*Thirty-Ninth Annual*

# GEOSCIENCE DAY

## PROGRAM AND ABSTRACTS

INDIANA UNIVERSITY OF PENNSYLVANIA
GEOSCIENCE DEPARTMENT

May 3, 2013
Room 134 Weyandt Hall

*Thirty-Ninth Annual*

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# GEOSCIENCE DAY SCHEDULE

7:50 **Opening Remarks - Dr. Steven A. Hovan**

## Session I – Paleontology and Astronomy

8:00 **John C. Kearney**
REFINEMENT OF SPECIES WITHIN THE LOWER ORDOVICIAN TRILOBITE GENUS *BELLEFONTIA*

8:15 **Joy J. Kiefer**
SPECIES DIVERSITY OF THE EARLY ORDOVICIAN TRILOBITE GENUS *PARAPLETHOPELTIS* IN THE MANITOU FORMATION OF COLORADO

8:30 **James A. Harley**
DEFINING THE TIME INTERVAL FOR THE FORMATION OF PEDESTAL CRATERS ON MARS

8:45 **Nicole D. Mountain**
INVESTIGATING THE SEASONS: A NEW MODEL IN SCIENCE TEACHING

9:00 – 9:15 **Refreshment Break- Poster Session**

## Session II – Sedimentology and Structure

9:15 **Kellie R. Kerner**
SEDIMENTARY ANALYSIS OF THE BLACK RIVER BAY

9:30 **Erin M. McGowan**
GIS ANALYSIS OF BATHYMETRIC DATA AND ACCUMULATION RATES IN YELLOW CREEK LAKE

9:45 **Matthew L. Toland**
3D INTERPRETATION OF MASS TRANSPORT DEPOSITS ON THE EAST SCOTIAN SLOPE, CANADA

10:00 **Daniel J. O'Hara**
SLIP PARTITIONING OFFSHORE SOUTHEAST TAIWAN AND SOUTHWARD PROPAGATION OF THE LONGITUDINAL VALLEY FAULT: EVIDENCE FROM FOCAL MECHANISM STRAIN INVERSIONS

10:15 – 10:30 **Refreshment Break - Poster Session**

## Session III – Energy and the Environment

10:30 **Aaron M. Blair**
STREAM REMEDIATION AS AN ESSENTIAL COMPONENT TO HEALTHY WATERSHEDS

10:45 **Adam T. Quinn**
CORRELATING LEVELS OF SALT AND METAL CONTAMINATION IN BEAVER RUN RESERVOIR TO HYDRAULIC FRACTURING OF NEARBY MARCELLUS DRILL SITE LOCATIONS

11:00 **Zachary A. Carr**
TOTAL DISSOLVED SOLIDS IN TWOLICK CREEK WATERSHED

11:15 **Aaron R. Brownley**
UNCONVENTIONAL RESOURCES IN THE APPALACHIAN BASIN: COMPARING THE UTICA AND MARCELLUS SHALES

11:30 **Anthony N. Vaiana**
ESTIMATING THE AMOUNT OF TOTAL ORGANIC CARBON IN DEVONIAN SHALES OF THE APPALACHIAN BASIN USING WIRELINE LOGS: A CASE STUDY FROM EASTERN KENTUCKY

11:45 – 1:00 **Lunch Break (on your own)**

1:00 – 2:00 **Guest Presentation: Alumni Lecture**
**Scott D. McCallum**
REGIONAL SEQUENCE STRATIGRAPHIC INTERPRETATION OF THE MARCELLUS SHALE

**5:00 – 8:00 Geoscience Banquet**

## REFINEMENT OF SPECIES WITHIN THE LOWER ORDOVICIAN TRILOBITE GENUS *BELLEFONTIA*

KEARNEY, John C.

Thirty years ago, the Lower Ordovician *Bellefontia* trilobite Zone was divided into three subzones in Oklahoma. The lowest occurrence of *B. collieana* was used to define the base of the middle subzone, while the appearance of *B. chamberlaini* marked the base of the uppermost subzone. Despite their importance, neither of these species has been adequately illustrated or quantitatively characterized since they were named early in the 20th century. In the present study, we examined large collections from several horizons in the Stonehenge Formation near Bellefonte, Pennsylvania, where *B. collieana* was first described, to better characterize that species and to determine whether *B. chamberlaini* occurs above it in the uppermost beds of the formation. The collections used to subdivide the *Bellefontia* Zone in Oklahoma were borrowed for comparison with the material from Pennsylvania. Specimens from Oklahoma assigned to *B. collieana* do closely resemble the type material from Pennsylvania, and many specimens from near the top of the Stonehenge display key characteristics of the material identified as *B. chamberlaini* in Oklahoma, suggesting that the formation extends upward into the highest subzone. However, others differ sufficiently to suggest that they may represent additional, new species yet to be described.

