The Maine Geologist

July 1997

Newsletter of the Geological Society of Maine

Vol. 23, No. 2

President's Message
by
Joe Kelley

As the University of Maine began developing plans for a new School of Marine Sciences (now mostly complete), the local joke went: "How many university faculty does it take to change a light bulb?" The exaggerated response is "CHANGE!", said with a sense of fear and paranoia. Though only a joke, change should provoke some sense of anxiety among specialized creatures adapted to their ecological niches.

The Maine Geological Survey recently hosted a group of coastal geologists from around the country to advise us on the erosion problems on Maine's beaches. Each visiting geologist noted that erosion was a serious problem in his home state also, and that it appeared to be a recent phenomenon. For the past several thousand years, sea level in many parts of the United States rose very little, if at all, until this century. In Maine, sea level rose about 0.2 mm/yr for the past 1000-2000 years, but tide gauges have recorded a tenfold increase in this century to rates between 2 and 3 mm/yr (Kelley et al., 1995, Journal of Coastal Research). This small change in the factor which most influences shoreline position, coupled with the relatively recent occupation of the beaches by people and houses, has led to hundreds of millions of dollars of expenditures in beach replenishment and property loss around the country. Our greatest difficulty in dealing with the change in sea-level rise is to determine if it is a permanent increase in the rate of rise, or whether it is just a "blip" on a long-term trend that will soon slow down. In other words, is this a change worth doing anything about?

It would be nice if geologic changes always required geologic time periods to occur. As we were all once taught, many earth processes operate slowly over long time periods. Recent work on ice cores from Greenland and the deep sea, as explained in a talk to our Society last year by Paul Mayewski of the University of New Hampshire, suggest some climate changes may occur very quickly. Change from a mild climate to full glacial conditions may only take a decade or so. A volcanic eruption, such as that in Tambora in the early 1800's, led to Maine's "year without a summer". At that time most crops in northern areas failed because of the volcanic-dust-caused cooling.

I wonder how ready we are today to accommodate geological change? As geologists, one of our roles in society is to unravel past geological events and anticipate future scenarios. Better information on the geological past will surely aid us in that endeavor, but the startling and counter-intuitive nature of CHANGE in circumstances we take for granted will always be difficult to overcome.

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Mark your calendars....

GSM Summer Meeting Field Trip Meeting Places:

Saturday, July 26: *Day Use Area* of Sebago Lake State Park at 9 a.m.

Sunday, July 27: Sebago Elementary School, Jct. Rts. 11 and 114, East Sebago Village at 9 a.m.

Summer Meeting and Field Trip Details

The 1997 Geological Society of Maine Summer Field Trip will be held in the Sebago Lake region on the weekend of July 26 and 27. Campsites are reserved in the *Day Use Area* (follow signs) of the Sebago Lake State Park for Friday and Saturday nights for $3 per person per night. The GSM business meeting and cookout will be held on Saturday evening at 6 p.m. in the *Day Use Area.* Food will be provided. Please contact Bob Johnston at the Maine Geological Survey (Robert.A.Johnston@state.me.us or 287-2801) to reserve a campsite or to make a cookout reservation so we know how many people to expect.

The field trip will look at a variety of ongoing geologic studies in the region. Saturday's stops will be around the north end of Sebago Lake. We will hear about modern erosion problems on Songo Beach in the State Park, the late Pleistocene to Holocene history of the Songo River at Songo Lock, the glacial and post-glacial history recorded in surficial deposits of the Naples-Casco region, and the petrology of the Sebago pluton, Maine's largest plutonic body, which crops out in this area.

Sunday's stops will be west and southwest of Sebago Lake. We will start at the stream gauging station in East Sebago, learning about the U.S. Geological Survey's water resources program in Maine. We will then see some of the metamorphic rock units that are being mapped in the Maine Geological Survey's bedrock mapping program in the Saddleback Hills and Limington areas. The day will culminate at the "dry channel" of the Saco River in Buxton with the State Geologist showing us bedrock structure, Mesozoic dikes, and discussing bedrock groundwater contamination.

DEP-Consulting Professionals Task Force Update

by
Carolyn Lepage

Karl Wilkins of the Office of the Commissioner provided the Task Force with an update on the department's home page (www.state.me.us/dep). All the bureaus will eventually have their own home pages as well. Karl was interested in what kinds of information Task Force members would like to see. Some of the suggestions included various permit applications, back issues of *Environews* profiles, information about the Task Force, and the list of approved guidance documents. I'd be happy to pass along any suggestions you might have as well.

The group also received copies of the draft stormwater permit application for review by May 1. Dave Silver reported at the May meeting that the legislature had approved the stormwater rules, but without the emergency provision. Because the stormwater statute becomes effective July 1, but the rules won't be effective until 90 days after the legislature adjourns, there appears to be a window where the law is in effect, but the rules are not. Discussion followed about ways to educate the consulting, client, and contracting communities about the new law and rules.

George Seel mentioned that his bureau was working on a new standard operating procedure for action levels for petroleum contaminated soils. The draft will be circulated for outside review and comment in mid-July, according to the current schedule. For more information, contact Denise Messier at 287-2651.

The group also discussed partnering agreements in light of the one recently signed by the DEP, Maine DOT, Consulting Engineers of Maine, and Associated General Contractors of Maine to encourage partnering in design and construction projects.

Please give me a call at 777-1049, send me a fax at 777-1370, or e-mail me at clepagegeo@aol.com with suggestions for training opportunities or topics for the Task Force to pursue.

GSM Member News

Lois Ongley (Bates College) has received the 1997 Kroepsch Award for Excellence in Teaching.

Members participating in the 1997 Bicycle Trek Across Maine include State Geologist **Bob Marvinney, Ellen O'Brien,** and **Rob Peale** and **Richard Heath** from the Department of Environmental Protection.

