THE STATE GEOLOGIST'S MESSAGE

A Compilation of Articles
by

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Maine State Geologist

for

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This extra issue of *The Maine Geologist* is a special one dedicated to Dr. Robert G. Marvinney. Bob, as he was most frequently known, retired in June 2021 after 26 years of service as the Maine State Geologist. Bob first makes an appearance in the Geological Society of Maine newsletter in 1998 and rarely missed an issue, resulting in the 63 articles assembled here.

When I asked Bob about the start of his column, he said that the idea arose from discussions with Dan Belknap, the newsletter editor at the time. Bob's inspiration for the column came from a copy of "From the desk of the State Geologist," by Pennsylvania State Geologist Arthur Socolow that Walter Anderson left behind in the office when he retired and passed the position of State Geologist to Bob. Bob tried to emulate Socolow's approach in producing short, timely pieces on important geological topics, events, or current policy discussions in Maine – we think he succeeded. Thank you, Bob, for your many contributions to the Geological Society of Maine!

Editor's Notes: The following articles have been reformatted from the original for consistency within this publication. If an article was published without a title, a subject has been added in italics. Most minor typographical errors were fixed. Original web addresses remain in the text as they were presented, but many no longer exist. The citation to the original newsletter issue is included. The title of the series changed slightly over the years: Message from the State Geologist, The State Geologist's Message, News from the State Geologist. All other errors are mine with apologies.

Amber T. H. Whittaker, Newsletter Editor

FOREWORD

This special issue of *The Maine Geologist* is published in honor of Dr. Robert G. Marvinney's fine service to both the State of Maine and to geologists across the country. We all owe him a debt of gratitude.

Bob was hired at the Maine Geological Survey as Physical Geologist in 1987. What brought him to Maine was his Ph.D. work at Syracuse University where he studied Maine's bedrock geology in the Seboomook Lake area. As Physical Geologist Bob developed and coordinated the Survey's bedrock mapping program and directed the development of the state's first geographic information system. After nine years in that job and upon the retirement of Walter Anderson in 1995, Bob was selected to be State Geologist. Not one to oversee the Survey's research programs from behind a desk, Bob traveled the state (and country) to educate and involve himself with Maine's environmental issues. From groundwater extraction to landslides, earthquakes, coastal erosion, arsenic – the list goes on of his involvement with the Survey. His expertise and fine judgement combined with an ability to discuss and compromise made him an outstanding State Geologist. He is Past-President of the Association of American State Geologists.

Bob ushered the Maine Geological Survey into the 21st century, leading the public agency in the task of educating the State on a number of concerning geological issues. He developed and presented the State's policy positions in the often-contentious public arena in an unbiased and scientific manner. He hired and worked with a diverse staff of professionals who were well directed in their research. A job well done for twenty-six years! Here is to a happy retirement!

Bob Johnston, GSM Historian

List of Articles

In chronological order, 1998–2021

View all GSM newsletters on the website: https://www.gsmmaine.org/newsletter_archive/

MESSAGES FROM THE STATE GEOLOGIST

Earth Science Week

By Gubernatorial Proclamation, Governor Angus S. King, Jr., has designated the second full week of October (11-17) as Earth Science Week in the State of Maine. This proclamation is part of a national effort, sponsored by the American Geological Institute (AGI) and supported by the Association of American State Geologists, to increase public awareness of geology and how it contributes to daily life. This first annual Earth Science Week was conceived by AGI as part of their 50th anniversary celebration this year. A dozen states now have gubernatorial proclamations, with several more on the way. Through these proclamations and Earth Science Week activities, the state geological surveys and other geological institutions hope to:

- Give students new opportunities to discover the earth sciences.
- Publicize the message that earth science is all around us.
- Encourage stewardship of the earth.
- Share our knowledge and enthusiasm about the earth.

I believe it will be worthwhile for each of us involved in the earth sciences to plan some sort of activity during that week to raise the public's awareness of earth science issues. Certainly, some recent events have helped us do that (Rockland landslide, Windham MTBE groundwater contamination) but these alone are insufficient to really raise the awareness of the valuable contributions earth scientists make to society. We at the MGS are in the process of developing a program for the week (field trips, open house, lectures) which we will publicize through our web site and by other means. The text of our proclamation is already available on our web pages: (http://www.state.me.us/doc/nrimc/mgs/mgs.htm) along with links to the AGI site and others participating in Earth Science Week. I plan to set up our web page as a central site for all Maine Earth Science Week activities, so let me know what you are planning! Let's all pitch in and make Earth Science Week a truly meaningful and worthwhile event in Maine!

State Geologists Come to Maine

The Association of American State Geologists held its 90th annual meeting in Portland, Maine, June 13-18, 1998, hosted by the Maine Geological Survey assisted by the New Hampshire Geological Survey. State Geologists from 45 states and Puerto Rico attended along with many staff members and guests. Invited speakers included representatives from the U.S. Geological Survey (including Acting Director Thomas Casadevall), the Bureau of Land Management, National Park Service, Minerals Management Service, the EPA, AGI, and others. Our period of excellent Spring weather broke just as the meeting was getting underway on Saturday, June 13. For 36 hours the meeting host (yours truly) nervously waited for the driving rains to abate before outdoor activities began. Somehow our schedule meshed gears very well with the weather: while meeting indoors all day Sunday, it galed outdoors; when it came time for our Casco Bay cruise on Monday afternoon, the rain dissolved away to a light fog that did little to dampen spirits as we enjoyed a lobster bake on House Island (thanks to Hilda Dudley and crew). Even more cooperative was the weather for our Mt. Washington trip on June 18. Our bus ride began in the rain but as we approached the Cog RR base station the clouds broke and provided views of the summit. By the time we got to the summit, the conditions there were sunny, in the 50s, with little wind! The best summit weather of the season, according to those few hardy souls who live there! Thanks to Dyk Eusden (Bates College), Brian Fowler (North American Reserve), and Woody Thompson (MGS) for developing an excellent geologic tour of the summit. Lest you should think that the State

Geologists only played while in Maine, we spent more than two and one-half days in serious discussion about the goals of the Association, our relationships with federal agencies, opportunities for partnerships, such as the National Cooperative Geologic Mapping Program (NCGMP), and many others. It is through Association-led efforts that we have the NCGMP, which has brought substantial mapping funds to Maine, and the Continental Margins program which provided much of the funding to map inner continental shelf geology. In spite of the weather all participants had a great time in Maine. Many extended their stays to take in other Maine sights and attractions. Maine presented itself very favorably to all and it could not have been so successful without the enthusiastic assistance of all MGS staff, and special assistant and general gopher, Walter Anderson. Especially helpful were the substantial financial contributions from many of you - representatives of many Maine geoscience-related businesses. My thanks to all.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 1998, Messages from the State Geologist: Earth Science Week & State Geologists Come to Maine. *The Maine Geologist*, v.24, n.2, p. 1–2.

MESSAGE FROM THE STATE GEOLOGIST

The National Cooperative Geologic Mapping Program and Maine

In 1992 the Congress overwhelmingly approved and the President signed legislation establishing the National Cooperative Geologic Mapping Program within the USGS. The program was initiated as the result of many years of determined effort by the Association of American State Geologists (AASG) and formalizes a cooperative program that has existed informally between the USGS and state geological surveys for many years. The program has three components: FEDMAP, which addresses federal mapping needs; STATEMAP, which funds state survey mapping projects; and EDMAP which provides funding for student mappers at universities and colleges. With the support of many of you, this program was reauthorized in 1998 with a modest increase to about $4 million in the STATEMAP component nationwide, and about $350,000 in EDMAP. What does this program mean to Maine? Through the 50:50 match of funds in the program we have been able to greatly expand our mapping budget without requiring additional resources from the state. To a limited degree this has offset the drastic state budget cuts of the early 90s. Since 1992, the Maine Geological Survey has conducted 5 STATEMAP projects resulting in the release of 28 new quadrangle maps. In these years we have focused both bedrock and surficial mapping in the more populous southwestern part of the state. Most notably, in 1998 Spike Berry and Art Hussey completed an outstanding compilation of the bedrock geology of the Portland 1:100,000 quadrangle. Woody Thompson and Tom Weddle, along with a company of dedicated contract mappers (both professionals and students), have completed new surficial quadrangles in the Sebago Lake and Lewiston areas. In the 1998 field season the bedrock focus shifted to Rockland with the goal over the next several years to fill in critical areas between the coast and Augusta. All the maps produced through this program are playing significant roles in issues such as aggregate resource, groundwater quality, and slope stability as well as contributing to our understanding of the timing of deglaciation and Siluro-Devonian tectonic history. The bottom line: new geologic maps, the foundation of much that we do in the geological profession, are being produced in a timely fashion to address important issues. The EDMAP component, while currently funded at only the most basic level, is providing an important opportunity for student mapping in Maine.

This program is open to all qualified graduate and undergraduate students to support mapping projects. In the past several years, students from Queens College and Ohio State had their Maine projects funded. In January of this year I had the pleasure of serving as one of AASG's representatives to the EDMAP review panel. Of the 45 proposals we reviewed, most were rated from good to excellent and received at least partial funding; only three received no funding. Two Maine projects by non-Maine universities were among those funded, along with one Maine undergraduate institution for a non-Maine project. I believe there is a very good and as-yet unrealized potential for Maine students to receive funding for Maine mapping projects through this program. When I review proposals in January 2000, I hope to see proposals from every Maine college and university. Shortly the AASG will begin a campaign to again reauthorize the program for the next 5 years, with funding for STATEMAP to reach $12 million and $1.2 million for EDMAP by 2005. I hope everyone who reads this will express support to their elected representatives for this important program.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 1999, Message from the State Geologist: The National Cooperative Geologic Mapping Program and Maine. *The Maine Geologist*, v.25, n.1, p. 3–4.

MESSAGE FROM THE STATE GEOLOGIST

Mapping Maine's Geology

The Maine Geological Survey is engaged in an ambitious program of geological mapping this summer with projects spanning the spectrum of Maine geology. Here are the key projects we will be working on: Aquifer mapping: Craig Neil and his crew of summer interns will map in detail the sand and gravel aquifers of eastern Maine, extending from Penobscot Bay eastward along the coast to Machias. With improved data collection techniques, including 12-channel seismic refraction, and the availability of detailed 1:24,000-scale base maps, the products of this work will be greatly improved over the existing generalized aquifer information for the area. As blueberry growers and other agricultural interests seek new sources of water for irrigation, the new maps will be indispensable.

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

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

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

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

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

Robert G. Marvinney, State Geologist

Marvinney, R.G., 1999, Message from the State Geologist: Mapping Maine's Geology. *The Maine Geologist*, v.25, n.2, p. 3.

MESSAGE FROM THE STATE GEOLOGIST

Maine Geological Survey Update

The Maine Geological Survey has spent the better part of the last year gearing up for our new "on-demand" plotting system, which we will use for all our future map publications. Such a method of delivering our products to our customers is a natural outgrowth of the use of GIS technology in automating many of our map production steps. Plotter technology has improved tremendously in the last few years, which enables us to move to the on-demand system. Bob Tucker and Marc Loiselle tirelessly researched different options to address our needs for a plotter that is fast, uses UV-stable inks (to prevent fade), and has a bulk ink supply (so that a series of plots can be run nightly). Our Encad plotter arrived in May and, after much testing for the optimal settings for our maps, is now in production. All our open-file maps will now be produced in easily readable color for only a few dollars more than the old black-line maps. Previously color maps could only be produced by expensive offset printing methods with the requirement that thousands of maps be printed to keep the cost per copy reasonable. With printed maps we are required to store thousands of copies. At the rate we are selling some of the older printed maps, we have a 500-year supply! We have now formatted several hundred new aquifer and surficial geology maps with more to come in the next year. Visit us in Augusta to see the new plotter and maps.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 1999, Message from the State Geologist. *The Maine Geologist*, v.25, n.3, p. 3.

MESSAGE FROM THE STATE GEOLOGIST

On Earthquake Misinformation

"Earthquake rumbles through region"
Kennebec Journal 2/27/99
"Pair of earthquakes just coincidental"
Portland Press Herald 1/5/00
"Finding faults"
Sun-Journal 1/30/00
"Experts differ on recent quakes"
Kennebec Journal 2/1/00
"Recent quakes seen as typical"
Bangor Daily News 2/1/00

Recent newspaper headlines such as these and the events they report have piqued an interest in geology by many a Mainer. Unfortunately what began as an excellent opportunity to educate the public about the nature of geology and seismicity in Maine rapidly degenerated into speculative misinformation.

The geological community knows that Maine is a seismically stable area, that the likelihood of a damaging earthquake is small (but not zero), and that the faults geologists have mapped in the State are without exception hundreds of millions of years old. We have an imperfect record of seismic activity for the State, but we know that small earthquakes of the type we have experienced in the last few months are common and broadly distributed. It is statistically quite probable to have several events in a year. Furthermore, Maine experienced a similar suite of magnitude 3 earthquakes in 1983-84, so the 1999-2000 group is not unusual. But the general public (and reporters) are not predisposed to the concepts of geologic time nor statistics and have been overexposed to certain geological generalities, such as "fault = earthquake." Try as I might to dissuade the reporter of the concept that Maine earthquakes are related to mapped faults, the Sun-Journal front page included a half-page graphic of epicenters and "ancient" faults, which to the casual reader presents an obvious connection. Driven more by the desire to make a scoop than to educate readers, the reporter emphasized differences in what the "experts" said and played down similarities. One expert looked at the 2% chance in 50 years of a damaging New England earthquake and said one could happen. Another looked at the 98% probability that we would not have such a quake and said one was unlikely. Both used the same information, but the report emphasized the difference, leading to confusion and mistrust by the public. While this episode points out that care is needed in how we present geology, it more importantly identifies the need for better earth science education for the public. Earth science education is not just the responsibility of the University or the State Geologist and his staff, but of all of us. Opportunities abound for education (scouts, planning boards, school presentations, boards of education, etc.) and others can be developed (Earth Science Week, field trips, etc.). I hope every GSM member will commit to doing one thing this year to further earth science education in their community.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2000, Message from the State Geologist. *The Maine Geologist*, v.26, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Groundwater Quality Program

In recent years a number of well publicized problems with Maine groundwater have focused public attention on the quality of the resource. The gasoline additive MTBE found in wells in North Windham in 1998 prompted a statewide study of the problem and the ultimate decision to eliminate its use in the state. Arsenic in groundwater has been frontpage news on several occasions, in the mid-90s in southern Maine and most recently in Northport and Ellsworth. Concerns about a cancer cluster in Fairfield prompted detailed scrutiny of groundwater quality there by the DEP. All of these situations point out that there is very little information available anywhere about ambient groundwater quality. We know little about the natural conditions of groundwater because, aside from the very limited information from real estate transactions, most data come from contamination sites.

To fill this gap in our information base, the Maine Geological Survey initiated an ambient groundwater quality program during the summer 2000. The goal of this program over several years is to develop a database of typical ambient groundwater quality in all the geological provinces of the state. The program is a partnership among MGS, the Bureau of Parks and Lands (some funds come from the agreement with Poland Spring for groundwater production at Range Pond State Park), the Maine DEP, the USGS, and the Water Research Institute at the University of Maine. With limited funding and resources we developed a modest program for 2000 in the drainage basins centered on Range Pond and Camden Hills State Parks. Within these areas MGS solicited participation from the home owners whose basic well information (well depth, yield) is in our existing database, with enthusiastic response. We sampled about 70 wells and will analyze the samples for a long list of metals and other compounds, and compare the results with local bedrock and surficial geology, and other factors. Over time a clear understanding of the relationship between geologic setting and water quality will emerge. Additionally, we may identify potential quality issues before they become large problems.

Earth Science Week

Earth Science Week 2000 is set for October 8- 14. We are in the final stages of planning several events. MGS is working with the State Museum on a special day of activities that will include displaying some of the extensive collection of Maine minerals and fossils that are not currently on public display. As with past Earth Science Weeks, I trust that the geology departments at Maine colleges and universities will host special events. Earth Science Week is a great opportunity for all earth scientists (this means you!) to engage in some activity or event that helps the public better appreciate Maine's geology. MGS will post a schedule of events on its website (http://www.state.me.us/doc/nrimc/mgs/mgs. htm) as soon as it is developed.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2000, The State Geologist's Message: Groundwater Quality Program & Earth Science Week. *The Maine Geologist*, v.26, n.3, p. 1–2.

THE STATE GEOLOGIST'S MESSAGE

Maine Geological Survey Program Updates

The Maine Geological Survey will conduct an ambitious program of geological mapping during the summer of 2001 with projects extending from the coast to Aroostook County. The key projects we will be working on are:

Aquifer mapping: Our program will focus in Aroostook County this summer as we wrap up the final field effort to upgrade all the aquifer maps to the 1:24,000 scale. Craig Neil and his crew of summer interns will carry out this program, along with Dan Locke and Tom Weddle. With improved data collection techniques, including 12-channel seismic refraction, and improved GIS processing, the products of this work will be timely and greatly improved over the existing generalized aquifer information for the area.

Surficial mapping: Through the past several years, Woody Thompson and contract mappers have been working on the surficial geology around Lewiston and to the west. This effort builds on the geologic framework developed by our earlier mapping of the 1:24,000-scale quadrangles that comprise the Portland 1: 100,000-scale sheet. This summer's program will complete the area around Lewiston and will extend the work westward toward the New Hampshire border. This mapping program is made possible with matching funds from the National Cooperative Geologic Mapping Program (NCGMP). An additional project under this program will be mapping the Bath quadrangle and vicinity by Tom Weddle.

Bedrock mapping: Again with assistance from the NCGMP, MGS will carry out bedrock mapping_ in the Lincolnville area, building on our understanding of the area's complex geology developed through several years of mapping in the area. Several contract mappers, including Dave West, will be part of this project which will cover a number of key quadrangles between Penobscot Bay and Augusta, part of the Survey's longer term goal to map the bedrock of the Augusta 1: 100,000-scale quadrangle. Making sense of this complex geology and directing a small group of contract mappers will be Spike Berry's primary responsibility.

Coastal geology: We are continuing work here on several fronts that will be the subject of a future report.

Geologist Certification

Two bills have been entered into the first session of the 120th Legislature to address the high renewal cost for certified geologists, which went from $80 to $140 last year. The titles are: "An Act to Move Oversight of the Board of Certification for Geologists and Soil Scientists to the Department of Conservation" sponsored by Representative Richardson, and "An Act to Revise Registration Fees of Geologists" sponsored by Representative Duplessie. We have not seen the language of these bills at this time. If you are concerned about the high cost of license renewal, inform your local Legislators about your concerns, and suggest they support one or both of these bills.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2001, The State Geologist's Message: Maine Geological Survey Program Updates & Geologist Certification. *The Maine Geologist*, v.27, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Water, Water Everywhere…

In Maine where we are blessed annually with about 45 inches of precipitation it is somewhat difficult to imagine that we face water supply issues. Yet over the past several years the State has faced several issues illustrating that even here we can have conflict. The most pressing issue has to do with water resources in eastern Maine. There the need for water to support irrigation of blueberry barrens is in direct conflict with habitat needs for Atlantic salmon, recently listed as an endangered species by the U.S. Fish and Wildlife Service. Conflict arises during dry summers (most recently 1999, but perhaps 2001?) when growers need water to irrigate during June and July. Rivers and streams approach base flows during this time and water withdrawals for irrigation on small tributaries can affect critical habitat. Over the past year and a half, my office has been engaged with other state and federal agencies, irrigators, wildlife managers, and other interested parties to develop solutions to this problem. The group is looking at ways to implement water storage so that some of the needs of irrigators can be handled by storing spring runoff. We are also looking to develop better information on base flows. Early in the process, we recognized that the State has very little information on low-flow conditions in rivers and streams other than general values that probably are not applicable everywhere. Together with funding from other state agencies, we are engaged with the USGS in a low-flow study of eastern Maine rivers that will establish base flow conditions that are protective of habitat in many of the small tributaries where water withdrawals occur.

Another water supply issue relates to lake level management. Consider the conditions of this past winter wherein water content in the snow pack was increasing in March rather than decreasing. This caused a great deal of concern among the members of the River Flow Advisory Commission about spring flooding. With typical April rainfall the State would nearly certainly have faced significant flooding and actions were taken to reduce this risk. Then it didn't rain. As a consequence, many dammed lakes will not reach full pond this year. At Sebago Lake, the water level on May 1 is usually at or near the spillway but was more than 2 feet below this year. Low water on the lake is actually beneficial for the beaches that have seen several damaging high-water storms in the last few years. Low water will allow waves to reactivate sand from deeper water and move it toward the beaches. It is a challenge to strike the appropriate balance here since many property and boat owners are not happy when they do not have access to their docks.

…And not a Drop to Drink

In the past year there has been much media attention on the issue of arsenic in groundwater, brought on partly the Clinton Administration's proposal to lower the maximum contaminant level (MCL) for public water supplies from 50 ppb to 10 ppb, and the Bush Administration's reconsideration of this change. Arsenic hot spots in Maine such as Standish and Northport have also received much media attention. In 1994 our office was involved in an arsenic investigation in the southern Maine towns of Buxton and Hollis. As part of that effort we used the Department of Human Service's (DHS) water analysis database to assess arsenic levels on a statewide basis. We found that more than 13% of the tested private wells statewide were above the 50 ppb MCL. More recent studies of wells in New Hampshire and neighboring New Brunswick show only 2-3% of the wells in those areas above the MCL. So why is Maine so high? Part of the problem is that the DHS database is populated with volunteered well information. Property owners may have suspected a problem with arsenic (perhaps their neighbor's well had elevated levels) and had their water tested. This has skewed the database toward higher values. Both the New Hampshire and New Brunswick studies use randomly selected wells. To correct this problem, we are working with

DHS on a study of arsenic levels in randomly selected wells. This project will be complete in early summer when we will better understand the statewide incidence of arsenic in groundwater. It is likely, however, that there are regional clusters of higher arsenic values. Using the NH rate of 3% above the MCL, only 120 of the approximately 4000 wells in the Buxton/Hollis area should have been above 50 ppb. In our sample of 1100 wells, we found 150 above 50 ppb. We will have an update on the random-well study at the end of the summer. In the meantime, have your water tested!

