34th Annual
FIVE COLLEGE GEOLOGY
UNDERGRADUATE
RESEARCH
POSTER SYMPOSIUM

WEDNESDAY, APRIL 25
5:00 - 6:00 PM
BENESKI MUSEUM OF NATURAL HISTORY
AMHERST COLLEGE

followed by Pizza Dinner
Room 100 - Beneski Building
Diagenesis and Dolomitization of Upper Ordovician - Lower Silurian Carbonates, Great Basin, Nevada

April 24th, 2013. Amherst College

Abstract:
Eustatic sea level fluctuations in the late Ordovician and early Silurian accompanied the waxing and waning of continental ice sheets over Earth’s south pole and the first mass extinction of the Phanerozoic Eon. The Great Basin contains miogeoclinal carbonate rocks deposited on the western margin of Laurentia that record those fluctuations as a series of shallowing-upwards sequences of bioturbated, cross-bedded, and laminated dolomite facies. Geochemistry, petrography, and paragenetic relations of dolomite rock textures at South Egan Range, Pancake Range, and Lone Mountain indicate that Great Basin carbonate successions underwent a complex history of diagenetic alteration that ranged from early shallow-subtidal diagenesis and dolomitization to late-stage deep burial diagenesis.

Evidence for early meteoric-mixing zone diagenesis is retained as silica pseudomorphs of relict allochems, dissolution surfaces on chert nodules, and isolated dolomite rhombs within chert matrices. Lack of isotopic trends below subaerial exposure surfaces precludes significant geochemical influence of meteoric waters. Uncompacted peloidal laminitie textures constrain massive cementation to the shallow subtidal realm, and highly zoned cathodoluminescence patterns within coarse void-filling sparry cements indicate variable pore-water conditions during cementation. Massive dolomitization occurred in the shallow burial realm as a product of marine fluid convection, which depleted carbonates of Sr and \(^{18}O\) but did not alter \(\delta^{13}C\) values. Deep burial (>500 m) caused dolomite fabric neomorphism, saddle dolomite formation, and pressure-solution stylolites, but did not significantly modify the carbonates’ geochemical signatures.

Paleogeographic variations in \(\delta^{13}C_{\text{carb}}\) chemostratigraphy indicate that the Great Basin miogeoclcline prograded seaward after the deposition of the Eureka Quartzite. Truncation of positive \(\delta^{13}C_{\text{carb}}\) excursions in Hirnantian-age strata suggest a prolonged hiatus between Ordovician and Silurian successions, and mid-Llandovery karsting at Pancake Range implies the formation of mid-ramp shoals in advance of ramp collapse and evolution into rimmed platform geometry in the late Llandovery.
Looking for anthropogenic influence: metals and phosphorus in an Irish marl lake
Alyssa Donovan
Amherst College

Lakes, which act as sinks for input from global, regional, and local sources, are excellent records of environmental change, and the geochemical consequences of modern and historical agriculture and industry can be entrained in their sediments for long periods of time. Sedimentary phosphorus and metal records in Lough Carra, Western Ireland suggest geochemical heterogeneity in the lake basins with regards to varying input sources as well as increasing cultural eutrophication and metal loading within the catchment over the past few decades.
Regional and global chemostratigraphic correlations of a Late Ordovician-Early Silurian carbonate shelf in central Nevada

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High-resolution carbon isotope stratigraphy from three localities (Lone Mountain, Pancake Range, and South Egan Range) was used to refine and further develop the chronostratigraphic framework of Late Ordovician-Early Silurian carbonate shelf strata in central Nevada. The $\delta^{13}$C records of these shallow water dolostones were correlated with Cincinnati Arch limestones and with deeper water sections from Estonia. The correlation with the Upper Ordovician (Katian Stage) Cincinnati Arch units suggests that sequences O1-O4 from central Nevada correspond to sequences C4-C6. The proposed Early Silurian (Rhuddanian Stage) correlation with Estonia constrains the time of deposition of sequences S1-S3, which is not consistent with the current biostratigraphic framework.

The $\delta^{13}$C records are mostly robust, but deviations from the global ocean $\delta^{13}$C$_{DIC}$, represented by uncorrelatable sections, were observed in Lone Mountain. The anomalous $\delta^{13}$C profile of Lone Mountain precluded any correlations, except for the partial Hirnantian excursion evident in all sections. As a result, Lone Mountain’s position on the carbonate shelf and its tectonic history should be re-evaluated. Moreover, the transition from a shallow ramp to a rimmed platform during the Silurian may have created a shallow restricted water mass. Suggestive but inconclusive evidence indicate that this transition prompted the development of lateral $\delta^{13}$C gradients that preserve local instead of global $\delta^{13}$C signals.
Controls on mercury storage in embayments along the Connecticut River,
Mark Hellmer,
Amherst College

Barton’s Cove lies 110 miles upriver of Long Island Sound, the outlet of the Connecticut River. This low energy water body, cut off from the main channel, houses two relict plunge pools making it an ideal sink for the settlement of heavy metals, organic matter and fine-grained sediments. Using a piston coring rig, a 10 meter deep sediment core was recovered from a plunge pool isolated near the eastern edge of the cove. The top 9 meters consist of dark, organic-rich, fine-grained mud with the bottom meter being fine to medium-grained sand. Mercury concentrations rise from 166 ppb at the sediment water interface to a high of 1006 ppb approximately 23 cm down the core. At meter one mercury levels lower to 90 ppb and by meter two concentrations remain below what is considered pre-anthropogenic levels at less than 60 ppb. The shape of the mercury profile, along with initial concentrations of 150-200 ppb, is similar to six previously studied off-river embayments along the Connecticut River. Cesium-137 and unsupported lead-210 profiles for these other sites date the peak mercury concentration occurring around the year 1960 for each. Similar results are found here at Barton’s Cove. Using the known depth and calculated age of this peak a sedimentation rate of ~ 0.3 cm/yr to ~0.7 cm/yr was constrained. This continues a trend found amongst the now seven sites under study of increasing sedimentation rates as you head towards the mouth of the river. These rates increase from those at Barton’s Cove to near 4.5 cm/yr at Hamburg Cove, close to the Long Island Sound. Total Organic Content (TOC), obtained through loss on ignition, increases from 20% for depths 0-50 cm to 50-60% for meters 2 through 8 after which TOC returns to 15-20% with the occurrence of sandy intervals. While organic matter content and mercury concentrations in the top meter correlate weakly due to the anthropogenic external input of mercury, a strong positive correlation can be observed in the pre-industrial record, highlighting the preferential burial of mercury with organic matter. Ten samples from within the peak mercury profile were separated into three different size fractions (sand-sized particles and plant litter, silt-sized particles, clay-sized particles) and tested for mercury concentrations and organic matter content. Mercury concentrations and organic matter content were found to increase with decreasing grain size. Silt and clay-sized fractions follow a similar mercury profile to that of the bulk sediment while the coarsest fraction varies in relative mercury concentration.

