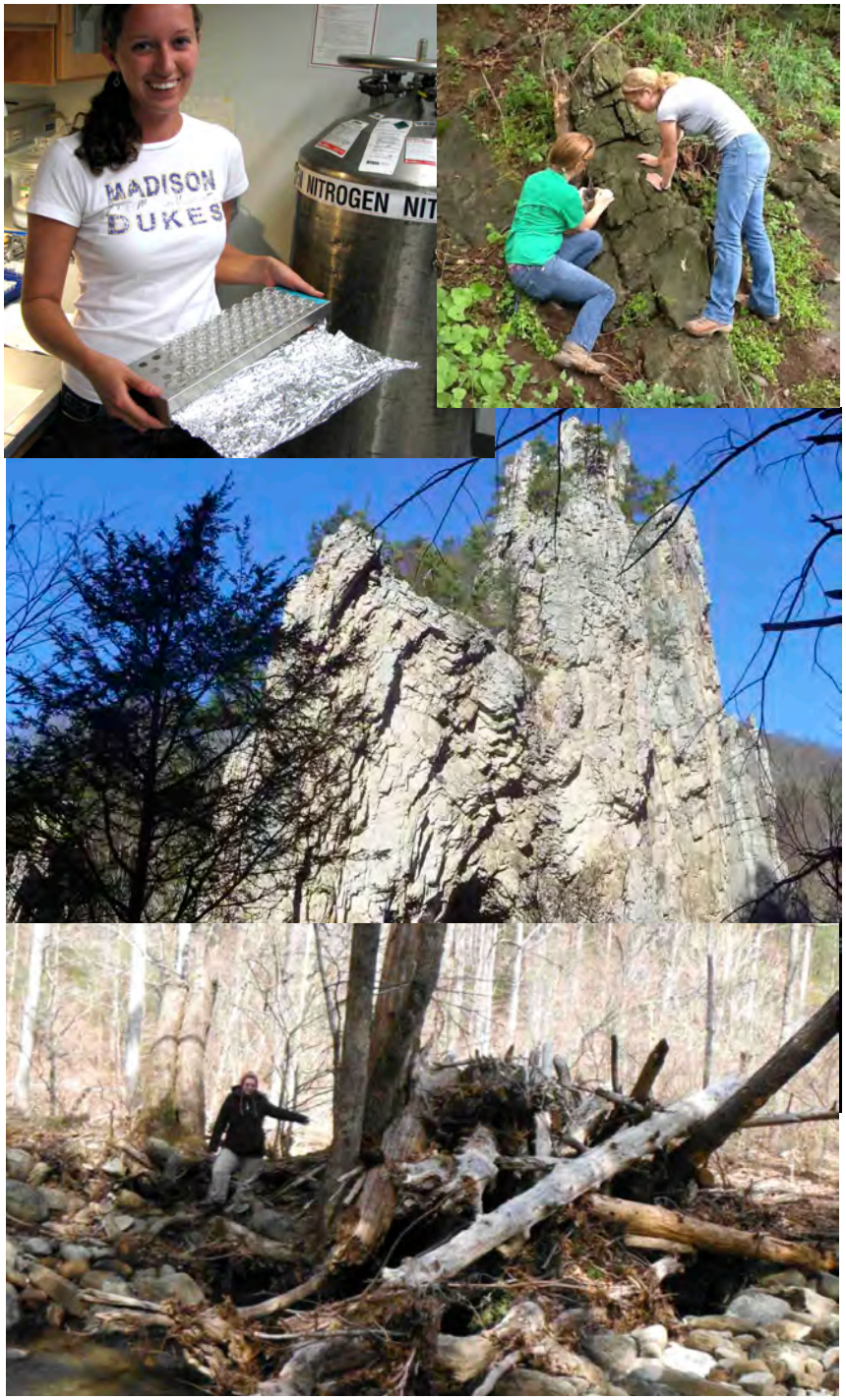

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Department of Geology
and Environmental Science

Student Research Symposium

April 26, 2013
Memorial Hall Room 7370

Abstracts with Program

The Department of Geology and Environmental Science
2013 Student Research Symposium

April 26, 2012 Memorial Hall Room 7370

Morning Session

10:05 Welcome and Introduction

10:10 Derek Guzman *advisor: Dr. Johnson*

10:25 Alex Kopylov & Robert Klopfer
advisors: Drs. Kearns & Courtier

10:45 Michael Tran *advisors: Dr. Eaton*

11:00 Adriane Lam *advisors: Drs. St. John & Leslie*

11:15 Meredith Butler & Ryan Santry
advisor: Dr. Steven Whitmeyer

11:35 Daniela DiCarlo *advisor: Dr. Ulanski*

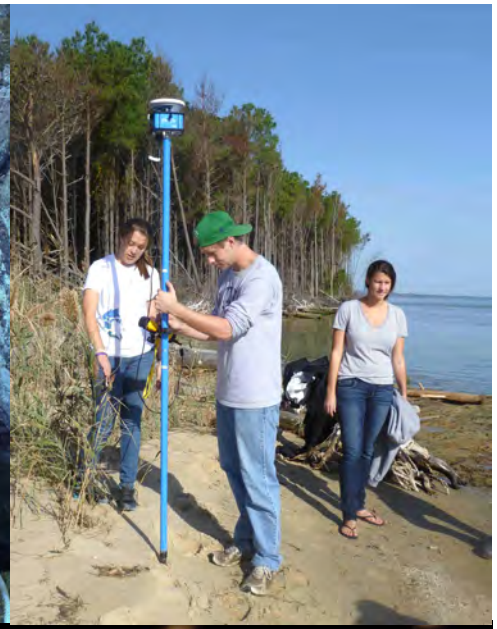
11:50 Gina Waclawski *advisor: Dr. St. John*

