THE MAINE GEOLOGIST

NEWSLETTER OF THE GEOLOGICAL SOCIETY OF MAINE

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25'th Anniversary Volume

The President's Message

Four years have passed since I retired (?) from 27 years of public service (Maine Geological Survey) and while still professionally active, I have the opportunity to catch up on my reading, including technical, non-fiction, fiction, and print media in general. From these sources I have seen many references to "science", often preceded by some meaningless adjectives and followed by unfathomable, if not mysterious definitions. The following are a few examples that come to mind: good science; bad science; pure science; basic science; applied science; quality science; sound science; big science; small science; miscellaneous science; voodoo science; weird science; junk science; dogmatic science; client science; politicized science; civic science; creation science; armchair science; anecdotal science; trendy science; new-age science; managed science; curiosity science; plausible science; fringe science. We can also include "ignored science," exemplified by the impending collapse of the fisheries in the Gulf of Maine despite a long standing body of research, facts, data, and scientific recommendations ignored by politicians and policy people. The list goes on and I'm sure you all can add a few more. Most of this must be generally confusing to the general public and it might therefore be useful (?) to place an appropriate definition of science, the scientific method, and geology on our WEB Site home page (www.gsmmaine.org). I solicit your comments, suggestions or recommendations on definitions.

SCIENCE (Webster) - (1) a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws; (2) systematic knowledge of the physical or material world; (3) systematized knowledge in general; (4) knowledge as of facts or principles; (5) knowledge gained by systematic study.

SCIENTIFIC METHOD (Webster) - a method of research in which a problem is identified, relevant data are gathered, a hypothesis is formulated from these data, and the hypothesis is empirically tested.

GEOLOGY (Webster) - (1) the science that deals with the physical history of the earth, the rocks of which it is composed, and the physical changes which the earth has undergone or is undergoing; (2) the geologic features and processes occurring in a given region on the earth or on a celestial body.

I wish to express my thanks to Doug Reusch at University of Maine who is leading an NSF/GSM sponsored Northern Appalachian field trip for secondary school teachers (following pages) -- another great GSM jubilee event! While on this subject and as vice-Chairman of NEGSA, I have been exposed to the SAGE Project of the GSA. It is an acronym for Science Awareness through Geoscience Education. Its mission is to promote geoscience education and enhance scientific understanding for all citizens. SAGE programs include: (1) Partners for Educators Program(PEP); (2) Geoscience Education; (3) Awards for Educators (our Patti Millette of Mt. Blue High School is a candidate for the national outstanding teacher award); (4) Encourage Underrepresented Groups in Earth Science; (5) Resource Materials and Career Information. I am especially impressed with the progress of the PEP program, which supports professional partnerships between geologists and K-12 educators both in formal and in informal settings. The program now includes more than 1700 volunteers in all 50 states and more than 60 international associates. Notably impressive is the PEP E-mail partners to help answer questions in their own specialties for each other, students, other educators, and the public. For those who wish to participate in this stimulating program you can contact: Wendy Cunningham, Project Coordinator for PEP at: pep@geosociety.org. Join up - it's fun!

Also, I don't think I've compromised our charter by writing to the Maine delegation to support the reauthorization of the National Geologic Mapping Act which furnishes funds for geologic mapping for federal (FEDMAP), state (STATEMAP), and educational (EDMAP) institutions. I have gotten positive responses from our delegation.

Finally, I hope to see you all at our summer jubilee field meeting hosted by Dee Caldwell at the Field Camp on Chesuncook Lake. Have a great summer!

Walt Anderson, President
<WAAGEO@aol.com>

The Editor's Message:

Last year we put out a call for those who might like to receive the newsletter electronically. We will implement that change soon, but will continue this experimental double subscription, snail mail as well as e-mail, to make sure that the bases are covered. PLEASE e-mail me with any problems, and if you would like your name added to the list of e-mail recipients, let me know.

Dan Belknap, Newsletter Editor
<belknap@maine.edu>

GSM Web Site !

A reminder that the GSM website is:

www.gsmmaine.org

Wayne A. Power, Webmaster, UMF
<wpower@maine.maine.edu>

Earth System Science Workshop/ Field Trip for K-12 Teachers

July 12-16, 1999

"Many, many factors have shaped the world as we know it, and these same factors are still at work. If we study what is here today, we may learn how to solve the 'equation of earth', decipher what happened long ago, and predict what may happen in the future." - Dan Reid at age 14 (final paragraph in his report "Geology of the Bangor High School area, Maine)

As articulated by the National Research Council in 1993, "the goal of the solid-earth sciences is: to understand the past, present, and future behavior of the whole earth system." Their 1996 publication "National Science Education Standards", which lays out a vision of scientific literacy for all students, places a strong emphasis on earth system science. As a result of their activities in grades K-12, all students should develop an understanding of earth materials and changes in earth and sky, the structure of the earth system, energy in the earth system, geochemical cycles, and the origin and evolution of the earth system.

To meet a widely recognized need for professional development opportunities for Maine science teachers, an "Earth System Science Workshop/Field Trip" will be conducted July 12-16. A National Science Foundation-supported program "Field-based investigations to understand the earth system," along with additional support from the Geological Society of Maine's education fund, will enable a dozen science teachers from around the state to participate. Later during the school year, presentations by six of the participants at education conferences will address a wider audience.