The heterogeneity of plant matter mass between intervals within the coarsest fraction likely account for this deviation. Elevated organic matter content in this fraction (30 % - 39 %) suggest that plant litter, rather than sand sized clasts, dominates this fraction. These results suggest that, though primary contamination is accommodated by anthropogenic external input, mercury housing is controlled by grain size and organic matter content.
Assessing the Potential Effects of Dolomitization on the Sulfur Isotopic Composition of late Ordovician and early Silurian Dolostones from the Northern Basin and Range Province, Nevada

Danielle Santiago Ramos, Amherst College

Bulk-rock isotopic and elemental analyses of forty-nine dolostone samples from the Late Ordovician-Early Silurian carbonate shelf of north-central Nevada were carried out in order to assess the effects of dolomitization on the sulfur isotopic composition of carbonate-associated sulfate (CAS). These strata were deposited as limestones on a passive continental margin along the coast of western North America and were later diagenetically altered through mixing zone fluids and during burial. The rocks analyzed were sampled from three ranges (South Egan Range (SE), Pancake Range (PR), and Lone Mountain (LM)), representing a proximal-distal environmental transect. From each range, two sequences were selected for analysis, one from the Late Ordovician (O4) and another from the Early Silurian (S3), so that variations in CAS isotope ratios could be resolved: 1) in space, by analyzing time-equivalent strata across the platform; and 2) through time, by tracking chemical variations from different sequences within the same range. An independent correlation scheme based on sequence- and chemostratigraphy allowed for a direct comparison of the $\delta^{34}$S$_{\text{CAS}}$ record of coeval strata.

Despite their varying location within the platform, strata at each range contained no gradient of dolomitization, as Ca/Mg ratios (1.06 - 1.09) and SO$_4^{2-}$ abundances (<150 ppm) remained fairly constant across ranges and through time. Dolomitization seemed to not have affected $\delta^{34}$S values, since no correlation was observed between sulfur isotope ratios and dolomitization proxies (Ca/Mg ratios and SO$_4^{2-}$ content).

O4 strata from Lone Mountain and Pancake Range had similar sulfur isotope ratios (21.5-33‰ and 21.3-31.9‰, respectively) and no clear compositional trends, whereas South Egan Range showed a pattern of isotopic enrichment up-section (22.5 – 36‰). In S3, mean isotope ratios decreased compared to O4 values in both ranges analyzed (from 32.4‰ to 26.2‰ in SE, and from 25.1‰ to 23.4‰ in LM), and South Egan Range showed a new trend in isotope composition, now towards depleted values.

Isotope ratios seem to represent global oceanic values more closely in S3 than in O4. The depositional environment at South Egan Range, however, seemed to not have had a direct connection to the open ocean during both O4 and S3 based on: 1) higher isotope ratios of SE strata from both sequences compared to the $\delta^{34}$S of coeval seawater; 2) mismatch between inferred secular variations in $f_{py}$ and expected global oceanic trends; 3) evidence for a smaller sulfur reservoir in South Egan, compared to PR and LM.
Quartz crystallographic fabrics from an isoclinal fold in Cummington, MA
Laura Tait, Amherst College

Abstract

The outcrop pattern of the Devonian Goshen Formation in western Massachusetts is dominated by approximately 100 m-scale isoclinal folds. This study looks at the microstructures and quartz lattice preferred orientations associated with a single well-exposed isoclinal anticline in Cummington, Massachusetts. Here, the Goshen Formation is a thin- to thick-bedded (cm- to m-scale) graded micaceous quartzite to schist sequence that was metamorphosed to staurolite-kyanite grade during the Acadian orogeny.

Eight oriented samples were collected from a roughly 12-meter section of the anticline and examined. The anticline has a small interlimb angle of no more than approximately 5°. The Goshen Formation has a penetrative foliation that is defined predominantly by the alignment of fine-grained muscovite, but also by the shape of fine-grained quartz and, less commonly, the alignment of biotite. Asymmetric tails on garnet and biotite porphyroblasts indicate non-coaxial deformation during foliation formation and mineral growth prior to fabric creation. More rarely, staurolite porphyroblasts, the growth of which is likely synchronous with fabric development, crosscut the foliation in several samples. Albite is present in very small amounts in all samples, but is not the focus of this study and is therefore not discussed further.

Quartz content in the samples varies greatly from roughly 80% to 20% modal percentage, going from the more quartz-rich base to the mica-rich top of the graded beds. Quartz lattice preferred orientations (LPOs) determined by electron backscatter diffraction (EBSD) differ around the fold and may be sorted into three groups. LPOs for those samples from the upright limb present a weak c-axis single girdle close to foliation. Similarly, pole figures from the overturned limb show a weak c-axis girdle, although oblique to the foliation plane. Near the hinge, pole figures have slightly stronger c-axis point maxima close to perpendicular to the foliation plane. A-axis maxima, although also fairly weak, are present in five samples and may indicate slip on <a>.

The quartz LPOs observed for this study are consistent with basal <a> slip, but are quite weak for the amount of deformation experienced by these rocks. Weakness of c-axis patterns indicates that diffusive mass transport was a major component in the deformation processes along with dislocation creep. This is especially likely in staurolite-bearing schists such as these when water is present as a product of the reaction: garnet + chlorite (+ muscovite) = staurolite + biotite (+ quartz + H₂O). Further, this reaction takes place above 600 °C, indicating that basal <a> slip, although generally a low- to medium-temperature active slip system for quartz, was still dominant at higher temperatures for the rocks of this study.
Geospatial Modeling of Groundwater-Fed Wisconsin Lakes with Complex Flooding Patterns
H. Leigh Honorof
Mount Holyoke College
Geology & Geography Class of 2013

In Milton, Wisconsin, devastating flood waters associated with heavy 2008 precipitation began receding only in recent months from a chain of four groundwater fed lakes\(^1\). The purpose of this research is to determine the potential influence of the local hydrostratigraphy on the regional groundwater flow and therefore lacustrine flooding. The working hypothesis was that local glacial and post glacial stratigraphy contains clay-rich intervals of low hydraulic conductivity obstructing the drainage of local flood waters. Research goals include determining the thickness, lateral extent and depth of three semi-continuous clay-rich intervals, and refining a previously published local water table\(^2\). Stratigraphic and water table data came was collected from private well construction logs, as well as several wells drilled and several older private wells monitored in summer 2012. Data were coded and entered into ArcGIS version 10.1. Two- and three-dimensional maps of three clay-rich intervals and the local water table constructed ArcMap and ArcScene revealed several trends. Overall, groundwater flows south to north, with a shallow horizontal gradient of \(-0.0019\). Clay rich intervals of low hydraulic conductivity are widespread, and appear to thicken and merge in the north of the study region. The water table intersects these intervals rather than taking a faster path. These low hydraulic conductivity intervals are likely inhibiting the northward drainage of groundwater throughout the region, promoting flooding and sustained high water conditions.