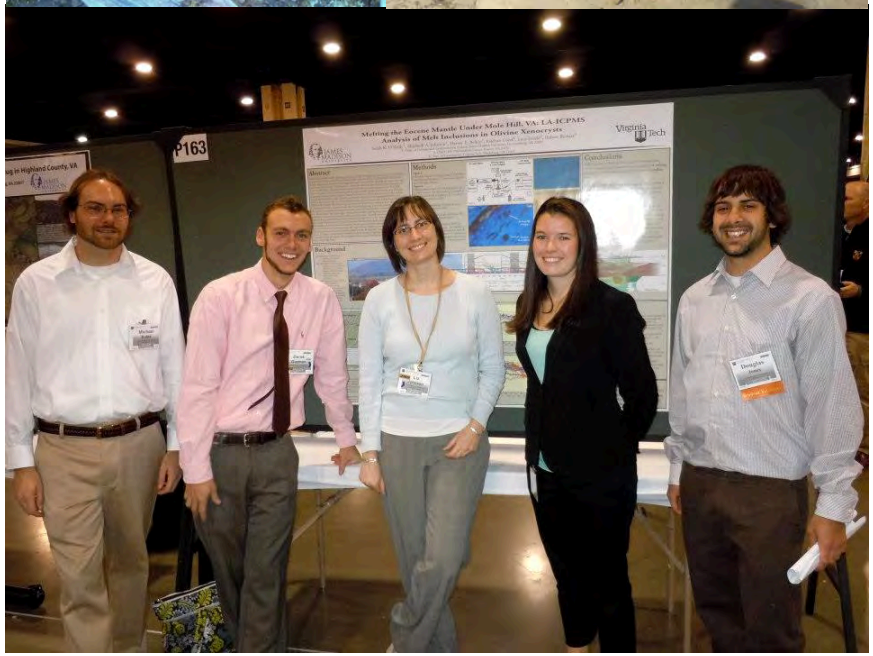
12:05 William Funke *advisor: Dr. Eaton*

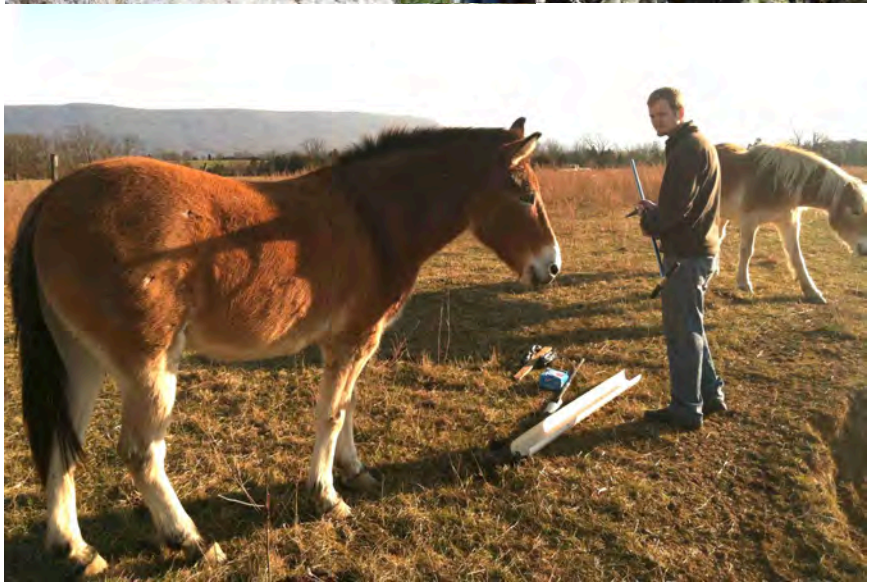
12:20 Stephen Stone & Billy Cheung
advisor: Dr. Eaton

12:40 Doug Jones *advisor: Dr. Johnson*

12:55 Lunch Break







The Department of Geology and Environmental Science
2013 Student Research Symposium

April 26, 2013 Memorial Hall Room 7370

Afternoon Session

1:30	Introduction	
1:35	T. Lane Stokes	*advisors: Drs. St. John & Kearns*
1:50	Jessica Antos & Johnathan Garber	*advisors: Drs. Eaton & Baedke*
2:10	Josh McKeon	*advisor: Dr. St. John*
2:25	Corey Bosselman & Megan McKinley	*advisor: Dr. Shelley Whitmeyer*
2:45	Amanda Wright	*advisor: Dr. Johnson*
3:00	Devon Dilla	*advisor: Dr. Steven Whitmeyer*
3:15	Chris MacPherson	*advisors: Drs. Eaton & Sherwood*
3:30	Megan Moss	*advisors: Drs. Haynes & Baedke*
3:45	Aimee Schuppin & Laura Hendrix	*advisor: Dr. Eaton*
4:05	Michael Bulas	*advisor: Dr. Johnson*
4:20	Sarah O'Reilly	*advisor: Dr. Johnson*

10:10

Evidence for a Two Stage Eruption at Trimble Knob, an Eocene Volcanic Plug in Highland County, VA

Derek Guzman

Trimble Knob is a hill formed by a basaltic Eocene neck located in Highland County, VA. It is one of a plethora of Eocene igneous bodies in the Valley and Ridge Province erupted between 48-35 Ma (Southworth 1993). The neck is 30 m in diameter and is located near the hinge of a SW-trending syncline along the contact between the Devonian Millboro Shale to the east and the Devonian Ridgeley Sandstone to the west. In this study, detailed field observations of the contact zone of the igneous body as well as petrographic observations are used to test two hypotheses: 1) Trimble Knob formed during a single eruption; 2) multiple eruptions occurred at Trimble Knob.

At the peak and on the western side of the exposed neck, poor- to moderately-developed columnar jointing is present. The basalt contains clinopyroxene and olivine phenocrysts in a fine-grained groundmass. The columnar basalt transitions to massive basalt along the southeast edge of the hilltop. A debris flow scarp has exposed the bedrock on the eastern slope of Trimble Knob. A transition zone of basalt with a hackly texture extends about 12 m down the eastern side of the neck and includes sparse angular black shale xenoliths several cm across. In thin sections, autolithic basalt fragments are cemented with carbonate minerals. Below the transition zone, a diatreme breccia containing rounded to subrounded xenoliths of shale, tan sandstone, and gray limestone is observed. In thin section, carbonate cement, clinopyroxene and olivine phenocrysts, and autobrecciated basalt clasts are observed. Based on field observations and petrographic characteristics, the diatreme xenoliths are identified as the Milboro Shale, the Ridgely Sandstone, and limestone from the Helderberg Group. The diatreme breccia was created by an explosive eruption that ripped out clasts of the country rock in a chaotic fashion. We propose that there was a single, two-stage eruption at Trimble Knob. An initial explosive eruption produced the diatreme, followed by a less violent flow of magma through the center of the plug.