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2001, The State Geologist's Message: Water, Water Everywhere… *The Maine Geologist*, v.27, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Update on Camp Ellis

The Maine Geological Survey has a long history of working on the coastal erosion issue at Camp Ellis, a problem that was carefully reviewed by Joe Kelley and Walt Anderson in their report "The Maine Shore and the Army Corps: A Tale of Two Harbors" published in Maine Policy Review. Since their first construction in 1867 the jetties, which provide safe navigation into the Saco River, have caused havoc to the beaches of Camp Ellis. Since that time more than 30 properties have been lost to erosion as the jetties reflect wave energy onto the beach and longshore drift carries most sand north to the benefit of residents at Pine Point. This is the state's most critical coastal erosion problem.

Over the years the Corps of Engineers has conducted numerous studies of the situation at Camp Ellis, most often concluding that the jetties play no role in the erosion problem. Their 1992 "Beach Erosion Study, Section 111" analyzed several remedial alternatives including building a beach-parallel breakwater, further hardening of the shoreline, roughening of the jetties, beach replenishment, and combinations of these. Their benefit:cost ratio for these alternatives at that time showed that costs exceeded projected benefits. Nothing was done. The Corps basically closed the books and washed their hands of the problem.

Last year under intensive pressure from the City of Saco, the state agencies, and our Congressional Delegation (in particular Tom Allen), the Corps decided they could take one more look at Camp Ellis. They "updated" their Section 111 report with additional economic information and more realistic erosion rates. Remarkably, those same remedial alternatives that previously had benefit:cost ratios less than 1.0 were suddenly in the 1.3-1.5 range. The Corps could now move forward with a project at Camp Ellis to address the erosion issue.

With these numbers in hand, several representatives from Camp Ellis and Saco and I visited our Senators and Congressmen in Washington last June. The result of these meetings is an appropriation of $350,000 (once the 2002 budget is passed) to undergo the design phase of a project to roughen the north jetty and add sand to the beach. Most geologists agree that roughening the jetty at best would reduce the force of waves reflected from the jetty and at worst would do nothing. Adding dredged sand to the beach from the harbor area and near the mouth of the jetty will mimic the transport of sand from the river to the beach that was disrupted by the jetty. The entire project will cost about $4 million to complete. We also continue to look at ways to fund

buy-outs of the most at-risk properties because it will make more sense to place the sand higher on the beach where a dune could form rather than lower.

Will this solve the erosion problem at Camp Ellis? Probably not. This is a short-term step in the right direction. Through this recent study, the Corps has acknowledged responsibility for the erosion and we need to make them commit to a long-term solution.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2001, The State Geologist's Message: Update on Camp Ellis. *The Maine Geologist*, v.27, n.3, p. 2.

THE STATE GEOLOGIST'S MESSAGE

A New Era of Map Production

For most of the tenures of the current and past two state geologists, the primary means of making geological maps available to the public at low cost was through various permutations of a diazo process. For this process, maps were drafted on mylar, placed on special photosensitive paper, exposed to light, and developed to produce a paper black and white map for only pennies a sheet. With the exception of a few high-volume maps like the state bedrock and surficial maps, all geologic maps up to 1990 were produced as black and white line maps on mylar. Even our first GIS-based maps were produced on mylar so that we could use the diazo process to make copies.

Early diazo equipment at the MGS included a homemade light box incorporating about 30 sunlamps for even exposure. Making mylar masters and paper copies was sweaty work even in February. Over the years, improved equipment replaced our improvised solutions, most recently our Oce machine, purchased in 1987. This beast would automatically feed mylar maps, advance a roll of special paper, cut the sheet, make the proper exposure, and develop the paper map all in a matter of seconds. It was the workhorse of the survey for a decade, but as map volume increased so did the labor involved. Eventually MGS staff was spending about half a man-year getting mylars from storage, running copies, replacing mylars, and folding paper maps.

With the digital revolution in mapping during the last decade, several problems began to develop with our map reproduction system. As the demand for diazo processing decreased, technical support for our equipment evaporated and paper was hard to find. Bob Tucker, Ben Wilson, and John Poisson did yeoman's work keeping our machine running with improvised repairs. But with paper supplies dwindling, we knew we had to make a change.

In 1999 we set on a course to convert all old maps to digital format. For part of this effort, we purchased a large format scanner to automate several older map series. We also digitized some maps. Most importantly, to see us through until the conversion was done we bought the last rolls of special diazo paper available in the country! After many months of scanning and formatting, our library of more than 1,000 scanned maps is complete. Maps are now plotted on two HP 5000 inkjet plotters with a single click of the mouse. The Oce machine was shut down for the last time in early February, disassembled, and hauled off to our surplus property shop. Thanks to all the

survey staff who made this conversion a great success! And, if anyone needs a heavy mooring block, I'm sure the state surplus folks would like to hear from you!

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2002, The State Geologist's Message: A New Era of Map Production. *The Maine Geologist*, v.28, n.1, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Impacts of budget shortfall at the Maine Geological Survey

All of you have heard much in the news about Maine's budget shortfall. To any of us with mutual funds or other stock investments, it seemed fairly obvious that 2001 would be a down year with reduced capital gains. Somehow the state's revenue forecasting committee lacked clear vision on this and over-estimated tax revenues from capital gains. Tax revenue forecasting is complicated, but it is still surprising to many that this particular aspect of reduced tax revenue was overlooked. The revenue shortfall has an immediate impact on the remainder of our FY 02 budget that ends June 30, and a continuing impact on our FY 03 budget.

Since this news broke in April, all of us involved in state budgets have been playing a game of "Calvin Ball" of sorts – we're in the middle of the game and the rules keep changing. In the last few weeks the magnitude of the problem has stabilized to about $180 million over two years. Projections at this time indicate that the problem is a short-term one, but if it's the same group of forecasters making this proclamation, hold onto your wallets! For FY 02, Governor King is covering the shortfall with the Rainy Day Fund. The problem with this strategy is that the FY 03 budget approved by the Legislature in early April already used some of those funds to fix a then-projected small gap in FY 03. A couple of contractual salary increases of a few percent in FY 03 compound the problem.

The immediate impacts at the Maine Geological Survey have been a curtailment of spending for the remainder of FY 02. Since we are a field-based organization, this has been particularly painful because our summer program gets underway during the last quarter of the fiscal year that usually has substantial start-up funds. We have been unable to do some contracts for assistance with our groundwater quality program, for some student interns, and for basic mapping. Fortunately, much of our summer program uses federal and dedicated funds. Our STATEMAP funded programs of bedrock and surficial mapping will move forward. Mapping of coastal bluffs in eastern Maine continues. With some shifting of staff and resources, our groundwater quality program will continue at a somewhat reduced scope. If we had not been successful in the past five or six years in shifting some of the programs to these other funds, the immediate spending curtailment could have been disastrous to our summer program.

State government is still working on the details of a plan to address the FY 03 problem. At this time, we are not contemplating any personnel cuts. Such cuts would have lasting impact since it has been nearly impossible for any state agency to justify additional positions for worthy programs in the past seven years. To put this in perspective, the last new position at the Maine Geological Survey was approved in 1989. Since the budget crisis of the early 90's we have lost six positions. Fortunately with our increased revenues from federal and dedicated funds we have been able to keep most of the programs going and have still had resources to address important new issues like

drought impacts and sustainable water use. Hope for a good 2002-2003 and a new group of tax revenue forecasters!

Robert G. Marvinney, Maine State Geologist

[*original* Editor's note: as most of you realize, in the fast-changing world of Maine revenue projections, Bob's column (6/02/02) has been overtaken by events, including the addition of State worker furlough days. Please check the newspapers for these painful changes that we can't keep up with in these pages.]

Marvinney, R.G., 2002, The State Geologist's Message: Impacts of budget shortfall at the Maine Geological Survey. *The Maine Geologist*, v.28, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Drought continues in Maine

Over the past year and a half, Marc Loiselle and I have spent much time in meetings of the Drought Task Force. This group is jointly chaired by the Chief of the USGS Water Resources Division in Augusta and the Director of the Maine Emergency Management Agency. Task Force members include state agencies, federal agencies, the National Weather Service, farm agencies, water utilities, reservoir managers, and others. While Maine has experienced a number of dry years in the past five, our current drought began in earnest in April of 2001. As you will recall, the winter of 2001 closed with a number of substantial snowstorms that increased water content in the snowpack statewide during March, a time when the water content is usually decreasing. Emergency managers were very concerned about the threat of flooding. But precipitation in April was 2-3 inches below normal around the state which led to an orderly snowmelt. Precipitation remained below normal for the rest of the year, so much so that 2001 became Maine's driest in over 100 years of record.

In some parts of the state, groundwater levels reached record lows during the fall of 2001. After the growing season is over, groundwater levels usually recover to some degree, but last year the groundwater levels kept dropping throughout the fall and winter. Recovery during the spring was close to normal for northern and eastern Maine. In southern Maine, however, the recovery was only half of normal. (Check the Sanford well at the USGS website - http://me.water.usgs.gov/gwmap.html.) In 2001 thousands of people around the state experienced problems with mostly dug wells that went dry. This year many more experienced problems. Through this entire period, there have been numerous reports of replacement bedrock wells going to 500 feet or more without finding water. Certainly, a few drillers have discovered that the distribution of water-bearing fractures in Maine is unpredictable, but the vast majority of new wells encountered water at reasonable depths.

After a disappointing winter season (at least for skiers), 2002 got off to a reasonable start with spring rain that was close to normal around the state. Farmers had a good start to the season. At the Drought Task Force we were warned that conditions could shift back into drought with just a few dry weeks. July and August were great for outdoor activities, but the lack of rain forced the state decidedly back into drought. In August we had just over an inch of rain – among the driest on record.

As we enter autumn, the northern part of the state has fallen into severe drought, and the central and southern parts of the state are in moderate drought. Coastal areas are a bit better off. Groundwater levels in southern Maine index wells are poised to reach all-time lows. The precipitation outlook for the next few months gives equal probabilities to normal, below normal, and above normal conditions. We'll need substantial rain this fall and a good New England winter to turn around the groundwater situation.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2002, The State Geologist's Message: Drought continues in Maine. *The Maine Geologist*, v.28, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Budgets continue their free-fall

When I last wrote in June of 2002 about the budget situation, the speculation at the time was that the revenue shortfall would be a short-term one. In the past 6 months you have all heard how the shortfall has extended into the 2004-2005 budget cycle to the tune of $1 billion! Again, I wonder who those revenue forecasters are and why their forecasts are consistently poor! Certainly most states are facing shortfalls and Maine's is small in comparison to some. Still, it will mean very difficult times for the Department of Conservation (DOC), which includes the Maine Geological Survey.

As part of the budget-balancing strategy, the Baldacci Administration has directed all departments in the next biennial budget to self-fund increases in salaries and benefits above the 2003 levels. At first blush this may seem fairly simple, but with scheduled salary increases and soaring medical premiums, this comes to $8 million for DOC, a whopping 15% of our budget! The MGS's part in this exercise comes to about $170,000 each year. For perspective, the Department represents only 0.85% of the state budget. We're going to see just how much blood you can squeeze from a stone!

Because the DOC is so heavily weighted toward personnel, it is difficult to come up with this type of money without cuts in positions. You may have heard in the news that other departments will have few position cuts and this is because their budgets are not as heavily weighted toward personnel. If the Governor's budget proposal passes the Legislature, in DOC more than two-dozen positions will be cut from the Maine Forest Service causing a reduction in fire suppression activities, Parks would lose 8 positions and de-staff some parks, and the Land Use Regulation Commission would lose 7 positions and close regional offices.

MGS will lose one position and some operating funds. This may seem like a minor scrape but, taken in the context of the last decade, it is severe. Since 1990 the MGS will have lost 7 of 19 positions, or 37% of its staff! Obviously, we cannot be doing as much as we were before the cuts, but some improvements in technology have at least partially compensated for this. We all use personal computers now, and GIS has made our map production system more efficient so we can manage without some positions. Others have been difficult to get along without. Through this latest cut, we will reduce our rate of aquifer mapping, eliminate our ambient groundwater quality program, and reduce our Sebago Lake profiling program. Our contribution to the Atlantic Salmon Conservation Plan will be eliminated, our cooperative with U Maine squeezed, and other funds for mapping reduced.

However, we will continue to aggressively pursue other sources of funding and cooperatives in order to meet the mission of the agency. Outside funding has been a tremendous benefit to our agency and has increased three-fold in the past 5 years. Funding from the USGS, for example, has made it possible to maintain a rigorous bedrock and surficial mapping program. Funding through NOAA has added a 2-year Coastal Fellow to our program. Cooperatives with DEP augment our aquifer mapping and water use programs. Most of these will continue.

As always, I thank the members of the Geological Society of Maine for their continued support. Should the Maine Geological Survey face further cuts than those I outline here, I will call on each of you to express your concerns to your representatives.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2003, The State Geologist's Message: Budgets continue their free-fall. *The Maine Geologist*, v.29, n.1, p. 3–4.

THE STATE GEOLOGIST'S MESSAGE

Geology at the State House

How often have you been out in the field looking at an outcrop when a passerby asks you if you are looking for gold? This happened to me just recently as I was examining the excellent new exposures along the access road for the third bridge in Augusta. Questions like this underscore the public's very poor understanding of the many facets of geology and the contributions geologists make to society. Geologists are viewed more as rock hounds than as scientists that are doing significant work. We know that this impression is far from accurate.

This narrow impression of geology as a profession extends to our elected officials in the State House as well. With the exception of the 13 Legislators on the Natural Resources Committee, most of the 151 members of the House and 35 members of the Senate probably have little knowledge of our profession. Yet every session our representatives vote on issues that have some geological connection. Last session the Legislature voted on bills concerned with rules for development on coastal dune systems, for reporting depths of water wells, and the use and proper disposal of arsenic-treated materials. All of these issues have clear connections to geology. Legislators could use more background on the nature of geology and the value of geological investigations to issues that affect society.

An excellent option for exposing more Legislators to our profession is through a "Geology Day" at the State House. Many other professions have their days in the Hall of Flags, too – "Marine Resources Day", "Dental Hygienists," and the list goes on. I propose to organize such a day during the next legislative session, perhaps sometime in February or March. But to make this successful, I need your help. These events usually involve a number of exhibits staffed by individuals who are knowledgeable about particular areas of geology. We need good representation from the geological professions to make this event a success. I hope I can call on all of you for support.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2003, The State Geologist's Message: Geology at the State House. *The Maine Geologist*, v.29, n.3, p. 3.

THE STATE GEOLOGIST'S MESSAGE

Snow survey critical to flood forecasting

With snowshoes strapped to his feet and long aluminum tubes slung over his shoulder, the gelogist heads into the brush. Tramping around over an acre of land, he pushes the tube into the snow in a number of places, retrieves it, makes a few notes, and moves on. Over the course of the day, he may stop at a dozen sites and repeat the process. What's this all about? The Maine Cooperative Snow Survey. More than a dozen government agencies and private enterprises participate in the annual survey aimed at assessing the condition of the snowpack through the winter and the critical spring run-off period. In addition to the Maine Geological Survey, the U.S. Geological Survey, the National Weather Service, Canadian and New Hampshire governmental agencies, several paper companies, and several waterpower companies participate in this truly collaborative program.

The survey begins in early January with measurements to develop a baseline for the winter. We conduct the second survey of the season in early February. In late winter (that's supposed to be March) we conduct a survey each week until the snow is gone. Surveyors use special aluminum tubes that are calibrated in inches on the outside for snow depth, and have a spring-loaded mechanism on the inside that calibrates the weight of the snow column in terms if equivalent inches of water. Multiple tubes screw together for deep snow. With this mechanism surveyors can determine the depth, water content, and density of snow in very short order in an area. The density is particularly critical since forecasters use it to estimate when the snow might melt. A density over 0.33 is considered "ripe."

Information from the numerous surveyors on each survey is phoned, faxed, or e-mailed to the Maine Geological Survey where we generate maps of the state showing snow depth, water content, and density. The standard series of maps is produced using GIS programs and also includes change in water content since the previous survey, mean water content in drainage basins, and comparisons of the water content to historical values for that date. Within hours of the report from the last surveyor, a set of preliminary maps is posted at the Maine Emergency Management Agency (MEMA) website (http://www.state.me.us/mema/weather/snow.htm). The National Weather Service (NWS) uses the information to prepare flood potential statements and running flood forecast models. In the event of a significant flood, the NWS would use the data to refine its estimates of flood crests. The data are also distributed through MEMA to county emergency management officials. Reservoir managers use the information in planning capacities for spring fill-up. While not the intent of the program, winter sports fanatics also use the information to determine when and where to go in the state to enjoy their activities.

Maine's winters are close to unpredictable and none approach "average." Throughout March of 2001, for example, water content in the snowpack was increasing rather than decreasing, raising well-founded concerns for flooding. April that year had almost no rain and mild weather, producing an orderly run-off. For the 2003-2004 winter season, we probably should have started surveys in December, given its unprecedented snowfall. But in January 2004, northern Maine was not even surveyed due to lack of snow. There is still much left to the winter of 2004! Check the MEMA website frequently for updated snowpack information.

Update on "Geology at the State House"

In the Fall 2003 newsletter, I made a pitch for Geology Day to take place sometime during the Legislative session now underway. Upon further investigation, I found that all appropriate dates

were booked well in advance. Therefore, Geology Day will debut in the Hall of Flags during the first regular session of the 122nd Legislature. Mark your calendars for January 18, 2005. I will pull together an organizational meeting for this event during the fall 2004. Stay tuned.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2004, The State Geologist's Message: Snow survey critical to flood forecasting & Update on "Geology at the State House." *The Maine Geologist*, v.30, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

National Cooperative Geologic Mapping Program

The National Cooperative Geologic Mapping Program is currently before the House of Representatives (HR 4010) and the United States Senate (S. 2353) for reauthorization and will benefit from your support! If you feel as strongly as I do that the nation needs modern geologic maps to address numerous societal issues (water resources, environmental protection, natural hazards, etc.) then please contact your representatives and request that they co-sponsor these bills. You can review information about the program plus some fact sheets at http://www.state.me.us/doc/nrimc/mgs/mgs.htm.

Some important points about the National Cooperative Geologic Mapping Program

- The Program was created with the passage of the National Geologic Mapping Act of 1992. Since that time, the program has produced more than 7,500 new geologic maps nationwide.
- The National Cooperative Geologic Mapping Program has been reauthorized in 1997 and 1999, each time by unanimous consent of Congress and with strong bipartisan support, attesting to the success of the program.
- Only 25% of the Nation is mapped in the detail necessary to address important societal issues.
- Rigorous economic analysis demonstrates that the value of geologic maps exceeds their cost of development by at least a factor of 25.
- The program is an excellent example of federal/ state partnership. State geological surveys are awarded federal funds through a rigorous competitive process that ensures the relevancy of the mapping and must match federal funds dollar-for-dollar.

In Maine:

- Only 15% of Maine has the detailed map coverage necessary to address issues of water resources, environmental protection, and risk reduction from natural hazards, among others. 50% of Maine is unmapped at even an intermediate scale.
- Over the past decade the program has contributed over $500,000 to creating more than 70 new geologic maps in areas of important societal need.
- Geologic maps provide the underpinning necessary to address such important issues as landslide risk (e.g. Rockland), coastal erosion (e.g. Camp Ellis), and groundwater issues. For example:

- More than 50% of our citizens rely on groundwater sources for their domestic water supply. Mapping the characteristics of the bedrock is critical to understanding groundwater quality, quantity, and strategies for protection.
- Mapping surficial geology is the first step in identifying sand and gravel aquifers, among the most significant groundwater resources in the state for municipal water supplies, irrigation, bottling, etc.
- Surficial geologic mapping establishes the distribution of glacial-marine mud, the deposits most susceptible to landslides.
- The program has doubled the mapping budget of the Maine Geological Survey.

Contact your representatives

Letters and phone calls to our congressional delegation from constituents who use geologic maps are far more effective than messages from a bureaucrat like me. However, I am pleased to inform you that on my request Congressman Tom Allen has agreed to co-sponsor HR 4010! Please thank him for his support! Check our web pages for contact information for our Congressman and Senators. The time to act is now!

Thanks for your continued support.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2004, The State Geologist's Message. *The Maine Geologist*, v.30, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Maine Water Facts

Although Maine is no longer in a drought, water issues continue in the news, whether it's a proposal to pump groundwater in Pierce Pond Township, to tax bottled water, or to ship Maine water to New Mexico in railcars. In response to numerous requests to my office for information on Maine's water resources, I've compiled a few facts to put Maine's resources in perspective. Here are a few:

Some Water Facts

- Average annual rainfall: 42 inches. Equivalent to 73,500,000 acre-feet or 24 trillion gallons statewide.
- Run-off: About 50% of precipitation, or about 12 trillion gallons, runs off the landscape in streams and rivers.
- Evaporation/transpiration: About 30-40% of rainfall evaporates or is transpired through vegetation. This equals about 7-10 trillion gallons.
- Infiltration to groundwater: About 10-20% of precipitation infiltrates to recharge groundwater. This is about 2-5 trillion gallons annually.
- Mapped sand and gravel aquifers occupy about 1,300 sq. mi. of Maine's landscape. Average annual recharge to these aquifers is about 240 billion gallons.
- One inch of Sebago Lake contains about 800 million gallons of water.
- Sebago Lake is the public water supply for about 200,000 people, serving them with about 8.5 billion gallons annually (about 10 inches of Sebago Lake water).

- Bottled water producers in Maine use about 500 million gallons of water each year.
- Some large blueberry growers irrigate with nearly 400 million gallons during dry years.

Aquifers

Many people perceive an aquifer is as a single, confined geological unit that underlies a vast area but has a limited recharge area. This type of aquifer is typical in the western United States but is not representative of Maine aquifers. Groundwater occurs in Maine in two primary kinds of aquifers, (1) sand and gravel, and (2) bedrock.

Sand and gravel aquifers: these are unconsolidated sand and gravel deposits, most of which were deposited during the last glacial episode which ended about 14,000 – 11,000 years ago. These deposits have excellent porosity and permeability that make them significant groundwater resources in the state. Because they formed as water melted from the glaciers, they are found only in limited areas around the state. Sand and gravel aquifers are recharged locally by precipitation.

Bedrock aquifer: The entire state of Maine is underlain with bedrock composed of igneous and metamorphic rock. Almost everywhere, this bedrock is fractured due to the many geological processes the rocks have endured since they formed between 360 and 650 million years ago. The fractures in the rock provide the porosity through which groundwater flows. Fractured bedrock in Maine is recharged locally.

