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SPRING MEETING PROGRAM

8:30AM COFFEE & REFRESHMENTS

9:00AM Charlotte Bemis: PRESENT-DAY HYDRODYNAMICS AND SEDIMENT PROCESSES OF THE INLAND SEA OF LAKE CHAMPLAIN

9:15AM Elgita Eglite: HYDRODYNAMICS OF ST. ALBANS BAY, VERMONT

9:30AM Brett Woelber: POST-GLACIAL ENVIRONMENTAL CHANGE RECORDED IN NULHEGAN POND, BRIGHTON, VERMONT

9:45AM Kirsten Stokes: A COMPARISON OF THE REEFAL AND LAGOONAL DEPOSITIONAL ENVIRONMENTS OF THE CROWN POINT FORMATION

10:00AM Samuel Schultz: LITHOFACIES OF THE CROWN POINT REEFAL AND INTER-REEF STRATA AT ISLE LA MOTTE, VT

10:15AM Daniel Chow: EVIDENCE FOR ULTRAMAFIC-DERIVED ARSENIC IN BEDROCK MONITORING WELLS, NORTH-CENTRAL VERMONT

10:30AM Jared Bean: A GEOCHEMICAL ANALYSIS OF GEOLOGIC CONTROLS ON NATURALLY-OCCURRING RADIOACTIVITY IN GROUNDWATER: HINESBURG, VERMONT

10:45AM BREAK

11:00AM Marissa Saccente*, Jessica Sperling, Ed Greiner, and Greg Druschel: THE FORMATION OF INTERMEDIATE SULFUR SPECIES DUE TO THE OXIDATION OF $FeS_{(aq)}$ CLUSTERS AND SULFUR SPECIATION WITHIN AN ANOXIC SPRING AT ELY MINE, VERSHIRE, VERMONT

11:15AM Robert Charnock*, Jonathan Kim, Keith Klepeis, and Daniel Chow: BRITTLE STRUCTURES AND TOPOGRAPHY IN THE KNOX MOUNTAIN GRANITE, NE VERMONT

11:30AM Spencer Paddock: LATE NEOGLACIAL HISTORY OF THE AGASSIZ GLACIER, MONTANA

11:45AM Simeon Hamilton: INTERPRETING LACUSTRINE PROXIES OF MID-HOLOCENE ENVIRONMENTAL CHANGE IN THE UINTA MOUNTAINS, NORTHEAST UTAH

12:00PM Charles L. Cavness III: SPATIAL DYNAMICS OF TERTIARY IGNEOUS INTRUSIONS IN RATON BASIN, SOUTHERN COLORADO

* Speaker

12:15PM Tucker Levy: GEOCHEMISTRY AND CLAY MINERALOGY OF ALLUVIAL FAN PALEOSOLS, SOUTHEASTERN SPAIN

12:30PM Katie J. Gladstein: ERUPTION DEFORMATION ANALYSIS OF MOUNT ETNA, SICILY, ITALY (2007-2008)

12:45PM JUDGING and AWARDS PRESENTATIONS

1:15PM EXECUTIVE COMMITTEE MEETING

ABSTRACTS

PRESENT-DAY HYDRODYNAMICS AND SEDIMENT PROCESSES OF THE INLAND SEA OF LAKE CHAMPLAIN

Charlotte Bemis, Geology Department, Middlebury College, Middlebury, VT 05753

The Inland Sea, located in the Northeast corner of Vermont's Lake Champlain, has restricted circulation from the Main Lake resulting in a unique hydrodynamic setting. In 2005, hydrodynamic data were gathered by instruments placed on eight subsurface moorings throughout the Inland Sea. Instruments on these moorings included temperature sensors and Acoustic Doppler Current Profilers (ADCPs) which monitored backscatterance, water speed and direction. Water level sensors were also set up in four locations throughout the Inland Sea. The hydrodynamic data were merged with sediment size information obtained from LISST instruments (in-situ laser diffraction particle size analyzers) and meteorological data from the Main Lake to create a complete picture of the hydrodynamic and sediment processes occurring in the Inland Sea. Analysis showed the presence of a dynamic internal standing wave, strong counter-clockwise circulation pattern in the deeper hypolimnion, less developed flow in the surface layer as well as the movement and eventual deposition of surface algal blooms into the deep water. Side scan sonar imagery combined with water velocity data confirm sediment scouring or at least the lack of deposition in the deep central channel connecting the northern and southern portions of the Inland Sea.

HYDRODYNAMICS OF ST. ALBANS BAY, VERMONT

Elgita Eglite, Geology Department, Middlebury College, Middlebury, VT 05753

Since the 1960's, St. Albans Bay has experienced significant alteration in its aquatic ecosystem due to prevalence of an algae-dominated environment. Extensive Cyanobacteria blooms are a severe response to continuous influx of phosphorus (P) from runoff. It is believed that poor circulation, especially applicable to the inner bay, limits water exchange and the P concentration increases over time. In this region, the algal blooms have caused significant property value depreciation, losses in tourism industry and more importantly health concerns. The issue is also pertinent to other restricted circulation regions such as Missisquoi, Malletts and Carry Bays within Lake Champlain. While $85 million have been spent so far on Vermont's Clean and Clear program to date, little if any improvement in water quality is observed in St. Albans Bay.

Mechanisms for increased primary productivity of algae depend on physical and geochemical parameters such as transparency, temperature, acidity, nutrient loading, oxygen abundance, nitrogen-P ratios and currents. None of the previous studies have considered the effects of hydrodynamics in their results.

In the summer of 2007, 13 subsurface moorings consisting of four Acoustic Doppler Current Profilers, 13 temperature sensors, 4 pressure-temperature sensors and 3 laser particle analyzers were placed in St. Albans Bay. Over 1.2 million *in situ* observations melded with wind data from Colchester Reef meteorology station are being analyzed to better understand the circulation dynamics of this region. The study should provide other researchers with valuable information relating to the distribution of geochemical characteristics.