4:20

Melting the Eocene Mantle Under Mole Hill, VA: LA-ICPMS Analysis of Melt Inclusions in Olivine Xenocrysts

Sarah O'Reilly

Mole Hill is a 48 Ma basaltic plug located just west of Harrisonburg, VA, and is part of a suite of alkaline Eocene volcanics within the Valley and Ridge Province of VA and WV. The Mole Hill basalt includes mantle clinopyroxenite xenoliths and disaggregated xenocrysts of olivine, Al-augite, and spinel that originated from ~40 km depth (Sacco 2011). In this study, we analyze the major and trace element compositions of melt inclusions within the cores of olivine xenocrysts in order to evaluate the magma source at Mole Hill. This data is important for understanding mantle compositional heterogeneities and the cause of Eocene magmatism along the passive margin of Eastern North America. Olivine phenocrysts and their melt inclusions were analyzed for major element concentrations using the JEOL Superprobe 8900R at the USGS in Reston, VA. Melt inclusion and olivine trace element compositions were measured using LA-ICPMS at the Virginia Tech Fluids Research Laboratory. Potassium concentrations from electron microprobe data were used to subtract contributions from the olivine host to the melt inclusion data. Olivine melt inclusions chosen for analyses were rounded, contained volatile bubbles, and were 4-20 μm in diameter. Pearce element ratio plots suggest some melt inclusions experienced minor post-entrapment crystallization of plagioclase or perhaps clinopyroxene. Trace element concentrations of melt inclusions are similar to whole rock data for Mole Hill except for lower Sr and higher P concentrations within the melt inclusions. The Sr anomaly may be attributed to fractional crystallization of plagioclase or clinopyroxene although lack of a corresponding Eu anomaly suggests that plagioclase is less likely. Melt inclusion and whole-rock geochemistry from Mole Hill are most consistent with geochemical characteristics of ocean island basalts and alkaline intraplate magmas. Since the trace element compositions of the whole rock and melt inclusions are similar, both must have originated from melting of a similar mantle source, and only minor fractionation or contamination of the Mole Hill basalt could have occurred. The olivine xenocrysts and their melt inclusions originated from ~40km depth (Sacco 2011) and preliminary calculations indicate the basalt originated from 60-70km such that the mantle composition of the Shenandoah Valley is the same at these two depths. The geochemical data supports an eclogitized root below Grenville basement at 45-60 km depth (Wagner 2012).

4:05

Timing and Eruption Mechanism of Felsic Eocene Dikes in the Valley and Ridge Province of VA and WV

Michael Bulas

In this study, we constrain the age and eruption characteristics of felsic magmas that are part of the alkaline igneous suite known as the Shenandoah Igneous Province (SIP) located in Highland County and Rockingham County, VA, and Pendleton County, WV. Paleomagnetic data and K-Ar and Ar-Ar age dates on limited samples indicate the SIP volcanics are Eocene in age (48-35 Ma) and represent the youngest known igneous activity in the Eastern United States (Southworth 1993). Although many of the igneous bodies are basalts or picrobasalts with SiO_2 <50wt%, there are a number of trachytes and trachydacites with SiO_2>63wt% containing phenocrysts of biotite, amphibole, and feldspars. The felsic magmas could have formed from assimilation and fractional crystallization (AFC) processes within the lithosphere. SIP dikes follow pre-existing structures, which may have slowed magma ascent through some fractures, allowing AFC to occur. We investigated the ascent time of magma in three felsic dikes from Highland County, VA, by observing the presence or absence of amphibole dehydration reaction rims under the polarizing microscope. Most amphibole phenocrysts had no observable reaction rims; a few amphiboles had reaction rims with maximum thickness of 2.054-3.828 mm. Assuming a magmatic temperature of ~900℃, these results suggest a total ascent time of <8 days for the felsic magmas (Rutherford and Hill 1993). With such short ascent times, differentiation must occur on a small scale within each dike system, rather than within a large magma chamber.

Mineral separates of biotite and amphibole for the three dikes were prepared for Ar-Ar age dating at the USGS in Reston using a Frantz Isodynamic separator and heavy liquids. Samples were irradiated at the USGS in Denver. Ar isotope analyses were completed using the VG1200 and MAP216 mass spectrometers at the USGS in Reston. One of the samples, a dike from the Hightown Quarry, has a previously determined Ar-Ar age date on biotite of 47.7±0.6 Ma (Southworth 1993). The Ar-Ar ages determined in this study will help constrain the duration and timing of SIP magmatism and the timing of felsic magmatism versus mafic magmatism.

10:25

"Helicon Focus" and the New Mineral Museum Website

Alex Kopylov & Robert Klopfer

The purpose of this work was to develop a new, updated website for the James Madison University mineral museum. In order to do so, many new specimens were carefully selected based upon their crystallography, unique traits, and inert characteristics. Specimens were selected from various collections of micro mounts (<1cm) along with minerals on display in the mineral museum. A great majority of the minerals selected were donated by private parties or individuals.

In order to prepare each specimen for photography it was first observed for a preferred angle and orientation. Background colors and lighting conditions were also strongly taken into consideration. The Cannon EOS Rebel XSI Camera paired with a EFS 60mm lens and the Helicon Focus 5.2 software package were used for the majority of the photographs. A Canon f/2.8 USM Macro lens was used to photograph the larger museum specimens. Once a properly lit and focused image was obtained it was edited in Adobe Photoshop.

The advantage of using this particular Cannon camera and the Helicon Focus 5.2 software was that the photo obtained in the end result is focused and clear, even at great magnification. This unique technology allowed us to take multiple photographs of each mineral all at different focal lengths. The Helicon Focus 5.2 software was then able to overlay the sequence of pictures to generate a single picture of superior quality. Once all of the pictures were edited and cropped using Adobe Photoshop they were properly documented and prepared for being uploaded to the new website.

