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Abstracts

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Photoacoustic Microscopy of Coal Macerals

The application of photoacoustic microscopy to characterizing coal macerals will be presented. Photoacoustic microscopy can be used as an analytical tool that is responsive to the thermal-elastic properties of individual macerals. In a typical experiment, the crushed-particle coal pellet is mounted on a piezoelectric transducer, and the unit is mounted on the stage of a reflectance microscope. Upon absorbing the chopped light, the temperature of the maceral rises and falls with the same frequency as the modulated light. The resulting temperature variation produces a periodic strain that is detected by the transducer, whose output voltage represents the photoacoustic signal. It is known that the photoacoustic signal is a function of the absorbing maceral's density, specific heat, and coefficient of linear expansion. The unique ability to probe the thermal-elastic properties of macerals is a principal advantage of photoacoustic microscopy when applied to the study of coal macerals.

A standard reflectance microscope is modified to measure both the reflectance and photoacoustic data from the same macerals. Since reflectance depends on the optical parameters of the maceral, and the photoacoustic signal depends on the thermal-elastic properties of the maceral, the two measurements are complementary. Macerals which differ in density, specific heat, or linear expansion exhibit different photoacoustic responses, even though they may display the same optical properties. In this respect, photoacoustic microscopy offers a potentially valuable way of differentiating between macerals which have identical optical properties but different thermal-elastic properties. Data will be presented showing both the photoacoustic and reflectance measurements from different vitrinite macerals of the same sample, as well as from samples of different rank.

ADAMS, SCOT C., Dames & Moore, Cincinnati, OH, and GUNNAR KULLERUD, Purdue Univ., West Lafayette, IN

Origin of Coal Seam Structures, Sullivan County, Indiana

Structures of Pennsylvanian coal seams in Sullivan County, Indiana, reflect deeper structural components, of which regional dip is dominant. Other components of structure result from differential compaction. The effects of these components are characterized by their closure, size, shape, and orientation. (1) The Mississippian unconformity surface is characterized by parallel valleys with up to 300 ft (91 m) of local relief. (2) The composite "lower" Pennsylvanian section below the Seelyville Coal has variable sandstone content. Some paleovalleys are filled with multistory sandstones, and others with claystone. Thickness of fill has intermediately scaled effects on overlying coal structures. The combined effects of "lower" Pennsylvanian thickness and sandstone content result in updip and downdip undulations in elevation of the coal seams along the regional strike, with an amplitude of up to 25 ft (8 m) and a magnitude of ± 2 to 3 mi (3 to 5 km). The resultant oriented, linear, structure highs parallel the trend of the underlying paleoridges. (3) Silurian pinnacle reefs form small, circular features with a diameter of 1 to 2 mi (1.5 to 3 km) and closures of 25 to 50 ft (8 to 15 m) on Pennsylvanian coal seams, 50 ft (15 m) on the Aux Vases Shale, and 150 ft (45 m) on the New Albany Shale. (4) The distributions and standard deviations of thicknesses, dips, and grain size of the sedimentary rocks between the coal seams demonstrate that seams above the Seelyville Coal were deposited in parallel and have concordant modern structures. Specific facies between seams have limited influence on the overall structure.

Coal structures in the Illinois basin can be defined by a drilling program that penetrates only 150 ft (45 m) of Pennsylvanian strata. The cost of testing nonreef structures can be halved by termination at a Mississippian horizon if 50 ft (15 m) of closure cannot be substantiated. Below the Seelyville Coal, units examined demonstrate basin-margin convergence.

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Tracing the Sole of a Thrust Through Thick and Thin of Salina Group (Upper Silurian): Decollement Tectonics of Southern Tier, New York

The elusive decollement of the Allegheny Plateau is identified by repeat stratigraphic sections on gamma-ray logs, and is mapped along the Southern Tier of New York. The detachment surface is found at three progressively lower stratigraphic levels from east to west within the Salina Group.

