Thirty-Fifth Annual

GEOSCIENCE DAY

PROGRAM AND ABSTRACTS

GEOSCIENCE DEPARTMENT
INDIANA UNIVERSITY OF PENNSYLVANIA

April 24, 2009
Room 134 Weyandt Hall

GEOSCIENCE DAY SCHEDULE

8:15 am **Opening Remarks - Dr. Karen Cercone**

Session I - Geology

8:20 – 8:40 **Thomas R. Bondra**

BIOSTRATIGRAPHIC CORELLATION OF THE LAURENTIAN CARBONATE PLATFORM USING NEWLY DISCOVERED TRILOBITE SPECIES

8:40 – 9:00 **Aaron G. Bowser**

JOINTING IN THE MARCELLUS SHALE

Session II - Environmental Geoscience

9:00 – 9:20 **Joseph J. Ruffini**

A HYDROLOGIC COMPARISON OF LEACHATE OF COAL REFUSE MATERIAL WITH CFB COAL ASH

9:20 – 9:40 **Chadwick P. Paronish**

ESTABLISHING A RELATIONSHIP BETWEEN METAL CONCENTRATIONS, PH AND DISCHARGE IN AN ACID MINE DRAINAGE

9:40 – 10:00 **Benjamin J. Stufft**

THE EFFECTS OF THE CONEMAUGH DAM ON FLOOD PLAIN SEDIMENTATION RATES

10:00 – 10:20 **Refreshment Break**

Session III - Oceanography

10:20 – 10:40 **Ashley M. Hague**

EOLIAN DEPOSITION PATTERNS IN THE EEP: INSIGHT INTO PALEOWINDS AND PALEOLOCATION OF THE ITCZ

10:40 – 11:00 **Christina L. Ritter**

ODP EASTERN EQUATORIAL PACIFIC LEG 138: EOLIAN DUST RECORDS TRADE WIND INFLUENCE ON GLOBAL CLIMATE

11:00 – 12:00 **Guest Presentation:**
Dr. Kevin M. Jones, IUP 2003
Columbia University

NEODYMIUM ISOTOPES IN THE OCEAN AND THEIR USE AS A TRACER OF PAST OCEANIC CONDITIONS

12:00 Noon **No-Host Luncheon at Pizza Hut**

6:00 **Geoscience Banquet**
Rustic Lodge, Indiana, PA

7:00 **Dinner**

8:00 **Awards**

BIOSTRATIGRAPHIC CORELLATION OF THE LAURENTIAN CARBONATE PLATFORM USING NEWLY DISCOVERED TRILOBITE SPECIES

BONDRA, Thomas R.

A decade ago, an international committee of geologists agreed to define the end of the Cambrian Period, and start of the ensuing Ordovician Period, by the appearance of the conodont (tooth-like microfossil) *Iapetognathus fluctivagus*. The age-equivalent horizon was known to fall somewhere within the *Symphysurina* trilobite (marine arthropod) Zone in North America. Three newly discovered trilobite species in Utah and New Mexico more tightly constrain the position of the boundary. *Symphysurina* new species A appears just below the boundary and range upward to just above it. *S.* new species B appears just above the boundary in the lowest Ordovician (Loch & Taylor, in prep.) The formations that yielded these specimens represent offshore, limestone-forming paleo-environments. Collections from time-equivalent rock exposures in the Rocky Mountains of Wyoming were studied to test the utility of these species for correlation of the boundary interval in deposits that formed in more nearshore paleo-environments

JOINTING IN THE MARCELLUS SHALE

BOWSER, Aaron G.

Tapping into one of the largest potential new gas reservoirs in the Appalachian Basin involves horizontal drilling into the organic-rich Marcellus shale. The Marcellus shale displays well developed joint sets where it is exposed in the folded rocks of the Valley and Ridge Province of Pennsylvania. However, not much is known about the physical characteristics of these joints and how they are oriented in the mostly flat lying rocks in the subsurface of the Appalachian Plateau. If exposed joints in the Valley and Ridge can be shown to predate folding, it would suggest the same joints are present in the Appalachian Plateau where subsurface drilling is taking place.

