THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

VGS Website: www.uvm.org/vtgeologicalsociety/

WINTER 2008	VOLUME 35	NUMBER 1

The Vermont Geological Society
Winter Meeting
March 1, 2008, 9:20 AM
Cabot Science Building, Room 085
Norwich University, Northfield, Vermont

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12:10PM	EXECUTIVE COMMITTEE MEETING

ABSTRACTS

CLIMATE IMPACTS, RESOURCE MANAGEMENT AND DECISION-MAKING: THE ROLE OF THE DEPARTMENT OF THE INTERIOR

ARMSTRONG, Thomas, R., Senior Advisor for Global Change Programs, U.S. Geological Survey, 104 National Center, Reston, VA 20192; tarmstrong@usgs.gov

The Nation's lands and waters provide many goods and services including ecological, economic, water, wildlife habitat, forage, open space and scenic beauty, resources and human habitation. The USGS Global Change Program focuses on providing critical science, monitoring and predictive modeling of information related to our changing climate and its effects. The science that results from this program helps policymakers, resource managers, and citizens make informed decisions about the management of the landscapes for which they have responsibility and on which they live.

In the next 10 years, the U.S. and other nations will need to make management and policy-level decisions and develop adaptation and mitigation strategies that anticipate the effects of a changing climate on the complex interdependencies between environmental processes and human affairs. Accurate, relevant scientific information will be essential for developing and validating adaptation and mitigation strategies. Current climate models and scenarios do not provide information at the spatial scales that most stakeholders require for effective resource or hazard management, and they do not provide information in ways that are accessible to the managers that need that information to effect sound decisions related to the resources to which they are entrusted.

USGS has begun development of an approach toward a better scientific understanding of the Nation's most sensitive lands, to link and truly integrate comprehensive information, geologic, biologic,

hydrologic, and geographic, across national, regional, and local contexts through time. To accomplish this, the USGS Global Change Program utilizes the well-established 1997 Committee on Environment and Natural Resources (CENR) conceptual framework for integrating monitoring and research. This framework combines data collection and analysis at three broad scales and methodologies—local, regional and national—to integrate across different temporal (extreme events to chronic conditions) and spatial scales.

Given the unique USGS capabilities in monitoring and research from broad-scale, orbital platforms down to detailed in-situ measurements, this approach provides an integrated scientific framework for essential scientific research, for climate-scenario testing, for the development, validation, and cost-effective modification of mitigation and adaptation strategies, and for the assessment of risk to communities. By determining the key processes controlling the effects of climate warming in multi-disciplinary studies of specific vulnerable landscapes and waters, assessing the complex interactive effect of climate warming and land use on ecosystem vulnerability, and modeling ways in which multiple stressors affect those inter-relationships, intensively-studied watersheds will provide foundation understanding needed to explicitly relate ecosystem dynamics to macro-indicators that can be monitored at large spatial scales. The primary benefit of this integrated cross-scale approach is that the results and outcomes are not only applicable to the intensively-studied watersheds themselves, but can also be applied to understand the effects of climate at the regional, national and even global scales.

LIFE AND TIMES OF THE HINESBURG THRUST IN WILLISTON, VERMONT: CONNECTIONS BETWEEN PALEOZOIC TECTONICS AND GROUNDWATER

KIM, Jonathan[1], GALE, Marjorie H.[1], DERMAN, Karen M.[2], and KLEPEIS, Keith A.[2], (1) Vermont Geological Survey, Waterbury, VT 05671; Jon.Kim@state.vt.us, Marjorie.Gale@state.vt.us; (2) Department of Geology, University of Vermont, Burlington, VT 05405; Karen.Derman@uvm.edu, Keith.Klepeis@uvm.edu

In 2007, the Vermont Geological Survey constructed a bedrock geologic map of the Town of Williston in order to address groundwater quantity and quality issues. The town is underlain by metamorphosed Late Proterozoic-Cambrian rift to drift stage clastic rocks of the Green Mountains on the east side that structurally overly Lower Cambrian–Middle Ordovician carbonate and clastic continental shelf sedimentary rocks of the Champlain Valley on the west side. These sections were juxtaposed by the west-directed Hinesburg Thrust (HT) during the Ordovician Taconian Orogeny. Recent logs for domestic groundwater wells demonstrate that this thrust can be penetrated at depths ranging from ~100-1000 feet depending on where the well is drilled relative to the thrust front; these wells frequently have high yields.

