THE GREEN MOUNTAIN GEOLOGIST

VERMONT GEOLOGICAL SOCIETY
DEPARTMENT OF GEOLOGY
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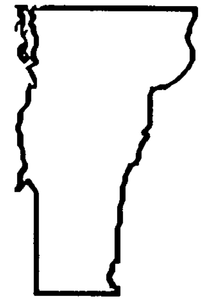

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

SPRING 1994 VOLUME 21 NUMBER 1

The Vermont Geological Society

Spring Meeting for the Presentation of Student Papers

SATURDAY APRIL 23, 1993, 9 AM

Twilight Auditorium
MIDDLEBURY COLLEGE

Directions: The spring VGS student meeting will take place in Twilight Auditorium on the Middlebury College campus. Twilight Auditorium is housed in the old Grammar school, a three-story brick building located in the green between Franklin Street and College Street (downhill and east of the Science Center). Members may park in the parking lot behind the Science Center.

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PRESIDENT'S LETTER

1 April 1994

Dear Members,

Don't be **fooled** in spite of the date!! The Vermont Geological Society does need you!

Although, many VGS members have served through the years and made our Society much stronger than those organizations where few do the work of many, we can do even better! Your perspectives and talents are VGS's lifeblood but only when you volunteer them.

Your executive committee is currently revising the VGS Constitution and Bylaws to be voted on at this fall's annual meeting. Your input regarding revisions is needed. The nominating committee is seeking VGS members willing to serve as officers, directors and permanent committee chairpersons for next year. Let the committee know you'd like to be a nominee. Stephen Wright is looking for guest editors for future *GMGs*. Give him a call. Kent Koptiuch is the guest editor for the summer *GMG* which will be devoted to groundwater issues. Tell Kent if you've something to contribute. The executive committee will be reviewing proposals in May that were submitted for VGS Research Grant Program funding. If you'd like to be a reviewer let us know. The Society needs leaders for future field trips as well.

The VGS spring meeting will be held on 23 April 1994 at Middlebury College. We had originally planned on holding the meeting at UVM, but the UVM campus and all meeting rooms were booked for a campus-wide event on that day. Students will present their research results and three VGS members are needed to serve as judges to determine the winners of the VGS best presentations awards. I've been a judge twice and was very impressed with the quality of the student research and their professional presentations. Plan to attend and support the students. They deserve our recognition.

As you can see there's no shortage of VGS functions to which you can apply your talents. It's simply a matter of making a commitment to do so. What's holding you back?

Sincerely,

Larry Gatto

SPRING MEETING PROGRAM

Twilight Auditorium, Middlebury College
April 23, 1994

8:30 Coffee/Doughnuts

9:00 Yana L. Minnis: *Field Relationships and Structural Analysis of an Ultramafic Belt near Westfield, Vermont*

9:15 Adam Schoonmaker: *The Brome Thrust in Northern Vermont*

9:30 Matthew J. Evans: *Geochemistry of Metadiabase Dikes and Metavolcanic Rocks from North-Central Vermont*

9:45 Laura M. Kretschmar: *Miocene Volcanism in Southwestern British Columbia: Geochemistry and Tectonic Implications*

10:00 Matthew K. Bingham: *Flood History Since 1800 in Relation to Late Holocene Climate Change and Stream Incision, Yellowstone National Park*

10:15 Peter M. O'Hara: *Morphometric Analysis of Flood and Erosion Potential of Drainage Basins in Northeastern Yellowstone National Park*

10:30 David Bryan: *A Geomorphic Approach to Maximum Discharge Estimation, New Haven River, Vermont*

10:45 Coffee Break

11:00 Kelly A. Kryc: *Surface Characterization of the Northern Bjorn and Gardar Sediment Drifts, North Atlantic*

11:15 Russell A. Schuck: *A Study of Metals in Arrowhead Mountain Lake, Milton, Vermont*

11:30 Scott D. Thompson: *The Effects of the Internal Seiche in Lake Champlain on a Shallow Basin*

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11:45 Kenneth Mansfield: *Geologic and Economic Analysis of Beach Erosion near Barnegat Inlet, New Jersey*

12:00 Michael B. Sayre: *A Correlation of Glacial Sediment Stratigraphy and Groundwater Availability on Block Island, Rhode Island*

12:30 Eugene Lee: *Radon Potential in the Middlebury and East Middlebury Area, Addison County, Vermont*

12:45 Timothy Loescher: *The Relationship between Soil Radon Concentrations and Surficial Sediment Characteristics in Middlebury and East Middlebury, Vermont*

1:00 Lunch: *Lunch is available at several restaurants within walking distance of the meeting.*

