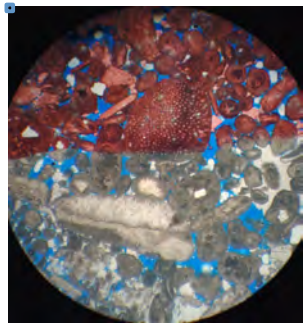


JAMES MADISON UNIVERSITY

STEM
JAMES MADISON UNIVERSITY

Department of Geology
and Environmental Science

Student Research Symposium

April 25, 2014
Memorial Hall Room 7370

Abstracts with Program

The Department of Geology and Environmental Science
2014 Student Research Symposium

Friday April 25th Memorial Hall Room 7370

Morning Session

8:35 John Haynes – Welcome and Introduction

8:40 Nicholas Rossi

8:55 Regan Sheets & Ashly Tracey

9:15 Collin Knox & Meiz Boozell

9:35 Derek Barry & Will Biggs

9:55 Matt Acosta

10:10 Stefanie Paige

10:25 Kimberly Mervine & Jason Booker

10:45 Anastacia Martyn

11:00 Varqa Tavangar

11:15 Olivia McClay

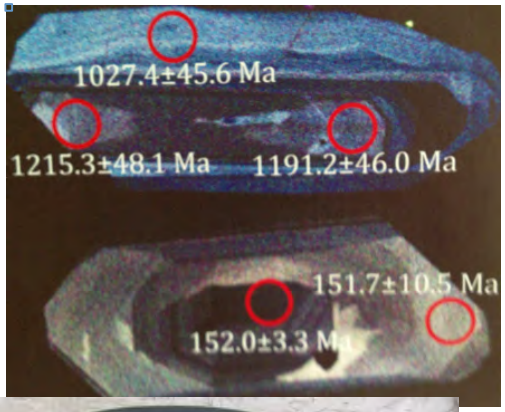
11:30 Emily Chapin

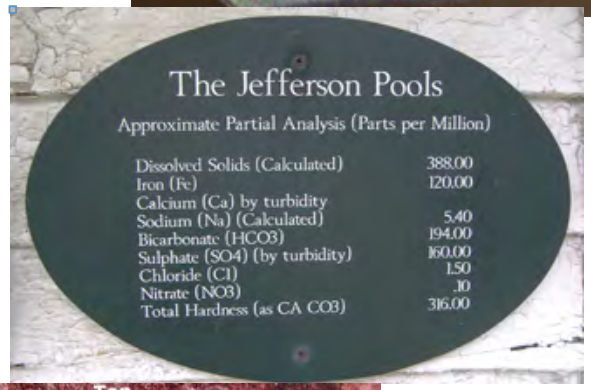
11:45 Alison Paylor

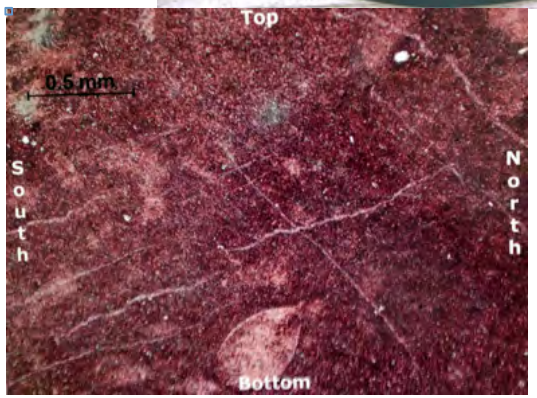
12:00 Marisa Hess

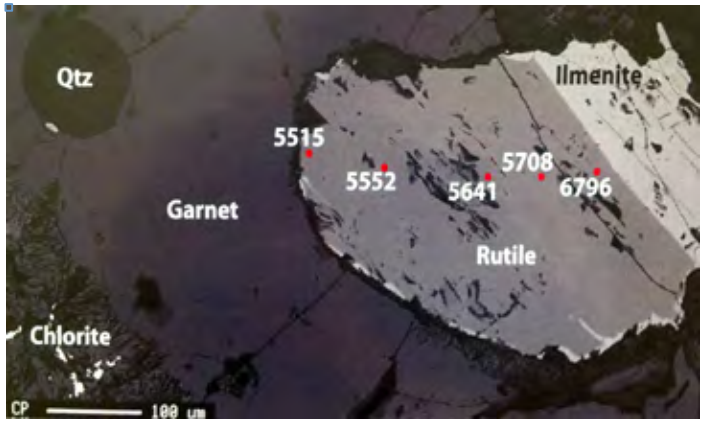
12:15 James Shada & Brandon Cohick

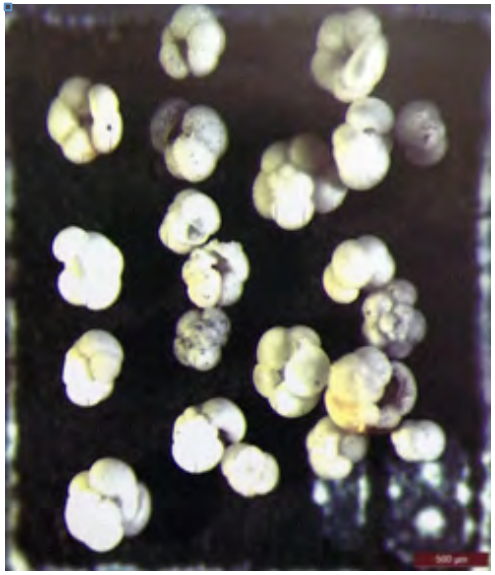
12:35 Lunch Break

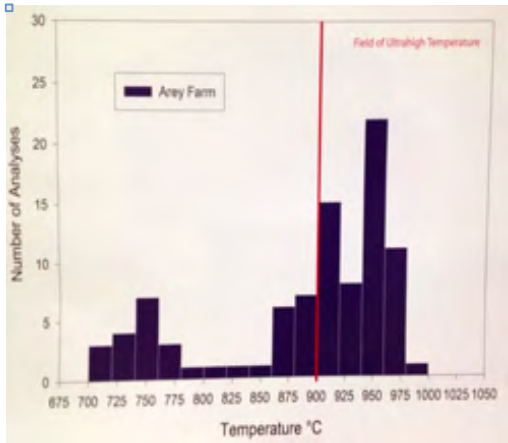












The Department of Geology and Environmental Science
2014 Student Research Symposium

