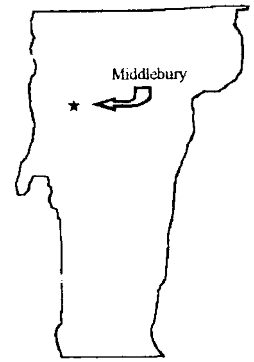
THE GREEN MOUNTAIN GEOLOGIST



QUARTERLY NEWSLETTER OF THE VERMONT GEOLOGICAL SOCIETY

SPRING 1996 VOLUME 23 NUMBER 2

The Vermont Geological Society Spring Meeting for the

PRESENTATION OF STUDENT PAPERS

SATURDAY APRIL 27, 1995, 8:30 AM

Twilight Auditorium

Middlebury College

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

Inside This Issue

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.

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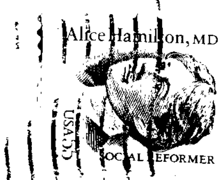

PRESIDENT'S LETTER

April 5, 1996

Dear Members,

The earth shakes and people are jarred from every day plans to ask why. Entity X comes to site a waste disposal facility in someone's corner of the universe and that somebody says why with a big W. Not only seismic events rock citizens from a foggy understanding of the physical world around them, but also grassroots movements that stem from community concerns. Meeting the laws of supply fueled the need for geologists in such fields as energy exploration, while it is the demands of concerned local citizens that lead the call to other examinations.

Whether we are working in the public or private sector it is the "need" to know and the "want" to know that pays the bills. When an organization, business, group, or individual writes the check, we deliver a product that is tailored to their needs. This includes no longer teaching students in a pure lecture format because they want to work cooperatively to get to an answer, or meeting a client request for a detailed technical report in response to a regulator's dictate.

At the *Geological Society of America* Northeast Section meeting in March, I participated in a symposium on Geographic Information Systems (GIS), Geology and Public Policy. My presentation focused on how GIS was used to meet the needs of a special legislative study committee on-slate. I argued that the power and utility of GIS is to quickly compile information for the chosen audience.

In many cases, the audience doesn't care about, or need to know all of the detail that makes us hum with geologic delight. We should know the detail to make a credible case, but it must be distilled for an assembly's needs. We need to put our heads in the head of the viewer.

If the audience consists of lay-persons, we can work hard to break information down to simple visuals that answer the key questions on their minds. If this is done, we will be asked back when the need and want to know again arises. If we don't recognize what drives the audience, we may be detoured to the unemployment line.

Students are to give papers at the annual Spring Student Presentation Meeting. They have worked hard to include details, and the process of uncovering those details is integral to their development as geologists. It is likely, however, that many will not be performing pure geological research in their future careers. So know your detail, but also know your audience. It may be understanding the mind-set of the employer/client/citizen that gives you the opportunity to present geological knowledge in a way that will makes them hum for an encore performance.

As a final word, I would like to thank all the speakers and those who participated in the *Winter Symposium* on rock and mineral industries. To my mind, the meeting raised the awareness of a significant piece of Vermont's economic past, present and future.

Sincerely,

Larry Becker

GEOLOGICAL INDICATORS OF RAPID ENVIRONMENTAL CHANGE: AN INTERNATIONAL CHECKLIST

by Dr. Carol E. Harris and Dr. Anthony R. Berger

As a contribution to integrated environmental and ecological monitoring and state-of- the-environment reporting, the International Union of Geological Sciences (IUGS) through its Commission on Geological Sciences for Environmental Planning has developed a checklist of geoindicators. These have been compiled as tools for tracking changes in the dominantly abiotic components of forest, aquatic, desert, coastal, polar, mountain and other terrestrial ecosystems.

Geoindicators are high-resolution measures of short-term (< 100 years) surface or near-surface changes that are significant for environmental monitoring and assessment. They measure geological variations, including those related to climate change, that are important for understanding terrestrial ecosystems. Geoindicators measure both catastrophic events and those that are more gradual but evident within a human lifespan. Most deal with changes on the landscape (0.1-10 km) and meso-scales (10-100 km), though some, like relative sea level and volcanic unrest, have regional dimensions.

Geoindicators have been developed from standard techniques used in geology, geochemistry, geophysics, geomorphology, hydrology and other earth sciences. Some, such as seismicity, groundwater quality, and coral chemistry, are complex and costly to measure. Others, such as shoreline position, areal extent of wetlands, dune mobility, and slope failure, are relatively simple and easy to apply. Geoindicators can also be used to unravel trends over the past few centuries and longer through paleo-environmental research, thus providing the important baselines against which human-induced and natural stresses can be better understood.

Twenty-seven geoindicators have been described in a checklist format that represents a 'menu' of core landscape indicators. These should be combined with other indicators (biological, climatic, even socio-economic) to construct a full picture of environmental condition and the stresses on ecosystems originating from both natural and human sources. Each geoindicator is described using a framework of sixteen different descriptors, as follows:

- *Name*: applied to individual geoindicators.
- *Brief Description*: What is the geoindicator, and how does it express geological processes and phenomena?
- *Significance*: Why is it important to monitor this geoindicator? How are changes in it liable to affect human settlements, agriculture, forestry, environmental health, and other sectors of the economy and societal issues?
- *Human or Natural Cause*: Can this geoindicator be used to distinguish natural from anthropogenic change, and if so how?
- *Environment*(where applicable): In what general landscape settings would this geoindicator be used?
- *Types of Monitoring Sites*: Where specifically should this geoindicator be measured?
- *Spacial Scale*: At what scale would this geoindicator normally be monitored in the field, and to which larger scale, in general terms, can it be readily aggregated?
- *Method of Measurement*: How is this indicator measured in the field?
- *Frequency of Measurement*: How often should this geoindicator be monitored in the field, so as to establish a proper time series and baseline trend?
- *Limitations of Data & Monitoring*: What important difficulties are there in measuring field or laboratory data on and applying this indicator?
- *Applications to Past & Future*: How can this geoindicator be applied to paleoenvironmental analysis, and what predictive potential has it?
- *Possible Threshholds*: What thresholds or limits are there across which drastic environmental change or threats to human health and biodiversity may occur?
- *Key References*: Listed here for further reference are a few, readily obtainable, practical manuals, or citations to key scientific/technical publications on this geoindicator.
- *Other Information Sources*: National agencies, scientific programs and projects or specific international organizations from which further information, data sets and expertise may be available.
- *Related Environmental & Geological Issues* -Overall Assessment

(Continued on Page 4)

(Geoindicators - Continued from page 3)

GEOINDICATORS LISTED

- Coral chemistry and growth patterns
- Desert surface crusts and fissures
- Dune formation and reactivation
- Dust storm magnitude, duration and frequency
- Frozen ground activity
- Glacier fluctuations
- Groundwater quality
- Groundwater chemistry in the unsaturated zone
- Groundwater level
- Karst activity
- Lake levels and salinity
- Relative sea level
- Sediment sequence and composition
- Seismicity
- Shoreline position and morphology
- Slope failure (landslides)
- Soil and sediment erosion
- Soil quality
- Streamflow
- Stream channel morphology
- Stream sediment storage and load
- Subsurface temperature regime
- Surface displacement
- Surface water quality
- Volcanic unrest
- Wetlands extent, structure and hydrology
- Wind erosion

The checklist will be published shortly as part of a monograph outlining the scientific and policy background and including a series of reviews of key geoindicators (Berger, A.R. and W.J. Iams (eds) 1996.
Geoindicators: Assessing Rapid Environmental Changes in Earth Systems. Rotterdam: A.A. Balkema). Meanwhile, the geoindicator checklist itself is available via the Internet at http://www.gcrio.org/geo/title.html.