Establishing the timing of joint propagation requires documenting the orientation of the joints with respect to the regional folds, and documenting their micro-structural characteristics. Thin sections were made to examine the so-called J_2 joint set in the Brallier formation, a silty unit immediately above the Marcellus. The well-developed joints in the Marcellus render the formation too broken to effectively study petrographically. In addition, geometric data on bedding, fold and J_2 joint orientations were collected and analyzed using stereographic projections to unfold the folds and determine joint orientations in undisturbed bedrock.

The results of the study show that the J_2 joint set does in fact predate folding based on cross-cutting relationships viewed in thin sections as well as preserved plumose structures on the face of the joints indicating a burial related propagation. Structural analysis shows the J_2 joints have a mean orientation of N38W, 89N in the unfolded rocks of the Appalachian Plateau. Data on the other joint sets in the Marcellus combined with this study should help guide future drilling plans in the Appalachian Plateau.

A HYDROLOGIC COMPARISON OF LEACHATE OF COAL REFUSE MATERIAL WITH CFB COAL ASH

RUFFINI, Joseph J.

Newly developed technology for processing low BTU waste coal (Circulating Fluidized Bed or CFB) has created a new waste product: CFB coal ash. Before this processing existed, the waste coal piles often created acid mine drainage (AMD) in places where they were left untreated. Now that CFB coal ash is being put back into the environment in place of the low BTU waste coal, it is possible that new and different environmental issues may replace the ones that were eliminated. In order to determine how much chemical reaction CFB coal may undergo in the environment, this project tested several samples with controlled variables." Samples of waste coal and the CFB coal ash produced after processing were taken from Cambria Fuel Management in Earnest, Pa. These samples were then committed to several separate variations of time and pH. The methodology was to subject these samples to acid baths of a 60/40 ratio of sulfuric acid to nitric acid, while varying pH by diluting the solutions with de-ionized water. Thorough mixing was accomplished with a mixing table set to simulate the percolating effect of water through these mediums. These experiments were designed to simulate varying hydrologic factors such as normal rain conditions, acid rain conditions, and subjection to AMD runoff, which are all very realistic situations in areas containing CFB coal ash. The determination of metal content leached from the water after interaction with the coal ash was measured by an ICP-OES. Acidity was measured by a digital pH reader. We expect to see a reduction in metal leachates and a dramatic increase of pH due to addition of limestone and ammonia during CFB processing.

ESTABLISHING A RELATIONSHIP BETWEEN METAL CONCENTRATIONS, PH AND DISCHARGE IN AN ACID MINE DRAINAGE

PARONISH, Chadwick P.