1:30 VGS Executive Committee Meeting: *All members are invited to attend!*

SPRING MEETING ABSTRACTS

FLOOD HISTORY SINCE 1800 IN RELATION TO LATE HOLOCENE CLIMATE CHANGE AND STREAM INCISION, YELLOWSTONE NATIONAL PARK

Bingham, Matthew K., Department of Geology, Middlebury College, Middlebury, VT 05753

Soda Butte Creek, a tributary of the Lamar and Yellowstone Rivers in the northeast corner of Yellowstone National Park, WY–MT, exhibits high gravelly flood bars which are especially prominent in Round Prairie below the narrow constriction of Icebox Canyon. Three locally distinct levels of these bars are populated by apparent even-age stands of conifers, primarily lodgepole pine (*Pinus contorta*), suggesting colonization of bars subsequent to deposition. Dendrochronological analysis of 180 trees within these stands was used to approximately date the deposition of the flood bars. Trees on the highest set of bars are up to about 110 yrs old, suggesting a large flood in the late 1800s (prior to instrumental discharge records). Indirect discharge estimates imply a flow of approximately 10,000 cfs (283 m^3/s) for the associated flood. This discharge is almost an order of magnitude greater than the 100-yr flood estimated using discharge/basin-area relations derived from gage records for the northern Yellowstone region; it approaches the maximum recorded flood for a basin of this size in the same region. The middle set of bars supports trees no older than about 59 yrs; discharge estimates are about 8,000 cfs (227 m^3/s). Narrative accounts exist of a probable associated flood on the Lamar River in June 1918. These accounts are corroborated by the highest recorded discharges on the Yellowstone River just north of the park. A smaller flood was produced on Soda Butte Creek by a mine tailings dam break at Cooke City in 1950; trees on associated flood bars are up to about 35 yr old and discharge reconstruction suggests a flow of about 4,000 cfs (113 m^3/s). Lower Soda Butte Creek displays a well-developed set of Holocene fill-cut terraces. ^{14}C ages show that overbank sedimentation on the lowest of these terraces (T4) began ca. 1200 AD. Tree-ring data suggest that this floodplain level became inactive by ca. 1850, thus T4 terrace activity approximately corresponds to the Little Ice Age. A trend toward warmer and drier conditions (largely due to reduced winter precipitation) since 1880 is evident in instrumental climate records in Yellowstone. Most large floods in this region are produced by heavy rain-on-snow events during snowmelt. Major floods, downcutting, and channel instability characterize fluvial activity at the end of the Little Ice Age in this area.

A GEOMORPHIC APPROACH TO MAXIMUM DISCHARGE ESTIMATION, NEW HAVEN RIVER, VERMONT

Bryan, David, Department of Geology, Middlebury College, Middlebury, Vt. 05753

Until recently, no consistent discharge records were kept of the New Haven River, which is located in central Vermont and flows west out of the Green Mountains. Previous discharge estimation was made by regional flood frequency analysis. This study used geomorphic features to indirectly estimate maximum discharges of large floods at study sites located above the confluence of the New Haven with the Muddy River Branch and at the Route 7 bridge. The physical features which were used to estimate maximum discharge are stepped flood plain surfaces and channel cross sections. The flood plain surfaces are similar to low terraces, but lack of soil development indicates a young age. A laser theodolite was used to survey flood plain slopes and channel profiles relative to present stream levels. Slope estimations from a flood insurance study were used because field estimates of flood plain slope proved to be inaccurate. The simplified slope area method estimated the maximum discharge to be 28,000 ft^3/s at the first site and 32,000 ft^3/s at the second site with an estimated error of ±30%. The relationship of maximum recorded flood discharge to drainage area for ten rivers in Vermont yielded a comparison for the Route 7 site estimate. The two greatest discharges for the ten rivers, in respect to drainage size occurred in 1927 and were close to 180 $ft^3/s/mi^2$. The relation for the New Haven is higher, 280 $ft^3/s/mi^2$, again with a possible error of ±30%. Results from this study suggest that recent large floods have had substantial impact on the geomorphology of the New Haven Valley.

GEOCHEMISTRY OF METADIABASIC DIKES AND METAVOLCANIC ROCKS FROM NORTH-CENTRAL VERMONT

Evans, Matthew J., Department of Geology, Middlebury College, Middlebury, VT 05753

Metamorphosed diabasic dikes and volcanic rocks from the Westfield area and metavolcanic rocks from the Newport Center area were sampled and geochemically analyzed.

The Westfield area rocks are primarily chlorite- and epidote-rich greenstones which display a prominent fabric. They are found in the Ottaquechee/Stowe formations. The diabasic dikes are feldspar-rich and are associated with dull green-gray phyllite. The metavolcanics near Newport Center are part of the Bolton Mountain volcanic complex in the Moretown Member of the Missisquoi Formation. They are slightly metamorphosed but retain some igneous structure, including pillows.

