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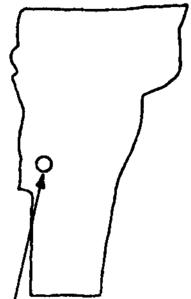

SPRING MEETING

VERMONT GEOLOGICAL SOCIETY
May 5, 1979
Middlebury College
Department of Geology
Science Center, Room 117

Registration; Coffee and Donuts	9:00
Brackett, Russell E.	9:20
Rubin, Jason S.	9:40
Frankel, Charles S.	10:00
Hoar, Robert S.	10:20
Oakes, Chandler A.	10:40
Esten, Douglas R.	11:00
Cushing, Grant W.	11:20
Carter, Craig M.	11:40
Hund, Gretchen E.	12:00
Lunch (Brown Bag)	12:20
Blank, Deborah L.	1:20
Ludue, Winslow H.	1:40
McBean, A. J.	2:00
Mann, Philip W.R.	2:20
Heindel, Craig D.	2:40
Business Meeting	3:20

MAGNETIC MODELS OF THE LAKE GEORGE REGION, NEW YORK

Blank, Deborah L., Department of Geology, Middlebury College, Middlebury, Vermont 05753

Lake George is found in eastern New York on the southeast edge of the Adirondack massif. The Adirondacks are composed of a Precambrian metasedimentary complex which can be correlated with the Grenville sequence in Canada. The massif is broken by normal faults which strike NNE and grow more abundant to the south and east. Lake George is traditionally interpreted as a graben bounded by two such faults. The rocks found on the islands and part of the shore are mostly lower Paleozoic.

This is a study of total magnetic field data collected by the marine branch of the U.S. Geological Survey on the southern portion of the lake. Analysis was done with the help of a two-dimensional magnetic profiling computer program. The user postulates magnetic bodies, and the computer calculates the field they generate. This can then be compared to the measured field.

The results show that Lake George is not a simple graben; the structure changes along its length. Several markedly different regions are apparent.

The lineation mapped as a fault on the western shore of the lake can be interpreted as the nonconformable contact between the Cambrian and Precambrian strata. The computer models support the theory that the region is made up of a series of fault blocks dipping to the east.

CHEMISTRY AND STRUCTURE OF THE METAMORPHIC AUREOLE OF THE THETFORD MINES OPHIOLITE SUITE, QUEBEC

Brackett, R., Department of Geology, Middlebury College, Middlebury, Vermont 05753

The Thetford Mines Ophiolite of southern Quebec displays a complete ophiolite suite emplaced onto the metasedimentary and metavolcanic sequence of the Notre Dame Trough, in Early Ordovician time. Recent work on the metamorphic aureole of the ophiolite shows it to be a fault bounded, discordant unit of east-dipping, northwest-trending amphibolites and greenschists which occupies a constant stratigraphic position at the base of the overlying ultramafics.

The lithology of the aureole is pyroxene-bearing amphibolites grading structurally downward through garnetiferous amphibolites and garnet-epidote amphibolites into chlorite-muscovite-epidote greenschists. This is similar to the lithology of western Newfoundland aureoles described by Williams and Smyth, (1973), but distinct from it in that no relict sedimentary features exist at Thetford Mines.

The primary schistosity (S_1), defined by crystallization of oriented amphibole and, structurally downward, epidote and muscovite, is deformed by isoclinal recumbent folds (F_2) the limbs of which define a schistosity (S_2) that is parallel to S_1. Schistosities S_1 and S_2 are deformed by broad folds (F_3), an event that may be related to the development of kink banding or a spaced cleavage (S_3). While the metamorphic grade decreases structurally downward, the intensity of all later deformational events appears constant throughout the unit. A probable Acadian prehnite-pumpellyite facies veining postdates the development of all other structures and is correlated to a similar event in granites of the same ophiolite.

Chemical analysis of the aureole rocks indicates they have a basaltic character. An average of 10 samples is, SiO_2 = 46.79, TiO_2 = 1.12, Al_2O_3 = 12.82, FeO* = 12.99, MgO = 10.04, CaO = 12.11, Na_2O = 2.20, K_2O = 0.26 and P_2O_5 = 0.47. Verification of a distinct basaltic parent is pending results from trace element analysis.

INTERPRETATION OF THE HINESBURG THRUST NORTH OF THE LAMOILLE RIVER, NORTHWESTERN VERMONT

Carter, Craig M., Department of Geology, University of Vermont, Burlington, Vermont 05401

Recent workers in the Colchester Pond region (Rosencrantz, 1975) and the Georgia Mountain region (Agnew, 1977) have suggested that the Hinesburg thrust lies to the east of Georgia Mountain rather than further to the west as shown on the Centennial map (Doll et al., 1961). This study conducted in the northeastern portion of the Milton quadrangle confirms the more easterly location of the thrust.

Detailed geologic mapping in the area from Georgia Mountain to the northern border of the Milton quadrangle has shown that the contact between the Lower Cambrian Cheshire and Dunham Formations previously interpreted as the Hinesburg thrust (Stone and Dennis, 1964) is actually a normal stratigraphic contact. The Hinesburg thrust actually lies further to the east and is marked by truncation of rocks of the Pinnacle and Cheshire Formations along their contact with the Fairfield Pond Phyllite and by a lithic sliver of Dunham Dolomite that lies along strike with similar slivers to the south.

The northeastern portion of the Milton quadrangle north of Georgia Mountain and the Lamoille River consists of a series of Eocambrian and Lower Cambrian conglomerates, phyllites, quartzites, and dolomites located along the trace of the Hinesburg thrust. Isoclinal folds (F_1) are present throughout the area and are responsible for the majority of the map pattern. One, and possibly two more cleavages overprint the F_1 deformation but do not greatly affect the map pattern in this area.

Earlier regional interpretations suggest that the Hinesburg thrust represents a gravity slide that was active in Middle Ordovician time which was correlated with the Taconic klippe to the south (Zen, 1972). However, the presence of carbonate slivers as well as intensely sheared and mylonitic rocks indicate that the Hinesburg thrust was not the result of a gravity slide but was emplaced by brittle deformation as a result of horizontal compression. The thrust originated in the rocks of the Fairfield Pond Phyllite and propogated westward until it encountered the more competent rocks of the carbonate bank which acted as a riser over which the Hinesburg thrust was displaced.

THE TECTONIC AND METAMORPHIC HISTORY OF CENTRAL AND EASTERN VERMONT

Cushing, Grant, Department of Geology, Middlebury College, Middlebury, Vermont 05753

Field and microscope characteristics of the Missisquoi, Northfield, Waits River, and Gile Mountain formations in central and eastern Vermont have been re-investigated in order to gain a better understanding of the relationships between metamorphism and the tectonic evolution in this region.

These units have experienced the same three distinct deformational events. The first event, D_1, is defined by a bedding plane schistosity and may be a result of tight folding. The second event, D_2, is identified as a slip cleavage axial planar to the most prominent tight folds, and is the prominent schistosity in these units. The third event involves a slight warping of the entire sequence.

These units have experienced at least two distinct metamorphic events and there is tentative evidence for a third event. The first event involved at least chlorite and biotite grade metamorphism, which was synchronous with the first deformational event. The second metamorphism is the most prominent event observed in this region. It is characterized by chlorite, biotite, garnet, staurolite, and kyanite porphyroblasts that crystallized during and after the second deformational event. New K-Ar dates suggest that this event occurred between 380 and 350 m.y.a. Isograds have been drawn and indicate that the Connecticut Valley-Gaspe Synclinorium has a relatively high-grade metamorphic core. This observation suggests either that the mapped stratigraphy is reversed and could represent an overturned limb of a large recumbent fold, or that an unusual high grade core occupies the central part of the synclinorium.

THE NATURE OF THE CONTACT BETWEEN THE STOWE AND MORETOWN FORMATIONS NEAR ROXBURY, VERMONT

Esten, Douglas R., Department of Geology, Middlebury College, Middlebury, Vermont 05753

The contact between the Stowe and Moretown formations was studied in detail near Roxbury, Vermont. Along a three-kilometer length where the contact is mapped to be, no simple surface of contact is found, despite extensive exposure. In close proximity to where the contact is inferred to exist, three outcrops of intensely sheared, extremely foliated Stowe schist contain small lenses of what appear to be banded Moretown quartzite. Some 40 meters east of one of these outcrops, blastomylonitized schist is present. These intensely tectonized rocks indicate that the contact is a relatively wide zone characterized by substantial strain, which may have been the result of tectonic transport.

Greenstone bodies are found fully incorporated within the Moretown Formation near the contact. They are mineralogically and chemically identical to Stowe greenstone, and because map patterns suggest that the Moretown has no indigenous greenstone, are identified as being originated from the Stowe Formation. Their presence within Moretown schist may be due to imbricate thrusting during transport.

Blocks of finely laminated Moretown schist also occur well within the Stowe Formation; their presence here may be due to the same processes.

Laminated Moretown schist becomes progressively more flattened, with an increasingly more prominent lamination, as one moves from the interior of the Moretown toward the contact. This phenomenon, together with a progressively more complete transposition of an earlier schistosity in the Moretown, further suggests transport-resultant strain between the Stowe and Moretown formations.

These results suggest that regardless of its original nature, the Stowe/Moretown contact is no longer depositional. If the Moretown was originally deposited upon the Stowe formation, constraints made by previous workers require this deposition to have been post-Taconic and unconformable. The Stowe/Moretown contact now appears to be the site of significant tectonic dislocation.

THE AGE AND ORIGIN OF THE GRANITIC INTRUSIONS OF THE THETFORD MINES OPHIOLITE

Frankel, Charles, Department of Geology, Middlebury College, Middlebury, Vermont 05753

The Thetford Mines ophiolite of Southern Quebec is interpreted as a flake of oceanic crust and mantle emplaced on the continent during the closing of the proto-Atlantic in Ordovician time.

The basal, tectonized ultramafic unit is intruded by stocks of massive rodingite, strongly deformed hornblende-biotite diorites, and by dikes of quartz monzonite. The dikes are the youngest group of intrusions at Thetford. Laurent (1972) interpreted them to be rootless plagiogranites intruded before obduction. Poole (1963) obtained K-Ar dates of 481 ± 30 and 477 ± 30 m.y. on two of these monzonites; these were interpreted as a maximum age for the emplacement of the ophiolite.