In recent years, the water quality of Neal Run and Aultman Run has been affected by acid mine drainage (AMD) generated by covered coal refuse piles and abandoned mines located in McIntyre, Pennsylvania. The focus of this study is on an Acid Mine Drainage seep originating east of McIntyre Road flows west under the road near the post office and discharges into Neal Run. The site is scheduled for remediation by the State of Pennsylvania pending suitable appropriations, however little is known about the local hydrology contributing to deteriorated water quality at this particular site. Specifically the relationship between stream discharge and water quality is poorly understood. For example, important for remediation design, it is unknown whether, during higher discharge, the total amount of metals discharged into Neal Run remains constant or changes significantly. To address this questions, water samples and flow measurements were taken weekly in January, February and March. By correlating measured stream flow and chemistry data and monthly temperature and precipitation records, the impact of snow melt and precipitation events on the discharge chemistry, particularly Fe, Mn and Al concentrations and pH can be established. Flow readings were taken from a weir that was emplaced in the seep and also taken using a flow meter on above and below the weir and in Neal Run. Water samples were analyzed using a pH-meter, and using the Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) to determine the metals concentrations. Metals concentrations and stream discharge were inversely correlated with lower concentrations associated with higher stream flow. However, the relationship between total metals discharge and stream discharge is more complicated. During late winter months before snowmelt and while the ground was still frozen, overall Fe, Mn, and Al discharge was 0.5 g/s Fe, 0.3 g/s Al, and 0.01 g/s Mn. During the initial thaw, snowmelt increased stream discharge with only a modest increase in metals discharge to 1.1 g/s Fe, 0.6 g/s Al and 0.03 g/s Mn. However, as temperatures warmed and the ground thawed, addition precipitation increased metals discharge to a much greater degree with 2.4 g/s Fe, 1.2 g/s Al, and 0.03 g/s Mn. We suggest that during late winter, frozen ground limits the interaction of snowmelt and rainfall with coal mine refuse and surrounding clays limiting the total amount of dissolved metals present in the seep. Once the ground thaws, and infiltration increases, the total metals discharge in the seep increases with increased discharge. The information obtained from this study will provide remediation companies with pH, metal concentrations, and stream flow data that will aid in the design of a future treatment system.

THE EFFECTS OF THE CONEMAUGH DAM ON FLOOD PLAIN SEDIMENTATION RATES

STUFFT, Benjamin J.

The construction of the Conemaugh Dam in 1952 introduced a new, human-induced mechanism for overbank accretion along the Conemaugh River in Blairsville, Pennsylvania. Prior to the construction of the dam a thin interval of alluvium several inches thick covered a cultural layer at the archeological Johnston Site containing artifacts of the Monongahela culture (AD 800-1400 +/- 40). A more recent 2008 excavation of the site revealed 1 to 2m of alluvium covered the same cultural layer excavated 56 years earlier. This accumulation is attributed to the construction of the Conemaugh Dam and the periodic flooding that occurred along the river over the past 50 + years. By analyzing several sediment cores taken from within the Johnston Site an attempt was made to determine sedimentation rates of the flood plain. Magnetic susceptibility along with fly ash spheroids were used to establish datums within the sediment. A sudden increase in magnetic susceptibility represents the fly ash introduced into the atmosphere from the Homer City Power Generating Plant going online in 1969. The sudden decrease in magnetic susceptibility further up the core represents the installation of scrubbers within the chimney stacks of the power plant during 1998. This also decreases the amount of fly ash contaminating the atmosphere which is represented by the lack of fly ash spheroids present in smear slides taken from this part of the core. Stratigraphic timelines were determined by using the fly ash as well as carbon dates acquired from the Johnston Archeological Dig (Sagi, 2009) to determine sediment accumulation rates for the flood plain.

EOLIAN DEPOSITION PATTERNS IN THE EEP: INSIGHT INTO PALEOWINDS AND PALEOLOCATION OF THE ITCZ

HAGUE, Ashley M.

Deep marine sediments contain continentally-derived sediments, mostly eolian dust, which provides an excellent opportunity to study past changes in global climate atmospheric circulation. Global climates during the Plio-Pleistocene (past 4 million years) transitioned from a relatively warm northern polar region to one dominated by long term ice-age cyclicity. Recent studies have suggested that the Eastern Equatorial Pacific (EEP) may have played an important role in these changes. One important connection involves the amount of heat that is moved by the pattern of Trade Winds and the surface ocean currents it creates in the EEP. The Intertropical Convergence Zone (ITCZ) marks the location where the Northeast and Southeast Trade Winds meet. Short-term seasonal changes and longer-term global shifts in climates cause variations in the strength of the Trade Winds and the latitudinal position of the ITCZ. In earlier studies, researchers noted a significant latitudinal shift in the ITCZ during the Plio-Pleistocene (Hovan, 1995). The same set of cores studied by Hovan (1995; ODP Leg 138 Sites 848 and 853) were analyzed. Variations in the grain size and mass accumulation of eolian deposition are associated with the ITCZ location therefore where utilized to track the ITCZ movement.

