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THE PRESIDENT'S MESSAGE

This is my last message as President since my term ends at the fall meeting on 11/6/14 that takes place in Augusta. I am happy to see that on my tenure we had an very well attended summer field trip in July that combined the Geological Society of Maine and the New Hampshire Geological Society in the Bethel area. About 70 people attended including about 20 from the Live Free or Die state. More information will be provided in the next newsletter.

As documented later in this newsletter, the downside of 2014 was the elimination of the Geoscience Department at the University of Southern Maine. Despite efforts from GSM and many others, the UMS Trustees failed to understand the value of the department as a stepping stone for employment in southern Maine, among other things. Ironically, my first President's message discussed how geology has finally become a mainstream, popular and better understood science. I guess not everyone is as up to speed as we thought.

Good luck to the new incoming President Marty Yates of UMO!

Keith Taylor
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207-591-7000

Notes for GSM Spring 2014 Business Meeting

The business meeting occurred at 3:30PM immediately after completion of the oral presentations. President Keith Taylor thanked the student presenters for the excellent quality of work. He then announced that the Educational Funding guide had been finalized and will be posted on the GSM website. Funding of groups in activities that promote geology in Maine and/or the education of Maine geology students are the primary targets for the grants. Up to $1,000 will be awarded per grant. Applications are due in March and September and awardees will be announced at the Spring and Fall GSM meetings, respectively.

Keith described the plans for the summer field trip that will be based on the Bethel, Maine area, with Saturday July 19th focusing on surficial geology (Woody Thompson) and engineering geology, the latter relating to the reconstruction of Rte. 2 from Maine to New Hampshire. Sunday July 20th will consist of a chairlift ride up the Sunday River ski area to observe bedrock outcrops with Dyk Eusden. A campground will be announced in the near future. Members of the NH Geological Society are expected to attend.

Steve Pollock of the University of Southern Maine (USM) spoke about the State's plan to eliminate their Geoscience Department. Steve explained that the decision-making process was not transparent and appeared to ignore that fact the department is vibrant and serving the "metropolitan" population that the school is supposed to be targeting. Steve noted that eliminating the department will actually cost the State a substantial amount over the next few years because of their contract conditions. Dan Belknap of the University of Maine stated the UMO and USM have a cooperative relationship and do not compete for funds or students. Steve asked GSM members and GSM the organization to contact USM officials and/or their State legislators. In an informal vote, the GSM members at the meeting agreed that GSM should support the USM geoscience department.

The business meeting ended at approximately 4:15PM.

Submitted by Keith Taylor

GSM WEBSITE: www.gsmmaine.org

THE STATE GEOLOGIST'S MESSAGE

ROBERT G. MARVINNEY, STATE GEOLOGIST

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."

UPCOMING MEETINGS OF INTEREST

SUMMER 2014 & BEYOND

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GSM 2014 Summer Field Trip & Meeting
Saturday & Sunday July 19-20, 2014
Bethel, Maine and vicinity.

Trip Leaders: Dyk Eusden of Bates College and Woody Thompson of Maine Geological Survey.

Stay tuned for further details & check
http://www.gsmmaine.org

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2014 New England Intercollegiate Geological Conference (NEIGC)
October 10 – 12th Columbus Day Weekend
Wellesley College, Massachusetts

http://w3.salemstate.edu/~lhanson/NEIGC/Conference.html

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Fall Meeting of the Geological Society of Maine

Augusta Civic Center, November 6, 2014. See website for details.

PROFILES OF MAINES COLLEGES AND UNIVERSITIES

This purpose of this column to highlight Maine's many colleges and universities that offer undergraduate and graduate programs in Geology and/or Earth Sciences. Regrettably, with this newsletter we must report that the Geoscience Department at the University of Southern Maine is facing potential faculty cuts or even elimination due to budget cuts proposed by the university administration. Printed below is the letter submitted by GSM President Keith Taylor to the University of Southern Maine on behalf of the membership.

Andrew Anderson
Dean College of Science Technology and Health,
USM PO Box 9300
Portland, ME 04104

May 6, 2014

Dear Mr. Anderson,

The Geological Society of Maine (GSM) is an active organization of about 250 people that includes consultants, members of state agencies, and professors from all of the geology departments in Maine, both private and public institutions. On a national level, geology is a growing field because of the high level of interest in environmental science among college students, but also because of a greater awareness of the geologic connection to the global problems such as water shortages, landslides, tsunamis, and sea level change. Of course the boom in natural gas has increased the demand for geologists as well.