After taking faculty refresher courses for proficiency in Web Developer 2 and familiarity with Cascades web development software, it was decided that it would be more practical to use a third party web development program called Sites. The features of this third party program allowed us to make the website more visually appealing and user friendly than possible with Cascades software.

10:45

Temperature Profile of Tide Springs Rockingham, VA

Michael Tran

Springs are commonly thought to have a consistent behavior, akin to Old Faithful in Yellowstone Nation Park. This assumption brings up problems when classification is concerned. Using the temperature profile data provided by Virginia Department of Environmental Quality's Groundwater Characterization Program, this study examined anomalies and cycles for potential correlations between flow temperatures and their durations. The data was gathered over the course of a year using a simple temperature probe that was placed in a secured area to negate the effects of wind and animals. The method looked for sudden shifts in temperature data, and identifying the event as either flow activity or ambient air temperature. Using these identified values, the data suggests that the amount of time it takes for the spring to recharge lessens as the year progresses into fall and winter. This could be due to ice, and the sharp contrast between the air temperatures and the groundwater temperature. Despite the obvious, Tide Springs does not seem to correlate its frequency of flow events with the amount of precipitation on a monthly scale. However, the variation in flow duration is significantly longer during the spring season along with the influx of precipitation. For example, the month of May, 2011 had a minimum of eight minutes and a maximum of 64 minutes. This variation in duration could be attributed to a pooling effect that resulted in erroneous measurements. The temperatures of flow increase in variance during the fall to winter months—shortly after the beginning of the water year in October. Both patterns of flow temperature and flow duration that was studied show a sinusoidal pattern with the seasons. Though a pattern can be discerned for flow temperature, with the introduction of a yearly sample, it can be seen that on a monthly scale, there is no clear path for the data to flow. In this case, the mean duration of flow in September, 2010 averaged 11 minutes; while in September 2011 flow temperatures averaged three minutes. These trends suggest that each year presents a different level of interactions with the groundwater and karst systems. Overall, the average flow temperature followed a well-defined path. Each month had at most a 2˚C difference in the 1st and 3rd quartile range of data—indicating that the groundwater temperature for this time frame is consistent. The data would suggest that Tide Springs shows a multitude of habits on flow duration, with a maximum variance in the spring season of 13˚C in the 1st and 3rd quartile range.

3:45

Flood and Erosional Hazards on Recreational Campgrounds Due to Large Woody Debris Buildup

Aimee Schuppin & Laura Hendrix

The objective of this study is to determine the dominant processes contributing to flooding hazards at North Creek campground along North Creek in the Jefferson National Forest near Arcadia, Virginia. A secondary objective is to create a map that documents potential hazards to the campground. These hazards include large woody debris piles, sediment aggradation of the stream channel, and flashy accumulation of water in the creek. The woody debris piles are formed from the natural felling of trees and have recently accumulated due to increased mortality rates of the Eastern Hemlocks from woolly adelgid infestation. The downed trees create temporary dams, plug up campground culverts, and erode the banks of the stream. In extreme conditions, water floods the campsites due to the campground being built on a floodplain. In addition to this, the impact of these hazards can also trigger rapid stream avulsion and redirect more of the flow onto the campsites. To determine the impact of hazards in the creek, GPS data was collected and imported into ArcGIS to create a hazard map. This map shows the locations of large woody debris as well as flow channel paths. The locations of these geologic hazards need to be considered when looking into the safety of the campground. We propose this method of geologic fieldwork should be used along with a standard hundred-year flood calculation to determine flood hazards. Understanding the impact of these flooding hazards is crucial in determining the safety of the campground.

3:30

Geothermal Evidence for the Source of Heat of Thermal Spring Waters in Caves of Bath and Alleghany Counties, Virginia

Meghan Moss

The thermal spring waters of Bath and Alleghany Counties have been monitored since the 1930's (*F Reeve 1932 Thermal springs of Virginia).* Current research is focused on determining the heat source of these thermal waters, using bulk geochemistry, and isotopic analyses of helium. This research is a continuation, and in recent years similar research and data collection for helium isotopes was performed by James Madison University undergraduates Nick Silvis and Katie Jepson in 2008-2010. The present research involved obtaining samples from three caves in which thermal waters are present: Dunn's cave in Bath County and Mud Pot and Warm River cave in Alleghany County. The sites for the sampling where chosen by their proximity to the first known location that the spring entered an air filled passage. To collect necessary data the field methods of samplingbulk geochemistry, which is temperature, pH, alkalinity, and water samples to run the various cations and anions, as well as the isotope analyses of helium, had to be modified to work in a cave environment, including Mud Pot where the stream temperature was 37.5° C and the air temperature was in the upper 80's with a high percent humidity.

Several obstacles were encountered when collecting the aqueous chemistry of the cave waters. Obstacles from being in a cave environment included: 1) bulky equipment taken through tight crawls, vertical repeals, cable ladders, and swimming water passages 2) poor air quality 3) accessible sites 4)caving technical work 5)humidity 6)accessibility to electricity 7)durability of gear 7) corrosion. To deal with the poor air quality the James Madison University geology department ordered gas alert detectors to monitor Hydrogen sulfide, Sulfer dioxide, and carbon monoxide. Other gear suggested to use in future work in caves: 1) Swago cave packs 2) Caving Helmets 3) Department rope.

The preliminary data shows temperatures ranging from 15.8° C from Dunn's to 37.5 degrees Celsius in Mudpot. One of the important measurements, the concentration of Ca^{2+} , also has a wide range from 170pmm at Mudpot compared to Warm River at 0.26pmm and Dunn's at 0.14pmm which are significantly lower. Helium isotope samples from Dunn's and a sample from The Homestead were analyzed by Lawrence Berkeley National Laboratory. The Homestead was analysis shows a strong mantle influence, however the Dunn's sample was lost due to cutting during the cold welding process.

The results from this research are consistent with the research that has been previously completed.

