The Maine Geologist

June 1994

Newsletter of the Geological Society of Maine

Vol. 20, No. 2

PRESIDENT'S MESSAGE

by

Steve Pinette

The month of April was a busy one for the Society. On April 8th we held our Spring Meeting and on April 15 we held our fifth annual Distinguished Lecture/Short Course titled Satellite-based Remote Sensing for Geologists. I want to thank Dr. Dyke Eusden and the Bates Geology Department students and faculty for soliciting student presenters and for hosting and organizing the meeting. Dyke, dinner was delicious. All of us appreciated the effort that the students devoted to their quality presentations. I want to thank Dr. Ina Alterman from the National Academy of Sciences for coming to Maine to present her evening talk on "Advocacy of Science and the Public Trust".

Our short course was also a success despite the relatively low attendance (~30). Dr. Benoit Rivard blended keen geologic insight and remote-sensing high-technology to deliver a very informative program. Thank you, Dr. Rivard, for traveling from Canada to teach your short course. I also want to thank Dr. Michael Collins for assisting with the course. Dr. Irwin Novak and the University of Southern Maine Geology Department deserve special thanks for hosting the short course.

Does Maine need its own Academy of Sciences, Engineering, and Medicine to conduct investigations on the public's behalf and to weigh in on the side of credible science as a basis for public policy? After listening to Dr. Alterman discuss the role of the National Academy of Sciences and the types of studies that it conducts in the public interest, I believe the answer is yes. Such a group could evaluate the merits of major public policy issues whose basis is science, engineering, or medicine and produce objective conclusions unfettered by the influence of policy-makers, special interests or bureaucrats. Debates on technically complex issues such as the environmental impacts of metallic mining, the environmental benefits of paper versus plastic bags, dioxin impacts to the surface water ecosystem, disposal of low-level radioactive wastes, and state environmental priorities confuse the public and highlight the need for a Maine Academy of Sciences, Engineering and Medicine. The general public is ill-equipped to deal with some of these complex issues and they generally put little credence in the pronouncements of bureaucrats and special interest lobbyists and their paid consultants. If a formal Academy is not possible, the State needs at least a non-profit mediation group to explore the common ground among the various groups participating in debates on these major issues. I wonder if the Society should explore these ideas further at one of our future business meetings.

GEOLOGICAL SOCIETY OF MAINE 1994 SUMMER FIELD TRIP

Saturday, July 30

Dr. Joseph Kelley, Maine Geological Survey

"Sand dynamics and engineering structures in Saco and Wells Bays, southwestern Maine"

Meeting Place: 9 a.m. at the Fisherman's Co-op at Pine Point, Scarborough

Sunday, July 31

Dr. Arthur Hussey, Bowdoin College

"Geology of the Coastal Lithotectonic Belt - southwestern Maine"

Meeting Place: 9 a.m. at Two Lights State Park, Cape Elizabeth.

Camping is available at Sebago Lake State Park, New Place Group Campsite, on Friday and Saturday Nights, with a cookout on Saturday evening. For camping and cookout reservations, please contact Bob Johnston at 287-2801 or Jim Hillier at 685-6138.

1994 NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

The annual meeting of the New England Intercollegiate Geological Conference will be based in the Millinocket region of Maine this fall, September 23 - 25, hosted by Salem State College and Boston University. Detailed announcements can be obtained from Lindley Hanson, Department of Geological Sciences, Salem State College, Salem, Massachusetts 01970. Trips will include glacial geology in the Penobscot River valley and Mt. Katahdin, numerous bedrock geology trips through the Paleozoic sedimentary and igneous sequence and structural geology of the region, as well as the archeology of the area.

CALL FOR PAPERS SEISMIC DESIGN IN THE STATE OF MAINE

The Maine Section of the American Society of Civil Engineers announces a one-day technical seminar to be held in Augusta, Maine on Wednesday, March 15, 1995, entitiled *"Seismic Design in the State of Maine: Current practice, future practice, and public perception."* This seminar will address topics relative to seismic design considerations in the practice of civil engineering in the State of Maine. Public, private, legislative, and professional concern for seismic risk varies throughout the State. The seminar intends to reduce this variability through a discussion of local seismic history, risk, current design practice, and evolving practice. The discussions will be tailored to address design of landfills, embankments, lifeline facilities, water and wastewater treatment facilities, building structures, and dams.

Abstracts are due on or before September 15, 1994. Abstracts should be no longer than one typewritten page. Four copies of the abstract should be sent to Mr. Michael Moreau, Robert G. Gerber, Inc., 17 West Street, Freeport, ME 04052. Upon review, authors will be invited to submit papers approximately 10 pages in length.

GSM SPRING MEETING MINUTES APRIL 8, 1993

submitted by
Marita Bryant

The business meeting began with the reading of the Treasurer's report, which appears in full elsewhere in this newsletter. The remainder of the meeting consisted of the following announcements and requests:

1.) Ollie Gates is recovering nicely from surgery. Those wishing to cheer him on may write to Ollie at P.O. Box 234, Wiscasset, ME 04578.

2.) The latest version of the by-laws should be available by late summer. In the future any new policies will be included as appendices.

3.) Bob Johnston is chairing the Nominating Committee and is looking for volunteers for the committee as well as for the offices of president, secretary, and treasurer.

4.) The Society is accepting proposals for a theme and a location for the Fall meeting. Please contact any of the officers with your suggestions. (Don't be shy!)

5.) The Summer Field Trip, to be led by Arthur Hussey and Joe Kelley, will be on July 30 and 31. For more information, contact Jim Hillier or Bob Johnston.

6.) The NEIGC trips will be Sept. 23-25, with headquarters in Millinocket.

7.) The **Geology of Maine** teaching kits will include a poster, four videotapes and a slide set. GSM will pay for assembling the kits and CREST will most likely produce the poster. More geological slides are needed! For details call Patti Millette at the Maine Geological Survey, (207) 287-2801.

The after-dinner speaker was Dr. Ina Alterman, a Senior Staff Officer of the National Research Council/National Academy of Sciences,

a group responsible for the independent investigation of scientific problems at the request of the government. Dr. Alterman discussed "Advocacy Science and the Public Trust".