GSM opposes the plan to eliminate the Geoscience Department at the University of Southern Maine (USM) for a variety of reasons. First, the geology departments under the University of Maine System (UMS) do not compete for students and serve very different needs. Directing a southern Maine student interested in geology to another UMS school ignores the fact that financial and geographic conditions play a strong influence in school selection and a student's ability to attend.

Having a geoscience program remain in the Portland area makes total sense from the perspective of employment and integration with a metropolitan area. There are dozens of companies and state agencies in southern Maine that hire geologists—in fact, most if not all of the environmental and geotechnical consulting firms in southern Maine have USM alumni on their staff.

It is also our understanding that the USM geology staff have prepared a plan that would revitalize the department as existing staff retire and younger professors are hired, as well as reducing operating costs. This plan warrants a serious review.

Geology is not an obscure, unpopular, or stagnant field. It addresses real-life problems in the Portland metropolitan area as well as farther afield, such as the ongoing revision of metallic mining rules for potential mines in Aroostook County. Maine has one of the more dynamic populations of geologists in the country and many have come from USM. We urge you to speak to the USM geology staff directly and review their plan for keeping a vibrant geology program going in southern Maine.

Sincerely,

Keith Taylor, Maine Certified Geologist
President, Geological Society of Maine

And USM's response:

From: Andrew Anderson via email
Sent: Tuesday, May 06, 2014 5:12 PM
To: Keith Taylor
Cc: Kalikow, Theodora; Stevenson, Michael
Subject: Re: USM Geosciences Dept.

Keith,

I, along with President Kalikow and Provost Stevenson, have received many phone calls, mail, and emails regarding the proposed actions to address the University's financial challenges. I appreciate your input on behalf of the Geological Society of Maine and will share your letter with the President and Provost.

The President has welcomed input on actions she recommended to address the FY 15 budget gap for USM. As she stated, there is a process underway regarding those recommendations, including the proposed program eliminations. In accordance with the USM governance constitution, proposals made by the President are placed before the Faculty Senate seeking their recommendations. Those recommendations and other input provided by faculty in the department are now being reviewed. That includes the plan from the department that you mention in your letter.

Thank you for contacting me and sharing your organization's endorsement of the Department of Geosciences and the need in Maine. Again, I will share this with the President and Provost.

Sincerely,

Andrew L. Anderson, Dean
College of Science, Technology, and Health
PO Box 9300
University of Southern Maine
Portland, ME 04104-9300

Spring Meeting at Bowdoin College
April 4, 2014
STUDENT ABSTRACTS
(Alphabetical by author)

A LATE-HOLOCENE PALEOENVIRONMENTAL RECONSTRUCTION OF LINNÉVATNET, SVALBARD USING GEOCHEMICAL AND PRODUCTIVITY PROXIES

Balter, Alexandra (1) Richter, Nora (2) Retelle, Michael(3) Edwards, Graham (4)
1 Bates College, 2 Northwestern University, 3 Bowdoin College

This study aims to reconstruct late-Holocene environmental change in Linnédalen, a glaciated valley in the Norwegian High Arctic, using a 1400 year geochemical and productivity record of proglacial lake Linnévatnet. A multi-proxy approach was utilized to document physical, chemical, and biological changes preserved in the lake sediments. Ca:Ti ratios obtained with XRF showed an increase from 0.25 to 1 at the onset of the Little Ice Age (LIA) in Svalbard around 1350 A.D, and remained high throughout the LIA. The Mn:Ti profile also shows a peak ~1350. At the same time, δ13C values of the sediment become enriched from -23 ‰ to -17‰. The sudden change in these parameters indicates rapid environmental change in Linnédalen at the onset of the LIA, which may have been related to a change in climate.
High Ca:Ti ratios and more enriched δ13C values during the LIA are interpreted as increased detrital carbonate input to the lake introduced from the Carboniferous Nordenskiöldbreen carbonate unit to the east of the lake. A large carbonate fan is observed on the shore of Linnévatnet, and sediment from this fan shows higher Ca:Ti values than other sediment sources to the lake. The fan appears to be seasonally active with a spring melt-water source in an upslope nivation hollow, although there is no glacier ice or perennial snowpack currently present to feed the fan.
The increased input of detrital carbonate at the onset of the Little Ice Age may be representative of a change in summer melt-water source to Linnévatnet, likely linked to a change in climate. A chlorophyll temperature reconstruction indicates a cold LIA, suggesting that greater ice extent in the carbonate unit was possible, providing a source for carbonate input to Linnévatnet.