This research show both sets of rocks have TiO_2 levels from 0.96 to 1.64 weight percent, Y concentrations from 22 to 44 ppm, and Zr concentrations from 96 to 167 ppm. The rocks are classified as tholeiitic basalts and both the Westfield and Bolton Mountain samples clearly display a MORB (mid-ocean ridge basalt) signature when plotted on tectonic discriminant diagrams such as Y–Cr and Ti–Zr–Y. These findings concur with previous geochemical work on metavolcanics and diabasic dikes in the Stowe and Ottaquechee formations but are in contrast to earlier theories for the Bolton Mountain Volcanics which had been interpreted as an island-arc terrane. Current research shows that both the Westfield and Bolton Mountain rocks probably formed as either late-stage rift or early ocean floor basalts which were tectonically emplaced during the closing of the proto-Atlantic ocean.

MIOCENE VOLCANISM IN SOUTHWESTERN BRITISH COLUMBIA: GEOCHEMISTRY AND TECTONIC IMPLICATIONS

Kretschmar, Laura M., Dept. of Geology, Middlebury College, Middlebury, VT 05753

Mount Noel and Chipmunk Mountain are two Miocene volcanic complexes located in the Coast Mountains of southwestern British Columbia, 120 km northeast of Vancouver. Stratigraphy, K/Ar age dates, petrography, and geochemistry show that the volcanics of Mount Noel are in close association with the Neogene Chilcotin Group Basalts, while the volcanics of Chipmunk Mountain are in close association with the Oligocene-Miocene Pemberton Volcanic Belt.

The volcanics of Mount Noel crop out in three 1–3 km^2 areas and consist of flat-lying, columnar jointed, olivine-bearing basalt flows interlayered with volcaniclastic debris flows. Major and trace element analyses on thirty-eight samples indicate that the Mount Noel rocks are predominantly tholeiitic basalts and basaltic andesites. The Mount Noel analyses plot directly in the within-plate tectonic environment of the Zr–Zr/Y diagram and plot transitionally between the within-plate and mid-ocean ridge tectonic environments of the Zr/Ti diagram. The geochemistry of the Mount Noel volcanics is similar to the Chilcotin Group Basalts. Spatially the Mount Noel volcanics lie in the range of the Chilcotin Group Basalts, and, at 19.8 Ma (Mathews, 1988), they probably represent early stages of Neogene Chilcotin volcanism.

The volcanics of Chipmunk Mountain, 15 km south of Mount Noel, crop out in a 12 km^2 area and consist of undifferentiated pyroclastics, sills, and dykes. Major and trace element analyses on twenty-six samples show that the rocks range from basalts to rhyolites, with the majority classifying as basaltic andesites and andesites. The trend of the whole-rock analyses on the FAM diagram and SiO_2 vs. K_2O is clearly calc-alkaline. On the MgO–Al_2O_3–FeO tectonic discriminant diagram, the Chipmunk Mountain analyses plot transitionally between the fields of orogenic and spreading island volcanics. The geochemistry of the Chipmunk Mountain rocks appear to be closely related to the calc-alkaline volcanic centers of the Pemberton Volcanic Belt. Spatially and temporally, at 26.8 ±1.4 Ma, the Chipmunk Mountain volcanics further correlate with the Pemberton Volcanic Belt.

The two volcanic complexes of this study represent two different episodes of Miocene volcanism in southwestern British Columbia. The Mount Noel volcanics and the Chilcotin Group Basalts appear to have erupted in a back-arc tectonic setting due to asthenosphere upwelling associated with the subduction of the Juan de Fuca Plate beneath the North American Plate while the Chipmunk Mountain volcanics appear to have erupted in an arc also associated with subduction of the Juan de Fuca Plate.

SURFACE CHARACTERIZATION OF THE NORTHERN BJORN AND GARDAR SEDIMENT DRIFTS, NORTH ATLANTIC

Kryc, Kelly A., Department of Geology, Middlebury College, Middlebury, VT 05753

The northern reaches of the Bjorn and Gardar sediment drifts, south of Iceland and east of the Rekjanes Ridge, have a complex history of sedimentary influences. Data collected during June 1993 aboard the *R/V Maurice Ewing* included 3.5 kHz seismic profiles and piston and gravity cores. To determine the surficial sedimentary processes in this area, echo-character mapping of 3.5 kHz seismic profiles was done. To elucidate the exact nature of the acoustic reflectors seen in the 3.5 kHz profiles, cores taken from the survey area were analyzed for compressional velocity and density. From these parameters, synthetic seismograms were generated and the results compared to the 3.5 kHz profiles.

