THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

WINTER 2003 VOLUME 30 NUMBER 1

The Vermont Geological Society's
Winter Meeting
February 8, 2003, 9:30 AM at Norwich University

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VERMONT GEOLOGICAL SOCIETY
Cabot Science Building, Room 085
Norwich University, Northfield, Vermont

February 8, 2003

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9:20 F. D. Larsen, R.K. Dunn and G. E. Springston: NEW CARBON-14 DATES FROM HOLOCENE LAKE AND STREAM DEPOSITS IN THE RANDOLPH, VERMONT, 7.5-MINUTE QUADRANGLE

9:40 George Springston: ANALYSIS OF CHANGES IN STREAM CHANNEL POSITION IN CENTRAL VERMONT USING DIGITAL ORTHOPHOTOGRAPHY AND HISTORIC MAPS

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11:20 G. J. Walsh & F. P. Lyford: STRUCTURAL CONTROLS ON GROUND WATER FLOW DIRECTIONS IN THREE HIGH-YIELD FRACTURED METAMORPHIC BEDROCK AQUIFERS OF MASSACHUSETTS

11:40 T.W. Grover: METAMORPHIC GEOLOGY OF THE POMFRET DOME AREA, VERMONT

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12:20 K. Klepeis & T. Rushmer: DIRECT OBSERVATION OF A FULL CRUSTAL COLUMN THROUGH AN ANCIENT MOUNTAIN BELT IN NEW ZEALAND: RELATIONSHIPS BETWEEN MAGMATISM AND DEFORMATION

12:40 LUNCH and VGS Executive Committee Meeting - All members are invited to attend.

ABSTRACTS

A PAIRED WATERSHED APPROACH TO TWO LARGE VERMONT WATERSHEDS

Lori Barg, Step by Step, 113 Bartlett Road, Plainfield, Vermont 05667

Although paired watershed analyses are usually conducted on smaller watersheds, the same approach has been undertaken on a grander scale. The analysis compared the 136-square-mile Third Branch of the White River watershed, flowing south from Roxbury to Bethel, to the adjacent 144-square-mile Mad River watershed, flowing north from Warren to Moretown. Both watersheds have similar drainage areas, have mainstems of approximately equal length, are located on the east side of the Green Mountains, and had valleys formerly occupied by glacial lakes - Winooski and Granville in the Mad River basin and Hitchcock in the Third Branch basin. The east side of the Mad River basin and the west side of the Third Branch are underlain by the Ottauquechee and Stowe formations. Both mainstems have been heavily mined for gravel in the past, and both have had extensive rip-rap along the mainstem. The Mad River has bedrock control at regular intervals along most of the length of the channel. This has limited incision and degradation, while the Third Branch has incised into the unconsolidated lacustrine and alluvial deposits along the mainstem. The varves from Glacial Lake Hitchcock can be as much as 1.5 meters in thickness, showing large annual sediment inputs into the Third Branch, while narrow laminated clays are typically found in the Mad. Other influences on the amount of sediment in the watershed include the amount of time the lake occupied the valley and the drainage history of the lake. Lakes that drained more rapidly carried more sediment out of the valley. The differences in surficial geology and bedrock

control have caused the mainstem and tributaries to respond differently to similar impacts from in-stream channel management and land use history. Basin features such as hydrology, flood frequency, precipitation, valley width, land use, flood plain access (for 2 year return flow) and presence of mass failures are compared and contrasted. This comparison is based on the preliminary results of fieldwork completed during 2001 and 2002 for the Vermont Geological Survey.

NEW CARBON-14 DATES FROM HOLOCENE LAKE AND STREAM DEPOSITS IN THE RANDOLPH, VERMONT, 7.5-MINUTE QUADRANGLE

Frederick D. Larsen, Richard K. Dunn and George E. Springston, Dept. of Geology, Norwich University, Northfield, VT 05663

Three new uncorrected carbon-14 dates obtained from wood samples collected in the Randolph quadrangle are (1) 330 $\pm$ 60 ^{14}C yrs BP, (2) 8910 $\pm$ 120 ^{14}C yrs BP, and (3) 9980 $\pm$ 130 ^{14}C yrs BP (Geochron samples GX 29694, GX 29693 and GX 29692).

(1) The 330 BP date was obtained from a log sticking 3.77m out of a bank cut in stream-terrace deposits and about 1.8m above the Third Branch. The site is 0.97km N84°W of the junction of Vermont Routes 12 and 12A. The base of the log is embedded in 2.8m of pebble-gravel point-bar deposits that are underlain by 0.5m of lake-bottom fine sand and overlain by 0.48m of overbank deposits and topsoil. The sampled log is one of 14 logs, all of which are exposed in a horizontal distance of 50m and are oriented to the northeast quadrant. The base of the channel deposits in which the 330 BP log is embedded is 0.5m above the surface of the Third Branch. The bottom of the modern channel is located an unknown depth below the present surface of the Third Branch making any estimate of the rate of downcutting difficult.

(2) The sample of wood dated 8910 BP is a small flattened log 18cm long with an elliptical cross section measuring 3.9cm by 2.7cm. The collection site is 2.0km, N18°E of the junction of Vermont Routes 12 and 12A. The sample was collected in organic-rich silt 2.2m above the surface of Ayers Brook and 80cm below a peat layer that has been dated at 8700 $\pm$ ^{14}C yrs BP (Larsen, F. D., 2002, Gr. Mtn. Geol. v.29, no.1, p.11). This gives an average sedimentation rate of 0.38cm/^{14}C year for the "ponded sediments of Ayers Brook valley".

(3) The collection site of the 9980 BP sample is in a small brook that drains east into Ayers Brook about 4.8km, N12°E of the junction of Vermont Routes 12 and 12A. The sample, a small log, was collected from 0.4m of very fine sand that is overlain by organic-rich sand with small wood fragments.

The 3 carbon-14 dates of 8700 BP, 8910 BP and 9980 BP, and related sediments, document the existence of an early Holocene Ayers Pond that was about 4.5km

long and 0.5km wide. The presence of *Liriodendron tulipifera*, tulip tree (L. Howard, pers. commun., 2001), in the Ayers Pond sediments indicates a climate warmer than present. Davis and others (1980) indicate a New England climate 2°C warmer than present at 9000 BP.

ANALYSIS OF CHANGES IN STREAM CHANNEL POSITION IN CENTRAL VERMONT USING DIGITAL ORTHOPHOTOGRAPHY AND HISTORIC MAPS

George Springston, Research Associate, Norwich University Department of Geology, 158 Harmon Drive, Northfield, VT 05663

Stream channel positions were analyzed at four locations in central Vermont: The Third Branch of the White River from Randolph to Bethel, the Mad River from Warren to Waitsfield, Great Brook in Plainfield and Orange, and the lower part of the Winooski River in Colchester and Burlington. Sources of stream location information included recent digital orthophotos and digital elevation models (DEMs) produced by the Vermont Mapping Program (VMP) of the Vermont Department of Taxes, older VMP orthophotos available as 1:5000 scale paper copies, custom digital orthophotos produced from older aerial photos, U.S. Geological Survey (USGS) topographic maps at scales ranging from 1:24000 to 1:62500, engineering plans, historic maps, on-site geomorphological evaluations, and eye-witness or anecdotal accounts. Some of these are already available in a georeferenced digital format and are ready for analysis using GIS techniques.

Custom digital orthophotos were produced from historic aerial photos (1939 to 1974) using ERDAS IMAGINE Orthobase7 photogrammetry software. Aerial photos were scanned at 800 dots per inch. Coordinates of ground control points were derived from the VMP digital orthophotos and digital elevation models. Camera calibration data was entered when available (it was determined that if there was sufficient ground control, successful solutions could be obtained even without camera calibration data). Once a sufficiently accurate photogrammetric solution had been achieved, USGS DEMs were used to produce fully rectified orthophotos.

The digital photogrammetric method is superior to older methods of aerial photo rectification such as the aerial sketchmaster, optical enlargers, the Zoom Transfer Scope, etc. because the older methods only rectify specific features that the analyst chooses to trace while the orthophoto can be produced at sufficient detail to show most of the detail in the original aerial photo. Standard GIS techniques can then be used to analyze a wide variety of stream corridor features such as land-use/land-cover, stream banks, landslides, sand and gravel bars, debris jams, etc. A further advantage is that this photogrammetric method allows for a quantitative assessment of the accuracy of the rectification.

These methods are best suited to streams of 3rd order or higher as the banks of the lower order streams are hard to detect on aerial photos if the terrain is wooded and/or steep. Also, the likely error in stream position for these small streams may be as great as or greater than the bankfull width of the stream itself, leading to greater uncertainty in interpretation.

This historical analysis of stream channel position can be used to make rough predictions of the direction and magnitude of future channel shifts if it can be shown that the conditions influencing the stream in the historical maps and images are still currently operating and can be expected to operate over the time of prediction. Thus the map analysis needs to be combined with on-the-ground assessment of the fluvial geomorphology of the stream reach in question. Predictions are further limited by the episodic and at times random nature of changes in stream channel position. Ongoing work in these watersheds will test the utility of this type of map analysis for predicting future channel positions.

HISTORICAL AND CURRENT HG DEPOSITION TO LAKES INFERRED FROM 210PB-DATED SEDIMENT CORES IN THE VT-NH REGION

Neil Kamman, VT Dept. of Environmental Conservation, 103 South Main, 10N, Waterbury VT 05671
D.R. Engstrom, Science Museum of MN

Mercury (Hg) contamination of aquatic systems is recognized to be a problem of global consequence, and in localized areas Hg bioaccumulates significantly, posing risks to piscivorous animals and humans who consume gamefish. In order to quantify historical and current Hg deposition to landscapes, we dated and performed Hg analyses on sediments cores from 14 lakes, at local and regional scales. On the regional scale, total Hg (HgT) fluxes to sediments ranged from 5 to 17 $ug \cdot m^{-2} \cdot yr^{-1}$ during pre-industrial times, and from 21 to 83 $ug \cdot m^{-2} \cdot yr^{-1}$ presently. Present-day HgT fluxes are between 2.1 to 6.9 times greater than pre-1850 fluxes. Current-day direct atmospheric Hg deposition to the study region was estimated at 21 $ug \cdot m^{-2} \cdot yr^{-1}$, which agrees well with measured HgT deposition, when re-evasion of Hg is accounted for. The regional data suggest that Hg fluxes to lake sediments have declined in recent decades, owing to reductions in atmospheric Hg deposition to the lake surfaces. On a small, localized subset of lakes occupying a forested, high-elevation landscape, baseline, peak, and present accumulations were higher than those estimated from the regional dataset, highlighting the role of watershed size and dissolved organic carbon export in mediating Hg delivery. Watershed export of atmospherically deposited Hg remains elevated relative to declines in present-day deposition rates, contributing to the impression that Hg retention by watershed soils has declined.