Friday April 25th Memorial Hall Room 7370

Afternoon Session

1:30 John Haynes – Welcome and Introduction

1:35 Katie McConahy & Tim Kropp

1:55 Katie Pijanowski

2:10 Cody Sheaffer & Christian Bruchman

2:30 Jillian Browning

2:45 Erin Schmitt

3:00 Evan Bryant

3:15 Jacob Helsley

3:30 Matt Aadland

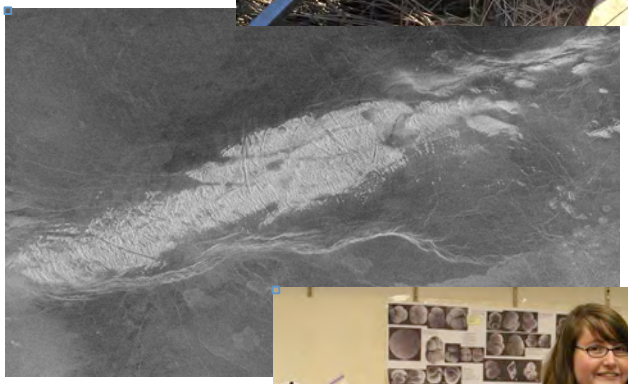
3:45 Daniel Rowson

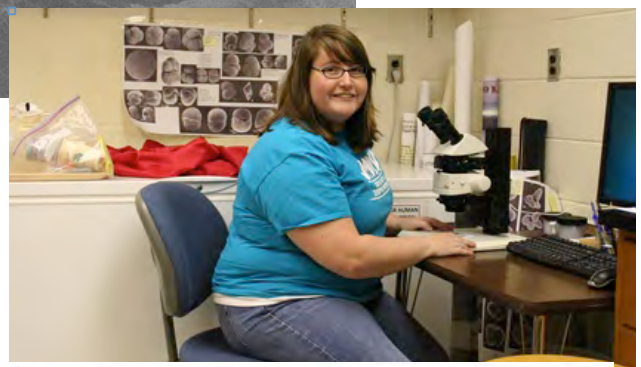
4:00 Paige Lambert and Angelica Watson

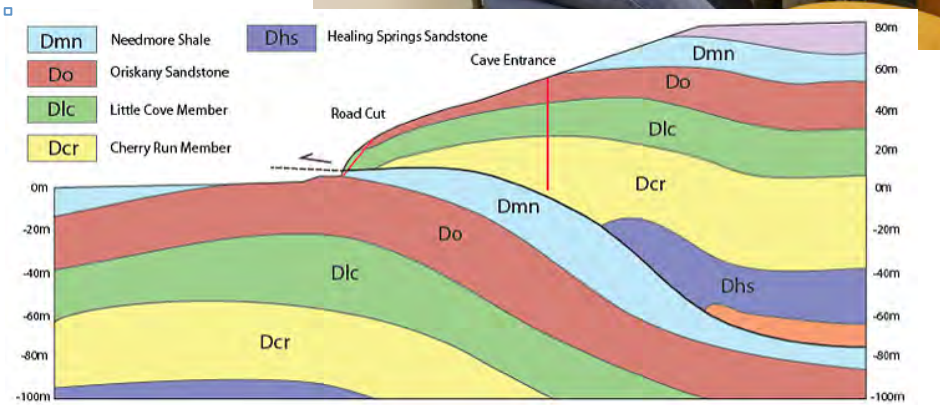
4:20 Lacey Matusik

4:35 Varqa Tavangar and Brandon Cohick

4:55 *End of Symposium*



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Dcr Cherry Run Member
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4:35

Fine Sediment Deposition and Transportation Through a Drainage Basin: Smith Creek, Shenandoah Valley, Virginia

Varqa Tavangar and Brandon Cohick

Smith Creek is a 35-mile long tributary stream of the North Fork of the Shenandoah River in the Shenandoah Valley of Virginia. The headwaters of the stream's drainage basin lie in northern Rockingham County just north of Harrisonburg. Its watershed comprises 106 square miles within Shenandoah and Rockingham Counties along the western slope of the Massanutten Mountain. We conducted a series of geomorphic assessments investigating how fine sediment accumulates and is transported throughout the drainage basin. Six assessment sites were chosen to display the overall characteristic patterns found in the stream. In higher order (larger) segments of Smith Creek where velocity and discharge is much greater, we observe excessive erosion and deposition of fine sediment in eddies along eroded cut banks. Shallow gradients of higher order streams also allows for sediment deposition. In contrast, we observe minimal fine sediment deposition in lower order, upland streams due to steep gradients, rocky stream channels and relatively narrow overall channel widths. Fine sediment was mapped throughout the stream channel using an x-y-z grid system, measuring length, depth and width of sediment deposits. Using this data we calculated volumes for each deposit. Findings confirmed the hypothesis that fine sediment accumulates in higher order streams due to favorable locations from erosion and debris. This basin can be used as a model to understand the process of deposition and transport of fine sediment on a much larger scale, such as the Chesapeake Bay drainage basin.

Advisors: Scott Eaton (JMU)
Allen Gellis (USGS)

8:40

U-Pb Geochronology of Grenvillian and Late Jurassic Lower Crustal Xenoliths in the Shenandoah Valley

Nicholas Rossi

Late Jurassic (~150 Ma) and Eocene (~48 Ma) volcanics in the Shenandoah Valley, VA, contain metasedimentary and igneous lower crustal xenoliths. The analysis of these xenoliths allows for vertical profiling of the crust and mantle and provides important constraints on the structure and geological history of the Eastern North American Margin (ENAM). U-Pb ages were determined for xenoliths from three locations at the LaserChron Center at the University of Arizona. Xenoliths were cut from dike material, and zircons crystals were separated and hand selected for analysis using laser ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICPMS). At two locations, Arey Farm and 5 Springs, only garnet-sillimanite-paragneiss xenoliths were found. The wide age ranges of 883-1161 Ma (5 Springs) and 938-1258 Ma (Arey Farm) from these xenoliths strongly suggest detrital populations of Grenville age and further detrital age dating is needed. At the third location, Vulcan Quarry, two distinct age populations were found: 151.7±1.8 Ma (MSWD = 0.50) and a less abundant population ranging from ~950-1215 Ma. The late Jurassic igneous xenoliths correspond in age with a pulse of magmatism at ~150 Ma in the Shenandoah Valley. The age of the Vulcan Quarry dike is unknown, but we hypothesize that the igneous xenoliths are cogenetically related to this magmatism that post dates the rifting of Pangaea by 50 Ma. The zircons from metasedimentary xenoliths have no discernible rims of post-Grenville age. This implies there has not been resetting by subsequent orogenic events in the Appalachians, even in the location which also contains ~150 Ma xenoliths. The gneissic xenoliths at 5 Springs and Arey Farm record ultrahigh temperatures (max T > 900°C; Helsley 2013). Future work to relate the Grenvillian xenoliths to known Grenvillian basement rocks exposed to the east in the Blue Ridge will provide regional context of the composition and age of the lower crust in ENAM.

