Geological Society of Maine
Spring Meeting

Friday, March 26, 2010, 12:30-6:30 PM

Department of Earth Sciences
University of Maine,
Bryand Global Sciences Building
Orono, ME

AGENDA:

11:00 – 12:30 Officers Meeting

Undergraduate students are eligible for the Anderson Prizes for poster and oral presentations

12:30 – 2:00 STUDENT POSTERS – Bryant Global Sciences 2nd Floor Atrium

ARNOLD, Robin, Determining Seabed Pockmark Activity With ^{210}Pb Dating In Belfast Bay, Me

CASTRO, Carlos, and EUSDEN, Dykstra, Paleostress Analysis of Mesozoic Fractures and Basalt Dikes in Tuckerman Ravine, New Hampshire

DENGLER, Elizabeth, Fracture Distribution and Characterization in Betasso Gulch, Colorado

* JOHNSON, Dustin, OLSEN, Amanda, AMIRBAHMAN, Aria, and NORTON, Stephen, Influences of Dissolved Organic Carbon and Iron Photochemistry on Phosphorus Cycling in Surface Waters: Implications of Particle-Size Distribution

JUDICE, Elyse V., JOHNSON, Beverly J., DOSTIE, Phil T., and LOCKE, William L., V, Stable Isotope Analysis of *Fundulus heteroclitus* (mummichog) and the Effectiveness of Ditch-Plug Restoration at the Sprague River Salt Marsh, Phippsburg, Maine

LOOPESKO, William V., JOHNSON, Beverly J., BOHLEN, Curtis C., DOAN, Mike, and DOSTIE, Philip, Stable Nitrogen Isotopes of *Zostera marina* as a Proxy for Anthropogenic Nitrogen Enrichment in Casco Bay, Maine

NIELSON, Adam, Effects of Seasonal Road Salt Application on Lily Pond, White Mountain National Forest, New Hampshire

POPPICK, Laura, RETELLE, Mike, POWELL, Ross D., and BRIGHAM-GRETTE, Julie, Modern Sedimentary Processes Proximal to a Polythermal Tidewater Glacier Complex, Kronebreen/Kongsvegen, Kongsfjorden, Svalbard

* ROY, Samuel G., and JOHNSON, Scott E., Brecciation Mechanisms and Self-Similarity of Transitional Rock Fragmentation in the Shatter Zone, Mount Desert Island, Maine

SCHULER, Kurt, and RETELLE, Mike, Monitoring Sediment Transport And Inlet Migration At The Seawall Beach Complex: Phippsburg, ME

2:00 – 3:30 STUDENT TALKS – Bryand Global Sciences Rm. 100 (* Graduate students)

BOUCHER, Kaleb, Magma Mixing in Composite Dikes of Jetteau Point, Gouldsboro, ME.

* BROTHERS, Laura L., KELLEY, Joseph T., BELKNAP, Daniel F., KOONS, Peter O., and BARNHARDT, Walter A., Pockmarks: Self-Scouring Mud Landforms?

GARDNER, Patrick, and EUSDEN, J. Dykstra, Mesozoic Extension In The Presidential Range: Huntington Ravine, NH

* WILSON, Kristin R., KELLEY, Joseph T., BELKNAP, Daniel F., HAMILTON, Gordon S., and LOFTIN, Cynthia S., Are Maine's Salt Marshes Drowning? Salt Pools as Dynamic Drivers of Surficial Change Maine Salt Marshes

3:30 – 4:00	**Business meeting:**	**BGSC Rm. 100**
4:00 – 5:00	**Keynote Address:**	**BGSC Rm. 100 –** Dr. Chris Gerbi, Univ. Maine: "Rheology in the field: what, why and how."
5:00 – 5:30	**Social Hour:**	**BGSC Atrium (Cash bar until 6:30)**
5:30 – 6:30	**Dinner:**	**Memorial Union Food Court**

GSM ABSTRACTS

DETERMINING SEABED POCKMARK ACTIVITY WITH ^{210}PB DATING IN BELFAST BAY, ME

ARNOLD, Robin, Dept. Earth Sciences, Univ. Maine, Orono, ME. Robin_Arnold@umit.maine.edu