The primary goal will be for participants to observe key parts of Maine's Paleozoic, Pleistocene, and Holocene geologic records. The trip focuses on a transect of the Appalachian mountain belt from Quebec City to the Gulf of Maine, along which teachers will observe evidence for the growth and subsequent destruction of the Paleozoic Iapetus Ocean. Teachers will have opportunities to develop geologic mapping and related skills needed to decipher the geologic record. The geochemical carbon cycle, a unifying concept in earth system science, will be introduced within the context of tectonic rearrangements of carbon sources and sinks through the Iapetan cycle. Later in the week, we will visit spectacular Pleistocene features in eastern Maine to examine evidence for the existence and demise of the Laurentide ice sheet.

On Wednesday afternoon at the UMF Geology Department, we will compile a set of recommendations on how to make use of Maine's rich geologic record in K-12 education. We will also evaluate Maine's Learning Results in the context of the National Science Education Standards and Maine's unique geologic record. Input from the professional geologist community is welcome. We will discuss how to institutionalize similar professional development experiences so that eventually all Maine teachers involved in science education will have opportunities to observe the best parts of their region's geologic record. An NEIGC-style field guide and a virtual field trip website are in preparation. Copies of the National Science Education Standards may be purchased for $19.95 plus $4 S/H from the National Academy Press, 2101 Constitution Ave. NW, Lockbox 285, Washington, DC 20055 or 1-800-624-6242.

Douglas Reusch, Postdoctoral Fellow, UM
<Doug@iceage.umeqs.maine.edu>

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Summer Field Trip

July 23-25, Chesuncook Lake

Dee Caldwell, Boston University, will host and lead our summer field trip out of the BU/UM field camp (Boom House) on Chesuncook Lake complete with cook and a traditional woods camp dinner. This event will take place July 23 (Fri.), 24 (Sat.), and 25 (Sun.). The plan: July 23- Arrive at Chesuncook Dam Boom House, T3-R12, with lodging in Boom House or tenting on grounds and pot luck supper. July 24 - An early breakfast and drive to Patten to begin field trip at Stop #1, at Top-of-the-World, about one mile south of Patten on Route 11 (for those who don't want to do much

driving, tent at Shin Pond, etc. and meet at Stop #1). We have reserved the campsite at Shin Pond for Friday night - about $3.00 /site. Stops proceed in and around Baxter Park ending Saturday evening at the Boom House for woods camp dinner and a Silver Jubilee evening event. July 25 - An early breakfast and on to Greenville-Monson area ending early afternoon at the Portland-Monson Slate Co.

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Teacher's Workshop

Joe Kelley (UM) and Bob Marvinney (MGS) call on your help and input for a day-long Teachers Workshop on the Geology of Maine during Earth Science Week, Oct.10-16, as a Fall GSM event. This workshop will be geared particularly toward school teachers who are implementing the Maine Learning Results.

Message from the State Geologist

Mapping Maine's Geology

The Maine Geological Survey is engaged in an ambitious program of geological mapping this summer with projects spanning the spectrum of Maine geology. Here are the key projects we will be working on:

Aquifer mapping: Craig Neil and his crew of summer interns will map in detail the sand and gravel aquifers of eastern Maine, extending from Penobscot Bay eastward along the coast to Machias. With improved data collection techniques, including 12-channel seismic refraction, and the availability of detailed 1:24,000-scale base maps, the products of this work will be greatly improved over the existing generalized aquifer information for the area. As blueberry growers and other agricultural interests seek new sources of water for irrigation, the new maps will be indispensable.

Surficial mapping: Over the past several years, Woody Thompson, Tom Weddle, and some contract mappers have done an outstanding job in completely mapping the 1:24,000-scale quadrangles that comprise the Portland 1:100,000-scale sheet. This summer's program west of Lewiston will build on and extend northward the geologic framework for surficial units developed through the earlier effort. This mapping program is made possible with matching funds from the National Cooperative Geologic Mapping Program (NCGMP). Thanks to all of you who helped maintain the funding for this important program through letters to our congressional delegation.

Bedrock mapping: Again with assistance from the NCGMP, MGS will carry out bedrock mapping in the Thomaston area, building on our understanding of the area's complex geology developed through several years of mapping in the neighboring Camden and Rockland areas. This area includes the only significant lime-producing region of New England, and a cornerstone of the local economy. Making sense of this complex geology and directing a small group of contract mappers will be Spike Berry's primary responsibility.

Bluff mapping: Joe Kelley and Steve Dickson are directing a group of student interns who are mapping the eroding coastal bluffs in mid-coastal Maine this summer. With the completion of this project, we will have a map series which extends from Portland through Penobscot Bay.

Cartography: It would be senseless to carry out these geologic mapping projects if the MGS had no means of making the information available to the public. Over the past several years we have converted our map-making process to be completely digital with on-demand map products. Our new plotter, with a bulk UV-stable ink reservoir system, will help us meet the goal of high-quality, durable and timely maps. Look for several hundred new geologic and aquifer maps by the end of the summer.

Earth Science Week: Earth Science Week presents an excellent opportunity for Maine geologists to show the public through lectures, field trips, demonstrations, workshops, and other means, the value of the work we do and the significance of geology to daily life. The Maine Geological Survey will once again coordinate activities for the second annual Earth Science Week, October 10-16, 1999. Last year each college and university geology department developed publicly oriented activities for this week, and I hope I can call on each to do so again. GSM will present a workshop, *The Geology of Maine,* on October 14 as part of the celebration of the earth sciences. This workshop will be geared particularly toward school teachers who are implementing the Maine Learning Results.

Robert G. Marvinney, State Geologist
<Robert.G.Marvinney@state.me.us>

GSM Member News

Dan Belknap is the new Chair of Geological Sciences at UM in Orono. He pledges to further increase the ties of UM Geological Sciences to GSM, and foster professional and educational opportunities for Maine geologists.

Bill Boettger and **Mark Shutty** are the Maine DEP's new geology technicians.