The surface echo-character map consists of four distinct echo types. The nature of these echoes include prolonged echoes, continuous echoes with multiple sub-bottom reflectors, discontinuous echoes with multiple sub-bottom reflectors, and acoustically transparent returns. The main portions of the Bjorn and Gardar sediment drifts are represented by continuous echoes with multiple sub-bottoms showing that they are formed from contourite currents. Morphologically, a "drift valley" separates the two drifts. Acoustically it is represented by discontinuous echoes with multiple sub-bottoms. This valley underlies the bottom current having the highest velocity, causing the deposited sediment to be modified by scour. Also, within this valley there is evidence of large deposits of sand which indicate that this region is subjected to large mass wasting events. Additionally, certain sections of both drifts have been faulted.

The correlation of the synthetic seismograms with the echo-character map and bathymetry of the survey site provides an accurate analysis of the sedimentary processes occurring on these sediment drifts for the most recent past. The surface characterization has shown that the sedimentary evolution of the northern regions of these drifts, though predominantly contourite controlled, has been modified and in some instances controlled by tectonism and mass wasting events. This is probably due to the proximity to the voluminous source of sediments on Iceland and to the Rekjanes Ridge.

RADON POTENTIAL IN THE MIDDLEBURY AND EAST MIDDLEBURY AREA, ADDISON COUNTY, VERMONT

Lee, Eugene, Department of Geology, Middlebury College, Middlebury, VT 05753

Radon is a potential leading cause of lung cancer. Average outdoor levels of radon are low enough (about 0.2 pCi/l), due to dilution by the atmosphere, that they do not threaten human health. It is only when radon levels accumulate and build up indoors that they become dangerous. The U.S. EPA's action-level for radon mitigation of a home is 4 pCi/l. Utilizing E-PERMs (Electret-Passive Environmental Radon Monitors), soil radon levels in six different surficial materials in the Middlebury and East Middlebury area in Addison County, Vermont, were obtained for periods of two, four, and eight days. Radon levels in houses built upon the six surficial materials were also obtained with E-PERMs for periods ranging from six to thirty days. Initial results show that the silt and the stream alluvium sites have low average soil and indoor radon levels with the average indoor levels registering 1.55 pCi/l and 0.5 pCi/l respectively on the short-term E-PERMs. Results from the long-term E-PERMs are still pending at the time of writing. The lacustrine sands and gravels of site 5 had high average soil and indoor radon levels with an average indoor level of 8.95 pCi/l. At each of the other three surficial material sites, indoor and outdoor radon levels did not agree in relative magnitude. Variations in indoor radon levels are difficult to explain solely by geological factors like soil porosity, permeability, and moisture content. Anthropogenic factors such as house design and freedom of air circulation in a house due to open or shut windows can strongly affect indoor radon levels and may account for observed relative differences between soil and indoor radon measurements.

THE RELATIONSHIP BETWEEN SOIL RADON CONCENTRATIONS AND SURFICIAL SEDIMENT CHARACTERISTICS IN MIDDLEBURY AND EAST MIDDLEBURY, VERMONT

Loescher, Timothy, Department of Geology, Middlebury College, Middlebury, VT 05753

The purpose of this research is to evaluate the reliability of surficial geologic characteristics as indicators of soil radon potential. Six surficial geologic environments common in the Middlebury/East Middlebury area were defined comprising a range of sediment type, texture, permeability, porosity, and moisture content. These include lacustrine clay, lacustrine silt, two deltaic sand and gravel units (Lake Vermont sediments), sandy glacial till, and sandy postglacial stream alluvium. Soil radon concentrations were measured in the surficial sediments for intervals of 2, 4, and 8 days at a depth of 18–19 inches. The highest soil radon levels were measured in the two sand and gravel units; the average levels were 201 and 241 pCi/liter-days. The glacial till and stream alluvium had low results with averages of 37 and 59 pCi/liter-days, respectively. The average soil radon level measured in the clay was 130 pCi/liter-days, whereas in the silt it was 55 pCi/liter-days. An anomalous radon level of 302 pCi/liter-days measured in the silt over the 4-day interval was omitted from the calculated average. Moisture content levels in the surficial sediments varied, but the percentages measured in each of the finer-grained clays, silts, and alluvium were near field capacity. The highly porous and permeable sands and gravels contained lower moisture content than both the relatively impermeable clays and silts and the moderately drained till and alluvium. The high moisture content and low permeability of the clays and silts contributed to a prediction of relatively low soil radon concentration. The average levels measured much higher than predicted, particularly in the clay; however, average soil radon levels declined substantially from the 2-day to the 8-day measurements. The inevitable soil disruption that occurs when radon detection devices are buried in the ground may release large amounts of previously immobile radon gas when the clay is disturbed. This results in initially high soil radon readings, but lower average flux rates over the longer time intervals. These results indicate that surficial geologic characteristics may be useful in predicting soil radon concentrations.

