and we asked the STATEMAP Advisory Committee (SMAC) members to give examples and ideas for uses of our maps. We were pleasantly surprised and energized by the list which resulted from that simple question. Thanks to those members and to Eric Hanson who has served for several years as the SMAC Chair.

Happy Holidays to all and here's to good things in 2020!

Respectfully Submitted,
Marjorie Gale, Vermont State Geologist

SECRETARY'S REPORT

New England Intercollegiate Geological Conference 2019, hosted by Norwich University

A personal account and photographic record by Graham Bradley



Figure 1. Real geologists don't get distracted by fall foliage at Nichols Ledge, Cabot.

My introduction to high school geology began over three decades ago in northwest England, before I hopped across the Iapetus Ocean to Scotland for my college years. Having moved to Vermont in 2017, this year's New England Intercollegiate Geological Conference (NEIGC) hosted by Norwich University, provided me with the opportunity to get an overview of the complex geological history of my adopted home and place my prior knowledge of related contemporaneous geological events further north into context. In preparing this account I also discovered with a sense of synchronicity that the first NEIGC field trip in 1901 was led by William Morris Davis, famous for his notion of landscape youth, maturity, and old age. My own doctoral research was on landscape evolution in East Africa, where theories based on Davis's "geographic cycle" have only recently been replaced by the modern paradigm of tectonic geomorphology. Thanks to this year's organizer, Dr. Chris Koteas, the 2019 NEIGC meeting included 13 field trips, was well attended, had beautiful weather, and was a resounding success! While the field trips are generally aimed at a professional level, the NEIGC welcomes students, amateurs, and professionals alike. I found the trip leaders were happy to refresh my knowledge of the basics, as well as eager to explain their more recent research.

To get an overview of the geological history of central Vermont, I chose three field trips that encompassed a cross section from west to east, including: the Laurentian margin low-grade metasediments of the Champlain Valley; the rift-stage medium to high-grade metasediments of the Green Mountains, deformed by the Taconian arc-continent collision; the volcanic arc rocks, continental margin and oceanic metasediments of the Rowe-Hawley Belt, assembled in the suture zone of the Taconian Orogeny; the post-Taconic marginal basin Connecticut Valley metasediments, deformed by the Acadian Orogeny; and the late Acadian emplaced New Hampshire plutonic suite of east-central Vermont.

Friday October 11, 2019 - My journey of discovery began at the end, by examining the variation in styles of granitic plutons on the western margin of the New Hampshire plutonic suite. The trip leader, Chris Koteas, reviewed the types of intrusive mechanisms preserved along the interface between Cambro-Ordovician units of Taconic affinity to the west, and the Siluro-Devonian units of Acadian affinity to the east, on a north-to-south transect between Hardwick and Barre. Chemical and isotopic variation suggest different degrees of assimilation as well as the influences of regional stress and strain along the Taconic margin to create unique intrusive features. While whole rock geochemistry indicates the likely source of magma was partial melting of middle-crustal continental material, rapid emplacement resulted in only mechanical interaction with the country rock nearest the roof and walls of the magma chambers. Small volume magma pulses took advantage of local structural weaknesses and were emplaced as sills and dikes, while large magma pulses exploited the low-angle regional structures.



Figure 2. Les Kanat and Bob Wintsch examining xenoliths in the granodiorite at Mackville quarry, Hardwick.



Figure 3. Raiders of the Lost Sill – some outcrops were more difficult to access than others!

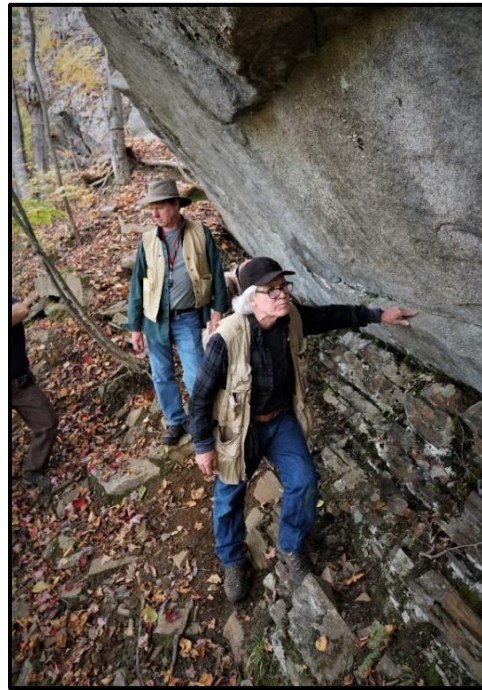


Figure 4. Examining the base of a granitic sill emplaced in concordance with the main foliation of the Waits River Formation at Buck Lake WMA

Saturday October 12, 2019 – My education continued to the west of the Green Mountains with a field trip to examine the tectonic history of the Champlain Valley Belt, led by Jon Kim, Keith Klepeis, Laura Web, and Will Amidon. The region can be divided into three lithotectonic slices which are, from structurally lowest to highest, and from west to east: a) the parautochthon (intermediate between *in situ* and displaced block); b) the hanging wall of the Champlain Thrust, and C) the hanging wall of the Hinesburg Thrust. All these slices were originally juxtaposed during the late Taconian Orogeny, but also experienced further deformation during the Acadian Orogeny, as well as during Cretaceous extension and magmatism, and even during lesser Neogene extension.