Rich Campbell has formed the Rich Campbell Environmental Group in Portland.

Liz Champeon gave a presentation in Boston this spring to the EPA's Blue Ribbon Panel on MTBE.

Rich Fortin and **Matt Reynolds** have formed a new company, Drumlin Environmental LLC, located on Franklin Street in Portland.

Intrepid geologists completing the Trek Across Maine: **Richard Heath, Andy Tolman** (Maine DEP), and **Matt Reynolds** (in tandem with his son).

Joe Kelley is now a faculty member at UM in Orono. His position is a joint appointment in Geological Sciences and the School of Marine Sciences, with funding from the Maine Geological Survey and continuing responsibilities to participate in research and advise the State on marine and coastal issues.

Patti Millette (Mount Blue High School) has just received the National Association of Geology Teachers award of recognition for the Northeast. Patti is up for the national recognition award as well.

Dorothy Richter is President of the New Hampshire Council of Professional Geologists. The Council is focusing on instituting registration for geologists practicing in the State of New Hampshire. Contact Dorothy via email <dorothy@hager-richter.com> for further information.

Andy Tolman (Maine Geological Survey) has roles in "The Fantasticks" at Johnson Hall in Gardiner in July, and in "Whose Under Where?" at Lakewood in September.

Please send member news to Carolyn Lepage at: clepagegeo@aol.com or PO Box 1195, Auburn, ME 04211-1195 or by fax to 207-777-1370 or just call 207-777-1049.

GSM Treasurer's Report

July 06, 1999

The Society currently has 323 members: They are distributed as follows:

Associates:	26
Institutions:	12
Regular:	267
Students:	18

Unfortunately it is easy to let your dues lapse. The dues date is shown on your mailing label.

Balance on Hand 03/03/99		**$ 10,687.76**
Receipts Subtotal	$	637.85
Dues	$	395.00
Anderson fund (intr. + contr.)	$	141.85
Education fund	$	6.00
Publications	$	20.00
Short Course	$	75.00
Expenses subtotal	$	865.19
Printing, mailing, stamps	$	325.70
Anderson Awards	$	200.00
Bank Charges	$	21.86
Spring Meeting Expenses	$	226.52
Miscellaneous	$	21.11
Website	$	70.00
Taxes	$	0.00
Balance on Hand 07/07/99		**$ 10,460.42**

Respectfully submitted,
Elizabeth A. Champeon, Treasurer
< Lchampeon@aol.com>

GSM Secretary's Report

GEOLOGICAL SOCIETY OF MAINE
Business Meeting
Date: April 23, 1999
Time: 4:40 PM
Location: University of Maine, Orono, Maine

Walter Anderson, President, conducted the meeting

Walter thanked Dan Belknap, Joe Kelley, and Marty Yates for organizing this meeting and the presentation of student papers.

Walter introduced the new GSM Officers: VP, Dave Gibson; Secretary, Pat Seaward; Treasurer, Liz Champeon; Newsletter Editor (and Postal Chairman), Dan Belknap; and new Director, Joe Kelley.

Secretary and Treasurer reports were accepted as printed in the newsletter. Walter asked Liz to break out the Walter Anderson Fund and list separately, to invite greater participation. The Federation of Maine Mineral and Gems Clubs contributes to educational programs to expand recognition of students. Management will decide how best to use this. They contributed $100 to the student presentation awards.

Noted that the summer meeting will be held at Boom House, Chesuncook on July 23, 24, and 25, 1999. This meeting is described on GSM website (www.gsmmaine.org) where details will be added as planning progresses.

Speaking of the website, many items are being planned for inclusion. GSM By-Laws, Earth facts, road logs for field trips, as well as all back issues of The Maine Geologist will reside on the website as Dave Gibson and Wayne Power find the time and material. There is also a committee [Dave Gibson, Wayne Powers, Patti Millette (Mt. Blue H.S.), and Beth Lewis (Cape Elizabeth H.S.)] to develop a page for K-12 educators. Walter also suggested that information regarding USGS water resources and MDEP activities also should be included.

As this is 25th year for GSM, special activities will be planned for both the summer field trips and the fall meeting. Dan Belknap proposed that the fall meeting focus on the history and founders of the organization. At this time, Walter proposed to establish the office of Historian for GSM to

contribute to meetings and newsletters; and Dan Belknap moved to nominate Art Hussey. Done deal.

Bob Marvinney announced that Earth Science Week will take place during the second week of October. MGS is involving GSM as a partner. Participation is expected from all state geological surveys, as well as all colleges and universities. Patti Millette suggested that GSM focus on the secondary level, too, to address earth science teaching; perhaps one day during Earth Science Week. Patti will work with Bob Marvinney and Joe Kelley for a session on the Geology of Maine geared toward educators. Notice for this seminar must get to the teachers before the end of the school year to arrange for time off and substitutes.

Bob focused our attention toward a Maine Metallic Mineral Conference he's working on with Spike Berry. Planned is a day of field trips on October 29 in Bangor, and a meeting on October 30, 1999 at a location to be determined (stay tuned to the website). The purpose is to schedule this opportunity between GSA (October 24-28,1999) and New Brunswickís Annual Review of activities (beginning November 1, 1999), and to invite our Canadian neighbors to join us. Bob was planning to send a flier in late April to determine the interest from the New Brunswick contingency. Moved by Marty Yates, this conference would also be a joint effort between MGS and GSM.

On another front, Bob informed us that the National Geological Mapping Program (by USGS and state surveys) is to be re-authorized by Congress this year, and is the only bill addressing geologic mapping. The grant would be competitive and matching. He urged us to contact our congressmen and women (by letter, telephone, e-mail) in the next few days, as they need to understand the importance of this program to state surveys, conservation and environmental protection, as well as educational institutions.