11:00

Planktonic Foraminiferal Biostratigraphy and Paleoclimatic Interpretations of Holocene-Late Pleistocene Core MD02-2535, Tunica Mound, Gulf of Mexico

Adriane Lam

Planktic foraminifera biostratigraphic zones were assigned to Calypso Core MD02- 2535 based on species frequency patterns leading to an age model and sedimentation rates for Tunica Mound, Gulf of Mexico. The upper 0.94 m of core belong to the Z zone, correlating with the beginning of the Holocene at 10 ky as indicated by elevated abundances of warm water forms. From the bottom of the Z zone to 4.85 mbsf is the Y zone, with the oldest constrained age of 42 ky occurring at the bottom of the Y_3 subzone. We suspect the bottom of core section VII does not exceed the Y_6 subzone at 68 ky because the first ash layer correlating with MIS 4 was not detected. Sedimentation rates in the core were found to be highest in the Z_2 subzone associated with glacial melt runoff. Rates are lowest in the Z_1 subzone owing to rising sea level and avulsion processes within the Mississippi River delta. Planktic foraminifera mass accumulation rates were found to have the largest increase at the onset of the Holocene. Stable $\delta^{18}O$ and $\delta^{13}C$ analyses of the thermocline species *N. dutertrei* and the mixed layer species *G. ruber* (pink) were used to test the hypothesis that local gas hydrates may compromise the utility of stable isotopes for paleoenvironmental interpretations. Isotopic data were well within "normal" ranges compared to planktic foraminifera oxygen and carbon isotope data from other Gulf of Mexico sites suggesting that local gas hydrates have not compromised the utility of stable isotopes. Three intervals of very low productivity were identified as interpreted from low $\delta^{13}C$ values and elevated abundances of *Globigerinoides* spp. All three intervals display elevated abundances of *G. sacculifer* and negative $\delta^{18}O$ values, a possible indicator of enhanced glacial melt runoff leading to low salinity values within the ocean's mixed layer. At 14.2 ky it was found that $\delta^{13}C$ values are heavier than expected for the thermocline species *N. dutertrei* compared to the mixed layer species *G. ruber* (pink). The heavier $\delta^{13}C$ signal of the thermocline species *N. dutertrei* could suggest shoaling of the thermocline and higher productivity during winter months since the Last Glacial Maximum.

11:15

Bedrock Geology of the Rileyville Quadrangle in Page and Shenandoah Counties, Virginia

Meredith Butler & Ryan Santry

A new 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. This map focuses on the southern half of the Rileyville quadrangle, which includes portions of Page Valley, Fort Valley, and the Massanutten Mountains. The new map is digitized in ArcGIS from data collected in the field using ArcPad on Xplore tablet PCs.

Current mapping is focused on the southern portion of the Rileyville 7.5 minute quadrangle, ranging from the South Fork of the Shenandoah River to the Massanutten synclinorium. Lithologies include Cambrian carbonates through Devonian clastic rocks. 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 between the peaks in the cores of the synclines.

Both Page Valley and Fort Valley are dominated by northeast-southwest trending structures associated with the Alleghanian orogeny. These structures included mostly west vergent folds, west-directed thrust faults, and associated joints and veins. 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. Another significant structural feature is the Massanutten synclinorium. Duplication of a Massanutten Sandstone ridge is seen in the Luray 7.5 minute quadrangle to the south, which appears to project to the northeast into the Rileyville quadrangle. Further work to the north will be necessary in order to complete the geologic map of the Rileyville quadrangle.

3:15

An Investigation of a Possible Loess Soil Capping: Shenandoah County, VA

Chris MacPherson

Loess covers approximately 10% of the earth's land surfaces. Extensive thick loess deposits can be found in northern China, the Great Plains of North America, central Europe, and parts of Russia. In North America the thickest loess deposits are concentrated near the Missouri River. Smaller deposits have been reported from northern Virginia and the Virginia coastal plain. Loess can be separated into two categories: desert loess and glacial loess. Most North America loess has glacial origins. The youngest and largest loess deposit in North America is called the Peoria loess deposit which formed at America's last glacial maximum 30 to 12.9 Ka as a result of Wisconsinan Glaciation. North America loess is characterized as aeolian silt that is predominantly quartz with small amounts of feldspar. At the time of formation loess is washed out from the ice sheet where winds across the outwash enable drying of the surface. Light silt size particles (quartz/feldspar) are put in suspension winds, caused by the convection of surface heat, in addition strong winds from the glacier put sand particles in saltation. At deposition, the material would be well sorted with quartz silt particles and with traces of sands that are frosted and rounded from saltation and abrasion. This process produces characteristics that were focused on in this study. The purpose of this research is to investigate a soil capping in Shenandoah County, VA that was identified by Louis Heidel a soil scientist for NRCS. The site Louis Heidel identified is located on Route 707 1.2 miles south from its intersection with Route 614. A total of 28 soil samples (designated A through J) were collected in and around the area of interest at depths of 6, 12, and 18 inches using a hand auger. In lab, I performed a specific gravity test, hydrometer test, sieve analysis test, classified the soil color, classified the soil texture, x-ray diffraction test, and looked at micro surface structures of fine sands under a binocular microscope. Samples A, D, I, and J showed interesting results in all the tests. The Hue values for these samples were 10 yr and the texture is classified as a loam. The gradation curve from the specific gravity, sieve analysis, and hydrometer test confirms the soil is primarily a highly uniform silt. From this data grain size distribution curves were constructed that show a well sorted silt dominated deposit. X-ray diffraction analysis was performed on the silt fraction sample J and the data confirms that the silt is predominantly quartz with very minute traces of plagioclase feldspar. Microscopic observations show that the fine sands and coarse silts are rounded to well-rounded and the smaller silt grains are subangular to angular. All the results for samples A, D, I, and J, collectively indicate that these sites have silt rich cappings of possible aeolian origins, that may be loess. It is important to investigate these deposits in the Appalachian area because they are datable deposits that could be used to improve our understanding of Appalachian climate and surface processes.