Rocks in the upper plate of the Hinesburg Thrust underwent four phases of ductile deformation. The dominant foliation (Sd) in these rocks is a NNE-trending gently east-dipping S1/S2 composite spaced cleavage formed by two generations of isoclinal folds. Asymmetric shear bands also locally define S2. Bedding is only preserved in S1 microlithons. Sd was deformed by NNE-trending, tight, asymmetric, gently plunging, and west-verging F3 folds with an axial planar crenulation/fracture cleavage. Whereas F3 folds can be identified conclusively in lower plate rocks, S1 and S2 cannot be consistently correlated across the HT boundary. Open F4 folds with steeply dipping E-W trending axial surfaces warp all earlier structures. Frequency-azimuth fracture plots show multiple statistical peaks with ~E-W trending fractures being dominant.

Pronounced linear topographic patterns observed on slope maps generated from LIDAR data are consistent with the orientations of ductile and brittle structures in the bedrock. Cross sections that were drawn across Williston and Hinesburg from well and structural data demonstrate that the HT surface is

irregular. Ongoing analysis seeks to correlate the HT subsurface morphology with elements of its complex structural history.

TERRAIN ANALYSIS USING LIDAR TOPOGRAPHIC DATA: A CASE HISTORY FROM WILLISTON, NORTHWEST VERMONT

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Surficial geologic mapping for the Vermont Geological Survey was greatly facilitated by the use of LIDAR (LIght Detection And Ranging), a form of airborne laser scanning. Williston, on the eastern side of the Champlain Valley, was an ideal test site due to the varied topography.

Lidar data obtained from the Vermont Mapping Program had already been processed to remove the effects of vegetation and buildings and was available as a grid of elevation points with 3.2 m spacing. Using ArcGIS™ software, an 8 m raster digital elevation model (DEM) was created and contour lines, percent slope map, profile curvature map, and shaded relief (SR) map were derived from it. Tests of slope maps derived from 4, 8, 16, and 32 m DEMs showed that the 16 and 32 m DEMs were inadequate for 1:24,000 mapping due to lack of detail.

The slope map dramatically reveals the fine texture of the landscape, with subtle changes in slope being shown through continuous shading from light to dark. By this means, many features having less than one meter of topographic relief are clearly shown. This allows field mappers to rapidly discern meander scrolls in the floodplains, lacustrine and fluvial terraces, gullies eroded into the terraces, till shadows, hummocky till, and many bedrock outcrops, whether in open or forested areas. Bedrock-controlled lineaments show up clearly. Wave-washed till slopes within the Upper and Lower Fort Ann stages of glacial Lake Vermont reveal subtle, contour-parallel “bathtub rings” that appear to represent down-stepping shorelines. The map is also effective for discerning contacts between surficial deposits, such as between a lacustrine terrace and a till slope.

The curvature map can also be a highly effective tool for revealing landforms. This map shows the rate of change of slope on a scale that runs from negative values (convex down) through neutral values (constant slopes) to positive values (convex up). Negative values accentuate bases of slopes while positive values reveal terrace edges and tops of features.

Although SR maps are widely used for portraying terrain, they are more cumbersome for detailed terrain analysis because multiple illumination directions are commonly needed. This is because the maps accentuate slopes facing away from the illumination source at the expense of illuminated slopes. SR maps were produced with illumination from azimuths 045°, 135°, 225°, and 315°. No one of these could show all of the features revealed by the slope map.