RAFTING EXPLORATIONS IN GRAND CANYON GEOLOGY, ARIZONA, U.S.A.

BLUHM, Denise, Geosciences, University of Southern Maine, 37 College Avenue Gorham, ME 04038, denise.bluhm@maine.edu

The stratigraphy of the Grand Canyon as seen from a raft trip down the Colorado River displays a wide variety of the paleogeographic environments which existed over the last two billion years. In the summer of 2013, long-time Geologic Society of Maine members Fred Beck and Alison Jones organized a geology focused 9-day rafting trip which took us down 303 km of the Colorado River through the Grand Canyon. The trip departed from Lee's Ferry, just below Lake Powell, and traversed from Permian limestones down section into the Precambrian and displayed in vivid detail the various paleo environments. The variety of paleogeographic landscapes over time varied from vast deserts to epeiric seas and is displayed in approximate 100 percent rock exposure. Hiatuses of deposition and erosion of over 1 billion years are seen at the Greatest Unconformity in Blacktail Canyon, and this stimulates the mind as to what was occurring in this part of the world then. Several impressive geologic structures are also present within the canyon as seen by raft or side canyon hikes including; dramatic drag faults, exfoliation joints, extensive cross-bedding in sandstones, massive pegmatite swarms, evidence of paleoseismicity in quartzite, large solution caverns, natural springs, slot canyons, lava dams, large-scale columnar jointing, and the remnants of an immense side canyon flood with a flow rate of 20,000 cubic feet per second. A trip through the Grand Canyon down the Colorado River displays incredible changes in paleogeography which existed during the Paleozoic era.

PRELIMINARY FIELD AND PETROGRAPHIC STUDY OF THE LEUCOGRANITE WITHIN THE NORUMBEGA FAULT ZONE IN THE HORSEBACK QUADRANGLE, MAINE

DICKINSON, Jared, Department of Environmental Studies & Sustainability, University of Maine at Presque Isle, 161 Main St., Presque Isle, ME 04769, jared.dickinson@maine.edu

Recent mapping in The Horseback 7.5' quadrangle has revealed that the "Passagassawakeag Gneiss" shown on the current Maine bedrock geologic map is composed predominantly of mylonitized leucogranite dikes and garnet-bearing, spangled muscovite quartz schist. The protolith of the schist was greywacke and slate of the Fredericton Trough. Both the leucogranitic mylonite and the schist are products of the early Norumbega ductile shearing. The leucogranite is composed of quartz, plagioclase, and K-spar with minor muscovite and biotite. It occurs as multiple phases of medium-grained and pegmatitic dikes that are intruded in the metasedimentary rocks and that contain abundant metasedimentary xenoliths. Outcrop-scale, pervasive diking within the metasedimentary rocks demonstrates a migmatic appearance along with local assimilation. Based on structural fabrics the leucogranite could be either pre-ductile shearing or syn-ductile shearing. In the more favorable syn-ductile shearing model, the ductile shearing could either facilitate ascent of leucogranitic magmas produced at depth or generate leucogranitic magmas by anatexis of metapelite due to elevated geotherms caused by "shear heating".

MONITORING THE IMPACTS OF A HARD STABILIZATION ROCK WALL AT POPHAM BEACH, PHIPPSBURG, MAINE

DOUGLAS, Alec, Geology, Bates College, 366 Bates College, Lewiston, ME 04240, adougla2@bates.edu