Some preliminary findings show an average counterclockwise circulation in the inner and outer bays, even though there are strong oscillatory circulation patterns observed. The strongest link between the sections is a shallow passage along the southern coast via which both southerly and northerly winds promote influx of water into inner bay. In the outer bay, there is a component of northward flow through the Ball Island and Burton Island passages. There appear to be phases of inflow of hypolimnic water from Inland Sea that also flood the inner bay. Oscillations range from 1.7-3.5 days, some linked to the Inland Sea.

POST-GLACIAL ENVIRONMENTAL CHANGE RECORDED IN NULHEGAN POND, BRIGHTON, VERMONT

Brett Woelber, Geology Department, Middlebury College, Middlebury, VT 05753

Changes in lake sediment properties over time can reveal past climate change in a given catchment. Sedimentary proxy trends reflect variations in the environmental variables of temperature and precipitation. This study investigated the sedimentary record from Nulhegan Pond, located within the Nulhegan Basin in NE Vermont. The Nulhegan Basin is a flat-floored depression mantled by permeable glacio-fluvial sediments and underlain by an igneous pluton. A series of Livingstone cores retrieved in 2006 and 2007, and a surface core retrieved in 2008, were combined to yield a composite stratigraphy extending from the modern sediment surface down to the base of the lacustrine sediment (~14 m in ~4 m of water). Analyses employed in this study include Loss-on-Ignition (%LOI), Carbon-to-Nitrogen ratio (C/N), and Grain Size (GS). %LOI analyses were previously conducted at a 1-cm interval along the entire length of the core by Rodgers (2007); C/N and GS were sampled at 4-cm intervals for only this study. Six AMS radiocarbon dates provide an age-depth model with an average sedimentation rate of 1.2 mm/year (~8 years/cm). Lake formation occurred in the latest Pleistocene (ca. 13.5 ka BP) as Wisconsinan ice vacated the Nulhegan Basin. Early-deposited silts (~13.5-12 ka) yield low %LOI, large grain size, and high C/N values, indicating a period of low lake productivity and large amounts of inwashing sediment. From ~12-8.5 ka, a prolonged rise in %LOI, high C/N values, and oscillating GS values track the variable maturation of Nulhegan Pond's aquatic ecosystem. From ~8.5-5.5 ka, %LOI and GS levels are high but C/N remains low, suggesting a long period of low lake level and shallow, productive water. From ~5.5 ka-present, all three proxies increase, possibly indicating slow eutrophication of the lake environment. All three proxies exhibit notable changes in the frequency of their variability ca. 5.5 ka BP, indicating that

natural climate forces and/or minor sedimentation rates changed around 5.5 ka BP. The most modern sediment contains an age-date of -53 BP, and provides both a reference point for all proxy values and a predictive trend for future climate values.

A COMPARISON OF THE REEFAL AND LAGOONAL DEPOSITIONAL ENVIRONMENTS OF THE CROWN POINT FORMATION

Kirsten Stokes, Department of Geology, University of Vermont, Burlington, VT 05405

The stratigraphic section of the Middle Ordovician Crown Point Formation of the Chazy Group was measured and sampled at Crown Point, New York so that lithofacies could be identified and compared to reef-bearing horizons of the unit found on Isle la Motte. The Crown Point Formation is 90 feet thick at this locality. Three lithofacies were identified: (1) wackestone containing cross-lamented ripple marks and interbedded with dolomite; (2) massive dolostone beds; wackestone containing variety of broken allochems; and (3) micstone and interbedded dolomite layers; and dolograinstone. Lithofacies are all interpreted to record a shallow lagoon environment. The exposed Crown Point Formation at Isle La Motte is different in that its lithofacies represent low energy reefal and inter-reefal environments. The similarities between the lithofacies at Crown Point and Isle La Motte are the presence of dolomite and micrite. In addition, trilobites, crinoids, and brachiopods are found frequently in both. At the Crown Point, New York locality, the massive dolostone bed and the wackestone lithofacies is repeated in the sequence. This cyclic repetition through the stratigraphic column is indicative of sea-level rise and fall. The dominant allochems in all lithofacies at Crown Point are trilobites and echinoderm (crinoid) fragments. Although oncolites are not found in every sample, their presence is an important indicator of my interpretation of a shallow water environment.

LITHOFACIES OF THE CROWN POINT REEFAL AND INTER-REEF STRATA AT ISLE LA MOTTE, VT

Samuel Schultz, Department of Geology, University of Vermont, Burlington, VT 05405

The reef and inter-reef rock of the Crown Point Formation at Isle La Motte, VT were sampled and analyzed to identify lithofacies that could refine the depositional environment in which the stromatoporoid mounds of this formation are found. Three lithofacies were identified: (1) grainstone containing a high percentage of micrite and dolomite with a variety of allochems which are dominated by crinoids, trilobites and brachiopods; (2) rudstone containing abundant micrite-encrusted allochems with a mix of dolomite and spar. The allochems present were mainly echinoderms and trilobites but bryozoa, coral, and algae were also found; and (3) boundstone containing large allochems of stromatolites with internal mud and dolomite. The abundance of mud was somewhat surprising but it suggests that either the stromatoporoids produced localized low energy environments that could accumulate mud and/or much of the micrite was produced by encrusting algae. In addition to identifying lithofacies of the Crown Point reefal horizons, I conducted an analysis of carbonate and oxygen isotopes of the calcite spar present in this strata. While these results are still being interpreted, delta Carbon -13 values recorded for reef rock were between -0.195 and -0.241, and between 1.230 and 1.378 for inter-

reef rock. The oxygen isotope values for the reef rock were between -7.9 and -8.33, while the inter-reef rock values were between -5.37 and -7.67.