Perhaps the most spectacular outcrop of the weekend for me was the Hinesburg Thrust Fault at Mechanicsville. Here the overturned and mylonitic metapsammitic schists of the early Cambrian Cheshire Quartzite rest on the recrystallized dolomite and limestone of the Bascom Formation. I'm always fascinated to see bedding and cleavage together and the next stop at Vergennes Quarry did not disappoint. Here we observed Taconian structures in the middle-Ordovician limestone below the Champlain Thrust Fault, including low angle (4°) minor bedding parallel thrusts and more steeply dipping (65°) pressure solution cleavage.

Next, we were treated to a spectacular view of the Adirondacks across Lake Champlain at Shelburne Farms. On Charlotte Beach, the tan-colored Cretaceous syenite dikes with an unusual spherulite texture stood out against the dark gray middle to late Ordovician limestone and shale. At the north end of the beach beneath Saxton Point a series of folds and thrust faults in limestone and calcareous shale have created a sensational puzzle for structural geologists to interpret with the aid of high-resolution photogrammetry. The final two stops included observation of wrench faults in the hanging wall of the Champlaine Thrust at Shelburne boat access, and a hunt for pseudotachylyte in the Cambrian Cheshire Formation exposed in the hanging wall of the Arrowhead Thrust in Milton.



Figure 5. Jon Kim explaining the lithotectonic slices of the Champlaine Valley



Figure 6. Putting my finger on the Hinesburg Thrust Fault



Figure 7. Paul Karabinos in Vergennes Quarry, taking a close look at pressure solution cleavage



Figure 8. Folding and faulting in the foot wall of the Champlaine Thrust at Shelburne Farms

Sunday October 13, 2019 – I spent the final day east of the Green Mountains, once again with Chris Koteas, this time examining structural variability along the Taconic-Acadian margin. This interface often recorded as the Richardson Memorial Contact (RMC) has long been described as an unconformable surface. However, there is also evidence for faulting and has been called the Dog River Fault Zone in Northfield and Montpelier. Between Woodbury and Craftsbury an anastomosing set of upper-greenschist to lower-amphibolite grade shear zones has been recognized. These zones are sub-parallel to the RMC but appear to operate independently and may be a continuation of the Dog River Fault Zone. The high-strain zones and extensive elongation of minerals suggests significant shortening normal to the RMC. It appears that the Taconic-Acadian interface is a zone of structural weakness that succumbed to significant strain late in the Acadian orogenesis



Figure 9. Hunting for the RMC on the Taconic continental margin



Figure 10. Greg Walsh standing on a plunging fold in the post-Taconian Waits River Formation, east of the RMC

I was excited to discover that the RMC may directly underlie my desk at the DEC in Montpelier. My personal NEIGC field trip continued into my Monday morning commute when I took a side trip to successfully identify the Taconic-Acadian contact in the road cutting on the north side of 189, south of the National Life offices. This year's conference left me hungry to learn and eager to encourage others to find out more about the geology of our state through the Vermont Geological Society. I look forward to meeting other members during future field trips.



Figure 11. Examining the Moretown Formation at an idyllic lunch spot west of the RMC

ANNOUNCEMENTS

Jon Kim (VGS President) and Keith Klepeis (VGS Vice President) will both be leaving their positions at the end of the year. As such, a committee on nominations will be formed to select a nominee(s) for each of the offices to be filled. VGS Members will then vote for the nominee(s). More information will follow. If you are interested in serving as an officer, please contact a member of the executive committee.

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

CALENDAR

2020 GSA Annual Meeting

Montreal, Quebec, Canada

25-28 October

2020 GSA Joint Section Meeting

55th Annual Geological Society of America Northeast Section Meeting

69th Annual Geological Society of America Southeast Section Meeting

Reston, Virginia

20-22 March 2020

AIPG 2020 National Conference

Sacramento, California

October 3-6 2020

EXECUTIVE COMMITTEE

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
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ADDRESS CHANGE?

Please send it to the Treasurer