Michaela Kim, Mount Holyoke College

**USING OSL DATING TO CONSTRAIN THE DEVELOPMENT OF LATE HOLOCENE BAYMOUTH BARRIERS AND SUBSEQUENT DUNE FORMATION IN DOOR PENINSULA, WISCONSIN, USA**

This study focuses on the dune and lacustrine sediments in two baymouth barrier systems found along Lake Michigan’s western shoreline. We used optically stimulated luminescence (OSL) dating to constrain when littoral sediments were deposited and the overlying dunes were activated at two baymouth barriers near Kangaroo and Clark Lakes. Sediments for particle size analysis and OSL dating were sampled using bucket augers and a vibracoring device. Particle size analysis and mineralogical observations indicate that the lacustrine sediment found in the two baymouth barriers range from 179-184 meters above mean sea level (mamsl). These deposits lie several meters above Lake Michigan, which historically fluctuated around ~ 177 mamsl, but within range of the Nipissing transgression that reached elevations of ~ 184 mamsl in the region. Our elevation data and 10 OSL ages that range from 5.8 to 4.0 ka suggest that the lacustrine sediments within the barrier were deposited during the Nipissing, which dates to ~ 5.5 to 4.5 ka in the Lake Michigan basin. The dunes found on these barriers correspond closely to the Nipissing and Algoma lake level highstands. Dunes at the Clark Lake site include small parabolics with 3-7 m of relief and large complex parabolic dunes that are 18-24 m in relief. At the Kangaroo Lake site two dune ridges are separated by ~0.4 km, where the ridge close to Lake Michigan has dunes with ~ 6 meters of relief and the ridge close to Kangaroo Lake has dunes with 15-24 meters of relief. At Clark Lake 21 OSL ages taken from dune crests span the late Holocene from ~7 to 1 ka, with an apparent peak in activity around 4.2 ka. The larger dunes at Kangaroo Lake have OSL ages between ~5.5 and 3.0 ka, with most corresponding to the regression of Lake Michigan after the Nipissing high. The ages of the smaller dunes at the Kangaroo Lake site range from 2.8 to 2.2 ka, corresponding roughly with the Algoma lake level high that dates to ~ 2.5 ka. Our findings show that the formation of the baymouth barriers and the subsequent activation of the dunes on these barriers occurred rapidly and within error of the OSL age estimates. This research is part of the Dune Undergraduate Geomorphology and Geochronology (DUGG) Project, a NSF-Research Experience for Undergraduates site.
Comparison Between Holocene Eolian Carbonate Deposits with Laminated Versus Spongiform Texture, Little Exuma, Bahamas

Viviana Aluia and Sabrina Camboulives
Advisor: Bosiljka Glumac, Department of Geosciences, Smith College

The purpose of this study is to compare the texture and composition of carbonate sand from eolian grainstone with and without spongiform fabric from the Holocene Rice Bay Formation on Little Exuma Island, Bahamas to better understand the origin and distribution of deposits with the unusual spongiform appearance. The term “spongiform” is applied to highly porous carbonate grainstone deposits with an intricate network of abundant mm- to cm-scale pores of variable morphology. This is in contrast with the laminated and less porous appearance of more typical carbonate eolianite deposits.

Exposed at Conch House Beach on Little Exuma, Bahamas, there is an irregular contact between the North Point Member with spongiform texture and some vertical pipes, and the laminated Hanna Bay Member of the Holocene Rice Bay Formation (stratigraphy after Carew and Mylroie 1995). The overlying deposits of the Hannah Bay Member at this site consist of interbedded eolianites with porous spongiform texture and laminated, more massive eolianites. Petrographic analysis suggests that both North Point and Hanna Bay Member carbonate eolianites are ooid grainstones with some skeletal fragments. Sand particles in both eolianites are fine to coarse-grained, well-sorted, very well-rounded, contain Halimeda green algae and Peneroplis foraminifera, show extensive microboring and micritization of grains, and are bound by clear, equant calcite cement. The spongiform North Point deposits generally have up to 30% porosity, whereas the laminated Hanna Bay strata usually have <10% porosity.

These observations suggest no major variations in sediment supply and transport mechanisms between these deposits. The observed difference in laminated versus spongiform fabric therefore implies variations in conditions during deposition and lithification of sediment. Spongiform texture in carbonate eolianites is a function of dune-stabilizing vegetation that baffles sediment and whose roots bioturbate the underlying deposits, destroying the original laminated texture and producing a highly porous spongiform fabric by lithifying sand around small and dense roots, stems, and organic litter (Glumac et al. 2012). Laminated eolianites, on the other hand, are formed by transport and deposition of sand by wind over vegetation-free, barren terrain. The abrupt vertical transitions from the highly porous texture of the spongiform North Point Member and Hanna Bay Member into the less porous texture of the laminated Hanna Bay Member is likely a result of high-energy storm events that eroded and flattened the tops of vegetated dunes. Understanding and documenting the origin and distribution of carbonate eolianites with spongiform texture could provide critical information about the amount of porosity and reservoir quality of these rocks, and could also contribute information about the frequency and severity of storms and their impact on erosion of coastal dune environments.

References:
Experimental Investigation of Garnet Nucleation from Chlorite + Quartz Mixtures at 8 kbar Pressure

Samantha Blanchett
Advisor: John Brady, Department of Geosciences, Smith College

Nucleation describes the process of when a mineral first begins to form on the microscopic level and the atoms align into the particular orientations of its crystal lattice. The volume of the crystal nucleus must also reach a critical size so that the decrease in Gibbs free energy from phase change is greater than the increase in Gibbs free energy due to surface energy of a small crystal. Minerals begin to grow because of chemical reactions that occur during metamorphism of a metamorphic rock or during the cooling of an igneous rock. For nucleation to occur, specific conditions must be in place. All of the elements necessary to create a mineral can be present in a rock, but unless the conditions are productive for nucleation, the mineral will not form. In the experiments described in this paper, I sought to discover specific experimental conditions that would promote nucleation of garnet.

Chlorite, quartz, biotite, muscovite, and garnet were ground into powders and subjected to temperatures ranging from 610°C to 750°C and 8kbar pressure in a piston cylinder press for lengths of time ranging from 4 to 18 days. Water was added to half of the samples in order to determine if it would promote garnet nucleation. Products were analyzed on a Scanning Electron Microscope (SEM). Garnet nucleation only occurred for the longest experiment at the highest temperature (750°C, 8kbar, 17 days and 20 hours). This temperature is 160°C higher than the calculated minimum temperature for garnet nucleation and growth from chlorite + quartz at 8kbar. Perhaps if the lower temperature experiments were run for longer periods of time, garnet would have nucleated. Cordierite nucleation, gedrite nucleation, garnet overgrowth, and grain coarsening occurred in several of the experiments.
Decorative Stones of the Van Buren Antiques Collection at Smith College
Kelsey Moore
Advisor: Bosiljka Glumac, Department of Geosciences, Smith College

The Smith College Van Buren Antiques Collection of the Department of Classical Languages and Literatures houses a group of thirty-one small cut and polished stone pieces whose origin has been a mystery to the Smith Community. Professor F. Warren Wright, chair of the Smith College Classics Department from 1942 to 1953, bought much of the collection in 1925 from Albert William Van Buren, a professor of archaeology of the American Academy in Rome. The collection resided at Yale University at the time it was purchased due to Professor Van Buren’s previous work at the University. Only two of the stones (the porphyries) were included in Professor Wright’s original collection catalogue. There is no mention of the remaining stones in any documents associated with the collection.