EVIDENCE FOR ULTRAMAFIC-DERIVED ARSENIC IN BEDROCK MONITORING WELLS, NORTH-CENTRAL VERMONT

Daniel Chow, Geology Department, Middlebury College, Middlebury, VT 05753

High arsenic (As) levels in private water supplies in north-central Vermont were first noted in the spring of 2005 when As levels of 90 and 327 ppb were found in two private wells (the EPA MCL is 10 ppb). Middlebury College students Kevin Bright (2006) and Colleen Sullivan (2007) found that serpentinite and other ultramafic rocks are the bedrock type with the highest As concentrations by far in the region. The purpose of this study is to further analyze As in regional bedrock and examine evidence for As migration into groundwater. With funding from the Lintilhac Foundation, three monitoring wells were drilled in a recharge area near Waterbury, VT. Well A is drilled through 30 m of Barnes Hill ultramafic (BHU) rock through a fault into underlying phyllites of the Stowe Formation, Well B is solely in the BHU body, and Well C is drilled through 5 m of BHU through a fault into phyllites of the Ottaquechee Fm. A 70-cm soil pit was also dug near the sites of wells A and B, revealing deeply weathered ultramafic saprolite. Rock chips were sampled every 1.5 meters and 44 rock samples from the wells and soil pit were analyzed by ICP-AES at Middlebury College and by ICP-MS at ACME labs in Vancouver, Canada. Groundwater was also obtained from October to March and analyzed by ICP-MS and other methods by the DEC for major and trace elements and anions. By far the highest As concentrations were found in ultramafic rock from well C (341-1104 ppm), but elevated values were also found in other ultramafics and several metasedimentary samples (up to 190 ppm). Groundwater in all three wells is characterized by an Mg-HCO_3 signature, consistent with ultramafic-derived water, and arsenic concentrations range from 2-9 ppb, with the highest value recorded in Well C. Given that this water is produced from a recharge area and contains a strong ultramafic signature, the arsenic in these monitoring wells appears to be derived from weathering of ultramafic rocks.

A GEOCHEMICAL ANALYSIS OF GEOLOGIC CONTROLS ON NATURALLY-OCCURRING RADIOACTIVITY IN GROUNDWATER: HINESBURG, VERMONT

Jared Bean, Geology Department, Middlebury College, Middlebury, VT 05753

Several studies over the past decade have identified and investigated elevated levels of radionuclides in the bedrock aquifer that straddles the east-dipping Ordovician Hinesburg Thrust (HT), which juxtaposes Precambrian-Cambrian meta-sedimentary rocks to the east atop Cambrian-Ordovician carbonate rocks to the west. The majority of these studies focused on the upper plate of the HT and hypothesized that its formations are the radionuclide source while groundwater from the lower plate exhibits low radioactivity and contributes to dilution of GA levels. Since elevated radioactivity in water poses a health concern, the purpose of this study is to carry out geochemical analyses of the lower plate in order to facilitate a comprehensive study of this complex aquifer system. 20 private well water samples and 24 bedrock samples were obtained from the lower plate west of the Hinesburg Thrust. None of the wells sampled in this

study contained gross alpha (GA) levels above the EPA maximum contaminant level (MCL) of 15 pCi/L. However, 12 of the 20 wells were above the Vermont Department of Health action level of 5 pCi/L recommending further testing for ^{226}Ra and ^{228}Ra. However, positive correlations between U and GA indicate that ^{238}U is likely the dominant source of alpha radiation in the lower plate carbonates. No correlation exists between distance from the HT and GA concentration, perhaps related to the low hydraulic conductivity of the thrust fault, which may act as an aquitard. Well yield is negatively correlated with GA, presumably reflecting low residence time and dilution of GA. Wells in the Clarendon Springs, Bascom, Shelburne, Winooski, and Monkton formations all contained wells producing water above the VDH action level of 5 pCi/L. Two of the wells contained elevated levels of nitrate which also poses a health risk. While agricultural runoff is a common source of this groundwater contaminant, corresponding elevated levels of Na and Cl indicate septic leachate.

THE FORMATION OF INTERMEDIATE SULFUR SPECIES DUE TO THE OXIDATION OF $FeS_{(aq)}$ CLUSTERS AND SULFUR SPECIATION WITHIN AN ANOXIC SPRING AT ELY MINE, VERSHIRE, VERMONT

Marissa Saccente, Jessica Sperling, Ed Greiner, and Greg Druschel, Department of Geology, University of Vermont, Burlington, VT 05405

In order to better understand the geochemical processes behind Acid Mine Drainage (AMD), it is important to understand the chemical pathways and species underlying the dissolution and oxidation of iron sulfide minerals. One particular intermediate, the iron sulfide aqueous cluster $FeS_{(aq)}$, is a key product in the formation, dissolution, and equilibrium description of Fe-S minerals [1]. $FeS_{(aq)}$ molecular clusters are important in understanding the redox pathways which Fe-S minerals follow, as the clusters are important in promoting the solubility of metal sulfide minerals in natural aqueous systems due to their high natural abundance in various environments [1]. Here, experiments show that $FeS_{(aq)}$ oxidizes along a pathway that yields different intermediate sulfur species than Fe-S minerals. $FeS_{(aq)}$ clusters, when subject to oxic conditions, produce only sulfate. Detectable levels of intermediate sulfur species, such as thiosulfate, were not produced. Research regarding the study of pyrite oxidation as it relates to the formation of sulfur intermediates shows that the primary intermediates formed at circumneutral pH's are thiosulfate and sulfite, this suggests that $FeS_{(aq)}$ clusters undergo alternate oxidative pathways which may be too rapid to measure [2]. The Ely Mine, one of Vermont Copperbelt mines, is characterized by acid mine drainage and is a comparable site for the investigation of sulfur speciation, where iron sulfide minerals are abundant. Sulfur speciation within an anoxic spring, fed by groundwaters percolating through tailings piles containing Fe-S minerals was evaluated by detailed geochemical analysis, surficial, and ground-water mapping and sediment analysis of contributing waters. The spring contains products from the anoxic dissolution of Fe-S minerals that oxidize only to sulfate, with no discernible thiosulfate or sulfite present in solution—in agreement with lab experiments.

[1] Goldhaber, M. B. (1983). Experimental Study of Metastable Sulfur Oxyanion Formation During Pyrite Oxidation at pH 6-9 and 30C. American Journal of Science, 193-217.