According to **Joe Kelley,** the faculty offices are scheduled to be moved into the Edward T. Bryand Global Sciences Center at the University of Maine the week of July 7, with labs being moved during the month of August.

Woody Thompson (Maine Geological Survey) and **Chris Dorion** (University of Maine) presented papers at the Annual Meeting of the Canadian Quaternary Association held in Montreal at the end of May. Woody also co-chaired the symposium on deglaciation of southeastern Quebec and adjacent Maine and New Hampshire.

Steve Pollock (University of Southern Maine) is leading the charge in organizing the Northeast Section of the Geological Society of America's Annual Meeting to be held in Portland in March 1998. **Tom Weddle, Marc Loiselle,** and **Spike Berry** (Maine Geological Survey) are chairing the technical and symposia programs.

Bob Marvinney and the Maine Geological Survey are hosting the Annual Meeting of the American Association of State Geologists in Portland in June. **Walter Anderson** is lending a hand with logistics.

In the travel department, **Dan Belknap** (University of Maine) is conducting field work in Peru. Dan and **Joe Kelley** are also working on a project in Ireland. Joe is also planning a trip to Glacier Bay in September.

According to **Keith Taylor**, Summit Environmental Consultants has moved to its new office at 95 Main Street in Auburn.

Send your 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 at 207-777-1049.

GSM Treasurer's Report
June 23, 1997

Balance on Hand 3/5/97	**$8766.36**
Receipts Subtotal	$ 602.87
Dues	438.00
Anderson Fund	28.87
Education Fund	0.00
Publications	136.00
Expenses Subtotal	$2438.24
Miscellaneous	90.52
Printing	1906.80
Postage	142.17
Spring Meeting Expenses	298.75
Balance on Hand 6/23/97	**$6930.99**
General Fund	1983.81
Education Fund	658.70
Anderson Fund	4288.48
Membership Total	**338**
Regular	273
Associate	22
Student	29
Institutional	14

Members Paid Through 1996	201
Members Paid Through 1995	49
Members Paid Through 1994	44
Members Paid Through 1993	44

Submitted by Martin Yates, Treasurer

GSM Spring Meeting Minutes
University of Maine at Farmington, Maine
April 11, 1997

The Spring meeting began after completion of dinner and an afternoon of student oral and poster presentations. President Joe Kelley conducted the meeting, with the following items being discussed.

1. The Fall 1996 Meeting Minutes were accepted as presented.

2. The Geology of Maine Short Course is tentatively scheduled for October 17, 1997. The short course will probably be held in the Augusta area. The speakers are almost lined up.

3. The Summer 1997 annual field trip and meeting will be in the Sebago Lake area the weekend of July 26-27.

4. Bulletin #4 is out. The cost for this bulletin was set at $10.

5. Student presentation awards plaque will be inscribed and will be given to the school that will be hosting the next Spring meeting.

6. Spring 1998 meeting will be held at the University of Maine in Orono, Maine.

7. Treasurer's report was given by Marty Yates. The balance is amount presented in the previous GSM newsletter less $1,765 for the printing of Bulletin #4.

8. Marty Yates is stepping down as Treasurer. We must find a replacement for him this summer and vote on it at the Fall 1997 meeting.

9. Walter Anderson is on a committee for buying public lands. Walter suggested obtaining a pegmatite location. He requested that GSM send a letter to support this idea. Walter will write up a letter for inclusion in the next newsletter.

10. The New Hampshire Geological Society suggested to Joe Kelley that we have a joint meeting with them sometime.

11. NEGSA is being held in Portland this spring. A list of symposia ideas is needed by June 1997.

12.UMF was thanked for hosting the meeting and the business meeting was adjourned.

Following the business meeting, Dr. Bernard L. Cohen, Professor Emeritus of the University of Pittsburgh, gave a talk entitled "Household Radon and Human Health". The following summary of Professor Cohen's talk is reprinted from the GSM 1997 Spring Meeting Program.

Professor Cohen has published extensively on the topic of radon exposure and the linear-no threshold theory of radiation carcinogenesis. He has dealt at length with ecological versus case-control studies for testing dose response relationships. His thorough and detailed examination of the relationship between low level radiation and human health, backed by powerful statistical analysis, has exposed the linear-no threshold theory of carcinogenesis to serious question in its application to low level radiation exposure. Dr. Cohen asserts that over 100 billion dollars has been added to the cost of nuclear power plants in the U.S. alone as a result of adherence to a theory of carcinogenesis that has never been experimentally verified. The societal consequences have been and will continue to be staggering.

Submitted by Rebecca Hewitt, Secretary

GSM SPRING MEETING STUDENT ABSTRACTS

The Effects of Road Salt on Chloride Concentrations in Rivers and Ground Water in Waterville, Maine

BAPTISTE, John E., Department of Geology, Colby College, Waterville, ME 04901

During the 1980s, Maine spread an estimated 45,000 to 54,000 tons of salt on its roads each year. Although this amount is decreasing, the Maine environment is still exposed to tens of thousands of tons of salt each year. While this dumping is a necessity in the de-icing of roads, it may also be a hazard. Melt water transports Na^+ and Cl^- ions into Maine's rivers and ground water. As a result, de-icing salt is hypothesized to be one of the greatest contributors to increases in chloride concentrations in both environments. To quantify increases in chloride concentration due to de-icing salt application, a number of water samples were taken from both surface and ground water over the past two winters. Titration of the samples with silver nitrate indicated that road salt application does have a measurable effect on the chloride levels. The most dramatic changes were observed in shallow ground water where, over the course of the 1995-1996 winter, chloride concentrations rose from 80 mg/L to 190 mg/L in the span of about two months. A similar rise occurred in 1996-1997, with chloride levels approaching 170 mg/L. These data suggest that rises in chloride concentrations in shallow ground water due to road salt can be extreme and may be hazardous to the public's health if they approach the EPA limit of 250 mg/L.