Groundwater recharge

In Maine groundwater levels fluctuate systematically throughout the year as the resource is recharged in the spring from runoff and rain. Groundwater levels decline during the summer and fall as available precipitation is consumed by evapotranspiration processes, and groundwater in storage flows into surface water. Annual fluctuations on the order of 3-4 feet are typical for many wells in the monitoring network maintained by the USGS. Long-term records show that groundwater levels have neither declined nor increased significantly.

This is in sharp contrast to aquifers in the western United States, for example the Ogallala aquifer that extends from the Texas panhandle to South Dakota. About 30 percent of the ground water used for irrigation in the U.S. is pumped from this aquifer, about 14 billion gallons per day in 1990. It is also an important public water supply, serving 2.2 million people with 332 million gallons per day in 1990. In an area that receives less than 15 inches of rain annually, this rate of use greatly exceeds recharge, resulting in groundwater mining. In some areas the water level has declined over 150 feet.

Conclusion

Water in Maine is an abundant, continuously renewable natural resource that, with careful stewardship, can be used to support a variety of economic activities.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2004, The State Geologist's Message. *The Maine Geologist*, v.30, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Report on Geology Day at the State House

About 20 geologists descended on the Hall of Flags at the Maine State House on January 18 in what I hope will become a biennial affair – Geology Day. The objective of this daylong event was to provide the Maine Legislature with an overview of the broad spectrum of geological activities that contribute significantly to Maine's economy and environment. During the course of the day, many legislators and administration officials stopped by the numerous displays set up around the room and discussed the work done by geologists. Thanks to the many participants that made this day successful. The real measure of success will come as Legislators debate bills addressing water, aggregate resources, and coastal hazards in this and future legislative sessions. Here's a summary of the presenters and displays.

- Maine Geological Survey provided an overview of geologic mapping and how mapping helps define sand and gravel aquifers.
- Dragon Products provided a broad perspective on mining, including cement production and the geological materials used in their process.
- Nestle Waters/Poland Spring provided an overview of aquifers, sustainable water use, and a perspective on water use in Maine.
- S.W. Cole displayed information on geothermal studies as it relates to heat exchange systems (part of green certification for buildings) and wastewater treatment that include snow systems.
- The Maine Drinking Water Program discussed public water supply location and protection.
- USGS discussed the real-time groundwater network and climate change – earlier ice out dates, earlier peak flows, no change to summer base flows, etc.
- Hillier Associates focused on storm water work, lake studies for DOT, and lake bathymetry
- Emery & Garrett reviewed several ground water applications.
- Northeast Geophysical Services had on display various geophysical units used in their investigations, including a seismograph.
- Pike Industries gave an overview of aggregates used in various construction applications.
- The University of Maine Department of Earth Sciences provided an overview of many coastal geological studies.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2005, The State Geologist's Message: Report on Geology Day at the State House. *The Maine Geologist*, v.31, n.1, p. 3.

THE STATE GEOLOGIST'S MESSAGE

A Reminder of Geologic Hazards

This spring we were again reminded that, although we live in a relatively stable geologic setting compared to many parts of the globe, Maine is not immune to a number of geologic hazards. April and May, 2005 will be remembered as very wet months with rainfall well above normal and a string of soggy weekends that frustrated outdoor enthusiasts of all types. A brief recount of significant rains in southern Maine:

March 28-29, 2.5 inches;
April 2-3, more than 2 inches;
April 23-25, 2 inches;
April 27-28, 3 inches;
May 7-8, 1 inch.

Rain contributed to significant flooding on minor streams and major rivers, but also seeped into the ground. Records for groundwater levels almost everywhere in the state exceeded seasonal highs and in some instances set all-time record high levels. While we can definitely say the drought is over by all measures, the water seeping into the ground had other less desirable consequences as well. In numerous places around the state, waterlogged glacial-marine mud gave way on steep slopes, generating small mudslides. Most of these were fairly minor, like several along I-95 in the Biddeford area. But in at least one instance the moving earth threatened a property.

On May 8 in the southern Maine town of Wells, the land gave way between a home and the Merriland River. The mudslide exposed a significant section of the home's foundation and temporarily rerouted flow in the river. No one was home at the time, so the exact time and sequence of the mudslide is uncertain, but it was likely a catastrophic event. The home was situated about 30 feet above the river at the crest of a heavily wooded slope. A few feet of fine sand overlies thick Presumpscot Formation clay at this locality. Slip probably originated in the clay and took out large blocks in retrogressive, rotational failures, leaving large trees tilted 45 degrees toward the house. The mudslide extended for several hundred meters along the river, gradually diminishing toward the north end.

Although the house was not damaged by the mudslide, it will likely be a total loss since the land behind it cannot be remediated to its former contours, and it would be difficult, potentially dangerous, and prohibitively expensive to move the structure. Unfortunately, the homeowner will likely bear the burden of this loss on their own as homeowners' insurance policies do not cover landslides.

While certainly small by Caleefornia standards, this event was catastrophic for one family and drives home the message that the landscape of our planet is dynamic. While we have excellent information on the distribution of the Presumpscot Formation, our information on landslide history and hazard is incomplete. With the University of Maine, we have been working to map coastal landslide hazards, and have completed 80% of the coastline, with the remainder scheduled for the next three summers. On inland rivers, streams, and lakes, we have general information but no detailed mapping of past landslides and hazardous areas. The resources at the Maine Geological Survey are stretched very thinly, but we continue to aggressively seek funding opportunities for

this important work. Please remember this if you are asked sometime soon to sign a petition to reduce the size of state government.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2005, The State Geologist's Message: A Reminder of Geologic Hazards. *The Maine Geologist*, v.31, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Marine Program Highlights

The devastating landfalls of Hurricanes Katrina and Rita serve as reminders of the vulnerability of our coastal communities to natural disasters. As Americans have streamed to coastal communities in record numbers in the past several decades, so too have the costs of disasters reached record levels. Many factors have contributed to this escalation in disaster costs, including to some degree the general public's unwillingness to accept information presented by scientists. It's too easy to reject science as being incomplete, inconclusive, flawed, biased, etc.

While we have not had a devastating storm on the Maine coast for many decades, smaller storms are still a serious concern. In an effort to improve our scientific understanding of Maine coastal dynamics, in 2003, marine geologists Steve Dickson and Pete Slovinsky acquired a nearshore survey system (NSS) through a grant from the Maine Technology Institute. This system consists of a personal watercraft (PWC) outfitted with a Real Time Kinematic (RTK) GPS system, a high-resolution fathometer, a base station with a companion GPS system, and radio telemetry between the PWC and the base for data logging to a portable PC at the base. With the NSS, it is possible to collect very detailed bathymetry in the nearshore zone in a short period of time. Repeat surveys will reveal bathymetric changes from which shoreline change rates, in addition to volumetric changes, can be determined. This system forms the basis for the Maine Geological Survey's efforts at mapping erosion hazard areas along the southern coastal dune system. Steve and Pete have used the system to establish baseline bathymetry at Camp Ellis, and have begun using the RTK GPS for terrestrial-based surveys of vegetation line positions along the coast.

Recently the marine geologists have used the system to assist the Department of Transportation. The DOT is currently developing several possible bridge replacement projects and called on our NSS to produce detailed bathymetry in places too tight or shallow for a traditional boat survey.

With the addition of an acoustic doppler current profiler (ADCP), it is also possible to use the NSS to establish detailed current data. Steve and Pete used this capability to analyze peak flood and ebb currents at the mouth of the Presumpscot River for DEP's oil spill response planning efforts involving proper boom placement.

The ADCP capability was critical this past summer, when several southern beaches had closures due to high bacterial counts in the water. Water quality data is monitored by volunteers of the Maine Healthy Beaches Program and is collected, on average, once a week, at Maine's swimming beaches. Currently, beach advisories and closures rely strictly on weekly (sometimes daily) sampling, with a 24- hour delay for results, and no predictive capability. This could result in a day of exposure and a day of unnecessary closure, plus considerable sampling expense. To see what role currents might play in the issue, Steve and Pete mounted the ADCP on a small boat and collected current data off Goose Rocks Beach during several tidal stages. With the analysis of

current, wind, and wave data, we were able to determine the combination of conditions that possibly lead to high bacterial counts, and thereby help the Maine Healthy Beaches Program better predict when to post closures or advisories, and when sampling should be done.

This is good science that is contributing critically needed understanding of the dynamics of our coastal environment. You can read more about the NSS at the April, 2004 MGS Site of the Month.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2005, The State Geologist's Message: Marine Program Highlights. *The Maine Geologist*, v.31, n.3, p. 3.

THE STATE GEOLOGIST'S MESSAGE

Bio-fuels to replace Fossil Fuels?

I recently attended a presentation by proponents of technologies that would convert forest biomass resources into fuels and products for any number of uses. The concept is to process "underutilized forest feedstocks and residues" through various pyrolysis and gasification steps to produce a variety of products, chief among them bio-oils that could offset Maine's thirst for heating oil. With the proper investment over the next 20 years, the proponents suggest, as much as 50% of Maine's heating oil demand could be met with these forest-derived products, thus contributing significantly to energy independence for Maine. Elsewhere in the news there has been considerable discussion of bio-diesel and ethanol as "green" and "renewable" energy sources that can contribute significantly to our nation's energy independence.

Certainly energy independence is worthwhile goal, but one that needs careful scrutiny to ensure that the proclaimed benefits are realized. In this arena there is currently a young but intense debate over the energy balance of producing these bio-fuels. If the energy put into processing wood chips to produce a unit of bio-oil, for example, is greater than the energy that can be derived from that same unit of bio-oil, then the endeavor will be counter to the goal of contributing to energy independence, and probably should not be considered "green" or "renewable" either. The fossil-fuel intensity of large agribusiness is all around us, and if large quantities of corn are to be processed into ethanol, then we had better be sure there is an energy benefit in so doing, lest the result be a greater consumption of fossil fuels, but in an offset location (the heartland of America, rather than in our gasoline tanks).

As it turns out, determining the energy balance of bio-fuel processing is both complicated and sensitive to input assumptions and boundary conditions. A recent report in Science (Farrell and others, 2006) reviews many past analyses of this energy balance and summarizes the key issues involved. Clearly the fuel used for farm machinery, largely fossil-fuel-based fertilizers and pesticides, and fuels used for transportation are all part of the energy put into the process. But should the analysis also include the energy cost of manufacturing farm equipment? And how should the analysis address the energy value of processing byproducts (which may or may not be used)? Complicated questions with complicated answers, and although the jury is still out on this issue, the Science report provides a glimmer of hope that bio-fuels can contribute in some way to our energy future.

And there are some contributions that are positive or that hold some real potential, such as bio-diesel made from waste oil. Getting more energy from stuff that was going to be thrown out is positive. It may also be possible to "co-generate" bio-fuels from forest biomass using the waste

heat from a paper mill or biomass electric plant. These are options worth investigating, but proponents must be careful not to oversell the benefits in terms of energy independence. Unfortunately, the general public holds the misperception that a gallon of biofuel offsets a gallon of imported oil. While this clearly is not the case, the contribution of bio-fuels to energy independence all depends on how you do the math.

Farrell, A.E., Plevin, R.J., Turner, B.T., Jones, A.D., O'Hare, M., and Kammen, D.M., 2006, Ethanol can contribute to energy and environmental goals: Science, v. 311, p. 506-508.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2006, The State Geologist's Message: Bio-fuels to replace Fossil Fuels? *The Maine Geologist*, v.32, n.1, p. 3.

THE STATE GEOLOGIST'S MESSAGE

Landslide Mapping Initiative

Last year at this time I reminded readers that Maine is not without geologic hazards. The very wet months of April and May in 2005 produced a number of small landslides, one of which led to the abandonment of a home in Wells. It seems we have played that tape over again during May and June of this year. Many of us in central and northern Maine enjoyed a very pleasant Mother's Day this year, perhaps unaware the southern Maine was being deluged. Portland received 2.77 inches of rain on May 13, the greatest 24-hour total since 1893! The rainy May was partly responsible for minor landslides in Cumberland, Skowhegan and elsewhere that did little property damage, but that rattled the confidence of some property owners in the stability of our rock-solid earth.

Fortunately, this year I can tell people we are doing something about it, at least in terms of identifying the hazard. Last year's landslides led the Maine Emergency Management Agency (MEMA) to reconsider and fund an earlier proposal by MGS to conduct a pilot study of inland landslide hazards in Maine using modern digital methods. This effort will build on the excellent work done by Irwin Novak (1987, 1990) and subsequently by his students on an inventory of landslides in portions of southern Maine.

Over the next year, Mike Foley and Marc Loiselle, along with other MGS staff, will develop a digital methodology for identifying potentially hazardous areas, focusing primarily on the distribution of the Presumpscot Formation in areas with steep slopes. This effort will build on our digital library of 1:24,000-scale surficial geology maps, and digital elevation models (DEMs) with 10-meter data spacing available from the Maine Office of GIS (MEGIS). In an attempt to identify previous landslides, we will review these areas using digital imagery, also available from MEGIS. Following this effort, we will select four towns, two in southern Maine and two in the Penobscot River drainage, for ground-truthing the potential hazard maps. This effort has generated interest in the Cumberland and York County Emergency Management Agencies, whom we will meet with before the end of June.

On another front, we continue to work toward completion of our coastal bluff hazard and landslide hazard series, with mapping in eastern Maine during 2006 funded by MEMA. This effort has produced excellent results with the Maine DEP giving these maps serious consideration when reviewing coastal development, and many coastal towns adopting them in their local ordinances.

Just today (June 12) I received a request from the Town of York to complete the map series in their town because these maps "provide important information for responsible natural resource management and the protection of public health and safety." Fortunately, the York maps are in final review and will be available shortly. Congratulations to Joe Kelley and Steve Dickson for driving this effort, and to the small army of U Maine graduate students who have done the bulk of the fieldwork through the years!

With the soaring value of coastal and shorefront real estate, the entire map series would be worth their cost by leading to the avoidance of **one** poorly placed multi-million-dollar home!

Novak, I.D., 1987, Inventory and bibliography of Maine landslides: Maine Geological Survey Open-File Report 87-3, 1:500,000-scale.

Novak, I.D., 1990, Air photo reconnaissance of slope failures in the Presumpscot Formation, Cumberland County, Maine: Maine Geological Survey Open-File Report 90-22, 1:50,000-scale.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2006, The State Geologist's Message: Landslide Mapping Initiative. *The Maine Geologist*, v.32, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

What I did this Summer: Important Contributions by Student Interns

Over the years I have talked in this column about many programs at the Maine Geological Survey and the staff that make the programs work. Near the close of this very busy field season, I realize that I have probably not given appropriate recognition to the contributions to the field programs made by our summer interns. Each summer, we have had a number of interns carry out some tasks that have been essential to the success of our field programs. Here's what they did this summer:

Aquifer mapping: Our focus this summer was the nearly inaccessible terrain between Jackman and Stratton, extending from near The Forks in the southeast to the Quebec border. The objective of this effort was to map the distribution of the sand and gravel aquifers in this area that, in spite of its remoteness, may not be immune to development (e.g. see the Plum Creek plan for the Moosehead Lake area). William (Tex) O'Brien and Jason Choquette both came to us from UM Farmington and were assigned the seismic refraction task in the program. Jason and Tex conducted 90 twelve-channel seismic refraction lines in remote areas for the project, spanning a total distance of 21,000 linear feet. Often besieged by mosquitoes and black flies, they tirelessly carried out this effort in good humor. Six of the assigned seismic lines could only be accessed by canoe and by foot and they used a hand cart to transport all necessary equipment to conduct the surveys a distance of over 2.5 miles from the nearest vehicle accessible road. Maps for this project will be available from the Maine Geological Survey in spring 2007. Gentlemen, thanks for the outstanding effort!

Ground water sampling: As part of an effort with Columbia University to better understand the connections between geology and ground water quality, we carried out a sampling program in towns around Augusta. This is part of a much larger global effort by researchers at Columbia to understand the factors that control arsenic concentrations in ground water. Heidi Cheek from St.

Joseph's College and Hilary Thibodeau from UM Machias sampled more than 650 residential wells in the area. Juggling sample bottles and various sampling apparatus, they collected samples for a suite of major and trace metals, some for extended suites, and also for radon. In addition, they measured temperature, specific conductance, pH, and dissolved oxygen in the field. While keeping their eyes on the crushing schedule that required 12-14 samples per day, they none-the-less took the time to adeptly explain the program to inquisitive homeowners. Over the next few months we will get the analyses from Columbia and consider how they relate to bedrock geology, before moving to a new field area next summer. Ladies, we could not have done it without you and thanks for the excellent public relations!

Most often we get our interns through the Margaret Chase Smith Government Intern Program administered by the University of Maine, but sometimes we hire them directly. Any students interested in the program for summer 2007, when we will need at least two interns, should contact the Margaret Chase Smith Center at UM in late winter.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2006, The State Geologist's Message: What I Did This Summer: Important Contributions by Student Interns. *The Maine Geologist*, v.32, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Investigations of Bar Harbor earthquakes

Everyone is now familiar with the series of earthquakes that have shaken Bar Harbor since late September. More than two dozen earthquakes have been recorded by the New England Seismic Network since September 22, with three events of magnitude 3.1 or greater. Seismographs temporarily deployed in a tight net around the Mount Desert Island have recorded even more events. The most common question to my office from the media, local residents, and emergency responders regarding this series is, "What does this mean?" The honest answer at this time is, "We don't know," but we are trying to learn more about these earthquakes.

The largest earthquake in this series was the magnitude 4.2 event on October 2, which was felt over a broad area of central coastal Maine. Occurring shortly after the magnitude 3.4 event in September, this earthquake generated considerable interest in the seismological community. Dr. Won-Young Kim, Director of the Lamont Cooperative Seismographic Network (Lamont-Doherty Earth Observatory, Columbia University), arranged to have a total of six portable seismographs deployed on Mount Desert Island and neighboring areas, in a careful distribution intended to provide very precise epicentral locations for these earthquakes. Several of these units were made available on short notice through the Advanced National Seismic System at USGS.

Since their deployment, the units have recorded dozens of small aftershocks. Dr. Kim reports that the earthquakes originate at a very shallow location in the crust – approximately 1.5 km. Furthermore, the preliminary data indicate a roughly N-S line of rupture beneath Frenchman Bay and possibly a reverse E over W motion along the plane of failure. As more data are retrieved from the portable instruments in the months to come, seismologists will be able to further refine the locations and motions of these earthquakes.

I think this is an excellent opportunity for research that can build on the data already being collected. According to studies by the USGS, although the seismic hazard in the northeast is much less than in the western U.S., when combined with relatively old and densely built infrastructure,

this defines a fairly high seismic risk. One area that has not been adequately researched is the attenuation of seismic energy in the relatively dense crust of the northeast. Most studies of ground shaking relative to earthquake magnitude have been done in more seismically active areas where the crust dampens seismic energy relatively rapidly. Refining the attenuation factor in the northeast is essential to refining seismic risk.

Little research has focused on the causal factors of earthquakes in the northeast. Looking back through the instrumentally recorded earthquake record for Maine, there are no sequences of earthquakes similar to the Bar Harbor sequence in number, magnitude, and close spatial distribution. This series is truly unique! Analysis of the excellent dataset from the portable seismographs will provide an important window into crustal processes that can be applied to the entire northeastern U.S. In the months to come, I and MGS staff will work with seismologists of the Lamont and Weston Observatories, as well as researchers at UMaine to develop research proposals to further investigate the causes and consequences of these events.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2007, The State Geologist's Message: Investigations of Bar Harbor earthquakes. *The Maine Geologist*, v.33, n.1, p. 4–5.

THE STATE GEOLOGIST'S MESSAGE

Testing coastal regulations: the Patriot's Day Storm

It is perhaps fitting that our friend and colleague, Barry Timson, passed away as the State stared into the teeth of the fiercest Nor'easter in decades, the Patriot's Day storm of 2007. As many of you know, Mayor Timson of Hallowell was the first marine geologist hired by the Maine Geological Survey in the late 1960s. During his tenure at MGS he mapped and compiled the coast-wide map series, Coastal Marine Geologic Environments, a Herculean effort done with a few assistants over several years. These maps are still valuable today in discussions of sensitive habitats and for assessing the potential impacts of oil spills.

After leaving MGS in the mid-1970s, Barry opened his successful consulting business, which focused on work for clients with projects in Maine's coastal sand dune system. The gentlemen's arm-wrestle between Barry and his successors at the MGS ensured that our marine program adhered to the highest standards for quality and integrity of work!

Most recently, my interaction with Mayor Timson was through a multi-year process to review and revise the regulations that govern development in the dune system. Maine's ground-breaking regulations were first put in place in the early 1980s by the Legislature in response to the devastating winter storms of 1978. While not universally appreciated, these regulations play an important role in acknowledging the natural geologic processes of the beach system when evaluating development proposals. There have been efforts from the beginning to undermine the effectiveness of these regulations, but none as intense as during the late 1990s-early 2000s, instigated in part by changes in how the federal government views takings of private property.

In the summer of 2004, a stakeholder group convened by the Legislature, including MGS staff, Timson, and others involved in coastal issues began a nearly two-year process of regulation review and revision. It was a painful process at times, but through it we preserved many important elements of the regulations: sea-level rise is explicitly recognized and construction/reconstruction must be elevated on posts; construction/reconstruction projects must be moved back from the sea

as far as practicable on the lot; and seawalls may not be enlarged. Perhaps the most important element, though, is that which prohibits reconstruction of buildings damaged more than 50% by a coastal storm, if that building falls within an area likely to be affected by erosion over the next 100 years. For scientists, it is hard to imagine how the two homes that were destroyed in the April storm at Camp Ellis would not be within this erosion hazard area. We face an intense period over the next several months as Maine's sand dune regulations play out in the storm recovery arena, and we see who, ultimately, wins the arm wrestle.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2007, The State Geologist's Message: Testing coastal regulations: the Patriot's Day storm. *The Maine Geologist*, v.33, n.2, p. 1–2.

THE STATE GEOLOGIST'S MESSAGE

A Few Program Updates

Over the past year in this column I discussed a number of exciting programs and activities at the Maine Geological Survey and herein provide updates on a few of these.