Our granitic samples collected in the ultramafic complex of Thetford Mines (monzonite intrusions in the open pit mines of Lake Asbestos, Black Lake region) yielded ages of 424 and 451 m.y.a. by the Rb/Sr method using whole rock, muscovite and biotite separates. The dates are probably accurate to within a few million years.

The high initial strontium ratios for both rocks, .718 and .720, indicate the source for the granites was continental crust. Dikes of oceanic plagiogranites originating in the mantle would have ratios ~.703. The $K_2O \times 100 / Na_2O \times K_2O$ ratio calculated from chemical analyses of the Black Lake monzonites ranges from 25 to 40. The dikes are therefore continental granophyres, as oceanic plagiogranites would have ratios of about 5.

We conclude that the quartz monzonites of the Thetford Mines ophiolite were intruded in the ultramafics as the ophiolite was thrusting onto the continent but before it came to rest at its present location (if the dikes are indeed rootless). The range in ages may reflect the duration of the obduction process.

BEDROCK HYDROGEOLOGIC REGIME OF THE MUDDY AND ALLEN BROOK WATERSHEDS, WILLISTON AREA, VERMONT

Heindel, Craig D., Department of Geology, University of Vermont, Burlington, Vermont 05401

Bedrock and surficial geologic information was used in conjunction with well data to determine major elements of the bedrock hydrogeologic regime of two adjacent watersheds in northwestern Vermont.

Rough approximations using Darcy's Law indicate that three-quarters of the recharge to bedrock groundwater comes through thin, permeable soils occupying only one-third of the total area. These areas not only are significant in supplying the majority of recharge to bedrock groundwater, but are particularly sensitive to contamination and development pressures, due to the poor pollutant attenuation characteristics of the soils. Flow is generally from the recharge areas in the uplands toward the lowlands, streams, and ponds, with the overall regional flow being predominantly northwest toward the Winooski River. Shelburne Pond, Mud Pond, the upper reaches of major streams, and the lower reaches of streams are groundwater discharge areas. the middle sections of the streams are predominantly located on thick lacustrine sediments, and do not receive groundwater discharge.

Bedrock well data indicate that the groundwater surface is, with several important exceptions, a subdued replica of surface topography. Differences in water table gradients and well yields support the hypothesis that the Precambrian schists in the eastern portion of the watersheds are much less permeable than the Lower Cambrian to Lower Ordovician carbonates in the west. Clear correlations between rock type, well yield and depth, and between drilling method, well yield and depth can be seen. A trend toward reduced yield with increased depths, deeper than about 400 feet, is observed. Data suggest that the Hinesburg thrust fault, a low-angle thrust trending north through the area, does not play a significant role in the hydrogeologic regime of the watersheds.

INTERPRETATION OF THE MISSISQUOI FORMATION, NORTHEASTERN VERMONT

Hoar, Robert S., Department of Geology, University of Vermont, Burlington, Vermont 05401

Bedrock mapping on a scale of 1:20,000 in the northeastern part of the Irasburg Quadrangle, Vermont, has delineated complex stratigraphy within the Missisquoi Formation (Doll, 1961). This formation is a heterogeneous mixture of pelites, breccias, volcanics, and volcanogenic rocks. Small pods as well as large bodies of mafic to felsic intrusives are locally abundant. These igneous rocks lack contact metamorphic aureoles or chill margins, are often small in size, are associated with blocks of metasediments, and have an extreme chemical variety seemingly unrelated to the New Hampshire Magma Series rocks with which they have formerly been related. These observations do not support an in situ origin for the igneous rocks and further suggest that they were emplaced as erosional blocks in a sedimentary matrix, and/or imbricated and transported by hard-rock thrusting. Mafic to felsic intrusives within this formation appear to correlate more with Ordovician intrusives (e.g., Bolton Group or Highlandcroft) than with the New Hampshire Magma Series rocks of Devonian age.

Correlation of the metasedimentary units of the Missisquoi Formation with those of the St. Daniel Formation in southern Quebec on the basis of lithic similarity and on-strike proximity suggests that at least part of the Missisquoi Formation is Lower-Middle Ordovician in age.

The Missisquoi Formation lies in sharp contact with the Umbrella Hill and Stowe Formations (Doll, 1961) to the west and is unconformably overlain by the Silurian Shaw Mountain and Northfield Formations to the east.

A HIGH STRAIN ZONE ON THE EAST BORDER OF THE MIDDLEBURY SYNCLINORIUM NEAR BRISTOL, VERMONT

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Results of field work near Bristol suggest that the thrust zone mapped by Klein (1978) and Boyce (1978) can be extended at least 6 km farther north. Based on field results from the study area and data obtained by Klein (1978), an overall view of the zone's geometry can be determined. The younger stratigraphic units (Monkton Quartzite and Dunham Dolostone) are found in the south, and progressively older units (Dunham and the Cheshire Quartzite) occur in the north. The thrust runs vertically through the younger units, but flattens to approximately 25-degree east dip in the older beds.

Approximately 400 ft. stratigraphic displacement occurred with Cheshire Quartzite thrust west over Dunham Dolostone.

In the thrust zone mylonitic quartzite defines the highest strain zone. This high strain zone is accompanied by isoclinal flexural flow folds. Microscale drag folds are present in the southern part of the study area. All rock units dip east to varying degrees, and trend north.

Strain is inhomogenous, with massive quartzite commonly found adjacent to phyllite. However, following Twiss' (1977) method for stress determination, the stress experienced throughout the area was 528 bars ± 95 bars (1 sigma).

A fault post-dating the development of the high-strain zone is located in the north, running through the western plate of Cheshire Quartzite. This fault probably represents an early Tertiary high-angle fault.

Results of this study suggest that the high-strain zone developed in response to the formation of the Green Mountain Massif. However, caution must be used in determining whether the Taconic or Acadian event, or one single continuous deformation, is responsible.

DEGLACIATION HISTORY AND GRAVEL AQUIFERS IN JERICHO, VERMONT

Ladue, Winslow H., Department of Geology, University of Vermont, Burlington, Vermont 05401

Glacial deposits and well records have been used to interpret the deglaciation history and to locate and assess gravel aquifers in the town of Jericho. A westward retreating icefront initially deposited ice contact deposits and dammed at least four isolated proglacial lakes in the upper Browns River, Lee River and Mill Brook valleys. Further retreat of the ice mass resulted in successively lowered water levels producing at least five previously described water planes of both local and regional extent.

Gravel aquifers now exist in kamic and deltaic deposits located in the Browns River, Lee River and Mill Brook valleys. Lacustrine silt-clay and till deposits confine gravel aquifers in buried valleys along the Browns and Lee Rivers. Well logs also suggest that till and silt-clay confine a gravel aquifer in a buried valley between Mill Brook and an unnamed brook in southwestern Jericho. The latter may represent ancestral courses of modern drainage.

Confined gravel aquifers in the Browns River, Lee River and Mill Brook valleys contain 5, 3 and 2 wells respectively which have median yields of 15, 7.7 and 33 gallons per minute. Unconfined gravel aquifers are perched on lacustrine deposits and located in deltaic sediments along the Brown and Lee River valleys. Two wells in each of these aquifers recorded well yields and show respective median yields of 17 and 4.5 gpm.

Recharge to the confined gravel aquifers may be through their up valley extensions of the juxtaposed bedrock aquifers. Recharge to the unconfined aquifers is through the overlying sediment, making them more susceptible to pollution than confined gravel aquifers. The location of recharge areas for both types of aquifers have been delineated.

ENVIRONMENTAL GEOLOGY OF THE TOWNSHIP OF LINCOLN, VERMONT

Mann, P.W.R., Department of Geology, Middlebury College Middlebury, Vermont 05753

The Vermont environmental protection regulations are recognized as some of the strictest in the United States. However, these new laws are difficult to implement because of a lack of pertinent geologic information. This study was designed to provide the Township of Lincoln such information.

Bedrock map of the Township is taken largely from Doll and others (1961); no detailed map has been published for the western two-thirds of the Township.

The surficial geology map of the region is modified from Stewart (1973); his "kame terraces" in the lower river valley lack slump features, and are here interpreted as meltwater alluvial terraces formed when the river valley was choked by ice blockages, during the retreat of the Burlington Stade. The step-like down wasting of the glacial ice left terraces at elevations of 1500, 1350, 1100, 1000 and 940 feet. The 1500 stagnant ice level was the most significant, creating many of Lincoln's landforms. Muck and peat deposits are former kettle holes, since filled with organic matter and sediments.

Lincoln lacks a gaging station on the New Haven River that it desparately needs for flood zoning and hydropower information; the water quality of the river should also be monitored more periodically, especially since the Township lacks any public sewage system, and relies on its zoning ordinances instead. However, the zoning was adopted only a year ago and the last water quality tests were fifteen years ago. Overall, the zoning seems adequate in all phases, except in mining operational ordinances.

The Township of Lincoln is very stable and will not change its rural, residential character in the foreseeable future.

THE NATURE AND SIGNIFICANCE OF THE PINNACLE BOULDER CONGLOMERATE IN NORTHWESTERN VERMONT

McBean, A.J., Department of Geology, University of Vermont, Burlington, Vermont 05401

A boulder conglomerate is located northeast of Cushman Hill in the northern sector of the Milton Quadrangle. It forms a basal sequence in the Pinnacle Formation, which is underlain by the Tibbit Hill Schist and overlain by the White Brook Dolomite. These units range in age from Eocambrian to Late Cambrian. The conglomerate is very local, forming resistant ridges, which appear as inliers to the predominantly anticlinal structure in the area. The beds of conglomerate range in thickness from 0.5 to 10 meters and are composed of igneous boulders and sedimentary clasts ranging in size from pebbles to cobbles. The matrix commonly displays a sequence that fines upward, and/or crossbedding, whereas the boulders and sedimentary clasts exhibit imbrication at the bottom of the beds. Soft sediment deformation is present in the form of slumping and bending of the sedimentary clasts around the igneous boulders. Where these sedimentary clasts are not associated with the boulders, greenschist metamorphism has produced extreme stretching of the clasts parallel to the dominant cleavage. A petrographic analysis of the boulders indicates that the source region is predominantly granitic. Textural analysis of the matrix shows angular feldspars, while the boulders are all well rounded.