Man-made hard stabilization structures often obstruct the natural sand transport of sandy beach systems. A section of Popham Beach, in Phippsburg, Maine currently faces disruption of sand movement due to an extruding rock wall. The wall, built in 2010, offers prime insight into the ongoing effects of hard

stabilization in a barrier beach setting. The study area lies on the east-facing portion of Popham Beach, which experiences consistent longshore sand transport in a northeasterly direction along the beach face. Long-term photographic observation and satellite mapping of Popham Beach from 1953 – 2014 indicate that sea level rise, tidal shifts, and weather affect sand deposition along the beach, and often result in fluctuations of beach size and shape, and changes to the modern dune position. Since the 2010 construction of the rock wall at Popham Beach, dune scarps proximal to the wall have retreated inland by up to 23 meters. Measurements of dune retreat, beach profiling, and consistent tide-cycle measurements of sand erosion and accumulation indicate that the imposing rock wall causes extensive variability in sand transport, with significant increases in turbidity and sediment flow limitations along the rock wall face. The offshore bar bathymetry at Popham Beach helps protect and replenish the sand budget over natural cycles, yet the presence of the rock wall poses a challenge to beach health. Sand flow is essential to replenishing the budget for dunes and beach face, and disruptions to this transport may hold dire consequences for the future of the beach and the community of Phippsburg.

THE EFFECT OF BASAL TOPOGRAPHY ON THE CALVING DYNAMICS OF RETREATING TIDEWATER GLACIERS IN THE MAINE COASTAL LOWLANDS

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The Laurentide Ice Sheet began to retreat northwards from coastal Maine between 17,500 and 12,000 years ago. Isostatic depression resulting in marine incursion (~70 m APSL) allowed for tide-water glacier conditions to exist, leaving behind distinctive sedimentary landforms during ice retreat. This study investigates well preserved glacial "end moraines" within unbroken, presumably annual, successions from the Maine coastal lowlands. Analysis is completed in ArcGIS 10.1 using high resolution LiDAR (Light Detection and Ranging) DEM (Digital Elevation Model) files. Recent developments in LiDAR remote sensing technology have enabled elevation data to display a vertical accuracy upwards of ~10 cm. This imagery is particularly groundbreaking for viewing glacial features that are shrouded in vegetation or difficult to detect with the human eye. Raw DEM files are downloaded from the Maine Office of GIS Data Catalogue and converted into Hillshade and Slope rasters. Well preserved sets of DeGeer moraines are digitized in ArcMap using Hillshade rasters for visual reference. The average distance between each annual moraine is calculated with 2-5 perpendicular transects across each annual event. Successions from Waldoboro, Hancock, Blue Hill and Trenton, Maine yield annual ice retreat ranging between 60-280 meters/year. Basal topography sloping downwards to the north results in larger northerly ice retreat (160-280 m/year). Upsloping basal topography associated with a northward ice flow results in smaller annual ice retreat (60-100 m/year). Flatter basal topography result in more consistent northerly ice retreat (100-160 m/year). It is likely that variations in topography had a strong effect on ice calving dynamics of the retreating Laurentide Ice Sheet, separate from climate controlled variations. Further analysis with other moraine successions across the Maine Lowlands would likely show similar spatial relationships with geometric variations in the basal topography. Additionally, comparing topography and calving relationships in tidewater glacier environments in foreign geographies could also be completed.

"PERMIT BY RULE" DUNE RESTORATION AT FERRY BEACH, SACO ME

GAVIN, Scott and Pollock, Stephen G., Department of Geosciences, University of Southern Maine, Gorham, ME 04038

Winter storms between late October 2012 and late March 2013 caused serious erosion of coastal dunes along an approximate 1.5 km long stretch of the southern portion of Saco Bay known as Ferry Beach. Dune retreat varied along Ferry Beach but is estimated to be between approximately 4 and 8 meters. Height of the erosional scarp varied between 0.5 and 1.5 meters. Approximately fifty six separate lots were adversely affected. Affected properties included two rights of way owned by the City of Saco, plus Ferry Beach State Park. Chapter 305, Section 16 (Activities in Coastal Sand Dunes) of Maine's Natural Resources Protection Act (Revised 30 June 2011) permits property owners to restore frontal dunes through a process referred to as Permit By Rule. Twenty three lot owners contracted with a consultant, and filed applications to restore the frontal dunes using "scraped beach sand and raked seaweed". Restoration was followed by planting of dune grass required by legislation.

Restoration occurred during September and October 2013. The 23 lots which had their dunes restored did so through the use of heavy equipment. Sand was scraped from the approximate high tide line onto the frontal dune. The 2013 erosional scarp ranged in height from approximately 0.5 to 1.75 m. The width of the restored dune face ranged from approximately 3 to 7 m when restoration was concluded.

Winter storms from December 2013 through March 2014 removed variable amounts of the restoration. Southern and northern portions of the Ferry Beach were less affected, while the central area of restored dunes experienced losses up to 80% the restored dunes.