Pockmarks are relatively newly discovered phenomena on the seabed found in muddy environments. King and McLean (1970) first noted these features on the Scotian Shelf. Pockmarks can be found on quiet, passive margins. Through numerous studies conducted around the world, these features are generally associated with the escape of fluid (i.e., gas, pore-fluids, and groundwater). Large volumes of sediment may be redistributed from the seabed but the exact mechanism is yet to be determined. It is important to understand pockmark formation given their potential hazard to seabed activity such as offshore infrastructure emplacement including oil rigs, LNG terminals, offshore wind turbines, utility cables and pipelines. If pipelines and/or cables reach a critical angle as an active pockmark evolves it will break. Methane release has been associated with pockmark formation and can play an important role in contributing to global warming. This study uses ^{210}Pb to analyze sediment accumulation or lack thereof in Belfast Bay, ME, one of North America's most studied giant pockmark fields. Use of ^{210}Pb as a radionuclide based dating tool has become an accepted method to help determine sediment accumulation rates. This study used this tool to test two separate hypotheses: Hypothesis 1: Pockmarks are actively venting fluid. Thus cores collected in the center of a pockmark will have a scattered signal. Hypothesis 2: Areas of the field without pockmarks are not actively venting fluids. Thus cores taken from the intra-pockmark field and outside the field should show a steady signal indicating steady sediment accumulation.

MAGMA MIXING IN COMPOSITE DIKES OF JETTEAU POINT, GOULDSBORO, ME

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The mixing of felsic and mafic magmas is difficult because of their contrasting physical properties, such as density, temperature, and viscosity. Nevertheless, felsic and mafic magmas do mix in nature and the phenomenon is a major process in igneous petrology. Composite dikes can often serve as a window into magma-mixing processes. Jetteau Point, located in coastal Maine contains composite dikes composed of aphyric mafic margins grading to a felsic interior that intrude into the Gouldsboro granite. Previous work on dikes found in the Gouldsboro intrusive complex suggests a magma-mixing origin for the chemical variation seen throughout the entire complex. This study conducts a more rigorous investigation of the composite dikes seen in one part of the Gouldsboro intrusive complex to test the magma-mixing hypothesis. Petrographic evidence, including hornblende halos around quartz phenocrysts and sieve textures in plagioclase phenocrysts imply a mixing origin. Furthermore, well-constrained linear trends in geochemical data imply that the Gouldsboro granite is the source for the felsic interior and that magma mixing occurred between the felsic and mafic end members to produce the hybridized rocks seen in between. Mafic magma intruded into a partially crystallized felsic magma chamber (the Gouldsboro granite), causing the felsic magma to flow in the interior of the dike. Detailed examinations of the composite dikes at Jetteau Point support the magma-mixing hypothesis suggested by earlier work.

POCKMARKS: SELF-SCOURING MUD LANDFORMS?

BROTHERS, Laura L., KELLEY, Joseph T., BELKNAP, Daniel F., KOONS, Peter O., Dept. Earth Sciences, Univ. Maine, Orono, ME, and BARNHARDT, Walter A., U.S. Geological Survey, Woods Hole Sci. Ctr., Falmouth, MA 02543. Laura.Brothers@umit.maine.edu.

Pockmarks, or seafloor craters, occur worldwide in a variety of geologic settings and usually within cohesive fine-grained sediment. Pockmarks may appear in fields numbering thousands in areas of petroleum production shelf basins, continental slopes and rises, deltas, fjords and previously glaciated estuaries. Associated with fluid escape, the mechanisms and timescale of pockmark formation are not well constrained and several hypothesis for their formation and maintenance have been proposed including seismic activity, cetacean feeding, and even meteorites. This study combines morphologic analysis and numerical modeling to assess the role of nearbed currents in pockmark evolution. In 2006, 2008 and 2009 the US Geological Survey Seafloor Mapping Group collected 35 km^2 of high-resolution swath bathymetry and Chirp sonar data in the Belfast Bay, Maine pockmark field. Bathymetry data were gridded at 2.5 and 5-m resolution and indicate that the field contains over 2,000 pockmarks representing over 15 million cubic meters of displaced sediment and pore fluid. Morphology varies throughout the field and indicates scour in certain locations. Though most pockmarks in the northern portion of the Bay are circular and concave, the largest pockmarks located at the center of the field have extensive flat bottoms. Back-scatter and seismic-