[2] Oduro, H., and Druschel, G. (2008). The Formation and Oxidation of FeS(aq) Molecular Clusters: Decoupling Iron Sulfide Mineral Surface Dissolution and Oxidation Reactions.

BRITTLE STRUCTURES AND TOPOGRAPHY IN THE KNOX MOUNTAIN GRANITE, NE VERMONT

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The Knox Mt. granite pluton of the New Hampshire Plutonic Series intruded Late Silurian-Early Devonian staurolite-grade metasedimentary rocks of the Gile Mt. and Waits River fms. during the Middle Devonian. The Vermont Geological Survey constructed a bedrock map of part of this pluton and surrounding rocks during the 2008 field season to serve as a framework for understanding elevated U levels in groundwater from public and domestic bedrock wells in the granite. One of the primary focuses of this study was to analyze brittle structures. The attitudes of 600+ fractures and 100+ pegmatites were measured in the field area. The topography of the granite landscape is characterized by distinct groups of steep elongate or blocky hills separated by flat low-lying areas. The purpose of this investigation is to correlate major fracture sets with topographic patterns in the field area.

For the granite portion of the field area, the dominant fractures and topographic lineaments trend to the NE, NW, and E-W. Most (~70%) pegmatites have a NW trend with subordinate groupings that strike ~E-W and ~N-S; many fractures develop along pegmatite/granite contacts. The major fracture and lineament azimuths vary geographically within the granite. Consequently, we divided the granite into six geographic domains: (1) Western Contact Domain, (2) Drew Mt. Domain, (3) Marshfield and Burnt Mt. Domain, (4) Lord's Hill Domain, (5) Owl's Head Domain, and (6) Hardwood Mt. Domain. The blocky shapes of the hills in domains 2, 3, 4, and 6 are controlled by two orthogonal "Lego" fracture sets, however, these fracture sets are not the same for each domain. The elongate and streamlined shapes of the hills in domains 1 and 5 are controlled by a single dominant fracture set. Topographic lineaments within the Gile Mt. and Waits River fm. rocks follow the NNE-trending dominant foliation (S1) whereas the most abundant fractures are roughly perpendicular to this foliation; subordinate NW and NE trending fracture sets also occur.

NNE-SSW, E-W, and NW-SE trending fracture surfaces with pronounced slickensides were observed at numerous granite outcrops. Based the presence of asymmetric steps on some of these fracture surfaces, slickenside kinematics were determined. Fault solutions show strike-slip and normal fault activity in the pluton and host rock.

LATE NEOGLACIAL HISTORY OF THE AGASSIZ GLACIER, MONTANA

Spencer Paddock, Geology Department, Middlebury College, Middlebury, VT 05753

The National Park Service identified understanding glacier dynamics as the primary issue facing Glacier National Park in the Park's 2004 Geologic Resource Evaluation. Current models predict the disappearance of all glaciers from the Park by 2030, but historical context is needed to discern whether this rapid retreat is part of natural climate variation or an unprecedented effect of anthropogenic climate change. To this end, two percussion cores were taken from Upper Kintla

Lake in the northwest corner of Glacier Park. The Agassiz Glacier, once one of the largest in the Park, lies less than 3 km upstream of Upper Kintla and is the dominant source of sediment in the watershed. Radiocarbon dating reveals that the cores span the past 1000 years at sedimentation rates averaging 3.3 mm yr^{-1}, meaning that both pre- and post-industrial revolution glacier dynamics are recorded in the sediment. Both cores were analyzed for biogenic silica (bSi) content at 2-cm resolution and grain size (GS) at 1-cm resolution. Additional bSi and GS analysis of sediment retrieved from a surface core was spliced with the percussion core data to extend the Agassiz's history from AD 1000 to AD 2007, with the uppermost surface sediment providing a reference point for down-core comparisons. Both proxies, bSi and GS, were also compared with Loss-on-Ignition (LOI) data previously gathered for the cores, which track the amount of organic productivity in the watershed and the amount of carbonate bedrock transported to the lake as glacial flour. Together these four proxies reveal a millennium where the Agassiz Glacier was primarily comparable to its current size, with several advances from 980-1020, 1527-1625, 1577-1597, and 1803-1884 AD, and two major retreats from 1260-1310 and 1908-1990 AD.

INTERPRETING LACUSTRINE PROXIES OF MID-HOLOCENE ENVIRONMENTAL CHANGE IN THE UINTA MOUNTAINS, NORTHEAST UTAH

Simeon Hamilton, Geology Department, Middlebury College, Middlebury, VT 05753

The sedimentary layers deposited in high-elevation lakes contain information about past climate variability. Understanding the nature, magnitude, duration, and timing of these climate changes provides a better understanding of current climate trends and improves models designed to predict future climate trends. This study focuses on sediment cores retrieved from nine lakes ranging from 2900 to 3500 m a.s.l. in the Uinta Mountains of Utah. Grain size distribution (GS), biogenic silica content (bSi), and mineralogy using X-ray diffraction (XRD) were applied to sections of each core spanning the interval ca. 4.5 to 4 ka BP to interpret the extent to which this region was affected by mid-Holocene climate change. Loss-on-ignition (LOI) analysis previously demonstrated a significant decrease in organic matter ca. 4.2 ka BP in six of the nine cores, while two cores showed no variation in organic matter at this time, and one core showed significant variation in organic matter throughout all of its sedimentary layers. The decrease in organic matter in the six cores is notable because numerous other records have suggested extensive drought in the central region and low-elevation western region of the U.S. at this time. Four of the cores that showed an LOI decrease at ca. 4.2 ka BP demonstrated an increase in total surface area of particles at this time. In GS analysis, an increase in total surface area of particles draws parallel to an increase in silt (<6μm) and clay (<2μm) sized particles. An influx of these types of sediments at ca. 4.2 ka BP is considered to be consistent with an increase in eolian processes related to regionally extensive drought. Ongoing bSi analysis will be used to determine if and how the productivity of the aquatic environment changed during this time, while ongoing XRD analysis will reveal whether changes occurred in the mineralogy of the lake sediment during this interval. This multi-proxy analysis from nine widely distributed lakes in the Uinta Mountains should allow for more detailed interpretations of the extent and characteristics of environmental changes during the ca. 4.2 ka BP paleoclimate event.