For further information contact:

Dr. A.R.Berger, Chairman,
Geoindicators Working Group
528 Paradise Street
Victoria, BC V9A 5E2,
CANADA
Phone/fax: (604) 480-0840.

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STATE GEOLOGIST'S REPORT

Towards a "New 1:100,000 Bedrock Geology Map of Vermont, Progress and Preliminary Maps" was well received as a Symposium/Poster session at the *GSA Northeastern Section Meeting* in Buffalo, New York. A number of visitors were impressed with the integration of digital geologic maps into the cooperative program between the Vermont Geological Survey and the US Geological Survey. Compilers and prospective mappers met following the session to chart a course for the 1996 field season to work towards the deliverable of a Northern Vermont compilation by July 1997.

The Vermont Survey will soon be in possession of a CD ROM of the 1961 Centennial Geologic Map of Vermont. USGS publications specialists have experimented with techniques to get the best possible reproduction of the map as a raster image. The Vermont Survey will make copies available for your needs, but determining amounts to reproduce are difficult at this time. Those who are interested, please contact the office (241-3608) to help us develop a list to guide reproduction.

The Vermont State Geologist is a member of the Water Policy Subcommittee of the Association of American State Geologists. The Subcommittee is to meet with the director of the USGS Water Resources Divison in April. Closer to home, draft Groundwater Protection Rules have been out for public comment. The primary concern of this office is to keep the ability for towns to designate future groundwater supplies for protection, not just those deposits which contain existing wells and springs. This is in keeping with the State Geologist's statutory direction to survey the geological resources of Vermont. It is the belief of this office that a mechanism to protect valuable untapped aquifer resources should remain in the rules.

Volumes of low-level radioactive waste have dropped over the last two years. A recent query of the generators in Vermont shows that 5237 cubic feet were generated in 1993, but only 3036 and 3264 cubic feet were produced in 1994 and 95 respectively.

The State Geologist participates in the *Biodiversity Committee* of the *Agency of Natural Resources*. A step in advising the Secretary of this Agency is to develop a list of the elements that are key factors that should be considered in making management decisions concerning biodiversity. Geology and soils are factors and are included in a draft document for review that will soon be found on the Agency's home page at http://www.state.vt.us/anr. Other physical systems such as water resources, climate and landscape context are included in the document.

Respectfully Submitted,
Larry Becker
State Geologist

You can contact the State Geologist's Office by calling :

(802) 241-3608,

or writing to:

State Geologist
Agency of Natural Resources
103 South Main Street, Center Building
Waterbury, Vermont 05671-0301

Research Grants/Scholarships Available

- *Vermont Geological SocietyStudent Research Grants* are designed to aid our future geologists investigate Vermont's geo-history. Awards are presented semi-annually to the student(s) with the best research topic(s) and associated method(s) in Vermont Geology. Students receiving assistance through the program will present their research results at the VGS Spring Meetings. Spring application deadline is May 15, 1996. For applications contact VGS Student Research Grants, Dept of Geology, UVM, Burlington, VT 05405-0122

CAREER OPPORTUNITIES

University of Maryland Baltimore County. The Department of Geography at UMBC invites applications for a one-year appointment as **VISITING PROFESSOR in PHYSICAL GEOGRAPHY/ ENVIRONMENTAL SCIENCE** beginning in August-September 1996. Our department presently offers B.S. and B.A. degrees in Geography, and current plans call for additional cooperative program development in Environmental Science, with the potential development of a graduate program. There is a possibility that an extended visiting position or a permanent tenure-track position will be available after the 1996-97 academic year. Candidates should have a Ph.D. degree and broad interdisciplinary training with research expertise in one or more of the following: climate and atmospheric processes; biogeography and ecosystem processes, which may include vegetation or wildlife; soil-water or soil-plant relations; biogeochemical cycling; watershed modeling and contaminant transport. Preference will be given to candidates who have some experience with remote sensing/GIS applications in one of these areas of interest. We welcome applications from senior faculty on sabbatical leave or research scientists who may be interested in a location convenient to federal agencies in the Baltimore-Washington metropolitan area. Specific course assignments are subject to negotiation. Conditions of appointment and rank commensurate with experience and qualifications.

UMBC is an Affirmative Action/Equal Opportunity Employer and we encourage applications from all qualified individuals regardless of gender or racial or ethnic background.

Please send curriculum vitae and cover letter together with names and addresses of three referees to:

Andrew J. Miller, Dept. of Geography, UMBC, Baltimore, MD 21228.

Review of applications will begin May 15 and will continue until the position is filled.

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SPRING MEETING PROGRAM

Twilight Auditorium, Middlebury College
Saturday, April 27, 1996

8:30	**Registration, *Refreshments (provided)***
8:50	**Call to Order**
9:00	**Martinez, Cynthia M.**, *Mantle Flow Structures In Harzburgite of the Troodos Ophioloite, Cyprus*
9:15	**Dondero, Anna C.**,*The Geochemistry of Mason Hill Road Greenstones, Pinnacle Formation, Central Vermont*
9:30	**Richardson, L. Alexis**, *Re-Evaluation of the Standing Pond Volcanics in Northeastern Vermont*
9:45	**Locke, Darren R.**, *Recognition of Upright Isoclinal Folds Using Primary Sedimentary Structures, Northfield Formation, Route 64, Northfield, Vermont*
10:00	**Mattox, Elizabeth A.**, *Metamorphic and Deformational Relationships in the Gile Mountain Schist Formation Adjacent to the Victory Pluton, Northeast Kingdom., Vermont*
10:15	**Applegate, G. Scott**, *The Geochemistry and Petrography of the Victory Pluton, Northeast Kingdom, Vermont*
10:30	**Questions & Answers, Coffebreak**
11:00	**Li, Lin**, *Environmental Changes Inferred from Pollen Analysis and New Carbon-14 Ages of Pond Sediments, Green Mountains, Vermont*
11:15	**Whalen, Timothy Nash**, *Incision History of the Huntington River , Winooski Drainage Basin, Vermont*
11:30	**Sayward, Shelley E.**,*Hydrodynamic System of Burlington Bay, Lake Champlain*
11:45	**Abbott, Michael D.**,*Characterization of Groundwater Recharge and Flow in a Vermont Upland Watershed Using Stable Isotope Tracing Techniques*
12:00	**Beck, Ethan W.**, *Phosphate and Nitrate Export from a Small Drainage Basin in the Ralph Myhre Golf Course*
12:15	**Long, Christopher J.**, *Evolution of Weybridge Cave and its Relationship to the Current Drainage System*
12:30	**Dahl, Christopher A.**, *Ground Penetrating Radar (GPR) and its Practical Application in Shallow Subsurface Analysis*
1:00	**Pearson,Aaron D.**, *Subsurface Analysis of a Possible Geophysical Field Site off South Street in Middlebury, Vermont*
1:15	**Questions & Answers**
1:30	**Awards Presentation**
1:45	**Meeting Adjourns**