Landslide hazard mapping: Over the past 18 months, MGS staff developed a digital methodology for identifying potentially hazardous areas, focusing primarily on the distribution of the Presumpscot Formation, steep slopes, aspect, and radius of curvature of water courses, which are all factors in establishing landslide susceptibility. Subsequently, we produced maps of landslide susceptibility for four towns: Wells, Cumberland, Bangor, and Greenbush. Through the summer and fall of 2006, our geologists reviewed aerial photos and made field visits to the four towns to map landslides. This ground-truth exercise shows that 91% of the mapped landslides fall within areas with slopes of 5 o or more. Furthermore, 83% of mapped landslides fall within areas that have at least one additional risk factor, whether geologic materials, aspect, or curvature of stream banks that focuses groundwater movement. We are working with FEMA to secure additional funds to continue this work.

Arsenic studies: Working with researchers from Columbia University, our interns collected about 800 water samples from private wells in the greater Augusta area in 2006. This was part of a much larger global effort by Columbia to understand the factors that control arsenic concentrations in ground water and effects on human health. Based on the analytical results from the 2006 samples, our Columbia colleagues selected four areas from within last year's project area for additional sampling in 2007, with the objective of densifying the datasets. Our interns collected about 350 samples this year with analytical work to be completed at Columbia this fall. Preliminary results from the 2006 work show that arsenic is broadly and nearly unpredictably distributed throughout the metamorphic rocks of the area (no great surprise), but perhaps arsenic becomes concentrated the contacts of granites with the metasedimentary rocks. We also found that wells in the two-mica granites in the area have water high in uranium.

Geologic mapping: We continue with our bedrock mapping in the Augusta area. Maps of the Winthrop and Augusta 1:24,000-scale quadrangles are nearly completed and are playing an important role in the arsenic studies. We are also making great strides in surficial mapping the Bangor area, which is an essential step for our plans to assess landslide susceptibility in that area.

Coastal geology: Following the Patriot's Day storm, our marine geologists have committed considerable efforts to map the post-storm shoreline and compare that with past surveys. Not

surprisingly to most of us, they have found that the beaches at Camp Ellis, the most hard hit by the April storm, have advanced landward by about 10 meters through a series of storms over the past several years. They continue to work with Saco officials and others on the best strategies to address coastal erosion.

Aquifer mapping: This effort continues in areas north of Moosehead Lake. A few years ago, many questioned the necessity of aquifer mapping in these remote areas. The Plum Creek proposal has changed that perspective dramatically.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2007, The State Geologist's Message: A Few Program Updates. *The Maine Geologist*, v.33, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Technological Advances at the Maine Geological Survey

The past few decades have brought some wonderful technological advances that have exponentially expanded our access to information, increased organizational efficiencies, and improved our lives. The Maine Geological Survey has embraced these technologies and in several instances, aggressively advanced them in the pursuit of better service to the public. Here are a few highlights –

Communications: When I arrived here in May of 1987, the agency of 19 people was served by four phone lines. Our two secretaries received all incoming calls and had to redirect them to the appropriate staff, the result being that only four people in the office could converse by phone simultaneously. Sometime in the early 1990s, our old black handsets (did I mention that they were rotary?) were replaced with modern, beige touchtone models, each with an individual phone number. Needless to say there was no e-mail -- all the information that left the office had to go out via hardcopy mail. As we expanded our use of computers (see below), we eventually provided e-mail and web access for all staff; these have become our most efficient means of information dissemination.

Computers: Our first computer was a TRS-80 (with 8- inch floppy drive), acquired around 1982 for the primary purpose of compiling bibliographic information that formed the foundation for the new statewide geologic maps published in 1985. We advanced from there to a Burroughs system with a single central processing unit and a few terminals that was used for report writing and some rudimentary database development. Our first PC, a Compaq, came on-line in the late 1980s and was used for our first inhouse GIS ventures. Over the next several years, we acquired a few more PCs, even building them from parts when we ran into red tape at our purchasing office. By the mid-1990s all professionals had PCs on their desks and used them for word-processing, database development, analysis, and communications. Prior to this, our secretaries typed all reports and correspondence on standard typewriters, from manuscripts hand-written by all of us. Databases were paper, only, like the old Mineral Resources Data System. With improvements in network capabilities, we now have common, secure digital files and databases accessible to all.

Map production: For the first 150 years of the Maine Geological Survey, map production changed very little, being a pen-in-hand process. Sure, the pens got better, we got Leroy sets for consistent lettering, and eventually acetate-transfer lettering and patterning for maps, but production remained essentially a manual process. In the mid-1980s Walter Anderson witnessed

the advantages of geographic information systems to geological issues elsewhere and began a successful campaign to bring this technology to Maine, often butting against bureaucracy that resisted this radical change. One of my first assignments was to scope out and spearhead a process to acquire modern GIS capabilities for the state, which was accomplished in 1990. In our first venture to produce digital geologic maps, using the Compaq and an 8-pen plotter, we had to monitor the plotting, often for hours for a single map, in order to replace pens as they ran dry. Through Walter's persistence at the Maine Low-level Radioactive Waste Authority, we acquired a high-powered workstation and truly put GIS to work for MGS. Over the past decade, we trained our Cartographers and other staff in GIS processing, and Marc Loiselle built a menubased GIS processing system that is the basis for our current map production. We reduced the production time for one map from weeks to days, and are building multi-use geological databases in the process. In late 2005, we converted all our maps to digital products that are available over the internet. Our transition to completely digital map processing was done with realignment of existing staff and no new positions. Efficient!

Outcomes: By embracing and advancing innovations, we have been able to do more with less. We are producing better, timelier, and more accessible geological datasets through these technologies. Concurrent with these changes, the MGS was also engaged in an inexorable process of budget reductions that is on-going today. Our 19 General Fund positions in 1990 are reduced to 10.6 today, with an additional 2.4 positions on other funds. Fortunately, with our ability to word-process at our desks, direct phone lines to staff, and digital map products on-line, we have been able to manage with reduced clerical staff. We are managing our map-production process with two fewer cartographic positions. Our financial management has been greatly streamlined through these technologies as well, allowing a position reduction there.

The Future: A fundamental question I ponder is whether future innovations will allow us to continue to provide quality services to the public with further reduced resources.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2008, The State Geologist's Message: Technological Advances at the Maine Geological Survey. *The Maine Geologist*, v.34, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

State Geologists Celebrate 100 Years of Association

Washington, DC, May 12, 1908: State Geologists from 23 states met at 2:30 PM in a conference room of the U.S. Geological Survey (probably the Patent Office Building, now housing the Smithsonian Institution's National Portrait Gallery) to consider "the advisability of effecting a permanent organization of State Geologists." With this modest beginning, the Association of American State Geologists was founded. In 2008, the AASG celebrates its centennial year and hundredth annual meeting with a return to its beginnings in Washington, DC[1], and a meeting cosponsored by the USGS. USGS Director George Otis Smith (who first mapped at Vinalhaven, Maine) invited the State Geologists to Washington in 1908. Director Mark Myers (former Alaska State Geologist) will welcome the Association this year.

So in the 100 years of association, what has the AASG really accomplished? The very first issue undertaken in 1908 was the status of topographic mapping of the nation. At that time, the nation had very inconsistent coverage, with some areas completed at the then most detailed scale

of 1:62,500, while other areas had essentially no coverage. The AASG worked with the federal agencies to implement a program of detailed mapping, cost-shared 1:1 by states and the USGS. This program produced Maine's 1:24,000-scale topographic maps that we rely on today.

Many of the policies and opportunities affecting state geological surveys are developed at the federal level, and the AASG established a liaison committee in the early 1960s to ensure that our voice would be part of the discussion of policies and programs. In the early years, this group consisted of half a dozen State Geologists that would visit Washington once a year. Imagine this group parking their car in front of departmental headquarters, walking in without an appointment, and having an audience with the Secretary! While this approach was very successful in those years, it would not get far today! Still, typically thirty State Geologists endure the security scrutiny twice annually to discuss issues of mutual interest with more than 30 federal agencies and other interest groups. This effort has paid many dividends in raising the awareness of the role of geological investigations to important national issues.

The AASG has promoted and supported important federal agencies. Considering the value of minerals to national defense, the AASG in its first decade pushed for legislation to create the U.S. Bureau of Mines. Having helped accomplish this, we subsequently lamented its demise in the 1990s. Similarly, when the USGS was threatened with abolishment in the 1990s, the AASG spoke on the values of USGS programs at congressional and committee offices on Capitol Hill. Fortunately, these views prevailed, and USGS maintains an important role in assessing the nation's natural resources and natural hazards.

State geological surveys have always focused on high-quality geological maps as primary products of their programs. In the 1980s the State Geologists noted, however, that more funding was being directed to derivative mapping (aquifer maps, landslide hazard maps, etc.) and more research-oriented work at the federal level and in some states, and away from the essential basic geologic map. At the time, only 20% of the nation had been mapped geologically in sufficient detail to address important issues. In response to this, the AASG began an effort to initiate a new mapping program focused on basic geologic information. The effort to push this program through Congress took nearly a decade, with many setbacks along the way, but in 1992 Congress passed the National Cooperative Geologic Mapping Act, which established the program as a cooperative between states and the USGS. Through this program Maine has received more than $1 million for important geologic mapping!

The AASG continues as a forum for discussion of the value of geological investigations to society and looks forward to the next 100 years!

[1]Not really Washington, but on the outskirts of the DC area in Shepherdstown, WV. Washington is just too expensive.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2008, The State Geologist's Message: State Geologists Celebrate 100 Years of Association. *The Maine Geologist*, v.34, n.2, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Energy - What's out there?

On July 14th, President Bush revoked most provisions of an executive order supporting moratoria on leasing of many areas of the outer continental shelf (OCS) for oil and gas production, as one part of a strategy to reduce our nation's reliance on foreign oil. This was followed shortly by declarations from our Congressional Delegation and Governor supporting a continuation of the moratorium on drilling in Maine's OCS. A few days later, my phone rang. Governor Baldacci was on the line and wanted to know what potential Maine's OCS held for oil and gas reserves. I hadn't really dabbled in petroleum geology since my three years at Exxon in the mid-1980s, and even there I did not focus on the exploration side of the work, but I plunged into this task anyhow.

The New England OCS was the subject of a substantial exploration effort as recently as the 1970s and 80s, when the Department of Interior sold leases on numerous blocks on the Georges Bank and other areas of the OCS to exploration companies. The Georges Bank held promise due to its thick accumulation of Jurassic and younger carbonate and clastic units, as confirmed by two Continental Offshore Stratigraphic Test (COST) wells drilled during this period. (Former State Geologist Walter Anderson visited one of these drill sites when it was active.) By this time, reasonable reserves of natural gas had been discovered near Sable Island offshore Nova Scotia in a similar geologic setting. The exploration holes in the Georges Bank, however, all came up dry. Importantly, the holes demonstrated that the organic carbon content of the sedimentary rocks was below the minimum necessary for hydrocarbon generation, and further, the units had not been heated sufficiently to generate hydrocarbons if there was enough organic carbon.

Still, 8 dry holes leave much wanting in terms of information on the area's potential for oil and gas. Using standardized techniques, geoscientists and statisticians at the Minerals Management Service (MMS) have conducted assessments of undiscovered reserves in the nation's OCS periodically, most recently in 2006. This assessment estimates oil reserves of 1.9 billion barrels and gas reserves of 18 trillion cubic feet (Tcf) in the entire Northern Atlantic Planning Area, which extends from New Jersey to Maine. For comparison undiscovered reserves in the Gulf of Mexico are set at 45 billion barrels of oil and 230 Tcf gas.

In discussing the hydrocarbon potential in Maine's OCS with geoscientists at MMS, a few points became clear. First, Maine's OCS includes but a tiny sliver of Georges Bank, most of which goes to Massachusetts, as determined by politically negotiated boundaries. So, the discoveries at Sable Island are irrelevant as analogs for potential plays in our OCS. (Note that in 40+ years of exploration since its discovery, no additional reserves have been added to Sable Island.) Second, Maine's OCS contains some older Triassic basins, but similar onshore and offshore basins elsewhere along the Atlantic seaboard have not produced oil and gas. There may, however, be some potential in Triassic basins of the Bay of Fundy, where maturation temperatures have been higher.

As you have heard through numerous outlets in the last months, Maine's OCS does contain a significant energy resource - wind. Perhaps it makes sense to pursue the development of wind

power here where that potential is great, and to focus oil and gas exploration at this time in places like the Gulf of Mexico, where the potential is great and supporting infrastructure is already in place.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2008, The State Geologist's Message: Energy – What's out there? *The Maine Geologist*, v.34, n.3, p. 3.

THE STATE GEOLOGIST'S MESSAGE

Groundwater at the Legislature

Among the many issues Maine's 124th Legislature will address during their first session, few will be as controversial or emotionally charged as the discussions of groundwater. At least 13 bills have been submitted that deal with many aspects of the use of this resource. All but a few target one specific area of water use – bottled water. The real target should be plain to all who have followed this issue over the past several years.

As you are probably aware, groundwater is not a new topic at the Legislature. There have been numerous discussions of water resources over the past several decades, beginning with concerns in the 1980s that southern New England states were looking to Maine's resource to solve their water supply problems. In previous legislative sessions, the heat around this topic has risen from a slow background simmer to a rolling boil. Much of this has been stirred by misinformation about the magnitude and renewable nature of this resource.

Several bills were prompted by the potential for one southern Maine public water system to sell some of the groundwater from their land to a commercial bottler. This proposal generated a deluge of commentary from the public and was subsequently tabled. One bill would prohibit such sales entirely, and the other would allow agreements with commercial bottlers only after approval in public referendum.

Another bill proposes an idea that the public has already rejected in referendum – an excise tax on bottled water of one cent per gallon. In spite of numerous presentations and a wealth of readily accessible information on the magnitude of Maine's groundwater resource, this bill sets the threshold for taxation at the absurdly low volume of 1 million gallons per year. Other bills with general titles like "An Act to Protect Groundwater," have not been drafted beyond their titles as of this writing. Other bills seek to exert local control over decisions on groundwater withdrawals.

Adding to the complexity of this issue is the fact that these bills will be heard before numerous legislative committees, including the Natural Resources, Utilities and Energy, and Taxation committees. Without strong leadership on the issue, there is great potential for committees to act across purposes.

Numerous interest groups are stoking the emotional fires with their rallying cries against privatization/commodification of water resources, distrust of multinational corporations, "theft" of water resources, and depletion of aquifers. It's hard to fathom the focus on bottled water – water that no one is forced to buy – but not on community water systems that are owned by private corporations – water that people in those communities have no choice but to buy. In one town it is not acceptable to pump groundwater to put directly in bottles, but it is acceptable to pump water from the same aquifer system, throw some potatoes in it, and call it vodka!

Regardless of where you stand on these issues, make no mistake about this: groundwater is one of Maine's most renewable resources, and strict regulations govern its withdrawal to safeguard sustainability and other water-dependent resources.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2009, The State Geologist's Message: Groundwater at the Legislature. *The Maine Geologist*, v.35, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Biennial budget considerations

Everyone has heard much over the past six months about the problems with the State's 2010-2011 biennial budget and ever-dwindling revenue forecasts. With a revenue shortfall in the hundreds of millions of dollars for the biennium, all departments and agencies have felt the impact of cuts. These translate into reductions in services and benefits to all citizens of the state.

For the Maine Geological Survey, the cuts have been the most severe I have dealt with in 14 years as Director, and probably exceed the magnitude of cuts of the early 1990s. Coming after years of flat budgets and small cuts, no "easy" options remain for reductions. When faced with a request from the Governor's budget office to reduce MGS expenditures by ten percent, I was left with no option other than cutting positions. Fortunately, at the time the request came in we had two vacant positions – our receptionist/secretary and one hydrogeologist. Our receptionist left in mid-2008 for opportunities outside the state, and Marc Loiselle retired. Rather than increase the personal hardship of this economy by eliminating other occupied positions, I eliminated these vacant ones. Some members of our legislative oversight committee and the Appropriations commit-tee objected to these cuts as too severe in a time when groundwater science needed focus, and attempted to restore them. In the end, the dismal revenue forecasts prevailed and the positions were cut.

While the Survey we have now is probably not one that anyone would build from scratch, we still have viable programs that will deliver good service to our citizens. The good news is that over the past decade of state budget reductions, MGS has become very successful at pursuing outside funding opportunities. Agreements with other state agencies, the private sector, and competitive grants from the U.S. Geological Survey currently support 2.4 positions and much of our field operational expenses. We continue our major programs in basic geologic mapping, ground water investigations, and coastal geology.

But some things must change. The elimination of our receptionist means that there will be no cheery personality to greet visitors or callers. The typical receptionist/ clerical responsibilities will be distributed among the remaining staff. Although this is not the most efficient use of field staff, the volume of this work has diminished in the past five years due to posting of maps and reports on the internet, a huge manpower savings for us. Some of the work done by Marc simply will no longer be done – advanced GIS analysis, for example. But he left us in good positions on most of the systems he developed over his tenure, and the ability to use and maintain those systems has been transferred to other personnel. We have also established a cooperative program on groundwater investigations with the USGS, allowing us access to their significant analysis and modeling capabilities. With USGS contributing 50% to this effort, we are able to stretch our remaining state funds farther.

I hope that all of us in Maine's geological community weather this economic downturn well, and have an opportunity to rebuild when things improve.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2009, The State Geologist's Message: Biennial budget considerations. *The Maine Geologist*, v.35, n.2, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Testing Wind Technology in Maine

Over the past several months, I have been working with staff of the Department's Submerged Lands program and from other state agencies and the University of Maine to meet a December 15 deadline to identify at least one offshore site in state waters where industry might test wind technology. In June 2009 the Maine Legislature unanimously passed a bill, "An Act To Facilitate Testing and Demonstration of Renewable Ocean Energy Technology," that set in place the schedule and criteria for site selection. The goal of this effort is to provide at least one location in state waters (to 3 miles offshore) where the University and industry can test the next generation of wind turbines – those that will float in deep water. On October 15, the University of Maine announced their success with the Department of Energy's renewable energy program that netted $8 million for testing various turbine components in the Gulf of Maine.

Wind in the Gulf of Maine is a substantial, renewable energy resource, with potential capacity measured in many gigawatts. Currently, there is only one full-scale test turbine in the world (in the North Sea) floating in deep water. If Maine can attract industry to our test locations, there may be a big opportunity later on to capture the jobs that will come with commercial wind farms deployed farther offshore in the Gulf of Maine.

In July, our team went through a basic mapping exercise that identified seven "planning areas" that meet the basic requirements set forth in statute – within state waters, with very good wind resource, having deep water (greater than 60 meters) for testing floating technology, and that avoid obvious obstructions like navigational channels, shipwrecks, dump sites, etc. Through August, we convened about a dozen small meetings centered on each of these planning areas and focused mostly on fishermen's concerns. In September, we held five public meetings from Machias to Wells to get broader public input, concerns, and comments about the planning areas. These meetings provided a wealth of information on the human uses and natural resource needs of the planning areas.

By the time you read this, we will have used information from the meetings, plus copious digital datasets to select several draft sites that we think will minimize the impacts on human uses and the ecology of the ocean by wind testing. A formal 30-day public comment period, which will close in late November, began with the release of the draft sites. When that period closes, we will use information from those comments to revise our draft sites for final release on December 15. With that accomplished, the University of Maine and their industry partners can begin the real work of advancing Maine as major player in the future of renewable wind power.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2009, The State Geologist's Message. *The Maine Geologist*, v.35, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

International Trade Agreements and Ground Water Regulation

Now that the winds of the Ocean Energy Demonstration Area siting process have died down, I can turn my attention back to matters more geological in nature. In the spring of 2009, I wrote in this column of the fourteen bills before the Legislature that addressed concerns over bottled water. Of those, only one survived and was morphed into a study of the potential impact of international trade agreements on the state's ability to regulate ground water withdrawals. The Legislature directed this task to the Water Resources Planning Committee (WRPC), which I chair, and the Citizen Trade Policy Commission (CTPC). The CTPC was established by the Legislature in 2003 to provide an on-going state-level mechanism to assess the impact of international trade policies and agreements on Maine's state and local laws, business environment, and working conditions. The WRPC was established by the Legislature in 2007 to plan for sustainable use of water resources.

The WRPC and the CTPC held five joint meetings from July through December 2009 in order to explore this issue. These meetings included overviews of the alphabet soup of trade agreements – GATT, GATS, NAFTA, etc. All are intended to open up trade opportunities, and from the perspective of these agreements, local and state regulations may be viewed as barriers to trade. As part of our study, the committees received an excellent overview of Maine's ground water resources thanks to Carol White. We also reviewed Maine's current regulatory setting, and the legal doctrines governing ground water use in various states – absolute dominion, reasonable use, correlative rights, and others. As part of our work, we delved into legal briefings on water law becoming quite versed in legal jargon, such as usufructuarial, in the process. Fortunately Deputy Assistant Attorney General Linda Pistner was involved in the process and tutored us on the legalese. Finally, on October 15, we held a hearing to receive the public's concerns regarding trade agreements and ground water. In the end, the interaction of trade agreements and state regulations is a very complex and dynamic issue, as trade agreements are being negotiated constantly and international arbitration tribunals resolve disputes. But a few things are very clear.

- Water in its natural state is not a commodity that is subject to international trade agreements. Bottled water, on the other hand, clearly is a commodity that is subject to these agreements.
- The best defense against challenges under international trade agreements is to adopt regulations that are clear, reasonable, have a sound basis, are applied equitably, and that are established through due process. Articles and legal briefings by attorneys from diverse backgrounds all confirm this view. Maine's current regulatory framework for ground water withdrawals evolved over years of public debate, and focus on impacts of withdrawals on other water-dependent resources and activities, rather than discriminating against particular uses of ground water, and thus position the State well against challenges under international trade agreements.
- International trade agreements are under constant negotiation by the U.S. Trade Representative, but with little opportunity for meaningful participation by states.
- The decisions of international arbitration tribunals are not precedential – each tribunal establishes its own basis for decisions, independent of prior decisions. But recent decisions have been very favorable to state concerns and it may be worthwhile to have the results of these decisions codified in future trade agreements.

- Finally, in our review we could not find a basis to assert that Maine's ground water resources would be better positioned to withstand challenges under international trade agreements if it were a public trust resource.

I presented these conclusions to the Legislature's Natural Resources Committee in February with recommendations for actions they might take to ensure that Maine can continue to adequately regulate ground water withdrawals in the age of global markets.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2010, The State Geologist's Message: International Trade Agreements and Ground Water Regulation. *The Maine Geologist*, v.36, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

What the National Cooperative Geologic Mapping Program has done for Maine

The National Cooperative Geologic Mapping Program (NCGMP) was authorized by Congress in 1993 through legislation developed by the State Geologists through the Association of American State Geologists. Since then more than $88 million in federal funds has been matched by state funds to support geologic mapping in critical areas nationwide. Maine has received more than $1.2 million to date that has made possible the completion of more than 75 surficial and bedrock geologic maps in southern and central Maine.