The slope and curvature maps can portray much of the subtle terrain texture that was formerly only available from stereoscopic interpretation of aerial photos. Combined with digital orthophotos and other high-resolution GIS information, they are highly effective tools for mapping surficial deposits and landforms.

THE SHATTUCK MOUNTAIN CHANNELS AND POTHOLES: EVIDENCE FOR HIGH-VELOCITY SUBGLACIAL STREAMFLOW IN THE NORTHERN GREEN MOUNTAINS, VERMONT

WRIGHT, Stephen F., Department of Geology, University of Vermont, Burlington, VT 05405; swright@uvm.edu

A system of deep bedrock channels, large-scale potholes, and fluvially scoured and fluted bedrock surfaces occurs across Shattuck Mountain in the Green Mountains of northern Vermont. These large-scale products of stream erosion are developed for ~4 km on either side of the drainage divide (320 m asl) between a northwest-flowing tributary to the Mississquoi River (The Branch) and a southeast-flowing tributary to the Lamoille River (Streeter Brook) in Waterville, Vermont. The pronounced bedrock erosional features are best developed at the drainage divide. The channel network across the top of the divide in places bifurcates as it cuts through schist and greenstone that is completely devoid of till. Potholes within the channels are 5 to 8 m in diameter and often extend up the entire ~15 m height of the deepest channels. Where the channels are shallow (1–2 m deep), the potholes are also 5 to 8 m in diameter. The channels appear structurally to be a product of coalesced potholes. A small ephemeral stream enters and drains southeast through a portion of the channel network, but otherwise the channels do not host any moving water.

The channel network is the product of high-velocity stream flow both up and over the drainage divide. It is unlikely that this channel network developed as an outlet to Glacial Lake Winooski, the large glacial lake that occupied the Winooski and Lamoille river valleys when ice in the Champlain valley blocked the outlets to these valleys. While the drainage divide where the channel network is developed lies below the local elevation of Glacial Lake Winooski (~330 m asl), reconstruction of the Laurentide ice sheet in the Champlain valley indicates that during the entire history of Lake Winooski, the ice sheet at the latitude of the channels was thick enough to flow across the drainage divide. Furthermore, the local NW to SE hydraulic gradient within the ice sheet would have prevented lake water from draining across the divide to the northwest.

A more likely explanation that accounts for the channel system and potholes developed on both sides of the drainage divide is that the channels developed in a subglacial (confined) drainage system similar to that responsible for the Labyrinth in Antarctica. The large scale of the potholes suggests that very high velocity water moved through this system, possibly during a single catastrophic drainage event possibly initiated by drainage of a supraglacial lake.

PRESIDENT'S LETTER

Hello all!

This is an exciting time to be a geologist. I can't think of another time in my life when Earth Science has been so steadily in the news. People all over the world are discussing "peak oil," ice core records, El Nino episodes, and even the K-T and Permo-Triassic extinction events. From every part of the media we hear about "global warming" and "climate change." I believe we geologists have an important role to play in helping politicians, lay people, and other scientists understand these environmental issues.

Although few of us here in Vermont are working on studies of the climate record over the past few hundred years, and I don't know any of us Vermonters who are involved in direct modeling of the future climate, the great majority of us have been deeply involved with studying some part or other of the Earth system, with all the attendant fragmentary records, multiple interpretations, and difficulties of discerning cause and effect. In brief, we are used to dealing with partial evidence and making the best of it.

It's all too common to hear someone say that the latest big hurricane (or snowstorm or drought or heat wave) is evidence of a long-term shift in the climate of the planet. That may, of course, be correct, but the systems are very complex and the search for cycles and chaotic patterns in the data is a long and difficult one. We probably really won't know if that hurricane was "caused by" global warming until many years later, if ever. That said, it's becoming increasingly clear that we do indeed live in a time of unprecedented climate shifts. We need to keep up to date on the wealth of new climate change research and help the public to interpret these studies so that good decisions can be made.