DETERMINING THE CAUSE OF ARSENIC CONTAMINATION IN THE GROUNDWATER OF ZIMAPAN, MEXICO

Helen Mango, Castleton State College, Castleton, VT

The groundwater of the village of Zimapan, state of Hidalgo, central Mexico, is contaminated with arsenic. Zimapan is a mining district, where base and precious metals, especially lead and zinc, have been extracted for over 400 years. Concentrations of arsenic as high as 1.01 milligrams/liter were initially detected in 1992; these concentrations are well above the Mexican drinking water guideline of 0.05 mg/L. This study analyzed water, soil, and rock, and determined that while part of the arsenic contamination is due to naturally-occurring arsenic-bearing minerals, the contamination is in some places greatly enhanced by mining and smelting activity. The study also devised a low-cost remediation technique.

URANIUM AND LEAD IN GROUND WATER PRODUCED FROM THE CLARENDON SPRINGS FORMATION IN THE CHAMPLAIN VALLEY

Peter Ryan, Geology Department, Middlebury College, Middlebury, VT 05753
Jon Kim, Vermont Geological Survey, Waterbury, Vermont 05671

Ground water derived from the late Cambrian-early Ordovician dolomitic Clarendon Springs Formation in Addison County contains uranium and lead in concentrations that exceed EPA maximum contaminant levels. Of ten wells analyzed by inductively coupled plasma-mass spectrometry (ICP-MS), one contained 40 ppb U, double the EPA MCL of 20 ppb, and all sites exceeded 1 ppb. Three of ten wells analyzed for Pb by ICP-MS contained from 200 to 600 ppb Pb, extremely high concentrations considering that the EPA MCL is 15 ppb. Analyses on 30 additional wells by ICP-atomic emission spectrometry (ICP-AES) indicate that approximately 50% of wells that produce water primarily from the Clarendon Springs Formation contain Pb in concentrations greater than the EPA MCL. Of 20 wells in this region that do not produce from the Clarendon Springs Formation, only one, at 26 ppb, contained Pb above the EPA MCL.

Field work indicates that elevated U and Pb may be related to brecciated zones rich in organic carbon. The heterogeneous distribution of these small (<20 m) pockets may explain the occurrence of widely varying U and Pb concentrations in wells separated only by 100s of meters. We are currently analyzing ground water compositions from additional wells in the Clarendon Springs Formation and also bedrock from brecciated and non-brecciated zones in the Clarendon Springs Formation to assess bedrock sources of U and Pb.

STRUCTURAL CONTROLS ON GROUND WATER FLOW DIRECTIONS IN THREE HIGH-YIELD FRACTURED METAMORPHIC BEDROCK AQUIFERS OF MASSACHUSETTS

Gregory J. Walsh, U.S. Geological Survey, P.O. Box 628, Montpelier, VT 05601
Forest P. Lyford, U.S. Geological Survey, 10 Bearfoot Road, Northborough, MA 01532

Geologic mapping and aquifer tests at three high-yield municipal water systems in fractured metamorphic bedrock in eastern Massachusetts indicate distinct structural controls on ground water flow at each site. The West Newbury well sites (yield = 250 gpm) are located in phyllite of the Silurian Eliot Formation. Ground water flow occurs along sheeting fractures parallel to a sub-horizontal foliation (S1), a steeply dipping foliation (S2), and steep joints. Drawdown during aquifer tests shows an elliptical trend that correlates with the strike of the steep foliation and a principal joint trend. During the tests, ground water in the bedrock shows a connection to ground water in the overburden and to surface water. The Maynard well site (750 gpm) is located in schist of the Ordovician Nashoba Formation. Secondary porosity in the rock is the result of intense fracturing between the Spencer Brook and Assabet River faults. Fracturing in the vicinity of the well site is complex and has associated sulfide mineralization. Drawdown during aquifer tests shows an elongate trend that correlates roughly with the strike of a penetrative foliation, the faults, and a principal joint trend. During the tests, ground water in the bedrock shows a direct connection to ground water in the overburden. The Paxton well site (180 gpm) is located in schist and granofels of the Silurian Paxton Formation. Here, rocks contain a pervasive, gently dipping foliation that exhibits excellent sheeting but limited vertical fracturing. Drawdown during aquifer tests occurs along a major water-bearing zone parallel to the foliation. During the tests, ground water in shallow bedrock wells shows direct connection to water in the overburden and to surface water, but deep bedrock wells show limited connection.

These findings illustrate the importance of pre-existing fabrics in foliated metamorphic bedrock to fracture flow anisotropy. Where foliation dips gently, fracturing is enhanced during isostatic unloading. Where foliation dips steeply, subsequent fracturing may create vertical pathways and along-strike directional drawdown. The highest yield well sites exhibit vertical pathways between deep ground water and shallow ground water in the overburden, locally along fractures parallel to foliation and joints.

METAMORPHIC GEOLOGY OF THE POMFRET DOME AREA, VERMONT

T.W. Grover, Dept. of Natural Sciences, Castleton State College, Castleton, VT 05735

The Pomfret Dome is an Acadian, north-trending, approximately 10 km long by 5 km wide antiformal structure within the Connecticut Valley-Gaspe Synclinorium in east-central Vermont. The dome is comprised of the Waits River (calcareous and metapelitic rocks), Standing Pond (mafic gneiss and amphibolite ± garnet), and Gile Mountain (metapelitic schist, quartzite) Formations.

Mineral assemblages in metapelitic rocks indicate a range in metamorphic grade from garnet zone around the periphery of the dome, through staurolite, staurolite + kyanite, to kyanite zone rocks in the core of the dome, with the local development of sillimanite zone assemblages. Geothermobarometric calculations for staurolite + kyanite and kyanite zone rocks suggest peak metamorphic conditions were approximately 600 °C and 7-8 kbar. Curved inclusion trails and discontinuities in inclusion trail patterns in garnet, staurolite, kyanite, and plagioclase suggest syn-deformational porphyroblast growth. However staurolite and kyanite crystals are also broken or bent suggesting some deformation after growth of these porphyroblasts. Late stage chlorite and muscovite crosscut the crenulated foliation.

Garnets in the metapelitic rocks are almandine-rich and compositional profiles show decreasing spessartine contents and Fe/Mg ratios from cores to rims, features typically associated with growth zoning. X-ray maps reveal garnet compositions were modified along rims, mineral inclusion boundaries, and fractures. There is a marked decrease in grossular content of garnet with a concomitant increase in the pyrope and almandine components in these regions. However, there is little to no change in the ratio of the almandine/pyrope components. In some, but not all samples, the compositional discontinuity is accompanied by the presence of abundant fluid inclusions in the garnet, both along the garnet rim and in the garnet interior near mineral inclusion contacts. These observations suggest high-temperature interaction between garnet and fluid.

THERMOCHRONOLOGIC EVIDENCE FOR EARLY - LATE CRETACEOUS EXHUMATION OF THE ADIRONDACK MOUNTAINS, NEW YORK AND WESTERN NEW ENGLAND

Roden-Tice, Mary K. and Tice, Steven J., Center for Earth and Environmental Science, Plattsburgh State University of New York, Plattsburgh, NY 12901

The goal of this study was to determine the extent of Early to Late Cretaceous exhumation between the Adirondack Mountains in northern New York state and Mesozoic Hartford sedimentary basin and adjacent Bronson Hill crystalline terrane in central Massachusetts and Connecticut. The existence of apatite fission-track (AFT) ages discontinuities associated with regional-scale normal faults, e. g., the eastern Border fault along the margin of the Hartford basin, and contemporaneous timing of unroofing and movement along faults in these two widely separated regions (~500 km) suggested a common uplift mechanism. AFT ages were determined for 100 samples from the Adirondack Mountain region and east-central New York state, Vermont, northwestern Massachusetts, and western New Hampshire along the Vermont-New Hampshire border. In the Adirondack mountains AFT age offsets (Roden-Tice et al., 2000) between the High Peaks region (170-130 Ma) and southeastern section (110-80 Ma), were confirmed by additional Late Cretaceous AFT ages from the southeastern Adirondacks and the continuation of Early to Late Cretaceous AFT ages (~90-120 Ma) for samples from across the Champlain Valley and Vermont to the Connecticut River valley.

Across the Ammonoosuc fault along the Vermont-New Hampshire border, an AFT age discontinuity exists between amphibolite samples from near Strafford, VT (~120 Ma) and near Orford, NH (~80 Ma). These results are consistent with published $^{40}Ar/^{39}Ar$ mineral ages (Harrison et al., 1989) for the same localities. AFT and ZFT (zircon fission-track) age offsets between the Hartford basin and Bronson Hill terrane in Massachusetts and Connecticut (Roden-Tice and Wintsch, 2002) confirm that the discontinuity extends further south.

In westernmost Massachusetts, a lack of apatite-bearing rocks made AFT age determinations impossible. AFT ages from west central Massachusetts did not yield a consistent pattern with the ages ranging from 170 to 113 Ma. (U-Th)/He apatite ages for samples from crystalline rocks in western Connecticut and the Bronson Hill terrane in Massachusetts were within error of the AFT ages determined for those samples [160 and 168 Ma (CT); 99 and 98 Ma (MA)] suggesting relatively rapid cooling from ~100° to 60°C. Using the extremes of (U-Th)/He and AFT age ranges and a geothermal gradient of 25°C/km, estimates of exhumation rates ranged from 0.02 to 0.09 km/m. yr.

(U-Th)/He ages determined for Mt. Marcy (115 Ma), Whiteface Mt. (126 Ma), and Sawteeth Mt. (136 Ma) from the High Peaks yielded cooling rates ranging

from 0.7°C/m. yr. to 2.4°C/m. yr. based on their AFT ages and estimated closure temperatures of 61°C (He system) and 100°C (AFT analysis). Assuming a geothermal gradient of 25°C/km, estimates of exhumation rates ranged from 0.03 to 0.1 km/m. yr. This data is consistent with exhumation rates calculated for the southeastern Adirondack region based on (U-Th)/He apatite and AFT ages of 85, 105 Ma and 91, 83 Ma, respectively. This discontinuity between the two regions (observed in both thermochronologic systems) may be the result of both Late Cretaceous reactivation of post-Ordovician normal faults and differential erosion of different lithologies.

DIRECT OBSERVATION OF A FULL CRUSTAL COLUMN THROUGH AN ANCIENT MOUNTAIN BELT IN NEW ZEALAND: RELATIONSHIPS BETWEEN MAGMATISM AND DEFORMATION

Keith Klepeis and Tracy Rushmer, Department of Geology, University of Vermont, Burlington, VT, 05405-0122

The mechanisms by which magma is generated and transported through continental crust and how these processes affect the chemical and mechanical evolution of the lithosphere are some of the least understood issues of continental dynamics. Much of this uncertainty arises because Phanerozoic mountain belts and magmatic arcs that allow direct examination of the lower crust are rare. There are even fewer field sites that allow us to examine structural and magmatic features that evolved simultaneously at lower, middle and upper crustal levels. However, in western New Zealand we have discovered exposures that allow us to examine directly how deformation interacted with magma generation and transport processes at 10 to 50 kms depth. The Fiordland part of the belt contains >5000 km2 of high-pressure (P=14-16 kbar) migmatites, granulite facies mineral assemblages, and layered mafic-intermediate intrusions that formed in the lower and middle crust (25-50 km paleodepths) of an Early Cretaceous magmatic arc. The Westland part of the belt preserves the middle to upper crustal levels of this same arc (10-27 km paleodepths) where granitoids were emplaced following partial melting of mafic-intermediate lower crust. This unusual degree of exposure allowed us to examine the evolution of a 50 km thick column of deforming continental crust over a 35 Ma cycle of tectonism. The configuration and deeply eroded character of this mountain system lead us to the following conclusions about magmatism and deformation at 10-50 km paleodepths: 1) The composition of the lower crust and the mineral reactions controlling crustal melting during mountain building strongly influence the mechanical behavior of deforming lithosphere and affect how melt travels through the crust. 2) Abrupt changes in lithospheric strength occur during magmatism and crustal melting. These changes produce transient periods of vertical coupling and decoupling of different crustal layers. This result implies that during some periods of mountain building, surface deformation evolves independently of deformation occurring in the deep crust. 3) The extensional

collapse of the Cretaceous mountain system in western New Zealand was driven by plate interactions rather than by gravitational forces and a weak lower crust. This conclusion contrasts with recent hypotheses suggested for collapsed mountain belts in western North America.