Advisors: Elizabeth Johnson (JMU)
Benjamin Schwartz (Texas State University)

8:55

Sedimentation Behind Millpond Dams Along Smith Creek

Regan Sheets and Ashly Tracey

Smith Creek is a part of a larger stream conservation project that attempts to reduce sediment pollution entering the Chesapeake Bay via stream bank instability. Previous research of streams in Pennsylvania that drain into the Chesapeake Bay were noted to have significant volumes of sediment accumulation residing behind breached milldams; and therefore provide an active sediment source for Bay-bound pollutants. The question at hand is do the same conditions exist here in Shenandoah Valley streams? Therefore, the purpose of this research was to examine the amount of sediment accumulation due to pre-20th century milldams along Smith Creek, a major tributary of the North Fork of the Shenandoah River. A literature review of documents and maps revealed numerous sites of past milldam activity. Field reconnaissance verified many of these sites and several of the remnant mill ponds were surveyed for the presence of sediment wedges residing behind the ruins of the dam. For this study, the four milldam sites and associated sediment accumulation include Lacy Springs Mill with a volume 570m3, Stultz Mill with 1310m3, Craney Island Mill with 4027.2m3, and Bruce Mill with 273.7m3. These accumulation volumes are substantially less than what workers observed in the Pennsylvanian streams under similar land use to the Smith Creek basin. We suggest that these minimal sediment accumulation values may be the result of high discharge values (and scouring potential) of Smith Creek, the trapping efficiency of the original reservoirs, and the long time spans in which the dam has been breached (and subsequent sediment scour) relative to our surveys.

Advisor: Scott Eaton (JMU)

4:20

A Terrestrial, Geomorphic, and Geospatial Analysis of the Argyre Basin in Mars

Lacey Matusik

The Argyre Basin, which resides in the southeast region of Mars, is one of the oldest impact basins and provides evidence of multiple epochs undergoing dramatic environmental change. These environmental changes parallel those that may have occurred during early terrestrial development. By examining the most recent rover images from the Mars Reconnaissance Orbiter via HiRISE, features of the basin can be analyzed in never before seen detail. In the southern mountain system, Charitum Montes, four main channels – Surius Valles, Dzigai Valles, Doanus Valles, and Palacopas Valles – indicate where water entered the basin from the southern pole. To the north of the basin, the Uzboi Valles in the Nereidum mountain system was arguably once a northward flowing channel that emptied the basin, either counteracting or preventing the basin from overflowing. Additional features such as long esker ridges along the basin floor, large boulders at the base of the mountains, ridges, and gullies are indicative of glacial and sub-glacial processes. This implies that, in addition to water, ice was a primary contributor to the basin's geomorphology. Because Argyre is a collision basin, it does not exhibit many features characteristic of terrestrial basins that are produced by sedimentation and/or subsidizing. It lacks any form of a delta system, there are no stream orders, and there are no complex drainage patterns or tributaries. Instead, channels and ridges truncate at the basin floor where water would have settled into a partially frozen lake. By examining the present mineral content at the surface and the morphology of the most characteristic features in CRISM, a timeline of basin events can be constructed based. This timeline provides a precise geologic reconstruction of Mars' early, active history – initially abundant water, followed by intense volcanism, and finally cooling and drying. The Argyre Basin provides a snapshot of a collision basin in the early stages of planetary development very similar to conditions that would have been active on Earth; however, collision basins no longer exist in the terrestrial rock record. Therefore, the Argyre Basin provides a potential model for terrestrial collision basins that formed early in Earth's geologic history.

Advisor: Eric Pyle (JMU)

4:00

A Comparison of the Water Permeability of In-situ Soils, Tilled vs. Fallow; Rockingham County, Virginia

Paige Lambert and Angelica Watson

This study compares the water permeability of tilled and fallow soils. Permeability of a soil is dependent upon soil structure, for if the structure of the soil does not possess connected pore spaces the soil will be impermeable. If the soil is less permeable, it is expected that more erosion will occur. However, a test has never before been done to compare the permeability of a tilled soil to an undisturbed soil (fallow soil) to ensure that the assumption that a tilled soil is less permeable is correct. To test the permeability of a tilled soil and undisturbed soil, we first attempted to utilize new field equipment, the Johnson Permeameter. The Johnson Permeameter was designed to perform a constant head test in-situ and was designed to be portable so as to test areas that lack easy access routes. However, in the course of this study it was discovered that the Johnson Permeameter does not work well in soils that are nearly saturated or that are fully saturated. Therefore, a percolation test (falling head test) was utilized to test the permeability values. Since different soil series possess different permeability values, in this study we tested only in sites with the same soil series for both tilled and fallow soils. Five tests were completed in tilled and fallow soils and the permeability values were compared.

Advisor: Scott Eaton (JMU)

9:15

The Stratigraphy and Structural Fabric of the Swift Run Formation in Greene County, Virginia

Meiz Boozell and Collin Knox

The Neoproterozoic Swift Run formation, located in the western part of the Blue Ridge in Central Virginia, is a metasedimentary unit that is above the granitic rocks of the Blue Ridge basement complex, but typically below the Catoctin Formation. Our research focused on the Swift Run type location, located roughly 1.5 miles east of Swift Run Gap on US Rt. 33. Field research incorporated detailed observations from both primary and secondary features such as mud clasts, cross bedding, foliations and small scale folds. Of particular interest was a steeply dipping fault that cuts through the middle of the outcrop. Trend and plunge data, strike and dip measurements, and correlated strip logs were used to try to piece together the deformation history, as well as looking at several sedimentary structures to determine its stratigraphic history. What was seen based on this data and by taking a look at some of the primary features such as cross bedding was that the beds have not been overturned because the strip logs from each side of the fault showed that siltstone layers can be correlated across the fault. The strip log correlations were done and we were able to successfully trace the siltstone layers across the fault, suggesting that the beds have not been overturned. Along with strip log correlation sedimentology and observation of sedimentary structures were used to determine depositional environments. Strike and dip measurements were also taken of bedding and cleavage showing that cleavage is dipping steeper than actual bedding, suggesting that bedding was not overturned. During the rifting of Rodinia, half grabens bounded by normal faults were created, and due to new accommodation space, Swift Run sediments were deposited in the grabens through fluvial systems into lacustrine environments. During the Paleozoic, normal faults were likely reactivated and upward thrusts created folds in the Swift Run formation. Folding was followed by subsequent low angle thrusts late in the Alleghenian orogenic sequence.

Advisors: Lynn Fichter and Steve Whitmeyer (JMU)

9:35

Evolution of Geologic Interpretations and Petrography of the Swift Run Formation in the Shenandoah National Park, Greene County, Virginia

Derek Barry and Will Biggs

This study focuses on the evolution of the Neoproterozoic Swift Run formation through literary analysis on a regional scale, and petrographic analysis on a local scale. Hand samples were cut into thin sections to be analyzed in more detail, while SEM images distinguished opaque minerals. The Swift Run formation crops out along the western flank of the Blue Ridge Mountains as a discontinuous clastic unit, with highly variable thickness and lithology. Swift Run metasediments were first mapped and described in 1894; however, they were formally named the "Swift Run Tuff" in 1946 by Jonas and Stose. Prior to 1946 rocks of the Swift Run were miscorrelated with basal members of the Catoctin "volcanic series" or thinned westward expanses of the Lynchburg, Loudoun, or Oronoco formations. Over the next twenty years areas of discontinuous metasediment eroded from granitoid basement interlayered with Catoctin greenstone were mapped along the NW flanks of the Blue Ridge. The Swift Run is generally composed of arkosic sediment, however, mineral analysis of our outcrop yielded no feldspar in thin section, and instead they were altered into the matrix. Sedimentary structures combined with petrographic evidence suggest a lacustrine or braid plain depositional system intermixed with pyroclastics. The work of previous geologists is culminating now as structural data and modeling software are able to reconstruct the original basin geometry, placing the environmental history into tectonic setting.