GEOLOGIC AND ECONOMIC ANALYSIS OF BEACH EROSION NEAR BARNEGAT INLET, NEW JERSEY

Mansfield, Kenneth, Department of Geology, Middlebury College, Middlebury, VT 05753

Barnegat inlet is one of five inlets on the New Jersey coastline stabilized through the use of jetties. The inlet was first stabilized in 1939–1940 by the construction of two converging stone jetties. In the 100 years prior to stabilization, the inlet migrated 1.6 km to the south, as a result of the net southerly longshore drift in the area. The inlet's behavior remained highly unpredictable, however, and in 1991 a new jetty was added to create a "subparallel" configuration. Littoral drift was prevented from entering the intra-jetty area, creating a more efficient inlet bypass system. In response to the new inlet dynamics, a large ebb tidal delta formed just seaward of the inlet. The ebb tidal delta created a local longshore current reversal, which is presently causing massive beach erosion south of Barnegat inlet. After analyzing all of the available options, it is recommended that an artificial reef is put into place off of those beaches experiencing erosion. Simultaneous beach replenishment could be used if rapid beach recovery is desired. Finally, a long term plan of beach management is proposed in which an end to coastal development, along with gradual retreat from the shoreline is urged.

FIELD RELATIONSHIPS AND STRUCTURAL ANALYSIS OF AN ULTRAMAFIC BELT NEAR WESTFIELD, VT.

Minnis, Yana L., Department of Geology, Middlebury College, Middlebury, VT 05753.

Field data collected in northern Vermont provides insight into the tectonic relationship of the rocks in this area. Mapping was done at a scale of 1:10,000 over a 4 square mile area near Westfield, Vermont. Rocks studied are located in an ultramafic belt, parts of which have been correlated with the Baie Verte–Brompton Line in Canada.

Lithologies mapped include a dark gray to black, rusty weathering, pyritiferous phyllite with associated greenstones; a dull, green-gray, homogeneous phyllite with associated metadiabasic dikes; a green-gray quartzose metasediment; and a white, micaceous sericitic schist. Serpentinite bodies have also been mapped and form ridges throughout the study area.

The rocks in this study area record at least two phases of deformation. The dominant foliation generally trends N20E to N40E and dips steeply to the east. Folding is recorded in many of the phyllites and can also be seen in map pattern. A second, less intense foliation cuts the dominant foliation between N40E and N60E and dips steeply to the north.

Data collected in the field supports current tectonic models of the Appalachian Mountain System applicable to this study area. One model proposed by previous workers suggests that the ultramafic rocks are fragments of oceanic crust thrust onto the continental margin of the North American continent as the proto-Atlantic Ocean closed during the Taconic Orogeny. The black phyllites can be correlated to the deep sea sediments of the North American continent, while the greenstones and metadiabasic dikes in this area are similar to other ocean crustal rocks found in northern Vermont.

MORPHOMETRIC ANALYSIS OF FLOOD AND EROSION POTENTIAL OF DRAINAGE BASINS IN NORTHEASTERN YELLOWSTONE NATIONAL PARK

O'Hara, Peter M., Department of Geology, Middlebury College, Middlebury, VT 05753

A recent controversy has revolved around the sources of turbidity in the Yellowstone River drainage. Drainage basins in the Soda Butte and Slough Creeks in northeastern Yellowstone National Park were analyzed using morphometric parameters to determine differences between drainage basins with incised alluvial fan channels and drainage basins with unincised fan channels. Drainage networks were constructed on USGS 7.5 minute topographic maps, and morphometric parameters such as drainage density (D), basin area (A), drainage frequency (F), and relief ratio (R_h) were determined. Soda Butte Creek has many incised fan channels, whereas Slough Creek had few prior to the 1988 fires. Mean values of relief ratio, drainage density, and drainage frequency are higher in Soda Butte Creek than Slough Creek (alpha = 0.01). There is a relationship between the morphometric parameters and incised fan channels. For basins less than 10 km^2, the formula $R_h = 0.34\ A^{-0.38}$ was obtained. This formula indicates the threshold value of R_h above which fan channels have a strong tendency to be incised. The formula $R_h = -0.11D + 1.25$ indicates the threshold relationship between drainage density and relief ratio. The greater the drainage density value, the lower the relief ratio value necessary for incised fan channels. These result suggest that intrinsic geomorphic differences are in large part responsible for fan erosion, thus higher suspended sediment loads in Soda Butte Creek.

A CORRELATION OF GLACIAL SEDIMENT STRATIGRAPHY AND GROUNDWATER AVAILABILITY ON BLOCK ISLAND, RHODE ISLAND

Sayre, Michael B., Departments of Geology and Geography, Middlebury College, Middlebury, VT, 05753.