The stones have diverse geological origins ranging from igneous porphyries to sedimentary limestones and travertines to metamorphic marbles. They are related, though, by common provenance and history of quarrying. Although they originate from at least seven different present-day countries, the stones were most actively quarried at a time when these countries were a part of the Roman Empire.

The stones can be organized into two groups. The first group includes the porphyries mentioned in Professor Wright’s catalogue. The remaining stones represent a second group, and include the limestones, travertines, marbles, and one slate, all of which are thin, polished tiles of similar shape and size. These stones have a common labeling pattern, in which the words “Paolo Triscornia di Ferd.” and “Carrara” accompany the name of the stone on a paper label adhered to the back of the stone. On samples whose labels are substantially worn, pencil markings directly on the back of the stone often indicate the name. These names match those written on small paper labels glued onto the polished front sides of many samples.

Investigation into Paolo Triscornia di Ferd revealed that a family of artists by this name once lived Carrara, Italy. It seems that this family at one time owned a stone sculpting and distribution company. A help wanted advertisement in an American magazine called Stone: An Illustrated Magazine from May 1908 to June 1909 reads:

“Wanted-Reliable agents (American or German), in the principal cities of America to represent a first class and leading Studio in Pure Art Sculpture, Architecture and Colored Marble Specialties. Must be well connected with Sculpturers, Architects, Ecclesiastics and Decorators. References required. Address Paolo Triscornia di Ferd, Carrara, Italy.”

It is possible that the stones not listed in Professor Wright’s catalogue came from this source as sample tiles. The phrase “colored marbles” often refers to travertines, limestones, and marbles used for sculpting and architectural purpose, and thus encompasses the stones of the second group. Why, when and where (e.g., in Rome, at Yale University or later on at Smith College) the stones became part of the Van Buren Antiques Collection that now resides in the Caveno Room of Neilson Library, however, for now remains a mystery.
Exuma Island offers excellent exposures of the Holocene North Point and Hanna Bay Members of the Rice Bay Formation. The purpose of this project is to compare composition, texture, and sedimentary structures of these deposits. Specifically, a comparison is made between strata at the Pleistocene/Holocene contact and from the two members of the Rice Bay Formation. Additional comparisons are made between the Hanna Bay deposits from a vertical succession that consists of foreshore deposits overlain by backshore strata on the bottom, and topped with eolian grainstone.

The Pleistocene/Holocene boundary is characterized by relatively thin but well developed a red *terra rossa* paleosol horizon that developed during a prolonged subaerial exposure of Pleistocene carbonate deposits. In comparison, modern exposures of Holocene deposits are dominated by erosion and karstification as well as incipient soil formation as a function of shorter duration of exposure.

The North Point and Hanna Bay eolianites have unique sedimentary structures and show slight variation in texture, composition, and diagenetic features. All eolianites of Hanna Bay and North Point are laminated, although the presence of large vertical pipes in the North Point member distinguish it from the eolianites of Hanna Bay. While Hanna Bay eolianites are ooid-peloid grainstone with rare skeletal fragments, their North Point counterpart is more skeletal. Moreover, the Hanna Bay eolianites are better sorted and have more rounded grains than do those of the North Point member. The Hanna Bay eolianites are poorly cemented with clear calcite cement as mostly meniscus morphology and only some isopachous rims. The North Point, on the other hand, has abundant clear calcite cement as equant drusy mosaic and isopachous rims along with meniscus and pendant morphologies. In both cases, micritization is evident in grains. Specifically within the Hanna Bay member there are distinct facies which each include their own characteristic sedimentary structures, texture, composition, and diagenetic features. Beach deposits are characterized by sub-horizontal to gently dipping lamination. The eolianite deposits have some gently dipping lamination in the lower part and grade upward into eolianite with highly porous spongiform texture. Petrographic analysis shows that the beach facies have more skeletal fragments and are generally medium to coarse grained, while the eolianites are more fine grained and are dominated by peloids and ooids. Diagenetically, beach deposits are better cemented with more isopachous rim cements while cements in eolianites have mostly meniscus morphology. In both cases, the cements are composed of clear calcite. Foreshore deposits within the Hanna Bay Member are finely laminated dipping gently seaward, and backshore deposits are finely sub-horizontally laminated. Additionally, the backshore deposits have more fenestral porositt than foreshore, which is evident both in the field and in thin sections. Both beach deposits tend to be medium to coarse grained and are peloid-ooid-skeletal grainstone with similar cements consisting of isopachous clear calcite rim cement and some meniscus morphology. These results indicate that complete characterization and detailed analysis of carbonate deposits in the Bahamas require a combination of both petrographic and field observations.
Searching for Isotopic Signatures of Hydrologically Closed Jurassic Lakes in Western Massachusetts

Nashipae Mosiany, Melody Cao, Claire Keller, Valeria Coronilla, Maria Cristina Del Valle, Karen Yu, and Wei Zhang
Advisor: Bosiljka Glumac, Department of Geosciences, Smith College

This study compares the isotopic composition ($\delta^{18}$O and $\delta^{13}$C values) of various carbonate components from multiple lacustrine successions of the Jurassic Turners Falls Formation from the Deerfield rift basin in Massachusetts. New results from the Barton Cove and Greenfield Road sites (samples from Seidman 2011) are compared with information on the Turners Falls Dam site (Glumac 2011). Such comparisons of isotopic data provide unique information that can help reconstruct our local geological paleolandscape by determining whether these lakes were hydrologically open or closed, and can be used to correlate isolated outcrops of lacustrine deposits within this sedimentary basin.

Samples analyzed from the Barton Cove and Greenfield Road sites represent muddy to silty laminated dolostone, and breccias with dolostone and siltstone clasts. Clustering of isotopic data suggests the presence of three distinct lake successions at Barton Cove. Although some of these lakes might be hydrologically closed, as evidenced by their positively covariant $\delta^{18}$O and $\delta^{13}$C values, they do not represent the same lake successions documented previously at the Turners Falls Dam site (Glumac 2011). Within a single set of samples the more silty and laminated carbonate deposits have more negative $\delta^{18}$O values compared to homogeneous dolomicrite, reflecting the relative influence of precipitation vs. evaporation. The strata exposed at Greenfield Road most likely belong to a single lake succession, which is similar to one of the Barton Cove lakes. The rest of the Greenfield Road data reflect the influence of later diagenesis (precipitation of coarse-crystalline calcite cement) and evaporation (with common evaporite molds now occluded by calcite cement).

This work supports previous stratigraphic observations about the presence of multiple lacustrine successions in the Turners Falls Formation. Stable isotope analysis of various carbonate components can be used to distinguish among distinct lakes, most of which were hydrologically closed and characterized by formation of dolomite as a primary precipitate or early diagenetic replacement. All analyzed lake successions have similar later diagenetic signatures, and some samples from the new Barton Cove and Greenfield Road study sites reveal a more pronounced evaporation influence as reflected by their more positive $\delta^{18}$O values and the presence of common evaporite molds.