3:00

Structural Duplication of the Tuscarora Sandstone in West Virginia
Devon Dilla

The Tuscarora Formation in Pendleton County, West Virginia, is particularly well exposed over a seventeen kilometer stretch from Nelson rocks to Seneca rocks. The formation, which strikes 030 and dips vertically, represents the western limb of the Wills Mtn. anticline. An initial bird's eye view of the region shows a ridge-line which is apparently doubled in some locations and thinned to a single ridge in others. Six roads, which cut perpendicularly through the ridge, provide a view of the vertical Tuscarora as it varies from gap to gap. Evidence from these road sections suggests that the ridge remains doubled in sections that were initially thought to be thinned to one fin. The continuous doubling of the ridge along the entire section indicates a NE-striking fault which thrust the western Tuscarora ridge and a few visible sections of the Juniata Formation eastward. As you progress northeast along the ridge-line from Nelson rocks, the east and west fins of the ridge progressively thicken and thin, respectively. Previous analyses of this section by W. J. Perry (1971) suggested that faulting occurred after folding, but may have begun as folding began to cease. Our data and analyses support the theory that folding took place prior to the faulting that thickened and doubled the section.

11:35

A Comparison of Two Tornado Seasons: An Assessment of the Relevant Meteorological Forcing Agents
Daniela DiCarlo

The main goal of my research was to compare tornado frequency for two years: 2008 and 2011. Statistical analysis (t-test) showed that there was a significant difference in the number of tornadoes that occurred in each year, with 2011 the highest. In order to determine why one year proved to be more active than the other, I analyzed a number of factors: vertical wind shear, capping inversions, and the position and strength of the jet stream. The latter agent proved to be the most important particularly when discrete tornado outbreaks--multiple tornadoes occurring in a short time--were isolated from the main body of data.

11:50

Terrigenous and Biogenic Input to the Gulf of Mexico During Late Pleistocene to Holocene Climate Transition, as Interpreted from Sediment Core MD02-2535

Gina Waclawski

Sediment compositional analyses were completed for the upper 7 sections (10.5-0 mbsf) of Calypso Core MD02-2535, Tunica Mound, Gulf of Mexico to determine sediment source input in response to climate change throughout the late Pleistocene into the Holocene. Analysis included: (1) petrographic observations of smear slides, (2) binocular microscope observations of the 106 to >150 µm fraction, (3) X-ray defraction (XRD) of the >63µm fraction and, (4) oriented XRD analysis of the <2 µm fraction.

From the bottom of core section VII to section IV, the nanofossil, clay, quartz and calcite percent compositions fluctuate. Nannofossil abundance ranges from 10-65%, clay abundance ranges from 20-40%, quartz abundance ranges from 10-30% and calcite ranges from 5-30%. Composition fluctuates in these intervals likely due to changes in terrestrial sediment supply and biogenic productivity during the stadials and interstadials of marine isotope stage 3 (MIS 3; 60 to 25 ky). However, due to poor age control for the interval older than 42 ky, exact causes and events cannot be determined. In sections IV to II, from about 34 ky to 19ky, the relative abundances of nanofossils, clay, quartz and calcite remain relatively unchanging. In section II, at 18 ky, the percent of nanofossils decrease by approximately 50%, and the clay, quartz and calcite relative abundances increase. This compositional change occurs between the end of the Last Glacial Maximum (LGM) and the beginning of the Bølling/Allerød (B/A) interstadial period. Increased percentages of clay and coarser minerals indicate an increase in terrigenous sediment supply to the Mississippi River and ultimately to the Gulf of Mexico during deglaciation. Decreased percentages of nanofossils may indicate lower productivity due to temporary decrease in SST and salinity, or may simply reflect a dilution of the biogenic fraction by the increased input of weathering products from land. Above this interval, in sections II and I, the percent of the nanofossils, clay, quartz and calcite return to similar percentages as existed from 34 ky to 19 ky, and remain relatively unchanging from this interval into and throughout the Holocene.

Investigation of 106 to >150 µm sand-sized fraction revealed intervals below 42 ky dominated by mud clasts relative to the microfossil assemblage which directly correlates with the clay percentage determined from smear slide analysis. Intervals which show an increase in mud clasts correlate with times of cooler climate as inferred from color reflectance data. River scouring during regressions may have caused more terrigenous input and redeposition of mud (the mud clasts) from inner shelf regions to further off-shore depositional sites in the Gulf of Mexico.

XRD of >63 µm sand fraction revealed that calcite dominates in the Holocene, whereas quartz dominated during the Pleistocene. This is consistent with smear slide and binocular microscope observations. Clay XRD analysis of >2 µm was done to determine clay composition, and document changes in the relative abundances of the clays. In the 5 clay samples analyzed, smectite, illite and kaolinite are present. Illite and kaolinite have higher abundances in the Pleistocene. The amount of smectite fluctuates throughout the core, with the highest amount being at 18ky. The results suggest that the source of terrigenous sediment supplied to the Gulf of Mexico may have changed from the LGM to the Holocene. During the Pleistocene the primary source of terrigenous sediment was ice margin drainage to the north Mississippi River and Ohio-Tennessee region. Whereas times of high smectite input may reflect shifts in sediment supply from more northwest sources, including the Missouri river drainage basin.

2:45

Petrologic Investigation of Lower Crustal Xenoliths in Highland County

Amanda Wright

In 2001, a highly weathered dike was found in Five Springs Cave, located in Bullpasture Mountain, Highland County, VA. Xenoliths sampled from this dike were determined to be metamorphic rock based on preliminary thin section investigations. This study focused on identification of the minerals present in the xenoliths so that future geochemical work can be done to determine the depth, temperature, and age of the lower crust in this area. We used the Nikon Eclipse 50l polarizing trinocular petrographic microscope and LEO 1430VP-SEM240 at James Madison University and the 8900R electron microprobe analyzer at the USGS in Reston to identify the minerals present in the xenoliths. The minerals found were garnet, rutile, zircon, apatite, perthitic alkali feldspar, quartz, monazite, ilmenite, orthopyroxene, amphibole, chlorite, calcite, and an aluminum silicate. Unusual textures found in thin section were quartz inclusions surrounded by radially fractured garnet and exsolved rutile needles within garnet. The first discovery of ultrahigh temperature (UHT) metamorphism on the East Coast of the US was recently found in the Brimfield Schist in the Merrimack Synclinorium of Connecticut. The textures and mineralogy of the Highland County xenoliths are consistent with an UHT origin. Further work on this project will include identification of the aluminum silicate as kyanite or sillimanite using Raman spectroscopy, radiometric age dating on the zircons, and determination of pressure and temperature using geochemical techniques.