Block Island, Rhode Island is located 10 miles south of the Rhode Island coast and 13 miles northeast of Montauk, NY. Over the past decade, increases in summer population have raised concerns about the future availability of fresh groundwater on the island. The U.S. Geological Survey initiated a study in 1988 to evaluate the hydrogeology and water resources of Block Island, however, water availability was assessed only on the basis of arbitrary elevation intervals such as above and below sea level. No correlation between geology and groundwater availability was made. The surficial geology of Block Island is dominated by late Pleistocene glacial deposits in which an upper and lower moraine zone have been identified. This research assessed whether the contact between the two moraine zones forms a significant hydrogeological boundary.

I employed a Geographic Information System (GIS) to construct a spatial data base of geologic and hydrologic parameters including well data, driller's logs, surficial geology maps, ground-penetrating radar data, and recent seismic data from the surrounding Block Island Sound. I used GIS to aid in classifying wells according to screening unit and water availability, to construct a model of the contact surface between moraine zones, and to investigate correlations between local geology and water availability. Although wells on Block Island have historically been drilled deeper to obtain greater yields, results indicate that water availability is not strongly dependent on screening depth. In addition, wells screened in each of three lithologic units (upper moraine zone stratified sediments, upper moraine zone diamict sediments, and lower moraine zone sediments) do not possess statistically different hydrologic or hydrogeologic characteristics. Results further suggest that siting priority for future well sites should favor shallow drilling depth to reduce energy and drilling costs, and to discourage salt water intrusion. GIS techniques as employed in this study should prove valuable to similar hydrologic studies across southern New England.

THE BROME THRUST IN NORTHERN VERMONT

Schoonmaker, Adam, Department of Geology, University of Vermont, Burlington, Vermont 05405

The Brome Thrust has been traced southward to the International Border by many workers in southern Québec and is regarded as a regional Taconian structure. Recent field observations indicate that the Brome Thrust extends into northern Vermont and may be genetically related to anomalous, along-strike, stratigraphic changes found in the Oak Hill Group west of the Green Mountain Axis. These along-strike variations, as well as the Brome Thrust may have been controlled by rift-related continental margin morphology.

Petrologic, stratigraphic, and outcrop evidence indicate that the Brome Thrust extends into northern Vermont and separates the Oak Hill Group into two distinct sequences that differ in intensity of tectonic deformation. The Oak Hill Group, west of the fault, is only slightly deformed, while lithologically equivalent stratigraphy to the east, is schistose and highly thinned. The Brome Thrust also marks a boundary for late metamorphic reactions associated with the fault-related deformation.

Structural and petrologic evidence indicates that the field area underwent 3 deformational events during Taconian evolution. Calc-alkaline volcanics of the Tibbit Hill formation and volcanic flows interbedded in the Pinnacle formation provide a reasonably accurate record of metamorphic changes that occurred during each of these 3 events. Structural relationships show that the Brome Thrust formed during the second of these events. This event reached chlorite-grade metamorphism, retrograding an earlier biotite- and hornblende-grade event and was only slightly retrograded later by muscovite growth during the third phase.

As the Brome Thrust continues southward into Vermont it appears to overturn from an initially west-dipping structure to one that dips steeply to the east. This characteristic may be responsible for along strike variations in stratigraphy, most notably the discontinuation of the massive belt of basal Tibbit Hill Formation south of the International Border.

A STUDY OF METALS IN ARROWHEAD MOUNTAIN LAKE, MILTON, VERMONT

Schuck, Russell A., Department of Geology, University of Vermont, Burlington, Vermont 05405

Arrowhead Mountain Lake, located in Milton, Vermont was formed when the Lamoille River was impounded in 1937. Analyses of surface sediment grab samples reveal high concentrations of arsenic and nickel. The concentrations of these metals exceed levels determined by NOAA to be toxic to biota (Long and Morgan, 1990). Determining the extent of metal contamination and its source is important for several reasons. A) Arrowhead Mountain Lake is actively used for drinking water and recreation and is home to a variety of wildlife. B) The Lamoille River carries water leaving Arrowhead Mountain Lake into Lake Champlain. Sediments near the mouth of the Lamoille in Malletts Bay, Lake

Champlain, show elevated concentrations of arsenic and nickel. C) By determining the source, measures may be taken to stop or decrease their input into Arrowhead Mountain Lake, as well as to Lake Champlain.

The goal of this project is to assess the extent of and temporal distribution of arsenic and nickel in the sediments of Arrowhead Mountain Lake. Secondly, an attempt will be made to identify potential sources of these metals. Based on my compilation of data within the Lamoille Drainage Basin, I hypothesize that the arsenic and nickel are derived primarily from exposures of ultramafic rocks within the drainage. Secondly, it is possible that the loadings of these metals have increased over the last 100 years by mining of asbestos and talc from these rocks. To test this, I plan to evaluate the extent of contamination and changes in metal input over time. Specifically, I will compare metal distributions and their relationship to different sediment types in Arrowhead Mountain Lake with those of a pond adjacent to the mining operations. Changes in metal input in Arrowhead Mountain Lake will be compared with historical data such as opening or closing of mines.