## SPECIES DIVERSITY OF THE EARLY ORDOVICIAN TRILOBITE GENUS *PARAPLETHOPELTIS* IN THE MANITOU FORMATION OF COLORADO

KIEFER, Joy J.

Expanded collections of the trilobite genus *Paraplethopeltis* from the Manitou Formation at Missouri Gulch in Colorado were quantitatively compared to Hintze's "Fauna C" in Utah, to determine how many distinct species of this genus can be distinguished near the base of the Lower Ordovician Stairsian Stage, which records the first mass extinction in the Ordovician Period. Only two specimens of *Paraplethopeltis* from the Manitou had been illustrated previously. Our collections from the thin (less than 2m) *Paraplethopeltis* Zone in Colorado, compare closely with *P. generecta* Hintze. However, this species was based on material from at least two different species (J.M. Adrain, personal communication). On close examination of the material gathered from the base of the *Paraplethopeltis* Zone, I separated the material into two distinctive morphs of both cranidia and pygidia, suggesting that two species exist within this zone. However, the current number of specimens recovered from the Manitou is too small to rigorously test this hypothesis. We can determine that neither morph ranges upward into the basal bed of the *Leiostegium* Zone at Missouri Gulch; *Paraplethopeltis* is represented at that level by *P. genacurva* or a closely related species.

## DEFINING THE TIME INTERVAL FOR THE FORMATION OF PEDESTAL CRATERS ON MARS

HARLEY, James A.

Pedestal craters are a subclass of impact crater whose ejecta patterns are topographically elevated tens to hundreds of meters above the surrounding terrain. Among the terrestrial planets, pedestal craters are unique to Mars and can be used to establish specific time constraints on its geologic history. Pedestal craters are associated with surface volatiles, so constraining the time of their formation to a particular period will allow more accurate determination when and in what form surface water might have been present. We generated topographic profiles for representative pedestal craters to establish a classification system that we used to correlate the pedestals with the surrounding terrain. Our goal is to identify a single time interval of deposition and subsequent deflation during which all pedestal craters were formed on Mars.

## INVESTIGATING THE SEASONS: A NEW MODEL IN SCIENCE TEACHING

MOUNTAIN, Nicole D.

There are several misconceptions commonly encountered among middle and high school students when asked to explain the underlying concepts of the seasons. Many college age students, and even IUP professors, still harbor misconceptions of the mechanics of the seasons. Two distinct hands-on teaching methods were developed to give students a more concrete foundation in understanding the seasons.

The first method used a dark line drawn on a light source to observe the spread of the shadows; while the second method used a light to illuminate a grid, both perpendicular and angled to it. The student groups tested were 45 high school students participating in the Upward Bound Math and Science Program, a local Girl Scout troop and 6 IUP students and staff. Tests taken before and after instruction were statistically analyzed using a t-test to determine which was the most effective in increasing understanding. The results show that both methods were highly effective in teaching the concepts behind the seasons, and correcting the misconceptions, however neither method was significantly better than the other.

## SEDIMENTARY ANALYSIS OF THE BLACK RIVER BAY

KERNER, Kellie R.

The Great Lakes formed during the most recent glacial maximum of the Holocene. Black River Bay, located in the north western Black River Watershed was on the outskirts of this last ice age retreat. Sediment transport history and sub-bottom data were analyzed to determine the major factors that controlled the development of the geomorphology of Black River Bay. These chirp sub-bottom profiles and sediment cores were collected by a joint archeological and geological survey searching for historical shipwrecks from the War of 1812. Geologic applications of the data are sediment history, rate of accumulation and sediment transport patterns. The data indicate that Black River Bay was initially glacially carved with possible till deposits and defined sedimentary features during initial erosion. It is now a present day fluvial driven system fed by the Black River as it main tributary.

## GIS ANALYSIS OF BATHYMETRIC DATA AND ACCUMULATION RATES IN YELLOW CREEK LAKE

MCGOWAN, Erin M.

Lakes constructed by dams often show significant impacts on bathymetry and sedimentological history. In 1969, an earth and rock dam was erected for the development of Yellow Creek Lake in Indiana County, Pennsylvania. This research focused on comparing changes in lake floor elevation that may have occurred between the construction of the dam and present day. Maps made prior to dam construction were obtained from Yellow Creek State Park. Using GIS, the maps were digitized to extract contour points from lake body and shorelines. Post-dam construction bathymetry data was then acquired by Indiana University of Pennsylvania's geography department using GPS and digital elevation models (DEM). These DEM's allowed extraction of additional contour points to analyze differences of elevation change. Comparisons were attempted, but due to inaccuracy in the datum used in each map the overall data assessment and sediment accumulation could not be attained. Eventual determination of sediment accumulation due to the dam and the extent of historical changes detected will allow us to predict the future evolution of Yellow Creek Lake.