SPATIAL DYNAMICS OF TERTIARY IGNEOUS INTRUSIONS IN RATON BASIN, SOUTHERN COLORADO

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The Raton Basin in southern Colorado contains several kilometers of Late Cretaceous to Early Tertiary sedimentary rocks that host extensive coal and coal-bed methane (CBM) reserves. During the Oligocene the basin was intruded by mafic dikes associated with the Spanish Peaks volcanic complex located along the northwestern margin of the basin. In addition to these dikes, thinner sills are pervasive within the basin, often preferentially intruding coal beds used by oil and gas companies to extract CBM. Previous research focusing on the geothermal potential of the basin suggests that the sill complexes are directly related to "feeder dikes" and are partially responsible for the elevated geotherm in the region. This report combines 100 CBM well logs and an aeromagnetic survey to test the feeder dike hypothesis.

Sills are identified in well logs by dual induction resistivity (DIR) log spikes exceeding 2,000 ohms. Dikes are identified by rotated to poll (RTP) vertical magnetic gradients exceeding 65 nT/m and can be mapped by tracing anomalous gradient ridges on aeromagnetic maps. Net sill thickness is quantified for five stratigraphic categories in each well. Net sill thicknesses are compared to (a) the proximity of the nearest dike to a given well, and (b) the number of dikes within ten proximity ranges (500 meter intervals from 500 m to 5 km).

Results show that net sill thickness is significantly controlled by the number of dikes within 500 meters from a well, but that dikes outside of the 500 meter range have an insignificant effect on sill abundance in a well. Furthermore, the proximity of the single closest dike has a negligible effect on sill abundance. Results are presented in a series of scatter and bar graphs with accompanying regression analysis. Isopach maps of sill thickness supports statistical results by showing sill "hotspots" coinciding with areas of dike convergence.

Given the quantitative and qualitative evidence that dike frequency within close proximity to a well affects net sill thickness, the feeder dike hypothesis can be confirmed. These results can be used to extrapolate sill abundance based on aeromagnetic surveys and predict areas of coal alteration near dike convergence centers. Additionally, the findings can guide further research into relationships between geothermal gradients and intrusion patterns.

GEOCHEMISTRY AND CLAY MINERALOGY OF ALLUVIAL FAN PALEOSOLS, SOUTHEASTERN SPAIN

Tucker Levy, Geology Department, Middlebury College, Middlebury, VT 05753

The geologic and topographic evolution of Andalusia (southeastern Spain) is dominated by post-Miocene uplift and deformation associated with the Betic Orogeny. The Betic Cordillera began to uplift at approximately 15-20 Ma. This event uplifted a previously submerged land surface to heights of up to 3500 m. The Betic Orogeny has resulted in massive denudation of uplifted areas and deposition in the numerous basins in the region, primarily in the form of alluvial fans. Due to a relatively arid, stable Holocene climate, these fans continue to form, leaving relic paleosols buried just below the surface. Depositional events mainly occur over longer time scales as a

result of gradual erosion off the range by surface water, but larger, singular mass wasting events triggered by floods and tectonic activity of the Padul Fault also contribute to fan evolution.

Two alluvial fan paleosol sequences were examined, one 20 km south of Granada (Durcal), and one on the SE margin of the Granada Basin (Ronda-Sur). Both sites are roadcuts. 8 samples were taken from a single stacked paleosol profile at Durcal and 16 samples were taken from three profiles at Ronda Sur. Analytical methods include XRD for clay mineralogy, ICP-AES for paleosol geochemistry (< 2 mm), Munsell analysis of color and oxide mineralogy, and pH analysis of soil exchange complexes.

The paleosols are middle to late Pleistocene and formed via weathering of garnet-mica schists and marbles denuded from the Nevado-Filabride and Alpujarride complexes that compose the Sierra Nevada. The paleosols contain 55-75% SiO_2, 10-20% Al_2O_3, 4-7% Fe_2O_3, <7% MgO, and 1.5-20% CaO, and all samples have pH in the range of 7.5 to 8.5. Parent mineralogy of the < 2 mm fraction consists of muscovite, paragonite and chlorite. Horizons range from distinctly red paleosols that formed during moist periods and contain pedogenic smectite phases and kaolinite, to caliche-like paleosols that are rich in parent materials and formed during periods of aridity. The weathering index of base cations (Al_2O_3+Fe_2O_3) generally correlates to field, Munsell and mineralogical indicators of weathering. Pedogenic clay minerals include ordered mica-smectite that is presumably derived from layer-by-layer decomposition of muscovite, as well as smectite and kaolinite that appear to be derived from chlorite.

ERUPTION DEFORMATION ANALYSIS OF MOUNT ETNA, SICILY, ITALY (2007-2008)

Katie J. Gladstein, Department of Geology, University of Vermont, Burlington, VT 05405

The largest and most active volcano in Europe, a Sicilian stratovolcano named Etna, towers 3343 m above the Mediterranean Sea, near the boundary between the African, Eurasian, and adjacent microplates. Etna's theorized east and southward gravitational spreading has created extensional summit structures and compressional base and flank structures, largely dictating the structural and magmatic evolution of volcanic constructs, including numerous cones, the massive Valle del Bove depression, and a concentration of dykes injecting east of the summit craters.

As one of the most actively erupting and degassing volcanoes in the world, the significance of monitoring Etna's activity and deformation is expansive. Volcanic eruptions have a direct impact on atmospheric chemical composition, and have altered global climates more abruptly than any other natural process. Etna dominates a fairly populated region of Sicily, including the major city of Catania; a region which has experienced and will face many more frequent, voluminous, and hazardous eruptions in years to come.

A new fissure eruption, accompanied by over 200 superficial earthquakes, began on May 13, 2008, about 2800 m above sea level, at the headwall of the Valle del Bove and just east of the summit craters. Several months later, during September and October of 2008, I assisted Dr. John Murray from the Open University (UK) in monitoring Etna's deformation via global positioning satellite (GPS) and leveling measurements, which Murray has been surveying annually for the

past 38 years. The May 13 fissure eruption, still taking place at a low intensity, has become the longest Etnean flank eruption of the third millennium.