Petrology and Geochemistry of the Black Narrows Section of the Moxie Pluton, Moxie, Maine

BLIGH, Amanda, Department of Geology, Colby College, Waterville, ME 04901

There are two major Mg-rich lithologies, peridotites and norites, present in the Black Narrows section of the Moxie Pluton, located in west-central Maine. The peridotites have high sulfide concentrations and are primarily composed of serpentine, olivine, and muscovite. The norites are primarily composed of plagioclase and serpentine. Geochemical data suggest there are significant changes in FeO and CaO in the pyroxenes and hornblendes between the peridotites and norites. Field evidence reveals an undulating contact between the norite and peridotite at Black Narrows.

There are different proposed theories regarding the emplacement of the Moxie Pluton, such as a single intrusion, 2 magma pulses, and a multiple injection model. A segregation of mafic zones within the pluton can be explained by lateral mixing, double-diffusive convection, bottom growth, or lateral accretion of layers. Differing sulfide concentrations within the peridotites can be explained by theories of batch separation and fractional segregation. Black Narrows seems to be in best agreement with the two magma model which explains the two predominant Fe and Mg phases in the area. Within this 2 magma emplacement theory, lateral mixing seems to best explain the differentiation between the Fe and Mg rich rocks while fractional segregation best explains the differentiation between the siliceous and sulfide-rich rocks.

HOLOCENE CLIMATE RECONSTRUCTION USING HYDROLOGIC CHANGES AT HATCH POND, MAINE, USA

Brown, Riley; Almquist-Jacobson, Heather; Department of Geological sciences; Sanger, David; Department of Anthropology, University of Maine, Orono, Maine 044691

Hatch Pond is a small kettle lake, formed in an ice-block depression within an esker complex, and sealed by marine sediment deposited between 14,000 and 12,000 ybp. Eight sediment cores were taken along a transect from shallow to deep water. Changes in sediment type, including total organic content, inorganic grain size, and plant macrofossil content, represent chances in water depth. The timing of those fluctuations is determined by radiocarbon dating, while the rates of lake level changes are established by comparing multiple cores.

From at least 5,000 ybp to 2,500 ybp, lake level was rising. That rise was relatively rapid from at least 5,000 to 4,500 ybp and from at least 3,000 to 2,500 ybp. Reconstructing past lake level changes is a direct way of measuring past climate changes in terrestrial systems. Once we know the rates and magnitudes of the hydrologic changes at Hatch Pond, we may then assess the variability and sensitivity of the environment in central Maine.

THE SCHOODIC POINT DIKE SWARM: A PETROGRAPHIC AND STRUCTURAL STUDY OF DIKE EMPLACEMENT.

BUTTON, L.J., GIBSON, D. and DALRYMPLE, L.: Dept of Natural Sciences, University of Maine at Farmington, Farmington, Maine 04938.

Recent studies concerning models for dike emplacement have emphasized the role of existing structural features within the country rocks and, using magmatic flow indicators, have argued for lateral as well as vertical emplacement, (Philpotts and Asher, 1994). At Schoodic Point on the Maine coast numerous basic dikes intrude the Devonian Gouldsboro granite. The excellent shoreline exposure (and hence lateral and vertical continuity) along with the nature of the host rock make this a superb field area to investigate these emplacement models.

To date over 40 dikes have been mapped along the southern part of schoodic peninsula. On the basis of their orientation, composition, texture, and size they are subdivided Into two main varieties designated Types I and II. Type I dikes are equigranular, medium to coarser grained diabase, often displaying fine grained chilled margins. They are the largest Intrusions of the dike swarm, averaging 8 *m* but commonly up to 20 m across, and generally trend NNE-SSW. Type II dikes are aphyric basalts which have thin quenched margins with the granite country rocks. They range in size from thin veins (5 cm) to 4 *m* but are commonly less than I m thick. Type II dikes generally trend N-S and cross-cutting relationships clearly show them to be younger than Type I diabase dikes.

Preliminary investigations of the joint pattern in the Field area have revealed three main orientations 1) an ENE-WSW trend, 2) a N-S trend, coincident with the younger Type II basaltic dikes and 3) a NW-SE trend which cuts both the dikes and their granitic host. Therefore it appears that the dikes have been intruded along and utilized some preexisting fractures In the granite. However flow indicators examined to date reveal ambiguous evidence as to whether this injection occurred laterally or vertically.

SEISMIC-REFRACTION ANALYSIS OF THE THOMAS BAY PALEOCHANNEL, BRUNSWICK, MAINE

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Thomas Bay, a small estuary in east Brunswick, Maine, occupies a SSE-trending valley excavated parallel to the regional strike of metamorphic bedrock. The northward continuation of this bedrock-bounded valley is occupied by a portion of the Brunswick sand plain, interpreted by Weddle (I 994) as a coastal braid delta constructed by the late- or post-glacial Androscoggin River during regression from the deglacial marine limit. At the time of deposition of the sand plain, the Thomas Bay valley conveyed at least a portion of the Kennebec River drainage to Casco Bay. The Kennebec now joins with the Androscoggin River to form Merrymeeting Bay which exists into Casco Bay through the Chops, a narrow valley cut across bedrock strike about 15km to the northeast.

This study is a seismic-refraction investigation of the Thomas Bay paleochannel, focusing upon the configuration of bedrock beneath the sand-plain surface. Using a twelve-channel seismograph system, five seismic-refraction lines were run perpendicularly across the former channel. Preliminary analysis of the seismic data indicates variable depth to bedrock, locally as much as 25 meters. Well data will be used to confirm some of the seismic measurements and to provide additional constraints upon the bedrock surface.