Advisors: Lynn Fichter and Steve Whitmeyer (JMU)

3:45

Geotechnical Investigation of an Embankment Slope Failure on the Campus of James Madison University, Harrisonburg, Virginia

Daniel Rowson

On March 13, 2013, an embankment slope on the campus of James Madison University began to fail and was eventually in need of repair requiring the removal of the section of the embankment that failed, and the construction of a retaining wall in its place. An embankment slope should be designed in such a way that its factor of safety against failure is greater than 1, resulting in a stable and long-standing structure. The embankment in question has a gentle slope angle of 16.8° which is expected to have a high factor of safety with failure unlikely. This project is a geotechnical investigation to identify the causes of failure of such a gentle embankment slope. Intact samples of the embankment soil were collected and classified as SW-SC with 30%-40% gravel using the unified soil classification system. Cohesion and friction values of 1665 lb/ft^3 and 13°, respectively, were determined using the direct shear test. After surveying the embankment, Slide 6.0, from the RocScience suite of geotechnical software, was used to determine the factor of safety based on Bishop's Simplified Method. Initial analysis resulted in a factor of safety of 7.6, suggesting other factors might have caused the failure. After obtaining precipitation data for the city of Harrisonburg from NOAA's National Climatic Data Center, it was found that a large amount of snow fell one week before the slope failure occurred and was piled from a nearby parking lot onto the head of the slope that would eventually fail. Along with snow increasing the load applied to the slope, a rise in the water table was also considered, but the resulting FS was still as high as 5.8. Additional scenarios such as the presence of a weakened horizontal boundary along the fill/residuum material contact at a depth of ~23ft, uplift caused by the infiltration of water into unrecognized tension cracks, and repeated stress applied to the head of the slope are possible causes of failure.

Advisor: Yonathan Admassu (JMU)

3:30

Analysis of the Power of Atlantic Hurricanes 1960 – 2012

Matt Aadland

Hurricanes are one of the costliest forms of natural disaster in the United States and around the world. Although a majority do not make landfall in the US, hurricanes are often devastating to communities when they do. They are a powerful combination of high winds, heavy rain, and high waves known as storm surge in coastal areas and are even capable of spawning tornadoes. Katrina alone killed nearly 2,000 people and caused over $100 billion in damage in 2005, and when Sandy made landfall in the New York area in 2012 as a minimal strength hurricane it caused extensive damage to the metropolitan area. To project the likelihood of future storms and ensure both coastal and inland areas are prepared, the data from past hurricanes was analyzed with particular emphasis on each storm's accumulated cyclone energy (ACE), which is the total amount of energy a storm releases over its life as a hurricane. ACE is a good indication of the overall power of a storm because it factors in the duration and intensity of a hurricane and is calculated by summing the squares of the storm's maximum wind speed and multiplying the result by 10^-4. Data collected from each hurricane from 1960-2012 was analyzed to determine long-term patterns of changes in ACE by season and by storm. Analysis of past data determined that both a high wind speed value and longevity of the hurricane play a major role in determining a storm's ACE. To further demonstrate this, case studies were conducted of Hurricane Katrina in 2004 and Hurricane Ivan in 2005. Ivan had a much higher ACE than Katrina primarily due to its much greater longevity and in fact had the highest ACE of any storm that was researched. It was determined that September is the peak of hurricane season and therefore residents in hurricane-prone areas such as Florida and the Deep South should be especially prepared during this time of year. While the Atlantic has been relatively quiet in recent years and the US has been spared from most hurricanes, past trends show this is a temporary hiatus and could end at any time.

Advisor: Stan Ulanski (JMU)

9:55

Terrestrial LiDAR based stability analysis of the Afton Mountain cut slope along I-64

Matt Acosta

This is project an investigation of the stability of a cut slope along I-64 between mile marker 102 and 103 just NE of Afton, Va. The cut slope consists of the Catoctin formation, which is a chlorite rich meta-basalt, with its foliation dipping around 42 degrees towards SE; hence daylighting into cut slope on the west bound side of I-64. In the past the Afton mountain cut slope has failed 3 times leading to lane closures and requiring expensive maintenance. It still poses a large threat to motorist traveling this route since the slope has not been stabilized using current engineering remediation measures. To analyze the past problems and existing stability issues, discontinuity measurement and description was performed using the window mapping method. Discontinuity orientation and discontinuity characterization was performed with chosen windows of 3 feet by 3feet. Once data collection of the existing slope had been complete the data was then plotted using DIPS 6.0 from the RocScience software suite. One major set of discontinuities with mean dip direction of 168° and dip of 32° and two other minor sets of mean dip direction 65° and dip direction of 141° and dipping at 88° and 87° respectively. The major set is foliation, with the minor two being joints. Kinematic analysis using DIPS in addition to Dip Analyst showed the potential for plane and wedge failure of the main foliation surface. After these results, factor of safety calculations were conducted using surface models generated from LIDAR scans.

Advisor: Yonathan Admassu (JMU)

10:10

Isotope Ratio Mass Spectroscopy Determination of $\delta^{18}O$ and $\delta^{2}H$ Composition of Thermal Waters in Bath and Highland Counties, Virginia

Stefanie Paige

Establishing the origin of surface and ground water has long been investigated by studying the various waters oxygen ($\delta^{18}O$) and deuterium ($\delta^{2}H$) isotopic composition and comparing these values to the Global Meteoric Water Line (GMWL) (Craig, 1961). The GMWL shows the global isotopic distribution of $\delta^{18}O$ and $\delta^{2}H$ in rainwater, so that if data plots on the GMWL the origin of water is interpreted as being derived from precipitation. If the data plots away from the GMWL it means that some mechanism, other than precipitation, is fractionating the isotopic composition of the water sample.

Thermal springs of Bath and Highland counties in Virginia have been studied by students and faculty at JMU in an effort to determine their origin. This work used isotopes of Helium to suggest that these thermal waters are influenced by the mantle sourcing water and/or heat to these springs. We have tested this hypothesis by analyzing $\delta^{18}O$ and $\delta^{2}H$ from three thermal springs in Bath and Highland Counties using an IsoPrime Isotope Rationing Mass Spectrometer (IRMS). Data shows these waters are minimally fractionated from the GMWL, meaning these waters are likely to be meteoric in origin. This adds to our understanding of these thermal springs in that we now know that the mantle is not the physical source of water emerging from these springs, but instead is likely only the source of heat for these springs.