The program is focused on important mapping and continuing productivity in state surveys. Each state is required to have a Geologic Mapping Advisory Committee to help identify important areas for mapping. Maine's Committee includes representatives from state agencies, federal agencies, academia, and the private sector – all users of geologic maps. Over the years, the Committee has helped focus the program on key areas – generally the more populated areas where mapping would contribute to the resolution of issues affecting our citizens. Many individuals have served on the Committee, and I thank them all for their service.

Each year, the Maine Geological Survey submits a proposal, based on the recommendations of the Committee, to the program administrators at the USGS. In this competitive program, a peer-review committee of State Geologists and USGS geologists carefully considers the merits and quality of each proposal. Having served on this panel on several occasions, I can attest to the rigor of this process. States are not guaranteed funds, but are awarded them based on the quality of the proposal, past performance, and quality of map products delivered annually. Maine has consistently earned among the highest scores, ensuring that we receive close to the funding we request.

The funds from the program have been critical to keeping MGS programs moving. The NCGMP requires a one-to-one match of state dollars, which for us has been the salaries of several state-funded geologists working on the program. The federal funds pay for field expenses and contract geologists; state funds for these expenses have been seriously eroded over the years of state budget cuts.

Some results from the program:

- MGS completed most of the detailed surficial mapping of southern Maine from York to Portland to Lewiston. The distribution of surficial units from these maps is fundamental to our subsequent efforts to construct maps identifying landslide risk in towns underlain with marine clay.

- The distribution of surficial units is also essential to identifying significant sand and gravel aquifers.
- Our bedrock mapping in the Augusta area is the underpinning for Columbia University's study of the relationship to bedrock of arsenic and other naturally occurring metals in groundwater.
- We have gained a far greater understanding of the geologic history of Maine's landscape.

I now am a member of the Federal Advisory Committee for the NCGMP that will help guide this important program through the next decade.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2010, The State Geologist's Message: What the National Cooperative Geologic Mapping Program has done for Maine. *The Maine Geologist*, v.36, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

New Baxter Park Bulletin completed!

After more than 3½ years of effort, the Maine Geological Survey's ***A Guide to the Geology of Baxter State Park and Katahdin*** is published. Conceived as a commemoration of Dabney W. ("Dee") Caldwell's life-long enthusiasm for Katahdin, this 80-page bulletin updates earlier publications on Katahdin and Baxter Park by Dee. The bulletin includes more than 75 figures, mostly color photographs, that illustrate important geological features. We were fortunate to have access to superb nature photography from the collection of Bill Silliker, Jr., now housed at the A.E. Howell Wildlife Conservation Center, North Amity, Maine. Although the bulletin presents a scientifically rigorous overview of the geological units of the Park, their origins, and geological processes that have worked upon the landscape, it is written in a style that makes it accessible to all Baxter State Park visitors. The final section includes descriptions of five geological hikes that highlight some of the most significant geological features and magnificent landscapes in the Park. Perhaps most importantly, the bulletin includes two large-format maps illustrating both the bedrock and surficial geology on a shaded-relief base, which greatly improve earlier maps.

Many individuals contributed to the success of this publication. We are pleased that Douglas W. Rankin, USGS, accepted our invitation to participate in the project, with a particular emphasis on improving the section on bedrock geology. In his early career, Doug spent many summers mapping the intricacies of the Traveler Rhyolite within the Park. Doug graciously accepted our editorial comments over several iterations of the text. I especially thank Gary M. Boone for initiating this project, for his boundless energy in moving it forward, and for his critical reviews of the manuscript and maps.

At the Maine Geological Survey, Bob Tucker oversaw the entire project, Tom Weddle contributed significant improvements to the section on geomorphology and glacial geology, Susie

Tolman skillfully implemented numerous map revisions, Henry Berry meticulously edited the manuscript, and Bob Johnston contributed some excellent photographs. I am sure Dee would be pleased with this fitting tribute to his life.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2010, The State Geologist's Message: New Baxter Park Bulletin completed! *The Maine Geologist*, v.36, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

New Leadership at the Maine Department of Conservation

On January 25, 2011, Dr. William H. Beardsley was confirmed through a unanimous vote by the Maine State Senate as the Commissioner of the Department of Conservation. Readers will recall Dr. Beardsley as the former head of Husson University who ran unsuccessfully for the Republican gubernatorial nomination in June 2010.

Dr. Beardsley has broad experience in natural resources, energy, and education, and is no stranger to Maine. He graduated from Johns Hopkins University in 1970 with a dissertation focused on the resolution of conflicts in forest resource management in T16R4, Aroostook County. After graduation, he held various academic, government, and private sector posts in Vermont through the early 1970s. In the late-70s, he was VP at Bangor Hydro. From 1981-1985 Dr. Beardsley held several positions in Alaska, notably as the director of the Divisions of Energy and Power Development, Finance and Economics, and the Office of Forest Products in the Department of Community and Economic Development. These experiences give him broad perspective on natural resource and energy issues.

Perhaps his greatest accomplishment was his 23 years at Husson. When he arrived, Husson was a small college struggling with its position among Maine academic institutions and facing dwindling enrollment. Under his leadership, Husson reinvented itself from College to University, focusing on programs in health, education, business, and legal studies, and such hands-on opportunities as boat building in Eastport. These programs provide students with many opportunities for employment in Maine and contribute to the expanding enrollment and success of the University.

Dr. Beardsley also understands the value of science – basic knowledge is necessary to make good decisions about natural resources or in any other policy area. In his first briefing as Commissioner before the Legislature's Agriculture, Conservation, and Forestry Committee, Dr. Beardsley introduced geology as the foundation upon which all the other functions of the Department are based! Undoubtedly we will get into differences of opinion regarding how society should respond to some of the science – sea-level rise and climate change, for example – because policy considers much more than just science. But it's clear that during Dr. Beardsley's tenure at the Department of Conservation, science will play an important role.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2011, The State Geologist's Message: New Leadership at the Maine Department of Conservation. *The Maine Geologist*, v.37, n.1, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Working to Reduce the Risks from Maine's Geologic Hazards

A series of small earthquakes occurred in the Bucksport area in early May, drawing disproportionate media attention to this hazard that is rarely damaging in Maine, due in part to heightened concern following the Sendai, Japan disaster. Maine experiences several felt events, and on average one magnitude 3 event, each year. Truly damaging earthquakes have been rare in Maine, but the potential for them should not be ignored. Assessing risk is an important part of emergency preparedness for any type of disaster. The Maine Geological Survey, in cooperation with the other New England states and the Northeast States Emergency Consortium (NESEC) has been investigating the value of geologic maps in assessing seismic risk. HAZUS, a computer program developed by FEMA, can assess risk using available information on population density, infrastructure age, geologic substrate, local seismicity, and other factors. In the absence of other information, the program assigns all the surficial materials to a class that is moderately susceptible to seismic amplification. Our work with digital surficial geologic maps shows that the program greatly overestimates risk in the more mountainous areas of New England, and underestimates it in low relief coastal areas underlain with glacial-marine mud. Geologic maps, then, are an important resource for assessing risk and focusing remedial efforts.

Following the 2004 Sumatran tsunami, the federal government initiated a comprehensive assessment of this hazard along all U.S. coastlines. Through funding from the Maine Emergency Management Agency, MGS is accessing potential tsunami inundation for the entire Maine coast. The most threatening source for a tsunami on the Maine coast would be from a large earthquake at the Puerto Rican trench. Such an event would allow many hours of lead time, and fortunately the Georges Bank would dissipate much of the wave energy. Still, damaging waves are possible in Maine and we are using Lidar and other elevation data, together with modeling by NOAA, to develop inundation maps. County emergency managers, in particular, are pleased to have this information as it will be readily useful for hurricane inundation as well.

Maine faces a more insidious coastal hazard in the form of incremental sea-level rise. While a few millimeters per year doesn't sound like much, over time it accumulates – to more than 7 inches in the past century – with no indication that the rate of rise will decrease anytime soon. Most scenarios predict a rapid increase in the rate of rise. An additional foot of sea-level rise gives the waters of a 10-year storm the landward reach previously achieved only by a 100-year storm. While it may be difficult to address the causes, we must not ignore the impacts. To this end, MGS is engaged with southern Maine communities and the Southern Maine Regional Planning Commission in the Sea-Level Adaptation Working Group (SLAWG). The SLAWG has been working for over a year on reviewing the science and helping communities understand the risks, how to assess risks to critical infrastructure, and options to mitigate these risks. This work continues.

In the past few years, we have developed a series of landslide susceptibility maps that inventory past events and identify areas that are highly susceptible to mass movement. Maps are completed for some southern Maine communities and we will work on others as resources permit.

Life is fraught with risks, but with careful assessment and planning, many can be avoided or their consequences reduced. Geology has an important role to play in reducing risks.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2011, The State Geologist's Message: Working to Reduce the Risks from Maine's Geologic Hazards. *The Maine Geologist*, v.37, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Deep unused boreholes wanted!

Here's an opportunity to have some good come from those deep boreholes in bedrock that didn't work out for your project! The Maine Geological Survey is working as part of a national consortium of state geological surveys to organize information about the nation's geothermal resources into a single comprehensive database. The National Geothermal Data System is funded by the Department of Energy and aims to develop a network of distributed databases and data sites that can be seamlessly used for research on geothermal resources. Read about state geological survey involvement here: http://www.stategeothermaldata.org/

In the first phase of this project, the MGS compiled available information ranging from heat flow measurements made in deep mineral exploration boreholes to groundwater temperatures from shallow water wells. In the next phase of this project, we are seeking to augment the existing information with new data, particularly in geographic areas that lack measurements. When we first scoped the project, we used our water well database to identify deep water wells in certain parts of the state, and particularly in granite bodies. Granites are likely to be more homogeneous through the depth range of a well than metamorphic rocks, greatly simplifying estimates of heat flow when rock samples are lacking. But using water wells is complicated by the hassle and cost of pulling pumps, not to mention the inconvenience to homeowners. Thus, we are seeking any unused deep boreholes in bedrock of which you may know.

While our preference is for boreholes in major granite bodies, we'll consider any available borehole of 300 feet depth or greater. To fill our geographic gaps we are most interested in boreholes in York County, northern Hancock and Washington counties, southern Somerset and Franklin counties, and central Oxford County, but we will consider boreholes anywhere. If you know of a borehole that might be suitable for this project, please contact Dan Locke at 287-7171, or daniel.b.locke@maine.gov.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2012, The State Geologist's Message: Deep unused boreholes wanted! *The Maine Geologist*, v.38, n.1, p. 2–3.

NEWS FROM THE STATE GEOLOGIST

A Tale of Reforms, Consolidations, and Mergers

Proposals to reform state government typically wax and wane with the political shifts in the State House, moving from one extreme of targeted small agencies to the other of mega-departments. Such proposals have been nearly perpetual since I took over as Director of the Maine Geological Survey in 1995. In that year, Governor Angus King's Productivity Realization Task Force instituted some significant changes within the Department of Conservation, demonstrating that incremental changes can successfully navigate the political waters. Wholesale change is a different matter. In the previous Administration, a long-debated proposal to corral all the natural resources agencies into one overarching super natural resource department failed due to the politics of oversight committees and concerns of advocacy groups. In spite of the past history, every Governor seeks a legacy of improved and streamlined government and the current incumbent is no different in this regard.

Several significant reform processes will affect the Department of Conservation and the Maine Geological Survey over the next six months:

1) LURC reform. If you have followed the discussions at all in the past 18 months, you will know that very significant changes are underway for the Land Use Regulation Commission in terms of its authority and the composition of the Commission. While not directly impacting MGS, the changes will involve a major restructuring of responsibilities within the agency and will change the types of permitting activities with which we assist LURC.
2) Dissolution of the State Planning Office. For decades, SPO was used by Governors in the manner of a think-tank – special studies were conducted through the agency and the results used to develop new policies. Maine's Quality of Place report and work of the Ocean Energy Task Force are two examples of the kinds of targeted activities SPO has provided. Governor LePage has decided to disband the office and refocus a remnant in an agency that seeks to improve government efficiency. But SPO also has on-going programs, many of which are moving to the Department of Conservation. For many years, coastal geologists from the Maine Geological Survey have worked with the staff of the Maine Coastal Program to develop appropriate policies on coastal development that have as their basis the geological processes that shape this landscape. I am pleased that the Coastal Program will be joining the MGS. Also relocated to our space in the Williams Pavilion is the Floodplain Management Program, which works closely with FEMA on implementing appropriate floodplain development policies and working to improve mapping. Also moving to the Department of Conservation are the Land for Maine's Future Program and the Landuse Team, which implements the Growth Management Act. These are all significant new responsibilities for our Department.
3) Departmental merger. At the end of the legislative session, a supplemental budget bill that makes adjustments to the FY 2013 budget beginning July 1, was passed by the Legislature through a majority vote. Part of the bill calls for the merger of the Department of Agriculture and the Department of Conservation into one agency. This proposal avoids a major pitfall of previous merger proposals, since there is only one legislative oversight committee for both departments, and thus, no bickering between oversight committees on loss of jurisdiction. Over the next few months, an ad hoc committee will look at how to better organize the new Department of Agriculture, Conservation, and Forestry.

All of these changes present challenges and opportunities. While the challenges cannot be ignored, I prefer to focus on the new opportunities these reorganizations bring in terms of

strengthened partnerships and breadth of expertise that can greatly enhance what our small agency can do. Stay tuned as these reforms are implemented.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2012, News from the State Geologist: A Tale of Reforms, Consolidations, and Mergers. *The Maine Geologist*, v.38, n.2, p. 2.

NEWS FROM THE STATE GEOLOGIST

Metallic Mineral Resources in Maine

Through numerous meetings over the past year, I have been working with the leadership of GSM and others to organize a conference on metallic mineral resources in Maine. The conference will occur within days of your reading of this column, as a collaborative event involving GSM, U Maine, and the MGS. We are very pleased that this informational meeting is happening! Many have asked why we are doing this, and it is a fair question given Maine's general lack of exploration and mining activity over the past several decades. In response, I offer several points:

• In March of this year, Representative John Martin introduced LD 1853, "An Act to Improve Environmental Oversight and Streamline Permitting for Mining in Maine." As presented, this bill would have made sweeping changes to statutes and rules that have governed metallic mineral mining since 1991. Notably, no projects have ever been permitted under those rules. During an unprecedented series of hearings and work sessions over a three-week period, the Legislature's Environment and Natural Resources Committee substantially modified the original bill and ultimately passed a law which, among other provisions, directs the Maine Department of Environmental Protection to adopt new mining rules by January 2014. The publicity around this bill has brought much attention to Maine's mineral potential.

• Over the past year, the Maine Geological Survey has responded to numerous inquiries regarding Maine's mineral potential and mining in Maine. A surprising number of Canadian firms have inquired about mineral claims, not realizing that for the most part mineral resources are private property in Maine. Property owners and land managers have called as well. Over the past several decades, large tracts of land in Maine have seen a dramatic shift of ownership, away from long-term paper company ownership to investment owners. Lacking the long association with the land that was common with prior owners, the new land managers may have little knowledge of the mineral potential of their holdings.

Our conference is intended to be informational, neither encouraging nor discouraging mining. We intend to bring exploration professionals, landowners and others together to explore the geologic context of Maine's metallic mineral deposits and the potential for undiscovered resources. Given the general lack of exploration activity for many decades and the great advances in exploration techniques in the interim, it is likely that a modern exploration program would make more discoveries. The conference will also provide information on landownership and access to lands, and a review of modern mining techniques. We hope this meeting will provide landowners,

exploration professionals and others an opportunity to meet and discuss common interests and concerns, and begin a meaningful dialogue about Maine's metallic minerals.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2012, News from the State Geologist. *The Maine Geologist*, v.38, n.3, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Maine Mining Statutes and Rules

A bit less than a year ago, the 125th Legislature passed significant changes to the laws that govern mining of metallic minerals in Maine. This act set in motion a lengthy process to revise the detailed mining rules administered by the Maine Department of Environmental Protection and the Land Use Planning Commission. Several inter-related processes are now underway to revise portions of the rules using direction from the laws.

Exploration rules: Having held hearings in December, the DEP is now in the final process of revising the regulations for metallic mineral exploration, including clearly separating more intensive advanced exploration processes from initial exploration. These new rules will be in place by early summer.

Rezoning in the Unorganized Territories: The Land Use Planning Commission (LUPC) has been directed to revise how rezoning would be accomplished to allow mining. Mining is not a pre-approved activity in any zone, so this activity can only move forward after a successful rezoning petition. Currently the rezoning process involves full evaluation of environmental impacts as well as socio-economic impacts. The new mining law shifts the entire environmental review process to the DEP. The LUPC in its rezoning deliberations is to consider only the socio-economic aspects of potential mining activity, and proximity to other uses. In December, the LUPC held several public hearings on the proposed revisions. On February 1, I helped organize an informational session for the LUPC during which Carol White, George Kendrick, and I provided information on various aspects of mining. The LUPC should complete its process by early summer.

Mining rules: The majority of the effort falls to the DEP to revise the mining rules by January 2014. Currently, the DEP has engaged the services of a consultant to create the new rules, a draft of which should be available by the early summer. These rules will be subject to a hearing and review process by the Board of Environmental Protection, followed by review before the Legislature.

Since the new mining statute was enacted, we had an election and a markedly changed composition to the 126th Legislature. Several bills have been submitted that may change the process the 125th Legislature set in motion. Here are some titles:

- An Act To Protect Water Quality and Avoid Taxpayer Clean-up Costs from Metallic Mineral Mines
- An Act To Protect Water Quality
- An Act To Protect Maine's Environment and Natural Resources Jeopardized by Mining
- An Act To Restore Former Provisions of Mining Laws
- An Act To Amend the Application Procedure for Mining Permits

Stay tuned as these bills come into play during this legislative session.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2013, The State Geologist's Message: Maine Mining Statutes and Rules. *The Maine Geologist*, v.39, n.1, p. 3.

THE STATE GEOLOGIST'S MESSAGE

Metallic Mineral Mining: Part II

Following much contentious debate, in its waning days the Republican-led 125th Legislature passed significant reforms to the laws that govern metallic mineral mining in Maine. The current rules were enacted in 1991 and since that time, no mines have been permitted, leading many to describe those rules as a defacto ban on mining. Since that time there have been many technological advances that have greatly improved the understanding and management of environmental impacts of metallic mineral mining, in particular those involving sulfide mineralization. The 2012 law directs the Maine DEP to develop new rules which will be vetted by the Board of Environmental Protection in the fall of this year and then sent to the Legislature in January 2014 for another round of review and approval.

With the seismic shift of the Legislature in the November 2012 election, the new Democrat-led 126th Legislature saw an opportunity to right the "wrongs" they perceived in the previous Legislature. To that end, several bills were submitted to revise last year's mining law, ranging from total repeal to charging a mining company $1 per gallon for polluted water. In the end, LD 1302 moved forward. Some key provisions of this bill are:

1. Require a third-party review of likely mine closure and reclamation costs.
2. Reinforce the financial assurances for mine closure.
3. Prohibit a permit for a mine that would require perpetual water treatment as part of mine closure.
4. Require wells for groundwater quality compliance to be within 100 feet of a mine facility.

Most people agree that points 1 and 2 make considerable sense. Most would further agree that avoiding perpetual water treatment and providing some sensible distance from mine facilities for monitoring also make sense, but the devil is in the details.

Unfortunately, in making their case to support LD 1302, some environmental organizations have resorted to fear-mongering, by suggesting that without the 100-foot limit, some large landowners might call their entire million-acre Maine holdings the "mine site", thereby allowing groundwater contamination throughout. In presentations, these groups have flashed images of Utah's Bingham Canyon mine – the largest man-made hole anywhere on earth – as an example of what might happen in Maine, without noting that the Bingham Canyon deposit is 1,000 times larger than Maine's most recent open-pit experience at the Callahan mine.

One discussion on LD 1302 centers on what length of time constitutes "perpetual" for post-closure water treatment. One environmental organization brought in a mining expert from Montana who said that 10 years would be generous. On the other hand, I spoke with respected certified professional geologists and engineers in Maine who suggested 30 years as a more realistic timeframe. The current law already requires a minimum of 30 years of post-closure monitoring.

The second discussion centered on the monitoring issue. The 100-foot distance for groundwater monitoring comes directly from solid waste management regulations, and anticipates

a fully engineered facility, with appropriate liners beneath. Since there is no way to install a liner below a mineral deposit, I and other professional geologists feel that the monitoring locations should be determined by the geology, not some arbitrary value. Because I have not supported the views of the mining professional from Montana (who has made a career of defending small communities from large mining corporations) and sought views from respected professionals in Maine (who have worked with mining interests), my views have been branded by some environmental groups as being biased toward industry.

I appreciate the very well balanced testimony and written communications on these issues by Alice and Joe Kelley, and Scott Johnson of the University of Maine. These contributed greatly to the discussion. At this writing, LD 1302 has failed due to inability of the House and Senate to agree on final language.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2013, The State Geologist's Message: Metallic Mineral Mining: Part II. *The Maine Geologist*, v.39, n.2, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Government Reform: Part II

Last year I wrote of several government reform efforts then underway that would impact the Maine Geological Survey. Most important at that time was the dissolution of the State Planning Office and subsequent move of the Maine Coastal Program to our agency. We have worked collaboratively with the MCP for many years and have worked together on many coastal projects. We are now seeing benefits from this closer alignment of the MCP and the MGS.

The lingering reform effort that was not fully resolved last year was the merger of the Departments of Agriculture and Conservation into one department – Agriculture, Conservation, and Forestry. Although the groundwork had been done in the 125th Legislature, it would be up to the 126th Legislature to finalize the merger. What looked like a done deal at the end of last summer became, after November 2012, the subject of contentious debate.