If you want to read a very concise summary of the state of our knowledge of climate change, I highly recommend the recent position statement on "Human Impacts on Climate" adopted by the American Geophysical Union Council (Eos, January 29, 2008, p. 41, and on the AGU website at *www.agu.org/sci_soc/policy/sci_pol.html*). I'll simply quote the first sentence and urge you all to take a look at the rest: "The Earth's climate is now clearly out of balance and is warming." That is a statement that merits our attention.

At the upcoming Winter Meeting we'll have the great opportunity to hear Thomas Armstrong from the USGS give us an update on climate change research at the Survey. See the program on page 2 in this issue for details. I hope you'll all make the effort to attend.

Sincerely,
George Springston, President

ANNUAL MEETING MINUTES & ELECTIONS

The meeting of the Executive Committee followed a successful Fall Meeting field trip led by Dave West of Middlebury College on Saturday, October 20, 2007. President Rick Dunn called the meeting to order and a total of six people were in attendance. The Treasurer's report was read and it was reported that the financial condition of the Society remains sound. The Advancement of Science Committee report was read and it was reported that three student research grants were recently funded totaling $1,190.00.

At the request of the Publications/Editorial Committee, the Executive Committee discussed the possibility of an entirely (or nearly entirely) electronic newsletter. The Executive Committee recognizes the greater cost and workload associated with printing and mailing hard copy versions of the *Green Mountain Geologist* (GMG). However, the Committee also respects the needs of libraries that still require hardcopies and the needs of members who do not have easy access to a computer. The Committee suggested that in future membership statements the "default choice" be that members receive the GMG electronically. In other words, in order to receive a hard copy of the GMG, members would have to specifically request it. It is hoped that by making the "default choice" the electronic receipt of the GMG, rather than the other way around, that this will further encourage members to go electronic. The Executive Committee does not want to lose membership over this issue.

The Committee briefly discussed plans for the Winter Meeting. The meeting will be held at Norwich University and a Saturday in late February or early March is currently being considered. The theme of "Holocene Climate Change" was reaffirmed and efforts are being made to secure a prominent keynote speaker for this meeting. The exact date of the meeting will be based on availability of facilities at Norwich and on the availability of possible keynote speakers. It was suggested that Saturday, March 8, 2008 be the latest possible date for the Winter Meeting in order to provide sufficient separation from the Northeast GSA meeting (late March) and the VGS Spring Meeting (late April).

It was reported that Jon Kim, the VGS Lecturer, has received numerous requests for presentations and currently has eight talks scheduled over the next several months. The Executive Committee commends Jon on his hard work and requests that he remain the VGS Lecturer until demand for his services diminishes.

Marjie Gale reported that Earth Science Week in Vermont was a huge success this year. The OMYA Quarry in Middlebury reported over 1,000 visitors for their Open House and they had nearly 100 volunteers help out. OMYA also sponsored the student poster contest again this year (including providing prizes). The North Branch Nature Center held a field trip and also provided opportunities for rock and mineral identification. The Vermont Geological Survey provided "Geologist in the Park" and several Vermont Geological Society members volunteered their services to various Earth Science Week activities around the state.

The Committee confirmed the unanimous election of the following VGS officers for the 2007-2008 year:

President	George Springston
Vice-President	John Van Hoesen
Secretary	Dave West
Treasurer	Steve Howe

The Committee then commended outgoing President Rick Dunn on his service to the Society over the past two years. The meeting was adjourned.

Respectfully Submitted,
Dave West, Secretary

TREASURER'S REPORT

The financial condition of the Society continues to be very strong. As of February 9, 2008, the Society's checking account balance was $6,070.87. As indicated in the Advancement of Science Committee report, three Research Grants totaling $1,190.00 were awarded during the latest round of review. I expect to be able to support the Research Grant Program at a similar level for the foreseeable future, given the relatively stable income derived from membership dues, additional research grant contributions, and publications sales. To my knowledge, there are no outstanding bills.