ODP EASTERN EQUATORIAL PACIFIC LEG 138: EOLIAN DUST RECORDS TRADE WIND INFLUENCE ON GLOBAL CLIMATE

RITTER, Christina L.

Over the past four million years, the Earth's northern polar region transitioned from a relatively warm climate system to one dominated by long term glacial cyclicity, known as Northern Hemisphere Glaciation (NHG). It is still unclear why the global climate changed during the Pliocene-Pleistocene transition but some research has pointed to the Equatorial Pacific oceanic region as a major influence in these changes. Trade Winds in the Eastern Equatorial Pacific (EEP) correlate with other oceanic conditions and provide a detailed account for past climatic conditions. Moreover, understanding how the Trade Winds vary during the warm Pliocene interval and how they influence and are influenced by other aspects of the climate system will be very helpful to develop computer climate models to study anticipated anthropogenic warming. In collaboration with colleagues from UC Santa Cruz, we examined a N-S latitudinal transect of core sites in the tropical Pacific from Ocean Drilling Program's (ODP) Leg 138. At IUP's Marine Geology lab, a record of tropical Trade Wind strength was constructed using mass accumulation rates and detailed grain size distributions collected from eolian dust that was extracted from each sample. We compared our record of wind strength with other climate proxies (e.g. sea surface temperature, ice volume, biological productivity) to gain a better understanding of what role the Trade Winds in the EEP have in equatorial upwelling and global climate changes.

NEODYMIUM ISOTOPES IN THE OCEAN AND THEIR USE AS A TRACER OF PAST OCEANIC CONDITIONS

JONES, Dr. Kevin M.

Lamont-Doherty Earth Observatory of Columbia University

Over the last 2 million years, the Earth's climate has undergone major changes associated with the waxing and waning of the great Northern Hemisphere ice sheets. It is important to understand the mechanisms underlying these climate changes so that we can better understand and address the potential problems that may arise during the current period of anthropogenic climate forcing. In this context it is important to study the ocean and the history of its circulation because it is responsible for redistributing vast amounts of heat and may amplify, or even trigger global climate change.

To reconstruct past ocean circulation, paleoceanographers rely on proxies—chemical, biological, or physical properties of sediments that reflect and record oceanic conditions. The deposition of layer upon layer of sediments leaves an archive of oceanographic conditions that can be recovered and studied.

One proxy that has shown great promise for the reconstruction of past ocean circulation is the neodymium isotope composition of seawater, as recorded by iron-manganese (Fe-Mn) oxy-hydroxide sediments. Seawater acquires its Nd isotope signature through the weathering of continental crust and the major water masses are tagged with distinct Nd isotope compositions, which reflect the age and geologic history of the crust surrounding their source regions. These water masses travel great distances from their source areas and a fraction of the Nd from these water masses is scavenged by the Fe-Mn oxy-hydroxide fraction of marine sediments along the way. Thus, these sediments provide information on the water mass that they were in contact with during burial.

My doctoral thesis research has been focused on increasing our understanding of Nd isotopes in the ocean and in sediments, so that we can more confidently apply them as a paleoceanographic tracer. Results from a modeling study and Nd isotope analyses of seawater, Holocene sediments, and Last Glacial Maximum (LGM ~ 20kybp) sediments will be presented and discussed. In brief, our results from simulations of Nd isotopes in the ocean using an ocean general circulation model suggest that the main assumptions underlying the use of Nd as a paleoceanographic tracer are reasonable. Analyses of Nd isotopes in modern seawater and Holocene sediments from the South African Margin demonstrate that seawater in this region is consistent with end-member water mass mixing, and that sediments faithfully record this signal. Finally, paired Nd isotope analyses of Holocene and LGM Fe-Mn oxy-hydroxide sediments will be presented and the fate of meridional overturning circulation during the LGM will be discussed.

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