

## GEOLOGY AND GEOGRAPHY

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### ABSTRACTS

#### **Ground-water Basins and Statewide Ground-water Monitoring—Indiana as an Example.**

KONRAD J. BANASZAK, U.S. Geological Survey, Indianapolis, Indiana 46254.—Designation of aquifers in the past generally has been by rock or sediment type, such as the Silurian-Devonian carbonate aquifer in Indiana. An accurate representation of an aquifer's function, i.e., the conveyance of ground-water from recharge to discharge zones, indicates that ground-water basins are the proper monitoring unit. There are at least seven ground-water basins in the Silurian-Devonian rocks, only two of which are completely in Indiana. Similarly, four ground-water basins are proposed for the Mississippian, twelve for the highly transmissive surficial deposits, and eight for the till-dominated deposits.

Once the ground-water basins have been delineated, the flow system within each ground-water basin needs to be understood. The recharge, natural discharge to evapotranspiration, streams, and other aquifers, and anthropogenic stresses, such as from wells or sewers, should be quantified. Knowledge of the flow system can be used to assess the needs for measurement of aquifer and ground-water properties. The strategy for measurement in both space and time could be deterministic or statistical. Suggested properties of the aquifer material to be monitored include the physical characteristics of saturated thickness, porosity, and permeability, and the chemical properties of mineralogy and adsorbed constituents. Suggested properties of the ground water are also physical, such as temperature, pressure, and density and chemical characteristics, such as the concentrations of trace elements and organic compounds.

An understanding of the basic hydrologic functioning of Indiana aquifers in ground-water basins leads to suggested monitoring strategies. In the well defined glaciofluvial aquifers, data collection can be based on flow paths. For the difficult to define till-bound sand and gravel aquifers, statistical definition of aquifer properties and water quality probably is the proper course.

**Weather Types Related to Extreme Maximum Temperature.** MARK BINKLEY, Department of Geography and Geology, Indiana State University, Terre Haute, Indiana 47809.—This study examined anomalous maximum temperatures and their associated synoptic components. Weather data from Indianapolis, Indiana for the months of January, April, July, and October (representing each of the four seasons) for the period 1960-1969 were examined utilizing a synoptic approach to determine the correlation, if any, between certain synoptic situations and the anomalous data.

This research on climatic anomalies focused on deviations from climatic normals. The mean (or climatic normal) for each variable was used along with the standard deviation. The criterion for a value to be considered anomalous was that it is greater than or less than two standard deviations from the mean. These few variables could be considered the true anomalies in each of the categories.

The data required to perform this research included both surface weather conditions at Indianapolis and corresponding surface weather patterns. Analysis of the surface data using a computerized statistical package provided the information described above. Extensive examination of Daily Weather Maps led to a system for classifying synoptic conditions on the basis of identified criterion.

The conclusions of the research confirm the validity of the alternative approach to developing a surface synoptic climatology. Although the backward, analyzing the data before the maps, approach cannot be accepted or rejected conclusively, the conclusions do indicate its usefulness in a base study.

**Evidence of Fossil Algae in the Upper Ordovician of Southeast Indiana and Southwest Ohio.** WILL H. BLACKWELL, Departments of Botany and Geology, Miami University, Oxford, Ohio 45056.—The Ordovician (Cincinnatian) sediments of southeastern Indiana and southwestern Ohio are well known for their rich invertebrate fossil fauna. In contrast, fossil algal material has been considered variously as extremely sparse or else lacking altogether. It is only logical though that some of the invertebrates must have grazed on algal material. Spurred in part by information associated with museum specimens, a reasonably extensive field search has yielded evidence of fossil algae in several formations, including the Elkhorn, Whitewater and Saluda fms. Both calcareous (skeletal) and noncalcareous forms may be found. Of particular interest are oncologic occurrences of calcareous algae such as *Girvanella* (cyanophytes) and *Solenopora* (rhodophytes). In some cases, the *Solenopora* specimens occur as crust-like masses or even as rhodoliths. The *Girvanella* oncalites may have developed around the perimeter of brachiopod/bryozoan colonies. Both *Solenopora* and *Girvanella* colonies accumulated in a shallow marine environment. Further search is quite likely to yield additional evidence of fossil algal material in Upper Ordovician (Richmondian) strata.

**Surficial Water Flow Patterns in *Fistulipora* sp. (Bryozoa) (Chesterian, Mississippian).** ANNIE CARSON, Broadripple High School, Indianapolis, Indiana, PAUL CHOJENSKI, Gavitt High School, Hammond, Indiana and MARK E. PATZKOWSKY, Indiana University, Bloomington, Indiana 47405.—Colony-wide water currents in marine bryozoans serve important ecologic functions that probably have high adaptive significance. Although Anstey (in press) has suggested that variations in water flow among fossil bryozoans have important evolutionary implications, this important function has not been rigorously studied in many fossil bryozoan taxa. A preliminary investigation of the colonial development of water flow in specimens of *Fistulipora* sp., a fossil encrusting bryozoan from the late Mississippian in eastern United States, indicates a systematic developmental pattern. Initially, water flow was centripetal, converging on a macula that marked the ancestrular area of the colony. As the colony grew larger, new maculae were added and flow around these new maculae was initially unidirectional (bypassed flow) but became more centripetal with time.

Macular diameters and intermacular distances increase as colony size increases. Monticules develop in larger colonies and, in our specimens, form a weak association with maculae. Thus, colony-wide water currents became more locally concentrated around maculae presumably to maintain efficient flow for feeding and disposal of waste and reproductive products. The well-integrated centripetal flow around each macula as described by Anstey (1981) is not present in our specimens, however, our materials do not include specimens as large as Anstey described.