Advisor: Steve Baedke (JMU)

3:15

Ultrahigh Temperatures Recorded in Lower Crustal Xenoliths from the Shenandoah Valley, Virginia

Jacob Helsley

Petrographic observations and Zr-in-rutile thermometry of xenoliths found within Late Jurassic dikes were used to constrain the phase assemblage and temperature of the lower crust under Eastern North America. Samples were collected from three locations in western VA: 5 Springs, Vulcan Quarry, and Arey Farm. Mineral phases were identified using EDS and Raman analyses. Metasedimentary gneisses from 5 Springs and Arey Farm contain quartz + alkali feldspar + garnet + rutile + sillimanite + zircon ± apatite ± graphite with retrograde chlorite, ilmenite, monazite, sulfides, and barite. A metasedimentary xenolith from Vulcan Quarry consists of feldspar + quartz + biotite + graphite + zircon + rutile with minor barite. Igneous xenoliths from Vulcan Quarry contain feldspar + pyroxene + apatite + magnetite + complex Nb oxide. Quartz inclusions surrounded by radial fractures within garnet were found in the metasedimentary gneiss xenoliths. Two types of rutile inclusions are present within garnet: exsolved needles (< 5 µm wide) and larger (~20 µm) subhedral grains. Zr concentrations of subhedral rutile inclusions in garnet and groundmass rutile were measured by EMPA. Preliminary comparison of the mineral assemblage of the gneissic xenoliths with the pseudosection of Ague 2013 (Geology, 41 271-274) constrains minimum P > 7.25 kbar for 840 °C <T<1000 °C. The presence of sillimanite restricts maximum P <14.5 kbar in this temperature range. The Zr-in-rutile geothermometer of Tomkins 2007 (Geology, 25, 703-713) in the β-quartz field was used to calculate temperatures assuming P = 10 kbar. The Vulcan Quarry biotite gneiss xenolith records temperatures between 655 - 784°C. The Arey Farm and 5 Springs xenoliths have calculated temperature ranges of 718 – 984°C and 637 - 912°C, respectively, that extend into the UHT (ultrahigh temperature) _eld. UHT have only been reported from one other location in the Eastern US (Ague 2013). The metasedimentary xenoliths have Grenvillian detrital zircon ages (Rossi 2013) with no evidence for growth in subsequent orogenic events. The UHT recorded in the xenoliths may have been produced by prolonged (>800 Ma) deep burial and partial melting of the lower crust.

Advisors: Elizabeth Johnson (JMU)
Robert Bodnar and Charles Farley (Virginia Tech)
Benjamin Schwartz (Texas State University)

3:00

Sedimentary Structures of the Silurian Wills Creek Formation, Highland County, Virginia

Evan Bryant

On the north side of State Road 642 just off of US 220 in northern Highland County is a complete exposure of the Silurian Wills Creek Formation. Upsection (to the east) is the Tonoloway Limestone and downsection (to the west), is the Williamsport Sandstone. The oldest beds in the Wills Creek are calcareous shales and shaly-weathering lime mudstones. Upsection, more massive beds of dolomitized limestone and a thick bed of quartz arenite are present, followed by calcareous shales that are interbedded with ostracode grainstones, some of which have prominent gutter casts. The youngest strata in the Wills Creek, near the Wills Creek-Tonoloway contact, are interbedded calcareous shales and shaly limestones some of which thicken and thin markedly across the exposure. Within these beds are ripples, gutter casts, and hummocky cross-bedding, and the bed of ostracode-bearing calcarenaceous quartz arenite. In one bed an exposure of domal stromatolites is present. Collectively, these sedimentary structures suggest that the sediments of the Wills Creek accumulated in nearshore carbonate environments including tidal flat (stromatolites), beach (quartz arenite), and storm-dominated shelf (hummocky cross-beds and gutter casts).

Advisor: John Haynes (JMU)

10:25

Middle Ordovician (Darriwilian) Conodonts from Inner Mongolia

Kimberly Mervine

Conodonts are useful for determining a relatively high resolution age for Paleozoic carbonate rocks. Samples from a section of rock from Inner Mongolia known to be of Ordovician in age were processed to increase age resolution. Samples were collected at approximately 10m intervals by Dr. Paul Myrow, Colorado College, and sent to JMU. Samples were crushed using a Bico Braun Chipmunk rock crusher to minus 0.635cm. The samples were placed into 10% formic acid buffered with $CaCO_3$ and Ca-triphosphate until most of the carbonate had dissolved. Residues from acid digestion were wet sieved using a 75µm mesh. Residue captured of the 75µm mesh sieve were placed into jars containing LST at 2.85 SG and spun with a Thermo IEC CL40 Centrifuge at 3000 RPM for 7 minutes. The heavy fraction was flash frozen using liquid N, and the light portion poured off. The heavy fraction was sieved and examined for conodonts microfossils. Species *Pygodus anitae* and *Periodon* were found. This places the age of the rock in the *Pygodus anitae* conodont zone, indicating an age of Darriwilian Ordovician.

Advisor: Steve Leslie (JMU)

10:25

Conodont Biostratigraphy of the Upper Edinburg Limestone and Lower Martinsburg Formation at Woodstock, Virginia

Jason Booker

Conodonts are useful for determining age with relatively high resolution for Paleozoic carbonate rocks. Samples from a section of rock from Woodstock, VA were collected and processed in order to increase age resolution. Twenty three approximately 8kg samples were collected within a 51.5m measured section that includes the Deicke and Millbrig K-bentonite volcanic ash beds to increase the conodont zone resolution at this site. Samples were crushed using a Bico Braun Chipmunk rock crusher to minus 0.635cm. The samples were placed into 10% formic acid buffered with $CaCO_3$ and Ca-triphosphate until most of the carbonate had dissolved. Residues from acid digestion were wet sieved using a 75**µ**m mesh. Residue captured of the 75**µ**m mesh sieve were placed into jars containing LST at 2.85 SG and spun with a Thermo IEC CL40 Centrifuge at 3000 RPM for 7 minutes. The heavy fraction was flash frozen using liquid N, and the light portion poured off. The heavy fraction was sieved and examined for conodonts microfossils. The upper Edinburg Limestone has a conodont fauna of *Periodon, Panderodus, Phyragmodus undatus, Protopaderodus liripipus*, and *Dapsilodus*. This is consistent with the *Phragmodus undatus* conodont zone. The lower Martinsburg formation has a conodont fauna of *Panderodus, Phragmodus undatus*, and *Amorphognathus sp*. The Boundary between the *Amorphognathus travernsis* and the *Amorphognathus superbus* zones is projected to be in the lower Martinsburg based upon its level in the Katian GSSP site in Oklahoma. The goal of this project was to establish this contact. Unfortunately, due to very large residue sizes, that goal was not achieved.