The following member has been approved for membership in the Society since the last report: John D. Thoren, Saint Albans, Vermont.

The 2008 membership renewal and directory information form was mailed to all members before December 31, 2007. The deadline for renewal was January 31, 2008. Many members have already returned their forms with their payments, including a number with additional contributions to the Research Grant Program, but there are still quite a few members who have not yet returned their forms. Please help the Society keep expenses to a minimum by renewing your membership promptly.

Despite the impending increase in postal service rates, I will recommend that dues remain at the same level as last year. I would like to express my appreciation to all of members who have chosen to receive the *Green Mountain Geologist* electronically as a .pdf file, so as to help keep the Society's publication

and mailing costs low, which will, in turn, allow us to keep membership in the VGS the bargain that it already is.

Respectfully submitted,
Stephen S. Howe, Treasurer

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The Committee has been busy with several projects since its last report, including reviewing applications to the Research Grant Program, upgrading the content on the Society's website, reprinting volume 6 of *Vermont Geology*, and soliciting abstracts for the Winter Meeting.

Three applications to the Research Grant Program were received by the October 1, 2007 deadline. The Committee was impressed with the quality and timeliness of these proposals and all three received at least partial financial support. The proposals were:

> "Ophiolite Sequences Associated with the Appalachian Orogeny: An Anomalous Graphite Deposit at Belvidere Mountain, Vermont" by Danielle Kerper, Harvard University.
>
> "The Geochemistry of Lamprophyre Dikes in Williston, Vermont" by Melissa Whitehead, Middlebury College.
>
> "Examining the Kinematics and Mechanics of Large Thrust Sheets in Northern Vermont and Southern Quebec" by Robert Zimmermann, University of Vermont.

All issues of the *Green Mountain Geologist* from 1994 through 2006 have been archived as .pdf files on the Society's website and we are in the process of scanning the remaining issues published during the twenty years following the Society's inception in 1974.

The upcoming Winter Meeting will have the theme "Holocene Climate Change." Thomas R. Armstrong, Senior Advisor for Global Change Programs at the U.S. Geological Survey, will be our keynote speaker.

Respectfully submitted,
Stephen S. Howe, Chair

VERMONT STATE GEOLOGIST'S REPORT

New Release Maps and Digital Data
The surficial materials digital data from a number of the Vermont Geological Survey open file reports (1992–present) have been packaged as a single file and may be downloaded directly from the Vermont Center for Geographic Information at *www.vcgi.org/dataware/*. The file contains only the materials data and people are still referred to the full open file reports for cross-sections, isopach maps, and more detailed unit descriptions. The Vermont Geological Survey produces surficial and bedrock geologic maps to address issues such as groundwater recharge potential, materials for infrastructure, radioactivity in groundwater and to mitigate rockfall and landslide hazard. The maps are available as paper copy open file reports and as images on the website. The digital data, however, were in a variety of formats and in various stages of completion/editing. The VGS, working with Erik Engstom (ANR GIS), edited the

existing files, wrote metadata, compiled the data into a single file and posted the digital materials data for 18 projects with VCGI on January 8th.

Maps recently released as open file reports and images recently posted at the Vermont Geological Survey website at *www.anr.state.vt.us/dec/geo/vgs.htm* include:

VG94-4 Westerman, D. S., 1994, Bedrock geology of the Northfield quadrangle, Vermont, 1 plate plus text, scale 1:24,000.

VG07-4 Kim, J., Gale, M., Thompson, P. J., and Derman, K., 2007, Bedrock geologic map of the town of Williston, Vermont, 1 color plate, scale 1:24,000.

VG07-5 Springston, G. and De Simone, D., 2007, Surficial geologic map of the town of Williston, Vermont, 1 color plate, scale 1:24,000.

Thanks to Marjorie Gale for pulling the digital data release and postings together for the Vermont Geological Survey.