profile data reveal that these pockmarks terminate in coarse grained sediments that characterize the Holocene/Pleistocene unconformity. Pockmarks in the southern portion of field, where the Bay transitions to a channel, are elongate and current-aligned. Recent work in the Oslofjord pockmark field observed upwelling currents within pockmarks and suggested the possibility of rotational flow. Our simulations of flow over a depression in both 2 and 3-dimensions corroborate these findings. Further, our simulations produce rotational flow within the depression whenever flow passes above the pockmark. In the simulations, zones of shearing occur at the depression's base and rim, suggesting that vortical flow may play a role in pockmark areal and vertical erosion, even in perfectly circular, concave pockmarks. From these findings we construct a novel working hypothesis that pockmarks result from initial seafloor perturbations that become modified and grow by vortical flow.

PALEOSTRESS ANALYSIS OF MESOZOIC FRACTURES AND BASALT DIKES IN TUCKERMAN RAVINE, NEW HAMPSHIRE

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The purpose of this research is to measure the fractured bedrock geometry of Tuckerman Ravine in the Presidential Range, New Hampshire, in an effort to determine the paleostress regimes in the Mesozoic during the continental rifting of the supercontinent Pangea. Strike and dip of fractures and associated basalt dikes of the region were measured and recorded spatially. Schematic maps and cross-sections of the fractures and basalts were made and later imported into ArcGIS. A rose plot map was also made that shows structural domains of discrete fracture patterns within the region. The main fracture trends of the region were determined using the Kamb contour method. The field data was then compared to a lineament analysis which was performed in ArcGIS on three separate datasets: 1) a black and white air photo; 2) hillshade maps derived from a 10m DEM with an illumination angle of 315 and 45; and 3) a high resolution Google Earth image. All three lineaments sets were merged and the duplicates removed. A domain overlap analysis was then made to identify discrete regions within the study area where lineaments and fracture domains have the same azimuth overlap to remove any final discrepancies. There are two dominant fracture trends striking 264.4°and 58.1° with two less dominant trends striking 2.3° and 153.2°. The dips for each fracture trend are 79.1 north, 84.1 southeast, 80.4 east, and 78.7 southwest, respectively. Two basalt dikes were mapped and one is parallel to the 60° fracture set (striking 61.6) while the other does not match any fracture set and strikes 110.0°. The dips for the dikes are 85.4 southeast for the 60 set and 85.4 southwest for the 110.0. A preliminary interpretation is that the three fracture sets yield three different stress fields oriented E-W (80 set), NW-SE (60 set) and N-S (180 set).

FRACTURE DISTRIBUTION AND CHARACTERIZATION IN BETASSO GULCH, COLORADO

DENGLER, Elizabeth, Dept. Geology, Bates College, Lewiston, ME. liz.dengler@gmail.com

This study focused on several questions regarding the structural geology of Betasso Gulch, Colorado, where detailed geologic and fracture maps were made to analyze the brittle structural geology: 1) How does the newly mapped bedrock geology relate to previous studies? 2) Do the fractures have a relationship to the rock types? 3) What were the paleostresses that caused the fractures? and 4) How do these stresses and fracture formations relate to regional geologic history? Betasso Gulch is located in the Front Range of the Colorado Rocky Mountains, just west of Boulder. The bedrock found in the gulch is primarily comprised of the Boulder Creek Granodiorite but lenses of quartz monzonite, syenite and pegmatite dikes have also been identified. SEM/EDS analyses of rock samples allowed for characterization of the rock types found in the area. Four main fracture orientations were found in the gulch: 41°, 81°E; 252°, 74°N; 10°, 40°E and 336°, 67° E. No correlation was found between fracture sets and rock type. The fractures are interpreted to be two different sets of conjugate pairs that formed under tensile-compressive stress after the Laramide orogeny. The formation of the Front Range of Colorado began about 1.8 Ga with the Colorado orogeny laying the groundwork for deformation in the Laramide. Faults formed in the Proterozoic were later reactivated during the uplift of the Front Range in the Laramide orogeny. The Laramide orogeny (80-60 Ma) is thought to have contributed to the current fracture patterns seen in Betasso Gulch. After the Laramide, there was a period of regional extension that allowed for the reactivation of faults, thereby forming the north-northwest (10° and 336° sets) conjugate pair. Between 50 and 35 Ma erosion in the Front Range caused the un-roofing of the batholith that created the east-northeast (41° and 252° sets) conjugate pair.