References:
Organic Microfossils in Ediacaran Strata of Northern Namibia

Eliana Perlmutter
Advisor: Sara Pruss, Department of Geosciences, Smith College

The Ediacaran Period is one characterized by dynamic evolutionary and ecological changes in the marine realm (e.g., Xiao and Kaufman, 2006). The organic fossil record preserved in carbonates is not well understood. In this study, I examined several carbonate samples of the Maieberg, Huttenberg, and Elandshoek formations of the Tsumeb subgroup exposed in northern Namibia. The period immediately following the Ediacaran was the Cambrian during which there was significant diversification of life. Studying the Ediacaran, and in particular this untapped repository of diversity preserved in carbonates, can help us understand the radiation of organisms leading up to the Cambrian Explosion.

In order to learn more about the organic fossils in these carbonate rocks, I dissolved the rock samples in acetic acid, looked at the filtered residue under a light microscope and picked the putative biological fragments with a brush. The most promising particles were examined under the Scanning Electron Microscope (SEM).

Organic material is characterized by a dark brown or black color and a characteristic swelling when wet and shrinking when desiccated (e.g., Dalton et al., 2013). I have found numerous large black fragments, including segmented and branched pieces, in the Hüttenberg Formation. I have also found some black fragments in the Elandshoek and Maiberg formations but these units have been less prolific. The SEM pictures of the organic material reveal a surface structure consisting of little rounded polygons.

These microfossils are from after the younger Marinoan glaciation (~635 Ma). Yet, the microfossils that I have found have identical characteristics to microfossils from the pre-Sturtian and pre-Marinoan periods. The black organic matter in all of these intervals is characterized by swelling when hydrated. The rounded bumps are also typical of earlier microfossils such as post-Sturtian microfossils from the Rasthof Formation. I have also found potential tests, hollow spheres of inorganic material within an organic matrix, which are also found in pre-Sturtian microfossils. This research is expanding the body of knowledge about what microbial ecosystems thrived in the aftermath of the Marinoan glaciation, which will ideally reveal critical information about how complex life developed in the Ediacaran.
Effects of Exotic Earthworms (*Eisenia Fetida*) on the Release of Dissolved Organic Carbon from Hemlock and Deciduous Forest Soils of Western Massachusetts

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The invasion of exotic earthworm species into forested soils in Minnesota has been shown to dramatically alter carbon and nitrogen cycling that can lead to an increase in the export of Dissolved Organic Carbon (DOC). In addition, an increase in the decomposition rate could also lead to the release of organically bound soil mercury accumulated from atmospheric deposition.

To evaluate the potential effects of invasive worms on forested watersheds in New England, a series of leaching experiments were done using O horizon soil samples collected beneath both deciduous and hemlock canopies within the Avery Brook watershed located in West Whately, Massachusetts. In this experiment an equal mass of a popular composting worm “Red Wiggler” (*Eisenia fetida*), was added to four replicates of each soil held in open plastic containers. These, along with an equal number of control samples, were watered weekly and the leachate was collected for analysis of DOC, SUVA, and total mercury. Prior to treatment, analysis of the organic horizons revealed mercury concentrations of approximately 200 ppb under the deciduous canopy and 150 ppb under the hemlocks.

The results of the experiment show that worms significantly increase organic decomposition rates. Concentrations of DOC in the leachate increased to over 300 mg/L in the worm bearing deciduous organic horizons compared to less than 100 mg/L in the control samples. Worm decomposition of the hemlock O horizons produced less DOC, with a maximum concentration of a little over 200 mg/L but still double what was observed in the controls. During the course of the experiment, Specific Ultraviolet Absorption (SUVA) decreased rapidly in worm bearing deciduous soils while the decrease occurred much more slowly in the hemlock soils. SUVA is a measure of the aromaticity of the DOC and the decrease in the samples with worms indicates more complete organic decomposition. Preliminary measurements of aqueous Hg\(_T\) show leachate concentrations near 200 ng/L for deciduous O horizons. In addition, the worm bearing soils all produced more drainage water indicating an even higher DOC and Hg\(_T\) flux. From this experiment it is clear that invasive worms have the potential to greatly increase DOC and Hg\(_T\) export from forested watersheds.
Provenance Analysis of Channel Sands in the Chickaloon Formation,
Matanuska Valley, Alaska

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Most of southern Alaska’s modern Matanuska Valley lies north of the rocks in the Mesozoic Chugach accretionary wedge (MCAW) and south of mountainous exposures of the Jurassic Talkeetna Volcanic Formation (JTVC) in the Talkeetna Mountains. The MCAW south of the Border Ranges Fault consists of blueschist, mesomelange (altered shale, interbedded sandstone and siltstone, red and black chert, basaltic lava, and recrystallized limestone), and greywacke-conglomerate (Clift et al. 2012). The JTVC north of the Castle Mountain fault consists mostly of basaltic and andesitic lavas and tuffs, as well as volcaniclastic rocks (Clift et al. 2005). The Chickaloon Formation was deposited in the Paleocene and early Eocene within the Matanuska Valley-Talkeetna Mountain forarc basin (Neff et al. 2011), and is thought to have been sourced from these uplifted terrains. Detailed study of Chickaloon facies associations indicate lacustrine and low-sinuosity fluvial depositional settings, with tidally influenced fluvial and estuary systems in the western portion of the basin (Trop et al. 2003).

This study seeks to describe the extent to which the MCAW and JTVC have contributed to the sediment within the medial channel sands of the Chickaloon Formation. Twenty-eight samples of this lithofacies in the Chickaloon Formation were collected from the coarsest deposits at each study site throughout the Matanuska Valley along the east-west basin axis. The majority of these deposits are lithic graywackes and arenites with common calcite cement. Petrographic analyses of twenty-two of these samples and point counting analysis on ten, reveal that the dominant lithic components of the sand-size fraction in all samples were chert, polycrystalline quartz, fine grained siliciclastics, and to a lesser extent schist. Volcanic lithic fragments did occur in some samples, but not in significant amounts.

Chert, polycrystalline quartz, and schist are all indicative of metamorphic provenance, and together they make up the bulk of the lithic fragments found in all samples. This finding suggests that the Mesozoic Chugach accretionary complex was the dominant sediment source to the sampled Chickaloon Formation. One possible explanation for this could be that this geographical area received significantly more precipitation relative to the JTVC due to an orographic rain shadow effect. It is also possible that during the deposition of the Chickaloon Formation there was more movement occurring along the Border Ranges Fault relative to the Castle Mountain Fault. This movement could be attributed to dextral oblique plate convergence caused by the northwestward shift in motion of the Kula plate, which started around 54 Ma (Trop et al., 2003). These results provide useful knowledge for reconstructing the evolution of fluvial systems of the Chickaloon Formation.