CALENDAR

February 8:	VGS Winter Meeting, Norwich University
February 15:	VGS membership dues deadline
March 27-29:	NE GSA, Halifax, Nova Scotia
April 1:	Student grant applications due
April 4:	Student paper abstracts due
April 4:	Submit executive committee reports to GMG
April 10:	VT GIS EXPO, Capital Plaza Hotel, Montpelier*
April 16:	Publish Spring GMG
April 26:	VGS Spring Meeting, Middlebury College

***VT GIS EXPO 2003**
Thursday, April 10, 2003

The statewide GIS event sponsored by:
The Vermont Center for Geographic Information
58 South Main St., Suite 2
Waterbury, VT 05676
802-882-3000

PRESIDENT'S LETTER

Dear Members,

Peter Thomas led a terrific fall field trip in the Waterbury area in September, showing us how to analyze floodplain deposits for archaeological information. It was very interesting to see how human activity over hundreds of years is preserved in the geologic record. It inspired me to dig a pit on the Castleton River floodplain when I got home! Thanks to Peter and to the hardy souls who helped dig the pits before the field trip, and then filled them in when we were done. As I recall, it was a rather warm day to be shoveling sand and gravel (the two feet of snow outside my office window today make that recollection a bit fuzzy, however...). Please let me know if you would like to lead a field trip, or know of someone who might be interested.

Earth Science week in October was a great success. Thanks to all the "Geologists in the Parks" who led school groups around various state parks. I enjoyed taking a bunch of ninth graders around the Mount Independence State Historic Site (although fourteen-year-olds are a pretty tough crowd!). I am really pleased to know how many teachers are interested in getting their students out in the field looking at geology. If you are interested in being a "Geologist in the Park" please let Marjie Gale know. There is more interest on the part of teachers than there are volunteer geologists to lead trips. As a society, we should be encouraging the study of geology at all levels!

The Spring student presentations meeting will be held at Middlebury College on April 26, 2003. Details are in the Call for Abstracts in this newsletter. If you have students completing research studies, please have them submit abstracts. Past presentations have been amazingly varied and interesting, and the opportunity to present research provides excellent experience for the students.

I look forward to this year as VGS president, with Tim Grover as vice president (conveniently located about 20 feet down the hall here at Castleton), Dave West as secretary, and Steve Howe as treasurer. If you have ideas on how to improve the Vermont Geological Society, please send them to me. I look forward to seeing everyone at the spring meeting.

Sincerely,
Helen Mango
Department of Natural Sciences
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(802) 468-1478; helen.mango@castleton.edu

ANNUAL MEETING MINUTES

September 14, 2002: Waterbury, Vt

Saturday, September 14, 2002 in Waterbury, Vt:
Meeting opened by President Ray Coish. Treasurer-elect Steve Howe reported that the financial status of the Society remains strong. Christine Massey reported for the Education Committee that preparations are well underway for Earth Science Week in mid-October. This will include the very popular "Geologist-in-the-Park Program" that last year involved 15 geologists and over 500 school students. Marjorie Gale (for the Publications Committee) reviewed the multistage process involved in the production of the GMG and possible changes to the general format of the GMG were discussed. It was agreed that no significant changes are needed with the exception of adding the new website address. A discussion of where archives of the GMG should be kept followed and it was agreed that it would be best to have a complete set stored at UVM and at the Survey offices in Waterbury. Steve Howe (Advancement of Science Committee) indicated the Student Research Grant deadline will be on April 1, 2003, and it is possible that a second application deadline (October 1, 2003) will be employed if proposals are lacking in the spring. It was also suggested the Society should look into publishing a general-level field trip guidebook on publicly accessible sites in the state. With regards to Public Issues, it was announced that a new Radionuclide map of the state has been released and can be accessed through the Vermont Survey website.

The committee voted to hold the Winter 2003 meeting on Saturday, February 8th at Norwich University. The committee voted NOT to change the name of the Society. The committee voted NOT to disband the Membership Committee, but suggested the committee become more involved in membership promotion. The following new officers were elected to the Executive Committee:

Helen Mango - President
Tim Grover - Vice President
Dave West - Secretary
Steve Howe - Treasurer

The Executive Committee acknowledged the outstanding service of outgoing President Ray Coish over the last year. The meeting was adjourned.

Respectfully submitted,
Dave West, Secretary

STATE GEOLOGIST'S REPORT

Aquifer Mapping and the Vermont Legislature

As chair of our society's Public Issues Committee, I would like to inform you of the Legislature's interest in aquifer mapping, naturally occurring contaminants of concern, and ground water classification. Act 133 of the 2001- 2002 Legislature session recognizes the importance of the ground water resource and requires the Secretary of the Agency of Natural Resources to prepare a report (by January 15, 2003) on the status of ground water and aquifer mapping in Vermont. The Vermont Geological Survey is coordinating closely with the Dept. of Environmental Conservation's Water Supply Division to draft a report for the new incoming Secretary of the Agency, Elizabeth "wibs" McLain. The potential obstacles, difficulties, and resources needed to complete the mapping, natural contaminant studies, and classification by July 1, 2007 (Date in Act 133) are discussed in this report, along with potential funding sources and partners. A suggested time frame is included for completing the work assuming that the necessary resources are provided.

66% of Vermont's population depends on ground water for their drinking water supply. Ground water is also used for manufacturing, agriculture, and commercial enterprises. While Vermont appears to have an abundance of ground water, the recent drought, competition for the resource and growing water use suggest this is not the case. As Vermont's population and economy grow, the demands for ground water increase. Understanding Vermont's ground water system can help predict the location of adequate high quality ground water supplies. Without the knowledge of aquifers and the ground water system, it is unlikely that this valuable resource can be sustained for multiple uses for succeeding generations.

Vermont's geologic landscape is the vessel that contains the State's underground water. To reveal aquifer resources and naturally occurring contaminants of concern requires a framework understanding of Vermont geology. An aquifer mapping effort that recognizes the importance of geology deserves support. Society members may consider contacting their elected representatives to encourage the mapping of aquifers and the identification of naturally occurring elements of concern. The Society should consider taking a position when the Natural Resources Committees in the House and Senate meet to discuss the report and how to address this vital resource. If you are interested in this issue, please contact me at 241-3496 or by e-mail at larryb@dec.anr.state.vt.us

Respectfully submitted,
Laurence R. Becker, State Geologist and Chair, Public Issues Committee
Vermont Geological Survey, 103 South Main Street
Waterbury, Vermont 05671-0301

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The Committee has been busy with two projects since its last report, soliciting abstracts for the Winter Meeting and adding content to the Society's website. The Committee has recently added downloadable Membership and Research Grant Program Applications to the Society's website. Members are welcome to submit information pertinent to Vermont geology and the Society, including digital photos, to showe@csc.albany.edu for inclusion in the website. Please visit our site at:

www.uvm.org/vtgeologicalsociety

The Committee wishes to encourage students and secondary school teachers to apply to the VGS Research Grant Program by the deadline of April 1, 2003. For those without Internet access, forms may be obtained by writing to me at the Dept. of Earth and Atmospheric Sciences, University at Albany, ES-351, 1400 Washington Avenue, Albany, NY 12222-0001, or by calling me at (518) 442-5053.

Respectfully submitted,
Stephen S. Howe, Chair, Advancement of Science Committee

VERMONT GEOLOGICAL SOCIETY TREASURER'S REPORT

It is my pleasure to serve once again as the Treasurer of the Vermont Geological Society, a position I last held 7 years ago. I would like to thank my predecessor, Kristen Underwood, for her fine efforts as your Treasurer during the past 3 years.

The financial condition of the Society is solid. As of November 26, 2002, the checking account balance was $3,542.61. A year-end balance was not available at the time this report was written, but to my knowledge, the Society has no outstanding bills. One check for $30.00, awarded as a result of the Earth Science Week poster contest, has not been cashed.

According to Article II of the Society's Bylaws, membership dues are due during the January. In an effort to have dues collection conform to our Bylaws, I will gradually be moving the date dues notices are mailed out earlier until I have reached a target date of late December. This year, I have sent all of you a new membership renewal and directory information form. Please fill out this form completely, even if your information has not changed since your last renewal, and send this form directly to me at the address indicated on the form, not to the University of Vermont. Dues must be received by February 15, 2003. Next year, I anticipate dues being due by January 31, 2004. The Society went to great

expense last year to contact those members who had not paid dues for over one year. Please help us avoid a similar unnecessary expense this year by renewing your membership before the due date.

The Society received an application for membership that is awaiting approval by the Executive Committee at our next meeting on February 8th.

I welcome your comments and suggestions concerning the Society's financial condition.

Respectfully submitted,
Stephen S. Howe

EARTH SCIENCE WEEK 2002

600 people attended the Open House at OMYA's marble quarry in Middlebury, VT. The attendance was double that of 2001. TV Channel 3 News covered the event. Many thanks to OMYA for participating and special thanks to Alice Blount, Shannon Foster, Ruth Gibbud and Andy McIntosh. For photographs and information, visit OMYA's web site at http://www.omya-na.com/pr121902b.htm

Other ES Week events and co-sponsors included: "Awesome Forces that Shape the Earth" poster contest at Perkins Museum at UVM, geologic tours at Fleming Museum, Mineral ID Day at VINS North Branch Nature Center, guest speakers from the Mercury Program at Vermont DEC, and the Geologist-in-the-Parks program at 5 state parks and historic sites.

Thanks to everyone who worked to make Earth Science week successful: Ginger Anderson, Lori Barg, Larry Becker, Tom Benoit, Alice Blount, Eleanor Bushman, Joseph Bushman, Karen Busshart, Ray Coish, Chip Darmstadt, Rob Farley, Chris Fearon, Shannon Foster, Peter Gale, Ruth Gibbud, Craig Heindel, Jon Kim, Kent Koptiuch, Fred Larsen, Helen Mango, Andy McIntosh, Ethel Schuele, Bill Schhuele, Shelley Snyder, George Springston, and Peter Watt. Many of these volunteers are doing multiple tasks in support of ES Week and we appreciate their efforts and the ability to roll with the punches once the week is in full swing. If anyone has time to come forward and plan/implement additional ES Week events or to mastermind publicity, please let us know.