EVOLUTION OF WEYBRIDGE CAVE AND ITS RELATIONSHIP TO THE CURRENT DRAINAGE SYSTEM

Long, Christopher J., Department of Geology, Middlebury College, Middlebury, VT 05753

Weybridge Cave northeast of Middlebury, Vermont was studied to investigate its evolution and its relationship to the present drainage system. The main passage of the cave trends roughly N75E. It is formed in the Beldens Formation, a fine-grained blue-grey limestone interbedded with massive, 0.05 - 1.0 m thick units of tan dolomite. The cave is situated within the nose of an anticline near the axis of the Middlebury Synclinorium. It lies in strata which strike N80E and dip approximately 14° SE. Major joint sets in the area strike approximately N15W and N70E and dip steeply. The surveyed cave has a length of 458 m and covers 38.9 m in relief. It is composed primarily of a series of steep, angular fissure passages that intersect an elliptical, partially mud-filled longitudinal trunk passage approximately 3 m wide and 2 m high. Although the fissure passages are clearly joint controlled, the trend of the main trunk was determined by a combination of joint and bedding influence. The trunk passage is currently above the water table which is at least 48 m below the surface as suggested by water levels in wells lying upgradient. The morphology of this trunk passage, however, clearly suggests phreatic conditions of origin. The steep intersecting fissures follow joints which carry percolating waters through the vadose zone. A large fissure pirated a stream into the cave via a sinkhole. Part of this stream resurges at a dye-traced spring downhill of the cave, but discharge measurements show the necessity of an additional resurgence, likely a spring several hundred meters to the south. Water exiting by way of these resurgences is about 5° C warmer than that which is entering at the sinkhole. Samples of inflow and outflow waters contained approximately 80% of EPA recommended nitrate and phosphate levels. During times of high inflow (> 0.05 m3/sec), these resurgences are unable to sufficiently discharge the water, resulting in the initiation of 3 and sometimes 4 additional resurgences at similar and higher elevations.

CHARACTERIZATION OF GROUNDWATER RECHARGE AND FLOW IN A VERMONT UPLAND WATERSHED USING STABLE ISOTOPE TRACING TECHNIQUES

Abbott, Michael D., Dept. of Geology, University of Vermont, Burlington, Vermont 05405

This project uses measurements of stable oxygen isotopes in precipitation (rain and snow) and groundwater (wells) to characterize groundwater recharge and flow in the upland portion of the Browns River basin in northwestern Vermont. The basin initiates on the steep western slopes of Mount Mansfield and consists of fractured metamorphic bedrock (schist) underlying glacial till of varying thickness. Due to the heterogeneous nature of groundwater flow in bedrock fractures, characterizing this type of hydrogeologic system is a complex effort. This study represents a new approach to the problem.

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Since early July of 1995, we have conducted weekly sampling of precipitation from several stations located at different elevations within the uppermost portion of the basin (i.e. the western slopes of Mt. Mansfield above Underhill Center). Rain, snow, and snowmelt samples are collected in order to determine the spatial and temporal distribution of rain and snow volume and to monitor the isotopic composition of recharge to groundwater. Water samples are measured for oxygen-18 composition at the University of Vermont isotope laboratory. We have observed a decrease in oxygen-18 composition with elevation in samples collected thusfar which we suspect to be a function of temperature gradients within the basin. The oxygen-18 composition at individual stations also varies seasonally.

In October of 1995, we began sampling and oxygen-18 analysis of groundwater from 8 wells within the study area. Wells exhibit temporal changes in oxygen-18 composition which may reflect seasonal isotopic signature of precipitation. The timing and magnitude of oxygen-18 variation is not consistent among the wells, indicating different recharge sources. This information is being used to identify upper elevation areas of recharge for each well, and to determine travel rates from the recharge zones to the lower elevations.

THE GEOCHEMISTRY AND PETROGRAPHY OF THE VICTORY PLUTON, NORTHEAST KINGDOM, VERMONT

Applegate, G. Scot, Dept. of Geology, Middlebury College, Middlebury, VT 05753

The Victory pluton is here concluded to be one of several previously studied plutons that comprise Vermont's Northeast Kingdom batholith. These intrude quartzites, marbles, calcareous schists, and phyllites of the early Devonian Waits River Formation, and amphibolites and quartzose to pelitic schists of the early Devonian Gile Mountain Formation. The Victory pluton has modal compositions of granite as do three small, outlying bodies formed from an equivalent magma source. Rocks from an adjacent, vast, outlying zone where granitoid and host rocks complexly commingle are quartz diorite, quartz monzodiorite, quartz monzonite, and granite. All compositions include biotite and minor muscovite, while some in the pluton and in the outlying zone contain hornblende. Accessories are apatite, zircon, allanite, clinozoisite, calcite, sphene, and ilmenite. Mineral fabrics and grain deformation in the pluton and in saccharoidal, quartz diorite dikes suggest pre- and syn-orogenic emplacement. Xenoliths and contacts of the host rocks are extensively contact metamorphosed.

Samples are peraluminous and show enrichment in LREE with weak negative Eu anomalies. Tectonic discrimination and fractionation diagrams based on major, trace, and REE suggest that subduction in a pre- to syn-collisional volcanic-arc environment generated calc-alkaline magma by partial melting of oceanic lithosphere and possibly continental crust. Observed I-type characteristics and subsolvus plagioclase crystallization are consistent with this interpretation.

PHOSPHATE AND NITRATE EXPORT FROM A SMALL DRAINAGE BASIN IN THE RALPH MYHRE GOLF COURSE

Beck, Ethan W., Department of Geology, Middlebury College, Middlebury, VT 05753

The Ralph Myhre Golf Course is owned and operated by Middlebury College. It is located across the borders of the towns of Middlebury and Cornwall, Vermont. The golf course is part of the Otter Creek drainage basin and the much larger Lake Champlain basin. High phosphate and nitrate levels in Lake Champlain are largely the result of loading from agricultural and urban sources. .The high levels result in high algae counts and eutrophication in Lake Champlain. Otter Creek has been identified as a major contributor of phosphate and nitrate. The purpose of this study was to determine if the Ralph Myhre Golf Course, which uses phosphate and nitrate as a fertilizer, is a significant source for these pollutants. The area of the drainage basin under study is 66.3 ha, of which 21.7 ha lies within the Ralph Myhre golf course.