Her definition of advocacy science included "the misuse of science by playing upon the perceived risk to the public" as practiced by scientists who use the media and politicians as attention-getting agents. The media and politicians, in turn, depend on scientists for information, or misinformation, for their own purposes. Several issues particularly attractive to advocacy science are 1) anything to do with nuclear and radioactive materials, 2) other environmental issues, such as exploitation of old-growth forests, and 3) animal rights and endangered species questions.

Dr. Alterman's experience has been dealing with the first group of issues as coordinator for the geological investigations of two proposed radioactive waste repository-sites. In the 1980's Yucca Mountain in Nevada was recommended for the disposal of high level radioactive waste. Later, Ward Valley, California was targeted for low level waste disposal.

In each case, scientists who questioned the site selection, leaked information to the press that was then presented in such a way as to greatly alarm the public. This led to the NRC involvement. In both instances, the primary task assigned the NRC was to clarify the relationship between the repository and the groundwater system. The NRC panel's investigation of Yucca Mtn., published as **Groundwater at Yucca Mountain: How High Can It Rise?** (1992), discounted earlier claims by J. Szymanski that seismic pumping had caused groundwater to rise to the surface in the recent past, but did not resolve the question of the site's suitability as a repository. The panel recommended a new, large-scale, multidisciplinary study at Yucca Mountain. In answer to the public's concerns about Ward Valley, Dr. Alterman is currently assembling a panel of independent, reputable scientists to examine that site.

SOURCES OF HIGH SALINITY IN MAINE GROUNDWATER

by
Steve Kahl
University of Maine, Orono

Overview. There are three sources of high salinity in Maine groundwater:

1) remnant seawater trapped during Quaternary continental deglaciation,
2) leachate from salt storage facilities (not usually runoff from road salting), and
3) modern seawater intrusion.

The Department of Geological Sciences Environmental Chemistry Laboratory at the University of Maine has evaluated the chemical and isotopic signatures of dozens of high salinity domestic wells in Maine (Snow et al., 1990). The distinguishing factors are:

1) the ratio Cl^-/Br^- is similar to the modern seawater value in remnant or intruded seawater, but is much higher in wells contaminated by road salt leachate,
2) the ratio SO_{4-2}/Cl^- is high in remnant or intruded seawater compared to wells contaminated by road salt leachate, and
3) the concentrations of tritium are low in remnant seawater wells versus seawater intrusion wells or road-salt contaminated wells.

At elevations above the marine submergence limit (80 m in coastal areas to 140 m inland), the source of saline ground water is generally leachate from road salt storage facilities. In areas below the marine limit, but not subject to seawater intrusion into bedrock aquifers, the differentiation of remnant seawater versus road salt in wells can be accomplished using the Br^-/Cl^- and SO_{4-2}/Cl^- criteria *if the laboratory can attain the necessary detection limits.* Determination of tritium concentrations will confirm the road salt versus remnant seawater interpretation, and differentiate between remnant and intrusion seawater.

Background. Some domestic water wells in Maine have elevated concentrations of Na^+ and Cl^-. Contamination from the 700 road salt storage facilities in Maine is commonly the source of the salinity. The state or town responsible for the salt and its application is usually held responsible for remediation, under the assumption that all salt contaminated wells are due to human activities. Resolutions include supplying bottled water, drilling a new well, or providing access to a public water supply. The cost to the local government or state agency is often thousands of dollars per claim.

In some geohydrologic settings in Maine, the saline well water may be from one of two *natural* sources. One obvious possibility is intrusion of modern seawater into bedrock aquifers adjacent to the ocean. This situation may occur seasonally as a result of lowered water tables, or in response to heavy drawdown from area wells. Seawater intrusion into domestic wells in Maine is uncommon.

Trapped fossil seawater is another source of salt contamination (Caswell, 1978; Tepper, 1980; Snow et al., 1990). During the last continental deglaciation 14,000 to 12,000 years ago, the ocean transgressed onto the land to a present elevation of 80 to 140 meters. The dense ocean water presumably displaced freshwater in bedrock aquifers during this period. After land emergence, fresh water gradually replaced saline water in most areas. However, zones of some aquifers are apparently hydrologically stagnant or partly sealed. These aquifers yield water that is more saline than that typically found in Maine today.

A common physical characteristic of areas with remnant seawater is topographic depression. Many of the known remnant-seawater wells are near lakes, or in local bedrock depressions. Presumably dense, high salinity seawater settled in the depressions during and after marine submergence, recharging underlying bedrock aquifers. Fine grained sediments deposited in the deeper water of the topographic depressions may also retard recharge from the surface. When groundwater circulation is locally very slow, modern withdrawals may be saline because the remnant seawater has been diluted rather than replaced.

Some previously potable wells have become increasingly saline over time, usually interpreted to be due to a human source. However, it is clearly feasible for drawdown to begin tapping nearby remnant saline water after a period of freshwater removal. Because saline water is denser than freshwater, the best remediation for a well contaminated with salt from any source is to drill a *shallower* bedrock well, in contradiction with typical conventional wisdom. If there is adequate water in a local sand and gravel aquifer, remnant salt will not be a problem from this source. Aquifers in surficial materials cannot contain remnant seawater and rarely contain road salt contamination, due to the density of saline water from any source.

Bromide ion is the most useful single chemical indicator of salinity source. Bromide is present in both the remnant-seawater samples and in the seawater-intrusion wells at a Cl^-/Br^- ratio similar to that of modern seawater (about 315:1 in mg/l; about 650:1 in charge equivalents). Furthermore, the road-salt contaminated wells have lower Na^+/Cl^- and SO_{4-2}/Cl^- ratios than the remnant-seawater or seawater-intrusion wells.

Although the chemical signatures of the remnant-seawater and seawater-intrusion wells are similar, radioactive Tritium (T) can differentiate the two sources. Concentrations of T are generally below detection in remnant-seawater wells due to the low initial concentrations, and to short half-life. Low values indicate a lack of significant post-1950 recharge to those wells. High concentrations of T indicate significant modern recharge. However, if drawdown near remnant saline water dilutes the salinity with modern freshwater, detectable concentrations of T may occur even in wells with a 12,000 year-old salt source.