## 3D INTERPRETATION OF MASS TRANSPORT DEPOSITS ON THE EAST SCOTIAN SLOPE, CANADA

TOLAND, Matthew L.

Mass transport deposits (MTDs) are the sedimentary products of submarine mass wasting. MTDs can make up a volumetrically significant fraction of deep water strata along continental margins and provide evidence for the recurrence of slope failures. Geohazard assessments along the Scotian slope (offshore Nova Scotia) have documented evidence for numerous MTDs using bathymetry, shallow cores and 2D seismic images yet few of these studies have characterized MTDs in 3D. Here we present results from a mapping project aimed at identifying and delineating late Cenozoic MTDs in a 3D seismic survey from the Scotian Slope. The seismic expression of several MTDs is compared and related to the mode of failure and/or transport. The largest MTDs were mapped in detail to estimate volumes of failed material. The findings presented here shed new light on the importance of MTDs along the Scotian margin and highlight key recognition criteria for MTDs in 3D seismic images.

## SLIP PARTITIONING OFFSHORE SOUTHEAST TAIWAN AND SOUTHWARD PROPAGATION OF THE LONGITUDINAL VALLEY FAULT: EVIDENCE FROM FOCAL MECHANISM STRAIN INVERSIONS

O'HARA, Daniel J.

Taiwan is the product of subduction polarity reversal coupled with arc-continent collision. The Philippine Sea Plate (PSP) subducts under the Eurasian Plate (EAP) at the Ryuku Trench north of Taiwan, while the roles are reversed at the Manilla Trench south of Taiwan. Unlike the oceanic lithosphere of the EAP which was subducted at the Manilla Trench, the buoyant passive margin of the EAP is resisting subduction, causing collision with the Luzon forearc on the leading edge of the PSP. Collision began ~6 Ma at what is now the east-central part of Taiwan, and has been propagating southward, closing the forearc basin while expanding the near-linear suture zone, the Longitudinal Valley Fault. We used statistical strain inversions of earthquake focal mechanism solutions from the forearc basin to study the deformation caused by the oblique arc-continent collision. Slip vectors from preferred nodal planes were used to track regional deformation. Inversion results suggest a transition from partition motion between the EAP and PSP in the south to oblique collision north of ~22.5° N. We hypothesize that the closing forearc basin is acting kinematically as a forearc sliver, with a block-bounding fault occurring on the eastern side of the basin, near the Luzon arc, that is allowing the sliver to translate northward more slowly than the PSP. Furthermore, we hypothesize that this block-bounding fault is related to the Longitudinal Valley Fault by a left-stepping sinistral structure, which is causing a localized pull-apart basin to develop off shore, south of the already collided arc.

## STREAM REMEDIATION AS AN ESSENTIAL COMPONENT TO HEALTHY WATERSHEDS

BLAIR, Aaron M.

Maintaining healthy and natural watersheds sustainable under the influence of human interaction is fundamental in meeting water quality standards and reducing harmful sediment pollution. This concept is no different when remediating a single stream. The targeted stream site and floodplain of Barshinger Creek, within the Codorus Watershed, were monitored to identify which areas of the stream banks were experiencing the most sediment erosion and deposition. Stream banks were mapped via GPS to categorize each section according to the amount of sediment lost. After monitoring the targeted region, areas experiencing the highest levels of erosion were most significant in contributing to sediment pollution and deposition downstream. These observations led to a series of restoration techniques, unique to each section of the stream. Remediation and restoration of this section will discourage nutrient rich sediment from being deposited into larger fluvial environments and ultimately, the vulnerable Chesapeake Bay.

## CORRELATING LEVELS OF SALT AND METAL CONTAMINATION IN BEAVER RUN RESERVOIR TO HYDRAULIC FRACTURING OF NEARBY MARCELLUS DRILL SITE LOCATIONS

QUINN, Adam T.

During 2011 and 2012 multiple Marcellus drill sites were installed in the vicinity of Beaver Run Reservoir which is a major source of drinking water for people of Westmoreland County and also for some residences in neighboring Indiana and Armstrong Counties. Samples that have been previously collected and analyzed from Beaver Run Reservoir were plotted relative to each drill site to show chemical levels versus distance from the reservoir. Our hypothesis is that if contamination is occurring, then levels of salts and metals that are associated with hydraulic fracturing of the Marcellus Shale will be correlated to the distance and number of drill site locations in the proximity of the reservoir. This is significant because Beaver Run could provide information for future planning of drill sites because of the unique circumstance of having multiple drill pads near a reservoir. Furthermore, two sizes of "what if" scenarios will be developed to show if spill events occurred at a drill pad and what implications they could have on the reservoir depending on the size of spill, the bathymetry of the reservoir and the dilution of the contaminants. Finally, we will show how one could misinterpret the data when the water level of the reservoir is low due to drought periods as a false alarm for contamination from the Marcellus drill sites.