Mapping the Ooid Distribution at Pigeon Creek Delta, San Salvador, Bahamas

Kiara Gomez
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Ooids are small spherical to ellipsoidal coated grains characterized by concentric layers of calcium carbonate. They usually form in agitated shallow, carbonate environments and are some of the most common components of carbonate sediments known from the geological record. Despite the prevalence of ooids in the geologic past, sites where ooids are actively forming today are very unusual. Oolitic sand accumulations were documented when they were discovered in subtidal and beach settings along the Pigeon Creek Delta on San Salvador Island during January 2012. More samples were collected during interterm 2013 for further research. The primary goal of this study was to determine the site of ooid formation within the tidal channel. Samples of subtidal sand were taken along the tidal channel at Pigeon Creek Delta, San Salvador and were returned to Smith College. To date, nine of the eighteen subtidal bulk samples have been analyzed. Loose sand photographs were used to analyze sand composition within each sample. Sand mounts were made and thin sections were prepared for petrographic analysis. For kite photography, a GoPro camera was attached to a kite to illustrate features of the tidal channel and constrain the site of ooid formation. In the future, these photographs will be used to further constrain the sites of sample collection using ArcGIS software. Ooid abundances varied throughout the tidal channel. Sites S1 and S3 were collected near mangroves, where it was highly vegetated with sea grass and 3.5 meters in depth. Grains at these sites were also very coarse and dominated by shelly material such as whole shells and foraminiferan tests. From sites S1 and S3, water depth increased until site S5, where water depth dropped to about 2 meters. At sites S5, S8 and S9, sand grains were more well rounded with higher ooid abundances and lower concentrations of shelly material. These bulk samples were collected from a rippled, barren seafloor. Samples from sites from S6 and S15 were sites of low ooid abundance and high amounts of shelly material that were mostly dominated by calcareous algae. Site S8 was collected in a relatively shallow portion (<1 meter) of the channel and had finer sand particles and the highest ooid abundance of all sites analyzed so far.

We believe ooids can be a locally important source of sand in the Pigeon Creek tidal delta and this suggests that ooids are forming in this area. Site S8 had the highest ooid abundances among all sites analyzed along the tidal channel. Additional quantification of sand samples and analysis of sampling sites may reveal the area where ooids are forming and/or being deposited in this tidal creek.
Investigating Unusual Brown Sand of Sediment-Starved Beaches on the Leeward Coast of the Bahamian Islands

Kiara Gomez and Savannah Lawson
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Bahamian beaches are famous for their white colored sands with pink hues. Sand of the Conch House Beach on Little Exuma Island, however, is unusually dark brown in color. The beach lies on the leeward side of the Island and is very narrow and highly sediment starved. The purpose of this project was to investigate the composition of carbonate sediment at this site to understand its composition and sources as well as the dynamics of transport and deposition along this low-energy, protected coast. Comparisons were also made with sand from high-energy, windward beaches of this island. Sediment samples were collected along a transect from the dune-backshore transition to approximately 250 meters offshore in Exuma Sound. These samples were then examined under a binocular microscope and thin sections of grain mounds were created for petrographic analysis. The study focused on: (1) determining the origin of brown colored particles; (2) examining the composition of grains along the transect and comparison with samples from the windward beaches of Exuma; and (3) investigating the dynamics of sedimentation along this sediment-starved beach.

The brown colored particles represent individual ooid grains and rock fragments, which likely formed by: (1) weathering of modern ooid sand; and/or (2) weathering and erosion of exposed Holocene Rice Bay Formation ooid grainstone deposits. These brown colored particles were found in highest abundance in our onshore samples, supporting their origin by surficial weathering. Future radiocarbon dating of these grains could be used to better understand the processes contributing to their formation and distribution in the sediment at this site.

Abundance of ooids in the sediment along the transect indicate that this leeward setting is conducive to ooid formation. Due to their relatively small size, ooids are preferentially accumulating in a lower energy, deeper (>2m water depth) offshore setting, and onshore in the backshore and eolian dune settings. Coarser-grained skeletal and rock fragments are most commonly found within the high-energy wave swash zone.

Comparison of backshore sediment from the Conch House Beach and beaches on the windward side of the island revealed both similarities and differences in their composition and color. Backshore sand from both windward and leeward beaches is dominated by ooids, with some small shell fragments and rounded rock fragments. Sand from windward beaches however, is mainly white in color and has a highly polished, glossy appearance. This is in contrast to the Conch House Beach sand, which has an abundance of dark brown particles with a dull, matte appearance, further supporting their origin by surficial weathering. In addition, an abundance of sediment was observed on the backshore of the windward beaches, whereas the Conch House Beach is sediment-starved. These differences are related to low sedimentation rates along the Conch House Beach, which is characterized by high storm erosion rate, relatively low transport and deposition rates by fair weather waves, and low subtidal sediment production as supported by our observations of offshore sediment stabilization. Windward beaches, on the other hand, appear to be characterized by higher sedimentation rates. Further comparisons among these sites would demonstrate how mechanisms of transport and deposition change over short periods of time, particularly in response to storm events.
Soil Biogeochemistry of Forest Succession Following Logging of Eastern Hemlock Trees at the Macleish Field Station, West Whately, MA

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Spread of the hemlock woolly adelgid (*Adelges tsugae*; HWA) in New England’s eastern hemlock (*Tsuga canadensis*) forests has caused forest succession by deciduous hardwood species, particularly black birch (*Betula lenta*). Because tree species influence soil nutrient cycling, succession of hemlock by black birch could change forest soil chemistry. In attempt to simulate the effects of this succession on nutrient cycling, we compared soil geochemistry from plots of mature hemlock and juvenile black birch that regrew after logging of hemlock 20 years ago. For 9 incubation periods from May 2011 to October 2012, we measured net soil nitrogen mineralization rates in the mature hemlock and juvenile black birch stands. For reference, net nitrogen mineralization rates for a mature black birch plot were measured over 4 incubation periods from May 2012 to October 2012. In addition soil pH, exchangeable acidity and exchangeable base cations were measured.

In the juvenile black birch (BB) organic soil horizon, low net N mineralization rates for 2011-2012 equal rates observed in hemlock (HEM) soil during 2011. BB results are dissimilar to the results from mature black birch (MBB) soils, which have high net N mineralization and nitrification rates. These results suggest that hemlock soil exhibits strong control over N mineralization, even after hemlock trees are gone. Surprisingly, HEM soils experienced an increase in N mineralization between 2011 and 2012, without a change in nitrification rate. Increased net N mineralization might be explained by recent spread of the HWA infestation in this forest.
Paleoecology of Post-Extinction Fossil Assemblages of the Lower Triassic Virgin Limestone Member in the Muddy Mountains, Southern Nevada: New Insights into Silicification of Recovery Faunas

Sophie Westacott
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The Virgin Limestone of the Moenkopi Formation in the southwestern United States has proven key in understanding the marine invertebrate recovery during the latest Early Triassic (e.g., Schubert and Bottjer, 1995; Pruss and Bottjer, 2004; Marenco et al., 2012), but to date no studies have focused on its silicified fossils. This work examined acid-extracted silicified assemblages in samples from Virgin Limestone exposures at two localities in Muddy Mountains, Nevada, and found a paleoecology dominated by bivalves, crinoids, microgastropods, and echinoids; the assemblages exhibit relatively low diversity and high dominance, concurrent with findings by Schubert and Bottjer (1995) and Payne et al. (2006) that the post-extinction radiation did not get underway until the late Spathian-early Anisian. Thin sections of the same samples were point-counted using the grain solid method for comparison purposes, as non-silicified fossils as well as silicified fossils show up in thin section. Differences between the silicified assemblage and point-count results are substantial, indicating taphonomical biases might account for some of the discrepancies between Virgin Limestone assemblages and others from the Lower Triassic (Schubert and Bottjer, 1995; Wheelely and Twitchett, 2005). A third part of the study compares δ¹³C_carb isotope profiles from Muddy Mountains with δ¹³C_carb profiles of dated Lower Triassic carbonates from the Great Bank of Guizhou, China, from Payne et al. (2004), and estimates the age of the Virgin Limestone at Ute and Overton exposures to be mid-Spathian.