Last, but not least, the Walter A. Anderson undergraduate awards for best oral and poster presentation were voted by judges, Walter, Joe, and Doc Berry. Recipient for oral presentation was Riley Flanagan-Brown, UMO. Recipient for best poster went to Jeff Nealon, Bowdoin College. Congratulations to you both for a fine job. Their abstracts, along with all the others given, are listed below.

Pat O. Seaward, Secretary
<Pat.O.Seaward@state.me.us>

Abstracts of the 1999 Spring Meeting, April 23, 1998

PALEOCLIMATIC CYCLICITY OF SEISMIC REFLECTION PROFILES FROM ODP SITE 1063, NORTHERN BERMUDA RISE SEDIMENT DRIFT

BURKE, Benjamin C., Department of Geology, Bowdoin College, Brunswick, Maine, 04011, bburke@bowdoin.edu

Recent results from drilling on sediment drifts show that the physical properties of these deposits may be modulated by cycles of eccentricity and obliquity. Seismic reflection profiles at ODP Site 1063 on the Northern Bermuda Rise suggest that the seismic response may have also been modulated in response to 100,000 and 40,000 climatic cycles. Spectral analysis of physical property and well-logging data at Site 1063 has indicated that those climatic cycles and a 21,000 year cycle based on precession do play an influential role in sediment deposition.

CONSIDERATION OF A BEDROCK SOURCE FOR ARSENIC IN DOMESTIC WELLS OF BAYSIDE, MAINE

BURNS, John, Dept. of Geological Sciences, University of Maine, Orono, ME 04469-5790 Jburns2553@aol.com

Twenty-four wells tested in Bayside, Maine have arsenic concentrations of 0.05 mg/l to 5.5 mg/l, hence, they are at or over the limit of 0.05 mg/l set by the EPA and pose a serious health hazard. Potential sources for this arsenic include both natural and human ones. One possible natural arsenic source is the local bedrock. This study is concerned with testing one aspect of this possibility.

The local bedrock consists of the metasedimentary, Ordovician age, Penobscot Formation, and the Northport granite. Twenty samples have been obtained from Dave Stewart of the U.S.G.S. as well as new collecting I have done myself. Thin sections of twenty samples were studied with a petrographic microscope and twenty-five polished plug mounts were studied with reflected light. These optical studies have revealed no arsenic minerals such as arsenopyrite, but did show abundant sulfides, pyrrhotite, with minor chalcopyrite and sphalerite, especially in the Penobscot Formation. Possible arsenic in these sulfides was tested for by means of electron microprobe.

The microprobe data show that in all specimens studied, arsenic is not present above the detection limit of 400 ppm with a 99% confidence. Hence in the context of the data presently available, it is suggested that the arsenic in the wells is not coming from arsenic minerals or arsenic-bearing minerals that are widely distributed throughout the Penobscot Formation or the Northport granite. If arsenic is coming from a bedrock source, it must involve localized sources within the rock units, such as particular beds or joint planes.

MICROGRANULAR MAFIC ENCLAVES AS EVIDENCE FOR MINGLING AND MIXING OF A MAFIC REPLENISHMENT MAGMA WITH THE SILICIC MAGMA CHAMBER DURING THE FORMATION OF THE LUCERNE GRANITE OF CENTRAL MAINE, U.S.A.

FLANAGAN-BROWN, R. E., Department of Geological Sciences, University of Maine, Orono, ME 04469. rbrown51@maine.maine.edu

The Lucerne Granite is a massive, coarse-grained, subhedral, seriate to porphyritic, biotite-bearing granite located in central Maine within the Coastal Maine Magmatic Province (CMMP) and emplaced ca. 370 Ma. Fine-grained to microgranular, ovoid to elongate enclaves of more mafic composition can be found at

numerous outcrops. These enclaves contain xenocrysts of the Lucerne Granite host, abundant quenched apatite crystals, and lack chilled margins. They are mineralogically similar yet compositionally more primitive, containing biotite with higher magnesium numbers and more calcic plagioclase cores (ca. An50), than the host granite. This textural and chemical evidence supports the interpretation that these enclaves are magmatic in origin.

Micro-granular mafic enclaves are common in most granites and have been studied in great detail by many igneous petrologists (see Didier, J. and Barbarin, B. (eds.), 1991. Enclaves and Granite Petrology. Developments in Petrology 13. Amsterdam: Elsevier, 625 pp.). The presence of magmatic enclaves in the Lucerne Granite is in conflict with the interpretations of Hogan and Sinha (1989), who identified the Lucerne Granite as the type example of plutons in the CMMP that have not interacted with mafic magma. Previous workers in the CMMP and elsewhere have interpreted enclaves similar to those described in this study to have formed from more mafic magmas that were mingled into the more silicic magma while it was still mobile.

Magma chambers form through some combination of processes including, but not limited to, partial melting of the crust, fractional crystallization, reactions caused by volatile components present, and the mixing and mingling of higher temperature mafic melts with lower temperature chamber material. Our ability to observe the results of these processes is dependent on the present orientation of the magma chamber relative to its position during crystallization, and the nature of what we observe is dependent on the combination of processes actually involved during the formation of the magma chamber. Wones and Ayuso (1993) proposed partial melting of the crust and fractional crystallization as two processes involved in the formation of the Lucerne Granite. The results of this study require mingling and mixing of a mafic replenishment magma with the silicic magma chamber to be included as a process that operated during the formation of the Lucerne Granite.