These recent results confirm the conclusions of Tepper (1980) on the sources of salinity in

Maine ground water. The methods developed by Snow et al. (1990) allow a quick and inexpensive evaluation of the source of salinity, helping determine liability prior to remediation. Above the glacial marine limit (locally 80 to 140 meters elevation), the source of saline ground water is probably leachate from a salt storage facility. Below the marine limit, chemical evaluation of the water should be done to determine the salt source. Analysis of anions by a laboratory capable of reporting Br^- and SO_{4-2} to a detection limit of 0.2 mg/l in a saline solution (about 0.02 mg/l in fresh water) will enable determination of salinity sources in a majority of cases. Most laboratories in Maine either do not analyze for both of these analytes, or do not report them to this level of detection.

References:

Caswell W.B., 1978. Maine's inland salt-water wells. Open file report, Maine Geological Survey. 14 p.

Snow, M.S., J.S. Kahl, and S.A. Norton, 1990. Geochemistry of high salinity solutions in Maine surficial and bedrock aquifers. Maine Dept. of Transportation, Technical Services Division, Tech. Rept. 90-1. 23 p.

Tepper, D.H., 1980. Hydrogeologic setting and geochemistry of residual periglacial pleistocene seawater in wells in Maine. MS thesis, University of Maine, Orono. 126 p.

EDUCATION COMMITTEE UPDATE

by

Patti Millette

The Maine's Dynamic Landscape poster is out for review, and the last film, "Discovering Maine's Mineral Resources," is almost finished. I have only received a few slides in reponse to my request in the last newsletter, and would appreciate some assistance from the membership on that. The slides only need to be on loan for a couple of weeks at the most, and they will be returned promptly and in good condition. Thanks! Please send slides to Patti Millette, Maine Geological Survey, State House Station 22, Augusta, ME 04333.

MEDIA RELATIONS FOR SCIENTISTS

by

Nick Houtman
University of Maine, Orono

Scientists and reporters generally work toward the same goal: the truth. Both groups claim to value objectivity and openness. Both collect information and present their findings in a written form.

And there the similarities end. Good science proceeds carefully, meticulously, to minimize bias and to weigh results against the probability of unpredictable chance. Ideally, scientific "facts" arise from measured, verifiable data.

Good reporters can be just as rigorous but often must use a different standard. Deadlines put severe pressures on the level of care or meticulousness a reporter can exercise. Journalistic "facts" are often opinions which, within the bounds of a single story, cannot be verified. Moreover, reporters don't put a lot of stock in mere chance. Not much drama in that. Instead, speculation about cause and effect often gains the same credibility as verifiable observations chronicled through experiments.

As a result, many scientists regard reporters with suspicion and even hostility. Ask any group of a dozen or more scientists about problems with the press, and you will get half a dozen war stories. In turn, reporters often find scientists to be poor sources. Interviews may turn to complex topics well out of the reporter's knowledge or experience. Moreover, there are endless qualifications. From the reporter's point of view, scientists rarely come back with a straight, quotable answer.

Nevertheless, members of both groups can benefit from working together. Well written science stories can enlighten public opinion or generate public support for research. For reporters, quotes from scientists can lend credibility and depth to stories.

When dealing with the media, scientists should beware of several pitfalls. I would sum them up as:

1) All reporters are alike - scientifically illiterate and interested only in sound bites.

2) I control the information - what I don't tell, the reporter won't know.

3) Off the record doesn't always mean off the record.

First and foremost is the tendency to stereotype reporters. Not all are pretty faces or scientific greenhorns. In fact, more journalism schools are offering classes in science writing.

In addition, to paraphrase Marshall McLuhan, the medium makes the message. Broadcast reporters may need only a ten-second sound bite, but print reporters can sometimes take the time to treat a subject in detail. There may be an order of magnitude difference in your approach to an interview with reporters from different media.

If you, as a scientist, are contacted for an inter view, it is useful to know who the reporter works for, exactly what sort of information he or she is looking for and how the information will be used. If the reporter's interest is suspicious for any reason, there is no Constitutional requirement to talk. Freedom of the press does not imply an eleventh commandment: thou shalt spill thy knowledge indiscriminately.

However, a refusal to grant an interview may also deny the reporter access to potentially significant information. As a result, less accurate views may gain prominence.

This problem leads to a second pitfall: the desire to control information. There is a natural tension between any reporter and his or her sources. Reporters are sensitive to being used by public officials, businesses and individuals who want their story told their way. However, through interviews and factual research, a reporter must build his or her own storyline.

This tension may be especially troublesome in technical areas where there is plenty of room for honest mistakes and intentional fact twisting on both sides. Reporters may need basic information as well as help in interpreting complex processes. Manipulating this effort is probably natural and necessary. But ultimately, reporters and editors decide what to broadcast or print. Moreover, they wield power by disseminating their work every day.

A commonly used technique in the negotiations over what information to print is the "off the record" comment or discussion. Asking a reporter if comments can be taken in this manner may give a scientist source a feeling of freedom. It also alerts the reporter that the information is necessary for context but probably not for the printed page.

Several issues arise in this situation. The first is trust. The reporter must be trusted to treat the information properly, and the source must be trusted not to divulge information so basic and important that the reporter would be negligent not to print it.

Secondly, the comments covered by the "off the record" rule must be clear. Failing to clarify when the discussion is back "on the record" can lead to misunderstanding.

Last, the nature of "off the record" should be clear. Does it mean that the information can be used but the source should remain anonymous? Does it mean that none of the information can be used at any time? Or that it can be used at a later date?

In any case, the reporter and editor are the final judge of what goes into the story. "Off the record" comments may not always be.

Once mistakes appear in a printed or broadcast story, sources have a right to get angry. Your life may have just gotten more

complicated. In some cases, your reputation may suffer. However, it is wise to contact the reporter after you have cooled off. The exact nature of the mistake should also be made clear. Was it factual? Was it a matter of context? Were important facts omitted? Was it a mistaken affiliation or a misspelling?

Depending on the seriousness of the problem, you may request a simple correction. However, it is rare for corrections to receive prominent treatment. You can also provide your own written comments. Some broadcast outlets offer a chance to go on the air.

In summary, both scientists and journalists have much to gain by cooperating in the search for truth. However, their relationship can be complicated by a variety of problems. By clarifying needs and responding openly to questions, these problems can be minimized.