The evidence suggests that the Pinnacle was deposited in the early stages of rifting at the continental margin. Local relief at the Eocambrian provided the mechanism for transporting large (30-40 cm) boulders to the depositional site, rounding them in the process. The matrix, eroded at the basin, was deposited with the boulders and sedimentary clasts in a shallow marine environment with enough high energy to rework the sediment, producing imbrications and crossbedding. Continued infilling of the unstable basin resulted in a decrease in energy, and a reduction of inflowing clastics, allowing the deposition of finer graywackes and, finally, the White Brook Dolomite on top of the Pinnacle Formation.

STRUCTURAL AND METAMORPHIC CHARACTERISTICS ACROSS THE GREEN MOUNTAIN AXIS

Oakes, C.A., Department of Geology, Middlebury College, Middlebury, Vermont 05753

The axis of the Green Mountain anticlinorium has been studied along Route 17, through the Appalachian Gap from Jerusalem to Irasville, Vermont.

Rocks of the study area occur in two separate zones, with distinct structural and metamorphic histories. A lower zone shows at least four deformations while an anomalous upper zone has seen only three. These two zones are separated by rocks which are intensely sheared, show extreme flattening and imbrication, and are interpreted to represent a thrust fault. The lower zone shows a retrograde metamorphic event from garnet into chlorite-muscovite grade. The upper zone, however, shows no retrograde event; the most recent event is instead a higher grade, garnet event. The inferred thrust fault separates these two units.

Differences in the observed structural and metamorphic data suggest that rocks of the upper zone are allochthonous and were emplaced on those of the lower zone by the event that developed their predominant schistosities and latest metamorphisms. The emplacement must have involved considerable lateral movement. A younger tectonic event, probably associated with the most recent uplift of the Green Mountains, is seen as west-verging folds with axial planar crenulation that dips steeply eastward.

AGE AND ORIGIN OF THE METAMORPHIC AUREOLE AT THETFORD MINES, PQ

Rubin, Jason, Department of Geology, Middlebury College, Middlebury, Vermont 05753

The Thetford Mines ophiolite complex sits on a kilometer thick dynamothermal metamorphic aureole related to ophiolite abduction. Metamorphic rocks of the aureole range from garnetiferous amphibolite at the contact with the ultramafic rocks to phyllitic greenschists in contact with the underlying Caldwell country rock. Temperatures of formation, derived from microprobe analyses of coexisting garnet and amphibole, range from 850°C (60 meters away from the contact), 675°C (160 meters from the contact), to 580°C (800 meters from the contact). Coexisting phases re-equilibrated during cooling to temperatures 20-100°C less than above. High temperatures near the contact may reflect frictional heat during ophiolite emplacement. Geologic constraints and low abundances of NaM_4 in amphiboles suggest that aureole rocks equilibrated at pressures on the order of 1-3 kbars (Brown, 1977). Garnet-clinopyroxene pairs suggest higher pressures (Perchuk, 1969).

Eight K-Ar, three total fusion, and one incremental heating $^{40}Ar/^{39}Ar$ experiment were done to determine the ages of the aureole rocks. Incremental heating results give concordant plateau and isochron ages of 491 ± 4 m.y. and 494 ± 8 m.y., respectively. One total fusion age is consistent with these results (495 ± 7 m.y.) while the other two yielded discordant ages. K-Ar ages are erratic and may reflect analytical error with low K_2O abundances and/or problems with excess argon. $^{40}Ar/^{39}Ar$ ages are older than those determined for Newfoundland aureoles (Archibald and Farrar, 1976; Dallmeyer and Williams, 1975) and probably date the initiation of emplacement of the Thetford mines ophiolite during the closing of the proto-Atlantic ocean.

A T T H E W I N T E R M E E T I N G

The second annual winter meeting at Norwich University was well-attended with up to 60 people present at mid-morning count. Lively conversations developed over coffee and donuts provided by Rock of Ages Corporation as members gathered inside on a particularly cold and clear Vermont morning. The morning schedule deviated from the printed program in order to delete one paper and include a post-deadline entry by David Scott of the Vermont Department of Health, "Naturally occurring radioactivity in Vermont drinking water supplies" which reported on problems caused by high radon concentrations in drinking water and some preliminary results of measurements of radon-induced radioactivity in some Vermont water supplies recently tested. When Chuch Ratte 's first paper ran into lunch time, we recessed to eat and returned to hear his second paper, followed by Barry Doolan's revelations of early Paleozoic tectonics in the Northeast Kingdom, and finally the feature talk "Acid Rain" by Dr. Noyes Johnson from Dartmouth College. He described the Hubbard Brook Experimental Forest in New Hampshire where the occurrence and effects of acid rain have been established. He clearly developed the background in geochemistry necessary to understand the interpretation of his experiments. Many questions were addressed to Dr. Johnson at the conclusion of his talk. These ranged from inquiries about the experimental methods at the study area to the sociological implications of the studies.

submitted by Jean Detenbeck

NATURALLY OCCURRING RADIOACTIVITY IN VERMONT DRINKING WATER SUPPLIES

Scott, David, Health Physicist, Department of Health, Barre, Vermont 05641

The Safe Drinking Water Act (Public Law 93-523) sets primary standards for drinking water including maximum contamination levels for radioactivity. Radioactivity in public water systems may be broadly characterized as naturally occurring or man-made, with radium 226, the most important of the naturally occurring radionuclides likely to appear in public water systems according to EPA criteria. It is primarily a problem associated with ground water and therefore smaller public water systems. This characterizes many of the Vermont potable water supply systems.

Section 141.15(b) of the EPA Drinking Water Regulations states that the contamination level for gross alpha particle activity does not include any uranium or radon that may be present in the sample. The agency also says they may consider proposing maximum contaminant levels for these radionuclides at a later date after determining the national need for such regulations, the cost of water treatment to remove these radionuclides and their dosimetry and potential for causing adverse health effects.

Radon exists in ground water at concentrations which are typically much greater than its immediate precursor, radium 226. This occurs because radon, as a noble gas, is freer to migrate into water than radium in the rocks, sands and clay which make up aquifers. A comparison of the data on radon in water from various reports indicate that the Northeastern U.S. has significantly higher radon concentrations than the U.S. as a whole. In granitic areas, the concentration may be an order of magnitude higher. The Northeastern U.S. data (256 samples) indicate that the ground water sources represented had radon concentrations where 56 percent exceeded 2,000 pCi/1, 24 percent exceeded 10,000 pCi/1, and 2 percent exceeded 100,000 pCi/1.

Regular users of radon-rich water may receive an appreciable internal dose. The ingestion pathway for radon has been studied and most authors consider the dose to the stomach as the limiting dose. One estimate showed that if 2 liters of water containing 10,000 pCi radon 222 per liter are ingested daily, a dose of 25 millirems per week is delivered to the stomach. If domestic water containing radon is heated and used for cooking, showering, etc. the radon will diffuse from the water into the home atmosphere. Once in the atmosphere radon daughters are formed by decay and are also available for inhalation by the occupants. It has been estimated that if the potable water being used in a dwelling contains 500 pCi radon per liter the resultant radon 222 air concentration could be 0.15 pCi per liter. The continuous exposure to this concentration could produce 500 millirems per year to the bronchial epithelium.

There has been considerable discussion in Vermont over the years about the high radon 222 concentrations in some ground waters used as potable water supplies; however, there has been little published data to substantiate those concerns. The U.S. Environmental Protection Agency's Eastern Environmental Radiation Facility has recently begun a study of radon concentrations in ground waters in New England. The Vermont Division of Occupational Health agreed to participate by organizing the sampling procedure with the assistance and guidance of the Division of Environmental Health. Preliminary data received from EPA show radon concentrations ranging from 0 to 8,000 pCi/1.

SPECIAL SURVEY PUBLICATION OFFER ENDS

The State Geologist, Dr. Charles Ratte' notified Dick Willey on February 23rd that the special offer to VGS members for complete collections of Survey publication has had to be withdrawn to " eliminate any possible criticism that may be forthcoming for giving special price priviledges to individuals or groups for a tax supported product." However, Dr. Ratte' is working out special bulk purchase rates for the Vermont Geological Survey publications which will apply to all purchasers. We will be notified when these are available.

MEMBERSHIP LIST - ADDITIONS

The following members have paid their dues since the last issue of the Green Mountain Geologist, and should be added to the membership list printed in that issue.

Eric Allinson	Box 195	Montpelier, VT 05602
Vernon Anderson	R.F.D.	Thetford Center,VT 05075
Donald Bailey	67 Delmont Ave.	Barre, VT 05641
Anthony Brainerd	R.F.D. #1	Franklin, VT 05457
Barry L. Doolan	Dept. of Geology, Univ. of VT.,	Burlington, VT 05401
Charles J. Duzinski	8 Prospect Street	Brattleboro, VT. 05301
Ballard Ebbett	R.F.D. 1 (Kirby)	Lyndonville, VT. 05851
Sandria Ebbett	R.F.D. 1 (Kirby)	Lyndonville, VT. 05851
Richard M. Fischer	25 Liberty Street	Montpelier, VT. 05602
William Glassley	Sci. Center -Geol., Middlebury College	Middlebury, VT. 05753
John Hepburn	14 Temple St. Apt. E 611	Framingham, MA 01701
Arthur L. Hodges, Jr.	P.O. Box 26	Camden, DE 19934
Frank J. Lanza	38 Terrace St.	Montpelier, VT 05602
J. Gregory McHone	Star Route	Pittsfield, VT 05762
Peter Northrop	39 Taylor Terrace	New Milford, CT 06776
John P. Oski	9 Oak Hill Road	Greenfield, MA 01301
Joan King Roberts	42 Monument Ave.	Bennington, VT 05201
Ethel Schuele	33 Clover St.	S. Burlington, VT 05401
Eric J. Slavin	R.R. 1 Butterfield Hill Rd.	Perkinsville, VT 05151
Shelley Snyder	380 S. Winooski Ave.	Burlington, VT. 05401
William Stockwell	8 Country Hill Rd.	Brattleboro, VT 05301
Diane M. Vanecek	19 Summer Street	Northfield, VT 05663

G E O L O G I C A L   R E S E A R C H   I N   V E R M O N T

Dr. Charles Ratte' has supplied the Green Mountain Geologist with the following list of current work being conducted in Vermont.