Surface water runoff was monitored at a culvert passing under South Street from the fall of 1995 until the spring of 1996. Using hydrographs measured for four storms during the fall and winter seasons, a curve for rainfall vs. runoff was established. A separate rainfall-runoff relation, taken from Dunne and Leopold (1978), was used for summer precipitation (May-September). With these curves and the average annual distribution of precipitation events, total annual runoff was estimated to be 17.08 inches. The average annual precipitation for this area is 36.12 inches.

One of the storms monitored was also tested for phosphate and nitrate concentrations. Using an average phosphate and nitrate concentration the average phosphate load in the monitored stream was estimated to be 29.6 kg/yr and the average nitrate load was estimated to be 90.0 kg/yr. The estimated export of phosphate from the study area is 0.58 kg/ha/yr, and export of nitrate is 2.08 kg/ha/yr. Estimated phosphate export from the study area is greater than that of the average agricultural area in the Lake Champlain drainage basin, which is 0.50 kg/ha/yr (Budd, Lenore, and Associates, 1984). The estimated nitrate export is lower than the average agricultural areas in the Lake Champlain basin area (Budd, Lenore, and Associates, 1984). The total phosphate load is a very small part (0.03%) of the load carried annually by Otter Creek (Vermont Department of Environmental Conservation, 1995). Although this location accounts for a minor part of the total load, it and other non-point source areas account for a substantial amount of phosphate and nitrate loading in Lake Champlain.

GROUND PENETRATING RADAR (GPR) AND ITS PRACTICAL APPLICATION IN SHALLOW SUBSURFACE ANALYSIS

Dahl, Christopher A., Dept. of Geology, Middlebury College, Middlebury, Vermont 05753

The use of Ground Penetrating Radar (GPR) as a primary subsurface surveying tool is quickly gaining acceptance for its accuracy, mobility, and quality of results achieved. GPR produces data which is similar to the modern seismic reflection devices, but utilizes a high-frequency electromagnetic wave to probe the subsurface as opposed to propagating sound used in seismic profiling. Combining both literature review and field testing during the spring of 1996, its uses in shallow subsurface exploration were assessed. Field tests using two varying frequency antennas (50 MHz and 300 MHz) compared transects from two test sites near the Middlebury College campus. Results of the field test varied accordingly along operating perimeters, as expected. The smaller 50 MHz antenna penetrated up to 20 meters but had lower resolution in comparison to the 300 MHz antenna which penetrated up to 10 meter with much improved resolution. GPR results greatly vary depending on the type of soil or rock the transmission is penetrating. Generally the best results occur in quartzose-rich clastic sediment which is generally free of silt and clay. A dirt auger core determined that both study areas consisted of clay. Even with the existence of clay, bedrock at one test area and a buried stream pipe and fuel tank were easily detected using either antenna.

THE GEOCHEMISTRY OF MASON HILL ROAD GREENSTONES, PINNACLE FORMATION, CENTRAL VERMONT

Dondero, Anna C., Dept. of Geology, Middlebury College, Middlebury, Vermont 05753

Greenstones near Starksboro, central Vermont are located within the Pinnacle Formation, which is predominantly made up of metasediments. One lens-shaped body, called the Mason Hill Road greenstone, covers an area of about 0.3 km2. It is in fault contact on its western side with metagraywacke. The greenstone varies in grain size and mineralogy. Some outcrops of the greenstone are coarse grained, sheared, and made up of pyroxene, plagioclase, and amphibole, while other outcrops are finer-grained, do not appear to have undergone shearing, and have less pyroxene and amphibole. The composition reveals that the greenstone was a high Ti, LREE-enriched (LREE =3D 100 x chondrite, HREE =3D 13 x chondrite) alkali basalt. Furthermore, the major, minor, trace, and rare earth element composition of the Mason Hill Road greenstone indicates that it was formed within a continental plate. Coish et al. (1991, Geology, v.19, p.1021-1024.) divide metavolcanics from Vermont into four north-south trending geochemical zones, which correspond to progressive changes in a rift sequence from west to east. The geochemistry of the Mason Hill Road greenstone matches that of other greenstones within the Pinnacle and Underhill formations (zone 2), the protoliths of which have been identified as early Paleozoic basalts, formed during early stages of continental rifting.

RECOGNITION OF UPRIGHT ISOCLINAL FOLDS USING PRIMARY SEDIMENTARY STRUCTURES, NORTHFIELD FORMATION, ROUTE 64, NORTHFIELD, VERMONT

Locke, Darren R., Dept. of Geology, Norwich University, Northfield, VT, 05663

Two large outcrops in the Northfield Formation (Silurian-Devonian?) were mapped in the fall of 1995 along east-west Route 64 in Northfield, Vermont. A discontinuous outcrop, A, 150 m long, lies 300 m to the west of continuous outcrop B, which is 370 m long. The eastern 60 m of outcrop B extend into the Waits River Formation as shown on the Centennial Geologic Map of Vermont. The Northfield Formation at this site consists of westerly dipping beds of (1) light-gray laminated quartzite, (2) medium-gray metasiltstone, and (3) brown to black, calcareous to noncalcareous phyllite. Bed thickness ranges from 1 to 25 cm. Strike of beds varies from due north to N23E, and dips range from 66=B0 to 87=B0 W.

Sedimentary structures include graded beds, minor ripple crossbedding, and a few flame structures. The sequence quartzite-metasiltstone-phyllite is repeated many times and is interpreted as the upper part (Tc-Td-Te) of an ideal Bouma sequence formed by a turbidity current. The rock units and associated sedimentary structures are similar to those displayed in the Iberville Formation at Clay Point, Colchester, Vermont. Detailed mapping of tops of beds using Bouma sequences with graded beds led to the recognition of 5 reversals of facing direction in outcrop A and 23 reversals in outcrop B. The noses of very tight isoclinal folds with nearly parallel limbs were observed at eight locations, and the axial planes of those folds correspond to reversals in tops of beds. All other reversals, where noses of folds were not observed in outcrop, are inferred to be isoclinal folds.

An interpretive cross section of outcrop B indicates that the wavelength of folds is 2 to 31 m and the amplitude of the folds may be over 2000 m. The calculated original thickness of the stratigraphic section is on the order of 80 m. The folds appear to climb to the east indicating that the rocks are younger to the west in the two outcrops studied. This interpretation is the same as that of Hatch (1988).

MANTLE FLOW STRUCTURES IN HARZBURGITE OF THE TROODOS OPHIOLITE, CYPRUS

Martinez, Cynthia M., Department of Geology, Middlebury College, Middlebury, VT 05753

Shape-prefered and lattice-preferred orientations of minerals in the peridotite section of the Troodos ophiolite, Cyprus, can be related to flow patterns in a mantle diapir below an oceanic spreading center. The shape-preferred orientation is measured as a foliation, and is apparent in the field as elongate orthopyroxene grains in harzburgite at the center of the ophiolite. This is related to shear strain in the minerals due to flow in the diapir, and is "frozen" into the rock during formation. Detailed field mapping of this plane revealed that it strikes north/south in the northern exposures, and gradually rotates towards northwest/southeast trends in the southern exposures. The foliation dips steeply, between vertical and 70 degrees west.