(Ed. note: Nick Houtman is Acting Director of the Water Resources Program at UM and was a former reporter and editor for newspapers before receiving an MS in Water Resources Management from the University of Wisconsin-Madison.)

REMOTE SENSING FOR GEOLOGISTS

by

Irwin D. Novak

"Remote Sensing for Geologists", a short course sponsored by the Geological Society of Maine and the Department of Geosciences of the University of Southern Maine, was held on April 15, 1994 in Bailey Hall on the Gorham Campus of USM. Approximately 40 people attended the all-day course prepared by Benoit Rivard of the Canadian Center for Remote Sensing and Michael Collins of the University of Maine. This short course was another in the successful series of workshops/symposia sponsored by the Geological Society of Maine.

Benoit, whose background included degrees in geology and remote sensing with an emphasis on geological interpretation, delivered the majority of the program, with Michael Collins supplying details of theoretical and mathematical aspects of digital imaging and data handling. The presenters stated in their short course notes that the objectives of the course were to cover the basic principles in remote sensing and airborne geophysics, including material on data characteristics, acquisition, type and processing. The emphasis was to be placed on satellite data including LANDSAT, SPOT, and ERS1, with examples from airborne sensors seeking geophysical (radiometrics and magnets) included as well. They stated that they designed the course for individuals with a strong geological background who wished to learn about the capabilities of remote sensing applied to geosciences.

In one intensive day, Benoit carefully and methodically steered the group through the mysteries of the electromagnetic spectrum; the various remote sensing platforms and what portions of the spectrum they "sensed"; and how data is acquired, digitized, stored, displayed, and manipulated. Along the way, the significance of spectral reflectance as applied to mineralogy, rock types and geobotany was discussed in the the context of "what is it, exactly, that the sensors sensed?" He explained the assumptions made and the "corrections" (for example, atmospheric absorption of part of the spectrum) that had to be made before image enhancement and interpretation could be made.

Throughout the day, outstanding examples of images were used to emphasize the "art" of image analysis. The examples and case studies came from arid Egypt, Saudi Arabia and the southwestern U.S.A., as well as portions of glaciated Canada. The latter included the impact structure associated with the mineralization of the Sudbury, Ontario area. Additional examples were shown which combined more than one type of remotely sensed data: airborne radar with LANDSAT or SPOT images, or thermal and Digital Elevation Models.

A portion of the program was devoted to recommendations on the types of computer

systems necessary to store and manipulate acquired data. In this portion of the course, hardware and software considerations, data formats (tapes, CD-ROMs, etc.), and cost were discussed. PC systems can put many of the tools into the hands of the non-remote sensing specialist at relatively modest cost. Judging by the response of the attendees, many were considering new ways to utilize remote sensing analysis equipment and products.

GSM TREASURER'S REPORT

For the period 1/15/94 to 6/1/94

Balance as of 1/15/94	**$5074.48**
Receipts:	
Dues	458.00
Publications	30.00
Other	
Bank interest	34.40
Education fund	5.00
Short course registrations	1650.00
Subtotal	2177.40
Expenses:	
Bank charges	43.85
Returned check	21.00
Newsletters	135.50
Newsletter postage	213.95
Miscellaneous expenses	41.64
Short course printing	454.85
Short course postage	87.00
Short course honoraria/travel	670.42
Short course coffee breaks	81.20
Spring meeting printing/postage	62.55
Subtotal	1811.96
Balance as of 6/1/94	**$5439.92**

Submitted by Marc Loiselle, Treasurer

A note on dues: The Society year begins August 1; members with a "93" on their mailing label will be 2 years in arrears and will be dropped from the mailing list for the Fall newsletter. Members with a "94" on their mailing label should send in their 1995 dues as soon as is convenient.

A note on mailing addresses: There has been progress; only 2 newsletters came back last spring, and we even got a couple of change of address notices. Thanks.

The Society wishes to thank Steve Pinette for his contribution to the Education Fund.

GSM SPRING MEETING ABSTRACTS

ORAL PRESENTATIONS

PALEOENVIRONMENTAL RECONSTRUCTIONS FROM LATE WISCONSINAN AND EARLY HOLOCENE GLACIALMARINE AND LACUSTRINE SEDIMENTS IN TAYLOR PON, AUBURN, MAINE.

GROVE, M.J., Dept. of Geology, Bates College, Lewiston, Maine 04240.

Taylor Pond, is a 5 km^2 lake basin in Auburn, Maine, and lies below marine limit for the area and contains the transitional sequence from glacial to lacustrine sedimentation.

Acoustic sub-bottom profiling of the Taylor Pond basin in the fall of 1993 documented five acoustically different stratigraphic units that correspond to till and bedrock, glacialmarine silt and clay, lacustrine organic rich sediments, sand and gravel, and natural gas. From three sediment cores obtained in the basin, it is possible to classify the sediments into three units; marine, transition and lacustrine sediments.

The marine unit is a massive gray clay, sometimes with sulfidic laminae, that has high magnetic susceptibility and low organic content. The lacustrine-marine transition sediments are dark gray silty clay, with moderate levels of organic material. Bulk magnetic susceptibility increases downcore in the transition sediments. These sediments are the coarsest and most poorly sorted of the three units. A sample from the lacustrine-marine transition was sent to be radiocarbon dated. The lacustrine sediments are a massive, very dark olive-gray, organic-rich silty clay or gytta. The gytta generally has low magnetic susceptibility and high organic content. The lacustrine sediment contains two major changes in sediment character that may be correlated with anthropogenic changes in the environment of the basin.

THE BEDROCK GEOLOGY OF THE SOUTHERN PRESIDENTIAL RANGE, WHITE MOUNTAINS, N.H.

MACONOCHIE, Jenna-Marie, Department of Geology, Bates College, Lewiston,Maine 04240.

The metasedimentary rocks of the southern Presidential Range have been correlated to the Central Maine Terrane sequence, including the Silurian Rangeley, Smalls Falls, and Madrid Fms. and the Devonian Littleton Fm.

The Rangeley has been subdivided into a gray migmatite and a rusty weathered migmatite. Within these are blocks of: a) abundant, well-bedded, calc-silicate granofels; b) rare, layered amphibolites; and c) rare rusty schist. The elongate blocks vary in length from, more typically, 30 cm to more than 1 km.