2:25

Geomorphic Change at Bluff Point

Corey Bosselman & Megan McKinley

Bluff Point, located on the western shore of the Chesapeake Bay, is a dynamic system which is constantly changing due to several factors, including sea-level rise, daily range of tides, and wave characteristics. Rates of sea-level rise at Bluff Point as reported by NOAA (~4.39 mm/year) are significantly higher than the average global rate since from 1961 to 2003 (1.8 mm/year) reported by the IPCC. Our study attempts to describe the effect of sea-level rise on erosion rates in this area. To do this we compare the erosion rates that we calculated based on field data, LIDAR data and historical orthophotos, to those published for other areas with similar hydraulic and geologic conditions. Our data shows that the average rate of erosion since 2002 at Bluff Point was 3.39 meters/year. This rate is higher than the other rates of erosion reported for other areas along the East Coast. This suggests that areas with a high rate of sea-level rise will have significantly greater erosion rates.

12:05

Effects of Urban Development on Stormwater Runoff

William Funke

This research examines relationships between increases in peak discharge flows of a second order stream due to changes in land use over time. Several homeowners in a single-family development near Port Republic Road in Harrisonburg, Virginia, are experiencing flooding of basements and properties due to a significant increase in surface runoff during moderate-to-severe rainfall events for the past several years. This increase in runoff can be attributed to changes in land use upstream of the development in question. Flooding is limited to areas along the natural and modified path of water flow through the basin; and the peak discharge during storms periodically overwhelms existing drainage and mitigation facilities. Resources such as Google Earth, ArcGIS, and the Rational Equation were used to quantify the volume of runoff, and identify potential choke points or general inefficiencies in the existing system. The effects of future headwater development also were considered to determine how these issues affect peak flow and potential scour. Field inspection showed that the discharge pipes, which act as the choke points during high flows, are restricted by concentrations of woody and rocky debris, as well as sharp turns in subterranean concrete pipes. These factors, along with a calculated 279 ft^3/s of water moving through the system create a situation where water flows freely at first, but over time slowly pools and backs up towards the properties in question. Compared to an undeveloped peak flow of 183 ft^3/s the basin is experiencing a 53% increase in water volume; and with further development could reach upwards of 398 ft^3/s or a 118% increase from the initial conditions. It is clear that changes must be made in order to mitigate these existing problems, as future development will only serve to increase the volume of water the system must be able to handle, thereby causing additional flooding

12:20

Estimation of Colluvial Filling of Debris-Flow Sourcing Areas of the Blue Ridge and Valley and Ridge Provinces in the Central Appalachians, Virginia

Stephen Stone & Billy Cheung

Page County, located in the central Appalachians of northwestern Virginia, is flanked to the west by the Massanutten Mountains and by the Blue Ridge Mountains to the east. Debris flows and other mass movements triggered by high intensity rainfall are common in the steep mountainous terrain of Virginia. In 1995, a catastrophic storm struck neighboring Madison County generating over 775 mm of rain in 16 hours in the Blue Ridge Mountains; triggering over 1000 slope failures, and scouring stream channels and debris fans. The potential for debris flow activity in Page County is likely due to the similarity of the geology, steep mountainous terrain, and the abundance of colluvium stored in debris flow initiation areas.

This project uses a quantitative procedure for calculating debris flow volumes by estimating the amount of colluvium residing in active drainage channels. Over 30 discrete drainages within Page County were examined, and approximately 200 colluvial wedges were determined to have the potential for transport as debris flow material during high magnitude rainfall events. Most of the colluvial wedges are situated within the active fluvial system of zero-to-second order tributaries. The wedges are dominantly poorly sorted, grain-to-matrix supported, and consist of sub-angular-to-angular shaped clasts. The volume of each wedge was approximated by field measurements of the dimensions of length, width, and a minimum thickness based on the estimated depth to bedrock. Median and maximum particle size of each deposit, and the slope of the wedge surface, were documented for calculations of bedload transport analyses. The extent and location of significant colluvial loading in these drainages provides knowledge to geoscientists that investigate the magnitude and frequency of past debris flow events and helps establish the percentage of drainages in this region that have the potential to yield debris flows in the future. This data also provides information to land planners and emergency responders of the potential of debris flow hazards that may occur in this region of the Appalachians in the future. Further study will include analysis of the geologic controls characterizing hazardous drainages in Page County.

2:10

Investigation of Orbital Forcing on Climate Variability at Shatsky Rise

Josh McKeon

Shatsky Rise, a submarine plateau off the coast of Japan, exhibits a dynamic history of marine deposition during the early Pleistocene. Shatsky Rise is characterized by cyclic climate change based on variations in the type and amount of the terrigneous and biogenic sediment deposited. These changes in sediment character are controlled by climate (e.g., weathering, winds) and productivity, which ultimately are driven by orbital cyclicity. The samples used in this study are from Ocean Drilling Program (ODP) expedition198, site 1208, core 8. Our objective was to investigate the orbital forcing on climate variability and deposition at Shatsky Rise. Given the lithology and color reflectance data already published, we focused our analysis on new X-ray fluorescence (XRF) data of the cut-core surface. The XRF analysis provides information on the elemental composition of the sediments, which is influenced by what was deposited and what happened after deposition (e.g., diagenesis). XRF measurement were taken for 14 elements ~20mm intervals between 62 and 70 mbsf. By first plotting the element abundances and color reflectance, the pattern of light and dark intervals were confirmed. To do this, cumulative length was converted depth below seafloor. The depths were converted further to age using the published sedimentation rate for Shatsky rise. In addition to the XRD data analysis, 16 bulk sediment samples were taken at ~8 cm intervals and smear slides were made and examined to confirm major compositional variation and investigate minor variation, particularly biosiliceous input.