Chief Worker	Affiliation	Project Title	Starting Date	Completion Date
Eugene L. Boudette	U.S.G.S.	Uranium resources in plutonic rock, Northeast United States	July 1976	June 1979
John F. Slack	U.S.G.S.	Massive sulfides of New England	Oct. 1978	Oct. 1981
Frank C. Canney Robert H. Moench	U.S.G.S.	Geochemical studies of the Sherbrooke-Lewiston $1^{o}x2^{o}$ quadrangles	Oct. 1978	1983
R.I. Grauch	U.S.G.S.	Uranium veins in the Eastern United States	1975	1978
Fred Pessl, Jr.	U.S.G.S.	Connecticut Valley urban valley area	1971	1976
C.S. Denny	U.S.G.S.	Geomorphology of New England	1975	continuing
F. T. Lee	U.S.G.S.	Research in rock mechanics	1966	continuing
T.C. Nichols, Jr.	U.S.G.S.	In situ stress, reactor hazards, research, Barre Granite	1974	1978
Rolfe Stanley	U.S.G.S.	Northern Vermont ultramafic belt	June 1978	Oct. 1981
Norman Hatch	U.S.G.S.	Lewiston 2^{o} sheet	June 1978	Sept. 1982
G.M. Richmond	U.S.G.S.	Quaternary geologic map of the United States	1976	1982
David B. Rowley	State Univ. of N.Y.-Albany	Eastern Giddings Brook slice of the Taconic Allochthon in parts of the Wells & Pawlet quadrangles, Vt.	June 1978	May 1979

Chief Worker	Affiliation	Project Title	Starting Date	Completion Date
H. Spetzler	U.S.G.S.	Holographic interferometry investigations of time-dependent deformation-Barre Granite		
R.W. Simpson	U.S.G.S.	Northeast regional tectonics	1978	1980
J.D. Wood	U.S.G.S.	Repeat magnetic surveys	1974	continuing
J.N. Towle	U.S.G.S.	Deep electromagnetic soundings in New England	1977	continuing
P.W. Pomeroy	U.S.G.S.	Northeast seismic network	1978	continuing
W.H.Diment	U.S.G.S.	Seismotectonics of Northeastern United States	1978	continuing
George W. Fisher	John Hopins Univ.	Detailed study of reaction mechanisms of isograd reactions in Eastern Vermont	May 1978	Uncertain
Peter Beblowski	U.V.M. (Graduate Student)	The late-glacial and post-glacial history of the Ritterbush Pond area	Jan. 1977	June 1978
Christopher M. White	Univ.of Mass.	Surficial geology and mode of deglaciation of the Eastern half of of the Wilmington,Vt. quadrangle	Nov. 1975	Dec. 1977
Norton G. Miller	Harvard Univ.	Paleoecological study involving plant fossils in laminated lacustrine sediments near Columbia Bridge (Upper Connecticut R.Valley)	Fall 1976	

Chief Worker	Affiliation	Project Title	Starting Date	Completion Date
John L. Rosenfeld	U.C.L.A.	1--Bedrock geology of the Connecticut Valley area, Southern Vermont 2--Nature of doming tectonics, Southeastern Vermont 3--Various petrological studies, Southeastern, Vt.		
Jesse Ford	Univ. of Minnesota	Effect of lithology on ecosystem development in Northern New England		May 1980
James R. Anderson	California Institute of Technology	The polymetamorphic sequence in the Paleozoic rocks of Northern Vermont: A new approach using metamorphic veins as petrologic structural marks	Thesis in progress	
Joe Laird	California Institute of Technology	Phase equilibria in amphibolitic schist and their application to understanding the polymetamorphic history of Vermont	Thesis in progress	
Jon P. Broderick	Labradex Corporation	Base metal exploration, Franklin County		Summer 1979
Richard G. Preiss	Urangesellschaft USA, Inc.	Uranium exploration		Summer 1979-83
Richard Wilson	Exxon Minerals, Inc.	Uranium exploration		Summer 1980
Tom Ray (UVM)	Northeast Seismic Network-Lamont-Doherty Observatory	Vermont Seismometer Stations Establishment and maintenance	Continuing	

Chief Worker	Affiliation	Project Title	Starting Date	Completion Date
Dr. William F. Jenks, & two graduate students; Alan Roth, & Frank Gehrling	Univ. of Cincinnati	Projection of massive sulfide or other distinctive but localized rock types in high grade metamorphic terrances on the basis of detailed structural-petrologic analysis Orange Co. Vt.	Aug.1978	June 1,1980
John Aleinikoff	U.S.G.S.	Petrologic studies of the Ammonoosuc Volcanics		
Bertram G. Woodland	Field Museum of Natural History-Chicago	Mineral deformation in relation to metamorphic-deformation stages		
Alfred H.Chidester	U.S.G.S.	Vt. Asbestos-Geology & petrology of Belvidere Mountain Asbestos		1977
B.W.Nisbet	St.University of N.Y Albany	Geology of the north end of the Chester Dome		1976
J.Gregory McHone	University of N.Carolina(Graduate Student)	Post-metamorphic mafic dikes of Central New England	July 1974	June 1978
Ronald J DeFilippo	Boston College	The East Dover ultramafic body of Southeastern Vermont	June 1972	June 1977
Thomas J.Holland	Holland Chemical Co.	Bennington kaolin sampling project		Fall of 1978
J. Greg. McHone	Chiasma Consultants,Inc. NURE Project	Glens Falls 2^{o} sheet		Summer 1979-80

MINERAL OF THE QUARTER

T A L C $Mg_3Si_4O_{10}(OH)_2$

Hardness - 1 on MOHS series; Color - pure-white to pale green, impure- grey to grey green. translucent; Specific Gravity - 2.6 - 2.8; Crystal System - monoclinic (crystals rare); Lustre - massive - waxy or greasy, pearly lustre on cleavage surface; Cleavage - perfect basal, micaceous cleavage; cleavage flakes flexible, not elastic.

Small amounts of Al and Ti can replace some Si in the talc structure. Small amounts of Fe, Mn, or Al can substitute for part of the Mg.

Talc occurs in Vermont both as foliated light green material as well as grey or pale green granular masses. Soapstone, the impure grey or dark grey-green variety of massive talc is common in Vermont. Our state has been one of the principal producers of both talc and soapstone in the United States.

According to Ray Grant in "Mineral Collecting in Vermont" retrograde metamorphism of igneous rocks such as dunite or peridotite has produced the talc we find in Vermont. Water reacting with the olivine in the dunite produced serpentine, which in turn was affected by CO_2 from the lime rich country rock to produce talc and magnesite. He indicates that over 100 altered and unaltered ultramafic igneous rock bodies are shown on the Vermont Geologic Map. We mentioned two if these sites in previous Mineral Of The Quarter articles:

ie. Carleton Talc Mine, Chester
Duxbury Serpentine Quarry.

The talc mine we will discuss at this time has been in operation since 1900. It is owned by the Eastern Magnesia Talc Co., a division of Englehart Industries. To reach this location proceed north from Johnson on route 100 C for 2.8 miles. Just beyond the Sterling Turf Farm property you will encounter a crossroad. Take the west trending road and continue along it for about a mile to reach the company office. Be sure to stop there and ask permission to collect on the tailings. They are very pleasant and will tell you where to collect safely. DO NOT WANDER ABOUT IN THE WOODS where the old mine holes and dumps are. Considerable surface cave-ins have occurred. The talc rocks in the piles are slippery and many of the old mine holes have filled with water.

Minerals found at this location in addition to the talc and soapstone are pyrite (crystals up to ½ inch in diameter), serpentine, magnesite, magnetite, dolomite. Also reported are bornite, chalcopyrite, pyrrhotite, graphite and ilmenite.

Talc has many industrial uses. Finely ground pure talc is used in cosmetics and ceramics. It is also used as a filler to give opacity to paint, paper and rubber products. It can be used as a lubricant and to make tailors chalk.

Soapstone slabs are used for acid-proof laboratory table tops. Soapstone also has many applications as a thermal and electrical insulator.

Submitted by Ethel Schuele

NEW TOPOGRAPHIC MAP RELEASED

A new $7\frac{1}{2}$ minute Barre Quadrangle map has just been released by the United States Geological Survey. This map is part of the ongoing remapping of the state of Vermont at a scale of 1/24000. The mapping program is carried out by the United States Geological Survey in cooperation with the Vermont Geological Survey. The new maps should be available locally or may be purchased by writing to: Branch of Distribution, U. S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202.

TAX MAPS COMPLETED

The State of Vermont Tax Department is continuing a program of complete orthophoto mapping of the state. Most of the southern part of the state has been completed and most of the western part of the state is being currently worked on. The northeastern part of the state will be the last part flown and mapped. Those interested in finding out more about this mapping should contact the Tax Department in Montpelier.

SUMMER MEETING PLANS INCOMPLETE

The Society will tentatively return to the Thompson Farm near Taftsville for its summer meeting and picnic. A firm date has not yet been set, nor possible mineral collecting sites for those wishing to come earlier.

POSITION PAPER ADOPTED ON MINING

Each member of the Society should have received a copy of the Position Paper on Subsurface Mineral Investigation. This paper was prompted by a request by Secretary Brendon Whittaker of the Agency of Environmental Conservation and the concern about mineral exploration, particularly the controversay about uranium mining and exploration. The Executive Committee tried to clearly seperate the two operations and to identify the minimal risks involved in exploration.

If you did not receive a copy of this position paper please let us know.

FIELD TRIP GUIDE STILL AVAILABLE

The excellent field trip guide developed by Terry Thompson for her Teachers' Workshop last spring is still available. There is no charge for a single coply of the guide to member of the Vermont Geological Society. And the guide may be purchased for $ 1.00 by non-members. To obtain a copy of the guide please write to the Society at Box 304, Montpelier, VT 05602.

SUGGESTIONS WANTED FOR G. M. G.

What do you think of the Green Mountain Geologist? We have tried to improve it and include more in each issue. Do you have some ideas or comments about what we are including? Do you have an item which you think might be of interest to other members of the Society. Please let us know.

F O R   T H E   T E A C H E R

GEOLOGY FIELD TRIP AND WORKSHOP IN NORTHEASTERN VERMONT

The Third Annual Vermont Geological Society Teachers' Workshop will be held Wednesday, May 23, 1979 at Lyndon State College. The purpose of the workshop is to help primary and secondary school teachers gain a general perspective and appreciation of the last 300 million years of geologic history of the area by field observations made along the Miller Run valley and Lake Willoughby. Some of the geologic topics to be discussed are:

1) erosion and deposition along a floodplain
2) features resulting from the wasting of a continental ice sheet
3) intrusion of a granite
4) relationship of the shape and distribution of hills and valleys to bedrock structure.