The Rangeley Formation is interpreted to be an olistostromal mélange in which bedding is progressively fragmented from intact turbidite beds to thoroughly disrupted strata with isolated fragments in a pelitic matrix. Mass-movements associated with subduction zone tectonics acted as a triggering mechanism causing the sediments to collapse down slope and be disrupted.

Three phases of deformation are recognized. The Tuckerman Ravine syncline and the Mt. Washington nappe represent the first phase, D1. These macroscopic folds are interpreted to be east facing and verging. The second phase, D2, is characterized by west over east asymmetric, microscopic to mesoscopic F2 folds. The third phase forms broad warps in map pattern.

The first prograde metamorphic stage in the Rangeley reached the andalusite zone during early- or pre-D1 activity. The next phase reached the sillimanite zone syn- and post-D1. The final prograde stage reached the zone of partial melting forming the migmatites. The retrograde stage involves the replacement of earlier minerals by chlorite and sericite.

THE EVOLUTION OF A HYPERSALINE, MEROMICTIC LAKE BASIN FROM A MARINE INLET, SOPHIA LAKE, N.W.T., CANADA.

MARSELLA, K.A., Department of Geology, Bates College, Lewiston, Maine 04240

The Canadian arctic region provides a unique setting in which coastal marine inlets evolve into lake basins as glacioisostatic rebound occurs. Seawater may become trapped in these basins, forming a density stratification or meromixis. Sophia Lake on the eastern coast of Cornwallis Island is one of these "isolation basins", however it is unique in that the bottom waters are hypersaline (58 ppt). At present, Sophia Lake contains a fresh to brackish (< 2 ppt) mixolimnion, overlying a hypersaline monimolimnion. The sediment porewater chemistry is hypersaline, with concentrations in the range of those in the monimolimnion. Cation ratios in the water column approximate those of seawater with increasing depth towards the sediment-water interface. The sedimentary record contains a massive marine unit overlain by lacustrine sediments.

The continuous hypersalinity of the porewater through the sequence of marine and lacustrine sediments, indicates that the hypersaline conditions are post-depositional. A four phase model of the evolution of the basin is presented based on this data. Phase 1 is characterized by the presence of a circulating marine inlet containing oxygenated waters of normal marine salinity. Phase 2 involves glacioisostatic rebound of the land surface, causing an initial isolation of the basin and entrapment of seawater. Intermittent exchange between the newly emerged basin and the sea likely occurred during this phase. Phase 3 represents complete isolation of the basin and onset of anoxia, due to increased uplift of the land surface. Permafrost growth beneath the basin causes the infiltration of brines into the basal waters of the lake, thereby elevating the salinity of the monimolimnion. Phase 4 may represent modern infiltration of nearby seawater into the lake basin through unfrozen taliks beneath the basin.

SURFICIAL MAPPING OF GLACIAL FEATURES AT HORSE POINT, BELGRADE, MAINE.

MOSTOLLER, D.E., Dept. of Geology, Colby College, Waterville, Maine 04901.

Glacial landforms and deposits were studied and mapped at Horse Point, Belgrade, Maine, by map and aerial photo interpretation and field reconnaissance. Six undisturbed and two disturbed kettles were delineated and mapped. The esker was studied and found to have seven recognizable segments. Six of the segments have single crests, while the seventh is composed of multiple crests. Two marginal troughs were differentiated from kettles and mapped as separate landforms. Sand and gravel extraction pits were mapped to provide a record of the current level of disturbance by these activities. Non-esker sediments were also mapped, including a large blanket of till and minor alluvial units. The study determined that a previously mapped kettle is actually a marginal trough and an area earlier mapped as a delta deposit is a glaciofluvial fan.

THE MINERALOGY OF CLAY SAMPLES FROM WONDER LAKE, ALASKA.

STRONG, B.B., Dept of Geology, Colby College, Waterville, Maine, 04901.

Twelve clay samples were obtained from three cores taken from two sites at Wonder Lake, Denali National Park, Alaska. Samples were selected from the cores to complement magnetic susceptibility studies. The samples were cleaned, separated by centrifuge, and then made into slides for analysis by the x-ray diffractometer. They were also analyzed following glycolosis to see if any noticeable peak shifts would be observed as a result of swelling. Finally, the samples were fired in a muffle furnace and analyzed by the XRD for a third time to see if peaks shifted due to collapse of clay mineral structure. These three techniques showed the clays to be rich in illite, clinochlore minerals, quartz, and a variety of other minerals. Subtle changes in mineralogy between the two sites suggest a shift in source. Since the only true inflow and outflow stream is at one side of the lake, it can be hypothesized that the mineralogy of the clays will be biased towards materials being introduced through the stream. Further studies are currently in progress. This study gives some insight into the surrounding rock types responsible for supplying the material for these clays.

High School Student Perspectives of the Geosciences: A Gender Related Study in Central Maine

VAN DER HOEVEN, Katrien J. and DOSS, Paul K., Dept. of Geology, Colby College, Waterville, ME 04901

This study examined gender differences in the way high school students perceive the natural sciences, their participation in science classes, and whether students recognize geology as a natural science. A survey, developed with help from a psychologist, was distributed to students in science classes at Erskine Academy, Waterville, and Lewiston High Schools. Students were asked to rate their individual science classes and their own level of class participation in science and English classes, and to compare their level of class participation to that of the opposite sex. Students also listed what disciplines they considered to be a part of natural sciences, and what constituted class participation.

In general, the female students rated their science classes the same or slightly higher than their male peers. Females indicated that they participated the same as their male peers; most students felt they participated an average amount. When listing natural science disciplines, most students, both female and male, did not include geology or any earth science as a natural science.

The results of this survey suggest that there is little to no gender difference in science class participation and the females were slightly more enthusiastic about science than the males. The lack of student recognition of geology as a part of the natural sciences suggests the need for greater emphasis on the earth sciences in the high school curriculum.