Advisor: Steve Leslie (JMU)

2:45

Planktic Foraminifera Biostratigraphy of Core MD02-2560, Kane Spur, Gulf of Mexico

Erin Schmitt

The IMAGES MD02 expedition recovered a 28 m sedimentary sequence at Site 2560 in 1029 m water depth, in the Mississippi Canyon, Gulf of Mexico. However, no age model was developed. Determining age is essential for paleoceanographic reconstructions and to compare and correlate to other sites. Based on age inferred from color reflectance patterns, this core extends from the Holocene through the Pleistocene. The purpose of my research was to (1) develop an age model for the upper 10 m of core based on planktic foraminifera biostratigraphy, and (2) infer paleoceanographic changes. Twenty-one samples were taken every 50 cm, and sieved at 150 µ m. Approximately 300 planktic foraminifera per sample were identified. Established zonal schemes were applied to develop an age model, and linear sedimentation rates (LSRs) were calculated. The Z1 subzone is dominated by warm water species of *Globorotalia mendarii*, *Globorotalia tumida*, and *Pulleniatina obliquiloculata*. The 6ka boundary of Z1/Z2 is at 2.8 mbsf. The Z2 subzone shows increased *Globorotalia crassaformis*, a cool water species. The Z/Y boundary is placed at 4.8 mbsf, and marks the Holocene-Pleistocene transition at 10 ka. However, this is deeper than a bulk lithologic change at 4.5 mbsf. The 16 ka Y1/Y2 boundary is located at 5.4 mbsf. Y1 represents the late Pleistocene as cool water species of *Globorotalia bulloides* and *Globorotalia falconensis* peak, and includes the Younger Dryas cool peroid. The Y2 subzone has high levels of *Globorotalia crassaformis* and represents the Last Glacial Maximum; its 24 ka base is placed at 7.5 mbsf. The total percent of planktic foraminiferas range from 15 to 20% between 10 and ~4 mbsf, where the percent abundance drops to ~5%. It increases to 40-50% between 3.5 and 1 mbsf, and this correlates with an increase in color reflectance. In the upper 1 m, planktic forams drop to 21%. LSRs are highest in the Holocene, 0.47 m/kyr in Z1 and 0.50 m/kyr in Z2, and may be due to increased biological productivity and increased terrigenous input from the Mississippi River. Holocene LSRs at MD02-2560 are similar to those at nearby IODP Hole U1324B, however U1324B's Pleistocene LSRs are much higher than at my sampling site, probably due its slope location that was prone to slumping. Further sampling and foraminifera analysis could extend the biostratigraphy to 28 mbsf.

Advisor: Kristen St. John (JMU)

2:30

Crust and Mantle Structure Beneath Samoa

Jillian Browning

We used teleseismic receiver functions to map the seismic structure under the Samoan Islands in the southern Pacific Ocean. We acquired seismograms for the permanent seismic station, AFI, and for five temporary stations located across the island chain from the Samoan Lithospheric Integrated Seismic Experiment (SLISE). We used multiple-taper correlation and Markov chain Monte Carlo algorithms to calculate receiver functions for events with epicentral distance of 30° to 95° and examined the results in a frequency range of 1.0 – 5.0 Hz for crustal structure and 0.1 – 2.0 Hz for mantle structure. We identify complex crustal layering, including the interface between volcanic rocks and the ocean crust and a substantial underplated layer beneath the normal ocean crust. We find that the crust thins with decreasing age across the Samoan Islands and correlates with previous observations from gravity data (Workman, 2005). We additionally identify a velocity increase in the range of 50-100 km depth, potentially the Hales discontinuity. Deeper in the mantle, we observe transition zone thickness of 245-250 km across the island chain, which is within the margin of error for globally observed transition zone thickness. When migrated with IASP, transition zone discontinuity depths do appear deeper beneath the youngest island, indicating slower velocities and/or deeper discontinuity depths relative to the older islands in the system. We will provide improved constraints on transition zone discontinuity depths from ScS reverberations for all stations, and will place the crust and mantle results into a multi-disciplinary context, with comparisons to geochemical and surface observations.

Advisor: Anna Courtier (JMU)

10:45

The Analysis of the Flow Dynamics and Formations in a Simulation of the Surface of Venus

Anastacia Martyn

Venus has been called Earth's twin due to similar size, mass, and composition, however, that is about as far as the similarities go. There is an incredibly intense atmosphere which coats Venus in a haze. This haze has shielded the planet and kept many details about the geologic processes from us. It was not until missions to Venus such as *Magellan* and *Venera 1-16* were we able to begin to piece together what could be happening beneath the harsh atmosphere of Venus. Extending upon prior research done by some past JMU Geology students, I have conducted an experiment to test the hypothesis that the thickness of Venus's lithosphere plays a large role in creating the flow dynamics and formations occurring on the surface of Venus. In this paper, I will explain the measures I took to create a simulation of the flow dynamics of the surface of Venus as well as an analysis of the results from the experiment. I chose a non-Newtonian fluid to represent the lithosphere and Powder Coat Paint to highlight the formations and flow dynamics throughout the simulation. The main compressional features I hoped to recreate through this simulation were tesserae which are complex highly deformed highlands thought to be among the oldest features on Venus. I will conduct an image comparison between the Nemesis Tessera and the simulation in order to determine the potential geologic cause for the features we see on its surface today. As a result, it appears that a thicker lithosphere is more likely to produce these features.

Advisor: Eric Pyle (JMU)

11:00

Ground Penetrating Radar Imaging of Fluvial Terraces at James Madison University Farm

Varqa Tavangar

Along the banks of the North River at the University Farm there are a series of fluvial terraces that form steps from the banks of the river upslope. This research project involves conducting subsurface imaging of the fluvial terraces using ground penetrating radar (GPR) at the University Farm. The main goal was to identify the spatial relationship of the water table and bedrock beneath the series of terraces. From geological maps, we see that this area is underlain by the Conococheague Formation. We used a GPR unit set at 200 Hz to get the deepest readings possible. We set up three transects, the first at the foot of the first terrace (river level), the second at the top of the first terrace and the third at the top of the final terrace. The images gathered from the GPR were processed using RADAN software and through a series of data processing steps we were able to identify reflective surfaces that could correlate to the location of the water table. At river level we see a surface 3-4.5 feet below the ground that we can correlate as the water table. As we move away from the river and up a terrace however, we lose this surface and by the time we reach the final terrace, the surface is no longer visible. Using a lower frequency GPR unit would give a deeper, clearer image of the subsurface as the unit used in this project was not sufficient.

Advisor: Anna Courtier (JMU)

2:10

A New Bedrock Geologic Map of the Rileyville Quadrangle in Page and Shenandoah Counties, Virginia

Cody Sheaffer and Christian Bruchman

A 1:24,000 scale geologic map of the Rileyville 7.5 minute quadrangle, northwestern Virginia, is being created with support from the EDMAP and STATEMAP programs of the US Geological Survey. The geologic map is digitized in ArcGIS 10 from data collected in the field using iGIS on iPad tablets. The Rileyville 7.5 minute quadrangle extends from the South Fork of the Shenandoah River in Page Valley, across the Massanutten Mountains and Fort Valley, to the North Fork of the Shenandoah River in Shenandoah Valley. Cambrian and Ordovician carbonates are concentrated in the southeastern region of the map around the South Fork of the Shenandoah River. To the west, Ordovician carbonates transition to Silurian clastic rocks associated with the Massanutten Mountain ridges. Devonian shales are found in Fort Valley in the center of the Massanutten syncline. Ordovician clastic rocks likely transition back to carbonates in the northwestern region of the quadrangle.

