



THE GREEN MOUNTAIN GEOLOGIST

QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

WINTER 2003

VOLUME 30

NUMBER 1

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

TABLE OF CONTENTS

WINTER MEETING PROGRAM	2
ABSTRACTS	3
CALENDAR	12
PRESIDENTS LETTER	13
VGS ANNUAL MEETING & ELECTIONS	14
STATE GEOLOGIST'S REPORT	15
ADVANCEMENT OF SCIENCE COMMITTEE	16
VGS TREASURER'S REPORT	16
EARTH SCIENCE WEEK 2002	17
CALL FOR STUDENT ABSTRACTS	18
ANNOUNCEMENTS	19

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

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

Executive Committee

President	Helen Mango	802-468-1478
Vice President	Tim Grover	802-468-1238
Secretary	David West	802-443-3476
Treasurer	Stephen Howe	518-442-5053
Board	Shelly Snyder	802-453-2333
of	Ray Coish	802-443-5423
Directors	Stephen Wright	802-656-4479

Committees

Advancement of Science	Stephen Howe
Education Committee	Christine Massey
Membership	Stephen Wright
Public Issues	Laurence Becker
Publications/Newsletter	Marjorie Gale, Peter Gale, Dave West

ADDRESS CHANGE?

Please send it to the Treasurer at the above address.
-Printed on Recycled Paper-

WINTER MEETING PROGRAM

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

February 8, 2003

- 8:30 COFFEE & EXHIBITS
- 9:00 L. Barg: A PAIRED WATERSHED APPROACH TO TWO LARGE VERMONT WATERSHEDS
- 9:20 F. D. Larsen, R.K. Dunn and G. E. Springston: NEW CARBON-14 DATES FROM HOLOCENE LAKE AND STREAM DEPOSITS IN THE RANDOLPH, VERMONT, 7.5-MINUTE QUADRANGLE
- 9:40 George Springston: ANALYSIS OF CHANGES IN STREAM CHANNEL POSITION IN CENTRAL VERMONT USING DIGITAL ORTHOPHOTOGRAPHY AND HISTORIC MAPS
- 10:00 N. Kamman & D.R. Engstrom: HISTORICAL AND CURRENT HG DEPOSITION TO LAKES INFERRED FROM 210PB-DATED SEDIMENT CORES IN THE VT-NH REGION
- 10:20 H. Mango: DETERMINING THE CAUSE OF ARSENIC CONTAMINATION IN THE GROUNDWATER OF ZIMAPAN, MEXICO
- 10:40 BREAK & EXHIBITS
- 11:00 P. Ryan & J. Kim: URANIUM AND LEAD IN GROUND WATER PRODUCED FROM THE CLARENDON SPRINGS FORMATION IN THE CHAMPLAIN VALLEY
- 11:20 G. J. Walsh & F. P. Lyford: STRUCTURAL CONTROLS ON GROUND WATER FLOW DIRECTIONS IN THREE HIGH-YIELD FRACTURED METAMORPHIC BEDROCK AQUIFERS OF MASSACHUSETTS

- 11:40 T.W. Grover: METAMORPHIC GEOLOGY OF THE POMFRET DOME AREA, VERMONT
- 12:00 M.K. Roden-Tice & S. J. Tice: THERMOCHRONOLOGIC EVIDENCE FOR EARLY - LATE CRETACEOUS EXHUMATION OF THE ADIRONDACK MOUNTAINS, NEW YORK AND WESTERN NEW ENGLAND
- 12:20 K. Klepeis & T. Rushmer: DIRECT OBSERVATION OF A FULL CRUSTAL COLUMN THROUGH AN ANCIENT MOUNTAIN BELT IN NEW ZEALAND: RELATIONSHIPS BETWEEN MAGMATISM AND DEFORMATION
- 12:40 LUNCH and VGS Executive Committee Meeting - All members are invited to attend.