POSTER PRESENTATIONS

HOLOCENE TSUNAMI DEPOSIT ALONG WESTERN NUSHAGAK BAY, SOUTHWESTERN ALASKA

ALLEN, Brian M., Geology Department, Bowdoin College, Brunswick, ME 04011

Holocene peatlands, up to 3 m thick, cap the coastal bluffs along the western side of Nushagak Bay. These peats contain a layer of pumiceous sand attributed to a volcanogenic tsunami. Characterization of the tsunami deposit will provide additional insight into volcanic hazards in southwestern Alaska.

Field study of seven sections along 4 km of bluffs on the eastern side of Nushagak Peninsula identified a tephra-bearing unit within the Holocene peat comprised of fine to coarse sand with abundant pumice lapilli up to 1 cm in diameter. Because adjacent beaches provide the only sand source on the landscape the sandy unit is interpreted as a tsunami deposit that incorporated water-rafted pumice. The tsunami deposit ranges from 7 to 30 cm thick and lies up to 18.4 m above mean high tide. In five of the seven sections, the tsunami deposit is directly and conformably underlain by a white silty to fine sandy airfall tephra, up to 2 cm thick. The lack of any peat or a weathered zone between this tephra and the overlying tsunami deposit provides stratigraphic evidence for near-contemporaneous deposition, and together with abundant pumice lapilli, suggests a volcanogenic mechanism of tsunami generation. The tsunami deposit and related airfall tephra are tentatively associated with the 3430-yr-BP eruption of the Aniakchak caldera, based on preliminary petrographic analysis and maximum radiocarbon ages from other sites in the Bristol Bay region.

GLACIAL AND POST- GLACIAL HISTORY OF THE SABATTUS VALLEY

BERNOTAVICZ, Alexa A., Department of Geology, Bates College, Lewiston, Maine 04240

The Sabattus Valley is located in Sabattus and Leeds, Maine. This area occupies one of the many tributary valleys of the Lower Androscoggin Valley which served as one of the main drainage systems in the coastal lowlands of Maine during the last major glaciation. The retreat of the Late Wisconsinan Laurentide Ice Sheet through this area has left deposits associated with a marine tidewater glacier environment, including stratified end moraines, glacial submarine fans, glaciomarine deltas, esker deposits and glaciomarine mud. Major ice-marginal positions can be determined from these deposits.

Detailed mapping of the surficial deposits has produced evidence for the retreat of the ice margin in a marine environment. The occurrence of a beaded esker system through the valley linking three major deltas is characterized by a series of discontinuous esker beads. These beads have a stratified drift composition and are draped by marine clay. They strike roughly north-south as a discontinuous ridge. Three Gilbert-style deltas show evidence for a progradation to sea level with gently sloping, sand and gravel foreset beds overlain by topset beds. The margin has also been determined to be active as opposed to stagnant as evidenced by the occurrence of glaciotectonic features such as thrust faults, folds in the stratified drift, and numerous small DeGeer moraines.

Stratified end moraines are also found within the valley. They form linear ridges, composed of sand and gravel, that run perpendicular to the ice margin. The submarine fan deposits consist of both graded and cross-laminated sand and gravel interbedded with thin layers of silt.

CHRONOLOGY AND SEDIMENTOLOGY OF LAST-GLACIAL LOESS, BRISTOL BAY LOWLAND, SOUTHWESTERN ALASKA

BUPPERT, Gregory D., Geology Department, Bowdoin College, Brunswick, ME 04011

Large regions of Alaska that escaped late-Pleistocene glaciation are blanketed by loess. Throughout the state, inorganic loess directly beneath organic surface deposits has generally been assigned to the late-Wisconsin glaciation. Very few of these loess sequences have yielded even a single radiocarbon age. Age assignments, as well as sedimentation rates, remain tentative. This study examines the chronology and sedimentology of upper-Pleistocene loess in the Bristol Bay lowland of southwestern Alaska. The paleoenvironmental signal inferred from the loess can be compared with that derived from coeval eolian sand-sheet and dune deposits that accumulated closer to outwash sources elsewhere in the lowland.

A 3-m section of sandy loess exposed in coastal bluffs of northeastern Bristol Bay was sampled at 15-cm intervals. Laboratory analyses included grain-size determination by sieve and Sedigraph, calculation of organic content by loss on ignition, and sieving to isolate organic material for AMS radiocarbon dating. Five radiocarbon ages range from 23,420 to 12,700 yr BP, confirming a late-Wisconsin age for the deposit. Modal grain size within the loess exhibits little variation (24 - 34 μm).

Radiocarbon ages indicate that loess deposition was contemporaneous with the aggradation of eolian sand-sheets elsewhere in the Bristol Bay-Nushagak lowland. Less-prominent sedimentological and environmental changes recorded in sand-sheet deposits are not detectable within the loess. Widespread loess deposits correspond to glaciation, but provide only a subtle record of climatic changes.

A HYDROGEOLOGIC INVESTIGATION OF GARLAND SWAMP, POLAND, ME.

DAVIES, Kyle A., Geology Department, Carnegie Science Bldg., Bates College, Lewiston, ME 04240.

Garland Swamp is a mixed forest wetland located south of Five Corners in the Town of Poland, Maine. This study delineates wetland hydrogeologic characteristics including surface and groundwater interaction, influence of precipitation on water table elevation.

Disconnected surface water channels and significant local subsurface flow suggest that Garland Swamp may be a potential location for ground water recharge. A monitoring grid of eleven water table piezometers and three piezometer nests has been established. Southern Maine experienced a markedly dry summer and water table levels declined as much as 75 centimeters between July and late August. Seasonal precipitation increases of late September combined with damming activities of a local beaver population contributed to a meter rise in the wetland watertable. Flow along a marine clay layer was rapid and experienced a one day response to rainfall events. Peat cores taken at each piezometer location revealed thicknesses of organic peat between zero and 2 meters above heterogeneous sands of various thicknesses. The sands are underlain by an unknown thickness of marine clay. Decreasing water saturation of the clay with depth indicates that Garland Swamp may be a local expression of a perched water table.

Hydraulic head data from the piezometer nests suggest complex vertical flow relationships both toward the surface and to depth. A further understanding of water relationships is limited using available water chemistry.