**Measurement of Slope Erosion.** J. FAN AND C.W. LOVELL, School of Civil Engineering, Purdue University, West Lafayette, Indiana 47907.—A rainfall simulator was

used for field erosion studies on plots 10 ft wide x 35 ft long or longer. The plot steepness ranged from 0% to 50%. The footings and the frames were designed for wind speeds as high as 20 mph. Extra inflow was introduced to simulate excess runoff from highway pavements or upslope lengths. Variable intensities of rainfall in time and in space can be programmed for the simulator.

A comparison is made between predicted and measured distributions of rainfall intensities on these steep slopes.

**Ice-marginal Drainage along the Glacial Boundary in Southeastern Indiana.** HENRY H. GRAY, Indiana Geological Survey, Bloomington, Indiana 47405. — In southeastern Indiana a pre-Wisconsinan ice sheet at its maximum confronted the massive Knobstone Escarpment along almost its entire perimeter. In most places the ice surmounted the escarpment. Much of the meltwater from this ice sheet flowed directly away from the ice margin and into southwestward-flowing preexisting major drainageways. No integrated ice-marginal drainage system was formed, but as the ice sheet wasted, meltwater formed interbasin cols that remain as features of the postglacial landscape and as clues to the direction and level of drainage. Minor drainage parallel to the ice margin is indicated mainly along the southernmost part of the margin where the ice did not overtop the Knobstone Escarpment. This is in contrast to ice-marginal conditions in southwestern Indiana where a series of features that apparently represent a single integrated drainage system of low gradient lie along the glacial boundary for almost its entire extent.

**Paleontology of the Waldron Formation (Silurian; Wenlockian) from near Muncie, Indiana.** HARVEY HENSON, Department of Geology, Southern Illinois University, Carbondale, Illinois 62901 and TRENT A. DEWEES AND RICHARD H. FLUEGEMAN, JR., Department of Geology, Ball State University, Muncie, Indiana 47306. — A diverse fauna of Silurian age has been collected from the DeSoto Quarry of the Irving Materials Corporation 3 km northeast of Muncie, Indiana. The fauna was collected from rocks assigned to the Waldron Formation. Lithology of the Waldron at this locality consists of a basal, medium bluish-gray (5B5/1) oolitic grainstone, 3 m thick followed by an interval of interbedded, light bluish-gray (5B7/1), wackestones and very thin clayshales 1.8 m thick. These lithologies are in stark contrast to the classic Waldron exposures of southeastern Indiana where shale is the dominant lithology. Despite the difference in lithology, the fauna from the DeSoto Quarry is a distinct Waldron fauna with all 34 species being previously described from classic Waldron localities. The fauna is dominated by articulate brachiopods with 12 species being recorded. Additionally, species of trilobites, ectoprocts, corals, bivalves, gastropods, cephalopods, sponges, and crinoids are also present.

The presence of Waldron species in a different lithofacies implies that the fauna was not substrate specific and that other ecologic conditions such as salinity, temperature, and availability of nutrients may have been more homogeneous south of the Michigan Basin during Wenlockian time than was previously suspected.

**The Microearthquake Storm of 1984 Recorded in Terre Haute, Indiana.** GERALD J. SHEA, Terre Haute, Indiana 47802. — Microearthquakes have been observed in the vicinity of Terre Haute for over 30 years. In 1984, an unusual series of events occurred during a three month period which can be called a microearthquake storm. During this time period 33 events were carefully studied and upon analysis were identified as of tectonic origin. Screening these events out from mine blasts was accomplished by a critical investigation of the P, S, and G waves. The velocity and depth of focus also was critical to the identification.

The exact cause of the microearthquake storm is at present unknown. Some possible causes considered during the study are: injection wells in operation causing an uplift in the strata; erosion and shifting of soil deposits along the Wabash River basin resulting in base rock strata adjustments; and, deep well operations removing mineral or water-gas resources resulting in adjustments of the strata.

Whatever the origin may have been, and it may be a long time before a plausible explanation is determined, the resultant microearthquake storm of July, August, and September 1984 was a unique geologic process. It deserves a very careful investigation to determine the important factors involved such as cause, effect and origin. The final results could be very interesting, perhaps for those yet to come, in the 21st Century.

**Engineering Geology of Indiana Lake Bed Deposits and their Effect on Coal Mining.** TERRY R. WEST, Department of Geosciences, Purdue University, West Lafayette, Indiana 47907.—Lake bed deposits overlie Pennsylvanian bedrock in 15 or more counties in southwestern Indiana. At many of these locations mineable coal occurs within the Pennsylvanian section.

The lake bed deposits in this area consists of intertonguing and interrelated unconsolidated sediments resulting from glacial action, but generally deposited beyond the glacial boundary. These beds were deposited in standing water adjacent to upland areas composed primarily of Pennsylvanian bedrock. Outwash, dune sand and loess deposits are directly associated with the lake beds and in some areas till is also involved. The lacustrine deposits themselves consist of layers of silt and clay plus thin sands, organics and marl. Overall stratigraphy of the system is extremely complex.

Lacustrine materials pose problems for coal strip mines. Instability in both the high wall and cast over piles have been evaluated in graduate research projects at Purdue University (Greengold, 1981; Oschman, 1984). Driller's logs from coal company exploration does not provide adequate detail to decipher the detailed stratigraphy of these deposits. Subsidence of thick deposits of lacustrine clays over underground coal mines is another concern. When underground coal mining becomes more active in the future, these concerns must be faced.

Studies are underway to determine the detailed stratigraphy of the lake bed deposits and determine engineering properties of the distinct layers of material. Borehole geophysics and groundwater data are being accomplished as well.