Sediment cores have been obtained from two locations in Arrowhead Mountain Lake and cores will be obtained from the mining district in April of 1994. These cores will be sub-sampled and analyzed for trace metals, grain size, organic content, and particle morphology. Furthermore, the sediments in the cores will be dated by isotopic methods (^{137}Cs, ^{210}Pb) so that depth vs. time correlations can be made. The profiles produced should reveal present, historical and background (pre-industry) concentrations of the metals in the two lakes and indicate how levels have changed since man's intervention. Grain size and organic content will be determined in order to recognize any correlation between these parameters and metal concentration. Particle morphology will be determined with a scanning electron microprobe using energy dispersive X-ray analyses and may provide information associating the metals to specific particles derived from the ultramafic rocks.

THE EFFECTS OF THE INTERNAL SEICHE IN LAKE CHAMPLAIN ON A SHALLOW BASIN

Thompson, Scott D., Department of Geology, Middlebury College, Middlebury, Vermont.

A consecutive ten day survey in July 1993 sampled eighteen stations throughout Thompson's Point Bay and the adjoining lake. This was a cooperative study between the New York Department of Environmental Conservation, Vermont Agency of Natural Resources, and Middlebury College to document the variability of water chemistry and quality within a shallow bay caused by internal seiche activity. For each station a temperature profile, using a Seabird CTD sensor, and discreet water samples were taken. The water samples were analyzed for phosphorus and carbon levels as well as chlorophyll-a to determine water quality.

The data were analyzed using a Silicon Graphics 4D-25TG workstation. These 4-dimensional data sets were investigated both quantitatively and qualitatively using a 3-dimensional gridding and analysis software package

(EarthVision from Dynamic Graphics, Inc.). Qualitatively the ebb and flood of the bay due to the wind-forced internal seiche was apparent. Quantitatively it was possible to determine the volumes of water flowing in and out of the lake (approximately 17 million cubic meters above the 20 meter contour). Minimum bottom currents were determined to be about 1.5 cm/s. A change in net heat due to the seiche impact on the bay and its relationship to chlorophyll-a was also determined.

Taking into account the meteorological data and current speeds from an up-looking Acoustic Doppler current profiler over a longer time period, the magnitude of the seiche during the study can be compared to other cycles of the seiche. From this we can estimate the impact of the seiche on the bay under varying seiche conditions. In turn, by observing this shallow bay, we can theorize seiche impact on similar regions throughout the lake.

VERMONT GEOLOGICAL SOCIETY BUSINESS AND NEWS

New Members

We are pleased to welcome the following new member who has joined the Vermont Geological Society since the Winter *GMG* was published:

Brenda K. Bryan-Wood Plano, TX

Treasurer's Report

The Society's finances are in excellent condition, in spite of the large drop in membership caused by the removal of members who have not paid their dues from the Society's rolls (discussed in more detail below). Income from dues continues to be supplemented by occasional sales of Volume 7 of *Vermont Geology*. Helped, in part, by the donations in excess of yearly dues made recently by several of our members, the Society has increased its commitment to the Student Research Grant Program by soliciting proposals to meet two deadlines, one in May and one in November, instead of a single May deadline, as was the case in the past. The Executive Committee, and from your comments, the vast majority of the Society's members, continues to believe that support of the Research Grant Program is one of our highest priorities.

As of April 11, 1994, the Society's membership stands at 125 members, a decrease of 68 members since my last report, two months ago. I have tabulated the results of the question concerning the level of VGS dues from the 99 dues statements returned to me with opinions and comments. A large majority of members, 86%, felt that the dues charged by the Society were appropriate. Four percent of our members felt that dues were too high, most often citing the difficulties of affording dues to a professional society while on fixed incomes. Ten percent of our members felt that dues were too low, suggesting that they could be raised as high as $25.00 for members. A close examination of our membership database indicated that most of the members who did not renew their membership were no longer actively employed in New England or attending school in the area; many had been carried on our rolls for as long as five years through the goodwill of my predecessors! The Executive Committee agreed last year with my opinion that the Society had to run a tighter ship and that it was fiscally irresponsible to continue to mail the *Green Mountain Geologist* to members who had not paid their dues. Stringent controls on unnecessary expenses such as these will allow the Society to postpone an increase in dues for as long as possible, despite increasing postal costs. You will note as you read this issue of the *GMG* that the Executive Committee is not content with a shrinking membership base, however, and has begun an aggressive membership drive.