MESOZOIC EXTENSION IN THE PRESIDENTIAL RANGE: HUNTINGTON RAVINE, NH

GARDNER, J. Patrick and EUSDEN, J. Dykstra, Dept. Geology, Bates College, Lewiston, ME. jgardner@bates.edu

Mesozoic extensional structures were examined in Huntington Ravine in the Presidential Range, New Hampshire to determine their relative ages, distribution, and paleostress fields. The bedrock geology of the ravine consists of schist and quartzite couplets of the Devonian Littleton Formation. The dominant joint sets in the ravine are not parallel to bedding or foliation planes and over 1,000 such fractures were measured and mapped. Four systematic fracture sets were identified and assigned relative ages based on field relations. The oldest fractures in the Ravine have a NE strike (~036, 74 SE) and are sub-parallel to the Pinnacle alkaline dolerite dike (~045, 58 SE). This joint set and the Pinnacle dike are likely coeval and are interpreted to be part of a regional NW-SE extension associated with the Late Triassic and Jurassic Eastern North American (ENA) igneous province, which formed during the rifting of the North American and African plates causing NE-SW extension in New England (Mchone & Butler, 1984). The next youngest fracture set in the ravine have a E-W strike (~284, 71 N), and are sub-parallel with the Upper Trail andesite dike (~270, 89.5 N) and Escape Hatch alkaline dolerite dike (~263, 59 N). Structures with similar E-W strikes are found throughout New England and Quebec as part of the Middle Cretaceous New England-Quebec (NEQ) province associated with regional N-S extension associated with north Atlantic rifting or passage of the North American plate over the Great Meteor hotspot (Faure et al. 2006). The third youngest fracture set is characterized by NW-SE striking joints (~162, 85 SW), which are found throughout the ravine. Correlations of these joints to others in the New England region are uncertain suggesting a localized event. The youngest fracture set is shallow dipping (~203, 17 NW) and are thought to have formed from glacial unloading.

INFLUENCES OF DISSOLVED ORGANIC CARBON AND IRON PHOTOCHEMISTRY ON PHOSPHORUS CYCLING IN SURFACE WATERS: IMPLICATIONS OF PARTICLE-SIZE DISTRIBUTION

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Dissolved organic carbon (DOC) provides a carrier for the export of terrestrially derived iron (Fe) to surface waters. Particulate and colloidal Fe is important in surface water chemistry because it readily adsorbs dissolved phosphorus (P), a limiting nutrient to phytoplankton. The cycling of P is an essential component in controlling the trophic dynamics and overall water quality in freshwater environments. Surface waters exposed to UV radiation undergo photo-chemical reactions involving DOC-Fe complexes that, in turn, influence how trace metals and nutrients, including P, interact in first- and second-order streams. We conducted laboratory photochemical experiments to assess the influence of concentrations of DOC and Fe on P cycling, as well as quantifying the size distribution of aqueous Fe and P particles during irradiation. Batch solutions were irradiated and analyzed for DOC, total Fe and P, and organically bound Fe. Samples were also sequentially passed through 0.45 μm, 100,000 daltons (~30nm), and 5,000 daltons (~3 nm) filters to evaluate relationships between similarly sized Fe and P particulate, colloidal, and dissolved fractions. Results indicate a negative correlation between DOC concentration and the size distribution of particulate Fe and P. Furthermore, a positive correlation exists between the particulate or colloidal Fe and P size fractions during irradiation, suggesting that a specific Fe size fraction scavenges similar sized P from solution. This analysis supports the importance of the characterization of photosensitive complexes in understanding how UV radiation influences the cycling of limiting nutrients in fresh surface waters.