In the eastern counties, Chemung, Schuyler, Tompkins, and Tioga, Unit F (salt) sections of the Syracuse Formation are vertically repeated two and three times along splays of the main thrust fault residing within Unit F. Fault throws as great as 400 ft (120 m) are shown on gamma-ray logs. Correlations provide evidence for overthickened sections, which are accounted for by imbricate thrusting of the section, thereby stacking the salt beds atop each other over decollement. The three-dimensional dome shape of the Syracuse Formation with planar base supports a thin-skinned tectonic origin and negates the primary depositional genesis. The thrust was upward to the northwest, and subsurface faults are associated with folds at the surface.

In Steuben and Allegany Counties, the overthickened Unit E sections of the Syracuse Formation again suggest the presence of stacked repeat sections rather than a depocenter. The detachment surface is near the base of Unit E. Mapping indicates that the rocks from the northwest have slid and overridden those to the southeast in the central region.

To the west in Chautauqua County, decollement terminates in a structure with northeast strike, here named the "Chautauqua anticline." This prominent subsurface thrust zone is of smaller proportions, but structurally comparable to the Burning Springs anticline of West Virginia. At the northwest edge of the underlying salt beds, the horizontal decollement bends upward into the Upper Silurian and Lower Devonian rocks, eventually dying out in the fissile shales of the Hamilton Group. Thin-skinned slippage has occurred on at least two planes—those of the evaporite beds in the Syracuse and Vernon Formations. The Chautauqua anticline forms the structural trap for the targets of recent plays in the Bass Islands and Akron dolostones of the Rondout Group overlying the Salina.

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Economics of Coal Industry East of Mississippi River

The past decade has seen a worldwide resurgence of coal as an energy source. The United States has been a major beneficiary of rising world coal trade, first in the coking coal sector and in recent years in the steam coal sector. Within the United States, a tremendous change has occurred in regional coal development patterns within the past 10 years. In 1972, almost 85% of U.S. coal was produced east of the Mississippi River; in 1982, only about 67% of U.S. coal was produced in the east. Eastern coal production increased only 8% in the decade, whereas coal production west of the Mississippi almost tripled. This shift in coal production away from the eastern U.S. was driven by the interplay between the utility companies' choices for compliance with the Clean Air Act and with the production and transportation economics of the two major coal producing regions. Consequently, significantly different developments have occurred in different coal fields within the eastern United States. This

paper reviews developments in coal consumption and production over the past 10 years, analyzes the causes of the changes, discusses policy options available for improvements in the economic conditions of eastern coal fields, and comments on differing prospects for individual eastern coal-producing areas in the decade to come.

BOLLA, WILLIAM O., Amerada Hess, Houston, TX, and JAMES A. NOEL, G & P Exploration, Houston, TX

Gravity Investigation of a Niagaran Reef

North Ridge and West Ridge, two isolated hills north of Cary, Ohio, in Wyandott County, were described by Winchell more than 100 years ago. His explanation for their origin was in keeping with the times. About 75 years later, Cummings designated the ridges as being underlain by Niagaran reefs after studying exposures in several small quarries.

The extensive exposures in the large quarries subsequently operated in North Ridge left little doubt that this ridge is underlain by a Niagaran reef. West Ridge is analogous in size, shape, orientation, and topographic expression. From the similarities, coupled with Cummings' earlier studies, it is assumed that West Ridge is also a Niagaran reef.

A gravity survey, using a LaCoste-Romberg gravity meter, was conducted over West Ridge. The survey was several traverses consisting of 423 stations with station spacing along the traverses of 200 ft (61 m). Elevations were determined by transit surveys, and densities were measured in the laboratory from samples collected in the reef and enclosing rocks exposed in the Wyandott Dolomite Co. quarry on North Ridge. The thickness of the glacial drift was determined from all available water well records. The gravity profiles were analyzed using the Talwani Method.