Respectfully submitted,
Laurence R. Becker, State Geologist

CALL FOR STUDENT ABSTRACTS

SPRING MEETING OF THE VERMONT GEOLOGICAL SOCIETY
SATURDAY, APRIL 26, 2008

The Vermont Geological Society will hold its Spring 2008 Meeting in Bicentennial Hall at Middlebury College in Middlebury, Vermont. 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 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 attachment to an e-mail message sent to Kathleen Howe at khowe@uvm.edu

If electronic submission is not possible, please mail your abstract well in advance of the deadline to:

Kathleen D. Howe
University of Vermont
Office of Health Promotion Research
1 South Prospect Street, Room 4428A
Burlington, VT 05401

Oral presentations will be limited to 15 minutes with 5 additional minutes for questions. A computer projection system for PowerPoint presentations will be available as well as slide and overhead projectors.

Deadline for abstracts: Monday, April 7, 2008 at noon

For additional information regarding capabilities for presentations at the meeting, contact David West at (802) 443-3476 or dwest@middlebury.edu

ANNOUNCEMENTS

STUDENT RESEARCH GRANT APPLICATIONS DUE APRIL 1, 2008

Students and secondary school teachers are encouraged to apply to the VGS Research Grant Program by April 1, 2008. Downloadable Research Grant Program applications are available from the Society's website at *www.uvm.org/vtgeologicalsociety/*. For those without Internet access, forms may be obtained by writing to Stephen S. Howe at the Dept. of Earth and Atmospheric Sciences, University at Albany, ES-351, 1400 Washington Avenue, Albany, NY 12222-0001. Telephone: (518) 442-5053; e-mail: showe@albany.edu

NEWS FROM THE VERMONT GEOLOGICAL SURVEY

Marjorie Gale has sent along the following item:

Digital data for the 1961 Centennial Geologic Map of Vermont may be downloaded through the U.S. Geological Survey at *pubs.usgs.gov/of/2006/1272/#VT*.

Larry Becker has updated his contact information:

Laurence R. Becker
Vermont State Geologist and Director
Vermont Geological Survey/Division of Geology and Mineral Resources
Vermont Dept. of Environmental Conservation
103 South Main Street
Waterbury, VT 05671-2420
Phone: (802) 241-3496
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Website: www.anr.state.vt.us/dec/geo/vgs.htm

VERMONT GEOLOGICAL SOCIETY CALENDAR

April 1: Student Research Grant Program applications due

April 7: Student abstracts for Spring Meeting due

April 8: Executive Committee reports due

April 26: Spring Meeting, Bicentennial Hall, Middlebury College

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	George Springston	(802) 485-2734	gsprings@norwich.edu
Vice President	John Van Hoesen	(802) 287-8387	vanhoesenj@greenmtn.edu
Secretary	David West	(802) 443-3476	dwest@middlebury.edu
Treasurer	Stephen Howe	(518) 442-5053	showe@albany.edu

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Richard Dunn	(802) 485-2304	rdunn@norwich.edu
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Jon Kim	(802) 241-3469	jon.kim@state.vt.us

Chairs of the Permanent Committees

Advancement of Science	Stephen Howe
Geological Education	Christine Massey
Membership	Stephen Wright
Public Issues	Laurence Becker
Publications/Editorial	Stephen Howe

Vermont Geological Society
P.O. Box 1224
Saint Albans, VT 05478-1224

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

Vermont Geological Society
Winter Meeting
March 1, 2008, 9:20 AM
Cabot Science Building, Room 085
Norwich University, Northfield, Vermont

Directions to Norwich University:

Norwich University is located on Vermont Route 12, one mile south of the center of Northfield. It can be reached from I-89 by taking Exit 5 and following Vermont Route 64 west to Route 12, and then north to the University. The Geology Department is located in Cabot Science Building, the southeastern most brick building on campus, just west of Route 12. The entrance is near the northeast corner of the very large white Kreitzburg Library, which can't be missed. The easiest parking for the meeting will be in the commuter lot opposite the Science/Engineering complex on the east side of Route 12.