STABLE ISOTOPE ANALYSIS OF *FUNDULUS HETEROCLITUS* (MUMMICHOG) AND THE EFFECTIVENESS OF DITCH-PLUG RESTORATION AT THE SPRAGUE RIVER SALT MARSH, PHIPPSBURG, MAINE

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The Sprague River Salt Marsh is a back-barrier salt marsh adjacent to Seawall Beach in Phippburg, Maine. The Sprague River Salt Marsh has undergone significant modification by humans over the past 300 years with evidence of three different episodes of ditching documented. In an effort to restore sections of the marsh by creating pool habitats, the

U.S. Wildlife and Fisheries Service plugged several of the ditches in the southern end of the marsh between 2002 and 2006. The purpose of this study is to evaluate the efficacy of the res-toration method by comparing food web dynamics and water quality in pools recently created by ditch-plug restoration versus pools that have been on the marsh for a longer period of time. Stable carbon and nitrogen isotopes from muscle tissue from *Fundulus heteroclitus* (mummichog), particulate organic matter (POM), and surface sediment were examined in three pools to the east and four pools to the west of a large ditch-plug in the SE section of the marsh. The ditch-plug has severely restricted tidal exchange with the pools to the east of the plug. Water quality parameters, including pH and specific conductivity were also measured at these pools. Our results show that livers are consistently depleted in ^{13}C relative to muscle tissue, likely reflecting the presence of more lipids in liver relative to muscle. Additionally, *F. heteroclitus* tissues and POM from the eastern pools are significantly more depleted in ^{13}C than tissues from the western pools. Because *F. heteroclitus* in pools from Sprague Marsh relies primarily on aquatic vegetation as a food source, the spatial differences in $\delta^{13}C$ are likely due to differences in isotopic composition of the dominant aquatic vegetation at each site. We suspect that this varies with salinity and degree and duration of water saturation of the pools. Our results suggest that nutrient dynamics in pools behind at least one of the ditch-plugs at Sprague Marsh have been altered to a significant degree.

STABLE NITROGEN ISOTOPES OF *ZOSTERA MARINA* AS A PROXY FOR ANTHROPOGENIC NITROGEN ENRICHMENT IN CASCO BAY, MAINE

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Common Eelgrass, *Zostera marina*, is the most abundant and productive seagrass in near shore coastal environments of the Gulf of Maine. Nitrogen is the primary limiting nutrient in marine systems; thus, any increase in its concentrations can have a profound effect on marine environments and eelgrass beds in particular. Stable nitrogen isotope analyses of eelgrass and associated organic matter provide a method for tracking nutrient flow through estuaries. The purpose of this study is to determine the extent to which, if any, stable isotopes in eelgrass can be used as a proxy for anthropogenic nitrogen loading in Casco Bay, an estuary in the Gulf of Maine.

Samples of particulate organic matter (POM), sediment and eelgrass were collected from two different areas of Casco Bay in Fall, 2009, and subsequently analyzed for stable nitrogen and carbon isotopes at the Environmental Geochemistry Laboratory, Bates College. One site is located at Mackworth Island, near Portland, ME, at the mouth of the Presumpscot River, where eelgrass biomass is relatively low and anthropogenic loading of nitrogen is expected to be relatively high. The other site is Maquoit Bay, 25 miles north of Portland, where eelgrass biomass is high and anthropogenic loading of nitrogen is expected to be low. Surprisingly, the average total nitrogen concentrations were similar at both sites. The nitrogen isotopic composition of eelgrass at Mackworth was slightly enriched in ^{15}N relative to eelgrass at Maquoit, possibly indicating the presence of isotopically enriched anthropogenic nitrogen available for uptake at Mackworth. The isotopic offsets between the POM, eelgrass, and sediments were different at each site, indicating differences in the rates of nitrogen uptake in the water column and the eelgrass beds at both sites. The results of this study suggest that the stable isotope composition of eelgrass may be a sensitive indicator to the presence of anthropogenic nitrogen, as well as areas experiencing different rates of primary production.