FORMATION OF RHYOLITE AT THE OKATAINA VOLCANIC COMPLEX, NEW ZEALAND: NEW INSIGHTS FROM ELECTRON BACKSCATTERED DIFFRACTION (EBSD) ANALYSIS OF QUARTZ CLUSTERS IN PLUTONIC LITHICS

GRAETER, Karina, Department of Earth and Oceanographic Science, Bowdoin College, Brunswick, Maine 04011, kgraeter@bowdoin.edu

Granitic lithic clasts from the 0.7 ka Kaharoa eruption at the Tarawera volcano of the Okataina Volcanic Complex (OVC), New Zealand, offer a rare glimpse into the magmatic processes occurring in the world's most productive rhyolite region. Combined Cathodoluminescence (CL) imaging of quartz growth histories and crystallographic orientation analysis of

quartz grain pairs from Electron Backscatter Diffraction (EBSD) reveal that 60% of quartz grain pairs are in preferred orientations that follow the Esterel and parallel twin laws. Out of 83 total clusters (groups of two or more quartz grains), 84% contain at least one pair in Esterel or parallel twin orientation. Although faint, CL zoning reveals that grains attached after individual crystal growth and many were subjected to one or more resorption events prior to complete solidification. When combined with previous research on the Kaharoa plutonic lithics, these results indicate that they formed as part of a crystal cumulate mush within a shallow magma chamber. Under the influence of dynamic processes such as compaction, some quartz grains within the mush came into contact along their dipyramidal faces. For those grains whose dipyramidal faces became oriented in parallel or Esterel twin orientation, their lattices joined together to form a stronger bond than the bond between those grain pairs that are oriented randomly. As a result, Esterel and parallel oriented grain pairs should be more likely to stay together throughout a remobilization event of the cumulate mush. The high percentage of twin-oriented pairs and the resorption features of these lithics indicates that multiple recharge events have occurred within the cumulate pile which have removed non-oriented clusters preferentially. Therefore, analysis of quartz clusters from these plutonic lithics provides direct evidence for repeated replenishment into a cumulate mush during shallow pluton formation in an active volcanic complex. This result is consistent with models that suggest rhyolite formation originates through interstitial melt extraction during crystal fractionation in the shallow crust and that parts of the active magma reservoir reach the solidus.

COMPARING VARIOUS DIGITAL IMAGERY TECHNIQUES TO DETERMINE LANDSLIDE ACTIVITY

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Mentors: Margaret Vose, Irwin Novak

Identifying locations of potential landslide hazards has been a focus of the Maine Department of Conservation for decades. Satellite and aerial imagery techniques have made detection of these potential hazard areas much more efficient. Recently, the State of Maine acquired 1.5 meter per pixel LiDAR imagery for much of the state. LiDAR is a method of remote sensing that utilizes a pulsed laser to measure distances from a satellite to the earth. This creates a precise, three dimensional image of the surface of the Earth. The focus of this project was to compare previously available imagery tools with the latest LiDAR imagery to determine if previously unmapped landslides could be seen, and if there was an advantage to using the LiDAR. Other imagery used was GIS based landslide hazard susceptibility map (Jones and Rich, 2006), aerial photo study (Novak, 1990), and the Maine Department of Conservation's Coastal Bluff Hazard Map of the Yarmouth Quadrangle, Spot Imagery, Orthoimagery 6inch per pixel and 1 foot per pixel, and Landsat Imagery (Vose, 2010). The focus area of Yarmouth, Maine was chosen due to the high number of previously mapped landslides. The results show the LiDAR imagery, though not as high resolution as some of the imagery, creates an advantage when observing potential areas of landslide activity because the image shows only the surface of the Earth, with no groundcover. This allows for viewing of detailed and minute landslide features, and several small, previously unmapped landslides may have been identified using this technique.