BED-LOAD ENTRAINMENT ANALYSIS OF THE UPPER SANDY RIVER, SMALL FALLS STATE PARK, MAINE

FUENTE, Dave and GRAHAM, J. P., Colby College, 5800 Mayflower Hill Drive, Waterville, ME. 04901 defuente@colby.edu, jpgraham@colby.edu

The Upper Sandy River at Small Falls State Park, a shallow pool-and-riffle sequence, contains a bed-load with exceptionally large clasts relative to channel morphology. Mean sediment size ranges from very coarse pebbles to fine cobbles. Maximum clast size for this area is coarse boulder. Integration of channel geometry, measured and calculated flow velocities, and grain size, indicates catastrophic processes must be employed to initiate entrainment of the larger clasts.

Flow velocities measured throughout the fall and early winter months ranged from 0.71 ft/s to 2.87 ft/s (0.22 m/s to 0.875 m/s). Measured velocities contrast markedly with those predicted by Manning for a natural, vegetated, mountain stream. Thus, the Manning equation does not properly model this stream.

Existing models require velocities from 5.2 ft/s (1.6 m/s) to 6.6 ft/s (2.0 m/s) to transport the mean clast size. Cross-sectional areas of 41.7 ft^2 (3.87 m^2) and 131.6 ft^2 (12.2 m^2) are required to handle the discharge velocities necessary to entrain the mean and maximum clasts, respectively. However, a seasonal cross-sectional area for the study area is 3.77 ft^2 (0.350 m^2). The discharge velocity for the mean clast size suggests that these sediments were deposited by either extreme flood events or glacial gravity flows. The discharge velocity required to move the maximum clast seems unrealistic for fluvial processes within this channel morphology. Emplacement of these sediments was probably a result of glacial gravity flows and further entrainment awaits the next ice age.

NOCTURNAL GLOBAL WARMING IN CENTRAL MAINE

GIAUDRONE, Dominic, J. and GRAHAM, J. P., Colby College, 5808 Mayflower Hill Drive, Waterville, ME, 04901 djgiaudr@colby.edu, jpgraham@colby.edu

Current models of the greenhouse effect predict that an increase in greenhouse gasses in the atmosphere will result in global warming and a rise in daily maximum temperatures. Recent studies in many parts of the world indicate that daily maximum temperatures are remaining relatively constant, while the daily minimum temperatures are on the rise. A rise in daily minimum temperatures with relatively constant daily maximums suggests that the increase in global mean surface air temperatures may be the result of a narrowing diurnal temperature range.

Analysis of daily minimum and maximum surface air temperature data from the National Climatic Data Center for the Augusta Airport from 1963-1997 indicates that Maine's diurnal temperature range is narrowing as a result of differential changes in daily maximum and minimum temperatures. Annual trends show that Augusta's annual average low temperatures are rising at nearly twice the rate of the annual average maximums. The narrowing of the diurnal temperature range appears to be seasonal. Nocturnal global warming is occurring more rapidly in the winter months. Winter data indicate that the winter diurnal temperature range is narrowing; however, both the summer highs and lows are increasing at similar rates, resulting in very little change to the summer diurnal temperature range.

The implications of long-term nocturnal global warming and narrowing the diurnal temperature range include major shifts in vegetation patterns as well as a need to rethink the way global climate change is modeled. Specifically, it is important to realize that nocturnal global warming and the diurnal temperature range are important aspects to consider in future models of global climate change.

FREQUENCY DEPENDENT ELECTRICAL MEASURE-MENTS RELATED TO HYDRAULIC CONDUCTIVITY OF UNCONSOLIDATED SEDIMENTS

GLASER, Dan R., SLATER, Lee D., ROBINSON, Anthony and SANDBERG, Stewart K. Environ-mental Geophysics Unit, Dept. of Geosciences, University of Southern Maine, Gorham, ME 04038, E-mail: lslater@usm.maine.edu

In recent experiments, performed at the University of Southern Maine, the relationship between the hydraulic conductivity of unconsolidated samples and their frequency dependant electrical response has been investigated. A laboratory system was designed, in which samples of varying grain sizes were tested. The system allowed hydraulic and electrical measurements to be made simultaneously and at a comparable scale. In the first experiment, measurements were taken on artificial sand and clay (bentonite) mixtures. Percentage clay content by weight was varied between 0 - 15 %. A close inverse relationship between a normalized chargeability parameter and log hydraulic conductivity was found. In contrast, the resistivity and chargeability were found to respond primarily to changes in the electrolyte conductivity and, possibly, porosity. In Maine glacially deposited unconsolidated deposits typically contain few clay minerals, despite containing clay-size grains that strongly control hydraulic conductivity. Preliminary measurements on

sand and till samples obtained from locations within Maine suggest that the relationship between electrical properties and hydraulic conductivity is more complex. However, the imaginary component of electrical conductivity (representing the dielectric response) shows a weak inverse correlation with log hydraulic conductivity. This work suggests that it may be possible to obtain order of magnitude estimates of hydraulic conductivity from electrical measurements made in the field.

SEDIMENTOLOGY, DEPOSITIONAL ENVIRONMENTS, AND SEQUENCE STRATRIGRAPHY OF THE SILURIAN HARDWOOD MOUNTAIN FORMATION, NORTHERN MAINE

HUTCHINSON, Anne E. and GRAHAM, J. P., Colby College, 5800 Mayflower Hill Drive, Waterville, ME., 04901 aehutchi@colby.edu, jpgraham@colby.edu

The Upper Silurian Hardwood Mountain Formation was formed following the Late Ordovician Taconic orogeny and preceding the Early Devonian Acadian orogeny. However, field investigations of sedimentary facies from remote stratigraphic sections in northern Maine, petrographic analysis, and bounding discontinuities suggest that the depositional environments in the Hardwood Mountain Formation do not represent passive, non-tectonic deposition but actually signal the advance of the Acadian orogeny into the area.