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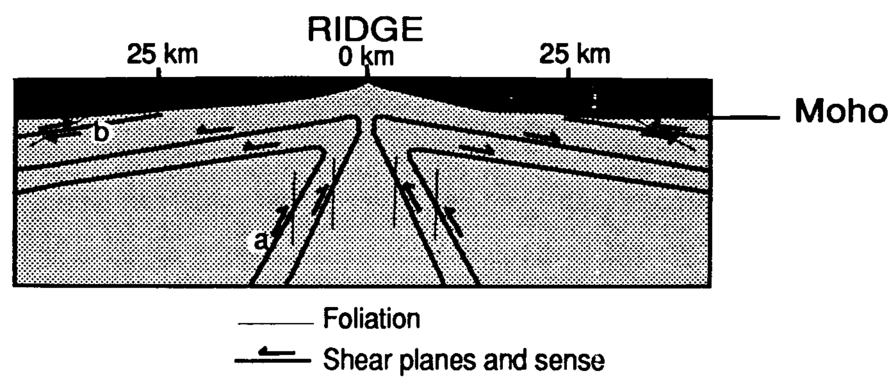
An associated lineation trends north-northeast in the northern part of the harzburgite, and rotates to westerly and southwesterly trends moving from north to south along the western side of the area.

Microstructural analysis of olivine grains using the universal stage reveals lattice preferred orientations related to shear planes. By comparing these planes to the foliation, sense of shear was determined and was associated with models of mantle flow in asthenospheric diapirs that were originally developed for the Oman ophiolite. In the Oman models, diapiric flow (Figure 1) is close to vertically upwards in a cylindrical flow pattern, turning sharply at the crust/mantle boundary and diverging close to horizontal in all directions away from the diapir (Rabinowicz, et al., 1987, Ceuleneer, et al., 1988). In Troodos, the shear sense is west side up in the northern and central parts of the harzburgite, and therefore could have been formed in one of two possible situations. First, the exposure could have formed as a result of flow in the near vertical part of the diapir where shear is west side up on the western side of the cylindrical flow pipe (Figure 1, location a). Second, it might have been formed with top-to-the-east shear sense farther than 25 kilometers away from the ridge in the near horizontal flow, where plate motion forces would be dominant over diapiric flow and could cause this orientation of flow (Figure 1, location b). To determine which of these models is true, better constraints on possible rotation of the harzburgites after diapiric formation is needed. The peridotites in Troodos are domed so that they form the topographically highest center of the ophiolite, but the processes which caused this are not understood. In both possibilities for diapir correlation, the ridge must lie to the east of the harzburgite due to shearing sense and curvature of foliation strikes and lineation diverging from a point to the east. This corresponds to a hypothesised paleo-ridge, the Solea Graben, a proposed relict axial valley of a Cretaceous spreading center located to the northeast of the study area (Varga and Moores, 1985).

Figure 1



METAMORPHIC AND DEFORMATIONAL RELATIONSHIPS IN THE GILE MOUNTAIN SCHIST FORMATION ADJACENT TO THE VICTORY PLUTON, NORTHEAST KINGDOM, VERMONT

Mattox, Elizabeth A., Dept. of Geology, Middlebury College,Middlebury, VT 05753

In northeastern Vermont, the Silurian-Devonian rocks of the Waits River and Gile Mountain formations are intruded by a suite of Devonian plutons. Rocks within the apparent contact aureole of the Victory Pluton have experienced deformation and a possible pressure increase during peak metamorphism. Metamorphic grades found in outcrop to the west of the pluton range from biotite to sillimanite-grade. Sillimanite replacing andalusite suggests metamorphism occurred at low pressures. There is also evidence of chloritic and muscovite retrograde metamorphism.

Two foliations are found in the Gile Mountain Formation. **S** is the dominant foliation in the pelitic metasediments. It strikes NNE and dips nearly vertical. **S** is defined by aligned muscovite, chlorite and occasionally biotite. In most outcrops in which bedding could be recognized, **S** and **S** are sub-parallel. The orientation of **S** is generally uniform with most variations associated with close (*a* 5 m) proximity to granitic dikes. A second foliation, **S**, is a crenulation cleavage primarily recognized in pelitic sub-units.

The chronological relationship between metamorphism and deformation has previously been interpreted as metamorphism occurring after deformation (Woodland, 1965). Investigation of micro structures and mineral relations now indicate Sformed synchronous with metamorphism; Swraps around and also trends through garnet and staurolite porphyroblasts. Chlorite and muscovite in pseudomorphs after staurolite are foliated parallel to **S** suggesting that even retrograde metamorphism occurred during deformation.

Garnet zoning patterns fall within two categories and in some garnets spessartine profiles indicate resorbtion followed by continuing crystallization. Most samples exhibit slight increasing of almandine, **=46e/Fe + Mg** and decreasing of pyrope and grossular at the rims. This has been characterized as common in medium grade pelites which have experienced a temperature increase during garnet growth.

If deformation and metamorphism occurred simultaneously then simple plutonic intrusion followed by later thrust faulting and resulting pressure increases is not sufficient. Devonian intrusion during thrust faulting could have provided the necessary environment for both heat and pressure changes to occur synchronously.

Subsurface Analysis of a Possible Geophysical Field Site off South Street in Middlebury, Vermont

Pearson, Aaron D., Dept. of Geology, Middlebury College, Middlebury, VT 05753

A preliminary subsurface survey was undertaken to describe the surficial sediment and upper bedrock surface within a 13,000 m^2 area adjacent to a landfill on South Street in Middlebury. The area is gently sloping with a total relief of 8 meters, and has an intermittent drainage down its center. Bedrock consists of Ordovician carbonate rocks, and is overlain by glacial sediments, including Lake Vermont deposits. The site is one of several possible locations of *(Continued on page 15)*

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a geophysical and hydrological test site, to be used for course work and experimental field projects by Middlebury College. Two types of surveys were done using seismic refraction and ground penetrating radar (GPR). Four reversed seismic refraction lines were made within the basin to obtain the seismic velocity structure and the thickness of sediment over bedrock. The seismic data were further reduced, using the time-delay method, to determine the shape of the irregular bedrock contact. Thirteen GPR survey lines were made. The data is displayed in real-time on the GPR's field computer as two-way travel time of radar returns. The data was further reduced using various filtration techniques with Radian software on a DOS system. The three-dimensional data points for topography and subsurface layers were gridded, interpolated, and plotted graphically on a Silicon Graphics workstation using EarthVision software.