POST-GLACIAL HISTORY OF DAMARISCOTTA LAKE, MID-COAST MAINE

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Damariscotta Lake occupies a 14-km elongate basin running NNE-SSW, roughly parallel to the strike of the metamorphic bedrock in mid-coast Maine. Because of isostatic effects associated with the Laurentide Ice Sheet, the coast of Maine experienced both an episode of coastal transgression and later regression following glacial retreat. The present elevation of the lake surface, 16.5 meters, lies well below the deglacial marine limit of 80 m in this area. This study examines the post-glacial history of Damariscotta Lake, focusing on the marine-lacustrine transition associated with the emergence of the land and possible fluctuations in lake level associated with post-glacial climatic change.

The project includes a seismic-reflection study utilizing a 3.5-kHz sub-bottom profiler linked to GPS navigation. The sub-bottom records show great variation in sediment thickness over an irregular bedrock basement. Typical seismic units range from acoustically transparent to strongly layered. In the latter units, layers may be horizontal, inclined, or draped. The seismic record is interrupted beneath deep subbasins by 'gas wipeouts' associated with the production of methane gas in organic Holocene lacustrine mud.

Seismic records are correlated with sediment cores collected over the winter by means of a Nesje percussion sampler. Variations in grain size, magnetic susceptibility, and organic content form the basis for interpreting depositional changes and their environmental and climatic controls.

AN N MANAGEMENT PROGRAM FOR CORN: ADVANCES IN MAINE

DALRYMPLE, Lisa M., Department of Natural Sciences, University of Maine at Farmington, 39 High Street, Farmington, ME, 04938, ldalry31@maine.maine.edu; FRANCOEUR, Danel S., Department of Natural Sciences, University of Maine at Farmington, 39 High Street, Farmington, ME 04938; MOROCCO, Martin T., Department of Natural Sciences, University of Maine at Farmington, 39 High Street, Farmington, ME 04938, torrymCmaina.maine.odu.

Over application of nitrate-nitrogen (N) based fertilizer to agricultural fields is a major source of groundwater contamination. To reduce groundwater contamination due to N runoff, efforts to improve the manner in which N forblizers are applied to corn fields have been developed. Since farmer profit was a major consideration,. the focus of these 'N managament programs is to determine the minimum N level in soil that would produce a maximum corn yield. Binford (1992) has shown that an early spring soil N test is a reliable indicator as to the fertilizer needs of the field. The results of the soil N tests provide the 'N status' of the field to the farmer.

The late spring soil test, however, cannot solve all N management problems. For example, the guidelines for N application based on the Soil test were developed in states that have very different soil types than are found In Maine. Since type is a major factor In N availability to plants, an N recommendation based only. on the soil test may be inaccurate for farmers in Maine. The availability of N in the soil can be assessed by measuring the N content of the corn stalk at the and of the growing season.

Seventy-five corn fields were studied in Franklin County, Maine. Soil N tests were conducted in the early spring, and stalk N tests were carried out at or near harvest time. In both cases, nitrate-nitrogen content was determined potentiometrically. Relationships between these two values will be presented, and examined In terms of soil type and crop yield.

PEAT ARCHIVES OF ATMOSPHERIC DEPOSITION OF HG - DO THEY WORK?

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In 1983, two peat cores were taken from a hummock of ombratrophic Big Heath, Mt. Desert Island, Acadia National Park, Maine, USA. Each core was analyzed for concentrations of Hg and ^{210}Pb, for calculation of the accumulation rate of Hg. Both hummock cores had integrated anthropogenic Hg accumulations (ΣHg_{anthro}) of 130 *ng/cm²* with a background (pre-1880) accumulation rate of about 3 ng/cm2/yr (Norton et al., in press). Accumulation rates began to increase about 1900, increased sharply after 1950, reached a maximum at 1970 (ca. 20 ng Hg/cm2/yr), and decreased to near background concentrations by 1980.

An additional peat core was taken from a nearby hummock of the same peat bog in July, 1996. The purpose of this study was to re-examine the pronounced chemical stratigraphy of Hg deposition to test the assumption that Hg is not mobile in peat environments. This core was analyzed for Hg concentration and 21OPb in order to compare the accumulation rates of the 1996 core to those of 1983, especially the 1970 peak. The 1996 core has Hg concentrations (ng Hg/g peat) that are 20 to 35% of the cores from 1983. Both 1983 cores reached background concentrations of Hg by 45 cm whereas the 1996 core had not reached background by 60 cm. This suggests that the hummock of the 1996 core must have had a substantially higher growth rate, and subsequent net peat accumulation rate, than the hummock of the 1983 coring site. The ΣHg_{anthro} in the 1996 core to 60 cm was 154 Hg/cm², consistent with the additional thirteen years since the 1983 cores.

INTEGRATING GEOPHYSICAL MAGNETIC SURVEYS AND SOIL ANALYZES TO DECIPHER MAGNETIC ANOMALIES ON THE OAK RIDGE RESERVATION, TENNESSEE.

Drasdis, John B. Dept. Of Geosciences, University of Southern Maine, Gorham, ME 04038

Airborne magnetic data from the Oak Ridge Reservation (ORR), revealed numerous magnetic anomalies in undisturbed areas, stimulating interest in characterizing possible anomalous sources. The geology of ORR has been well mapped, and the predominantly dolomitic rocks show no signs of magnetic susceptibility. An interest in the unknown anomalous source is warranted since certain areas of reservation are waste disposal areas, and hence pose a potential environmental hazard.