Workshop techniques and handouts should assist teachers (both the uninitiated and those having a geology background) in conducting similar class fieldtrips in the area or in the vicinity of their own school.

Time: 9:00 A.M. Wednesday, May 23, 1979
(coffee and refreshments when you arrive)

Place: Lobby of Alexander Twilight Theater, Lyndon State College
(Eight miles north of St. Johnsbury on U.S. Route 5 or 191 (exit 23) is Lyndonville, Follow signs from Lyndonville Post Office.

-------- Registration ----------

Fee: $2.00 each (checks payable to VGS) **NO FEE FOR MEMBERS**

Mail to: Ballard and Sandra Ebbett
Lyndon State College
Lyndonville, Vt. 05851

Name (s) of Participants ______________________________

Address ______________________________

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GREEN MOUNTAIN GEOLOGIST
VERMONT GEOLOGICAL SOCIETY
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FIRST CLASS

Charles A. Ratté
10 Independence Green
Montpelier, VT 05602

THE GREEN MOUNTAIN GEOLOGIST

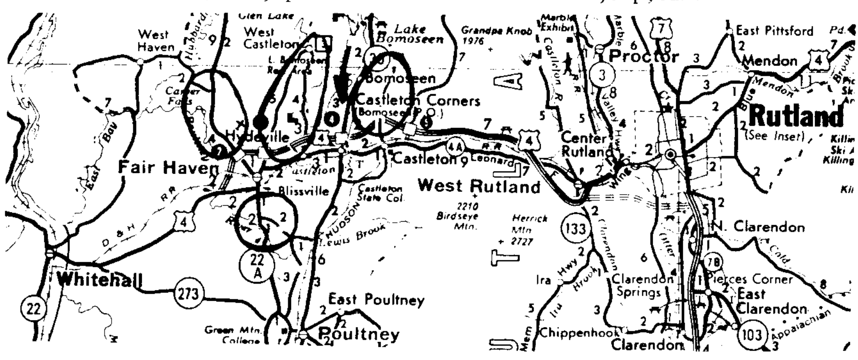
QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

SUMMER 1979 Volume 6 Number 2

A N N U A L M E E T I N G ---- S E P T E M B E R 29, 1979

Field Trip: Assemble on west side of village green, Fair Haven, Vermont
Leave at 9:30; 10:30; 1:30 p.m. Trip leaders: Brewster Baldwin, Andrew Raiford. Bring camera to photograph features of deep-water sediments and styles of folding in Taconic klippe. See Zen, G.S. A. Bull, 1961, p.293-338.
9:30 leave green for Eureka slate quarry (green and purple slates of Mettawee Fm); return to green.
10:30 leave green for West Castleton:
North Brittain "conglomerate"; type section of West Castleton Fm. (includes limestone turbidites); much-photographed synclines (Zen, 1961, Pl.3, Figs. 1,2).
Lunch at Bomoseen State Park. Return to village green.
1:30 leave green; drive northwest on VT 22A to see wildflysch: 330-foot section of Poultney Slate with turbidite interbeds (See Baldwin, GMG Winter 1978, v. 4, n.4); wet-sediment deformation; return to Fair Haven and go west to New York side of Poultney River to see folds.

Banquet and Meeting at Trak-In Motor Court and Steakhouse (468-2403) (NOT Trak-II), on VT 30, 1.0 miles north of junction U.S. 4.
Bar opens 5:30 p.m.
Dinner at 6:30 pm
prime rib of beef $8; baked stuffed chicken breast $7;
Boston scrod $6.50; price includes full dinner, tip, tax.



MINERAL OF THE QUARTER

This quarter we will discuss a rock rather than a mineral collecting locality. A very unusual white, grey and black granodiorite with large black orbicles of biotite mica can be found in an outcrop 3/4 mile long and 1/8 mile wide at the northwest edge of the Village of Craftsbury. This material is called "prune granite" locally from the resemblance of the biotite nodules to a wrinkled prune after they have been removed from the matrix. Because of its uniqueness this material proved useful to geologists studying the paths of glaciers over the North American Continent. The last advance of the ice sheet dragged pieces of this rock as far south as the lower New England States. The field positions of finds of this distinctive Craftsbury granite can be plotted and help document the path of the last glacial advance.

submitted by Ethel Schuele

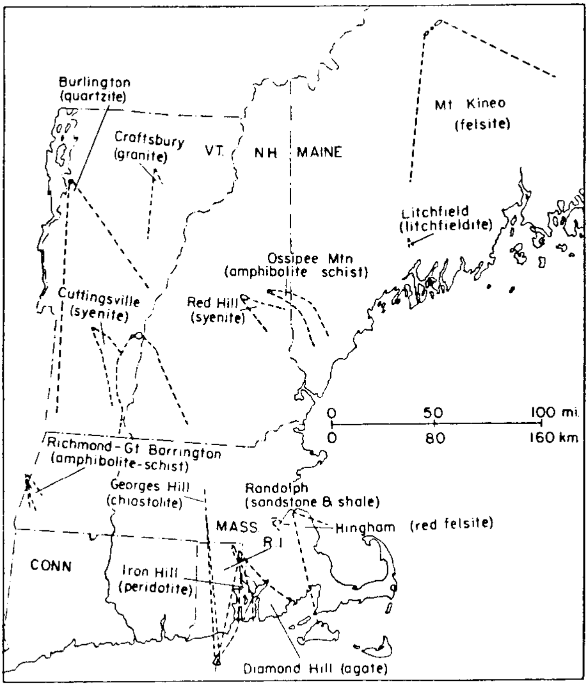


Figure from Glacial and Pleistocene Geology by Richard Foster Flint, 1957, John Wiley and Sons, Inc., pg. 126.

TREASURER'S REPORT

Financial Report for Fiscal 1979 (7/1/78 - 6/30/79)

Cash on Hand 7/1/78		$ 667.82
Checking	$ 323.11	
(9/30) Savings	344.71	
Total	$667.82	
Income		$ 695.18
Dues	$ 650.00	
Interest	21.16	
Teachers Workshop	24.00	
Misc.	.02	
Total	$ 695.18	
Expenditures		$ 482.13
Printing	$ 207.68	
Postal Service	110.26	
Typing	42.00	
Annual Meeting	54.00	
Awards	50.00	
Misc.	18.19	
Total	$482.13	
Balance for 1979		$ +213.05
Income	$695.18	
Expenditures	- 482.13	
Balance	+$213.05	
Cash on Hand 6/30/79		$ 880.87
Checking	$522.82	
Savings	358.05	
Total	$880.87	

Submitted by Stewart Clark, Jr. 8/2/79
Treasurer

GEM and MINERAL SHOW

On August 4, the Burlington Gem and Mineral Club and the Vermont Geological Society co-sponsored the second annual Gem and Mineral Exhibition and Sale. It was held at the University Mall in South Burlington and attracted a dozen exhibitors and was viewed by several thousand shoppers. The Geological Society set up several display boards that presented information on Vermont Geology, the Vermont Geological Society and geology in general. Additional membership information and application forms were disseminated by John Malter. The State Geologist's Office set up an exhibit and was manned by Diane Vanecek of the Society. There were demonstrations on faceting and cabbing of gemstones, soap stone carving and silver work.

Submitted by John A. Malter

STATE GEOLOGIST REPORT

The office of State Geologist has recently taken on some significant changes within the Agency of Environmental Conservation. Secretary Whittaker has recently announced the transfer of the office from the Planning Division to the Department of Water Resources where Dr. Charles Rattè will be director of a Division of Geology and Earth Resources under the Commishioner of Water Resources. Dr. Rattè will also retain his position as State Geologist directly responsibile to the Secretary of the Agency of Environmental Conservation.

A long range program involving a detailed assessment of the geology and mineral resources of state lands was initiated this summer at the Okemo State Forest. The project will include the mapping of Vermont's Precambrian terrain in sufficient detail to begin to sort out the stratigraphy and structure of what has heretofore been known as "The Mt. Holly complex." Alan J. McBean II, a recent graduate of the University of Vermont is working with Dr. Rattè this summer.

Diane Vanacek has been working this summer on the revisions to the "Bibliography of Vermont Geology". It is expected to be ready for publication early in September. The bibliography will also be placed on the state computer system with the capability of sorting for specialty items and area based on county and township.

Dr. Rattè has been asked to serve on the Advisory Panel to the Vermont Fragile Areas Registry Development Staff. At a recent meeting, it was agreed that the first nominations to the registry should be non-controversial, i.e. they should be on state or federal lands, easily recognized for their natural quality, sufficiently remote so as to not likely be disturbed and have multiple category significance and current scientific documentation.

Some geologic features that were suggested were the summit areas of Mt. Mansfield and Camel's Hump, the Texas Falls Gorge and Pot Holis, Weybridge Caves, The Champlain Thrust at Lone Rock Point, and Quechee Gorge and Smuggler's Notch.

The U.S. Geological Survey has announced that under the cooperative topographic mapping program three additional 7½ minute revisions will be published this fiscal year to complete the revised mapping of the 15 minute East Barre quadrangle. These will be the Knox Mountain,West Topsham and Washington quadrangles. The Barre West quadrangle was published last March and is now available for sale.

Also the U.S.G.S. has authorized revision of the St. Johnsbury, Plainfield, Hardwick and Lyndonville 15 minute quadrangles under its own federally funded program. The Jay Peak, Hyde Park and Memphremagog quadrangles have the next priority for revision mapping under the cooperative program.

U.S. Geological Survey topographic maps may now be purchased through the State Geological Publications Sales Outlet at the Vermont Department of Libraries.

STUDENT PAPERS PARTICIPANTS

There were 14 participants in the annual spring student papers competition held this year a Middlebury. Graduate student winner was Craig Heindel and undergraduate winner was Jason Rubin.

The Winners - Craig Heindel, left, and Jason Rubin, right.