With Dr. Murray, I utilized Leica GPS transits to monitor about 90 GPS stations in Etna's region, as well as a Leica level and staff to record the elevation of about 215 leveling nails. Our GPS data indicates that Etna has deformed a significant amount over the last year, with significant deformation in the eastern fissure region as well as on a southwestern flank. In addition, the leveling data provides a subsurface implication for the elevation changes that have accompanied the recent activity. I will be presenting an analysis of Etna's 2007-2008 deformation by interpreting our data as well as its implications for the flux of magma beneath Etna's surface.

PRESIDENT'S LETTER

Below are my notes from the members' roundtable discussion that the Society held on Saturday afternoon, following Steve Mabee's excellent presentation at our Winter Meeting.

Comments on this meeting:
The early afternoon time for the meeting was popular, making it easier for those coming from far away to attend. The single-speaker format seemed successful. The social aspect of the meeting (potluck luncheon with plenty of a great variety of food) received good reviews. Jeff Hoffer pointed out that he liked the timing of this meeting (during "mud season").

Ideas for future indoor meetings:
Dave West suggested that we could mix up the style of the Winter meeting in particular, perhaps alternating between soliciting abstracts for short talks from professional Society members (as we have done the past several years) and inviting a single outside speaker to give a longer talk, and this seemed like a popular idea. Jon Kim offered to arrange another speaker, perhaps for a fall meeting. Jon noted that we could make use of the rooms at the Cyprian Learning Center at the State Office Complex in Waterbury at a modest cost, but only during the week, not on weekends. Steve Howe reminded us that we do indeed need to have a fall meeting, which according to the Society's Bylaws must be within 30 days of October 15th. Kristen Underwood suggested a joint meeting with the watershed groups in the State. Larry Becker and Dave West mentioned the success of the recent Maine Groundwater Conference that was held in conjunction with the recent Northeast GSA meeting in Portland, Maine.

Field trips:
Both summer and fall field trips are generally popular. We discussed running only a summer field trip this year, as NEIGC is in Vermont this year. We need someone to volunteer to lead a summer trip.

Meeting the needs of K-12 educators:
Greg Walsh offered to lead a workshop in using GoogleEarth as an effective tool for geological education.

Encouraging students to join the Society:
Thelma Thompson pointed out that in the early days of the Society there was heavy student involvement, largely from UVM students. John Van Hoesen suggested that we could lead field trips focused on some particular method (fracture analysis, pump test, etc.). This evolved into the idea that students might be able to come out in the field with professionals when something interesting was happening, such as pump tests, soil borings, etc. The new ListServ could be a way of getting the word out for such opportunities. Probably there would be coordination with professors. Dave West suggested that some sort of mentoring activity for students seeking employment would be quite popular with students. There was discussion as to whether or not we'd be able to get employers involved who actually were hiring. Finally, we discussed the idea of offering prizes to entice students to join the VGS (such as a rock hammer, hand lens, or Brunton), but this was met with mixed enthusiasm.

I know I've left some things out, but I think this gives you a good idea of the spirit of the discussion. If any of this inspires you with an idea or an observation, let us know. You can email me at gsprings@norwich.edu or call me at (802) 485-2734.

Sincerely,
George Springston, President

WINTER MEETING MINUTES

The meeting of the Executive Committee followed the potluck lunch, Steve Mabee's talk on fractures studies and groundwater in Massachusetts, and a member's roundtable discussion (see the President's Letter above for the details of this discussion) held on April 4, 2009 at the University of Vermont. President George Springston called the meeting to order with a total of five people in attendance. The meeting began with finalizing plans to make the "VGS ListServ" available to VGS members and beyond. The ListServ will allow for on-line discussion of issues related to Vermont geology and the Society. It was agreed that an e-mail will be sent out to members with instructions on how to subscribe. Members will then have the option whether to participate or not. It was also agreed that non-members should be able to subscribe and subscription instructions will be posted on the VGS website.

Treasurer Steve Howe indicated that the financial condition of the Society is sound (see the Treasurer's Report for details). It was indicated that fewer than 20 paper copies of the GMG are now being mailed and this has resulted in a significant savings in copying and postage costs. Jon Kim, Chair of the Advancement of Science Committee, indicated that two student Research Grant proposals were received before the most recent April 1st submission deadline. It was confirmed that each proposal should be reviewed by more than one person and that a short critique of each proposal, along with justification of the amount awarded, should be provided to applicants. A somewhat lengthy discussion of student eligibility requirements for the VGS Research Grant Program followed. The issue surrounds whether students who do not receive degree credit for independent research at their home institutions should be eligible for student Research Grants. The Executive Committee did not make a final decision on this matter but will

solicit additional opinions and continue discussions. It is hoped that a decision on this matter can be reached before the next student Research Grant submission deadline (October 1st).

The Committee briefly discussed the Summer Field Trip and agreed to work in the coming weeks to secure a leader for a trip. The meeting was adjourned.

Respectfully submitted,
Dave West, Secretary

TREASURER'S REPORT

The financial condition of the Society continues to be extremely strong. As of April 4, 2009, the Society's checking account balance was $8,519.11. Two Research Grant proposals were submitted by the April 1, 2009 deadline and are currently under review by the Advancement of Science Committee. The amount of the funding awarded during this round will be reported in the Treasurer's Report in the Summer 2009 *Green Mountain Geologist*. I expect to be able to support the Research Grant Program at a similar level for the foreseeable future, given the relatively stable income derived from membership dues, additional research grant contributions, and publications sales. To my knowledge, there are no outstanding bills.

The following member has rejoined the Society since the last report: Peter Ryan, Middlebury, Vermont.