Ground magnetic profiling has confirmed the existence of anomalies in the airborne data, excluding: I)the possibility of false anomalies responses in the airborne survey, and 2) unnatural metallic objects causing the magnetic responses from the surface, pointing at the in situ geology as causing the magnetic responses.

Soil samples were extracted from cores both inside and outside of the mapped anomalies. The samples were fractionated using sieve analyzes, and both physically and chemically separated to extract the magnetic minerals. Soil particles were randomly analyzed using X-ray diffraction to obtain soil mineralogy. This analysis revealed that maghemite was found In all the samples, yet susceptibility measurements from inside the anomalies were approximately four times as large as susceptibility readings outside of the observed anomaly.

It was concluded that the majority of airborne anomalies were either a product of increased concentrations of magnetic minerals in soils overlying the bedrock, or a localized increase of soil thickness, and thus, pose no environmental hazard.

COMPARISON OF HG FLUXES AND TOTAL ANTHROPOGENIC BURDENS DERIVED FROM SEDIMENT CORES FROM EIGHT PONDS IN MAINE

EVANS, Gordon C., Department of Geological Sciences, University of Maine, 5711 Boardman Hall, Room 119, Orono, Maine 04469-5711, GEVANS51@Maine.Maine.Edu

New and archived lake sediment cores from Maine lakes were analyzed to evaluate the total accumulation and accumulation rates of Hg during the last 200 years. One core was taken from Bracy, Crystal, Dream, Hodgdon, Klondike, Mud, Sargent Mountain, and Speck Ponds during the period 1978 to 1996 in a variety of hydrologic settings across Maine. All but Bracy and Crystal were dated using ^{210}Pb profiles; others were assigned calendar year ages based upon interpretation of total Pb analyses and the known Pb pollution history for Maine. Intervals from each core were processed and analyzed by cold-vapor atomic fluorescence for total Hg. Accumulation rates vs. calendar age were plotted for each location. Five of the cores show good agreement in terms of Hg accumulation trends and timing. Three of the cores deviate from these general trends and timing due to dating errors, water level disturbances, bioturbation, or extremely low sedimentation rates. Peak anthropogenic accumulation rates range from 2 to 20 ng/cm²/yr, and total anthropogenic burdens range from 35 to 269 ng/cm².

The data indicate that atmospheric deposition (net flux to lake sediments?) of Hg began increasing by approximately 1900 in Maine and peaked around 1970 to 1980. Fluxes increased in some lakes by as much as 10 times background. Accumulation rates of Hg have declined since 1980 in most lakes. These trends parallel those from ombrogenic peat cores from Acadia National Park, Maine.

Beach Profile Dynamics at Popham Beach, Phippsburg, Maine

Gimpel, Robert W. Department of Geology, Colby College, Waterville ME 04901-8858

Popham Beach is on the West bank of the Kennebec River as it outlets to the Atlantic Ocean in Phippsburg, Maine. Beach sediments are transported by the river's flow and by wave-activated longshore transport. To understand the effects of these forces and how they change with time, normal transects of the beach are being surveyed.

Five stations were created along the length of the beach. Each station was marked with a stake placed at the dune vegetation line. On approximately a weekly basis, transects are surveyed at at each station and at a set compass reading perpendicular to the length of the beach. Surveyed distance and elevation data are plotted to create a profile, which is compared from week to week for each station, and evaluated with respect to tidal and weather conditions.

Although this research is ongoing, preliminary analysis of profiles has shown a small increase in berm elevation (1-2 ft.) and a large increase in beach length (3 to 4 times longer) towards the southern end of the beach. The slope of the beach face decreases towards the southern end. The berm is generally small, but is becoming larger and higher as the system changes from a winter to a summer profile. After a significant storm that occured at high tide, there was significant deposition along the north end of the beach, and erosion along the middle section.

STRATIGRAPHY AND DUCTILE DEFORMATION OF THE GREAT GULF, PRESIDENTIAL RANGE, NEW HAMPSHIRE

GUZOFSKI CHRIS, and EUSDEN, J. Dykstra; Dept. of Geology, Bates College, Lewiston, ME, 04240, cguzofsk@abacus.bates.edu, deusden@abacus.bates.edu.

The bedrock geology of the Great Gulf region of the Presidential Range, New Hampshire, was mapped as part of an on-going study aimed at redefining the bedrock geology of the Presidential Range, The metasedimentary rocks that were mapped lie within the Central Maine Terrane, a belt of polydeformed and metamorphosed Silurian-Devonian metasedimentary rocks..

Four metasedimentary formations have been mapped in the region, These include, from oldest to youngest, the Silurian (?) Rangeley, Smalls Falls, and Madrid Formations, as well as the Devonian (?) Littleton Formation. Within the study area three sub-members of the Rangeley Formation were mapped; a migmatitic gneiss, a calc-silicate with granofels, and a rusty schist. The Smalls Falls Formation consists of a rusty, sulfidic schist. The Madrid Formation conrists of biotite and calc-silicate granofels. The Littieton Formation consists of interbedded schists and quartzites which have been subdivided into 14 members and 2 submembers based upon differences in the bedding style of the schist and quartzite.

Within, the Great Gulf, four major phases of ductile folding as well as one phase of thrust faulting have been preserved. The first phase of folding is characterized by isoclinal nappe folds (Fl) with a pervasive axial planar schistosity (Sl). These folds occur as macroscopic fold hinges throughout the Great Gulf , but are also preserved as mesoscopic folds in the lower altitudes of the Great Gulf. The Greenough Spring thrust fault thrusted the Rangeley Formation upon the Littleton Formation as the next phase of deformation. This thrusted block is now exposed as the Clay Klippe. The second phase of folding his been characterized by large scale warps (F2) which deform earlier structures. The macroscale F2 folds that have been mapped within the study area are; The Horn anticline, Lowes Bald Spot syncline, and multiple un-named F2 folds within the Clay Klippe and Spaulding Lake area. The third phase of folding is the most pervasive within the Great Gulf. This phase has been characterized by asymmetrical, east-verging mesoscopic folds (F3) throughout the Great Gulf and a distinct crenulation within the lower elevations of the Great Gulf. The fourth and final phase of folding is limited to the lower elevations of the Great Gulf. This phase has been characterized by upright to inclined east striking mesoscopic and macroscopic folds as well as a pervasive crenulation (F4). This phase of folding has not been identified within the higher elevations of the Great Gulf and is believed to die out.