ABSTRACTS

A PAIRED WATERSHED APPROACH TO TWO LARGE VERMONT WATERSHEDS

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

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

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

NEW CARBON-14 DATES FROM HOLOCENE LAKE AND STREAM DEPOSITS IN THE RANDOLPH, VERMONT, 7.5-MINUTE QUADRANGLE
Frederick D. Larsen, Richard K. Dunn and George E. Springston, Dept. of Geology, Norwich University, Northfield, VT 05663

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Neil Kamman, VT Dept. of Environmental Conservation, 103 South Main, 10N, Waterbury VT 05671

D.R. Engstrom, Science Museum of MN

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

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

Helen Mango, Castleton State College, Castleton, VT

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

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

Peter Ryan, Geology Department, Middlebury College, Middlebury, VT 05753

Jon Kim, Vermont Geological Survey, Waterbury, Vermont 05671

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

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

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

Gregory J. Walsh, U.S. Geological Survey, P.O. Box 628, Montpelier, VT 05601

Forest P. Lyford, U.S. Geological Survey, 10 Bearfoot Road, Northborough, MA 01532

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

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

METAMORPHIC GEOLOGY OF THE POMFRET DOME AREA, VERMONT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CALENDAR

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

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

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

PRESIDENT'S LETTER

Dear Members,

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

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

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

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

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

ANNUAL MEETING MINUTES

September 14, 2002: Waterbury, Vt

Saturday, September 14, 2002 in Waterbury, Vt:

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

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

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

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

Respectfully submitted,
 Dave West, Secretary

STATE GEOLOGIST'S REPORT

Aquifer Mapping and the Vermont Legislature

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

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

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

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

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

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

www.uvm.org/vtgeologicalsociety

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

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

VERMONT GEOLOGICAL SOCIETY TREASURER'S REPORT

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

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

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

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

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

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

Respectfully submitted,
Stephen S. Howe

EARTH SCIENCE WEEK 2002

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

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

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

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

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

The Vermont Geological Society will hold its Spring 2003 meeting in Bicentennial Hall at Middlebury College in Middlebury, VT. The meeting is dedicated to students conducting research in the geological sciences. Undergraduate and graduate students are encouraged to submit abstracts outlining the results of their research. Abstracts covering all aspects of the geological sciences are welcome and will be published in the Spring issue of the Green Mountain Geologist. The Charles Doll Award for outstanding undergraduate paper will be presented. A cash award for "Best Paper and/or 2nd place" will also be presented based on quality of the research, the abstract, and the presentation of the paper, including abstract content and style, presentation clarity and thoroughness, and the student's mastery of the subject matter.

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

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

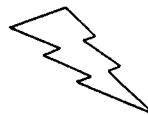
Deadline for abstracts: Friday, April 4, 2003.

Send abstracts to:

Marjorie Gale
Vermont Geological Survey
103 South Main St., The Laundry Building
Waterbury, VT 05671-0301
email: marjieg@dec.anr.state.vt.us

For additional information, contact Marjie at (802) 241-3608 or Helen Mango at (802) 468-1478. For technical information (e.g. computer hook-up capabilities for PowerPoint presentations), contact Dave West at dwest@middlebury.edu

ANNOUNCEMENTS



**STUDENT RESEARCH GRANT APPLICATIONS
DUE APRIL 1, 2003**

Students and secondary school teachers are encouraged to apply to the VGS Research Grant Program by April 1, 2003. Downloadable Research Grant Program Applications are available from the Society's website at www.uvm.org/vtgeologicalsociety. For those without Internet access, forms may be obtained by writing to Stephen Howe at the Dept. of Earth and Atmospheric Sciences, University at Albany, ES-351, 1400 Washington Avenue, Albany, NY 12222-0001. Tel: (518) 442-5053; E-mail: showe@csc.albany.edu

**MEMBERSHIP RENEWAL
DUE FEBRUARY 15, 2003**

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

**VGS SPRING MEETING AND STUDENT PAPER PRESENTATIONS
APRIL 26, 2003
BICENTENNIAL HALL, MIDDLEBURY COLLEGE
MIDDLEBURY, VT**