PLEISTOCENE GLACIAL-ESTUARINE DEPOSITS IN THE KVICHAK BAY REGION, SOUTHWESTERN ALASKA

FISH, Amy M., Geology Department, Bowdoin College, Brunswick, ME 04011

Bluffs on Kvichak Bay, a macrotidal sub-estuary, expose Pleistocene glacial-marine sediment related to ice advance >41.2 ka. Facies analysis of these sediments and comparison with modern estuarine environments indicates deposition in the intertidal zone. These examples of shallow-water glacial-estuarine deposition extend conceptions of glacial-marine sedimentation.

Exposures near Second Point exhibit a coarsening-upward sequence of estuarine sand and gravel. Sandy facies associations include small- and medium-scale cross strata that record migration of ripples on tidal flats and shoals. Sigmoidal tidal bundles and reactivation surfaces within sets of cross beds provide a clear signature of tidal currents. A gravelly facies association exhibits laterally variable sorting and multidirectional imbrication, suggesting wave deposition. Large-scale, low-angle cross strata are interpreted as prograding beach deposits.

Exposures south of the Naknek River record outwash sedimentation and estuarine reworking. Upper deposits include lensoid gravel which comprises a massive to cross-stratified unit with a convex upper boundary. This unit is interpreted as an outwash fan deposited within the intertidal zone. Lateral transitions to sand and mud indicate increased influence of tidal currents away from the meltwater source. Cross-stratified sand and low-angle cross-stratified gravel are interpreted to indicate migration of dunes on sand shoals and beach/spit progradation, respectively.

The Second Point and South Naknek examples illustrate the interaction of waves, meltwater and tidal currents, as well as extensive reworking of glacial sediment in a shallow, high-energy macrotidal environment.

THE ROLE OF PLANT-SEDIMENT INTERACTION IN BARRIER BEACH MAINTENANCE MECHANISMS AT SEAWALL BEACH.

GUARDENIER, H., Dept. of Geology, Bates College, Lewiston, Maine 04240.

Development along the Maine coast and subsequent disruption of the natural processes affecting Maine's sandy beaches is an issue that has sparked many debates among politicians, homeowners, and environmentalists. In an effort to understand barrier beach maintenance mechanisms and thereby the consequences of shoreline development, this study investigates the processes of recovery from winter erosion and the factors which may have a significant influence on sand accretion.

This study focuses on the beach processes occurring at Seawall Beach in Phippsburg, Maine. Beach profiling through a modified and control site provides evidence for differential recovery between the site containing wrack and berm colonizers and the site where these factors are absent.

The formation of a berm and eolian ramp, two accretionary structures, are significantly more pronounced in the presence of wrack and berm colonizers. The volume of sand which accumulates in the wrack and berm colonizer-free site is significantly less than that which accumulated in the unaltered site. The interaction of eolian processes and vegetation is significant in the accumulation of sand.

This study clearly indicates that the interaction between eolian activity and wrack and berm colonizers is an essential process which increases volume and height on the beachface and is an integral component of barrier beach maintenance mechanisms.

Petrology and Mineralogy of Incineration Products from a Municipal Waste Incinerator in Burnaby, British Columbia.

HOLLAND, E.A., Dept. of Geology, Bates College, Lewiston, Maine 04240.

The objective of this study is to characterize pre-incinerated waste, grate siftings, and bottom ash from a municipal waste incinerator. This characterization involves the classification of waste and ash particles, identification of incineration minerals and associations, and chemical analysis of the particles and minerals.

The study is part of the WASTE Program which is being conducted by the EPA and Environment Canada on the Burnaby incinerator in Burnaby, B.C. The main objective of the study is to evaluate the effects of waste characteristics on the incineration processes and to determine the fate and behavior of metals.

Sample analyses were done using transmitted light microscopy, scanning electron microscopy (SEM), and energy dispersive spectrometry (EDS). Transmitted light microscopy was used to identify minerals and classify particles. The SEM provided information about the fine structure of particles. Chemical compositions of minerals and the glass matrix were obtained with the EDS.

The waste samples principally consist of demolition and construction debris. Incinerator residues (grate siftings and bottom ash) contain: 1) abundant waste minerals and lithics; 2) isotropic, clear glass with vesicles and schlieren structures; 3) opaque, black, glass; and 4) precipitated euhedral silicate and oxide minerals. An assessment of the samples provided evidence that some waste products only experienced partial melting. Furthermore, the melt in the incinerator system was probably in a silica saturated disequilibrium condition. The temperature of incineration was about 1200^0 C. These findings may ultimately assist in optimizing the engineering of facilities utilizing this method of waste treatment.

BEDROCK AND STRUCTURAL GEOLOGY OF THE SOUTHERN GEORGES ISLANDS, MUSCONGUS BAY, MAINE.

KING, Amy E., Department of Geology, Bates College, Lewiston, ME 04240.

Detailed mapping of Burnt, Little Burnt, Allen, and Benner Islands has revealed a stratigraphic sequence that has been altered by three discrete phases of deformation, two phases of regional plutonism, two phases of metamorphism, and late brittle faulting.

The stratigraphy is divided into three units: the Benner conglomerate, Benner garnet coticule schist, and the Allen Island Formation. The Benner conglomerate and Benner garnet coticule schist are correlated to the Cambrian(?) Megunticook Formation and are separated from each other by an angular unconformity. The Allen Island Formation, which is sub-divided into three units, the quartzite, schist, and calc-silicate units, is correlated to the Cambrian-Ordovician(?) Penobscot Formation. All of these units are part of the Atlantica Composite Terrane.

Both D1 and D2 deformation are characterized by isoclinal folding, although F1 folds are on a larger scale than F2 folds. D3, which was synchronous with the later phase of igneous intrusion, created a regional, open, northeast trending syncline observable only on a macroscopic scale. Unfolding of D3 could allow for either northeast, west, or an indeterminate direction of vergence for F1 folds; therefore, D1 vergence of this region remains uncertain.

Two discrete phases of plutonism occurred. A Silurian(?) gabbro-diorite which occurred post D2, and a Devonian(?) granodiorite which may be responsible for D3 deformation.

The first thermal event recognized in the study area is sillimanite grade prograde metamorphism. M1 was a static contact metamorphism and is characterized by randomly oriented sillimanite needles. M2 retrograde metamorphism was a late event and is characterized by spotty chlorite alteration.