The results indicated that light-colored sediment intervals (calcareous oozes) generally contain higher abundances of Ti, Si, Al, Fe, and P. In our preliminary analyses of the XRF data, we focused on the Ti/Al ratio, which was used as a grain size proxy to determine aeolian input and paleowind interpretation. Other terrigenous interpretations came from the Si/Al ratio, which we interpret to be a biogenic silica proxy. Si/Al was increasing in abundance when biological productivity increased, perhaps due to greater supply of limiting nutrients to the surface waters. Our interpretation of these patterns is that they represent a cyclic alternation of glacial and interglacial times. Light intervals were shown to be highly productive biologically with strong wind influences during glacial climate. Dark intervals were interpreted as interglacial times with lower biogenic productivity and Fe and Si transported by winds. We interpret these cycles to be Marine Isotope Stages (MIS) 51 through 58. A cycle periodicity of ~42k years indicates obliquity orbital forcing influenced terrigenous and biogenic sedimentation.

1:50

Temporal and Spatial Changes in Stream Channel Morphology of Smith Creek, Shenandoah Valley, Virginia

Jessica Antos & Johnathan Garber

The purpose of this study was to validate that erosion and deposition from storms dictate the overall hydraulic geometry of both the cross section and the longitudinal profile of a stream. These results were derived from data of bank erosion, longitudinal profile changes through segments of the watershed, and through analyses of temporal changes of the sediment budget during a one year period. Data of bank pin scour, sediment sampling stations, and core sampling units suggest that stream bank erosional rates correlate with bank density and storm events. The bank pin scour data revealed a maximum erosion of 40 cm, minimum erosion of 1 cm, and average erosion between 3-9 cm in less than one year; most of the research sites demonstrated that erosion is a more prevalent factor in stream morphology changes. Deposition had a lesser effect, with the maximum deposition being 36 cm, minimum deposition of 0 cm, and an average deposition from 4-8 cm. Agricultural variables likely accelerate the depositional and erosional tendencies of the stream banks. This can be seen specifically where cattle have been fenced out of the stream; and comparing it to the bank profiles before they were fenced out 6 years ago. Because of the high agricultural influence, Smith Creek has provided an ideal study location for these erosional parameters to be assessed.

12:40

Depth and Temperature of the Eocene Lithospheric Mantle Beneath Highland County, VA

Doug Jones

An abundance of Eocene alkaline igneous dikes, sills, and plugs are exposed in the Shenandoah Valley and Allegheny Front in VA and WV. These igneous bodies provide important petrologic and geochemical constraints on the depth and composition of the lithosphere and asthenosphere under Eastern North America. In this study, we determine the depth and temperature of the lithospheric mantle under Highland County, VA, using mantle xenocryst compositions from a small Eocene picrobasalt located along Rt. 631, northeast of Monterey, VA. The plug contains xenocrysts of clinopyroxene and olivine up to ~1cm in diameter within a groundmass of devitrified glass containing microphenocrysts of plagioclase, olivine, and clinopyroxene. The JEOL Superprobe 8900R electron microprobe at the USGS in Reston, VA, was used to quantify clinopyroxene compositions at 15 kV and 20 nA with WDS, and to identify unknown mineral phases using EDS analyses. Olivine xenocrysts contain Cr-rich spinel, consistent with a mantle origin for these minerals. Clinopyroxene xenocrysts contain silicate melt inclusions, as well as inclusions containing calcite, dolomite, and sulfides. Clinopyroxene and clinopyroxene-melt geothermobarometric equations summarized in Putirka (2008) were used to calculate P and T from compositional data. The whole-rock composition was used to represent the melt composition in equilibrium with crystal cores. The clinopyroxene cores have an average composition of $Wo_{47}En_{45}Fs_{9}$ (n=82). The average T calculated for clinopyroxene cores is 1371±38℃, and the average P = 17.5±3 kbar (corresponding to ~53 km). Two clinopyroxene-only barometers (Eqns. 32a and 32b of Putirka 2008) produce P = 14.1±1.8 kbar (~42 km). The T and P recorded by the Highland County clinopyroxene xenocryst cores are significantly higher than those calculated for clinopyroxene xenocrysts cores from the Mole Hill basalt located 55 km to the northeast (T = 1250±19℃ and P = 10±2 kbar; Sacco 2011). The P are the same within error if the clinopyroxene-only barometers are used (13±1 kbar for Mole Hill vs. 14.1±1.8 kbar for Highland County). These results suggest an increase in melting temperature towards the southwest and a possible increase in melting depth and/or a southwesterly thickening of the lithosphere across the Valley and Ridge of VA.

1:35

Relative Mineral Abundances Over a Short, High Resolution Time Interval for Eocene Central Arctic Ocean Clay in a Time of Climatic Transition

T. Lane Stokes

New mineral evidence was obtained and explored to learn about the paleoceanography and paleoclimatology of the Arctic during the Eocene cooling of Hot House Earth. The clay fraction from sediment core samples from drill site 2A of the Arctic Coring Expedition (ACEX) 302 was analyzed with X-Ray Diffraction (XRD). Forty-five samples were collected on the <2 µm sediment size fraction over high resolution time interval in 45.96-46.32 ma (236.07-244.74 rmcd). Data on each sample for XRD peak areas was collected for two versions, one treated with glycol and one plain air (untreated). Results show that there was more smectite and less illite transported to the central Arctic during this Eocene climate transition, than during the Miocene. Decrease in smectite would be expected due to the cooling climate weathering conditions. Smectite can only have abundant formation in warm climates with low precipitation. Illite, chlorite, and kaolinite are a more common component of the clay in times of glaciation when the minerals are formed while they are being glacially eroded. The minerals are derived from weathering of different terrestrial provinces around the Arctic. The increasing illite could be coming from north Greenland by wind, or Alaska and the Bering land bridge by ocean transport assisted by sea ice. The Eocene clays, strongly dominated by smecite, likely have their fluvial source from somewhere on the stretch of land from the Khatanga river on the East side to the Enisei River.

The Eocene mineral data were compared to data on abundance of ice rafted debris (IRD), which represents glacial input. Smectite lows and 5*(3.6 Å glycol peak area)-(7.2 Å glycol peak area) highs correlated with IRD highs (and vice versa). This correlation in the clays also seems to show a 40,000 year cyclicity, which is interpreted as obliquity climatic forcing, and for our immediate purpose is just more evidence that the terrestrial deposition in the central Arctic is driven by climate.