Commissioner of the new department, Walt Whitcomb, has done an admirable job bringing together the disparate programs of the department and developing an unconventional organizational chart that shows the divisions directors working as part of one large team. Unfortunately, the unconventional nature of the organization did not resonate well with the newly reconstituted Agriculture, Conservation, and Forestry committee of the 126th Legislature. Through many public hearings and work sessions, the ACF committee heard from many interest groups regarding the structure of the merged departments. What has prevailed is an organizational structure that looks very neat on paper – four nearly evenly balanced Bureaus with Directors that report to the Commissioner, and programs beneath that report to Directors. Parks, Forestry, and all the Agricultural programs remain in their three respective bureaus. All the remaining programs are lumped into the fourth bureau titled "Resource Information and Land Use Planning." This includes MGS, MCP, the Natural Areas Program, the Floodplain Program, the Land for Maine's Future Program, the Land Use Planning Commission (formerly known as LURC), and the Municipal Planning Assistance Program.

The Commissioner was directed to adopt this new structure with no additional personnel, even though the structure clearly inserts another layer of bureaucracy (the Bureaus) into the

organization. To meet this requirement, the Commissioner scavenged Director positions from several of the Divisions to populate the Bureau Director positions. For better or worse, the State Geologist position has morphed into the Bureau Director of that fourth catch-all bureau, and I remain in that position. It certainly is not the Bureau anyone with detailed knowledge of programs would design, but it's what we have been dealt and we'll make lemonade from it. Over the next few months, I'll begin a strategy process for the Bureau centered around the theme, "Science for landuse planning, conservation, and natural resource management." Stay tuned.

-Bob Marvinney

Marvinney, R.G., 2013, The State Geologist's Message: Government Reform: Part II. *The Maine Geologist*, v.39, n.3, p. 2–3.

THE STATE GEOLOGIST'S MESSAGE

Legislative Review

Although the State budget and Medicaid expansion should rightfully dominate the current legislative session, bills currently being debated by our elected representatives cover a broad range of issues. Here are a few related to geoscience issues:

Mining rules: Over the past two years, I have devoted much space in this column to discussion of Maine's mining law and mining rules. The process set in place nearly two years ago by LD 1853, "An Act to Improve Environmental Oversight and Streamline Permitting for Mining in Maine," is coming to conclusion in the Legislature, and the outcome will probably be known by the time you read this. The mining law revisions of 2012 directed the Maine DEP to conduct rule-making based on criteria established in statute, which was completed in summer 2013. The draft rules were subsequently reviewed by the Board of Environmental Protection through a series of hearings and work sessions during late 2013. As required by Maine statute, in early January the rules were returned to the Legislature for review and final adoption or rejection. Anyone who has seen any media coverage in late February knows that the debate has been very contentious. If rejected, rules governing metallic mineral mining will revert to those promulgated in 1991.

Gold dredging: Gold fever brought on by record high gold prices created something of a rush a few summers ago to favorable streams by prospectors using mechanized suction pumps and sluice boxes. Activities got out of hand in some areas, prompting property owners to deny access to certain waters for concern that they would be blamed for environmental problems caused by negligent operators. A bill last session tightened the regulations on this activity and limited the season to periods with low potential impact to aquatic species. In the current session, LD 1671, "An Act to Prohibit Motorized Recreational Gold Prospecting in Certain Atlantic Salmon and Brook Trout Spawning Habitats," sought to prohibit motorized dredging in specific stream reaches. At this writing, several work sessions have explored various amendments to the original bill, but without resolution at this time.

Ocean acidification: An impact of increasing atmospheric carbon dioxide concentrations and climate change is increasing acidification as the oceans absorb more CO2 from the atmosphere, a concern which has received more attention recently. LD 1602, "Resolve, Establishing the Commission to Study the Effects of Ocean Acidification and Its Potential Effects on Commercial Shellfish Harvested and Grown along the Maine Coast" is currently in deliberations. It would

establish a commission of stakeholders to begin to summarize potential impacts of ocean acidification on commercial shellfish.

Geologist certification: As part of the biennial budget passed in July 2013, the Legislature directed the Governor's Office of Policy and Management (OPM) to identify cost-savings measures within state agencies. Released in September, OPM's report included a recommendation to eliminate the Board of Certification for Geologists and Soil Scientists, suggesting that this could be done "without jeopardy to public safety." In a hearing on January 17 before the Joint Standing Committee on Appropriations and Financial Affairs, eight certified geologists and several certified soil scientists testified in opposition to this recommendation. Ultimately the committee voted unanimously to reject the OPM recommendation to eliminate certification. Thanks to Keith Taylor for carrying the important message of opposition on behalf of GSM.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2014, The State Geologist's Message: Legislative Review. *The Maine Geologist*, v.40, n.1, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Will shale-gas production come to Maine? No!

A recent article in *Mainebiz* (June 10, 2014) with the seductive title *Romancing the stone: Will shale gas extraction sneak under Maine's feet?* cautions landowners and lawyers to consider mineral rights when negotiating easements for pipelines and other subsurface activities. Written by an attorney, the article notes that several states have economically drillable shale plays, made so by advances in horizontal drilling and hydraulic fracturing, and further notes that "…additional new North American shale plays are being identified. Could Maine be next?" A subsequent statement, "Maine is one of only five states in the United States currently with no oil or gas production," leaves the reader to ponder the reasons for lack of activity. Many *Mainebiz* readers may likely conclude that Maine's "burdensome" environmental regulations cause this lack of activity; few will recognize the fundamental geological basis for the lack of oil and gas activity in Maine.

As geologists, we know that the landscape that we call Maine was assembled over more than half a billion years through multiple crustal plate interactions. When the Appalachian Mountains were thrust up over 400 million years ago in the last major plate collision to significantly affect northeastern North America, Maine rocks were subjected to extreme temperature and pressure. For petroleum generation from organic material, rocks must experience specific temperatures for an appropriate length of time. Too low a temperature and the organic material in the rock does nothing; too high and the organics are "cooked" beyond the oil and gas "window," leaving graphite as the only vestige of former organic materials. Through decades of mapping, geologists have determined that Maine's rocks have been almost universally heated well beyond the ideal temperatures for oil and gas. Indeed, many rocks contain abundant graphite. Extreme northern Maine may have escaped the unfavorable temperature conditions, but the Acadian foreland basin rocks there represented by Seboomook Group turbidites are highly deformed and organic-poor, leaving little potential for significant oil or gas accumulations.

Some may speculate that the prolific gas producer – the Ordovician Utica Shale – may be at depth in northern Maine. Most tectonic models for our part of the northern Appalachians, however,

indicate that the Laurentian passive margin sequence in which the Utica is grouped is inboard of the volcanic island arc sequence that welded to Laurentia during the Taconic orogeny. The back-arc basin outboard of the Taconic volcanic arc would not present the type of sedimentary environment conducive to the accumulation of organic-rich shale like the Utica.

The reason Maine has no oil or gas production is because our rocks have no oil or gas – simple as that. The fracking frenzy that has seized other northeastern states will not sneak in "under Maine's feet."

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2014, The State Geologist's Message: Will shale-gas production come to Maine? No! *The Maine Geologist*, v.40, n.2, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Legislative Review

In November, Maine voters elected a new Legislature, which maintains control of the House by Democrats and shifted the Senate to Republican control. In the Senate, there are 15 new members, many of whom have previously served in the house, but 5 of whom have no previous legislative experience. In the House, while many incumbents were re-elected, 53 newly elected Representatives have no prior legislative experience. Several Representatives moved over from the Senate, having been termed-out there. With this mix of seasoned and freshmen legislators, I expect old issues to resurface and new ones to be introduced, as the legislative session opens on January 7.

It is certain that this Legislature will again take up the issue of metallic mineral mining - at the top of my list of bills related to geology. To recap, an after-deadline bill was submitted late in the 2012 session to revamp the laws related to metallic mineral mining. The bill that eventually passed changed several key provisions of law regarding mining, perhaps most importantly that the term of a permit would be for the life of a mine, rather than the arbitrary 5-year term in previous law. With the new law as guidance, the Maine DEP pursued rule-making which was completed during the summer of 2013, when the draft rules were handed off to the Board of Environmental Protection. Through lengthy public comment and deliberations, the BEP reviewed and amended the rules, returning them to the Legislature in early 2014, where they were ultimately rejected. This leaves Maine with a framework law from 2012 and rules from 1991 (slightly modified) – a situation that is ripe for reappraisal.

There likely will be bills related in one manner or another to climate change. The previous Legislature established a "Commission to Study the Effects of Coastal and Ocean Acidification" which met over the summer and fall to consider the broad impacts of ocean acidification to Maine's economy (e.g. shellfish) and make recommendations for actions. Staff from the Maine Coastal Program (part of my Bureau) participated in the process. The draft report released on November 10 includes recommendations to improve monitoring, address quality of outflows from sewage treatment plants, review/improve agricultural BMPs, and others. Undoubtedly many of these recommendations will come forward in the session. Also, we have heard some rumors about bills related to sea-level rise. It will be good to have an open discussion about these issues, informed by science.

In one session a few winters ago, no fewer than 14 bills were presented related to water resources, mostly focused on groundwater extraction. Will there be a repeat? With a new Legislature and a large contingent of freshmen, anything may happen.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2014, The State Geologist's Message: Legislative Review. *The Maine Geologist*, v.40, n.3, p. 2.

THE STATE GEOLOGIST'S MESSAGE

Legislative Review

The Legislative session is in full swing, and several geologically related issues are figuring prominently in deliberations. Mining regulations. Legislative Document (LD) 146 resubmitted for approval by the Legislature are the same mining rules rejected by the previous Legislature. Prior to the public hearing on this bill, the Legislature's Environment and Natural Resources Committee invited me to provide an overview on metallic mineral deposits in our state and components of a typical mine. Scott Johnson and Andy Reeve of U Maine also provided an overview of groundwater and modeling. Both of these presentations were well received by members of the committee.

At the day-long public hearing on February 25, the Committee took testimony from numerous individuals and organizations opposed to these revised rules, many citing likely environmental consequences of mining Bald Mountain, and others citing the on-going, expensive clean-ups at the Callahan and Kerramerican mines. Supporters of the revised rules noted that they are intended to apply statewide, not just to Bald Mountain, and that problems at legacy mines like Callahan and Kerramerican provide little guidance for future mines. A subsequent hearing on LD 750, a slightly different tack on the mining issue, generated similar testimony. Both of these bills will be the subject of lengthy work sessions by the committee during the weeks of April 6 and April 13.

Several bills address sea-level rise. LD 408 would encourage coastal communities to consider sea-level rise in their comprehensive plans. At the public hearing, I presented factual information on sea-level rise to the committee. Although all who testified spoke in support, the Committee subsequently voted Ought Not To Pass, split along party lines. There will be more opportunities to discuss this issue during public hearings on LD 795, *An Act To Encourage Prudent Development along the Coast or in a Flood Zone by Considering Predictions for Sea Level Rise*, and LD 426, *An Act To Authorize a General Fund Bond Issue To Address Sea Level Rise*. Several other bills address ocean acidification.

Once again under scrutiny is the extraction of water for bottling. LD 169 would impose a 1-cent per gallon excise tax on groundwater pumped for bottling, with conditions that would limit this new tax to one Maine company. One legislator and one proponent spoke in favor of this bill, while several legislators and many others spoke in opposition. I spoke in opposition, noting the renewable nature of Maine's groundwater and the maze of regulations which ensure that groundwater pumping is done in a sustainable manner.

Here's an interesting bill, LD 1116, *An Act To Authorize the Development of Thorium Energy*. In spite of Maine's ban on mining thorium, this bill would allow thorium refining and/or a liquid fluoride thorium reactor, which would be considered a renewable energy source.

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2015, The State Geologist's Message: Legislative Review. *The Maine Geologist*, v.41, n.1, p. 3.

NEWS FROM THE STATE GEOLOGIST

Geological Surveys in the Cross Hairs

"Arizona Geological Survey is on life support," the June 15th headline blared, as a process begun many months ago neared completion. In an unanticipated and shocking move in January, Arizona Governor Doug Ducey proposed in his Fiscal Year 2017 budget to transfer the Arizona Geological Survey (AZGS) duties and responsibilities to the University of Arizona, beginning July 1, 2016 – and with no state funding. The proposal was developed without consultation with AZGS State Geologist Lee Allison or any interaction with the Arizona geological community. The Governor's policy adviser for natural resources said the AZGS was moved to the University of Arizona because its functions are research-oriented and have "a lot of crossover and synergy" with the university. "One of the things we said from the outset in our discussion with the UA is that we recognize the Geological Survey has a lot of talent. They get a lot of work done, and that is valued by the customers. We held several meetings to make sure we did not see a talent drain or a detriment to the level of service."

The consequences of the transfer, however, have been just the opposite. Twenty-five percent of AZGS positions are threatened by the consolidation and another 20% have been vacated as staff, faced with an uncertain future, sought other opportunities. Furthermore, the survey must consolidate to office space one-quarter its current size, with the loss of many valuable collections and research capabilities.

We all know that this political move has little to do with "synergy" and everything to do with a very short-sighted goal to reduce the state budget. According to an AZGS report, over the past five years, the state has provided $5.37 million in support, which attracted over $35.8 million in external research grants. (The AZGS proposed and managed a hugely successful multi-year program funded through the Department of Energy to collect and standardize state geothermal data – we were a subrecipient of this grant.) All this is now in jeopardy as UA has agreed to fund only one year at the state's former level before cutting the survey loose to fend for itself (and, oh yes, provide those exorbitant indirect funds to UA from future grants!). Has the AZGS been a victim of its own success?

While the geological community would like to dismiss this event as a fluke, it has happened before and likely will happen again as chief executives and legislatures are seduced by the notion that budgets can be trimmed with no loss of services. In the early 2000s, the Georgia Geological Survey was reduced to skeleton status as responsibilities were transferred to other agencies. The Michigan GS was gutted, with responsibilities and no funds transferred to Western Michigan University. In 2013 Colorado Governor John Hickenlooper (himself a former exploration geologist), facing a budget shortfall, "successfully" transferred the Colorado Geological Survey from state government to the Colorado School of Mines, while reducing its budget by half. His

spokesman explained that "the university could offset budget reductions by having students, graduate students and faculty members assist in research and apply for grants." Right. The CGS is still struggling to recover. Perhaps the truly successful recent transfer was of the Illinois State Geological Survey from their Department of Natural Resources to the University of Illinois. But in that case the ISGS was already co-located with UI, and ISGS staff already enjoyed the salary and retirement structures of UI faculty. This move actually released the ISGS from some burdensome state bureaucracy.

Nearly every state is dealing with budget issues, but in times when society is placing ever-increasing demands on geological resources, it is incredibly short-sighted to reduce or eliminate the few dollars directed toward state geological surveys. However, if it can happen to Arizona, it can happen to anyone. Who's next?

Robert G. Marvinney, Maine State Geologist

Marvinney, R.G., 2016, News from the State Geologist: Geological Surveys in the Cross Hairs. *The Maine Geologist*, v.42, n.1, p. 2–3.

NEWS FROM THE STATE GEOLOGIST

Mining Rules – Round 3

Among the more divisive topics debated by the Maine Legislature in recent years are the DEP's Chapter 200 Metallic Mineral Mining rules. You will recall that the effort to revise mining statutes and rules began with a bill submitted during the eleventh hour of the 2012 legislative session on behalf of the owners of the Bald Mountain VMS deposit in northern Maine. Among other provisions, the bill directed the DEP to revise the rules. Although the rules subsequently developed were twice defeated by the Legislature, a revision that addresses many of the major environmental concerns is now being reviewed by Maine's Board of Environmental Protection (BEP). While a scenic landscape image may be worth many dollars to an art collector, seeing a locality in person is priceless. In August, I took MGS Bedrock Geologist Henry Berry, BEP Member Tom Eastler,

and several DEP staff to visit the Eagle Mine in northern Michigan, a large underground nickel and copper sulfide mine now in production in broadly analogous geology and climate to northern Maine's.

We visited this mine, meeting with both the Eagle Mine's environmental managers and the State of Michigan's mine regulators, because the Eagle Mine is recognized as a modern metallic mineral mine permitted under modern, stringent regulations, and one that is operating with an exemplary environmental record. In fact, this mine was highlighted by environmental advocates in floor debates in both the Maine House and Senate in June 2013 because it was permitted under very strict regulations, including a mine closure plan that eliminates the need for water treatment within five years of closure – shorter than the 10-year limit in the rules being reviewed by the BEP.

I took away three important points from that visit:

1) Mining of metallic sulfide minerals can be done responsibly in a northern temperate climate;
2) The proposed Chapter 200 mining rules currently before the BEP are stricter than Michigan's in important ways:
   - The primary mining zone at the Eagle Mine is 1,000 feet directly beneath the Salmon Trout River, an important fish habitat in northern Michigan. Mining is underway without significant impact to the river. Water infiltration into the mine that must be pumped and processed through the water treatment plant is about 10 gallons per minute – the equivalent of five garden hoses. Maine's proposed rules would prohibit mining beneath Great Ponds, rivers, and streams.
   - The Humboldt Mill used to process ore from the Eagle Mine discharges tailings to a wet storage pond which will remain flooded after the mine is closed. It may be fortuitous that northern Michigan has many old iron open pit mines that may serve this purpose. Maine's proposed rules would prohibit wet tailings impoundments after mine closure.
   - Michigan does not allow perpetual water treatment after a mine is closed, but the rules do not specify the length of time beyond which treatment is considered perpetual, leaving this critical determination to be considered on a case-by-case basis. The proposed Maine rules limit post-closure water treatment to 10 years, beyond which treatment is considered perpetual and is prohibited.
3) A successful process like Michigan's to develop modern mining statutes and rules begins with broad community engagement. This is perhaps the most important lesson from the Michigan visit and one where Maine has failed miserably. The late introduction in 2012 of the mining bill and the lack of engagement with stakeholders disenfranchised the environmental community and many citizens, setting the process off on the wrong foot from which it has yet to recover, if it will at all.

All of this was quite evident on September 15, 2016 when the BEP respectfully listened for five hours as dozens of opponents testified against these rules, often citing environmental problems at the Callahan and Second Pond mines while failing to acknowledge that those mines were active before any environmental regulations were in place. We heard about disastrous tailings dam failures, while no one spoke of modern society's voracious appetite for these materials – an appetite that is driving many mining operations to third-world countries where environmental regulations are lax. I spoke of the apparent success of the Eagle Mine and the important ways in which Maine's proposed rules are stricter than Michigan's. You can read all the testimony at: http://www.maine.gov/dep/bep/featured.html

Several steps and opportunities for engagement remain in this process. Through several meetings, the BEP will further deliberate on the rules, making revisions before forwarding them

in January to the Legislature for final approval. You can expect the debate in the next Legislature to be a painful, rancorous one. But it is an important debate in which more voices need to be heard. I encourage you to participate.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2016, News from the State Geologist: Mining Rules – Round 3. *The Maine Geologist*, v.42, n.2, p. 2–3.

NEWS FROM THE STATE GEOLOGIST

Groundwater at the Legislature

Nothing dies harder than a bad idea. I last wrote a column about groundwater in 2009 when the 124th Maine Legislature was deluged with more than a dozen bills addressing various aspects of groundwater, all motivated by concerns over large-scale withdrawals for bottling. Among the bills currently before the 128th Legislature are those that would tax bottled water, create a water trust, and limit a water district's ability to sell water for bottling. Bills like these surface whenever Poland Spring/Nestlé investigates potential new sources, as they are currently doing in the Rumford area. All the legislative attention is predicated on the perception that among all groundwater withdrawals, those for bottled water pose a greater threat to Maine's aquifers and the environment than withdrawals for other purposes. There is no basis for this position.

Groundwater is among Maine's most renewable resources. Monitoring wells managed by the USGS and distributed across the state clearly demonstrate the annual recharge cycle of Maine's groundwater, in stark contrast with USGS wells in many western states that show decades of decline due to pumping for irrigation and municipal water supplies that outstrips recharge. "Groundwater mining" like that simply is not happening in Maine. In fact, decades of monitoring show that groundwater levels are increasing across most of Maine. Furthermore, large groundwater withdrawals for irrigation (in areas regulated by the Land Use Planning Commission) and bottling are heavily regulated, requiring expensive investigations and rigorous analyses to demonstrate the sustainability of the withdrawals.

In 2015 Poland Spring bottled around 900 million gallons of water from nine different gravel aquifer sources distributed around southern and western Maine. For comparison consider that in a typical year one large blueberry grower in eastern Maine uses about 1 billion gallons from one aquifer. One public water system in southern Maine produces about 900 million gallons annually from several clusters of wells in one aquifer system and has done so for decades. Monitoring data for all these withdrawals demonstrate groundwater recharge on an annual basis. I visited all of Poland Spring's well sites in October 2016, at the nadir of our recent drought. Each site had flowing springs – a testament to careful oversight by the resource managers at Poland Spring and the State's regulatory framework that limits withdrawals during drought.

Activist groups opposed to withdrawals for bottling often ascribe environmental catastrophes to this activity – groundwater mining, aquifer collapse, loss of wetlands, private wells run dry throughout a region – but never express similar concerns about irrigation or public water system uses of similar magnitude. These same groups suggest that Nestlé's goal is to control Maine's groundwater supply and sell it back to Maine citizens at a profit. I have heard this same view expressed by Maine Legislators. Groundwater withdrawals for bottling should be taxed, they say, in a way similar to excise taxes on oil and gas production in Alaska. As we all know, an analogy

that compares non-renewable resources such as oil and gas to renewable resources such as groundwater is one that does not work.

Taxing bottled water was a bad idea in 2005 when Maine voters rejected a referendum to do just that. It was a bad idea in 2009, 2011, and 2015 when bills to tax bottled water were rejected by the Legislature. It remains a bad idea today.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2017, News from the State Geologist: Groundwater at the Legislature. *The Maine Geologist*, v.43, n.1, p. 3.

NEWS FROM THE STATE GEOLOGIST

Work of Arthur M. Hussey II and colleagues receives honors

As the Geological Society of Maine prepares for the summer field trip in southern Maine, it is fitting to celebrate the national recognition bestowed on the most authoritative work on the bedrock geology of this region. Together, MGS Bulletin 45 and accompanying MGS Geologic Map 16-6 have been selected to receive the Association of American State Geologist's Charles J. Mankin Memorial Award for 2017! The Award is given each year to a nominated geological map, compilation, or report on regional, energy, or mineral resource geology published by a state geological survey. Bulletin 45\Geologic Map 16-6 was judged to be the best publication in a very competitive field of nominations spanning the nation. The work marks the culmination of decades of mapping by Arthur Hussey in Maine, and Wallace Bothner in New Hampshire, with significant contributions by Peter Thompson.