## TOTAL DISSOLVED SOLIDS IN TWOLICK CREEK WATERSHED

CARR, Zachary A.

Twolick Creek drains an area of 190 square miles in Indiana County and is part of the larger Blacklick Creek watershed. It is home to many pollution sources, and contains five streams that provide much of the fresh water used in the county of Indiana for drinking. Data collected from April 2011 to February 2013 show Total Dissolved Solids (TDS) variations related to precipitation in the area. Concentrations were recorded by dataloggers, and then used to create time-series of data. The data showed spikes in the TDS concentrations temporally and spatially. The question is whether the time-series show hysteresis pattern of TDS vs. water level or a more linear pattern. Establishing this relationship will help us to understand the watershed and when and where TDS fluctuations occur. Future research is needed to identify what the TDS is composed of, and if found to be volatile, the best action for remediation.

## UNCONVENTIONAL RESOURCES IN THE APPALACHIAN BASIN: COMPARING THE UTICA AND MARCELLUS SHALES

BROWNLEY, Aaron R.

Development of unconventional oil and gas resources is playing an increasingly significant role in meeting our energy needs. The Devonian Marcellus Shale has received much attention as a significant unconventional reservoir in the Appalachian Basin, but much less is known about the Ordovician Utica Shale. In this study I present a systematic comparison of the Utica and Marcellus Shales in terms of their geology, source rock characteristics, and producibility. By synthesizing information from academic, government and industry sources, we are able to highlight key similarities and differences, along with significant gaps in our understanding of the Utica relative to the Marcellus Shale. Our work supplements existing comparisons between shale reservoirs in different basins and should be of general interest to those seeking information on unconventional resources in the Appalachian Basin.

## ESTIMATING THE AMOUNT OF TOTAL ORGANIC CARBON IN DEVONIAN SHALES OF THE APPALACHIAN BASIN USING WIRELINE LOGS: A CASE STUDY FROM EASTERN KENTUCKY

VAIANA, Anthony N.

Quantifying the amount of total organic carbon (TOC) in shale is a key step in evaluating its potential as an unconventional reservoir. Generally TOC is measured from core samples in a lab, which can be time consuming and costly. Estimating TOC using standard wireline logs could improve efficiency in characterizing shale reservoirs. Recent work has indicated that a log-based TOC estimate used in conventional plays can be adapted for use in unconventional plays. We use this method to estimate the variation in TOC through Upper Devonian shale reservoirs of eastern Kentucky using logs from over 100 wells. Future work will focus on comparing and calibrating our estimates to samples from wells in the study area, with the goal of testing the accuracy of log-based TOC predictions for the Upper Devonian rocks in the Appalachian Basin.

## REGIONAL SEQUENCE STRATIGRAPHIC INTERPRETATION OF THE MARCELLUS SHALE

MCCALLUM, Scott D.

Scott D. McCallum, Christopher G. Willan, Ashley S. B. Douds, David R. Blood, and Travis B. Warner
EQT Production, Pittsburgh, PA 15222

The Middle Devonian Marcellus Shale was deposited in relatively shallow water in the Acadian foredeep of the Appalachian Basin and is a proven gas source and reservoir. Several regional correlative surfaces have been identified from standard triple combo well log data and interpreted within the Marcellus. Regional correlations, incorporated with core analysis, have led to the development of a sequence stratigraphic framework for the Marcellus.

The Marcellus rests disconformably on the Onondaga Limestone and contains a minimum of two third order sequences and several higher-order, sub-regional sequences. Accommodation space for the sequences is created by subsidence in the foreland basin. The base of each sequence is represented by black, laminated shale with large amounts of detrital shell material, which, in turn, is overlain by transgressive black, organic rich shale. The black shales grade upward, as well as in a proximal direction, into gray shale which is occasionally capped by a shallow water limestone. This sequence is repeated through the deposition of the Tully Limestone, after which Acadian clastics replace the carbonates.

Identification of the systems tracts and mapping their regional distribution has highlighted differences in the nature of the grey and black shales and allowed for the creation of a depositional model. The sequence stratigraphic framework, seismic data, wireline log data, core data, and petrophysical and geochemical analyses have been integrated to predict key parameters such as porosity, organic carbon content, and mineralogy and then incorporated into a general basin model to determine burial and thermal maturation history.

NOTES:

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