The mapping of the Devonian-Silurian boundary in the lower elevations of the Great Gulf suggests the presence of a conformable contact, rather than a thrust fault as has been previously interpreted. Also changes in the characteristics of Fl and F3 suggest the existence of a significant vertical variation In ductile deformation in the Presidential Range. Characteristics of this vertical variation include an increase in ductility in the lower elevations of tlxe Great Gulf and an Increase in metamorphic grade in lower elevations of the Great Gulf.

THE INFLUENCE OF SEAMOUNTS ON THE GLACIAL-AGE DRIFT SEDIMENTATION; NORTHERN BERMUDA RISE

HELMRATH, Erika K., Geology Dept., Bowdoin College, 664 Smith Union, Brunswick, Maine 04011, ehelmrat@bowdoin.eduThe patterns of sedimentation, as revealed by 3.5 kHz echograms and seismic reflection profiles, suggest that the seamounts, both single and multiple, on the Eastward Scarp of the northern Bermuda Rise, may exert an influence on the deposition and erosion of the glacial-age hemi-pelagic lutites. On the Eastward Scarp, Wyoming Seamount appears to focus erosion and deposition from westward flowing bottom currents. A complex pattern of deposition of sediments within and adjacent to the New England Seamounts suggest that these features may have an influence on the deposition from both bottom currents and perhaps turbidity currents

LATE QUATERNARY RELATIVE SEA LEVEL CHANGE IN THE BASIN, PHIPPSBURG, MAINE.

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Sediments contained in coastal inlets and lake basins in Maine can provide continuous records of glacial and post-glacial sedimentation since the last glaciation of the coastal zone. By examining these sedimentary records, it is possible to reconstruct past environmental conditions, including postgolacial sea level change. This thesis examines the stratigraphic record of The Basin, Phippsburg, Maine in order to gain insight into the late Quaternary (ca. 14,000 yr B.P. - present) geological history of the area.

The stratioraphy is investigated by using acoustic seismic profiles and two sediment cores obtained from the inlet. The stratigraphy observed shows a record of transition from glacial to glaciomarine, to Holocene lacustrine and terrestrial, to late Holocene marine sedimentation. Radiocarbon dates taken from a Holocene organic rich terrestrial deposit and a Holocene marine shell hash layer helped in the interpretation of the timing of the observed stratigraphy. A late Quaternary geologic history of The Basin is proposed by incorporated acoustic stratigraphic units observed, lithofacies observed in sediment cores, radiocarbon dates taken from sedimentary lithofacies, and previous published theories, primarily relative sea level curves.

The Basin was covered by the Laurentide Ice Sheet during the glacial maximum (ca. 15,000 yr B.P. to 14,000 yr B.P.). As the ice sheet retreated and the sea transgressed over the isostatically depressed landscape (ca. 14,000 yr B.P. to 11,600 yr B.P.), glaciomarine sediments were deposited in the submerged inlet. During the lowstand (ca. 11,600 yr B.P. to 5,400 yr B.P.), The Basin's threshold to the sea was above sea level. A lake formed in the exposed inlet, and an organic-rich deposit formed on the subareally exposed glaciomarine sediment. As global eustacy initiated the second marine transgression, marine waters once again entered The Basin (ca. 5,,400 yr B.P.). Relative sea level has continued to rise to present day.

THE UTILITY OF EARTH TIDES FOR EVALUATING PHYSICAL PARAMETERS OF FRACTURED BEDROCK AQUIFERS

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Earth tides are the cause of ground water level fluctuations induced by lunar forces. These lunar forces bring about sinusoidal fluctuations in ground water levels which can provide both qualitative and quantitative information about the physical parameters of the aquifer. These parameters include specific storage, porosity, transmissivity, compressibility and hydraulic conductivity. Earth Tides also have a variety of applications outside of aquifer analysis in hydrology. Seismologists, for example, are investigating Earth Tides as a means of predicting earthquakes.

We have applied Earth Tide theory to an aquifer in Waterville, Maine, in order to evaluate certain physical parameters of the aquifer. Ground-water level fluctuations in the deep piezometer of the deep-shallow nest, which is installed into vertically fractured metapelitic bedrock, display a periodicity attributed to Earth Tides. Fluctuations appear on hydrographs as sinusoidal wave-forms with a period of 12.5 hours and a magnitude of fluctuation in head of approximately 0.03m. There exists an inverse relationship between the oceanic tidal fluctuations in Bath, Maine and the corresponding ground-water fluctuations in the aquifer. We plan to use these Earth Tides to evaluate physical parameters of the aquifer including compressibility, specific storage, and hydraulic conductivity.

STRATIGRAPHY AND GEOMORPHOLOGY OF
THE GLACIAL OUTWASH AND MODERN SONGO RIVER DELTAS,
SEBAGO LAKE STATE PARK, MAINE

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Sebago Lake State Park is located at the northern end of Sebago Lake, which is 32 km northwest of Portland, Maine. The Songo River valley has been the major inlet to the lake since deglaciation of the area at approximately 13,000 years BP. Stream terraces produced by channel incision into the glacial outwash delta are approximately three m above the river at the head of the Songo, 2.2 km north of the lake, and grade to lake level of 81.4 m above MSL. These late Pleistocene/Holocene fluvial terraces display medium-grained, cross-bedded sand deposits. Fluvially reworked material has been deposited to form low-lying islands of the floodplain in the Songo River.