Respectfully submitted,
Marjorie Gale and Christine Massey, ES Week Coordinators

CALL FOR ABSTRACTS
SPRING MEETING OF THE VERMONT GEOLOGICAL SOCIETY
SATURDAY, APRIL 26, 2003, 8:30 A.M.

The Vermont Geological Society will hold its Spring 2003 meeting in Bicentennial Hall at Middlebury College in Middlebury, VT. 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 outstanding undergraduate paper will be presented. A cash award for "Best Paper and/or 2nd place" will also be presented based on quality of the research, the abstract, and the presentation of the paper, including abstract content and style, presentation clarity and thoroughness, and the student's mastery of the subject matter.

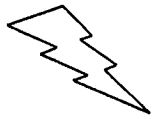
Abstracts are limited to one double-spaced 8.5 x 11" sheet and can include figures and tables. The minimum font size is 10. Please submit both paper and electronic copy (email or disk; email preferred) of abstracts, reviewed by the student's advisor, to the editor at the address given below. Disks should include both a formatted and "text only" version of the abstract (either Mac or IBM; IBM preferred).

Oral presentations will be limited to 15 minutes with 5 additional minutes for questions. Two slide projectors and an overhead projector will be available.

Deadline for abstracts: Friday, April 4, 2003.

Send abstracts to:
Marjorie Gale
Vermont Geological Survey
103 South Main St., The Laundry Building
Waterbury, VT 05671-0301
email: marjieg@dec.anr.state.vt.us
For additional information, contact Marjie at (802) 241-3608 or Helen Mango at (802) 468-1478. For technical information (e.g. computer hook-up capabilities for PowerPoint presentations), contact Dave West at **dwest@middlebury.edu**

ANNOUNCEMENTS



STUDENT RESEARCH GRANT APPLICATIONS DUE APRIL 1, 2003

Students and secondary school teachers are encouraged to apply to the VGS Research Grant Program by April 1, 2003. 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 Howe at the Dept. of Earth and Atmospheric Sciences, University at Albany, ES-351, 1400 Washington Avenue, Albany, NY 12222-0001. Tel: (518) 442-5053; E-mail: showe@csc.albany.edu

MEMBERSHIP RENEWAL DUE FEBRUARY 15, 2003

Downloadable Membership and Research Grant Program Applications are available from the Society's website at www.uvm.org/vtgeologicalsociety. Renewal notices were mailed to members in December. Please send your dues to Stephen Howe, Dept. of Earth and Atmospheric Sciences, University at Albany, ES-351, 1400 Washington Avenue, Albany, NY 12222-0001. Thanks.

VGS SPRING MEETING AND STUDENT PAPER PRESENTATIONS APRIL 26, 2003

BICENTENNIAL HALL, MIDDLEBURY COLLEGE
MIDDLEBURY, VT

THE GREEN MOUNTAIN GEOLOGIST
VERMONT GEOLOGICAL SOCIETY
DEPARTMENT OF GEOLOGY
UNIVERSITY OF VERMONT
BURLINGTON, VERMONT 05405-0122

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ADDRESS CHANGE?
Please send it to the Treasurer at the above address.
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V. G. Survey

THE
GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

SPRING 2003 VOLUME 30 NUMBER 2

The Vermont Geological Society's Spring Meeting

Presentation of Student Papers
April 26, 2003, 8:30 am
Middlebury College

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Directions to the Spring VGS Meeting
Middlebury College
April 26, 2003
8:30 am

Take Rte. 125 west, past the Catholic Church, up hill through the college. Go over the crest to the bottom of the hill as it flattens to a valley; turn right onto the winding driveway and park in the large parking lot on the west side of Bicentennial Hall.

Meeting is in Bicentennial Hall, Room 104 (NOT Room 220).

CALENDAR

April 26	VGS Spring Meeting, Middlebury College
May 16	The Adirondack Section Of The Society Of Mining Engineers field trip, Albany, NY*
July 19	VGS Summer Field Trip, Colchester, VT; Contact: Jon Kim @ 241-3469**
Sept. 24-26	54TH Annual Highway Geology Symposium Burlington, VT; Contact: Tom Eliassen @ 828-6916
July 26-27	24th Annual Champlain Valley Gem, Mineral And Fossil Show, Tuttle Middle School, Dorset St., South Burlington, VT. Contact: 802- 863-5980
Oct. 10-12	NEIGC 2003, Amherst College and Smith College.

*Tour of the Lafarge cement operation just south of Albany, NY including the limestone quarry (fossils!), the aggregate plant, and the explosives operation. Information and directions can be found at the Pittsburgh SME section's website: http://www.smepittsburgh.org/calendar.htm

**Jon Kim, VT Geological Survey, will lead a bedrock and environmental geology field trip in the Colchester area. Meet at 9:30 am at the Park and Ride on the east side of the intersection of Routes 2 and 7, Exit 17 off I-89. Trip runs rain or shine. Bring lunch. For details contact Jon at 241-3469.

SPRING MEETING PROGRAM
Annual Presentation of Student Papers
Bicentennial Hall, Room 104
Middlebury College, Middlebury, Vermont

April 26, 2003

8:30 COFFEE

8:45 M. Wesolowski: GEOCHEMICAL ANALYSIS OF SOILS AND SURFACE WATER DERIVED FROM CHEMICAL WEATHERING OF ULTRAMAFIC ROCK, CORNWALL, ENGLAND: SPECIATION AND ECOLOGICAL CONSEQUENCES

9:00 D. Salaverry: GIS ANALYSIS OF THE RECENT RETREAT OF GLACIERS IN THE TANGGULA SHAN, TIBETAN PLATEAU

9:15 B. McCurdy: GEOCHEMISTRY AND MINERALOGY OF VOLCANIC PALEOSOLS FROM CHILE'S TENTH REGION: IMPLICATIONS FOR VOLCANIC FINGERPRINTS, HOLOCENE CLIMATE CHANGE, AND TRACE METAL AVAILABILITY

9:30 N. Greenglass: ORIGIN AND TRANSPORT OF NATURALLY OCCURRING METALS IN GROUND WATER, NORTHERN ADDISON COUNTY, VERMONT

9:45 J. Shakun: LAST GLACIAL MAXIMUM EQUILIBRIUM-LINE ALTITUDES IN NORTHEASTERN UTAH, U.S.A.

10:00 K. Musselman: ANALYSIS OF SPATIAL VARIABILITY OF PRECIPITATION AND SNOW ACCUMULATION ON MOUNT MANSFIELD, STOWE, VERMONT

10:15 E. Butler: USING DISCUSSION SECTIONS AND OTHER EFFECTIVE TEACHING METHODS TO IMPROVE A LARGE INTRODUCTORY GEOSCIENCE COURSE*

10:30 BREAK

10:45 D. Anderson: PETROGRAPHIC CORRELATION OF DIKES AND LEUCOGRANITE FROM THE NORTHFIELD IGNEOUS COMPLEX, VERMONT

11:00 D. Byrne: GEOCHEMISTRY OF THE FERNANDEZ PLUTON AND ASSOCIATED DIKES, AND THEIR CORRELATION WITH OTHER ROCKS OF THE NORTHFIELD IGNEOUS COMPLEX, VERMONT

11:15 A. Schoonmaker: TECTONIC SETTINGS OF ORDOVICIAN AND DEVONIAN MAFIC ROCKS NEAR CHESUNCOOK LAKE, NORTHERN MAINE*

11:30 L. Fernandes: GEOLOGY OF THE WEEKS MILLS QUADRANGLE, EAST-CENTRAL MAINE

11:45 H. Beal, M. Swanson & M. Bampton: INTEGRATED PRECISION DIGITAL MAPPING AND STRAIN ANALYSIS OF SYNTECTONIC GRANITE INTRUSIONS WITHIN THE NORUMBEGA FAULT SYSTEM, CASCO BAY REGION, MAINE

12:00 M. Reilly: PETROGENESIS OF THE LATE SILURIAN-EARLY DEVONIAN LINCOLN SHONKINITE, SOUTH-CENTRAL MAINE

12:15 W.C. Simonson: CRETACEOUS AGE EXTENSIONAL DEFORMATION IN WESTERN NEW ZEALAND *

12:30 LUNCH & AWARDS

* Graduate research project

ABSTRACTS

GEOCHEMICAL ANALYSIS OF SOILS AND SURFACE WATER DERIVED FROM CHEMICAL WEATHERING OF ULTRAMAFIC ROCK, CORNWALL, ENGLAND: SPECIATION AND ECOLOGICAL CONSEQUENCES

Martin F. Wesolowski, Geology Department
Middlebury College, Middlebury, VT 05753

Ultramafic rocks are known to possess exceptionally high metal concentrations, which are often reflected in their weathering products. The focus of this study is the Lizard Complex of Cornwall, England, an ophiolite sequence containing variably serpentinized peridotite and dunite that contain high concentrations of Cr, Ni (~3000 mg/kg each) and Co (~150 mg/kg), which have the potential to migrate into surface or groundwater and pose ecological and health concerns. The purpose of this investigation is to quantitatively determine the speciation and availability of these metals and to better understand their fate and transport from serpentinite parent material. Rock, soil, surface and ground water samples were collected from freshly exposed soil profiles and streams. Analyses included sequential chemical extraction (SCE) coupled with quantitative X-ray diffraction (Q-XRD) of bulk soil and rock samples; XRD of the <2 μm clay fraction; and the chemical comparison of rocks, soils and waters by Inductively Coupled Plasma-Atomic Emission (ICP-AES) and ICP-Mass Spectroscopy (ICP-MS).

Metal concentrations in water samples reflect significant natural enrichment, but are within common ultramafic ranges. Selected samples contained Co, Cr, and Ni concentrations above those of safe drinking water levels. For example, two separate ambient shallow groundwater samples sites produced elevated Ni concentrations of 153 and 288 ppb, Cr values of 28 and 90 ppb, and Co concentrations of ~5 ppb. Al, Fe, and Mg also exceed UK standards at some sites. SCE data reveal significant Co and Ni liberation from the reducible fraction (e.g. ~1500 mg Ni per kg of soil) and chemical and XRD data support the presence of Ni and Co in trioctahedral smectite and vermiculite as well as poorly crystalline Fe hydroxides. The liberation of significant amounts of Al, Si and Mg in the reduction stage is also consistent with smectite and vermiculite as sources of Ni and Co. Cr

liberation is primarily from the oxidizable fraction (~100 mg Cr per kg soil), suggesting that Cr occurs in organic material or Cr-bearing oxides such as chromite, where Cr may oxidize from Cr^{+3} to Cr^{+6} during the extraction. Approximately 50% of Ni in the soils occurs in easily extractable clays, oxides, and exchange sites, which helps to explain the higher concentrations of Ni in shallow ground water as compared to Cr, which is likely contained in more resistant oxides.