At Jim Pond, the Hardwood Mountain consists of a vertical sequence of ripple marks, algal laminations, and parallel laminations, as well as a vertical sequence of macrofauna consisting of crinoids and brachiopods in the lower part of the section, tabulate corals and algae in the middle of the unit, and brachiopods in the uppermost beds. This sequence is again repeated in two sections at Hardwood Mountain. Petrographic examination of mixed clastic and carbonate debris supports this deepening-shallowing-deepening pattern to the Hardwood Mountain Formation. The vertical sequence represents a lowstand systems tract separated from a transgressive system tract by a flooding surface. Significantly, the depositional environments illustrate a pattern of relative sea level fall just prior to the transgression initiated by the advancing Acadian orogeny.

SURFICIAL DEPOSITS IN WESTERN VICTORIA VALLEY: A RECORD OF PALEOENVIRONMENTS IN SOUTHERN VICTORIA LAND, ANTARCTICA, SINCE MIDDLE MIOCENE TIME

KELLY, Meredith A., Department of Geological Sciences and Institute for Quaternary Studies, University of Maine, Orono, ME.

The polar East Antarctic Ice Sheet and the Southern Ocean together constitute a major component of the climate system. Important questions of global change involve the stability of this Antarctic ocean-cryosphere component. When did it form? Did it subsequently breakdown during periods of global warmth? I address these questions by examining surficial deposits in western Victoria Valley that register paleoenvironments in southern Victoria Land.

Bull drift, a silty till that contains striated clasts, is the only deposit in western Victoria Valley indicative of a temperate environment. Contiguous with a widespread map unit in the western Dry Valleys, Bull drift is at least 15.0 Ma. Areally scoured bedrock and the irregular pattern of the silty till unit in the western Dry Valleys reflect subsequent erosion beneath an overriding ice sheet. Dates of volcanic ashfalls on Asgard till (deposited during the overriding event) indicate that ice dissipated by 10.5 Ma.

Bull drift is the stratigraphically lowest unit in western Victoria Valley. The sedimentary sequence that overlies Bull till represents all deposits accumulated since the overriding event. Most deposits, mapped as Victoria drift, display arcuate ridges and are composed of loose, commonly sorted sediment. A leading hypothesis is that Victoria drift is a series of recessional moraines. However, the sedimentology and weathering of the drift are unlike tills elsewhere in the Dry Valleys. AMS radiocarbon dates of fossil algae from within Victoria drift have a disorderly areal distribution, also not anticipated from a typical moraine sequence. An alternative hypothesis is that Victoria drift was formed by a lake-ice conveyer. Because they require perennially ice covered, proglacial lakes, such conveyers can exist only in polar environments. The interpretation of Victoria drift as a lake-ice conveyer deposit is compatible with the existence of polar conditions in Victoria Valley since the overriding event 10.5 Ma ago, and suggests that the Antarctic ocean-cyrosphere system remained stable during this time period.

HYDROGEOCHEMICAL INVESTIGATION OF ROAD DE-ICING SALT EFFECTS ON GROUNDWATER IN WINTERPORT, MAINE

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Sodium (Na^+) and chloride (Cl^-) concentrations were measured in groundwater samples from domestic wells in Winterport, Maine, between 1986 and 1998. These samples indicate that a nearby road salt storage facility has impacted groundwater quality. The salt plume was used to illuminate groundwater flow paths, characterize hydraulic anisotropy, and identify chemical processes. Bedrock does not provide a significant source of Na^+ or Cl^- to the system and $Cl:SO_4$ and Cl:Br ratios in these samples show that trapped relict seawater from Quaternary marine inundation does not contribute to salinity. The road salt storage pile at this site was uncovered from 1976 to 1989 and averaged 4600 m^3 in size. Chemistry of water samples from the domestic wells and adjacent streams, and cation exchange capacity and base saturation of area soils indicate that cation exchange was an important process controlling the chemical dynamics of the plume. Calcium and magnesium are preferentially exchanged for Na^+, creating a hardness problem in these wells. Shallow (3 m maximum) monitoring well nests were placed in the silt-rich overburden (<5m thick) to monitor hydraulic head. The water-table configuration was estimated using these monitoring well nests and detailed surface water-level measurements. The most elevated Na^+ and Cl^- concentrations occurred in domestic wells to the southwest of the previous storage facility. Terrain conductivity surveys also suggest movement of salt-contaminated groundwater to the southwest of the former storage site. Although NaCl must move through the soil to reach the bedrock, these data do not allow a statement to be made regarding a saline plume in the overburden. Apparently the anisotropy created by underlying fractured bedrock and glacial sediments provide a significant control on mass transport of the contaminant through the system.

DOES MASSIVE BURIED ICE IN BEACON VALLEY, ANTARCTICA, HAVE PALEOCLIMATIC SIGNIFICANCE?

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The central portion of Beacon Valley, Antarctica, contains massive ground ice beneath 10 to 100 cm of diamicton and volcanic ash deposits up to 8.1 million years old. Two hypotheses have been put forth to explain the existence of the ice in one of the coldest and driest polar deserts on Earth. One

hypothesis, based on models from the Arctic, explains the ice as an accumulating lens segregated from active sand wedges in the overlying soil. This explanation implies the continuous formation of relatively young ice beneath soil that may be much older. The ice would therefore have little paleoclimatic significance.