Page Valley, Fort Valley, and Shenandoah Valley are dominated by northeast-southwest trending structures. These structures include west-vergent folds, west-directed thrust faults, and associated joints and veins. East-directed back thrusts are locally apparent, as are occasional northwest-striking normal or strike-slip faults. In Page Valley, the South Fork of the Shenandoah River is often constrained by jointing or faulting as exhibited by the parallel nature of river meanders. The Shenandoah Valley displays similar structures in areas around the North Fork of the Shenandoah River.

The central part of the Rileyville quadrangle is dominated by the Massanutten synclinorium, where Silurian sandstones core ridges with 1000+ feet of relief over central Devonian shales. The Massanutten synclinorium is a first order syncline that reaches a width of more than 6 kilometers, and within it contains parasitic anticlines and synclines. The southernmost Massanutten Sandstone ridge is fault duplicated across the full extant of the Rileyville quadrangle, extending from the Hamburg quadrangle in the southwest, to the Bentonville quadrangle in the northeast. Deformation features throughout the Rileyville quadrangle are interpreted to have resulted from the northwest-directed collision of Gondwana with eastern Laurentia during the Alleghenian orogeny.

Advisor: Steve Whitmeyer (JMU)

1:55

Historical, Episodic, and Short-term Changes at Long Beach Island, New Jersey

Katie Pijanowski

In October 2012, Long Beach Island, NJ saw dramatic changes due to Hurricane Sandy. Episodic events such as Hurricane Sandy can cause large changes to the shoreline in very little time compared to the changes created by the typical wave conditions. Sometimes barrier islands are able to recover naturally after large erosional events like this through accretion, which typically takes place during the summer months. At Long Beach Island however, human response, such as rebuilding the dune system to provide immediate protection from a subsequent Nor'easter and localized dredging, was the main cause of recovery.

For this research project historical shorelines were digitized off of orthophotography from the New Jersey Geographic Information Network and imagery from Google Earth collected by NASA. Historical shorelines from New Jersey Department of Environmental Protection were also included in the shoreline change analysis. Both long-term erosion rates and short-term changes during Hurricane Sandy were calculated using the USGS Digital Shoreline Analysis System extension for ArcGIS. The average long-term erosion rate was 1.35 m/yr over the past 176 years; whereas the average amount of shoreline lost during Hurricane Sandy was 10 meters and the largest amount of shoreline lost was 166 meters. The shoreline change observed during Hurricane Sandy is equal to ~7 years of erosion at the long-term rate.

In addition to the historical data, four locations were chosen to measure beach profiles during the summer of 2013. The data from these stations did not follow the historical trend and show there is much short-term, spatial variability along the island. The two locations from the center of the island were fairly stable, whereas the northern end eroded and the southern end accreted. The accretion was likely caused by nearby dredging. This data also shows that three of the four profile locations indicate the island had recovered to the pre-storm conditions.

The morphology of the coast is the result of many processes-natural/ anthropogenic, short/long-term. All of these processes need to be considered when studying these complex systems and determining the appropriate monitoring frequency.

Advisor: Shelley Whitmeyer (JMU)

11:15

Bluff Point — An Examination of a Fetch-limited Barrier Island System in the Chesapeake Bay

Olivia McClay

Bluff Point is a dynamic, spatially heterogeneous, undeveloped shoreline along the western shore of the Chesapeake Bay. This area comprises a mainland beach backed by forest and two types of fetch-limited barrier islands as described by Pilkey (2009)—classic and marsh-fringe. This area also provides a unique opportunity to study shoreline changes in a region that is experiencing accelerated rates of sea level rise. According to data from nearby NOAA tide stations, sea level near this site is rising at a rate of 3.5-5.0 mm/yr, whereas eustatic sea level rise is only 2 mm/yr over a similar time period (IPCC 2013). In this study, the shoreline was classified using historical aerial photos and erosion rates were calculated using the USGS Digital Shoreline Analysis System extension for ArcGIS. The data was employed to describe and analyze morphologic changes so the physical processes affecting each region could be better understood.

Between 2002-2009, erosion rates along the classic barrier averaged 3.1 m/yr, while along the marsh-fringe barrier, the erosion rate averaged 2.7 m/yr. The forested shoreline between these two islands had an average erosion rate of 4.0 m/yr between 2002-2013. The classic fetch-limited barrier and forested shoreline are eroding more quickly than the marsh fringe fetch-limited barrier. The marsh at the southern end of the island may be stabilizing the beach. Sea level rise can accelerate shoreline change on these types of islands. Although a comparison between local sea level rise and rate of change at other fetch-limited locations around the world showed a weak relationship, Bluff Point still exhibited the highest rate of change and highest rate of sea level rise. A better understanding of the morphologic changes at Bluff Point will help resource managers provide more effective planning for fetch-limited coastlines as these areas will likely experience more development pressure in the future, and provide a better understanding of changes likely to be seen in other areas as sea level rise accelerates over the next century.

Advisor: Shelley Whitmeyer (JMU)

11:30

Geologic Provenance of the Marker Stones Used in the Mason-Dixon Line Survey

Emily Chapin

The Portland Stone, used for marking the Mason-Dixon line, was studied in order to determine its location in the stratigraphic column, composition, and the historical background associated to the Mason-Dixon survey. Currently, there is no record as to where on the Isle of Portland the stone was quarried. With a sample provided by the Surveyors Historical Society, research was conducted in conjunction with the Mason-Dixon Preservation Society. The stone, deposited on a carbonate ramp in the Jurassic period, is an oosparite limestone that is moderately sorted and compacted. By use of the Pelcon point counter, an analysis of the sample was executed, finding that the sample is mostly composed of oolites, often in grapestones, with mollusks (bivalves), echinoderms, and bryozoans in a cement of sparry calcite. *Drawing the Line* by Edwin Danson provided a historical context to the research, giving necessary background about Mason and Dixon, as well as the methods Mason and Dixon used to perform the survey. I believe that out of the five layers of the Portland stone, the line markers were quarried from a two to three meter section on the North East side of the island, resembling the stone quarried today from Jordan's Mine. Because of the importance these stones have had creating a boundary line between families and ideals, the State Museum of Pennsylvania houses one of these monumental stones, with hope to revamp the display the stone is currently in. These stones help to connect American colonial history to southern England through the use of Earth materials.

Advisor: Eric Pyle (JMU)

1:35

Surface and Subterranean Mapping Documents a Regionally Significant Alleghanian Thrust System in the Millboro Quadrangle, Bath County, Virginia

Katie McConahy and Tim Kropp

Previously unmapped, regionally significant, westward verging thrust faults cross-cut a "breadloaf"-shaped, doubly-plunging anticline along State Highway 42 in Bath County, VA about 6 miles south of Millboro Springs. A localized thrust that dips shallowly to the southeast, where it reaches the surface, placed chert-free quartzose limestones of the Little Cove Limestone Member of the upper Licking Creek Limestone over the stratigraphically younger Needmore Shale. Investigation of the structural and stratigraphic relations in nearby Porter's Cave shows that the cherty lower Licking Creek is present in normal sequence, indicating that the subhorizontal fault exposed along State Highway 42 cuts down section southeast of the road. We interpret the fault as a -at-to-ramp thrust that dips progressively more steeply from west to east. Constraints on the lateral extent of the fault are limited, but we hypothesize that the fault projects southeast under the Rough Mountain syncline, which is cored by clastics of the Devonian Brallier Formation.