GIS ANALYSIS OF THE RECENT RETREAT OF GLACIERS IN THE TANGGULA SHAN, TIBETAN PLATEAU

Daniella Salaverry, Geology Department
Middlebury College, Middlebury VT 05753

Glaciers exist in a sensitive state of equilibrium and are therefore good indicators of climate change. The slightest changes in atmospheric conditions can affect temperature and precipitation, thus affecting the overall mass balance of the glacier. Globally, the retreat of glaciers began at the end of the Little Ice Age in the 19th century when temperatures began to increase. In the past 50 years, however, the rate of retreat has accelerated, indicating the link between anthropogenic activities, climate change and glacial recession.

The objective of this study is to quantify recent glacial recession in the Tanggula Shan, Tibetan Plateau. A Geographic Information System (GIS) was used collect and analyze the data from four satellite images from 1976, 1977, 1989 and 2001. In the IDRISI program, the images were registered, resampled and manipulated into false infared composites used for unsupervised cluster analysis. The ARC GIS program was used to digitize thirty glaciers and calculate their area. The analysis conducted with the GIS provides evidence that glaciers in the Tanggula Shan have decreased in area from 1976 to 2001, with an average percent change of –21.

These results are supported by ice-core analysis and climate trends. Ice-core data from central Asia records provide evidence of warming associated with low-latitudes and high altitudes suggesting that tropical and subtropical glaciers may be more sensitive to climate change. Moreover, temperature data from weather stations near the site of the coring show a 1.2°C warming trend since the 1950s. The conclusions from the ice-core analysis support results from the Tanggula Shan where high

elevation and relatively low latitude glaciers have lost considerable area in 25 years. In the Tian Shan of Western China, meteorological data show a warming of 0.5-1.6°C over the past 60 years. Given their proximity, temperature changes have also likely occurred in the areas of the Tanggula Shan. By comparing the results of the GIS analysis of the Tanggula Shan to previous research, it is evident that these glaciers have been retreating in accordance with recent climate changes over the past 25 years.

GEOCHEMISTRY AND MINERALOGY OF VOLCANIC PALEOSOLS FROM CHILE'S TENTH REGION: IMPLICATIONS FOR VOLCANIC FINGERPRINTS, HOLOCENE CLIMATE CHANGE, AND TRACE METAL AVAILABILITY

Brian McCurdy, Geology Department
Middlebury College, Middlebury, VT 05753

Subduction of the Nazca plate under the South American plate has produced a very active volcanic arc in the Andes Mountains of southern Chile. In Chile's tenth region, La Región de los Lagos, there are over twenty stratovolcanoes of basaltic to andesitic composition that have formed an impressive series of post-glacial volcanic ash-derived paleosols. Three paleosol sequences were sampled along a north-south transect across the tenth region. Samples were collected for chemical and mineralogical analysis at 5cm intervals from trail and road cuts.

Although color and texture were often the only characteristics needed to distinguish volcanic ash depositional events, in some cases field observations are unable to distinguish between successive paleosols. Initial analysis of soil geochemistry by ICAP shows that a molar ratio of Bases:R_2O_3 (in weight percent of major element composition, where R = Al, Fe and Ti) accurately describes transitions from one volcanic event to another. Values ranged from 0.11 in the upper layers of paleosol profiles to approximately 0.5 in underlying, unaltered ash. Once fresh parent materials had been identified by major element chemical analysis, lowermost layers (mainly ash and tephra) from each paleosol were analyzed for rare earth element (REE) compositions to provide more complete chemical fingerprints for the magma sources.

XRD studies were conducted on the less than 5μm size fraction from the uppermost layers of paleosols to assess mineralogical content. The

presence of halloysite, imogolite and allophane reflects the intense weathering environment and rapid crystallization characteristic of high precipitation (2 – 5 m MAP) and relatively high temperature. The presence of smectite in some samples is interpreted to represent less intense weathering, shorter time intervals of weathering exposure, or possibly periods of drier Holocene climate. The northernmost profile, Marífilo, had previously been studied, and therefore had C^{14} dates for individual volcanic layers. The remaining two paleosols, Ensenada and Cochamó, did not have dates, and ages were estimated by comparisons to the mineral alterations of the Marífilo profile.

Concerns about mobile heavy metals stemmed from other research showing elevated concentrations of chromium in many of the local lakes. Ongoing analyses of acetic-acid extractable and bulk trace metal concentrations will be applied to an evaluation of trace metal mobility in these environments with pronounced soil leaching.

ORIGIN AND TRANSPORT OF NATURALLY OCCURRING METALS IN GROUND WATER, NORTHERN ADDISON COUNTY, VERMONT

Nora Greenglass, Geology Department
Middlebury College, Middlebury, VT 05753

Concentrations of lead and uranium in excess of EPA maximum contaminant levels have been detected in ground water derived from the late Cambrian-early Ordovican dolomitic Clarendon Springs Formation (CSF) in northern Addison County, Vermont. Analysis by inductively coupled plasma-atomic emission spectrometry (ICP-AES) was performed on ground water derived from 20 wells drilled into the CSF and other members of the regional siliciclastic-carbonate sequence. Preliminary results indicate that 11 of 20 ground water samples contain Pb concentrations above the MCL (15 ppb); 5 of these samples had Pb concentrations greater than 150 ppb. Seven of these 11 wells are drilled into the CSF. The remaining four wells draw ground water from the Monkton Quartzite or Ordovician carbonates, and are located within approximately 3 km to the west and east of the assumed position of the CSF. Analysis of additional ground water samples by both ICP-AES and ICP-mass spectrometry will further delimit the concentration and geographic extent of both lead and uranium in ground water in northern Addison County.

Brittle-fracture and photolineament analyses was undertaken to determine structural controls on the transport of metal-bearing ground water. Dominant fracture orientations within the CSF trend approximately N45°W, N10°W, and N30°E, reflecting regional Taconic and Acadian deformation. Local ground water flow converges in an aquifer situated within the carbonate sequence, including the CSF. Thus, ground water is exposed to CSF rocks bearing Pb and U, and is then directed by fractures throughout the region. Carbonate dissolution and subsequent whole-rock geochemical analysis will determine where Pb and U are sequestered within the CSF dolomite. Lead in the CSF may have been deposited contemporaneously with early-Ordovician epigenetic dolomitization by low to moderate temperature, hypersaline basinal brines, in a process analogous to the formation of Mississippi Valley Type Pb-Zn deposits. Previous ICP-MS analysis of the CSF and associated ground water indicates that areas of uranium concentration are highly localized, and may have been formed by roll-front deposition in organic-rich breccia zones formed by karst dissolution in a shallow-sea or sub-aerial environment.

LAST GLACIAL MAXIMUM EQUILIBRIUM-LINE ALTITUDES IN NORTHEASTERN UTAH, U.S.A.

Jeremy Shakun, Geology Department
Middlebury College, Middlebury, VT 05753

Thirty Last Glacial Maximum (LGM) alpine glaciers from the Uinta and Wasatch Mountains of northeastern Utah were reconstructed. Their equilibrium-line altitudes (ELAs) were determined using four methods: accumulation-area ratio (of 0.65), toe-headwall altitude ratio (of 0.4), highest extent of lateral moraines, and the lowest cirque-floor method. The ELA estimates from each of these four methods were combined in a weighted average to yield an LGM ELA for each of these glaciers. ELAs rise steadily eastward from 2460 m on the Wasatch Front to 3120 m at the eastern end of the Uintas. This significant westward ELA depression is likely due to pluvial Lake Bonneville-enhanced snow precipitating over the Wasatch Range and western Uintas leaving areas further downwind (i.e., east) of Lake Bonneville progressively snow-starved. LGM ELAs were also determined for five valley glaciers from the Stansbury Range of north-central Utah, and the East Humboldt Range and Ruby Mountains of

northeastern Nevada, these latter two ranges being just west of Lake Bonneville. ELAs in these ranges are somewhat higher than those in the Wasatch and western Uintas (2540 m to 2730 m), despite their relative proximity to the major moisture source of the Pacific Ocean, reflecting the influence of Lake Bonneville on ELAs in the mountains of northeastern Utah. ELAs on the south slope of the Uintas are ~50 m lower than those on the Uinta north slope. This is likely due to lake-effect snow coming from southwest of the Uintas at times. The lateral moraine method appears to have been the most accurate in reconstructing ELAs. The lowest cirque-floor method yielded the highest ELAs and was likely the least accurate. The accumulation-area ratio likely underestimated and the toe-headwall altitude ratio overestimated LGM ELA depression for the seven, extremely large Uinta south slope glaciers because of their geometry and non-uniform area-altitude distribution. Accordingly, a higher accumulation-area ratio and toe-headwall altitude ratio should have been used for these seven, complex glaciers.

ANALYSIS OF SPATIAL VARIABILITY OF PRECIPITATION AND SNOW ACCUMULATION ON MOUNT MANSFIELD, STOWE, VERMONT

Keith N. Musselman, Department of Geology
University of Vermont, Burlington, VT 05405

Recent research on two upper watersheds of the West Branch Little River (West Branch) and Ranch Brook, both located on the eastern side of Mount Mansfield in the town of Stowe, Vermont, indicates substantial differences in unit area runoff between the two basins. These disparities may be explained in part by spatial variability of precipitation inputs. This study seeks to better understand the microclimatology of these upper elevation watersheds. The costs and difficulties in maintaining an adequate network of upper elevation weather stations have limited research focused on spatial precipitation patterns. Forecasting these small-scale precipitation patterns in mountainous regions is a difficult undertaking due to the insufficient density of recording stations and the variable effects of terrain and elevation on storm behavior. This study obtains large quantities of precipitation data (13 stations) over a 22.5-km^2 study area. Rainfall occurring between August 10th and October 30th, 2002 was documented using a network of thirteen automated recording rain gauges recently installed throughout the two watersheds. The network is designed to create three transects of individual mountain slopes; the Gondola Transect, running the length of the eight-passenger gondola, the Spruce Peak Transect, and Ranch Brook Transect.

Each transect is composed of five gauges, spaced at relatively equal elevation intervals. Snowfall from December 12, 2002 through the end of the 2003 snow season was monitored along the Ranch Brook Transect with a network of three snow gauges and NWS station data from the summit. These snow data were complimented by repeated snow pack analyses using coring techniques, conducted along the Ranch Brook transect. These precipitation data are used to map, document, and increase understanding of small-scale precipitation trends in the region. They are analyzed for average elevation/precipitation regressions. The study is geared toward proving a direct correlation between increases in precipitation with elevation as well as understanding the effect of azimuth and large topographic features such as ridgelines and prominent summits. Preliminary results of this study suggest an average positive linear precipitation/elevation relationship of 3cm/250m. A significant increase in precipitation is also observed in close proximity to major ridgelines and summits. During a single widespread rain event in late September, 2002, the West Brach station *'Gondola 750m'* located in the shadow of a 450m ridge recorded 1.5cm more rain than the Ranch Brook station *'Ranch 820m'* located in a col of the same ridge. This storm event loaded the West Branch watershed with 38% more rain than fell within the Ranch Brook watershed. These findings are possible contributors to the runoff discrepancy observed between the upper elevation watersheds of Ranch Brook and West Branch of the Little River.