The second hypothesis explains the ice as a remnant of a glacier preserved beneath ablation till and eolian sediments. This requires the ice to be of the same age or older than the covering volcanic ash deposits. The existence of ice 8.1 million years old would argue strongly for the stability of the Antarctic ice-sheet and climate system since the formation of the Antarctic circumpolar current (ACC) in the early Miocene. The stability of antarctic climate within an ACC dominated regime has ramifications for the studies of global sea level, ocean and atmospheric circulation, and computer modeling of the Earth's climate system.

To test these hypotheses, I am conducting a sediment-ological study comparing the covering deposits and ice-cemented wedge deposits to sediment contained within the ice. The sediment will be examined on the basis of grain size, sorting, lithology, and weathering characteristics. Stratigraphic relation-ships were established in the field in hand-dug excavations exposing the buried ice surface and the diamicton, volcanic ash and ice-wedge deposits. The ice was sampled and will be analyzed for chemical properties and ice crystal orientation fabrics.

Preliminary field observations suggest that the ice was derived from a source outside of Beacon Valley prior to the emplacement of the volcanic ash deposits. Glacially striated granite clasts are common in and overlying the ice, while no granite bedrock occurs in Beacon Valley. Furthermore, although sand wedges overlying and penetrating the ice may be active, they do not appear to be associated with the formation of the ice. The wedges often display cross cutting relationships with ice foliation and do not produce the raised polygon edges or upturned beds commonly associated with growing ice or sand wedges.

LANDSCAPE EVOLUTION AND POLYGON DEVELOPMENT ON A DEBRIS-COVERED GLACIER SURFACE, BEACON VALLEY, ANTARCTICA.

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The question pertaining to the stability of the East Antarctic Ice Sheet(EAIS) during the Cenozoic can perhaps be answered with the aid of stratigraphic information contained in the surficial deposits of the Dry Valleys region. Beacon Valley may hold stratigraphic clues that can be used to support or refute the notion of a collapsed or stable EAIS during the Pliocene. Debris-covered glaciers are prominent features in Beacon Valley, and the large polygon array that covers them is intriguing. Previously reported 40Ar/39Ar ages of ashes in Beacon Valley are of Miocene age, which implies that the buried ice is quite old. Questions arising from this discovery have been numerous- How can ice exist for such a long time in an polar desert environment? How can a landscape covered with patterned ground be considered stable? These questions may be successfully answered through an analysis of the geomorphology and stratigraphy in Beacon Valley.

Surveys and excavations of many polygons in Beacon Valley yielded information pertinent to both patterned ground formation and landscape stability of this region. Mapping the physical dimensions and characteristics of these polygons provides data which can be used to compare the morphology of these features along the long axis of the debris-covered glacier. Some down-glacier trends observed included increases in polygon size, polygon relief, steepness of polygon trenches, width of polygon trenches, and thickness of sedimentary cover. The preservation of delicate stratigraphic and sedimentologic features, such as aeolian bedding, intact volcanic ash wedges, textural immaturities of ash grains as well as buried desert pavements suggest that this particular area of patterned ground may not have been formed by typical cryoturbative processes. The process by which these polygons form may actually be the preservation mechanism for the buried glacial ice in Beacon Valley.

The buried Miocene ice in this valley, as well as the stra-tigraphy contained in this particular polygon complex would have likely been destroyed in a temperate glacial climate. This evidence contradicts the hypothesis of a meltdown of the EAIS during the Pliocene, and supports a stable polar climate in the Dry Valleys region since Miocene time.

THE USE OF ELECTRICAL GEOPHYSICAL METHODS IN THE INVESTIGATION OF A FRACTURED BEDROCK AQUIFER SYSTEM IN MAINE

LIPFERT, Gail[1], SANDBERG, Stewart[2], SLATER, Lee[2], REEVE, Andrew[1], and LOISELLE, Marc[3].
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Electrical geophysical methods have been used to better understand the ground-water flow system of a fractured bedrock aquifer at a site in Verona, Maine. In particular, changes in resistivity over time were monitored topographically down gradient from a formerly uncovered municipal sand/salt pile. A plume was delineated by terrain conductivity measured using a small horizontal loop electro-magnetic (EM) profiling technique. The angular shape of the plume corresponds to the predominant orientations of regional and local bedrock fractures and indicates possible fracture con-trol of the ground- water flow. In areas where the overburden is shallow, fractures were located by anomalies in the terrain conductivity data collected along traverses. A permanent array of electrodes was established along six of the EM traverses and electrical resistivity measurements were taken every one to two weeks over a five-month period. After two and a half months of minor but consistent changes in resistivity, a sudden and distinct change in overall resistivity values was recorded. This change in apparent resistivity is attributed to the mobilization of salt associated with rain events.

IGNEOUS PETROGENISIS OF THE TATNIC COMPLEX, SOUTH BERWICK AND WELLS, ME

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The Tatnic complex in southwestern Maine is a 122MA age igneous complex related to the White Mountain Magma Series. It intrudes the Silurian(?) age Kittery Formation of the Merrimack Trough sequence and the Early Devonian Webhannet pluton. The Tatnic Complex is primarily mafic to intermediate in composition and was formed through two intrusive episodes.

A central funnel of gabbronorite and the later intrusion of poikilitic gabbronorite represent the first intrusive episode. The poikilitic gabbronorite was possibly intruded as a cone sheet into partially solidified gabbronorite.