The surficial sediment was found to vary in thickness from one-half to seven and one-half meters. Seismic velocity varied from 386 to 743 m/s in the unconsolidated sediment. The sediment was augered and two units were identified, separated by a poorly defined boundary. The upper unit is a clay and silty lacustrine clay, whereas the lower unit is a coarser deposit, possibly a till, containing clasts up to at least cobble size. Because the auger cannot penetrate through material containing large clasts, this layer could not be investigated completely. Bedrock was found to have seismic velocities ranging from 2242 to 2874 m/s, which are consistent with limestone.

The conditions at this site were found to meet several of the criteria for development as a field test site. The thickest sediments are sufficient for burial of steel drums and other test objects, and the surface topography and subsurface characteristics are variable enough to provide for interesting hydrologic studies, such as a simulation of pollution flow in ground water.

RE-EVALUATION OF THE STANDING POND VOLCANICS IN NORTHEASTERN VERMONT

Richardson, L. Alexis, Dept. of Geology, University of Vermont,Burlington, Vermont 05405

The Connecticut Valley - Gaspe trough (CVGT), a major Siluro-Devonian litho-stratigraphic belt of the northern Appalachians, has been described, in Vermont, as a belt dominated by two thick pelitic/psammitic sequences and a very thin amphibolitic horizon, the Standing Pond Volcanics (SPV). The SPV was mapped (Doll, 1961) as a singular, massive section of amphibolite at the interface between the two metasedimentary units. Evidence from northern Vermont, however, indicates that this apparent continuity breaks down. The northern amphibolites occur at different stratigraphic positions that may be near, but not necessarily at, the gradational sedimentary facies interface. The SPV occurs as either: (1) apparently discontinuous, meter-scale lenses of massive, hornblende-plagioclase amphibolites, or (2) cm-scale amphibolitic and typically quartz- and/or calcite-rich interbeds. The disparity between these two types of outcrops suggests that the SPV amphibolites may not represent a continuous, homogeneous volcanic protolith.

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Several observations suggest that some of the amphibolites do not represent a strictly primary volcanic protolith. First, thin section examination of an amphibolite layer (28 cm) reveals microscopic zircon-rich horizons, which appear as pleochroic halo trails in hornblende. The zircon-rich bands suggest detrital heavy mineral concentration, indicative of a reworked epiclastic rock. Typical ortho-amphibolites are unlikely to have such a high Zr content. Second, the SPV's characteristic garbenschiefer texture of large, aluminous-hornblende sheaves & garnets is most prevalent in the thin amphibolitic layers. Carbonate-rich layers and quartz-rich layers are interbedded by the amphibolite layers. Also associated with this texture are chlorite layers with large (>3 cm dia.) garnets. Previous workers have suggested that the metamorhpic garbenschiefer texture forms in originally interlayered volcanoclastic and clastic metasediments. Finally, both outcrop types undergo dramatic changes in thickness and distribution along and across strike. This varied distribution, along with the heterogeneous lithofacies associated with the outcrops may reflect the nature of their depostion in a clastic basin experiencing volcanogenic activity.

HYDRODYNAMIC SYSTEM OF BURLINGTON BAY, LAKE CHAMPLAIN

Sayward, Shelley E., Dept. of Geology, Middlebury College,Middlebury, VT 05753

Previous work has demonstrated that the internal seiche can impact shallow bays (<100 feet) along the margins of Lake Champlain. This has environmental implications for cities and towns whose water intake and sewage effluent pipes are located within these shallow bays. The Burlington Bay area of Lake Champlain is a shallow bay containing a waste water treatment plant outflow pipe and three water intake pipes which supply the majority of Burlington city residents with water. An initial dye study showed that water from the diffusion pipe was reaching the water intake pipes. It is unclear what hydrodynamic system acting within the bay is moving waste water in the direction of the intake pipes.

An array of sub-surface moorings and bottom mounted current meters were deployed from June to October 1995 to investigate the hydrodynamics of this bay. In addition, a side-scan survey characterized the lake bottom in Burlington Bay. This denoted the exact location and geometry of the existing pipes, historical wrecks and bottom morphological features. A side-scan mosaic allowed for further characterization of the bottom morphology. In particular sediment furrows and lineations were identified and gave bottom current direction from their orientations.

Current, wind and temperature observations were used to determine the predominant speed and direction of water currents in Burlington Bay. Hourly observations of temperature were three-dimensionally modeled to create the best fit thermal structure within the bay. These models show episodes of the hypolimnion flooding the epilimnion out of the bay over a 1.8 to 2 day duration. It has also beendetermined from hourly speed and direction recordings that it would take 14.6 hours for water to travel the median distance of 2.1 km from the effluent to the intake pipes at the average current speed of 4.1 cm/s. Of the four month survey period, 42% of the data meets these

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qualifications and demonstrates currents moving water from the effluent pipe towards the northwest in the direction of the water intake pipes. The hydrodynamics of Burlington Bay provide the potential for sewage effluent release to reach the water intake pipes.

ENVIRONMENTAL CHANGES INFERRED FROM POLLEN ANALYSIS AND NEW CARBON-14 AGES OF POND SEDIMENTS, GREEN MOUNTAINS, VERMONT

Lin, Li, Department of Geology, University of Vermont, Burlington, Vermont 05405

Three cores and five Carbon-14 analyses provide the direct estimates for the timing of deglaciation and revegetation in the mountains of northeastern Vermont. We collected our cores from Sterling Pond and Ritterbush Pond in the northern Green Mountains of Vermont. The surrounding vegetation consists of both conifers and northern deciduous trees. Two sediment cores (one 5.7 m and the other 5.3 m) were collected from the deepest parts of Sterling Pond (8.5 m) and Ritterbush Pond (13.7 m). Pollen was collected and counted at 10 cm intervals. AMS radiocarbon dates (LLNL) were obtained on acid- and base-treated gyttja from four levels of Sterling Pond by J. Southon. Results are as follows:

260 cm	4,180 +/- 50 C-14 years
420 cm	8,600 +/- 60 C-14 years
490 cm	11,180 +/-60 C-14 years
521-523 cm	12,760 +/- 70 C-14 years

A twig at 260 cm is 280 C-14 years younger than the adjacent gyttja. The basal date of 12,760 C-14 years, oldest we are aware of from this part of New England, indicates that our core includes sediment deposited during Younger Dryas time, and suggests that ice likely left the mountains of northwestern Vermont before 13,000 C-14 years ago.

Six pollen zones, A, B, C, D, E-1 and E-2 can be distinguished. Zone A (12,000-11,750 C-14 yBP) is characterized by increasing fir, decreasing spruce, and the high percentage of pine. Birch, maple, oak, alder, ash and hemlock start to appear. Zone B (11,750-10,000 C-14 yBP) has a peak abundance in spruce; pine experienced a sharp decrease. Alder increased greatly, reaching its peak at about 10,000 C-14 yBP, apparently during Younger Dryas time. Zone C (10,000-8,500 C-14 yBP) is featured by the decrease of fir and the increase of spruce and pine. The first peak of birch and ash, the clear increase of maple, oak, and beech, and the decline of alder all happened in zone C. Zone D (8,500-4,500 C-14 yBP) is marked by the gradual decrease of fir, spruce, and pine, the peak of hemlock, oak, and elm, and increasing of beech. Zone E-1 (4,500-1,500 C-14 yBP) is dominated by deciduous trees. Birch, beech, and ash reached their highest stages. Hemlock gradually increased after reaching the lowest point at the beginning of this zone. Zone E-2 (1,500 C-14 yBP to present) reflects the increasing fir, spruce, and pine. The ragweed pollen reached its highest point in the past 100 years. Our results generally agree with the only two other sites in Vermont (both low elevation) at which pollen has been counted.