USING DISCUSSION SECTIONS AND OTHER EFFECTIVE TEACHING METHODS TO IMPROVE A LARGE INTRODUCTORY GEOSCIENCE COURSE

Eric Butler, Paul Bierman, & Joanna Reuter, Department of Geology
University of Vermont, Burlington, VT 05405

Teaching large introductory geoscience classes presents many challenges to faculty attempting to make such classes interesting, educational, and enjoyable to students. Educational research suggests that students learn best when they are involved with the material being taught and can build connections with their own lives and interests. At the University of Vermont, we have used personal experience and educational research to develop a large introductory geoscience class, Earth Hazards (GEOL 007) that uses effective lecturing techniques and weekly discussion sections to build student interest and learning. Interactive, student-centered lecture periods build student interest and knowledge, and are complemented by discussion sections in which hands-on activities and proper discussion

facilitation help non-science students experience the material first-hand and build links between science and the real world. Our experiences teaching this class have helped us determine what works and what does not at the university level, and we feel that our curriculum and methods can be applied in many university settings to enhance student learning and enjoyment of geoscience.

Please see our web site: http://geology.uvm.edu/morphwww/classes/ehaz/hazards_site/Front.html

PETROGRAPHIC CORRELATION OF DIKES AND LEUCOGRANITE FROM THE NORTHFIELD IGNEOUS COMPLEX, VERMONT

Daniel J. Anderson, Geology Department
Norwich University, Northfield, VT 05663

The Fernandez pluton, a peraluminous leucocratic tonalite, crosscuts six associated dikes that intruded parallel to the foliation of the surrounding metasediments of the Moretown Formation. These intrusive units were investigated to determine their relationship with a more widespread series of north-northeast trending intrusions west of Northfield, Vermont, referred to here as the Northfield Igneous Complex. Petrographic analyses were conducted on selected samples of both pluton and dike material. In the pluton, plagioclase feldspar is the most abundant mineral with compositions near Ab_{90} - An_{10}; alkali feldspar occurs in minor amounts. Quartz and muscovite are present as euhedral to subhedral crystals, as well as in the matrix. Muscovite also occurred with chlorite, epidote, calcite, and rarely biotite as alteration products on the plagioclase. The dikes have similar plagioclase and quartz as euhedral or fragmented phenocrysts. Crosscutting relationships show that the pluton post-dates the dikes, but their geochemical and mineralogical similarities suggest they are both derived from the same melt. These relationships suggest all these magmas were fed from a deeper source where quartz and plagioclase growth was underway prior to emplacement. Intrusion parallel to folded layers of country rock, combined with post-emplacement alteration, is compatible with emplacement that post-dated the Taconic orogeny and pre-dated the Acadian orogeny.

GEOCHEMISTRY OF THE FERNANDEZ PLUTON AND ASSOCIATED DIKES, AND THEIR CORRELATION WITH OTHER ROCKS OF THE NORTHFIELD IGNEOUS COMPLEX, VERMONT

Daniel I. Byrne, Geology Department
Norwich University, Northfield, VT 05663

The Fernandez pluton, a member of the Northfield Igneous Complex, is located within the Moretown Formation west of Northfield, Vermont. The Moretown Formation was deformed and metamorphosed during both the late Ordovician Taconic orogeny and the Devonian Acadian orogeny. Beds in the Moretown Formation are preserved in nearly vertical isoclinal folds. Contacts of the igneous body cut across the bedding and subparallel cleavage of the Moretown Formation, showing that the pluton intruded the Moretown following its deformation. Further constraint on the time of emplacement of the pluton comes from evidence of its weak metamorphism that suggests emplacement prior to the Acadian orogeny. Geochemical analyses of six samples, four from the main body and two from associated dikes, show these rocks to overlap in composition with SiO_2 values ranging from 72.03-74.49 wt% and combined alkalis ranging from 7.62-9.03 wt%. The rocks are peraluminous with aluminum saturation index values from 1.1-1.2, and all samples are corundum normative. Similar values were found in previous studies for other members of the Northfield Igneous Complex. In addition, all members are muscovite-bearing, leucocratic S-type granites. Their magmatic origin is interpreted to result from partial melting of Al-rich continental crust during post-Taconic extension. However, the rocks of different plutons tested in prior studies plot separately in AFM and granite ternary plots, suggesting each intrusion had a unique fractionation history.

TECTONIC SETTINGS OF ORDOVICIAN AND DEVONIAN MAFIC ROCKS NEAR CHESUNCOOK LAKE, NORTHERN MAINE

Adam Schoonmaker & W.S.F. Kidd
University at Albany, Albany, NY 01222

Field relationships and geochemistry of the Bean Brook Gabbro and equivalents ("Boom House" Gabbro) indicate a correlation with the Ordovician Dry Way Volcanics at the Ripogenus Dam, northern Maine. The gabbros (K/Ar age 472.5 Ma) intrude the Hurricane Mountain Mélange and related Cambrian sedimentary strata, but are conspicuously absent

above the Taconic unconformity at the base of the Siluro-Devonian. This temporal distribution of gabbros is similar to that seen in the Ordovician section of the Exploits Terrane and Dunnage Melange in Newfoundland. Geochemical tectonic discrimination and trace element patterns of Ordovician and Devonian mafic rocks indicate that they have been either geochemically influenced by subduction-related sources or contaminated by the assimilation of upper continental crust.

Ordovician basalts and gabbros range from tholeiitic arc to calc-alkaline arc on Th/Ta/Hf/3 and Ta/Yb vs Th/Yb diagrams. Trace element diagrams of the Ordovician lavas and gabbros show low amounts of enrichment of the incompatible trace elements (relative to N-MORB) with a consistent Nb-anomaly suggesting that the Bean Brook and Boom House Gabbros are genetically related to the nearby Dry Way volcanics. REE patterns for the Bean Brook and Boom House gabbros and Ordovician Dry Way volcanics all show similar flat patterns, although at elevated concentrations (relative to chondrite), inconsistent with a direct MORB origin. These magmas could be the result of a ridge subduction event, or the formation of a back-arc basin.

The Devonian volcanics were erupted in a rapidly subsiding basin dominated by fine-grained mudrocks and subsequently overlain by the Acadian Seboomook Flysch. This suggests that these basalts may have been erupted on the outer trench slope of a subducting plate. The basalts show a significant Nb-anomaly but are strongly calc-alkaline-to-shoshonitic, consistent with either a volcanic arc or a within-plate origin. REE patterns are highly elevated (relative to chondrite) and show a negative slope also consistent with a volcanic arc or within-plate setting, or with melting of a slab-enriched lithosphere source during an early stage of the Acadian collision.

GEOLOGY OF THE WEEKS MILLS QUADRANGLE, EAST-CENTRAL MAINE

Leslie C. Fernandes, Dept. of Natural Sciences
Castleton State College, Castleton, VT 05735

The Weeks Mills quadrangle is located in east-central Maine along the contact between the Central Maine sequence and the Falmouth-Brunswick sequence. The rocks in this region have experienced several periods of metamorphism and deformation associated with multiple orogenic events related to Appalachian Mountain building. The area consists predominantly of southwest-trending, northwest-dipping metasedimentary and metavolcanic units, all of which have been variably intruded by pegmatite. The structurally lowest point in the southeast corner of the map area consists of garnet-andalusite schist, gray-green schist, and garnet-coticule schist tentatively correlated with the Scarboro Fm. Structurally above these units to the west, is a mylonite over 100m thick. The mylonite represents the Sand Hill Corner Fault, part of the Norumbega Fault System. Sillimanite is found in the rocks northwest of the mylonite, while andalusite is abundant in rocks to the southeast of the mylonite. To the west, the mylonite gradually changes to a protomylonite, with feldspar and muscovite porphyroclasts. The Cape Elizabeth Fm., a light gray quartz-plagioclase-mica granofels and schist, is the next unit to the northeast. Structurally above the Cape Elizabeth Fm. are well-laminated plagioclase-quartz-biotite-hornblende gneisses of the Nehumkeag Pond Fm., which locally contain 2 cm – 2 m amphibolite layers. The Beaver Ridge Fm., a dark gray to black, sulphidic and graphitic, quartz-plagioclase-mica schist recognized by its thoroughly rusty-weathered appearance, lies structurally above the Nehumkeag Pond Fm. The Hutchins Corner Formation, an interlayered, well laminated calc-silicate and biotite-quartz granofels, is separated from the Beaver Ridge Formation by the Hackmatack Pond Fault. One lens of the Sandy Pond Fm., a lithologically diverse unit containing garnet amphibolite, feldspathic schists and pelitic schists with staurolite, kyanite, cordierite, and sillimanite, was found on the east side of the Hackmatack Pond Fault. The northwest corner of the study area consists of the felsic intrusive rocks of the Three-Mile Pond Pluton.

Two phases of folding are recognized. The first set of folds (F2 on the basis of regional correlation) are upright isoclinal folds with fold axes that

plunge shallowly to the northeast. The F2 foliation is overprinted by F3 Z-folds with variably plunging, north-trending fold axis. Dextral shear kinematic indicators are found throughout the area.

INTEGRATED PRECISION DIGITAL MAPPING AND STRAIN ANALYSIS OF SYNTECTONIC GRANITE INTRUSIONS WITHIN THE NORUMBEGA FAULT SYSTEM, CASCO BAY REGION, MAINE

Heather Beal, Geology Department
Middlebury College, Middlebury, VT 05753
M. Swanson, Dept. of Geoscience, U. of Southern Maine, Gorham, ME
M. Bampton, Dept. of Geography & Anthropology, U. of Southern Maine, Gorham, ME

Casco Bay, Maine is composed of steeply-dipping and strongly-lineated metamorphic rocks and deformed granite intrusions resulting from transpression associated with shearing on the Norumbega Fault Zone. Within the three study sites of Merepoint, Wood Island, and Hermit Island, strain partitioning during dextral transpression resulted in initial intrusions orthogonal to the shear direction and continued shearing resulted in CW rotation and elongation into strings of granite boudin pods oblique to the host rock flow layering. To conduct strain analysis, the sites were digitally mapped using the precision techniques of Trimble 5700 dual frequency GPS receivers, Spectra Precision Geodimeter 608 series total stations, Excel, and Arc View GIS. These techniques were able to capture fine-scale detail over large areas, providing insight into structural processes. By using geometric analysis of the boudin strings and foliation, surface area reconstruction of boudin pods, and a line length technique for folded intrusions, the γ-shear strain, elongation, and shortening values were determined to estimate the pure and simple shear components to the deformation. In close proximity to the main Norumbega shear zone in inner Casco Bay, Merepoint produced γ-values of 11.6 and 12.6 (assuming simple shear) with elongation of 316-610%. Farther to the east in outer Casco Bay, Wood and Hermit Islands show γ-values ranging from 1.3-10.7 for simple shear and elongation values from 45-220%. These values appear to be independent of the bedrock structure, with variably dipping folded layers at Wood and steeply dipping limb layers at Hermit along the eastern flank of the Hen Cove anticline and an interpreted "Phippsburg Shear Zone". All sites also display a significant pure shear layer-normal shortening component to the deformation as seen in crumpled orthogonal

granite intrusions with shortening values from 25 to 66 % that reduces the apparent simple shear values calculated from the boudin string-foliation geometry.