EFFECTS OF SEASONAL ROAD SALT APPLICATION ON LILY POND, WHITE MOUNTAIN NATIONAL FOREST, NEW HAMPSHIRE

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Road salt application to roads in northern states, provinces, and mountainous areas is a common practice for deicing. Unfortunately melt season runoff from salt-laced snow banks impacts the adjacent aquatic environment by contaminating both ground water and surface water. This study investigates these effects by focusing on Lily Pond, a local pond in the White Mountain National Forest, New Hampshire. A major highway passes through the vast watershed on the southern side of Lily Pond providing an inevitable source of road salt into the ground and surface water entering the lake throughout the year. The purpose of this study is to examine and help explain the effects of the presence of a major roadway positioned within close proximity to an undisturbed freshwater system. This research will hopefully find a correlation or pattern between specific conductivity and various ion concentrations throughout the winter months. The ions in question are all prime components in the production of road salt, potassium (K^+), magnesium

(Mg^{2+}), calcium (Ca^{2+}) and most importantly sodium (Na^{+}) and chlorine (Cl^{-}). Field monitoring will consist of water profiles, which include temperature, specific conductivity, dissolved oxygen and pH levels through the consistent utilization of a hydro-lab and conductivity logger throughout the year. Information about the ground water entering from the road will be obtained by monitoring wells dug between the road and the lake. Water and snow samples will be collected in various locations in and around Lily Pond throughout the winter months to be further analyzed in the Geochemistry laboratory at Bates College. Previous studies on high mountain lakes, including Lily Pond, have shown a direct correlation between the amount of snow run-off and higher conductivity measurements throughout the water column. This helps to support the various hypotheses of the effects of road salt on natural mountain lakes. Data taken from Lily Pond throughout the year will be used as a proxy to help show the effects of road salt application on local freshwater body systems.

MODERN SEDIMENTARY PROCESSES PROXIMAL TO A POLYTHERMAL TIDEWATER GLACIER COMPLEX, KRONEBREEN/KONGSVEGEN, KONGSFJORDEN, SVALBARD

POPPICK, Laura[1], RETELLE, Mike[1], POWELL, Ross D.[2], and BRIGHAM-GRETTE, Julie[3], [1]Bates College, Lewiston, ME, [2]Northern Illinois University, DeKalb, IL, [3]University of Massachusetts, Amherst, MA

A series of sediment gravity- and box-cores were collected in Kongsfjorden, Svalbard during the summer of 2009 as part of the Svalbard REU project, which aims to charac-terize the modern sedimentary environment proximal to the Kronebreen/Kongsvegen tidewater glacier margin. This study serves to generate baseline data for future assess-ment of the local polythermal glacial response to climate change, and to contribute to the framework by which proximal polythermal glacimarine environments are interpreted in the sediment record. Sedimentary facies identified within the cores, collected between 60 – 900m from the ice face and spanning the width of the ice margin, serve as proxies of modern meltwater and sediment depositional processes at the tidewater margin. Sedimentary facies are characterized, with increasing resolution, through x-radiograph, thin section, and grain size analyses and are considered in relation to local fjord floor morphology and sedimentation rates as measured from sediment traps.

Ubiquitous evidence of sediment reworking from gravity flows in all cores implies a predominance of underconsolidated mud along the slope of the submarine outwash fan and surrounding moraines. Correlative laminae units on the millimeter scale observed in two cores collected 400 and 600m from the ice-front suggest a >200m lateral extent of episodic sediment gravity flow events. Cyclically laminated fine sand/silt and clay couplets, interpreted to have settled from suspension, are also preserved at varying intervals through most cores. Additional analysis is required to identify the forcing mechanism responsible for the cyclicity of these deposits. Once identified, sedimentation rates can be estimated and compared across the ice-front.

BRECCIATION MECHANISMS AND SELF-SIMILARITY OF TRANSITIONAL ROCK FRAGMENTATION IN THE SHATTER ZONE, MOUNT DESERT ISLAND, MAINE

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The Shatter Zone is a 450 m to 1 km thick aureole of fragmented rock that defines the perimeter of the Cadillac Mountain Granite. Fragmentation was caused by a Late Devonian volcanic eruption correlated with the volcanic rocks of the nearby southern Cranberry Islands. The volcanic edifice has subsequently eroded away exposing breccias that formed at 2-5km depth. The dominant mechanism of brecciation was apparently explosive fragmentation during the volcanic eruption, with additional magma-filled fracture propagation along the outer edge of the breccia. The result is a succession of increasing rock fragmentation from the farthest point of the Shatter Zone to the Cadillac Mountain Granite interface. We hypothesize that this progressive fragmentation may correlate with the dissipation of kinetic energy from magmatic volatile volume expansion. In this model, the outer zone of brecciation may preserve a record of the earliest stages of brecciation experienced by the more fragmented rocks. Alternatively, the different stages of fragmentation may represent multiple volcanic events. Breccias formed by a common mechanism tend to display similar particle size distribution curves dependent on the tendency of a rock to fracture into self-similar fragment sizes. The slope of the curve is dependent on the power of the brecciation event. The particle size distribution record for the Shatter Zone is marred by thermal alteration of the smallest size fragments, specifically for breccias near the magma chamber interface. During the volcanic event and related brecciation, ca. 900°C magma was emplaced into the fractures. Viscosity needed to be low enough