The Treasurer gratefully acknowledges the contributions to the Society's Research Grant Program by the following members:

Laurence R. Becker
Ray Coish
John E. and Anita M. Cotton
Jeanne C. Detenbeck
Barry Doolan
Bruce F. Douglas
Albert W. Gilbert, Jr.
Carey Hengstenberg
Barbara L. Hennig
Jefferson P. Hoffer
Eric T. Lapp
Frederick D. Larsen
J. Gregory and Nancy W. McHone
Alexis P. Nason
Peter Ryan
George Springston
Sharon Strassner
Peter J. and Thelma B. Thompson
Roger and Terry Thompson
David West

Respectfully submitted,
Stephen S. Howe, Treasurer

ADVANCEMENT OF SCIENCE COMMITTEE REPORT

On Saturday, April 4, 2009, the "Winter" Meeting of the Vermont Geological Society (VGS) was held in 219 Delehanty Hall, the home of the University of Vermont's Department of

Geology. The meeting consisted of a potluck lunch, a guest lecture by the Massachusetts State Geologist, Dr. Steve Mabee, and a members' roundtable discussion. Twenty people attended this meeting and dined on the eclectic cuisine prepared VGS members Steve Howe, Marjie Gale, George Springston, John Van Hoesen, Jon Kim, Dave West, Kate Gladstein, Larry Becker, Peter Thompson, Greg Walsh, Jeff Hoffer, Kristen Underwood, and Joe Hayes. Thanks to all these contributors.

Steve Mabee's presentation, entitled "Fracture Characterization Mapping in Bedrock: How Useful is it?" was basically divided into two parts. The first part explained in detail the procedures that the Massachusetts Geological Survey (MGS) uses to collect fracture data in the field and to analyze these data to delineate "hydrostructural domains" (bodies of bedrock with similar fracture characteristics). Examples of the MGS fracture and groundwater maps were shown in the talk and also hung on the walls of the meeting room. The users of these maps were also outlined. The second half of the talk discussed how the "hydrostructural domain" concept was tested by the MGS and the U.S. Geological Survey in numerous Nashoba Terrane bedrock wells in eastern Massachusetts using modern borehole logging equipment. Three important preliminary findings of this study were that groundwater only flowed along 4% of fractures logged, different "hydrostructural domains" could have similar hydrogeologic characteristics, and that groundwater flow in fractures was restricted to the upper 100 meters of the wells. The talk was followed by 40 minutes of questions and discussion.

The Advancement of Science Committee received two applications to the VGS Research Grant Program. These proposals will be evaluated in the near future.

Respectfully submitted,
Jon Kim, Chair

VERMONT STATE GEOLOGIST'S REPORT

Geological Society of America – Northeastern Section (NEGSA) Meeting
The Vermont Geological Survey (VGS) participated with Middlebury College, the University of Vermont, and Norwich University on presentations and posters at the NEGSA meeting in Portland, Maine, March 22-24, 2009. The State Geologist chaired a symposium on natural hazards and gave the introductory presentation:

THE VERMONT NATURAL HAZARD EXPERIENCE AND THE NESEC STATE GEOLOGISTS, BECKER, Laurence R.[1], SPRINGSTON, George E.[2], DEWOOLKAR, Mandar M.[3], KIM, Jonathan J.[1], and DESIMONE, David J.[1], (1) Vermont Geological Survey, (2) Department of Geology and Environmental Science, Norwich University, (3) Civil and Environmental Engineering, University of Vermont.

The Northeastern States Emergency Consortium (NESEC), consisting of the Directors of the Emergency Management Agencies for eight states in the Northeastern U.S., invited the state geologists in the region to advise NESEC on the science of natural hazards and the Vermont State Geologist is organizing this new group. Two other State Geologists gave talks. Eight

papers covered such hazards as seismic activity and risk, landslides, coastal erosion, river erosion and flash floods. George Springston of Norwich University gave a talk on an "ANALYSIS OF ROCK FALL AND DEBRIS FLOW HAZARDS IN SMUGGLERS NOTCH, GREEN MOUNTAINS, NORTHERN VERMONT", summarizing work conducted in cooperation with the VGS, the Department of Forest and Parks, and the Agency of Transportation.

Groundwater-related Presentations and Posters

The work presented follows from geologic mapping projects, groundwater chemical analyses, and student support.

RADIONUCLIDES, GROUNDWATER GEOCHEMISTRY, AND HYDROGEOLOGY ABOVE, BELOW, AND THROUGH THE HINESBURG THRUST: NW VERMONT, KIM, Jonathan[1], RYAN, Peter[2], NORTH, Katharine[2], BEAN, Jared[2], and DAVIS, Leland[2], (1) Vermont Geological Survey, (2) Geology Department, Middlebury College.

CONNECTION BETWEEN ORDOVICIAN MANTLE METASOMATISM AND ARSENIC IN VERMONT GROUNDWATER, RYAN, Peter C.[1], KIM, Jon[2], CHOW, Daniel[1], SULLIVAN, Colleen[1], and BRIGHT, Kevin[1], (1) Geology Department, Middlebury College, (2) Vermont Geological Survey.

BEDROCK CONTROL ON SURFICIAL DEPOSITS AND GROUNDWATER ISSUES IN PART OF THE KNOX MOUNTAIN GRANITE PLUTON: NE VERMONT, KIM, Jonathan[1], SPRINGSTON, George[2], and CHARNOCK, Robert[3], (1) Vermont Geological Survey, (2) Department of Geology and Environmental Science, Norwich University, (3) Department of Geology, University of Vermont.

Tectonics and Geomorphology

Basic geologic mapping is also at the core of the following poster:

THE RELATIONSHIP BETWEEN BRITTLE STRUCTURES AND TOPOGRAPHIC PATTERNS IN THE KNOX MOUNTAIN GRANITE: NE VERMONT, CHARNOCK, Robert[1], KIM, Jonathan[2], KLEPEIS, Keith[1], and CHOW, Daniel[3], (1) Department of Geology, University of Vermont, (2) Vermont Geological Survey, (3) Geology Department, Middlebury College.