PETROGENESIS OF THE LATE SILURIAN-EARLY DEVONIAN LINCOLN SHONKINITE, SOUTH-CENTRAL MAINE

Michael J. Reilly, Geology Department
Middlebury College, Middlebury, VT 05753

Highly distinctive rocks of the Lincoln shonkinite (a.k.a. Lincoln Sill) are exposed discontinuously over a distance of nearly 75 kilometers, from Boothbay Harbor in south-coastal Maine to near Liberty in south-central Maine. The 418 +/- 1 Ma (Tucker et al., 2001) shonkinite intrudes rocks of both the Liberty-Orrington and Fredericton lithotectonic belts and has been variably sheared and metamorphosed during Middle to Late Devonian orogenic activity. In south-central Maine, where the width of the intrusive body is greatest, the effects of this subsequent tectonism are minimal and pristine igneous mineralogies and textures are well preserved. This study presents field, petrographic and geochemical data from these pristine igneous rocks and interpretations of this data will provide much needed information on the tectonic setting of this region during the early stages of the Acadian orogeny.

Field work in south-central Maine revealed only subtle compositional and textural variability within the undeformed portions of the shonkinite intrusion. The dominant rock type is highly porphyritic, containing megacrysts of alkali feldspar up to 6 cm in length set in a finer-grained matrix dominated by clinopyroxene, orthopyroxene and biotite. Plagioclase and quartz is rare to absent in most samples and olivine (Mg-rich) has been found at only one locality. Minor accessory minerals include apatite, zircon and Fe-Ti oxide minerals. Fine-grained mafic enclaves can be observed at most localities, although they are not overly abundant. Alkali feldspar megacrysts often show a preferred orientation within a given outcrop, although there appear to be no systematic trends within the intrusive body as a whole.

Whole rock geochemistry from samples unaffected by metamorphism reveals highly unusual igneous rock compositions. SiO_2 contents range

from 55-60% and the rocks are noticeably rich in alkalis (K_2O = 6.0 to 7.5% and Na_2O = 1.5 to 2.5%) and magnesium (7-9%). Trace element analyses yield relatively high abundances of both compatible and incompatible elements (e.g., Cr = 419 to 729 ppm and Ba = 1500 to 2000 ppm). Rare earth element plots reveal LREE enrichment (200-300 times chondrites) as compared to the HREE (10 times chrondrites). Future work, including mineral chemistry and isotope geochemistry will further characterize the Lincoln Shonkinite and provide information on the tectonic setting of the region during Late Silurian-Early Devonian time.

CRETACEOUS AGE EXTENSIONAL DEFORMATION IN WESTERN NEW ZEALAND

W. Corey Simonson & Keith A. Klepeis, Department of Geology, University of Vermont, Burlington, VT 05405

Previous field work in extensional terranes around the globe has allowed geologists to link particular styles of deformation to specific extensional environments e.g. continental rifting, back arc basin development, intra-arc extension, syn and late orogenic extension etc. One distinctive style of deformation associated with extensional metamorphic core complexes has been well documented based on examples from western North America, the Aegean, and elsewhere.

Detailed structural mapping within the Paparoa metamorphic core complex, northwest South Island, New Zealand, indicates an extensional system characterized by two major conjugate detachment surfaces, intense asymmetric ductile deformation including the development of mylonitic and ultramylonitic shear zones, semi-brittle shear zones and conjugate brittle normal faulting. Based on cross-cutting relationships, we have established a sequence of at least four events beginning with the formation of ductile fabrics and high temperature folding in metamorphic and plutonic rocks at depth on both the northern and southern ends of the system. In the south, this resulted in protomylonite, mylonite, and ultramylonite rocks interfolded with variably deformed host rocks. In the north, well developed S-C fabrics are preserved in megacrystic granites. As extension continued, a series of lower temperature kink folds affected the southern half of the core penecontemporaneous with semi-brittle normal faults in the north. Finally, conjugate brittle normal faults cut all previous fabrics and structures within the core complex. This sequence records the

progressive evolution of the extensional system as deforming continental crust passed through the brittle-ductile transition zone.

The contrasting style of deformation and structural geometry among the Paparoa metamorphic core complex and North American core complexes is related, we believe, to the mechanism or cause of extension in each case. Some North American core complexes are thought to be strongly influenced by gravitational forces acting on overthickened crust. In New Zealand, extensional structures formed during the fragmentation of Gondwana. Thus, the driving force behind the formation of an extensional metamorphic core complex strongly influences the style of deformation produced during extension.

PRESIDENT'S LETTER

Dear Members,

Wow! What a great winter meeting! Thank you to all the presenters, who brought us a diverse and very interesting group of topics. Thank you also to Norwich University for hosting the meeting, and providing us with such an ample supply of Box o' Joe. I was also pleased to see current and former geology students from several campuses. This is something we need to encourage!

At the Executive Committee meeting afterwards, we discussed the VGS by-laws and focused on several places where changes may need to be made regarding payment of dues, membership, etc. If you have any proposed changes, please bring them to the spring meeting so that we can put them into shape so that they can be properly warned for the annual meeting. The complete by-laws can be found on the VGS web page:

http://www.uvm.org/vtgeologicalsociety

Thanks again to Steve Howe for developing and maintaining this site. Also, if you know of field trips or other events of potential interest to the VGS membership, please let me know the details so that they can be advertised on our website and in the GMG calendar.

It looks like our spring student presentations meeting will be another success, with fourteen submitted talks. Please encourage other students to attend, especially those who may wish to do thesis or independent study work of their own. Seeing what other students have done can be very motivating!

Our summer plans are shaping up as well, with Jonathan Kim offering to help lead a trip on Saturday, July 19, in the Colchester area, including information on the radioactivity map he's been working on. Details are elsewhere in this publication.

See you in Middlebury!

Sincerely,

Helen Mango
Department of Natural Sciences
Castleton State College, Castleton, VT 05735
(802) 468-1478; helen.mango@castleton.edu

WINTER MEETING MINUTES

Saturday, February 8, 2003
Northfield, Vermont

Present were Helen Mango (President), Tim Grover (Vice President), Dave West (Secretary), Steve Howe (Treasurer); also Peter Ryan, Dave Westerman, Larry Becker, Rick Dunn.

President Helen Mango opened the meeting. It was agreed that it would be all right to advertise field trips and meetings associated with other geological organizations in the GMG and on the Society Website. Steve Howe indicated that the website is being expanded and updated regularly. Steve Howe (as Treasurer) reported that the financial status of the Society remains strong and about two-thirds of the members have paid their dues. The committee then discussed reducing the grace period for members with delinquent dues and it was agreed this issue should be discussed more widely at the annual meeting, perhaps involving a change to the bylaws. Any proposed change would be warned at least one month in advance for possible action at the fall annual meeting. The bylaws concerning who may be a Society member (as opposed to an associate member) also need review. Increasing the number of student members

was also discussed. Larry Becker thanked the Vermont Geological Society on behalf of the Vermont Geological Survey for the letter sent to the state Legislature indicating the Society's support of the State Survey and the description of the services the Survey provides on behalf of the State of Vermont. Larry also provided an update on attempts to initiate an aquifer-mapping program in the state. Members of the Executive Committee pledged support for such a program and asked to be kept informed of progress.

Arrangements had been made for the Spring VGS meeting in Middlebury on April 26th. It was also reported that Jon Kim of the Vermont Survey offered to lead the summer VGS field trip on July 19. The focus of the trip would be the bedrock and environmental geology of the Colchester quadrangle.

Respectively submitted,
Dave West, Secretary

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

The Society's Winter Meeting was an unqualified success, with some of the most interesting talks we have ever had at a winter meeting. Members are encouraged to contact me with any suggestions they may have for a theme for next year's meeting.

The Committee did not receive any applications for the Society's Research Grant Program by the due date of April 1, 2003. I will recommend to the Executive Committee that a due date of October 1, 2003 be established for a second round of applications. The Committee will strengthen its efforts to advertise the Program .

The Committee gratefully acknowledges the contributions to the Society's Research Grant Program by the following members:
Laurence R. Becker
Jeanne C. Detenbeck
Lawrence W. Gatto
Arthur W. Gilbert, Jr.
Barbara L. Hennig
Jefferson P. Hoffer
Carl Koteff
Eric Lapp
Frederick D. Larsen

John A. Malter
Alexis P. Nason
Ileene Schmidt
Ethel M. & William J. Schuele
Sharon Strassner
Peter J. & Thelma B. Thompson
Roger & Terry Thompson
Richard & Susy Ziegler

Finally, the Committee continues to add content to the Society's website. Members' contributions are always welcome.

Respectfully submitted,
Stephen S. Howe, Chair, Advancement of Science Committee

VERMONT GEOLOGICAL SOCIETY TREASURER'S REPORT

The financial condition of the Society continues to be strong. As of April 3, 2003, the checking account balance was $5,170.54. To my knowledge, there are no outstanding bills.

I would like to thank the large majority of members who promptly renewed their membership by the due date of February 15, 2003. However, about 15 members have not paid their dues. Please send your check and green membership directory form to me at the address indicated on the form, not to the University of Vermont

The following members have been approved for membership in the Society since the last report: John Carmola, St. Albans, VT; Keith Musselman, Burlington, VT; Adam Schoonmaker, Albany, NY; Matthew Stein, Windsor, VT;Bryan and Beverley Wemple, Burlington, VT

Respectfully submitted,
Stephen S. Howe, Treasurer

STATE GEOLOGIST'S REPORT AND PUBLIC ISSUES

With a new administration, the Vermont Survey sponsored a map showing for the Agency of Natural Resources. More than 50 people came to view maps and meet the geologists working on the projects. The maps addressed the naturally occurring radionuclide issue, landslides,

erosion, groundwater recharge mapping, and basic bedrock and surficial geology.

The Division of Geology and the Division of Water Supply formally transferred a "A Report on the Status of Groundwater and Aquifer Mapping in the State of Vermont" to the chairs of the Natural Resource committees in the Legislature. The report, developed by the two Divisions, is intended to meet the reporting requirements of Act 133 of the Adjourned 2001 Legislative Session.

Two recent requests for aquifer information came from Castleton and Woodstock. The Northeast Rural Water Association (NRWA) is working with Castleton to combine planning approaches for groundwater protection and stormwater discharges. The town wants to look at existing groundwater supplies and the nature of the aquifer. The State Geologist is advising the NRWA in their effort to develop a groundwater protection ordinance. The Woodstock Conservation Commission wants to better understand groundwater on a town wide basis. The State Geologist will visit Woodstock in May and make a presentation to the Commission.

Water Quality Division is requesting advice on the potential collapse of a 60-100' Lamoille Valley RR embankment in Morrisville. The embankment started sliding this past fall. Stormwater impounding behind the embankment may be the cause due to a clogged stone box culvert.

Two years ago, the Vermont Survey began working with the Vermont Dept. of Agriculture to understand the geologic basis for nitrate contamination of bedrock wells in the vicinity of a farm in East Montpelier. Geologic mapping was completed in the vicinity of the East Montpelier farm by Jon Kim and two undergraduate student assistants from the University of Vermont. The Div. of Geology, in cooperation with Water Supply Division, submitted a 319 non-point source grant application to the Water Quality Division to further address the problem. The proposal is entitled: A Role of Geologic and Hydrologic Setting in the Development of Effective Nutrient Management Plans at Vermont Farms.