SEDIMENT DYNAMICS OF THE LOWER PORTION OF THE CATHANCE RIVER, BOWDOINHAM, MAINE

MERRYMAN, Angela A., BANGS, Benjamin C.W., Geology Department, Bowdoin College, Brunswick, ME 04011

The Cathance River, which is tidally influenced in its lower portion, is one of four major tributaries to Merrymeeting Bay, a large freshwater estuary. The Cathance River is narrowly contrained by bedrock, whereas Merrymeeting Bay occupies a trough excavated parallel to the regional NE-SW bedrock strike. Merrymeeting Bay has served as a sediment sink for its tributaries and, as a result, water depths in the bay average only 10 feet. In contrast, the lower Cathance River has maintained an average depth of 24 feet, with a maximum of 35 feet along the axis of the channel. The goal of this study is to determine the variables that allow the lower Cathance River to remain relatively free of sediment, thus maintaining depths greater than those of Merrymeeting Bay.

Side-scan sonar and bathymetric surveys have revealed that the channel of the lower Cathance River is characterized by steep banks, whereas Merrymeeting Bay contains broad sandy shoals locally mantled by dunes. Bed-material samples, from the lower Cathance River, showed bimodal grain-size distributions with peaks in the fine to medium sand and mud range. Velocity measurements over three tidal cycles indicated equally fast flood and ebb tidal currents, with maximum velocities of 2.0 m/sec. Suspended inorganic sediment concentrations range from .007 g/L to .022 g/L, and remain relatively constant throughout the tidal cycle. High current velocities, in conjunction with a short period of waning flow between flood and ebb tides, apparently do not allow for the settling of suspended grains. The inability of grains to settle in the fast-flowing currents maintains a bed that is composed of bedrock with patches of thin sediment cover.

MODERN DEPOSITIONAL ENVIRONMENTS IN TAYLOR POND, AUBURN, MAINE.

POLITIS, G., Dept. of Geology, Bates College, Maine 04240.

The Taylor Pond basin, located in Auburn, Maine, has been inhabited by people of European descent since the late 17th century. Large scale farming practices were used up until the mid 19th century, at which time most large farms were abandoned. However, Taylor Pond became a place of recreation for the people of Lewiston and Auburn. Residences were built, and human enhanced erosional processes continued within the basin. These processes have continued up until the present time.

The occupation of a lake basin by agricultural societies has a large effect on the erosion of the basin, and the sedimentation rates within the lake. When living in a basin, agricultural societies tend to remove vegetation and other ground cover. Root systems are no longer present to stabilize the soil, causing enhanced erosion. These sediments carry iron bearing minerals with them. The sediment influxes can be observed by plotting variations in the magnetic susceptibility down the length of a core. When down core magnetic susceptibility variations are plotted against organic content and grain size, much can be inferred about the environment in which the sediments originated.

In this study, salinity, conductivity, and temperature profiles were taken in the water column, and 30 surface samples were taken to better understand the present sedimentary environment. Eleven short cores of lacustrine sediments were also recovered, to study the changes in the lacustrine sediment record over time. These cores were tested for grain size, percent bulk organic matter, and magnetic susceptibility.

Down core magnetic susceptibility variations were used to correlate the suite of cores. Once correlated, the cores revealed that over what is probably the span of human occupation the sedimentation rate has increased dramatically.

ACOUSTICAL AND SEDIMENTOLOGICAL ANALYSIS OF LATE QUATERNARY STRATIGRAPHY, COCHNEWAGON LAKE, MONMOUTH, MAINE.

ROSENBERGER, Kurt, Dept. of Geology, Bates College, Lewiston, Maine, 04240.

The upper limit of marine submergence associated with the retreat of the Late Wisconsinan ice sheet from the Monmouth area in the Androscogin valley in Maine is presently documented up to 120 meters (350ft.)above present sea level. Thus, fossiliferous glaciomarine deposits blanket the topography of this region particularly infilling depressions such as lake basins. Typical depositional sequences in these basins include till, glaciomarine, and lacustrine sediments as well as deposits associated with transitional environments. One such basin, Cochnewagon Lake (44°13'30"N 70°2'30"E), although below marine limit at 82 meters (270ft.), is not documented in the submergence zone. Preliminary reconaissance using a Datasonics acoustic profiler suggests that the glaciogenic sequences exist beneath the Holocene lacustrine muds.

This study focuses on the vertical and lateral distribution and nature of the subsurface sediments using both acoustic sub-bottom profiling as well as sediment coring with a Livingston corer. Analysis of sediment properties through numerous laboratory techniques is used to groundtruth sub-bottom profiles obtained.

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 dialoge among geologists working in Maine; and to further public awareness and understanding of the geology of the State of Maine; and of the modern 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 1st to July 31st. Annual dues and gift contributions to the Society are tax deductible. There are three classes of memberships:

$7.00	REGULAR MEMBER	Graduate geologists, or equivalent, with one year of practice in geology , or with an advanced degree.
$6.00	ASSOCIATE MEMBER	Any person or organization desirous of association with the Society.
$4.00	STUDENT MEMBER	Persons currently enrolled as college students.

A $2.00 APPLICATION FEE is a one-time fee for all new members, payable when applying for membership.

THE GEOLOGICAL SOCIETY OF MAINE ANNUAL RENEWAL / APPLICATION FOR MEMBERSHIP

Application Fee	$2.00	$_____
Regular Member	$7.00	$_____
Associate Member	$6.00	$_____
Student Member	$4.00	$_____
Education Fund Contribution		$_____
TOTAL ENCLOSED		$_____

Name_____

Address _____

_____

_____

Checks payable to:
The Geological Society of Maine
Marc Loiselle, Treasurer
c/o Maine Geological Survey
State House Station 22
Augusta, ME 04333

1994/95 SOCIETY YEAR BEGINS AUGUST 1 - PLEASE SEND IN YOUR DUES

THE GEOLOGICAL SOCIETY OF MAINE
c/o Arthur M. Hussey, II
Department of Geology
Bowdoin College
Brunswick, ME 04011

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 Marc Loiselle, Maine Geological Survey, State House Station 22, Augusta, ME 04333.
Items for inclusion in the newsletter may be directed to Susan Corderman Weddle, 11 Beech Drive, Brunswick, ME 04011.