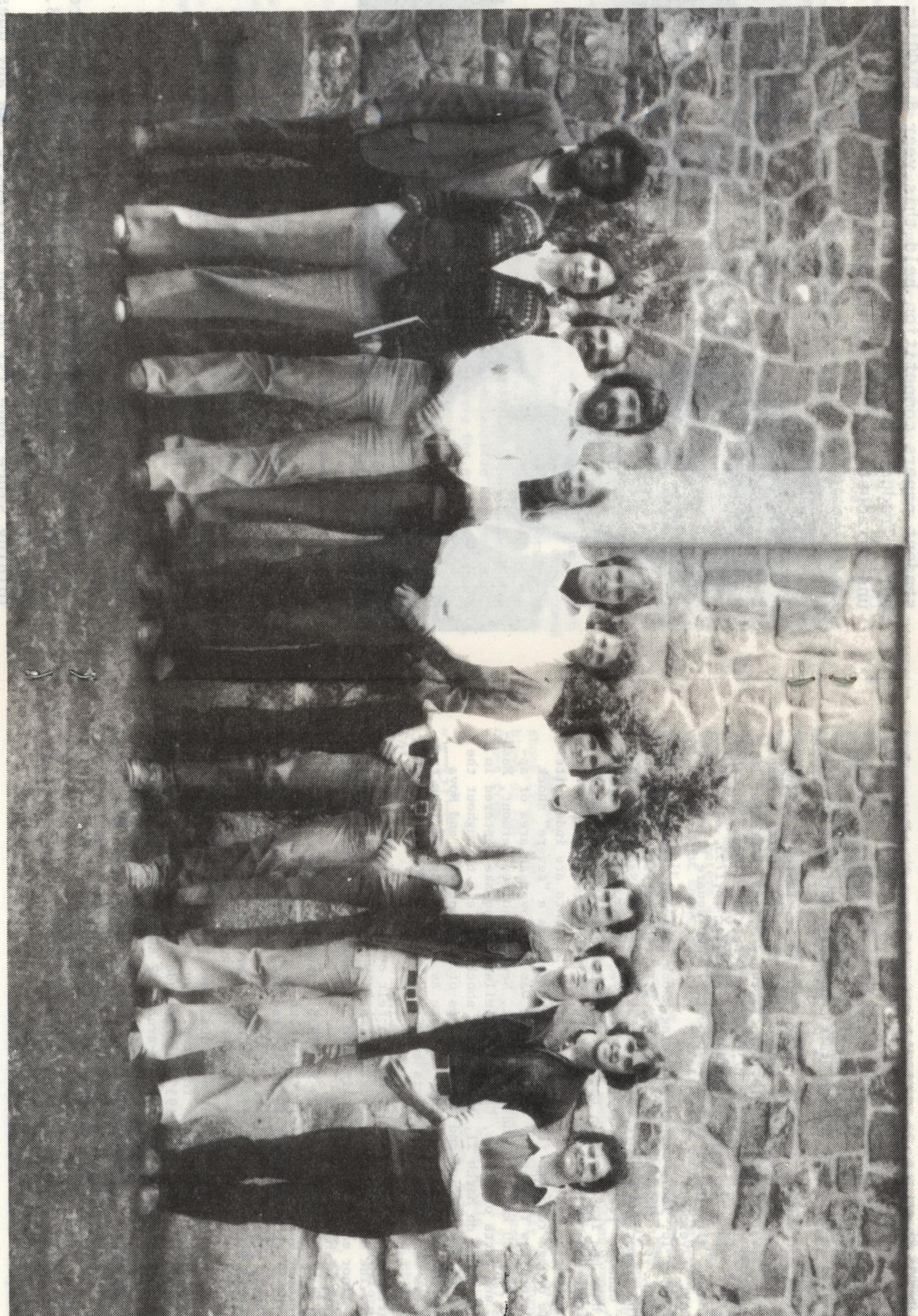
The participants (photo on next page) front row: D. Blank, C. Carter, G. Cushing, D. Esten, L. Frankel, back row: C. Heindel, R. Hoar, G. Hund, W. Ludue, P. Mann, A. McBean, C. Oakes, J. Rubin. Not in picture: R. Brackett.

DUES ARE DUE

Unless notified otherwise, your yearly dues are now due. Dues for Full and Associate members is $8.00. Dues for student members is $4.00. Those members joining since June 1st do not currently owe any dues.

Dues are due   DUES ARE DUE   D U E S   A R E   D U E

Send to V.G.S., Treasurer, Box 304, Montpelier, Vt.



EARTHQUAKES IN NEW ENGLAND

The following is re-printed from the Earthquake Information Bulletin of U.S. Dept. of the Interior Geological Survey, September-October 1977, Volume 9, Number 5:

"Earthquake History of Vermont by Carl A. von Hake, National Oceanic and Atmospheric Administration, Boulder, Colo.

Seven earthquakes of intensity V or greater on the Modified Mercalli Scale (MM) are known to have originated within Vermont. Many additional shocks centered in other New England States and Canada have been strongly felt in Vermont.

A violent earthquake, probably centered in the St. Lawrence Valley, was felt throughout the New England area on June 11, 1938. Other strong shocks on April 14,1658, February 10,1661, February 5,1663, September 16, 1732, November 29,1783, and October 17,1860, were felt over broad portions of the region. Also, the major earthquake of November 18,1755, east of Cape Ann, Mass., affected a large area (about 777 000 square kilometers), including all of Vermont.

On December 18, 1867, an early morning shock awakened persons (MM V) in Burlington, Vt., Odgensburg and Syracuse, N.Y., and Hamilton, Ontario, Canada. The tremor was also reported felt as far east as Sackville, New Brunswick, Canada. Previously listed as centered in Vermont, this earthquake may have had its origin in the St. Lawrence Valley region, the dominant seismic zone in the area. Many of the earlier earthquakes have limited information available and the historical accounts are indefinite.

Little damage resulted from what was described as a "severe" shock in northeastern New York on May 27,1897. It was felt over an area of approximately 288 000 km^2 , including New York, New Hampshire, Vermont, Massachusetts, and parts of Quebec, Canada. A similar earthquake centered in southeastern Maine on March 21, 1904. This shock was felt throughout the greater part of New England and the provinces of New Brunswick and Nova Scotia. The affected area was about the same as that of the previous tremor. Chimneys were damaged at Calais and Eastport, Me., and St. Stephen, New Brunswick, Canada.

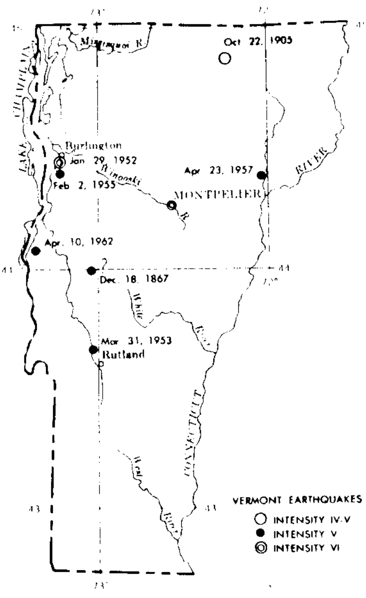
An earthquake on October 22,1905, was felt over a small area of northern Vermont. The early morning shock (estimated MM IV) was centered near Newport. A minor earthquake at Berlin, H.H., on April 25, 1928, was also felt in parts of Maine and Vermont.

Two strong earthquakes in 1929 and 1935 located at great distances from the Vermont borders were felt throughout all or most of the State. A magnitude 7.2 shock on November 18,1929, fractured 12 submarine cables in the Grand Banks area of the Atlantic Ocean. The tremor was felt in all of the New England States. Many people in southeastern Maine were alarmed by the shock, which knocked articles from shelves. Reports of cracked plaster were received from Hanford, Vt. At numerous other places in the State,slight rattling of doors and windows was reported. Two or three shocks were noted by many persons. On November 1,1935, a magnitude 6.25 earthquake near Timiskamig, Quebec, Canada, was felt over an area of 2 600 000 km^2 in the United States and Canada. The strongest intensities observed in Vermont were from Bennington,Brattleboro,St. Johnsbury, and White River Junction. Some cracks in walls were noted; also, beds shook and windows and dishes rattled."

"On December 20,1940, a strong earthquake (estimated magnitude 5.8)occurred near Lake Ossipee, N.H. This was followed by a shock of approximately the same intensity 4 days later. Some damage resulted in the epicentral region. At Bloomfield, Vt., the top bricks on some old chimneys were displaced. Many persons were awakened by the 2.27 AM tremor on December 20. Other effects reported included cracked plaster and stucco,broken dishes and overturned objects. An earthquake near Massena, N.Y. (12:39 AM Eastern War Time, September 5,1944), was felt strongly at Burlington, Rutland, and St.Albans, Vt. Lesser intensities were noted throughout the State.

On January 29, 1952, a local shock near Burlington affected an area of about 132 km^2. Minor damage included cracks in pavement, basement walls, and a city gas main (MM VI). Ground cracks about 3 kilometers long and 4.5 meters apart were observed in the North End. The earthquake was also felt at Essex Junction, where cracked walls were noted. Other tremors were felt in the area the following day. A moderately strong earthquake in the Rutland area about 1 year later caused only MM V effects. Houses trembled, some furniture was moved, knicknacks fell, and other small objects were disturbed at Brandon and Rutland from the March 31,1935, tremor. Rattling of dishes and windows were observed at other communities in the nearby region. The tremor was also felt in northern Washington County, N.Y.

Another local shock at Burlington occurred on February 2,1955.Houses shook, windows and dishes rattled, and many thought their oil burners had blown up (MM V). A large ground crack was seen in the North Burlington area. Other tremors were reported a few hours later. On April 23, 1957,earthquake was felt by many within a radius of 24 km of St. Johnsbury. Buildings shook;windows and dishes rattled (MM V). Many persons thought there had been an explosion or a plane crash. Felt reports were received from Danville,East Barnet,Lyndonville, Passumpsic,St. Johnsbury, Waterford, and West Barnet.



An earthquake centered in western Vermont on April 10,1962,caused MM V effects over a large area. The total felt region covered about 52 000 km^2 of Vermont, Maine, Massachusetts, New Hampshire, and New York. A beam supporting the Vermont State House at Montpelier was dislodged and the brace dropped about 127 millimeters, two beams under the dome were weakened, and 20 window panes cracked. Cracked plaster was reported. At Barre, several pieces of tile fell from the ceiling of a bank, and two cracks appeared in walls. The shock was also felt strongly at a number of places in nearby New Hampshire and New York. Less than 3 months later(June 20,1962) a large portion of Vermont experienced MM V effects from a shock in southern Quebec Province,Canada. A chimney was cracked at North Montpelier.Slight "damage occurred at Springfield, Vt., from a June 20,1964,earthquake centered at Warner, N.H.,about 55 km away. MM V effects were also noted at White River Junction. Lesser intensities were observed in several other Vermont towns.