to allow filling of 1mm wide cracks 1km from the magma source. The magma chamber itself was hot relative to typical granitic magma, causing extensive contact metamorphism of the country rock. Thermal modeling is underway to provide constraints on the time required to form the metamorphic aureole and the degree of fragment melting.

MONITORING SEDIMENT TRANSPORT AND INLET MIGRATION AT THE SEAWALL BEACH COMPLEX: PHIPPSBURG, ME

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Monitoring seasonal and long-term changes of the undeveloped Seawall Beach complex in Phippsburg, Maine is crucial to understanding this dynamic barrier system as sea-level rise continues to affect local coastal environments. The goal of this study throughout the summer and fall of 2009 and winter of 2010 was to document current longshore transport patterns on the barrier beach and adjacent spits in this swash-aligned system. The spits accrete sediment over time due to westward and eastward longshore transport patterns stemming from the center of the system (Chandler 2009). Such transport is possible due to a central wave corridor (Cary 2005) which cannels the energy of refracted southeastern approaching waves. The evolution of the resulting northeastern and southwestern spits can in turn control the flow of two backbarrier inlets, the Sprague and Morse Rivers, which define the margins of Seawall Beach. At the Sprague River in the southwest, progradation of the spit has caused westward migration of the inlet and erosion of the pocket beach, Little Beach. Just south of the Sprague River inlet, Ice Box Beach accretes sediment throughout normally erosive winter months as it is well protected from approaching southern waves. Eventually the sediment from this beach is transported offshore and circulated into the barrier system. To the northeast, eastward migration of the Morse River has recently caused significant erosion to Popham Beach and destruction of the backbarrier maritime forest. Topographical profiles GPS tracking and weather data were used to record beach morphology during the study period. Historical photos, satellite imagery and previous studies were used to document and compare the long-term changes. Ongoing investigation of this transgressive system is necessary to predict the beach's adaptation to sea-level rise.

ARE MAINE'S SALT MARSHES DROWNING? SALT POOLS AS DYNAMIC DRIVERS OF SURFICIAL CHANGE FOR SIX MAINE SALT MARSHES

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Salt marshes are critical components of coastal systems and are vulnerable to rising sea level in response to climate change. Studies in the Gulf of Mexico and Mid-Atlantic regions indicate that one response to sea-level rise is an expansion of salt pools in interior marsh sections, leading to the rapid conversion of once-vegetated surfaces to open water over short time periods. These changes are a concern because they signify ongoing loss of ecosystem area and associated natural systems and resources. This may represent an irreversible ecological tipping point (or state change) within these environments. In Maine, previous work demonstrates that the dynamic exchange between pools and tidal creeks is one mechanism for substantial transformations of the marsh surface. This study examines surficial dynamics of six salt marshes distributed S-N along Maine's coast (Ogunquit, Wells, Brunswick, Gouldsboro, Addison, and Lubec), combining field surveys of pool ecophysical properties with geological coring and spatio-temporal analyses. Time-series of aerial photographs starting in the 1960s indicate that many pools alter their shape and size and that new pools form over decadal time periods. Dating sediments with ^{210}Pb and ^{137}Cs in high-marsh and re-vegetated pools indicate that pools can drain, rapidly fill in, and re-vegetate at 2-3 times the rate of the adjacent high-marsh surface. By this process, some north-temperate salt marshes may mitigate or circumvent potential drowning. Preliminary results of the ecophysical data (area, location, elevation, pool depth, and surrounding vegetation type) from 458 pools suggest that there are several distinct types and that pool type may relate to observed patterns of surficial change. Our results demonstrate that many pools are dynamic and that they are important drivers of surficial change as these marshes respond to sea-level rise.