THE COOLING HISTORY OF THE DARK HARBOR BASALT, GRAND MANAN ISLAND, NB, CA

LYNN, Stephanie, Earth and Oceanographic Science, Bowdoin College; 6800 College Station, Brunswick, ME 04011, slynn@bowdoin.edu

The Dark Harbor Basalt is a ~201 Ma sequence of thoeliitic flood basalt associated with the initiation of the Mid-Atlantic Ridge. Located on Grand Manan Island, NB, CA, the Dark Harbor Basalt is composed of three members: two medium-grained columnar members and a series of highly altered vesicular flows. Previous studies of columnar basalt have demonstrated that column size is inversely proportional to cooling rate, such that columns cool fastest and have the smallest dimensions at the margins of the flow. Columnar basalts emplaced in water-rich environments, however, often have small columns at the base. The orientations of column faces are thought to be random. This study combines measurements of the strike and width of >2,000 column faces with statistical work to examine two aspects of the cooling history of the two columnar members of the Dark Harbor Basalt: 1) changes in column size with depth within the two columnar basalts and 2) the distribution of column face orientations. The results show that column size increases with depth by a factor of ~2, which is consistent with cooling rate decreasing with depth within the Dark Harbor Basalt and a dry emplacement environment. The results for the strike measurements are more complex. The upper columnar basalt has preferred 000°, 090°, and 070° orientations, indicating that the column faces are not randomly oriented. Aggregated data collected from a range of depths within the lower member yield a uniform distribution of strike measurements, but the base of the lower member has a preferred orientation of 010°. This orientation is consistent with the regional stress field during the initiation of the Mid-Atlantic Ridge. The cooling history of the Dark Harbor Basalt reflects the pattern of emplacement, regional paleo climate, and geologic setting.

STRAIN LOCALIZATION AND DEFORMATION ALONG THE NORUMBEGA FAULT SYSTEM, MAINE

McDONOUGH, Kevin, Department of Earth and Oceanographic Science, Bowdoin College, kmcdonou@bowdoin.edu

A long-standing question in structural geology is how strain is accommodated in shear zones. Understanding how these rocks deform at the grain scale may help better the understanding of how large strike-slip fault systems form. The differentially exhumed Norumbega Fault System (NFS), located in Maine, provides an excellent natural laboratory to study how strain localizes. This study presents optical petrography and SEM data collected from two outcrops (~60 km apart) of the metasedimentary Cape Elizabeth Formation that were selected because they expose deep and shallow portions of the NFS. This study categorizes strain localization and deformation mechanisms at these two locations to test the hypothesis that

strain is accommodated by micas at lower temperature and lower strain rate, which is determined by proximity to the fault zone, and by both micas and quartz at higher temperature and strain rate. Based on optical petrographic observations, the sheet silicates, the weakest phase within the Cape Elizabeth Formation, were the first minerals to deform. They deformed by slipping along the {001} cleavage plane and forming interconnected layers. The quartz matrix deformed to varying extents based on strain rate and temperature. At lower temperatures and strain rates, the quartz matrix did not accommodate deformation by recrystallizing. With increases in strain rate and temperature, the quartz matrix did deform to some extent by dynamic recrystallization. At the highest strain rates and temperatures, which were represented by a sample collected within a mylonitic zone, the quartz matrix completely recrystallized and experienced extreme grain size reduction. These data suggest that there is a continuum of fault-related deformation based on temperature and strain rate, which is based on proximity to the fault strand.

EFFICIENT DATA MODEL FOR DIGITIZING GEOLOGIC LEGACY DATA

MILLER, Silas. Department of Geoscience, University of Southern Maine, silas.miller@maine.edu

Before the use of handheld GPS and other digital devices was commonplace, geological data were typically recorded on paper maps and notebooks. Such legacy data are extremely valuable when digitized to standards used by geospatial scientists. To address issues of efficiency and interoperability a data model was developed. The data used in this study were bedrock maps of NW Maine, recorded by Stephen Pollock in the early 1980s. Original location data were plotted on 1:10,000 stereo pair aerial photographs and 1:2,000 aerial photos provided by paper company landowners. These locations were transferred to, first 1:62,500 USGS topographic quadrangles and then to 1:24,000 USGS topographic quadrangles when they became available in the late 1980s. Outcrop locations, formation contacts and faults were keyed to notebooks containing more detailed information. This presents two major challenges: first, determining accurate spatial coordinates for each feature and second, entering notebook data into tabular form. This data model organizes the data into tables and displays it in standard geologic map formats. Data entry is done feature-by-feature from a scanned and georeferenced image of the field map. To produce accurate representations of geologic features and formations, topology rules are applied, ensuring bedrock units do not overlap or have gaps. This data model provides a preliminary systematic framework for digitizing and validating geological legacy data.