All of Vermont felt tremors from a magnitude 5.2 earthquake located in Western Maine. The June 14, 1973, shock was felt over an area of about 250 000 km^2, including portions of Maine, New York, eastern Quebec Province, and all of Connecticut, Massachussetts, New Hampshire and Rhode Island. MM VI effects were felt at Canaan and Montpelier, Vt., Plaster was cracked, chimneys moved away from walls, and some road surface cracks were reported."

NOTE: The Earthquake Bulletin has many interesting articles on earthquakes. Some of which apply to the Northeastern U.S. area. See Also "Earthquake Hazard in New England,'A.F. Shakal and M.N. Toksoz. Science Vol 195, Jan. 14,1977 pps 171-173.

N O M I N A T I O N S

NOMINEES for the 1979-1980 year presented at the Summer Meeting on July 28, 1979 were:

PRESIDENT:	Rolfe Stanley
VICE PRESIDENT	Bruce Watson
SECRETARY	Lance Meade
TREASURER	Stewart Clark
BOARD OF DIRECTORS:	
1 Year Term 1980	Diane Vanecek
2 Year Term 1981	Jeanne Detenbeck

CONSTITUTIONAL CHANGES

The following are constituional changes to the bylaws proposed for action at the Annual Meeting.

Article II, Part C: Dues shall be due during the month of January.

Article III,: The fiscal year of the Vermont Geological Society shall be the same as the calendar year.

(Note: those wishing to pay dues for fiscal year 1980 may do so at the fall 1979 meeting or wait to January 1980

Article II, part F; Fiscal year be divided into quarters and initial dues for new members reflect the period remaining in the fiscal year.

MEMBERSHIP LIST

The following are additions, corrections and changes to the membership list printed in the Winter and Spring issue:

Peter Beblowski	40 Booth St,Burlington,VT 05401
Chapin Library	Norwich University, Northfield, VT 05667
Mary Crandall	17 North St., Rutland, VT 05701
Richard Eliot	42 Skyline Dr.,Lyndonville, VT 05851
Peter B. Harris	The White Mt. School,Littleton, NH 03561
John Christopher Hepburne	Dept. Geology & Geophysics, Boston College, Chestnut Hill, MASS. 02168
George E. Holman	Elmore Mt. Rd,Morrisville, VT 05661
Jeffrey Limoge	R.D. 2,Morrisville, VT 05661
Roland Marcotte	Box 71, Bakersfield, VT 05441
Linda Marek	Water Resources Ctr,601 Main St. Burlington, VT 05401
Lance Meade	P.O. Box 133, Pittsford, VT 05763
Peter Northrop	3230 S.Gressner Apt 716, Houston,TEXAS 77063
William Siok	Wehran Consulting Engrs, 6663 Main St, Middletown, N.Y. 10940
Vt. Institute of Natural Science	Woodstock, VT 05091
Mark Zdunczyk	7 East St., Bennington, VT 05201
Robert L. Badger	43 Gloria Ave., Rutland, Vermont 05701

TALK ON MINING IN VERMONT AVAILABLE

Geomapping Information Services of Pittsford, Vermont has just released a new talk on MINING IN VERMONT- - IT'S PAST .... PRESENT AND FUTURE. This informative and entertaining slide presentation and talk will be individually tailered for your group - showing the geologic, historical, environmental and socio-economic impacts of the extractive mineral industries in Vermont.

Some of the topics of the past (1800's and early 1900's) include the glass factories, brick plants, iron mines and furnaces, lime kilns, copper mines and mills, kaolin pits and plants, asbestos, talc-soapstone, marble, granite and slate.

The present mining industries to be examined in MINING IN VERMONT include asbestos, talc-soapstone, granite, marble, slate, concrete batch plants and asbestos plants.

There will also be an examination of the future including the economic, environmental and other regulatory restraints which may effect this industry.

This 30 to 60 minute program is available at no charge to interested community groups and particularly to junior and senior high school science and history classes. For more information call Lance Meade at 802 483-2283 or write to Geomapping Associates; P.O. Box 133; Pittsford, VT 05763. When writing indicate three choices of dates you would like the presentation, the size of the audience and whether you have a screen, overhead projector and 35 mm slide projector. Lance should also be at the Annual Meeting to answer any of your questions.

GREEN MOUNTAIN GEOLOGIST
VERMONT GEOLOGICAL SOCIETY
BOX 304
MONTPELIER, VERMONT 05602

FIRST CLASS

The GREEN MOUNTAIN GEOLOGIST is published quarterly by the Vermont Geological Society, a non-profit educational corporation.

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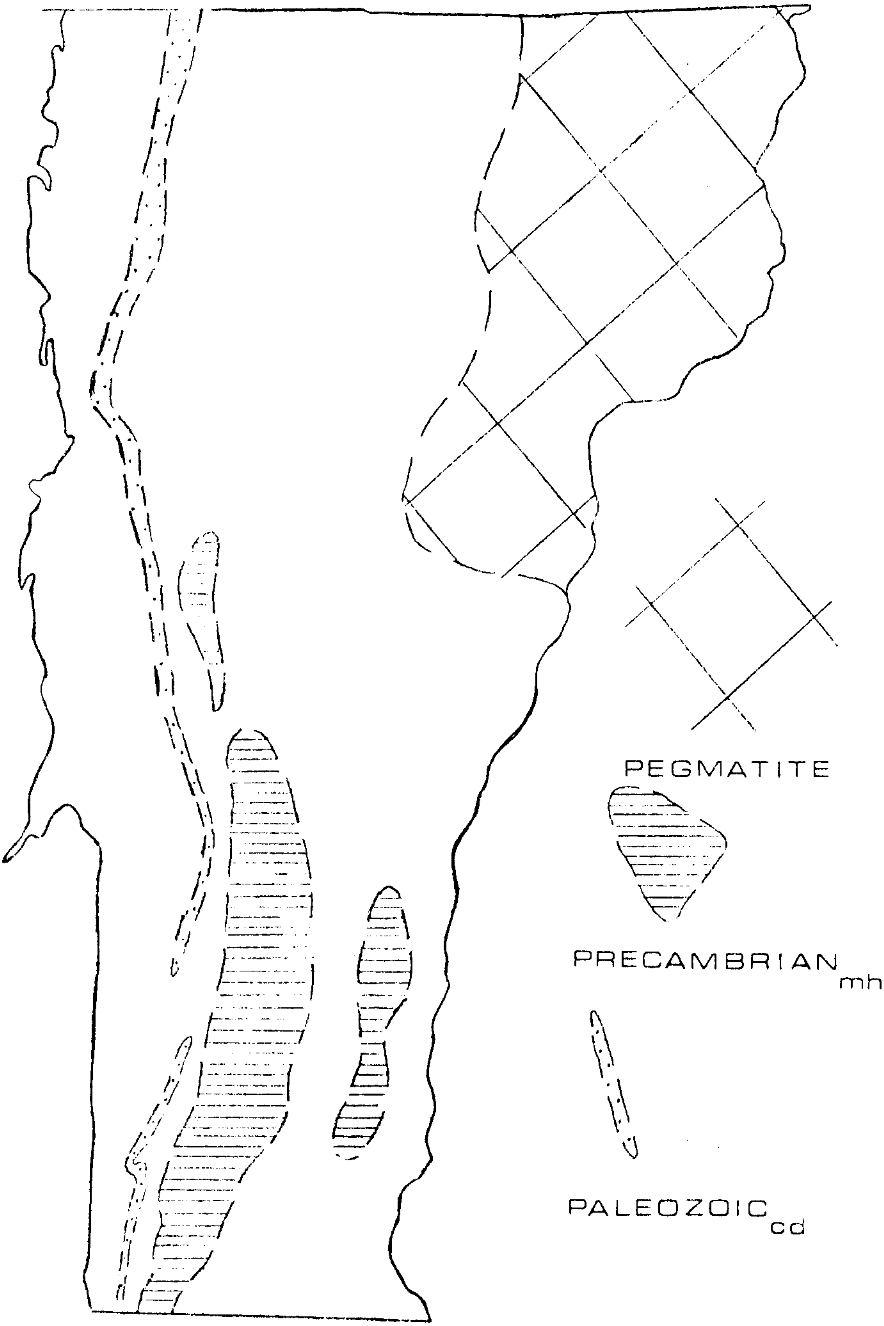
URANIUM PROVINCE MAP OF VERMONT



Five major criteria are set forth each with several specific subdivisions for consideration:

1. Geometrical Criteria

The size and shape of Vermont's crystalline rock bodies are reasonably well known from existing map information. Depth dimensions are less well known and depth characteristics, although likely to be similar to surficial characteristics, are yet untested save some evidence from mining, water well drilling and other relatively shallow penetrations. Internal rock body properties are yet untested with regard to their effect or influence on repository design and/or construction, and compatibility with the waste to be stored.

2. Long-Term Stability Criteria:

Vermont's geologic terrain is relatively aseismic and non-volcanic. Modern tectonic boundaries that may heighten the risk of earthquake stability in Vermont are the St. Laurence Valley and the Boston (Massachusetts) area.

3. Hydrologic Criteria:

Vermont's present and past (and very likely future) hydrological and climatelogical setting is not amenable to the long term isolation of nuclear waste from the biosphere. Vermont's highly fractured crustal rocks, 40+ inches of annual precipitation, past glacial and potential future glacial influence on the hydrologic environment are likely to dampen serious interest in Vermont as a site for a (HLW) nuclear waste repository.

4. Geochemical Criteria:

The effects of heat production, chemical reactions, the presence of or introduction of ad-absorping materials are not known in the specific detail necessary for site selection.

5. Mineral Resource Criteria:

Vermont's mining districts and potential mineral resource areas are not likely to be considered. Vermont geologic formations now provide resources for the granite, marble, talc, slate and asbestos industries. Other potential mineral resources include copper, clay, uranium, oil and gas. Limestone and other sources of rock aggregate which constitute only shallow surface operations are not likely to discourage site selection.

LOCAL GLACIATION ON HAYSTACK MOUNTAIN, WILMINGTON QUADRANGLE, VERMONT

White, Christopher M., RD 1, Box 240, Bristol, Vermont 05443

The existence of local glaciation in late and postglacial times in southern Vermont has long been debated (Goldthwait, 1916; Hubbard, 1918; Shilts, 1967). Hubbard identified numerous loop moraines in valleys leading from Haystack Pond on Haystack Mountain. I mapped these and other features suggestive of local glaciation.