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Dynamics of Shallow Marine Deposition and Sediment-Organism Interaction in Times of Warm Climate, High Sea Levels and Increased Storm Activity
Jennifer Leman and Sarah Stephen
Advisors: Bosiljka Glumac and H. Allen Curran, Department of Geosciences, Smith College

Shallow marine rocks deposited during the latest Pleistocene interglacial time period (MIS 5e), when sea level was higher than present, can now be found exposed on the surface in the Bahamas. We examined one such exposure of subtidal carbonate deposits from Harry Cay on Little Exuma Island, in order to petrographically compare three distinct units and four burrow trace fossils, *Ophiomorpha*, *Planolites*, *Conichnus* and *Skolithos* (Curran 2007). We collected samples and recorded field observations of the exposed rock succession and burrow infills at two sites, Harry Cay Marina and Harry Cay Quarry, and did petrographic analysis of these samples in thin section.

Unit 1 at the Marina was 30 to 50 cm thick, composed of ooid-peloidal grainstone, had some horizontal lamination, and contained all four burrow types. Unit 2 was a tabular, 27 cm thick unit of heavily bioturbated ooid-peloidal grainstone, contained *Ophiomorpha* burrows, and had a sharp upper contact marked by penetrative caliche and rhizoliths. Unit 3 was 45 cm thick, composed of crossbedded ooid-skeletal grainstone and contained no burrows. At the Quarry site, however, *Ophiomorpha* and *Conichnus* were also present in unit 3. *Ophiomorpha* are branched burrows about 3 cm in diameter with a knobby wall composed of stacked pellets and sand infills, constructed by callianassid shrimp. *Planolites* are horizontal, circular tubes of fine-grained material averaging around 1 cm in diameter; these are thought to be excreted by barranoglossid worms. *Conichnus* are conical burrows about 8 cm at their widest diameter, made up of successive layers of sediment. They most likely represent escape burrows constructed by sea anemones. *Skolithos* are long, thin vertical burrows around 0.25 cm in diameter that were dwelling tubes for polychaete worms. This subtidal stratigraphic succession was dominated by ooid-rich grainstone, indicating a relatively high-energy environment. Samples of *Ophiomorpha* and *Conichnus* burrow walls, however, contained more peloids and micrite. *Planolites* and *Skolithos* infills appear more firmly lithified than the surrounding deposits.

The degree of bioturbation and preservation of primary physical sedimentary structures can be used to evaluate sedimentation modes and rates for these deposits. Unit 2 was the most heavily bioturbated and completely lacked lamination, suggesting a rather long period of bioturbation under a relatively slow sedimentation condition. Unit 3 had the fastest sedimentation rate, as indicated by well-developed crossbedding and the lack of bioturbation at the Marina site. Unit 1 had an intermediate sedimentation rate, with some horizontal lamination and numerous discrete trace fossils preserved. The rapid deposition in unit 3 may represent a storm event or high-energy tidal currents. However, the presence of micrite and *Ophiomorpha* and *Conichnus* burrows in the Quarry exposure indicate that this area was a slightly lower energy contemporaneous environment. Our study confirmed that the organisms that produce *Ophiomorpha* and *Conichnus* burrows can highly alter host sediment and play a large role as ecosystem engineers in dynamic subtidal environments.

Infrared Spectra of Tourmaline from Tamminen-Waisanen Pegmatites, Maine

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Abstract

Specimens of tourmaline were collected from the Tamminen and Waisanen quarries, in the Greenwood Pegmatite fields of SE Maine. Approximately 20 Fourier transform infrared spectra were collected on tourmaline from each of the quarries. The frequency of stretching vibrations of OH groups can be used to help interpret site occupancies in tourmaline. The shorter the OH bond length, the higher the frequency of vibration, and the higher the wavenumber of the bond when subjected to infrared radiation. OH occurs in two sites in tourmaline: at the center of hexagonal rings (OH1) or between hexagonal rings (OH3). The OH1 and OH3 stretching bands are at higher wavenumbers in elbaite than in schorl (Castaneda et al., 2000) because the O-H1 and O-H3 bond lengths are shorter in elbaite than they are in schorl. Tourmaline from the Waisanen and Tamminen quarries have spectral characteristics that overall are more similar to those of elbaite than to schorl. The 1338/cm band in the Tamminen tourmaline indicates that Mg$^{2+}$ and Al$^{3+}$ are on the Y sites nearest to the BO$_3$ groups. The 2336/cm band in Waisanen tourmaline indicates that a small amount of carbon dioxide is present in the tourmaline, either in fluid inclusions or structurally bound in the mineral.
"Exploring warm interglacial marine seasonality along the northwest Alaskan coast."

John Gilbert

UMass

During past interglacials, warm water masses penetrated northward into the Arctic and subarctic seas influencing the climate system, causing among other things changes in seasonal sea ice extent. Such changes are accelerating today. To better understand the seasonality of temperature in Arctic coastal waters during past interglacial periods one approach is to measure changes in the oxygen isotope geochemistry of annual growth bands in fossil mollusks that lived at different times. This study explored the suitability of several bivalve species for producing paleorecords of seasonal changes for comparison with extant specimens recovered from the northwest coast of Alaska. Intact shells of *Hiatella arctica*, *Mya pseudoarenaria* and *Astarte borealis* were chosen for study from existing Alaskan collections representing warm interglacials dating to 125ka, 410ka and ~2.6 Myrs ago. Each sample was embedded in epoxy, cross-sectioned, polished, and imaged prior to isotopic sampling using a micromill capable of 100µm sampling resolution. The resulting carbonate powders were then analyzed for oxygen isotope geochemistry using a Finnigan Delta XL+ ratio mass-spectrometer attached to a Kiel III automated carbonate preparation system. Changes in δ18O content of the fossilized specimens are compared to the δ18O content of modern specimens to evaluate differences in seasonality relative to other paleoproxies from the same collection sites. The efficacy of these methods in determining the amplitude and range of variability in past and current seas surface temperature is determined. Changes in seasonality provide important data sets contributing to ongoing data-model comparisons by other scientists using global circulation models.
Title: Thrust Faults accommodate strain within the Eastern California Shear Zone
Karl Grette