COASTAL CURRENTS IN THE GULF OF MAINE: A MECHANISM FOR ALGAL BLOOM TRANSPORT

PEABODY, Ryan; Roesler, Collin, Department of Earth and Oceanographic Science, Bowdoin College, 678 Smith Union, Bowdoin College, Brunswick, ME 04011, rjpeabod@bowdoin.edu

The Gulf of Maine experiences blooms of Alexandrium fundyense, a toxic dinoflagellate, almost every year between May and October. These blooms appear cyclically in the spring and fall, and appear to be dependent on a combination of seasonal stratification cycles and wind forcing. Spring blooms occur when warming water temperatures cause phytoplankton and nutrients to be held at the surface where light is abundant, allowing for a bloom. The fall bloom occurs during the onset of destratification when cooling waters at the surface sink and allow deeper, nutrient-rich water to rise to the surface. The propagation of blooms is along the coast and generally unidirectional, signifying that bloom movement is probably due to residual current flow.

We present the development and application of a quantitative model of current circulation along the shelf in the Gulf of Maine. The model matches observed patterns in summer surface circulation and allows for further understanding of the mechanisms driving both current circulation and algal bloom advection. Current flow is primarily along the coast in a southerly direction, with some diversion offshore. This is likely controlled by river plumes that raise nearshore sea surface height, causing geostrophic flow to be south and west along the coast. Fall current flow is not southerly off the coast of New Hampshire, meaning that fall algal bloom propagation is not due to current advection in the southern Gulf of Maine. The modeled circulation climatology provides insight into hydrographic patterns and ecosystem dynamics as they relate to alongshore advection.

BASELINE CREVASSE MEASUREMENT ON NORTH CASCADE GLACIERS TO DETECT CLIMATE CHANGE

PELTO, Jillian, Department of Earth and Climate Sciences, University of Maine, 1 Timberview Dr Apt 1E Orono, ME 04473, jill.pelto@maine.edu

In August 2012 and August 2013 I measured the characteristics and distribution of crevasses on glaciers in the North Cascade Range, Washington. This work is in conjunction with the North Cascade Glacier Climate Project (NCGCP). The goal is to observe crevasse characteristics compiling a baseline database that can be used to assess how crevasses change through time. In the North Cascades crevasse formation is usually caused by flow of the glacier over a change in slope, where the ice is being strained. Decreases in glacial movement as a result of decreasing ice thickness results in less strain on the ice, meaning that fewer crevasses will form, this is a means of monitoring glacier velocity response to climate change. Can we identify a relationship between a glacier's health and the size and extent of its crevasses? The observations made at each crevasse are location, surface slope, width, depth, and length. I used a cam-line measuring tape to attain depth, and found an average of approximately 9.1 m. In order to measure the crevasse length I used a laser range finder to determine an average of about 37.8 m. Data was collected from sixty-six crevasses on seven glaciers this past summer, to add to fifty-six crevasse measurements on five glaciers in summer 2012. With this base line data I can begin to map how the crevasses change year by year as the glaciers respond to climate change.

GROWTH BANDS AND TRACE ELEMENTS IN BAMBOO CORALS FROM THE GULF OF ALASKA

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Trace element to calcium ratios in calcifying organisms have been used to reconstruct past climate and ocean temperature. Bamboo corals, which live for 100-300 years and have growth bands, have been proposed as archives of deep-ocean conditions. Visible bands measured with a petrographic microscope were used to align trace elemental data collected along three replicate radii of the calcitic internodes of two well-dated corals from the Gulf of Alaska via laser ablation ICP-MS (collected live at 720m and 643m; 48°3'N, 132°44'W). Both lines were smoothed using a 1-year moving average. The laser ablation lines of both corals are reproducible for Ba/Ca (#3 mean r = 0.842 ± 0.032, #5 mean r = .739 ± 0.056), and for Mg/Ca (#3 mean r = 0.866 ± 0.047, #5 mean r = 0.814 ± 0.025); this suggests that Mg and Ba vary in response to the external environment on timescales greater than 1 year. Timeseries analysis has demonstrated that Mg/Ca and Ba/Ca data from coral #3 (720m) and ENSO and PDO indices show coherent cycles at 7 and 10 years. Results suggest that coral #3 Ba/Ca increases during a warm PDO regime, possibly due to water mass changes. Ba/Ca values from # 3 and #5 (643m) are partially reproducible (r = -0.40). Ba/Ca in #5 behaves opposite to that in #3 during the second warm regime. In addition, electron backscatter detection performed with a scanning electron microscope showed a preferred crystal orientation that does not correspond to bands or elemental composition (different from published hypotheses). Overall, the data show that regional oceanic signals are recorded as trace elemental variability in these corals. Mg/Ca and Ba/Ca have potential to act as temperature and productivity proxies, respectively. Such evidence for interannual-scale variability could strengthen our understanding of how rapid climate change impacts the intermediate-depth ocean.