INCISION HISTORY OF THE HUNTINGTON RIVER, WINOOSKI DRAINAGE BASIN, VERMONT

Whalen, Timothy Nash, Department of Geology, University of Vermont,Burlington, Vermont 05405

I have surveyed, mapped, and trenched flights of river terraces in the Huntington Valley, a sub-basin of the Winooski drainage basin, in north-central Vermont. These data have been used to construct a river terrace chronology from deglaciation to present using radiocarbon dates from overlying alluvial fans and previously-dated baselevels. The identification of historic river terraces is aided by the presence of cloth and other cultural artifacts in the floodplain deposits.

Cross-valley profiles demonstrate that the terrace development prior to the formation of the Huntington Gorge (~ 8000 C-14 yBP) resulted from deep incision events of different magnitudes. Since that time, incision events, as inferred from the terrace levels, have been of lower, but roughly equal, magnitudes.

There are five possible explanations for the incision events which formed the Huntington River terraces: 1) baselevel changes in the Champlain Basin; 2) Holocene climate changes; 3) glacio-isostatic tilting; 4) human land use; and 5) internal adjustments of the fluvial system. Each explanation can be discerned from independent, local records. By comparing the terrace chronology to the independent records, likely causal relations are proposed for each terrace level.

VERMONT GEOLOGICAL SOCIETY BUSINESS & NEWS

Executive Committee Meeting Minutes - March 2, 1996, Northfield
Committee Members Present:
Pres. Larry Becker, Treas. Allen Carpenter, Sec. Jeff Pelton, Dir. Eric Lapp.
Members Present:
Bruce Wilson, Dave Westerman, Shelley Snyder. Guest - Beth Madeiras.

1 **Past Minutes:** The minutes of the January 18, 1996 Executive Committee Meeting were read and approved.

2 **Treasurer's Report:** Allen Carpenter reported the following for the period 1/1/96 through 2/29/96: Income $1,558.55; Expense $334.87; Total Balance $5,218.91

Considerable discussion took place about potential benefits to the society from expanded electronic mail use, both within the VGS, and linking VGS to the outside. We need to define our goals. Main items discussed were the acquiring of more member's E-mail addresses, and the creation of VGS' own electronic mailbox. Emphasis was given to ensuring that members without electronic mail capability not be excluded from communications. More talk will take place with Stephen Wright of the Publications Committee.

3 **Membership:** Six (6) new members since the last reporting. Dave Westerman brought up the fact that currently the VGS makes no direct effort or no mailing to geology students at major schools in the state. The suggestion came out to enlist the Geology Department Chair, or other person, as an on-campus *VGS Representative* to receive and distribute membership application packets in September of each year. *(Editor's note: VGS Campus Representatives were established ...in November 1994*

(Business & News Continued from page 18)

by the Executive Committee. Representatives are: Stephen Wright (UVM), Tania Bacchus (Johnson), Helen Mango (Castleton). Representatives are still needed for Middlebury and Norwich). The perennial issue of lapsed members was addressed — the By-Laws will be consulted.

4 **Spring Student Presentations:** Stephen Wright will send abstract deadline to the schools; Larry Becker will call Middlebury College to check on logistics for meeting.

5 **Summer & Fall Field Trips:** Summer; Victor Rolando was mentioned as a possible leader. Larry Becker will talk to Rolfe Stanley at UVM for a possible bedrock trip. Fall; Stephen Wright is looking into a glacial geology trip.

6 **Green Mountain Geologist:** Items discussed; A) an *official calender*, B) guest editor, C) winning student paper, D) State Geologist's Report.

7 **VGS Student Research Grant Awards:** Discussion revolved around the desire to increase the number of student applications. Suggestions were to A) raise the award cap, B) make awards twice per year in April & December, C) increase encouragement to students, & D) have grant recipient's paper abstracted in the GMG. Dave Westerman will talk to Middlebury, UVM, and other to get their ideas.

8 **Electronic Bulletin Board:** A brief discussion was held on the value of establishing a VGS electronic *bulletin board* on which to post notices of job opportunities and internships.

9 **1996-1997 Slate of Officers:** Shelley Snyder (Chair) and Eric Lapp agreed to serve on the Nominating Committee. A proposed slate is: President - Dave Westerman; Vice President - ??; Secretary - Jeff Pelton; Treasurer - Allen Carpenter; Directors - Larry Becker, Eric Lapp, and ??. Dave will ask Helen Mango is she would consider being Vice President.

10 **Role of VGS:** Eric Lapp volunteered to work on this and suggested a questionnaire to get input from members. Shelley Snyder spoke on the GSA's *Partner's for Education*program, and suggested that the VGS have its own variety to work with elementary and secondary school teachers. She will contact the Vermont Science Teachers' Association and will write up her ideas in the next GMG. Jeff Pelton asked if there was a need to catolog sensitive geologic sites to prevent them from being destroyed by future development.

Respectfully submitted,
Jeff Pelton, Secretary

SEMINARS, MEETINGS, and FIELD TRIPS

April 26: University of Vermont Spring Seminar Series (4 P.M.): *"Negative pH, ultra acidic mine waters and the challenge of environmental restoration at the Iron Mountain mine superfund anomaly"* Kirk Nordstrom, U.S. Geological Survey.

April 27: Vermont Geological Society Spring Meeting for the presentation of Student Papers, Twilight Auditorium, Middlebury College.

April 29: University of Vermont Spring Seminar Series (4 P.M.): *"Lake Champlain: A thirty year perspective"* Bruce Corliss, Duke University.

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(Seminars, Meetings, & Field Trips - Continued from page 19)

May 3-5: **Maine Mineral Synposium**, Senator Inn & Conference Center, Augusta, contact: Robert Hinkley, Yarmouth Road, Gray, ME 04039, (207)657-3732.

May 7-10: **"Annual Spring Meeting,"** *New York Section, American Water Works Association*, Albany, NY. Contact: NYS AWWA, P.O. Box 9, Syracuse, NY 13211; (315) 455-2614.

May 23: **Vermont Geological Society** *Executive Committee Meeting*. Location and time to be announced. Contact Larry Becker, (802) 241-3608.

May 31-June 2 : **Northeastern Friends of the Pleistocene Field Conference** in Machias, Maine. Contact H.W. Borns, Jr., Institute for Quaternary Studies, 5711 Boardman Hall, Orono, ME 04469, (207) 581-2196, borns@maine.maine.edu for more information.