Respectfully Submitted,
Laurence Becker, State Geologist and Chair, Public issues Committee

THE GREEN MOUNTAIN GEOLOGIST
VERMONT GEOLOGICAL SOCIETY
DEPARTMENT OF GEOLOGY, UNIVERSITY OF VERMONT
BURLINGTON, VERMONT 05405-0122

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THE
GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

FALL 2003 VOLUME 30 NUMBER 3& 4

The Vermont Geological Society's Annual Meeting & Fall Field Trip October 25, 2003

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PRESIDENT'S LETTER

Hello all-

This is my last message to you as President of VGS, and in true outgoing style I am writing it at the last minute. Tim Grover will be taking over as President (having had a full year to observe me in action), and Rick Dunn of Norwich University has agreed to be nominated for the Vice-Presidency.

Our summer field trip was just great – thanks so much to Jonathan Kim and Peter Thompson for introducing us to the issue of radioactivity in groundwater in the Colchester area. Peter Ryan has been overseeing studies of radioactivity in groundwater in the Middlebury area, and I hope to do some similar work in and around Clarendon (home of the Clarendon Springs Formation, the likely culprit). This issue shows how important an understanding of geology is to the greater good of society, in this case in the arena of public health.

If you have students working on senior theses and projects, please have them consider presenting their results at the spring meeting. This is an excellent forum for students to practice presenting their own research without the pressure of regional or national meetings, and gives them a handy deadline that comes *before* the end of the spring semester. It is also a terrific way to find out what folks are doing at the different educational institutions in Vermont.

Our fall field trip, Annual Meeting and elections will be held on October 25 in the Pomfret-Quechee area (details elsewhere in this publication). The meeting is open to all.

I hope to see you later this month!

Sincerely,

Helen Mango
Department of Natural Sciences, Castleton State College
Castleton, VT 05735
(802) 468-1478; helen.mango@castleton.edu

FALL FIELD TRIP, ANNUAL MEETING & ELECTIONS

Saturday, October 25, 2003

FIELD TRIP:
Time: 9:30 am – 3:30 pm
Location: Rt. 14 in West Hartford where the bridge crosses the White River (there is a small store here for folks who forget to pack a lunch....)

If you are coming from the north on Interstate 89, exit at Sharon (Exit 2) and take Rt. 14 south to West Hartford. If you are coming from other directions on different roads, bring your gazeteer!

The VGS fall field trip will examine the various lithofacies of the Waits River, Standing Pond, and Gile Mountain Formations in the Pomfret Dome area. The rocks in this area were metamorphosed under garnet- through kyanite-zone P-T conditions and show evidence for multiple phases of deformation.

ANNUAL MEETING AND ELECTION OF OFFICERS:
The VGS Annual Meeting will take place in Quechee immediately following the trip. We will meet at 3:30 pm in the parking lot on the south side of the road just east of Quechee Gorge. From there we will caravan to a local restaurant for the Annual Meeting and Election of Officers.

If you are unable to attend the Annual Meeting, please send in the enclosed absentee ballot by October 24, 2003. Ballots should be sent to Dave West, Dept. of Geology, Middlebury College, Middlebury, VT

Nominees for offices are:

President-	Tim Grover
Vice-President-	Rick Dunn
Secretary-	Dave West
Treasurer-	Steve Howe

New and returning Board Members are:
Board- Helen Mango, Ray Coish, KristenUnderwood
Advancement of Science- Steve Howe
Education Committee - Christine Massey
Membership – Stephen Wright
Public Issues- Larry Becker
Publications- David West

STATE GEOLOGIST'S REPORT

Groundwater

The Vermont Geological Survey is working on a number of groundwater related issues. The Agency of Natural Resources is aware of geology and the Vermont Survey's role in solving groundwater supply and protection problems. Some of the following work results directly or indirectly from the "Report on the Status of Groundwater and Aquifer Mapping in the State of Vermont" that the Vermont Survey coauthored with the Water Supply Division of DEC and transferred to the legislature in January 2003.

Well Location Work

The State Geologist is discussing with Regional Planning Commissions (RPC) the possibility of locating water wells to improve positional accuracy. Discussions are underway with the Bennington Regional Planning Commission about conducting location work. In May, the State Geologist presented information on groundwater in Woodstock for the Conservation Commission. Woodstock has now contacted the Two-Rivers Ottauquechee RPC to pursue Vermont Municipal Planning Grant funds to locate water wells and data in their town.

Nitrates near a Large Farm

A September 11, 2003 public meeting was held in East Montpelier to explain the Vermont Survey study plan for understanding the source of nitrates in domestic wells near a large farm operation. The EPA funded study requires an EPA approved quality assurance plan. Comments have been received from EPA on the plan. We hope to finalize the plan in October.

Radionuclides - Fate and Transport

The State Geologist will perform science oversight for Vermont on a University of New Hampshire (UNH) study that looks at the fate and transport of naturally- occurring radionuclides from filter backwash systems into wastewater disposal systems. To kick off the study, the New England Interstate Water Pollution Control Commission moderated a conference call between Vermont, the New England States, EPA and the New England Water Treatment Technology Center at UNH.

Respectfully,

Larry Becker
State Geologist and Chair, Public Issues Committee

EDUCATION REPORT

Earth Science Week 2003 is the week of Oct. 12-18, 2003. Check out the list of activities and the Governor's Proclamation at the State Geologist's website: http://www.anr.state.vt.us/geology/vgshmpg.htm.

The UVM Perkins Geology Museum is working on two digital image archives. The museum collections will soon be available on-line. Secondly, the next phase of the Landscape Change Project is underway with the coordination of Jens Hilke (656-1374). He is working with Vermont students, teachers, historical societies and towns to add historic/modern image pairs to this second image database. If you have historic photographs of Vermont physical landscapes, please contact Jens.

The JASON Project is now coordinated through the Perkins Museum. The award-winning JASON curriculum is a multi-disciplinary, multi-media program for grades 4-9 students that focuses predominantly on science and research. This year students and teachers are visiting Panama virtually with "JASON XV: Rainforests at the Crossroads." JASON curricula typically have a strong geology component. The next

professional development training for teachers is Oct. 24, 2003 at UVM. Contact Christine Massey for more information (656-1344).

A list of Vermont Geology Outreach Centers is being compiled by Robert Pye of the VT Marble Museum (800-427-1396). He is creating a brochure for tourism purposes called "Vermont Rocks." Included will be listings for museums, quarry visitors centers, ferry lines, and state agencies. If you know of a geologic "center of information" in Vermont, please contact him.

Sincerely,

Christine Massey

SPRING MEETING STUDENT AWARDS

Congratulations to the students who received awards at our Spring 2003 Meeting:

1st Place Graduate Student Award ($75):
Eric Butler, University of Vermont

1st Place Undergraduate and Doll Award ($75):
Heather Beal, Middlebury College

2nd Place Undergraduate Award ($50):
Jeremy Shakun, Middlebury College

3rd Place Undergraduate Award ($25):
Brian McCurdy, Middlebury College

The Charles G. Doll Award, given for the top undergraduate student presentation, is a plaque with the student's name and school engraved on it that is kept at the student's school until the following year's Spring Meeting.

CONGRATULATIONS!

2003 OUTSTANDING EARTH SCIENCE TEACHER AWARD

The 2003 Outstanding Earth Science Teacher Award winner from the New England Section is Shelley F. Snyder, who teaches Earth Science at Mt. Abraham Union High School in Bristol, VT. In her fifteen-year teaching career she has been an energetic innovator, having her students involved in collecting field data, doing research, and integrating local environmental issues into science classes. Shelley comments that "It is well and good to learn about the rain forests, but we need to learn about the forests in our own backyard.... [If] we talk only about the faraway places, our back yards seem insignificant." In addition to her hands-on approach, she successfully includes the arts and humanities in science classes (and general education) using story-telling and drama.

Shelley is an excellent role model and mentor to beginning teachers. One of Shelley's goals is to design open-ended investigations that are challenging but not overwhelming for the students. In her classroom Shelley maintains a working river system model, complete with plants, fish, and running water. Students are interacting with the hissing cockroaches or the rock pile depending on the subject of the day. Students engage in discussion and experimentation routinely.

Shelley challenges herself academically by taking classes such as forensic anthropology and workshops like the NASA Snow and Ice investigations held at Lake Placid, N.Y. in 2001.

Shelley is a consistent presence in the Vermont Geological Society, and has been President three times. She has given many professional presentations to teachers and the public, and written grants and journal articles. Her passion for science and teaching is contagious.

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

Despite the Committee's efforts to strengthen its advertisement of the Society's Research Grant Program, no applications were received by the due date of October 1, 2003. I will recommend to the Executive Committee at the Annual Meeting that two due dates for applications of April 1, 2004 and October 1, 2004 be established and that the maximum award for each round be increased from $500 to $800. I will also recommend the expenditure of funds to print flyers advertising the program and to mail these flyers to earth science departments of local universities.

The Committee will recommend several dates in late February 2004 for the Society's next Winter Meeting. Members are encouraged to contact me with any suggestions they may have for a theme for the meeting.

Respectfully submitted
Stephen S. Howe, Chair

TREASURER'S REPORT

The financial condition of the Society continues to be strong. As of September 30, 2003, the checking account balance was $5,031.69. To my knowledge, there are no outstanding bills. As of January 1, 2003, the Society's checking account is no longer interest-bearing. A financial statement for the period 10/1/02-9/30/03 is indicated below.

The following member has been approved for membership in the Society since the last report: Nathan Donahue, Northfield, VT.

The 2004 membership renewal and directory information form will be mailed out to all members by December 31, 2003. The deadline for renewal will be January 31, 2004.

Respectfully submitted,
Stephen S. Howe, Treasurer

Treasurer's Report (continued)

Income and Expenses
10/1/02-9/30/03

INCOME		
Total Dues		$1,564.00
Member	$1,200.00	
Family	$240.00	
Student	$24.00	
Institution	$100.00	
Student Grant Contributions		$392.00
Vermont Geology Sales		$97.00
Checking Account Interest		$2.42
TOTAL INCOME		$2,055.42
EXPENSES		
GMG Printing		$289.69
Postage	$201.12	
Office Supplies		$26.95
Telephone		$2.72
Winter Meeting Refreshments		$49.06
Awards	$285.00	
Spring Meeting Student Talks	$225.00	
Earth Science Week Posters	$60.00	
Bank Research		$8.50
TOTAL EXPENSES		$863.04
TOTAL INCOME – TOTAL EXPENSES		$1,192.38

ABSENTEE BALLOT 2003
Vermont Geological Society

Please enter your name and address here:

Officers:

President	Tim Grover	_____
Vice-President	Rick Dunn	_____
Secretary	Dave West	_____
Treasurer	Steve Howe	_____

Board of Directors (Select 2)

Ray Coish	_____
Kristen Underwood	_____

If you will not be attending the annual meeting, please complete the absentee ballot and return it to **David West, Dept. of Geology, Middlebury College, Middlebury, VT 05753** no later than October 24, 2003.

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