Ground penetrating radar (GPR) and seismic reflection profiling, were employed to provide stratigraphic and geomorphic data from the glacial outwash and active deltas. Four kilometers of GPR lines were collected from the main roads in the state park, and 18 km of seismic reflection track lines were run over and around the modern river delta. Pre-existing bedrock well logs and new drilling logs from the glacial outwash delta support interpretations from correlative sections of GPR. Bathymetric and bedrock surface contours of seismic data, as well as isopach construction, indicate that sedimentation of the glacial outwash delta was bedrock controlled. Seismic profiles also show that the modern Songo River delta is built on top of the glacial outwash deltaic bottomset beds. A model is presented to reconstruct a sequence of major events that produced the geomorphological features seen today.

SHORELINE FEATURES AT THE UPPER MARINE LIMIT IN HANCOCK COUNTY, MAINE: IMPLICATIONS FOR THE BEHAVIOR OF LATE PLEISTOCENE RELATIVE SEA LEVEL

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The late-glacial marine submergence of coastal Maine reached its maximum height above present sea level sometime between 14,000 and 13,000 B. P. as the ice margin retreated across this area. This maximum height of sea level during ice retreat is defined as the upper marine limit. The upper marine limit is known mainly from the elevations of topset-foreset contacts in ice contact deltas that formed during this ice retreat. The highest shoreline features such as wave-cut bluffs, wave-washed bedrock, boulder lags, and sand and gravel terraces provide an independent measure of the upper marine limit and point to the behavior of relative sea level at this time. The upper most shoreline features concurrent with the topset-foreset elevations of the deltas in Hancock County suggest that a stillstand of relative sea level occurred during the formation of the deltas. Subaerial features such as meltwater channels and kettles preserved on the delta surfaces indicate that the deltas were never overtopped by sea level once the deltas formed.

GEOLOGIC EVIDENCE FOR A RELATION BETWEEN FAULT SCARP WIDTH AND ACTIVE CREEP ZONE WIDTH ON THE CALAVERAS FAULT IN HOLLISTER, CALIFORNIA.

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The city of Hollister, California is built across the Calaveras Fault, an aseismic dextral fault in the San Andreas Fault System, approximately 125 kilometers southeast of San Francisco. The ground surface of the study area is paved and underlain by Quaternary alluvium above a thick sequence of older Cenozoic marine and non-marine sediments. Topographic profiles were constructed to determine relations between fault scarp parameters and creep zone dimensions. Active creep was defined as the area in which visible displacement of structures occurred; passive creep was defined as the outer limits of jointing occurring parallel to the fault. Active creep zone width ranged from 0 to 3.2 meters; scarp width ranged from 0 (not-detectable) to 163.1 meters. A strong positive relationship between fault scarp width (X) and active creep zone width (Y) was determined:

$$y = 0.2321x - 33.936$$

$$R^2 = 0.9479$$

This relationship can be used to estimate active creep zone width in areas where the active creep zone can not directly be observed. Special thanks are extended to Peter Anderson of Pacific Geotechnical Engineers for overseeing this project.

The Thickness and Character of Unconsolidated Sediments in Waterville, Maine

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Information on unconsolidated material is useful in municipal planning for placement of wells, underground storage tanks, buildings, pipelines & roads. We are compiling data on the thickness and nature of unconsolidated sediments in Waterville, Maine, and are analyzing these data relative to land-use planning and historical interpretation. Primary objectives of this research are the generation of a large-scale isopach map of unconsolidated material (1:12,000) and interpretive geologic cross-sections.

Sediment types and thicknesses are being determined from boring logs, wells, and bedrock outcrops; this information was found in publications, unpublished governmental data and by field reconnaissance. At most sites, Waterville Fm. metasediments are overlain by till or outwash, then Presumpscot Fm. silts and clays, and lastly by Embden Fm. or fluvial sands. Bedrock is exposed consistently along the bank of the Kennebec River and randomly throughout the rest of the area. Areas of thick overburden (>30 ft.) occur along North Street from the Messalonskee Bridge to Gilman Street, and in the vicinity of Pine Grove Cemetery.

Upon its completion, this project should provide a clear picture of the nature and thickness of the unconsolidated sediments in Waterville, Maine, that will be useful in environmental management and land-use planning, as well as in understanding the late Quaternary geologic history of this area.

TIMING OF METAMORPHISM AND DEFORMATION IN THE PRESIDENTIAL RANGE, NH, BASED ON NEW U-PB AGES

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The Presidential Range, NH, is made up of Silurian and Devonian metasedimentary rocks. These rocks have been affected by four phases of deformation (three of folding and one phrase of thrust faulting) and five phases of metamorphism all related to the Acadian Orogeny. M_1 and M_2 are both syn-tectonic in nature, related to D_1 and D_2, and are andalusite and silliminite grade respectively. M3 and M4 are two phases of staurolite grade contact metamorphism which bracket D4, M5, is a regional chlorite and sericite grade retrograde Metamorphism.

U-Pb age dates were obtained for several igneous intrusions which included the Peabody granite, the bigolow Lawn granite, the Bickford granite, and the Wamsutta diorite. Two metamorphic rocks were dated including a schist from the Littleton Formation and a gneiss from the Rangely Formation. Monazites extracted from the metamorphic rocks were used to date the timing of peak metamorphism and migmatization within the Presidential Range. Monazites and zircons were used to date the timing of the various intrusive events that effected the study area. Four phases of intrusional events are currently recognized: an early Spaulding-type diorite intrusion, and three later granite intrusional events. The plutons are bracketed by deformational events and provide constraints on the timing of pre- and post-intrusion phases of folding in the Presidential Range.