This award honors the memory of Charles Mankin (1932-2012), who as Director of the Oklahoma Geological Survey for forty years (1967- 2007) was a tireless advocate for geologic mapping. Charlie played a key role in establishing STATEMAP, the program administered through the U.S. Geological Survey that provides crucial funding to the state geological surveys for geologic mapping. Much of the work captured in B45 and GM 16-6 was funded through this program.

Bedrock of the Kittery quadrangle records over 500 million years of earth history, from sedimentation and magmatism in the Iapetus Ocean through continental collision, accretion, and assembly of the supercontinent Pangea, to continental rifting and the evolution of the modern Atlantic Ocean. Bulletin 45 and Geologic Map 16-6 mark a quantum step in understanding the local geologic history of this region, including a new timeline established with high-precision U-Pb geochronology that documents a very rapid sequence of deposition, deformation, metamorphism and intrusion in the Merrimack Group.

Furthermore, the bulletin and map are designed to appeal to a broad audience. Geologists will find data and technical details in appropriate sections of the bulletin. Consultants will appreciate the internally consistent, systematic nomenclature and photographs of representative rock types. Educators will find that conclusions are justified by logical arguments tied directly to the data, including clear statements of alternative interpretations and uncertainties. The interested non-geologist will enjoy the narrative summary sections in the bulletin and the map sidebar text, which is written to a nontechnical audience and illustrated with photos.

Praise from the authors' colleagues:

"My Bates geology students love to explore the diverse geology in this part of the State and we have spent many days with the Kittery map and report in hand looking at the rocks. I have the students lead various sections of our fieldtrips through the Kittery Quadrangle. Both the map and the report are so well portrayed and written, that all is accessible to my undergraduate geology students, making these excursions very successful."

-- J. Dykstra Eusden, Professor, Bates College.

"I consider Bulletin 45 and MGS Map 16-6 to be among the most important contributions to understanding the evolution of the Northern Appalachians in Maine. Other works that belong in that category are broader in scope, dealing with state-wide features and processes, but this research focuses more narrowly and answers questions that broader scale publications can't. The research is world-class and the information invaluable for students of the Northern Appalachian orogeny."

-- Allan Ludman, Professor, Queens College.

"From the perspective of an educator in New England, I honestly cannot think of another geologic map and supporting materials with greater utility. …. The Kittery 1:100,000 map not only portrays the geologic relationship accurately, but it is visually stimulating and complemented by a colorized inset map, unit correlation chart, and a sidebar that provides numerous photographs with explanatory descriptions that are accessible to students of all levels. The accompanying bulletin takes this a step further by providing exceptional visual documentation of dozens of individual map units and geologic structures."

-- David P. West, Jr., Professor, Middlebury College.

I would be remiss not to mention the significant efforts contributed by staff at the Maine Geological Survey to make these publications truly exceptional. Chris Halsted maintained his positive outlook on life through innumerable map edits and expertly formatted the report into its highly readable format. Editor extraordinaire Henry Berry was primary liaison with the authors on both the map and report, ensuring that the geologic information and interpretations presented in each were literally on the same page!

We hope you will avail yourselves of the wealth of geological information captured in these publications by Art Hussey and colleagues. The report and map are available online:

http://digitalmaine.com/mgs_publications/132/
http://digitalmaine.com/mgs_maps/517/

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2017, News from the State Geologist: Work of Arthur M. Hussey II and colleagues receives honors. *The Maine Geologist*, v.43, n.2, p. 3–4.

NEWS FROM THE STATE GEOLOGIST

National Geologic Mapping Act Reauthorization

Geologic maps have tremendous application to critical aspects of modern society. Given their capacity to identify mineral and fuel resources for creating and energizing modern conveniences, their use to characterize aquifers that provide 43% of the nation's irrigation water and 37% of public supply water, and their application to landslide and earthquake risk assessment, it is difficult to overstate the contributions of geologic maps to society. In fact, a rigorous economic analysis of the benefit to cost ratio of geologic mapping indicates, conservatively, a 5:1 benefit. With such clear benefits, why has the United States been among the most poorly geologically mapped modern nations?

In the late 1980s and early 1990s, the directors of the state geological surveys, acting through the Association of American State Geologists (AASG), recognized that a nation with only 20% coverage by geologic maps was unacceptable and decided to do something about it. Working together with (and sometimes at odds with) our colleagues at the U.S. Geological Survey, the State Geologists worked to advance through the Congress the National Geologic Mapping Act. Among the findings in the Act was that, "A comprehensive, nationwide program of geologic mapping based on Federal, State, and private efforts is essential to systematically build the Nation's geologic-map data base at a pace that responds to increasing demand for data necessary for the long-term needs of the Nation." After two years of debate (short by current standards!), the Act was first passed in 1992. It was subsequently reauthorized in 1997, 1999, and 2009, and is currently up for reauthorization.

In Maine, the State Geologic Mapping Component (STATEMAP) of the Act has nearly doubled the pace of geologic mapping. After a surge in the late 1970s and early 1980s in advance of the 1985 state geologic maps, geologic mapping went into somewhat of a slump in the late 80s due to budget cuts. Since 1993 through STATEMAP, the Maine Geological Survey has completed about 150 geologic maps, mostly in southern and central Maine but also in eastern and northern Maine. We have received more than $1.9 million through the program for mapping in critical areas, each federal dollar matched by a state dollar. Our Geologic Mapping Advisory Committee, with representation from industry, consulting, academia, and government agencies, has guided our geologic mapping program to priority areas with great success. Maps produced through STATEMAP have been used by a broad range of users to address an equally broad range of issues.

On September 14, Senators Angus King (I-Maine) and Lisa Murkowski (R-Alaska) introduced the National Geologic Mapping Act Reauthorization Act to the Senate which would reauthorize the programs through 2023. In a press release about the bill, Senator King stated, "By reauthorizing the National Cooperative Geologic Mapping Program, we can help ensure responsible environmental stewardship, mitigate natural hazards, and foster economic growth." I and the membership of the AASG will be working in the coming months to ensure the passage of this bill.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2017, News from the State Geologist: National Geologic Mapping Act Reauthorization. *The Maine Geologist*, v.43, n.3, p. 1–2.

NEWS FROM THE STATE GEOLOGIST

A revision of a column written in 2008

What goes around comes around. I first wrote about offshore oil and gas potential in 2008 when national security drove a reevaluation of the nation's energy policy, including the long-standing moratorium on drilling in the North Atlantic. Here's the first paragraph of that column, edited to reflect the current times:

"On ~~July 14th~~ January 4, President ~~Bush~~ Trump revoked most provisions of an executive order supporting moratoria on leasing of many areas of the outer continental shelf (OCS) for oil and gas production, as one part of a strategy to reduce our nation's reliance on foreign oil. This was followed shortly by declarations from our Congressional Delegation ~~and Governor~~ supporting a continuation of the moratorium on drilling in Maine's OCS."

In 2009, as part of the then Ocean Energy Task Force's review of offshore energy potential, I compiled a summary report of Maine's potential for oil and gas resources, both onshore and offshore. (Report at Digital Maine: http://digitalmaine.com/mgs_publications/534/) We geologists know that four ingredients are required for the generation of significant hydrocarbon accumulations: sufficient organic carbon in sediments, a specific thermal history applied to those sediments, rocks that can act as reservoirs, and suitable traps that allow migrating hydrocarbons to accumulate in the reservoir.

Looking at the second criterion first, almost all onshore Maine can be eliminated from hydrocarbon potential by thermal history. Based on metamorphic mineral assemblages, we know that most of the rocks now exposed experienced temperatures above 200°C, beyond the optimum temperature range (100-200°) for the development of hydrocarbons from naturally occurring organic material. Above about 225°C, organic carbon is converted to graphite, a common mineral in many metamorphosed sedimentary rocks of Maine. Only extreme northern Maine has escaped the extreme heat, and the turbidite rocks there are unlikely to have sufficient organic carbon.

Moving to the offshore: Well-exposed rocks on Maine's coast have attracted geologists for centuries. Their collective work demonstrates that the immediate coastal areas and coastal islands, to the 3- nautical-mile limit of state jurisdiction, have experienced a similar geologic history as the remainder of Maine. High-grade metamorphic rocks and igneous intrusions abound to the outermost islands, leaving no opportunity for preservation of hydrocarbons.

Less is known of the geology in federal waters beyond 3 miles, but sufficient work has been done to provide a framework for assessing hydrocarbon potential. One of the very first applications of seismic refraction techniques in the Gulf of Maine was by Katz and others (1953). Their work investigated the nature of the crust along a traverse that extended from about 25 miles seaward of Yarmouth to about 35 miles seaward of Mount Desert Island. The compressional wave velocities they determined with this experiment are consistent with granite as the dominant rock in the shallow crust.

The work of Hutchinson and others (1988) summarizes much of what is known about the geology of the Gulf of Maine. Based on seismic reflection profiles and aeromagnetic surveys, they delineated several Triassic rift basins related to the Fundy rift system. Due to a series of sidestepping faults, the rift basins are located progressively farther offshore as one moves from the Bay of Fundy to the southwest. Based on aeromagnetic signatures similar in strength and pattern to those of the subaerial igneous and metamorphic terranes, on seismic refraction velocities, and interpreted seismic reflection profiles, Hutchinson and others (1988) concluded that most of the

Gulf of Maine inboard of the Triassic basins is underlain with the extension of the terranes of igneous and metamorphic rocks that geologists have mapped throughout New England. The short answer is that the Gulf of Maine to the northern boundary of the Georges Bank has no potential for hydrocarbon accumulations.

The Georges Bank is another story. Eight exploration holes were drilled there during the 1970s and 80s, among them two Continental Offshore Stratigraphic Test (COST) wells. Walter Anderson visited one of these drill sites when it was active. These wells showed favorable Mesozoic stratigraphy, similar to that of the productive area offshore Nova Scotia at Sable Island, but they were short on organics. Furthermore, the units had been insufficiently heated to generate hydrocarbons, had there been enough organic carbon.

Despite long odds, assessments of undiscovered and technically recoverable hydrocarbon reserves have been made by the Bureau of Ocean Energy Management (Department of Interior) for the North Atlantic Planning Area, a region extending from southern New Jersey to The Hague Line. The 2016 assessment estimates reserves of 1.8 billion barrels of oil (BBO) and gas reserves of 11.8 trillion cubic feet (Tcf) in the entire Area. This assessment takes into account plays that are productive at Sable Island and shows of oil and gas in holes off New Jersey. For comparison, undiscovered reserves in the Gulf of Mexico are set at 48 BBO and 142 Tcf gas.

So the question for the near-term is will there be oil and gas exploration leases anywhere within the Gulf of Maine or on the Georges Bank? We'll see.

Hutchinson, D. R., Klitgord, K. D., Lee, M. W., and Trehu, A. M., 1988, U. S. Geological Survey deep seismic reflection profile across the Gulf of Maine, Geological Society of America, Bulletin, v. 100, no. 2, p. 172-184.

Katz, S., Edwards, R.S., and Press, F., 1953, Seismic refraction profiles across the Gulf of Maine, Geological Society of America, Bulletin, v. 64, no. 2, p. 249-251.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2018, News from the State Geologist: A revision of a column written in 2008. *The Maine Geologist*, v.44, n.1, p. 2–4.

NEWS FROM THE STATE GEOLOGIST

Lidar, landslides, and hazard mitigation

Lidar (Light detection and ranging) technology is revolutionizing how we measure and image the landscape. Using high resolution lasers from aircraft, ground stations, drones, or other platforms, the technology produces a point cloud of billions of points from which very precise locational and elevation data can be extracted. Innovative applications of this technology to natural resource management are revolutionizing how we work. Geologists generally prefer the bare-earth datasets created through post-processing which strips away vegetative cover and manmade structures to reveal the intricacies of the natural landscape as no other technology can. Foresters often prefer to process the multiple returns from single locations from which forest metrics can be generated. The applications are endless.

Over the past several years, a consortium of state and federal agencies along with private sector interests have contributed to acquiring lidar coverage for the entire state, a goal which will be met in the next few years. Early coverage on the coast revealed systematic recessional moraines

marching northward as glacial ice retreated, features that were impossible to see without this technology. An early application by MGS geologists of coastal lidar was the development of a storm surge inundation portal that graphically illustrates the impact of this hazard in coastal areas.

One of the more important applications and one to which we are now committing significant resources is landslide investigations. Even casual review of lidar data in areas of the state underlain with the Presumpscot Formation reveals dozens of previously unrecognized landslide features. Vegetative cover was too dense and the features too subtle for MGS geologists to recognize them in some areas during detailed surficial mapping.

Of course, the potential for landslides, predominantly in the Presumpscot, has long been recognized as a geologic hazard. Periodic catastrophic landslides remind us that this is an ongoing hazard: the 1868 Westbrook slide that dammed the Presumpscot River, flooding the mill; the 1983 Gorham landslide that destroyed a home; the 1996 Rockland landslide that destroyed two homes and prompted significant remediation of unstable areas of Rockland Harbor.

The revelation of so many prehistoric landslide features in southern Maine led to this overarching question: Did many of these landslides occur immediately post-deglaciation when precipitation patterns were different and the landscape was largely unvegetated, or have they occurred sporadically over the last 10,000 years? If most were old, the hazard would be of lesser concern, but what if most were not old? To answer this question, we have been working with the Maine Emergency Management Agency (MEMA) over the past two years to investigate a subset of these landslides. Among MEMA's responsibilities is developing and updating the State's Hazard Mitigation Plan. With the Plan due to be updated in the next few years, we had the perfect opportunity to access Federal Emergency Management Agency funding to investigate these landslides. Through last fall and continuing this summer, Senior Geologist Lindsay Spigel has been mapping the details of several dozens of these landslides, sampling the subsurface materials primarily via hand auger. Carbon-14 dating of the organic material she retrieved is revealing an intriguing picture of episodic landslides. While several landslides occurred in the suspected timeframe around 10,000 years ago immediately following deglaciation, there is a large cluster of events in the 600-700-year timeframe. We'll probably never know what triggered these, but perhaps it was a significant rain event, a forest fire over a broad region, or an earthquake. From the standpoint of hazard mitigation, we can no longer dismiss these features as irrelevant to modern hazard. Over the course of this summer, Lindsay will be collecting additional datable materials to further refine our understanding of these significant landslide features.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2018, News from the State Geologist: Lidar, landslides, and hazard mitigation. *The Maine Geologist*, v.44, n.2, p. 2–3.

NEWS FROM THE STATE GEOLOGIST

Mineral exploration core rescued!

While attending a geological meeting in Presque Isle a few years ago, Fred Beck approached me brimming with excitement. “I just found something I’ve been seeking for the past 20 years!” he said. “What’s that?” I asked. In answer, Fred reached into his bag and pulled out several short sections of drill core. What Fred had rediscovered in nearby Easton were thousands of boxes of drill core from mineral exploration drilling at Mount Chase and Ore Mountain, among the most significant ore bodies in Maine. With this rediscovery began a several-years-long effort to carefully inventory and move the core to a permanent, secure location.

In the late 1970s and early 1980s, Getty Mining Company carried out a mineral exploration program in the vicinity of Mount Chase near Patten, seeking base and precious metal deposits. In the first borehole at a depth of 134 feet, the drill intercepted over 20 feet of massive sulfide, with zinc grades to 2.90% – the initial discovery of the Mount Chase deposit (now called Pickett Mountain by the new owner, Wolfden Resources Co.). A total of about 100 holes were drilled over the next few years to prove out the distribution and tonnage of the deposit, reported then to be 2.4 million tons grading 11.3% zinc and 4.8% lead. Nearly 100,000 feet of drill core were carefully placed in cardboard boxes, ten feet of core to each, and stored for later examination. After Getty left the project and through several changes of ownership, the cores remained in warehouses at the Huber manufacturing plant in Easton, their whereabouts long forgotten by those involved with the project. Huber, having sold the mineral rights to both the Mount Chase and the Ore Mountain properties, no longer had any interest in the cores they had been storing for 30 years.

At the time Fred rediscovered these drill cores, time, weight, and weather had taken their toll on the boxes and their contents. While cardboard core boxes stacked carefully no more than three feet high on pallets, protected from the elements, and secured in a rodent-free setting might have an indefinite lifespan, changing just one of these conditions can lead to catastrophic loss. Unfortunately, at the Huber warehouses all three of these conditions were compromised. Pallets were staked pallet upon pallet upon pallet, the boxes in the bottom layer succumbing via simple shear to the weight above, spilling their contents irretrievably. Over the decades, a few sections of roof and walls had torn away, exposing the boxes to the ravages of the elements. And a few animals

had made comfortable homes among the boxes. The prospect of sorting through the mayhem to retrieve intact core was daunting, to say the least!

With funding from the National Geological and Geophysical Data Preservation Program administered by the USGS, with enormous assistance from managers at Huber, and with free space offered by the Presque Isle Industrial Council, we plunged once more into the breach! Prof. Chunzeng Wang from U Maine PI spearheaded the project to bring the cores home. With an able crew of students lead by Caleb Ward (see photo at the end of the newsletter), the cores at the Huber warehouses were systematically triaged – those intact boxes that would be moved, those that required TLC to recover, and those that were lost.

Over the course of several months this summer, the core boxes were carefully extracted from the jumbled disorder, organized by hole number, and restacked on pallets. Once a load of pallets was ready, they were shipped via flatbed to the storage building in Presque Isle, and restacked onto new core racks by the same crew. In all, some 11,000 boxes of core were moved. At about 20 pounds per box, that's 110 tons of core that were moved and restacked. With a minimum of two lifts per box (onto pallet and off pallet) each team member moved about fifty(!) tons over the course of the summer! I advise against challenging any of them to an arm-wrestling match!

While perhaps not the most convenient to access due to the goal of recovering as much valuable core as possible, the current storage is secure, out of the weather, boxes are not overloaded, and the space is rodent-free (we hope!). Very special thanks are due to Jim Reed and employees (Huber Engineered Woods, LLC) for donated forklift work that was essential to the success of the project; to Tom Powers (Presque Isle Industrial Council) for free storage space and forklift services; to Fred Beck for his determination to locate the core and guidance during the project; to Chunzeng Wang for hours of donated effort to keep the project on task and on schedule; and to the students who reported to work faithfully each day. This project has been a superb example of Maine's can-do spirit!

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2018, News from the State Geologist: Mineral exploration core rescued! *The Maine Geologist*, v.44, n.3, p. 3–4.

NEWS FROM THE STATE GEOLOGIST

A New Direction for Maine

In November, Maine voters elected a new Governor and a new Legislature, placing control of both chambers plus the Governor's Office in the hands of Democrats. Clearly, priorities for the next few years will be quite different from the past eight. In her inaugural address, Governor Janet Mills laid out new directions for the State of Maine, consistent with many of her campaign pledges. Among them is a new commitment to address climate change, given high priority in the Governor's address. Policies to address climate change are also high priority for the 129th Legislature. While we await the confirmation of Commissioners (including for the Department of Agriculture, Conservation and Forestry) – the leaders who will implement the Governor's priorities – we can glean much from about the policy directions of the State through bills submitted by members of the 129th.

The First Regular Session of the 129th Maine Legislature convened on Wednesday, December 5, 2018, comprising 88 Democrats, 56 Republicans, and 6 Independents in the House, and 21

Democrats and 14 Republicans in the Senate. With many newly elected freshmen in the House and a few in the Senate, there will be a steep learning curve on the issues coming before each of the Legislature's policy committees. Already more than 2,000 bill titles have been submitted, but at this early stage of the session, only a few bills have been printed with full language. Of interest to geologists are dozens of bills on energy-related matters, many on climate and sea-level rise, and others that address groundwater issues.

On the climate-change front, there are at least half a dozen bills on topics ranging from ocean acidification, to updating the State's Climate Action Plan, to addressing greenhouse gas emission standards. There are two bills intended to prohibit offshore drilling for oil and gas. As the State's jurisdiction in the marine submerged lands extends to only 3 miles offshore, we geologists can definitely state that there is zero potential for oil and gas in Maine's territorial waters. Furthermore, the only real potential for hydrocarbon accumulations is over 100 miles south at the Georges Bank, and even there the potential is low. These bills will certainly make for some lively public hearings!

Several bills will address sea-level rise, including a $50,000,000 bond to "to improve waterfront and coastal infrastructure in municipalities to address sea level rise." Another borrows from the State of New Hampshire by proposing a Coastal Risks and Hazards Commission to develop policy recommendations to address sea-level rise and increasing storm hazards. Marine geologists from the Maine Geological Survey will be intensely involved in the discussion of these bills as they proceed through the legislative process because, unlike the policy of the past 8 years, subject-matter experts in the state agencies will be permitted to present the science behind these issues. In an excellent example of providing science for policy development, on January 22 Marine Geologist Pete Slovinsky participated in an overflight with a southern Maine legislator to review the impacts of the most recent King Tide.

Finally, there are a slew of bills focused on groundwater extraction. Some proposals aim to broaden the State's oversight of groundwater by moving this resource into the public trust. Others very specifically seek to tax groundwater extraction for bottling. Behind these bills are many misperceptions about Maine's groundwater resources, among them that extractions for bottling have more impact on Maine's aquifers than extractions for other purposes. There is no scientific basis for this view. During a recent introductory session at the Legislature's Environment and Natural Resources Committee, one anti-bottled water activist declared, "Our aquifer levels are on steady decline," a statement for which there is not one shred of evidence.

Just for a bit of levity during the session, lawmakers will discuss the merits of *An Act to Rebrand Maine's License Plate Slogan from "Vacationland" to "Staycationland."*

Whether on a serious topic or the nonsensical, the first regular session of the 129th Legislature will be engaging!

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2019, News from the State Geologist: A New Direction for Maine. *The Maine Geologist*, v.45, n.1, p. 6–7.

NEWS FROM THE STATE GEOLOGIST

Leading the way on climate

By the time you read this, the 11th Beaches Conference will have already happened. Since 2000, this conference, organized by Maine Sea Grant with significant input from the Maine

Geological Survey, Maine Coastal Program, and other agencies and organizations, has focused attention on the health of Maine (and since 2017 – New Hampshire) beaches. A major theme throughout the nearly two decades of the conference has been the impacts of sea-level rise (SLR) and coastal storms. For each conference, Marine Geologists Pete Slovinsky and Steve Dickson, along with marine interns, have created graphs showing the status of Maine's significant beaches in terms of erosion and accretion of sand. Much of the data comes from an army of volunteers who monthly measure profiles across these major beaches. On average over the last decade, Maine's beaches have been evenly split among those that are accreting, those that are remaining stable, and those that are eroding. Many of you will recall that the winter storms of 2018 were particularly rough on Maine's beaches. And fortunately, through the profile data we see that most beaches have recovered significantly by 2019. But what will the impact be of additional rise in sea level?