LIDAR AS A TOOL FOR LINEAMENT MAPPING AND THE REEVALUATION OF BEDROCK AND GLACIAL GEOLOGY: EXAMPLES FROM THE MOUNT MOOSILAUKE REGION OF THE WHITE MOUNTAIN NATIONAL FOREST, NEW HAMPSHIRE

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The increased availability and reliability of meter and sub-meter resolution LiDAR data has provided unprecedented opportunities to map features of bedrock geology in the last decade. Using ArcGIS and 2011-2012 LiDAR provided by the Natural Resources Conservation Service, this study remotely measured fractured bedrock lineaments and reevaluated the distribution and character of previously mapped bedrock units in the Mount Moosilauke region of the White Mountain National Forest, New Hampshire. The lineament measurements were checked against steeply-dipping fracture data collected in the field for the five major geologic units of the region, including the Oliverian Plutonic Suite, the Ammonoosuc Volcanics, the Bethlehem Granodiorite, the Kinsman Granodiorite, and the Littleton Formation. LiDAR hillshade maps with azimuths/altitudes of 315/45 and 45/45 produced the best images to view the predominately NE and NW striking geologic elements, respectively. Correlations between field measured joint sets at single outcrops and remotely measured lineament sets were modest. However, most joint sets were detectable through the LiDAR lineament analyses. This suggests that LiDAR is an effective tool to evaluate the fractured bedrock lineament geometry of a large region and the correlation to field-measured joints is dependent on the number and location of outcrops measured. LiDAR was also used to evaluate the accuracy of existing geologic maps and map glacial erosional and depositional features among other revisions. Overall, LiDAR has proved to be an extremely effective tool to study bedrock and glacial features and generates a list of many regions where targeted fieldwork should be done.

SILURIAN STRATIGRAPHIC REVISIONS AND EVIDENCE FOR THE PISCATAQUIS VOLCANIC ARC IN THE GILEAD-NEWRY REGION, MAINE

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The Gilead-Newry region of western Maine contains migmatized Silurian (?) metasedimentary rocks intruded by Devonian (?) diorite-tonalite suites, Devonian to Permian (?) two mica granite, and widespread pegmatites. The region borders the south of the Piscataquis Volcanic Arc and is NW of the Sebago and Songo Plutons. The bedrock was remapped in 2013, with the goal of reevaluating the region's stratigraphy and intrusive rocks. Eight meta-sedimentary units and two igneous units were mapped for this project.There are 7 diorite-tonalite plutons: two large and five smaller sill-like intrusions.. Petrographic analysis categorizes igneous rocks on the QAP ternary diagram. XRF data from these plutons show that the diorite-tonalite fall within the volcanic arc and within plate fields while two-mica granites fall within the syn-collisional field.The metasedimentary rocks from youngest to oldest (?) include: Sgf, a biotite and/or calc-silicate granofels (DSm?); Ssqr, a rusty schist and quartzite (Ssf?); Sqsc, quartzite and schist with calc-silicate pods (Sp?); Ssqg, a biotite granofels; Ssq, a greyschist and quartzite with calc-silicate pods; Ssg, a greyschist; Ssr, a rusty weathering schist with calc-silicate pods; Ssqm, grey schist and quartzite with calc-silicate pods. The five oldest units are likely correlative with the Rangeley Fm. The abundant calc-silicate pods may represent olisotromal features deposited in an active tectonic setting during the Salinic Orogeny. Folding and migmatization occurred during the Acadian Orogeny.Preliminary results show that much of what was previously mapped in the region as Littleton Formation now correlates best with the Rangeley Formation. The diorite-tonalite plutons are an extension of the Piscataquis Volcanic Arc. Both findings have significant implications for regional Appalachian tectonics, and validate the importance of creating a new map.

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