VGS Web Postings

Marjorie Gale continues to post additional material to the Survey web site:
http://www.anr.state.vt.us/dec/geo/mapsonlineinx.htm

VG09-1, Wright, S., S. Fuller, S. Jones, A. McKinney, S. Rupard, and S.D. Shaw, 2009, Surficial geologic map of the Burlington, Vermont 7.5 minute quadrangle, 1 color plate, scale 1:24,000.

VG95-7a, Doolan, B., 1995, Bedrock geologic map of the Gilson Mountain, Vermont 7.5 minute quadrangle, 2 color plates, scale 1:24,000.

VG09-2, Wright, S., A. McKinney and S. Rupard, 2009, Surficial geologic map of the Colchester, Vermont 7.5 minute quadrangle, 1 color plate, scale 1:24,000.

VG09-3, De Simone, D. and Gale, M., 2009, Surficial geology and hydrogeology of Dorset, Vermont, 9 color plates, scale 1:24,000.

VG08-2, De Simone, D., 2008, Surficial geologic map of the town of Londonderry, Vermont, 2 color plates, scale 1:24,000.

VG08-3, Kim, J., Charnock, R., Chow, D. and Springston, G., 2008, Bedrock geologic map of the Knox Mountain pluton area, Marshfield and Peacham, Vermont, 3 color plates, scale 1:24,000.

VG08-4, Springston, G. and Kim, J., 2008, Surficial geologic map of the Knox Mountains area, Marshfield and Peacham, Vermont, 2 color plates, scale 1:24,000.

2/17/09–Preliminary statewide analyses of groundwater resources is posted.

2/9/09–Bulletins 5 and 9 text as PDF files have been added to the web site.

Ten USGS Open-File Report maps have also been posted as PDF files on our site.

Respectfully submitted,
Laurence R. Becker, State Geologist

ANNOUNCEMENTS

VERMONT GEOLOGICAL SOCIETY'S NEW LISTSERV

I am happy to announce that we have tested and now implemented an electronic ListServ for anyone with questions or interests related to Vermont geology. This ListServ will hopefully develop into a central portal used to disseminate information regarding educational opportunities, pertinent local and regional meetings, workshops, and talks. It will also serve an educational role by allowing member and non-members to ask the geologic community questions.

If you are interested in joining the Society's new ListServ, please visit this link:

http://listserv.greenmtn.edu/scripts/wa.exe?SUBED1=VGS&A=1

You will be able to control the way and how frequently you receive information via the ListServ during registration. Please contact me if you have any questions regarding the ListServ via vanhoesenj@greenmtn.edu

John Van Hoesen, Vice President

VERMONT GEOLOGICAL SOCIETY LECTURER PROGRAM

The goal of the Vermont Geological Society Lecturer Program is to offer local colleges, universities, and high schools the opportunity to invite a member of the VGS to speak at their institution on timely topics within the broad realm of earth and environmental sciences. The program is primarily intended to reach those departments which either do not hold a regularly scheduled seminar series or whose finances do not permit them to invite external speakers to present talks on a regular basis. Any costs associated with the Lecturer's travel, lodging, and meals are borne entirely by the Vermont Geological Society.

Stephen Wright, Ph.D., Department of Geology, University of Vermont, is our 2009 Lecturer. Stephen is offering the following lecture topic: "Glacial Geology of Northern Vermont: Ice Flow, Water Flow, and Glacial Lake History." For scheduling information, see the Society's website at http://www.uvm.org/vtgeologicalsociety/lecturer_program.html

STUDENT RESEARCH GRANT APPLICATIONS

Students and secondary school teachers are encouraged to apply to the VGS Research Grant Program by **October 1, 2009**. Downloadable Research Grant Program applications are available from the Society's website at http://www.uvm.org/vtgeologicalsociety/. For those without Internet access, forms may be obtained by writing to Jon Kim at the Vermont Geological Survey, 103 South Main Street, Logue Cottage, Waterbury, VT 05671, e-mail: jon.kim@state.vt.us, or by calling (802) 241-3469.

VERMONT GEOLOGICAL SOCIETY CALENDAR

April 18	LCRC Spring Student Symposium, Poultney, Vermont
April 25:	VGS Spring Meeting, Delehanty Hall, University of Vermont
Sept. 25-27:	NEIGC Conference, Lyndonville, Vermont
Oct. 1:	VGS Research Grant Program applications due
Oct. 18-21	Geological Society of America Annual Meeting, Portland, Oregon

The **Vermont Geological Society** is a non-profit educational corporation.
The **Executive Committee** of the Society is comprised of the Officers, the Board of Directors, and the Chairs of the Permanent Committees.

Officers

President	George Springston	(802) 485-2734	gsprings@norwich.edu
Vice President	John Van Hoesen	(802) 287-8387	vanhoesenj@greenmtn.edu
Secretary	David West	(802) 443-3476	dwest@middlebury.edu
Treasurer	Stephen Howe	(518) 442-5053	showe@albany.edu

Board of Directors

Richard Dunn	(802) 485-2304	rdunn@norwich.edu
Les Kanat	(802) 635-1327	les.kanat@jsc.edu
Jon Kim	(802) 241-3469	jon.kim@state.vt.us

Chairs of the Permanent Committees

Advancement of Science	Jon Kim
Geological Education	Christine Massey
Membership	Stephen Howe
Public Issues	Laurence Becker
Publishing	Stephen Howe

Vermont Geological Society
P.O. Box 1224
Saint Albans, VT 05478-1224

ADDRESS CHANGE?
Please send it to the Treasurer at the above address

Vermont Geological Society
Winter Meeting
April 25, 2009, 8:30 AM
Delehanty Hall, Room 219
University of Vermont, Burlington, Vermont

Directions to the University of Vermont:

Delehanty Hall is located on the old Trinity College campus adjacent to the University of Vermont. From I-89, take Exit 14 (Main Street–Route 2 exit), and go west (towards the lake) to East Avenue. Turn right on East Avenue and go to the end of East Avenue. At the stoplight, proceed straight across Colchester Avenue and into the driveway ahead of you. Once on the driveway, bear around to the left and the parking lot is in the rear of Delehanty Hall, which has a slate exterior and large granite blocks in front of it.