One mile northeast of Porter's Cave, an extensive roadcut bisects the anticline and exposes shallowly-dipping thrust splays that place the Keyser Limestone including the Clifton Forge Sandstone Member of the Keyser Formation and the Healing Springs Sandstone over the stratigraphically younger Licking Creek Limestone. The Tonoloway Limestone, which underlies the Keyser in this area, is truncated along a minor fault, as it is locally present and then disappears abruptly. The Clifton Forge Sandstone Member and underlying limestones of the Byers Island Member of the Keyser, also in the hanging wall of the lower thrust, appear to wedge out to the west. Deformation including large-scale folds and micro-folds in the Clifton Forge Sandstone is associated with faulting. Oriented thin sections of the upper Licking Creek and other units reveal multiply fractured quartz grains, with fractures parallel to the direction of principal stress during faulting.

Though a fairly localized, kilometers-scale structure, this fault bend anticline provides an example of thin-skinned deformation features that predominate in the southeastern Appalachian region. As with similar features in the region, deformation is interpreted to derive from the northwest-directed collision of Gondwana with eastern Laurentia during the Alleghanian orogeny.

Advisors: John Haynes and Steve Whitmeyer (JMU)

11:45

Connemara Marble: A Piece of Ireland

Alison Paylor

The story of the Connemara Marble, indigenous to Ireland, provides a unique aspect on Ireland's geologic and anthropologic history. Not only has it been used architecturally but its intricate folds and striking green color make it desirable commercially in many forms like jewelry and household items. The geologic and cultural history of the Connemara Marble has not previously been documented in a publically accessible format. The Streamstown quarry, where the marble in this film originates from, has been owned and operated by the Joyce family since the 1920's. Having never been filmed before, this documentary attempts to compact a story that started 600 million years ago into a short 10 minutes. Planning for this project began in August of 2013 following a class trip to the quarry. Production on location took place over spring break of 2014, with one other day spent in Harrisburg, Pennsylvania at the State Capitol building. This documentary was filmed using a Canon 60D camera and edited in Final Cut Pro 10. After successful completion of this project, there are plans to extend the documentary into a slightly longer, commercially available piece. Connemara Marble been utilized extensively as an educational tool, especially for JMU students, but perhaps more importantly represents a very significant intersection of Ireland's rich archaeological history and complex geologic past.

Advisor: Eric Pyle (JMU)

12:00

Developing Fundamental Skills for Broadcast Meteorology: An Internship at WHSV

Marisa Hess

I secured an internship with WHSV-TV3, the local news station in Harrisonburg, for the Spring 2014 semester. I pursued an internship with WHSV because I have the goal of becoming a broadcast meteorologist. With that goal in mind, I was eager to expand my skill sets and obtain experience in the field. Specifically, I wanted to acquire knowledge to become fluent in analyzing weather models and forecasting. Furthermore, I had an interest in learning how to organize the gathered information to accurately convey the weather to a public audience. My duties started out as watching and learning from the weather staff as much as possible. I asked frequent questions throughout the day as they recorded cut-ins, sent weather feeds to their radio partners, and broadcast live. I built weather graphics for on air use, recorded daily climate data, and was taught how to interpret weather models to achieve an accurate forecast. I also attended and presented the forecast at the morning and afternoon editorial meetings. Through my observations I gained fundamental knowledge into how things are done around the station and how important it is to be efficient with your time. Lastly, I practiced how to deliver a forecast on the Chromakey wall and built a demo tape by the end of the internship. This helped me enhance my skill sets because I gained confidence and I had the opportunity to connect and communicate with the public. My duties directly related to my goal because I obtained firsthand experience in taking the knowledge gained in a classroom and applying it towards real life experiences. My advice to others who seek a similar experience would be to not only apply the knowledge and skills but to also identify the connections to the people that use them.

Advisor: Eric Pyle (JMU)

12:15

Structural Controls on the Method of Eocene Magmatic Intrusion in Blue Grass Valley, Highland County, Virginia

James Shada and Brandon Cohick

A concentrated episode of volcanic activity (47-49 Ma) occurred in Virginia and West Virginia during the Eocene epoch, producing the youngest igneous rocks along the tectonically passive Eastern North American Margin. The Eocene magmatism is perplexing because 1) the last significant tectonic activity in this region was the rifting of Pangea, which occurred ~200 Ma and produced the ~190-200 Ma Central Atlantic Magmatic Province and 2) the mechanisms that permitted the magma to ascend through the lithosphere and erupt are poorly understood. We conducted a case study of igneous intrusions located in the Blue Grass Valley, Highland County, Virginia, to test the hypothesis that the Eocene magmas exploited preexisting Alleghenian structures to ascend to the surface. Two study sites were created at adjacent hills in the field area, Site 1 and Site 2 respectively, with Site 2 ~NW of Site 1. Igneous intrusions were mapped using GPS units to mark the location of outcrops in the field area. Orientation measurements of the country rock – middle-Ordovician carbonates associated with the Beekmantown formation – were obtained and mapped to interpret the local-scale structural features found at each site. Phenocryst assemblages and textural features of the igneous rocks and contact zones were documented. Two compositionally distinct igneous rocks are present at Site 1: a massive amygdaloidal basalt containing phenocrysts of pyroxene and olivine, and a fine-grained trachyte containing phenocrysts of feldspar, biotite, and hornblende, while the felsic dike alone was found at Site 2. Contact zones found at Site 1 between the felsic dike and the country rock is brecciated and the chilled margin in the dike is glassy. These two pieces of evidence indicate rapid, explosive emplacement of the dike. The felsic dike at Site 1 strikes ~017, and is consistent with the NE-SW orientation of other Eocene dikes in the region. However at Site 2 we see a slight change in strike of the felsic dike, now trending ~050, but still consistent with our NE-SW orientation. The dip measurements of the carbonate bedding are highly variable, but are generally steeply dipping to sub-vertical. At Site 2 we can see a well-exposed anticline-syncline system in the bedrock, where weakness from tight folding allowed for the creation of channels for the dike to ascend. In addition, dip measurements as well as offset of a nearby stream show evidence for a possible fault running through the north end of Site 1 NW to SE. All indications confirm the fault post-dating structural deformation seen throughout the field area, but pre-dating the igneous intrusions. Strike measurements to the entrance of caves found in the field area show correlation to other caves in Highland County. The presence of these caves is yet another structural example displaying a weak, deformation prone, subsurface. In conclusion, these caves along with our dikes being located on the hinge of folds, supports the hypothesis of small-scale structures providing the shallow crustal conduits for the Eocene magmatic event.

Advisors: Elizabeth Johnson and Steve Whitmeyer (JMU)