This and other questions will be addressed by the Maine Climate Council proposed by Governor Mills in a bill before the Legislature. The proposed 39- person Council would draw membership from the Legislature, senior leadership in almost every government department, and 20 members "representing state interests affected by climate change or with expertise in climate change issues." Many of the climate bills I discussed previously have been rolled into this one initiative.

Among the duties of the Council is to appoint a Scientific and Technical Subcommittee charged with analyzing the best science on the direct and indirect effects of climate change and the factors contributing to those effects. Perhaps most important to southern Maine beach communities, this Subcommittee shall establish "science-based sea-level rise projections for the State's coastal areas," and "create maps that indicate the areas of the State that may be most affected by storm surge, ocean and river flooding, and extreme weather events…." MGS Marine Geologists Pete and Steve will be heavily involved in this work. In fact, over the past several years they have developed datasets that show potential inundation under several SLR and storm surge scenarios. MGS's GIS Manager, Chris Halsted, created a web mapping portal for easy access to these data.

https://www.maine.gov/dacf/mgs/hazards/slr_ss/ index.shtml

Parts of the Climate Action Plan that the Council is charged with updating will set aggressive goals for GHG reduction and goals for electricity production from renewable (low-carbon) sources. In updating the Plan, the Council will evaluate mitigation strategies that would be most effective in meeting those goals. The Plan will also focus considerable effort on adaptation and resiliency strategies and actions. Many coastal communities are already developing adaptation strategies but are having difficulty finding the funding to implement them. Perhaps a bond will address some of this need.

During the hearing on the Climate Council bill, one Legislator asked, "If we do all the things called for in this bill, at considerable expense, will there be any impact on the rate of sea-level rise in Maine?" The answer is "no." But coastal communities, in particular, are already facing the impacts of climate change. Someone needs to take the first step. Dirigo.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2019, News from the State Geologist: Leading the way on climate. *The Maine Geologist*, v.45, n.2, p. 3.

NEWS FROM THE STATE GEOLOGIST

Can Maine Contribute to the Nation's Reserves of Critical Minerals?

Critical minerals provide the raw materials for vital components of our modern conveniences – everything from cell phones to solar panels to batteries. Yet, the USA relies heavily on imports for most of these materials, and supply disruptions can have devastating consequences. In response to Presidential Executive Order 13817 which targets national self-reliance in critical mineral supply, in 2017 the U.S. Geological Survey completed the report, "Critical Mineral Resources of the United States— Economic and Environmental Geology and Prospects for Future Supply." Paraphrased from the report's introduction:

This report reviews 23 mineral commodities viewed as critical to a broad range of existing and emerging technologies, renewable energy, and national security. The commodities included are antimony, barite, beryllium, cobalt, fluorine, gallium, germanium, graphite, hafnium, indium, lithium, manganese, niobium, platinum-group elements, rare-earth elements, rhenium, selenium, tantalum, tellurium, tin, titanium, vanadium, and zirconium. These commodities have been listed as critical and/or strategic based on likelihood of supply interruption and the possible cost of such a disruption. For some of the minerals, current production is limited to only one or a few countries. For many, the United States currently has no mine production or any significant **identified** resources [*emphasis added*].

The Executive Order further directs the federal agencies to develop "a plan to improve the topographic, geologic, and geophysical mapping of the United States….to support private sector mineral exploration of critical minerals," that will ultimately lead to the identification of new significant resources in the USA.

As part of this effort, the USGS has initiated a cooperative program with state geological surveys to gather available information about these critical minerals and, more importantly, to identify prospective areas in the States where exploration might be most fruitful. The Maine Geological Survey received a grant through this program by which we are addressing beryllium, cesium, lithium, cobalt, manganese, and tin – the first three commodities are important components of pegmatites and the latter associated with sulfide ores or slates. Choosing lithium as an example, worldwide reserves occur in only two geologic settings: salt brines and pegmatites. Imports to the USA come from the world's largest reserves in salt brines of South America and pegmatites of Australia. Yet, thanks to spodumene discoveries in western Maine, we know that there is significant potential in Maine's pegmatites for world-class lithium resources.

It is our great fortune to have an experienced team working on this project, including Fred Beck (FM Beck, Inc.), Dwight Bradley (USGS, emeritus), Myles Felch (Maine Mineral and Gem Museum), Amber Whittaker (MGS Senior Geologist), and Chris Halsted (MGS Director of Earth Resource Information). Fred brings decades of Maine exploration knowledge to the process, Dwight is a co-author of the USGS report, Myles has extensive experience in pegmatites, and Amber and Chris bring GIS and data management expertise. In October, Amber, Fred, and Myles will attend a Critical Minerals Workshop hosted by the USGS in Reston, VA, to further network

with other eastern geologists working in the program. By the end of the year we expect to have a series of potential resource maps that I think, in terms of addressing critical mineral needs, will shine a lithium-powered spotlight on Maine.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2019, News from the State Geologist: Can Maine Contribute to the Nation's Reserves of Critical Minerals? *The Maine Geologist*, v.45, n.3, p. 5–6.

NEWS FROM THE STATE GEOLOGIST

Water Resources Planning Committee 2.0

Water is abundant in Maine and is one of the State's most renewable resources. In an average year, more than 24 trillion gallons of precipitation fall across the State, and up to 5 trillion gallons recharge groundwater annually. Groundwater is an enormously important resource for public water systems, irrigators, commercial interests, and to the maintenance of stream flows that sustain important habitats. Analysis of decades of groundwater level records from monitoring wells maintained by the USGS demonstrates that, with a few minor exceptions, levels are stable or slightly rising across almost all areas of the State. And with climate change, it is likely that precipitation will increase across our region.

Despite these facts, small but vocal groups continue to claim that Maine's water resources are under assault, most recently expressed in an anonymous flyer distributed at the January 29 Maine Climate Council meeting claiming that commercial interests are mining groundwater (i.e. using at rates greatly exceeding recharge). Few statements about Maine's groundwater are farther from the truth.

None of these are new claims. A year ago, the Legislature faced about a dozen bills focused on one aspect or another of Maine's water resources. As one response to the concerns, the Legislature reestablished the Water Resources Planning Committee (WRPC), a stakeholder group that provides a forum for discussion of water resources and the regulations governing their use. From 2007 to 2012, the WRPC had provided effective guidance on water issues before falling victim to the dismantling of the State Planning Office under which it was organized. The WRPC rev. 2.0 is administered in the Department of Agriculture, Conservation and Forestry and includes representation from:

State agencies charged with regulating water withdrawals; agricultural water users; public water utilities; water bottlers; use of water by private domestic well owners; environment and conservation organizations; commercial users of water; water conservation educators; stormwater or wastewater managers; and from Maine's tribes.

Among the charges to the WRPC are:

- Collecting and reviewing information regarding water withdrawal activities;
- Coordinating state water resources information;
- Refining the most recent watershed supply and demand study;
- Conducting appropriate water resources investigations in select watersheds;
- Considering projected increased water use by population, agricultural irrigation, commercial users, industrial users and other users;
- Considering seasonal use;

- Considering potential effects of climate change;
- Considering the effects of anticipated future water quality classification changes on the availability of water for withdrawal;
- Establishing priorities for further investigations, seeking input from the user community, from towns dealing with multi-municipal aquifers and from towns with significant local aquifers;
- Developing guidelines for consistency in further investigations; and
- Conducting annual reviews of state policy.

The Maine Geological Survey presented overviews of current water-related research at the first meeting of the WRPC in November 2019. During the interim WRPC-less years, we developed many new tools that will further our water work: a statewide soil-water balance model with the USGS for estimating groundwater recharge; improved water use data collection across twelve sectors; densification and improved geographic distribution of Maine's groundwater monitoring network; and studies of potential saltwater intrusion in coastal areas. These and other on-going efforts by the MGS move us a long way toward addressing the charges to the WRPC.

At future meetings, the WRPC will take up the review of Maine's current extensive and rigorous regulations governing large-scale water extractions. Stay tuned as this important stakeholder process continues.

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2020, News from the State Geologist: Water Resources Planning Committee 2.0. *The Maine Geologist*, v.46, n.1, p. 5–6.

NEWS FROM THE STATE GEOLOGIST

Critical Minerals – Part II

As a follow-up to my October 2019 column on critical minerals in the U.S., I am pleased to announce that the Maine Geological Survey has been awarded a two-year grant through the U.S. Geological Survey's Earth Mapping Resource Initiative (Earth MRI) to investigate lithium resources in western Maine. Through the effort I described in October, our project team developed several focus areas with the potential for critical commodities: lithium in the pegmatites of western Maine; nickel, cobalt, and platinum group elements in and around Moxie Pluton in central Maine; base and precious metals in the Munsungun area of northern Maine. Our Oxford County Pegmatite Field project focuses in the Rumford and Newry areas.

While our project in the fall was really an office effort – compiling available information on resources in Maine – this project will generate new data. Bedrock mapping is a key component of the project to better establish the geologic context of abundant pegmatites in the region. In addition to traditional geochemistry of rocks, our project includes a stream-sediment survey aimed at developing prospecting tools for lithium-rich pegmatites. To refine our understanding of the genesis of pegmatites, our team will collect samples for geochronological studies using several techniques: U/Pb analysis of igneous zircons; detrital zircon analysis of metasedimentary rock samples; and U/Pb dating of cassiterite.

For a project focused on lithium resources, we have assembled the dream team: Dwight Bradley (USGS, emeritus) – guidance on geochronological studies, particularly on cassiterite;

Myles Felch (Maine Mineral and Gem Museum) – geologic mapping and handheld XRF analyses of pegmatites; Chris Koteas (Norwich University) – geologic mapping and sampling for geochem and geochron; Dyk Eusden (Bates College) – geologic mapping and sampling for geochem and geochron; Steve Smith (USGS) – guidance on stream-sediment sampling; Dan Locke (MGS Hydrogeologist) – lead on stream-sediment sampling; Amber Whittaker (MGS Senior Geologist) – GIS analysis and geologic interpretation; Chris Halsted (MGS Director of Earth Resource Information) – GIS and database functions; and field interns to assist with mapping. And, oh yes – I get to push around all the paper for this project.

We're glad that Governor Mills' COVID-19 protocols allows this interstate team to convene (within no less than six feet) on western Maine this summer. We are looking forward to great results!

Robert G. Marvinney, State Geologist

Marvinney, R.G., 2020, News from the State Geologist: Critical Minerals – Part II. *The Maine Geologist*, v.46, n.2, p. 4–5.

NEWS FROM THE STATE GEOLOGIST

Dynamic Earth

While for most lifetimes in Maine our landscape seems firm and unchanging, planet Earth periodically reminds us that we live in a dynamic place. On the morning September 16, the landscape along the Presumpscot River in Westbrook suddenly gave way, releasing tens of thousands of cubic yards of unconsolidated mud and sand into the river, carrying with it trees and anything else on the surface. The blockage in the river immediately backed up the flow, causing the river level to rise more than 10 feet in just a few minutes, but thankfully there was no injury or loss of life and relatively little property damage. The event prompted the City of Westbrook to declare a state of emergency, and a swarm of media descended on the locale. Fortunately, Maine Geological Survey landslide expert Lindsay Spigel was just a few miles away sampling old landslides (!) in Gorham when I sent her into the fray. While the media was interested in determining causes and laying blame, Lindsay clearly and calmly reported that the underlying cause of the landslide was the underlying sensitive clay of the Presumpscot Formation.

Geologists have long known that this area along the Presumpscot River has a significant landslide hazard. Professor Edward Hitchcock (Amherst College) described a landslide in this area in 1831. In 1868, the largest documented landslide in Maine (38 acres) blocked the river and flooded the mill upstream until mill workers dug a channel through the blockage. Other prehistoric landslides have occurred throughout this region and elsewhere in the southern Maine areas underlain by the Presumpscot, as revealed by recent lidar data. Lindsay's work on dating landslides has resulted in a surprising chronology of sporadic events since deglaciation, with an interesting cluster of events in the 600–700 year BP timeframe. Might these have been triggered by an earthquake or a regional wildfire? More research is required.

In the meantime, the Portland Water District (PWD) responded to the immediate threat to several of their distribution pipes which cross the Presumpscot River literally a few feet downstream from the slide site. PWD removed the tangle of massive trees and much of the blockage in the river, at considerable expense. While the immediate concerns caused by this landslide have been addressed, there remains the question of landslide hazard in the region. MGS

continues to work as part of a multi-agency effort to encourage Westbrook and partners to better assess this hazard, and to seek ways to fund such an assessment.

"Civilization exists by geological consent, subject to change without notice." – Will Durant

Robert G. Marvinney, State Geologist

For more on Maine's landslides, visit the Maine Geological Survey landslide website.

Marvinney, R.G., 2020, News from the State Geologist: Dynamic Earth. *The Maine Geologist*, v.46, n.3, p. 3–4.

NEWS FROM THE STATE GEOLOGIST

Living Shorelines

The ambitious "Maine Won't Wait" climate action plan, released in December 2020 by the Governor's Maine Climate Council, includes a strong emphasis on community resilience. Strategy F, Build Healthy and Resilient Communities, recommends that the State adopt official sea-level rise (SLR) projections to guide policy on coastal development. MGS Marine Geologists Steve Dickson and Pete Slovinsky, together with U Maine Marine Sciences Prof. Joe Kelley, developed the recommendation to manage for 1.5 feet of SLR by 2050 and 3.9 feet by 2100, and to plan to manage for 3 feet of SLR by 2050 and nearly 9 feet by 2100. These projections use intermediate and high SLR scenarios, respectively, as determined by using the U.S. Army Corps of Engineers sea-level change calculator. Since 1912, sea-level in Portland has risen at a rate of 8.7 inches/century, and in the last 25 years, that rate has increased to 15.9 inches/century. Updating the State's coastal development policies with these projections is a step toward resiliency.

But we're not satisfied with simply setting a policy without providing some tools to help communities with their adaptation and resiliency efforts. In addition to setting SLR standards for policy, Strategy F also makes recommendations about community responses to SLR, among them to leverage nature-based solutions to address issues like coastal erosion. A living shoreline is a nature-based solution that we are exploring in several locations in Casco Bay. Living shorelines consist mostly of native vegetation or other natural elements, often in combination with materials like oyster shells, to stabilize shorelines. They reduce erosion while maintaining the land and water connection important to sustaining habitats, as opposed to the impacts to habitat by hard rock and other structures typically installed to control erosion. Our project is part of a regional collaboration managed by The Nature Conservancy with funding from NOAA that includes the states of ME, NH, MA, RI, and CT. Local partners in the Casco Bay project are the Maine Coastal Program, Town of Brunswick, Brunswick-Topsham Land Trust, Maine Coast Heritage Trust, Casco Bay Estuary Partnership, and MaineDOT.

After many months of site analysis, selection, materials acquisition, and planning, Pete, Steve, and the team installed materials at three sites – the Wharton Point boat landing, Maquoit Bay Conservation Lands, and Lanes Island. Salt marsh is eroding at the first two sites, where the typical wave and tide energy is fairly low. The Lanes Island site is an eroding bluff with more potential for damaging waves due to the prevailing fetch. During summer 2020, the team placed natural materials such as coir bags (fiber from coconut husks) filled with aged and cleaned oyster shells, shell-filled gabion bags, tree trunks, and root balls at each site, following detailed engineering designs. Many volunteers from the project partners assisted with this work. The concept is that the

natural materials will trap sediment and promote additional salt marsh growth that will protect the sites from further erosion. For the most part, the installations worked well through the summer and fall, only requiring minor maintenance. Unfortunately, the Lanes Island site was hit hard by winter storms before the installation could promote marsh growth. In the coming months, Steve and Pete will continue to monitor the effectiveness of these living shoreline installations with an eye toward fine tuning the analysis of suitable sites and materials.

Finally, a personal note. My column in the June 2021 GSM newsletter will be my last. After 34 years at the MGS and 26 years as State Geologist, I'll be taking the off-ramp to retirement on June 30! More on that next time.

Robert G. Marvinney
State Geologist

Marvinney, R.G., 2021, News from the State Geologist: Living Shorelines. *The Maine Geologist*, v.47, n.1, p. 3–4.

NEWS FROM THE STATE GEOLOGIST

Signing Off

On January 8, 1987, I received a call at work while I was toiling with the rudimentary GIS, Arc/Info rev. 2.3 (no on-screen editing!). The caller was Walter Anderson, and he asked, "How would you like to come to Maine?" With that call, my purgatory of the prior 3.5 years in the hot, flat, and crowded environment of Houston, TX, came to an end. A few exceptional people can map out their chosen career path from beginning to end, but I am not one of them. My path to here was rather circuitous with opportunities at times serendipitous. Suffice it to say, I could not have gotten to Maine without going through Texas where I was immersed in the early applications of GIS. When Walter called that January day, he was seeking a geologist who knew Maine geology and GIS. At that time there were very few of us.

So began my 34-year career at the Maine Geological Survey and 26 years as State Geologist. There have been many accomplishments during that time, but I cannot claim credit for many of them. They are really the accomplishments of a group of people, both past and present, committed to the mission of the MGS to improve our understanding of the geology of Maine as a basis for sound decisions about resources and the environment. Their collective expertise, creativity, and innovation has served the MGS and the people of Maine well.

One remarkable achievement has been the complete transition of electronic data management and communications. When I arrived in May 1987, the MGS had four phone lines for the office – our secretaries would use the intercom to tell us, "Call on line 2." No PCs, no email, most reports typed on a typewriter, one Burroughs system computer that allowed rudimentary file sharing among users on text-only terminals. Our map production system was based on cartographers taking pen in hand to draw lines on mylar (aided by architectural curve tools), lettering using Leroy templates, and zipatone pattern sheets for filling areas. Editing these maps required erasing and redrawing. Once a mylar map was completed, we created copies with an Ozalid machine that was larger than an SUV!

It's unnecessary to point out that the paper maps had no database behind them. If we wanted to do some type of analysis using multiple map layers, we had to use the photo shop – the actual shop, not the software! It was a laborious process of enlarging or reducing images, then overlaying them on a light table for analysis.

The transformation to completely digital map production happened over several years, without the addition of more staff – in fact, typically doing more with less. Our cartographic group and geologists recognized the value of the GIS tools and plunged into recreating our processes electronically. Many geologists now collect information in the field electronically, aided by GPS, and upload the day's work before they return to the office. Our GIS group has developed an integrated database for managing map and publication data, and for seamless analysis of geologic information statewide. It is hard to imagine a process transformation of similar magnitude in the coming years, but it will probably happen, and we'll wonder how we managed before.

In 1992, the Congress passed the National Cooperative Geologic Mapping Act that for the first time directed significant funding to the states to conduct mapping in areas with greatest scientific and societal need. Our first project under this program was mapping the surficial geology of one quadrangle in southern Maine, for which we received $8,750 in federal funding. To date, we have completed around 160 bedrock and surficial maps through the program, in areas across the State deemed important by our Geologic Mapping Advisory Committee (GMAC). For 2021, we received $162,706 in federal funding, matched by State funding, to map the surficial geology of three quadrangles and the bedrock geology of six quadrangles. In addition to MGS staff mappers, our team includes the most experienced mappers in Maine. I offer thanks to our volunteer GMAC members who have helped us focus the program on relevant projects that garnered support by the federal/state peer review panel.

The coastal/marine and groundwater programs have flourished in the last decade. Our marine geologists and summer interns have been systematically mapping Maine's major beaches, capturing information on berm width and edge of vegetation that is critical to our understanding of the impacts of sea level rise. We've developed a very strong collaboration with the Maine Coastal Program in the Department of Marine Resources that helps us direct our efforts towards the interface of the shore with the built environment and methods to adapt to changing conditions. One approach we've been working on is Living Shorelines – using natural materials to encourage growth of salt marshes to protect vulnerable shorelines. The work of our marine program has been essential to formulating state policy sea level rise adopted by the Legislature in June of this year.

Every Mainer benefits from MGS's work on water resources. The annual snow survey collects important information about the water content of the snowpack, and how that might impact the potential for spring flooding. Decades of data will be useful to studies of how our winters have changed in response to climate change. We are working to enhance and expand the National Groundwater Monitoring Network in Maine, and with funding from the USGS, have added around 30 wells to the network. These will also provide valuable data on the response of groundwater to climate change. With ever increasing demands on Maine's water resources, our work to compile statewide water use information across all sectors will be in great demand. All of these groundwater efforts are conducted through collaborations with the USGS.

Perhaps our greatest collective accomplishment has been enhancing the reputation of the Maine Geological Survey, established by my predecessor, as the trusted source of unbiased information on all aspects of Maine's geology. When MGS professionals speak, people listen – homeowners and business owners, coastal residents, groundwater professionals, legislators, Department leadership, Governors (Independent, Democrat, and Republican), and anyone else with an interest in geology. The integrity of this organization, built on the reputations of MGS staff, is its greatest asset. I am honored to have carried the MGS banner for these many years. I extend my thanks to the Maine geological community for all your support during my tenure as State Geologist.

Robert G. Marvinney
Maine State Geologist, 1995 – 2021

Marvinney, R.G., 2021, News from the State Geologist: Signing Off. *The Maine Geologist*, v.47, n.2, p. 2–3.

MEMBERSHIP DUES STATEMENT

The GEOLOGICAL SOCIETY OF MAINE, INC. (often referred to as **GSM**) is a non-profit corporation established as an educational Society to advance the professional improvement of its members; to inform its members and others of current and planned geological programs in Maine; to encourage continuing social contact and dialog among geologists working in Maine; and to further public awareness and understanding of the geology of the State of Maine; and of the 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 a field trip). A newsletter, ***The Maine Geologist***, is published for all members three times a year. The Society year runs from Aug. 1 to Jul. 31. Annual dues and gift or fund contributions to the Society are tax deductible. There are four classes of membership:

2021 FEE SCHEDULE

$ 30.00	REGULAR MEMBER	Graduate geologists, or equivalent, with one year of practice in geology, or with an advanced degree.
$ 30.00	INSTITUTIONAL MEMBER	Libraries, societies, agencies, businesses with interests in or practicing geology and related disciplines.
$ 15.00	ASSOCIATE MEMBER	Any person or organization desirous of association with the Society.
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THE GEOLOGICAL SOCIETY OF MAINE ANNUAL RENEWAL / APPLICATION FOR MEMBERSHIP

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