June 9-14: *"From Small Streams to Big Rivers,"* **Society of Wetland Scientists National Meeting**, Kansas City, MO. Contact: Thomas J. Taylor, (913) 551-7226, e-mail; taylor.thomas@epamail.epa.gov.

June 16-22,: *"Karst Hydrology"* Short Course offered by **Center for Cave and Karst Studies**, Western Kentucky University & Mammoth Cave National Park. Contact: Nicholas Crawford, Director, Center for Cave and Karst Studies, Dept. of Geography and Geology, Western Kentucky University, Bowling Green, Kentucky 42101-3576.

July 7-10: **"Annual Conference/Rocky MTN Rendezvous/Soil Quality & Soil Erosion Interaction,"** *Soil & Water Conservation Society*, Keystone, CO. Contact; (800) THE-SOIL, e-mail; swcs@netins.net.

August 10: **New Hampshire Geological Society Summer Field Trip** to Isle of Shoals. Planning for this trip is in progress.

September 27-29: 1996 New England Intercollegiate Geologic Conference headquartered in the Gorham-Littleton area of northern New Hampshire and jointly sponsored by *Harvard University*, the *Mount Washington Observatory*, and the *New Hampshire Geological Society*. Contact: Mark Van Baalen, Dept of Earth and Planetary Sciences, Harvard University 617-495-3237; mvb@harvard.edu.

Got an idea for a VGS field trip or seminar? Let us know how you want your Society to work.

A Discussion on Soil Fertility, Quality, & Health from an Italian Perspective

by Marino Perelli, free-lance agronomist, Italy, E-mail: marino@veneto.shineline.it & Sandra Toniolo University of Padova, Italy, Senior Librarian,E-mail: tonsa@ipdunil.unipd.it *(Guest Editor's Note: This discussion has been excerpted from an ongoing internet discussion on the Soils List)*

We think that this is a very important theoretical subject to discuss for agronomists and soil scientists, because it is easier to understand soil fertility in common language than in a scientific one. We want to express our ideas, this is not a complete theoretical system, but only some short opinions.

Soil Fertility

Soil fertility is a very old concept, known in the Nile and Euphrates river valleys 4500 (or more) years ago, and the word was used by Roman agronomists from the second century B.C. The word comes from the Greek verb "ferein", which means *"to bring (fruits)"*, and also *"to produce (fruits)"*. In Latin we have the same verb *"ferre"*.

For "fertile" the ancient Greeks used just the adjective *"agathos"*, which means good (see Odyssey, IX, 134-136). *"Ge agathe"* (a good soil) is a fertile field and *"agathe cora"* (a good region) is a fertile country. Two ancient Greek words came from the same root: *"ferbo"* (to feed) and *"feres-bios"* (one which give life, or food). The last one expression is more or less equivalent to *"fitos"*, which means also *"natural"* and it came from *"fiton"* (plant).

The history of the word is only a little help, but still the definition of soil fertility is not so easy. Cosimo Ridolfi, an Italian agronomist, wrote in 1843: *"Soil fertility is the wonderful capability to produce"* *("la mirabile attitudine a produrre")*. Really, this definition may be good (and poetic), but it is not able to measure the soil fertility. In the **Glossary of Soil Science** you can find: *"The ability of a soil to supply the nutrients essential to plant growth"* (SSSA, 1987). The same definition is used in France (*"The nutrient potential of the soil")*, but we think that soil fertility is more complex. The nutrient availability is not the only soil factor which takes part in plant growth. Think to water availability, soil atmosphere, organic matter, etc. Really, the plant yield is the result of the interaction between soils and plants.

In Europe many people involved in forestry use this definition of fertility: *"the quantity of biomass that an environment can yield"*. This is a quantitative definition, but it is not the soil fertility: it is the environment fertility, which includes rain, energy availability, etc.

Soil Quality

Soil quality is a more recent term and often it is used only as a synonym of soil fertility or to have a better definition of soil fertility. In *"Defining soil quality for a sustainable environment"* (SSSA Special Publication No. 35, SSSA, Madison, WI) Doran & Parking suggested a definition: *"The capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health."* This is a good definition, but it is not a definition of ....

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(Soils - continued from page 21)

... *"quality"*. At worst, it is the definition of one of soil's qualities. We think, other definitions of soil quality, quoted by Doran & Parkin, are better: Inherent attributes of soil that are inferred from soil characteristics or indirect observation (e.g., compactability, erodibility, and fertility) (SSSA, 1987) and especially: Simply put *"Fitness for use"* (Pierce & Larson, 1993) Really, the concept of *"quality for a specific utilization"* is more useful. In a stony soil you cannot grow rice or sugar beet, but you can produce a very good wine. The quality *"stoniness"* is good for grapes, but it is bad for rice and sugar beet. It seems to be the same concept of *"fertility"*, but it is different. In a stony soil you have a low yield of grapes, but the quality of wine may be high (if you work well in the cellar). The soil is not fertile, but it has a good quality for a specific crop. Fertility is one of the soil qualities, and the two concepts are not interchangeable.

Finally, you must remember that in recent years, *"quality"* was used as a synonym of *"good quality"* (see ISO 9000), but it is a neutral word: you can have a good quality, but also a bad quality (see Aristotle and Wittgenstein, and also the definition of the word *"quality"* in the Webster's Dictionary, as quoted by Doran & Parkin in the same paper).

Soil Health

Only one consideration about soil health. It may be an important concept when the soil may be polluted, but we must remember the soil's ability to self perepuration (?). So you can have a dead soil, but is very difficult to have a sick soil. You have a sick soil only in very special situation (e.g., Chernobyl).

Suggested readings:

Michel Sebillotte (Ed.) *"Fertilite et systemes de production"* (Fertility and production systems), Inra, Paris, France, 1989.

L.L. Boersma et al. (Ed.) *"Future development in soil science research"*, Soil Science Society of America, 1987 (especially the papers by Letey; and by Westerman and Tucker).

L. Wittgenstein., **Tractatus logico-philosophicus.**

GOVERNMENT

The House and Senate have finally come to agreement on the provisions of the 1996 farm bill. The bill allocates more than $2.5 billion in new funding while extending the *Conservation Reserve Program* (CRP) and the *Wetlands Reserve Program* (WRP). The *Environmental Conservation Acreage Reserve Program* (ECARP) will serve as an umbrella for the CRP, the WRP, and the Environmental Quality Incentives Program (EQIP). This reauthorization is for the next six years (through 2002). Some highlights of changes in the programs include: CRP authorized to maintain up to 36.4 million acres at any given time; WRP authorized with an open enrollment goal of 975,000 acres at any given time through both permanent and 30 -year easements. Swampbuster provisions were amended to provide increased flexibility under the Food Securities Act (FSA) to address wetlands issues. Items not included in the reauthorization were: Watershed Protection & Flood Prevention Program amendments, the runoff retention pilot program, and revisions to make the Water Bank Program land eligible for CRP.