Finally, I would like to acknowledge the efforts of the rest of the Executive Committee. These individuals donate their time to running a very smooth ship, often refusing to accept financial compensation for legitimate expenses. The spirit of volunteerism is, most definitely, alive!

Sincerely,

Stephen S. Howe

Executive Committee Minutes—February 26, 1994

The Executive Committee of the Vermont Geological Society was called to order at 1:30 p.m. on February 26, 1994 at the CRREL research facilities in Hanover, New Hampshire. Members present included Larry Gatto, Steve Howe, Stephen Wright, Shelley Snyder, Kent Koptiuch, and Nancy Keller.

Treasurer's Report: Steve Howe reported a current balance of $3,654.31 in the VGS bank account and updated the status of the membership dues. VGS currently has 193 members on its mailing list. Of those, 104 members have paid their 1993 dues. Steve projected that the paid membership may reach 125. With this projection, VGS income per year should range between $1,800 and $2,000. This would mean that, after the expense for the *GMG,* there should be approximately $700 to $800 available per year for student research grants.

Brenda K. Bryan-Wood, a senior geologist with the Arkoma Basin Exploration Company in Rockwell, Texas, was accepted as a new member.

Membership Directory: Steve Howe will organize the directory once the dues statements are returned. The directory is expected to be ready by May or June 1994.

Reciprocal Agreements: Reciprocal agreements between the New Hampshire and Maine Geological Societies were briefly discussed. More information regarding these agreements will be forthcoming at the next executive committee meeting.

Guest Editors: Kent Koptiuch has volunteered to be the guest editor for the Summer 1994 issue of the GMG which will focus on environmental geology.

Permanent Committee Report(s): Education Committee Chair, Shelley Snyder, reported that she and Kent will update the teacher's hand-book for geologic information and have it ready for release by October 1994. VGS would like to distribute this and other related information at the Vermont Education Association's convention, October 19–21, 1994.

Public Issues Committee Chair Vacancy: Tabled until next executive committee meeting.

Nominating Committee: Larry Gatto reported that he has contacted a list of potential nominating committee members. Since a full committee is not yet established, it was agreed to publish a request for nominations of VGS officers in the GMG. In the meantime, Larry and Shelley Snyder have agreed to continue to work on recruiting membership for this committee.

VGS Posters: Larry shared the poster designs for advertising the VGS Research Grant Program and for encouraging membership in VGS. Revisions will be shared at the next executive meeting before final printing. It was agreed to set a budget of $120.00 for this project.

VGS Research Grant: Deadlines for the 1994 VGS Research Grants were discussed. It was decided that there will be two award periods per year. Proposals would be due on May 15 and then again on November 15, thus accommodating those students whose projects are planned in the Fall and Spring Semesters.

Summer and Fall Field Trips: The upcoming Summer and Fall field trips were discussed. The committee agreed to ask Lucy Harding to lead the Summer field trip to Crown Point, New York and to ask Gregory and Nancy McHone to lead the Fall field trip to the Rutland area. Tentative dates of July 9 and September 25 were chosen.

By-laws Changes: Shelley Snyder and Steve Howe have agreed to do the initial modifications of the by-laws. these revisions will be reviewed at the next executive committee meeting. Changes to the by-laws would then be published in the Summer GMG and voted by the VGS membership during the Fall meeting.

Spring Meeting: The 1994 Spring Meeting was discussed. It will be held on April 23 at the University of Vermont in Burlington, Vermont and will feature student research presentations. Morning refreshments will be provided by the Society.

Next Meeting: The Executive Committee will hold a luncheon meeting on April 23, 1994 at the University of Vermont.

Meeting adjourned at 3:33 p.m.

Respectfully submitted,

Nancy Keller, Secretary

SEMINARS, MEETINGS, and FIELD TRIPS

April 18: **University of Vermont Fall Seminar Series** (4 P.M.): *"Risk Assessment: Using earth sciences for safety decisions"* Dr. Richard Bernknopf, U.S. Geological Survey.

April 23: **Vermont Geological Society Spring Meeting:** *Student Papers,* Middlebury College, see this issue of the *GMG* for details.

July 9: **Vermont Geological Society Summer Field Trip:** *Depositional Environments in the Mid-Ordovician Section at Crown Point, New York,* Field Trip Leader: Lucy Harding.

September 24: **Vermont Geological Society Fall Field Trip:** *Cretaceous Intrusions in the Rutland Area,* Field Trip Leaders: Greg and Nancy McHone.

October 7–9: **New York State Geological Association Annual Meeting.** *Geology of the Rochester Area of New York; Fairchild's Genesee Valley Geology Revisited;* For details send a postcard with name and address to Dr. Carlton E. Brett; Dept. of Earth and Environmental Sciences; Univ. Rochester; Rochester, NY 14627.