The second intrusive episode overlaps the southeastern portion of the first episode. It began with the explosive activity, which formed an andesite breccia. This breccia is represented by stoped blocks within the younger phases of the second episode. The andesite breccia is composed of fragments of Kittery Formation, Webhannet granites, pokilitic gabbro-norite , and gabbronorite residing in an andesite matrix that is identical to the nonbrecciated andesite phase of the complex believed to be intruded at the same time. Following this explosive activity an olivine gabbro which dominates the edges of the second episode was intruded. During the final stages of the intrusion of the olivine gabbro, a more felsic magma was injected leading to the formation of an inter-mediate composition mixed phase. This mixed phase is evidenced by nebulitic swirly patterns of lighter and darker material of intermediate composition. The final intrusion of the Tatnic resulted in the emplacement of a quartz diorite, which commonly contains well-digested dark inclusions of unidentified affinity. This phase forms the largest part of the complex and was intruded into olivine gabbro, country rock and the first episode gabbros.

STUDY OF POCKMARK EVOLUTION USING SEAFLOOR IMAGING, BELFAST BAY, MAINE

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The present study's primary goal evaluates the amount of change in size and growth of pockmarks in Belfast Bay, Maine over the last decade. Pockmarks are depressions that originate from the escape of subsurface methane gas probably contained in Holocene mud. The seafloor in Belfast Bay, located in the northwest corner of Penobscot Bay, and other nearby regions is covered by these crater-like pockmarks. The Belfast Bay field contains at least 2000 pockmarks of various shapes and sizes. The eruption of methane gas that creates such pockmarks is a potential geologic hazard to commercial and pleasure boating. By mapping the extent of the gas deposits and creating a three dimensional model of the basin it is hoped that further evidence for the creation of these features will be discovered. This study reports on the computerized mapping being carried out to produce an accurate surficial and sub-bottom map of this area. The data consists of remotely sensed side scan sonar swaths, ORE geopulse seismic data recorded in a 350 m grid, and ROV images used to ground truth specific features. The sonar lines were scanned and rectified to geographic coordinates, merged into a mosaic, and the features were digitized into vectors. From the overlay of two vector data sets in a GIS, one recorded in early 1989 and the other in middle to late 1998, we are analyzing the rate and extent of pockmark growth / formation over the decade since their discovery.

ARSENIC MOBILITY IN GROUNDWATER FROM ZIMAPAN, MEXICO: GEOCHEMICAL COMPUTER MODELING USING PHREEQC SOFTWARE TO EXAMINE VARIANCES IN pH AND pe.

SKINNER, Kate, Department of Geological Sciences, University of Maine, Orono, ME

Since 1995, a group of students from the Research Experience for Undergraduates (REU) program has travelled to the town of Zimapan in the state of Hidalgo, Mexico. The REU program is headed by Dr. Lois Ongley, Bates College, Maine; Dr. Allison Lathrop, Linden State, Vermont; and Dr. Helen Mango, Castleton State, Vermont. Zimapan is located about 250 kilometers northeast of Mexico City.

The limestone bedrock of Zimapan contains subsurface mineralized zones. The primary source of drinking water in the area is groundwater. Mining has dominated the local economy since the 1700's. Minerals (arsenopyrite and pyrite) extracted from the mines are known to contain elevated concentrations of arsenic. High concentrations of arsenic were found in the groundwater during a 1992 routine test for cholera bacteria. Arsenic may originate from natural sources, such as oxidation of sulfides in the groundwater, or from anthropogenic sources, such as leaching from exposed mine waste piles.

Water chemistry data from 1997 are being used in this study. Three end member samples from springs and wells were chosen as controls on arsenic solubility. PHREEQC geochemical modeling software is being used to investigate the controls on arsenic solubility at various pH and pe values. Modeling results are still pending.

THE ROLE OF REGIONAL GROUNDWATER IN THE GLACIAL LAKE AGASSIZ PEATLANDS, NORTHERN MINNESOTA

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Ground-water modeling of the Glacial Lake Agassiz Peatlands, completed using MODFLOW, indicates that distinct regional and local flow systems exist. Understanding ground-water flow in the region is an important element in evaluating the peatland carbon cycle.

The study area, located in north central Minnesota, contains several small drainage basins covering a total of 10,160 km^2. Maximum topographic relief of the area is less than 150 m and GPS surveys indicate a major east-west trending water-table divide exists through the center of the study area.. Much of the area is blanketed by 1-3 m of Holocene peat above a complex assemblage of till, lacustrine clay, and beach deposits. Unconsolidated sediments average 30 m in depth and overly low permeability crystalline bedrock. Model simulations suggest that two prominent topographic highs act as recharge zones for the regional ground-water system, which discharges to rivers bounding the peatlands. Interconnected sand and gravel stringers within the glacial sediments strongly influence ground-water flow. An area of flowing wells adjacent to the peatlands supports the existence of these high permeability zones. Local ground-water flow cells, driven by small (less than 1 m relief) ground-water mounds beneath the bog crests, are the dominant flow system within the peatlands. Steady state modeling shows little interconnection between these two systems during non-drought conditions.

MEMBERSHIP DUES STATEMENT

The GEOLOGICAL SOCIETY OF MAINE, INC. is a non-profit corporation established as an educational Society to advance the professional improvement of its members; to inform its members and others of current and planned geological programs in Maine; to encourage continuing social contact and dialog among geologists working in Maine; and to further public awareness and understanding of the geology of the State of Maine; and of the modem geological processes which affect the Maine landscape and the human environment.

The Society holds three meetings each year, in the late fall (Annual Meeting), early spring, and mid-summer (usually field trips). A newsletter, ***The Maine Geologist***, is published for all members three times a year. The Society year runs from August 1 to July 31. Annual dues and gift or fund contributions to the Society are tax deductible. There are three classes of memberships:

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1999/2000 SOCIETY YEAR BEGINS AUGUST 1 - PLEASE SEND DUES TO TREASURER

THE GEOLOGICAL SOCIETY OF MAINE
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