Most of the "loop moraines" are bedrock-cored. However, some ridges do appear glacial in origin. There are valley steps in Binney Brook valley, suggesting a valley glacier flowing from Haystack Pond existed there (Colman, 1976). Haystack Pond occupies a possible cirque that has dramatic morphometry. However, its age and origin are uncertain.

A weather station was maintained at Haystack Pond to see if the topoclimate could have supported local glaciation. Data comparison between Haystack, other Wilmington quadrangle stations, and Mount Washington summit records indicate a difference of 15°F (8°C) on average in summer temperatures between Haystack Pond and Mount Washington. Since Tuckerman Ravine, on Mount Washington, is in a stage of incipient local glaciation, with snow sometimes remaining there throughout the year, temperatures at Haystack Pond would have had to cooled at least that much for local glaciation to become possible. Hypothetical cooling schemes, such as the effect of the Little Ice Age, are insufficient to cool Haystack's climate to local glaciation conditions. However, significant climatic deterioration such as might accompany increased continentality could provide a nurturing environment for local glaciation in southern Vermont. Such increased continentality probably existed during late glacial times immediately after continental deglaciation of the area.

MEMBERSHIP LIST

All members below have paid their dues and are full members except those with the following after their name: (A) Associate Member; (L) Lifetime.

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FOR THE TEACHER

Teachers Workshop - May 23, 1979

The Third Annual Vermont Geological Society Teachers' Workshop will be held Wednesday, May 23, 1979 at Lyndon State College, Lyndon Center, Vermont, which is at the northeast part of the state, toward the north end of the Willoughby Arch (if you're a bedrock geologist) or toward the northern most extremity of the Connecticut Valley Glacial Lakes (if you're a "surficial" geologist). The purpose of the workshop will be to establish a sequence of geologic events and "man-induced" events that is consistent with many diverse observations seen along Miller Run Valley and at Willoughby Gap.

Most observations in Miller Run Valley will be made on glacial meltwater and flood plain deposits and their landforms. At Willoughby Gap there is a spectacular cliff on which is exposed a Devonian granitic pluton with associated pegmatites and a contact metamorphic aureole in regionally metamorphosed dark shales and limestones. The trend of the Willoughby Gap and Miller Run both parallel a set of vertical joints that strike northwest. Wild speculation will be entertained on the origin of this trend in-the-light-of Plate Tectonic Theory and the effect this trend had on very recent glaciation, deglaciation, and super-highway construction.

We hope that the fitting together of obvious and not so obvious observations made on this one day field trip will be a useful exercise for anyone living in Vermont who would like to do the same for his home area where there is seldom any literature that summarizes the geologic history and the many observations that are consistent with it.

New Appalachian Map

A large and colorful map of the entire Appalachians has recently been published that makes it possible for people with and without extensive training in Geology to speculate on rocks and structures that suggest plates moved apart, converged or passed in translatory motion. The map is titled Tectonic Lithofacies Map of the Appalachian Orogen, 1:1,000,000, compiled by Harold Williams, and available from the Department of Geology, Memorial University, St. John's, Newfoundland, Canada, and costs $20.00. Checks should be made payable to the Appalachian Research Fund. Barry Doolan of this Society and the University of Vermont did the compilation for Vermont and the cross-sections of the New England Appalachians.

Every rock in the Appalachians is put into one of twenty four units, twelve of which occur in Vermont. College students in their second semester of an introductory geology course seemed to like the map because they could relate Plate Teconic Theory to familiar landscapes.

New Rock and Mineral Book

A new book for the identification of rocks and minerals for the beginner is Simon and Schuster's Guide to Rocks and Minerals edited by Martin Prinz, G. Harlow and Joseph Peters, all of the

American Museum of Natural History. The book is $7.95, and was printed in Italy. Students will like the color plates of handspecimens, which to the purest are a bit "gaudy" and often not true colors. The photographs of rock handspecimens are more complete than those of most books of this nature and are often accompanied by a color photograph of a rock thin-section under cross polarizers.

submitted by Ballard and Sandria Ebbett
Education Committee Co-Chairpersons

STATE GEOLOGIST REPORT

The major functions of the Office during 1978 were in public relations and advisor-consultant to other departments and agencies of state, regional and local government.

Pre-publication copies of "A bibliography of Vermont geology" are now available through the Geological Documents Section,Vermont Department of Libraries, 111 State Street,Montpelier,Vermont,05602. Work is continuing on up-dating of references,cross referencing and stylization.

The Vermont Mapping Advisory Committee was reinstituted in March, 1978, by executive order. Dr. Ratte' was named chairman of that committee. A brochure on the "availability of Vermont Maps has been prepared by the committee, and may be obtained free of charge by writing the chairman.

The Vermont U.S.G.S. cooperative topographic mapping program has been re-established, and the Barre N.E. 7 ½ min. quadrangle will be published in April 1979.

Considerable attention has been given to uranium exploration in Vermont's Precambrian terrain. Exploration and mining leases have been sought by several mining companies. This sudden interest has caused quite a mix of reactions in a state not heretofore considered rich in mineral resources, and with a population geared for tourism, vacation homes, retirement and outdoor recreation. Since public lands are involved, the state is faced with a major policy decision concerning uranium mining as a proper use of state land.

Research continues on the use of mine tailings as resource materials. This research is part of a cooperative program with the U.S. Bureau of Mines. The waste slate-waste marble project is being conducted at the University of California and has reached the small pilot plant production stage where the economics of the process of producing glass fibers and rock wool can be determined. The Federal Highway Administration is continuing research on the production of a highly durable, skid resistant road aggregate.

The cooperative program with the U.S.B.M. also continues to develop base-line chemical data on silicate and limestone bedrock formations.

The joint study (with Vermont's Agency of Transportation) of rock-fall and rock-slide potential along Vermont's Interstate Highway System has advanced to the completion of Phase I -Identification and Classification of Critical Sites. Forty sites have been identified as highly critical and are recommended for Phase II - Detailed Geologic and Engineering Study to provide data for the design of mechanisms for correcting the hazards.

The Task Force on Erosion and Sedimentation problems as related to the enforcement of Vermont's Land Use and Development Law has developed a procedure for evaluating construction projects and establishing a Criticality Class. The system is uncomplicated and can be used by all parties involved in the permit process. A second document is being prepared that will establish minimum design standards (for controlling erosion and sedimentation) for each Criticality Class.

The following programs are in progress or in the development stage: 1) development of a 5 year plan; 2) increase financial, administrative and technical support of Vermont's Ground Water Programs; 3) develop proposal to be submitted to U.S.B.M. for a comprehensive study of the technical and institutional character of Vermont's Slate Industry; 4) establish guidelines for mine, quarry and rock borrow quarry reclamation; 5) assess the oil and gas potential in Vermont's Champlain sedimentary basin; 6) commence revision of the Vermont geologic and surficial geology maps to include a re-assessment of Vermont's mineral resource provinces and mining districts; 7) continued partial financial and/or logistical support for field studies and research conducted by the Geology Departments at the University of Vermont, Middlebury College and Norwich University:

i. the serpentinite (ophiolite) zone of northern Vermont;
ii. the depositional environments of Vermont limestones;
iii. the geology of Vermont's State Parks;
iv. the application of geology to Vermont's environmental problems including forensic and medical geology;
v. the mapping and analysis of high angle faults along the Green Mountain Front in Western Vermont.

RARE II Statement. The State of Vermont supports the approach stated as Alternative A, i.e., no action is to be taken at the present time; allocation decisions for the inventoried roadless areas will continue to be made through the Forest Service land management planning process, as the method for the designation of wilderness areas on the Green Mountain National Forest.

The State of Vermont is presently working with the Green Mountain National Forest Staff in its unit planning process and recreational composite planning as the State's Comprehensive Outdoor Recreation Plan is being developed. The State Geologist's office will cooperate fully in the proper assessment of earth resources in the Green Mountain National Forest. Wilderness designations should be addressed carefully and in concert with this plan. A full statement of the State of Vermont's position on the RARE II question is available from the State Geologist's office.

submitted by Charles Ratté

ANNUAL MEETING AND FALL FIELD TRIP

October 14th ushered in another typical Vermont weekend. Cold, dark, with a heavy threat of rain in the air. The ground was already damp from a couple sprinkles. The annual fall field trip was scheduled to begin at 9:30 way up at the northern reaches of Vermont at the cross-roads at Jay. You can easily miss it if you don't stop for the stop sign. Not only were there a few people there on time, there was a CROWD! After the Middlebury contingent arrived there were 45 participants. Mark Zdunczyk brought some students of his all the way from Bennington.

The field trip started in the back room of the General Store. Rolfe Stanley explained the area he had studied in Jay and up into North Troy where only by very details carefull mapping was it possible to unravel the startling geology of this area for it to make sense. Then Barry Doolan put up a copy of the Tectonic Lithofacies Map of the Appalachian Orogen (see information on this map under For the Teacher) and explained the significance of these ultramafic rocks to an understanding of the tectonics of the northern Appalachians. Barry also explained his area which lies on the Canadian border.

Fortunately the only real shower occurred during the briefing, and during the rest of the day there was only some light drizzle. Stew Clark got pneumonia and everyone got somewhat damp. But everyone agreed that this was one of the most current, well planned and informative field trips the Society has ever had.

Most of the group (and some additions) then adjourned to the Schneehutte for an excellent chicken dinner followed by the Annual Meeting. The highlights of the meeting were:

- Rolfe Stanley introduced our hosts, Barbara and Buddy Loux
- There is $344.71 in savings and $247.94 in checking accounts.
- The Society endorsed plans for the Contributions to Vermont Geology.
- Barry Doolan commented on the NYS Geogram which publishes data on who is doing what.
- The slate of officers for the new year was presented and was elected by unanimous vote. They were:

President	Richard Willey
Vice President	Jean Detenbeck
Secretary	Paul Mills-Brown
Treasurer	Stewart Clark, Jr.
Director for 2 years	J. Charles Fox
Membership Chairperson	Dorothy Richter
Meetings Chairman	Robert Cushman
Professionalism Chairman	Charles Ratté
Communication Chairman	James Ashley

- Dick Willey reported on plans for the Winter Meeting at Norwich University (Hope you ALL COME!)
- Jack Drake requested help for a Career Day being planned for U.V.M.
- Chuck Ratté asked Vermont Bibliagraphy reviewers to get comments in.
- Meeting adjourned at 8:30 P.M.