Abstract:
The Eastern California Shear Zone in southern California is an area of high tectonic complexity where a lot of faults interact closely with one another. The Community Fault Model, a numerical model using Boundary Element code, is a model that attempts to understand how slip is distributed across the region. However, there are significant disparities between the predicted rates in the model and measured geologic slip rates from the field, which is due to differences between our understanding of the fault interactions and geometry and the actual fault system. I have attempted to improve the model by adding three recently mapped thrust faults which previously were not included in the model. These faults reduce off-fault deformation predicted by the model and provide slip rates that are closer to the geologic slip rates measured in the field.
Title: Hurricane Irene’s Reactivation of a Rotational Landslide on Route 2, in Charlemont, MA

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Abstract:

In late August 2011, a rotational slide destroyed highway route 2 in Charlemont, MA. The slide, which had previously slipped in 1938, was reactivated by extensive rainfall (~6”) from Hurricane Irene. Hurricane conditions also caused the 1938 slide. We investigate the conditions causing the reactivation of the slide in 2011 using numerical models based on subsurface soil characterization. The MA Department of Transportation characterized borehole samples in the 1970's and again in Fall of 2011. Along with these logs, we collected and analyzed soil samples for current characteristics, such as water content, density and Atterburg Limits. We develop a three-dimensional representative model of the subsurface that incorporates local topography and the topology of subsurface layers, from borehole information. A composite two-dimensional cross-section is constructed from the 3D model, and imported into ComSol. The ComSol model incorporates the properties of the subsurface materials and the influence of gravity. We use the stresses calculated and material properties to calculate how much water was required for slope failure.
Superstorm Sandy: A 1,000-Year Event?

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Hurricane Sandy hit New York City, NY on October 29th, 2012 and the associated storm surge raised water levels 3.5m above sea level at the Battery, causing the highest recorded storm surge since the mid-1700s (Scileppi & Donnelly 2007). Studies using synthetic hurricane models estimate that Hurricane Sandy is a 1-in-1000 year event (Lin et al. 2012). But sediment cores collected in back-barrier ponds on Staten Island indicate that more frequent events of a similar magnitude have hit New York City within the past 250 years. A spike in grain size is characteristic of the Sandy overwash deposit, and is interpreted as an indicator of past storms. The Sandy deposit shows a fining upwards sequence and a grain size decrease further inland, indicating sediment transport via suspension (Woodruff et al. 2008). The onset of Zn, at about 1850-1900, provides down-core age constraints for past storms. Continued analysis of back-barrier event layers will allow for a more accurate estimate of the reoccurrence interval of events like Superstorm Sandy.
Reconstructing climate and environmental change over the last 9000 years based on a peat bog record from northern Norway

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Peatlands form by the accumulation of partially decayed vegetation in wetlands and provide archives of paleoenvironmental information. The rate of peat accumulation, the surface wetness, and the distribution of vegetation types can be related to paleoclimate and paleohydrologic conditions. In addition, characteristics of peat can be influenced by human activities and provide records of human impacts on landscapes. Here we present preliminary results from the investigations of a low-elevation (26 m a.s.l; 0.32 km²) ombrotrophic peat bog (69°44’40.50” N, 19°07’55.43” E) located 13 km northeast of Tromsø, northern Norway. The peat bog is formed on a late glacial recessional moraine along Balsfjord and is surrounded by a complex of Neolithic archaeological sites occupied from c. 10-5 cal ka BP. Here we focus primarily on results from the analysis of peat humification to reconstruct bog surface wetness (BSW) related to regional paleoclimate, but the overall purpose of the study is to reconstruct Holocene climate variability based on a multi-proxy analysis of sediment cores taken from the deposit, and to examine relationships between periods of human occupation of the site during the early Holocene and paleoenvironmental conditions.

In 2012, ground-penetrating radar profiles were collected and sediment cores were recovered from three sites across the deposit. Cores were split, described, and photographed. RGB data were extracted from core images to study colors variations, and radiocarbon dates were analyzed from all three cores to examine the rate of peat accumulation. More detailed analysis has focused on core sites Tø12-A and Tø12-B, where additional radiocarbon dates have been collected, and samples were taken for analysis of organic content by loss-on-ignition and the degree of humification using an alkali extraction and colorimetry technique.

Our results show that the bog is generally 5-6 m thick, has an organic matter content of 94-99%, and accumulated over the last 9,000 cal yr BP. The record of humification from site Tø12-B also shows distinct changes throughout the Holocene and we interpret greater humification to correspond with intervals of decreased BSW. Transmittance values range from 55-85%. During the early Holocene, reduced BSW persisted from 518-471 BP and was followed by an abrupt shift to increased BSW at 462 ka BP. During the late Holocene the data show two significant shifts in BSW. There is a shift to lower values at c. 4.5 ka BP and a return to higher values from 0.6 ka to present. These variation in BSW interpreted from our humification analysis also correspond to visible color variations in the cores. The relationship between BSW and regional temperature and/or precipitation changes is not always clear, so we will compare these results to quantitative pollen-derived records of paleoclimate in order to explore the factors affecting BSW at this site.
Detrital Monazite: Process and Future Application
Brian D. Wells, Michael L. Williams, Michael J. Jercinovic, and Sean P. Regan

Detrital zircon studies have had a major impact on sedimentology, structural geology, and tectonics over the past decade. The ages of detrital zircon in sedimentary and metasedimentary rocks are used to constrain the ages of the sediments and the nature of the source terrain(s). To a large degree, these advances are possible because new analytical methods allow efficient dating of large numbers of zircon crystals.

Although the analysis of detrital zircon provides important new constraints in many studies, significant ambiguities and questions can remain largely because zircon provides an imperfect fingerprint of the source region. In many ways, detrital monazite is an ideal complement to detrital zircon. Whereas zircon is particularly sensitive to the age of igneous rocks in the source region, monazite is particularly sensitive to metamorphic events in the source region. Further, monazite shows wide compositional variation that, along with age, can help to strengthen the fingerprint of the source region.

This research devises and implements a system to separate and date detrital monazite from sedimentary and metasedimentary rocks to constrain the age and character of the source of the sediments. Practical applications for such findings include the timing of tectonic events throughout Earth history and also may help us determine the paleogeography of past supercontinents.

Our project has two main components. The first is to use known monazite-bearing sediments (and metasediments) to develop an efficient methodology to separate and analyze large numbers of detrital monazite grains. The second part applies the new techniques to an ongoing tectonic problem, namely the ages of major Proterozoic quartzite sequences and the timing of tectonism in the southwestern USA. The sequence in question is part of the Proterozoic Hess Canyon Group in the Transition Zone, central Arizona. Extensive detrital zircon geochronology has been done to date tectonism in the area. The Blackjack and Yankee Joe formations yielded ages from 1500 Ma to 1600 Ma, which indicates a source of igneous activity not known for that region of Laurentia. There are multiple possible source terrain(s) for these sediments, including South America, Australia, and possibly Antarctica. It is our goal to match the unique fingerprint of monazite from the Hess Canyon Group with its source terrain.