Ages indicate the initial phase of folding and metamorphism (DI, MI) occurred somewhere between 418Ma to 408Ma (age of diorite intrusion).Peak of metamorphism (M2)occurred from roughly 405-402 Ma , and coincided with one phase of granite emplacement (ages from the Littleton schist, Rangely gneiss, Bigolow Lawn granite, and Bickford Granite). M3 occurred ~394 Ma (age from the Littleton schist). M4 occurred ~355 Ma and coincided with the intrusion of the Peabody Granite.

RECESSION RATES OF TILL BLUFFS, SEBAGO LAKE, MAINE

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Sebago Lake is a 12-km-diameter lake in southwestern Maine excavated in granitic rocks of the Sebago pluton. The lake is lined in places by actively eroding bluffs comprised of till of late Wisconsinan age. Anecdotal reports of increasing recession rates of the bluffs have generally been correlated with increased lake levels over the last few decades. Measures to slow the rate of bluff retreat, including sea walls, breakwaters, and rip-rap, have been largely unsuccessful. Sand beaches around Sebago Lake have also been significantly reduced by the higher water levels.

This study examines the relationship between increasing lake level and recession rates of the bluffs. Six study sites were selected around the lake, representing different combinations of exposure to dominant wind directions, fetch, vegetation cover and apparent rate of toe erosion. At four sites, bluffs range from 10 to 15 meters high, while two sites show heights of approximately 5 to 9 meters. Bluff material is fairly consistent at all sites, comprising unconsolidated sandy till. Erosion processes that have been identified are slumping, toppling, and undercutting of the bluffs at the toe. Undercutting is associated with more vegetated slopes. Slumping has been observed at all sites.

Bluff profiles taken with a total station at four week intervals, and erosion pins were used to monitor bluff retreat. Rates of recession have not been uniform among sites in the short term, suggesting the variable influence of vegetation and facing direction. Longer-term monitoring is required to determine seasonal patterns of bluff erosion, as well as multi-year trends.

SUBGLACIAL FORMATION AND POST-GLACIAL MODIFICATION OF GULF HAGAS GORGE, CENTRAL MAINE

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Gulf Hagas gorge is a narrow bedrock canyon that cuts southeastward across the strike of the near-vertically dipping beds of the Devonian Carrabasset Formation. The gorge contains the West Branch of the Pleasant River which, confined by shear bedrock walls up to 400 feet high, drops over 400 vertical feet in approximately four miles. Gulf Hagas gorge was apparently initiated by meltwater erosion during the last glaciation. Since ice retreat, the West Branch has continued to modify the gorge to its present condition. This study uses modeling techniques and field investigations to elaborate the glacial and postglacial history of Gulf Hagas Gorge.

A Geographical information system (GIS) and digital elevation data are being used to model the hydraulic potential underneath the Laurentide Ice Sheet in the Gulf Hagas region. Creation of the deep, narrow gorge likely reflects (1) the ability of the southeast-sloping ice surface to drive subglacial meltwater up and over a low NE-SW divide at the gorge location, (2) lateral focusing of subglacial flow by the 2300- to 3500-foot peaks in the region, and (3) the nearly vertical dips of the local bedrock, which favored vertical rather than lateral erosion.

After the initial formation, post-glacial processes have continued to sculpt and rework the gorge to its present condition. A 900-m longitudinal profile in the lower gorge reveals that steep stream segments, characterized by cascades and short rapids, form in reaches tightly confined by bedrock walls. Maximum constriction is usually associated with the formation of deep scour pools and the introduction of very coarse clasts from the valley walls. Less-confined reaches are characterized by gentler slopes, a higher proportion of riffles, and generally smaller clast sizes. Paleohydraulic conditions associated with large floods are being modeled using the HEC-RAS step-backwater method. In the absence of reliable paleostage indicators, estimates of peak discharge are derived from a regional analysis of maximum historical flood as a function of drainage-basin area.

HIGH-RESOLUTION MAGNETIC SURVEY TO INVESTIGATE THE SPILLER FARM PALEOINDIAN SITE IN WELLS, MAINE

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The Spiller Farm Archeological Site in Wells, Maine is a paleoindian site of approximately 2000 m^2 area, upon which multiple clusters of stone tools have been found. Evidence exists that the site may contain one or more paleohearths which were used for heat treatment of stone tools, cremation of human remains, and/or for cooking of food over long periods. Heat treatment of cherts was performed for enhancing the quality of the material for flaking. Due to these long-term, high temperature heat-treatment activities, remanent magnetization of sediments may have been affected in these hearth areas. Therefore, a high-resolution ground magnetics survey was performed to locate these features. Hearth areas are of significant interest for archeological excavation due to the types of activities performed at these locations and the subsequent deposition of artifacts.

The ground magnetics survey resulted in three discernable anomalous magnetic field trends. Two of these anomalies are of the order of magnitude expected for disturbances in the remanant magnetic field of sediments which could be caused by high temperature heat-treatment activities, such as hearths. The other anomaly has an anomaly shape indicative of a surficial, or near-surface ferro-magnetic object, such as a piece of steel.

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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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THE MAINE GEOLOGIST is published three times a year, in early fall, mid-winter, and summer, for members of the Geological Society of Maine.

Correspondence about membership in the Society should be mailed to Martin Yates, Department of Geological Sciences, 5711 Boardman Hall, University of Maine, Orono, Maine 04469.

Items for inclusion in the newsletter may be directed to Susan Weddle, 11 Beech Drive, Brunswick, ME 04011.