The theoretical profiles were computed using parameters which simulated the size, shape, and density of the reef exposed in the quarries on North Ridge. The field gravity profiles over West Ridge matched the theoretical closely with only 0.008 mgal difference.

A cross section constructed from electric logs shows the stratigraphy of the area. A structure contour map of the bed rock reveals that West Ridge is a bedrock-controlled topographic feature, and that its size and shape, although modified by glacial erosion, are similar to other Niagaran reefs in northwestern Ohio.

Gravity studies such as this can be used to locate shallow buried reefs in other parts of the area.

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Laser-Induced Coal Fluorescence Microscopy

A new laser-equipped fluorescence microscopy system has been developed to significantly widen the analytical scope of coal characterization. The system uses a pulsed tuneable dye laser interfaced to a state-of-the-art Leitz MPV3 fluorescence microscope. The fluorescence of the coal macerals is excited with ultraviolet radiation in the range of 260 to 450 nm and analyzed between 300 and 800 nm. The temporal decay of the fluorescence induced by the pulsed laser is studied. The anode pulses from a fast photomultiplier detecting the fluorescence are digitized by a fast waveform digitizer, and the information is then processed by a desk-top computer to obtain the decay curves and the corresponding decay times. The anode pulses which contain the time signatures of the fluorescence are corrected for temporal instrument response by deconvolution. The decay curves can also be spectrally resolved and, with further data manipulation, time-resolved spectra can be obtained. The decay times are believed to be as characteristic of the fluorescing macerals as the excitation and emission spectra, which are also being studied more extensively using monochromatized radiation from the conventional xenon and mercury arc lamps in the wavelength ranges mentioned above. The photomultiplier is cooled to reduce noise and to improve signal acquisition, and, with the red-sensitive spectral response of the photomultiplier, the fluorescence of other macerals such as vitrinites are being investigated. The technique of pulse counting is employed for greater sensitivity in detecting weakly fluorescing macerals.

Current spectral studies involve observing statistical variations of fluorescence spectra of a given maceral and obtaining its averaged spectrum. The spectra are parameterized by such values as Q (red/green quotient), λ_{max} and Q_{max} (intensity at λ_{max}/intensity at 500 nm). Excitation and emission spectra are fed directly into the computer through an analog-to-digital converter as the corresponding monochromator scans the wavelengths. The computer signal averages each wavelength interval while sampling, and then corrects the averaged raw spectrum for spectral instrument response. This multiparameter analysis of the optical properties of coal is expected to enhance coal characterization.

BRANT, RUSSELL A., and WAYNE T. FRANKIE, Kentucky Geol. Survey, Lexington, KY

Geology of Coal Resources in Eastern Kentucky

Since 1976 the Kentucky Geological Survey has been engaged in a Coal Resources Project. During this period over 22,000 new correlated measurements of the coal beds and enclosing rock were made. Other sources provided an additional 3,000 data points. This large data set was analyzed in detail and used in the preparation of coal bed isopach maps. This work has resulted in a definition of the extent of coal beds, variations and trends in thickness, and reevaluation of coal-bed correlations. Coal-bed isopach maps outline basic geologic areas of peat accumulation. Trends outlined by isopachs show channels or related nondepositional areas such as bays. In addition, use of structural maps in conjunction with isopach maps show correlation between coal deposits and structural controls such as synclines, anticlines, faults, and troughs. The detailed analysis of coal resource data is an effective tool for determining the geologic condition of coal formation.

BREEDON, DAVID, JOHN B. DROSTE, and HAYDN H. MURRAY, Indiana Univ., Bloomington, IN

Stratigraphy and Sedimentation of Mississippian Ste. Genevieve–Cedar Bluff Interval, Southwestern Indiana

The Ste. Genevieve Limestone and Cedar Bluff Group of Mississippian age, both important sources of hydrocarbons in the Illinois basin, were traced from a subsurface stratigraphic section in White County, Illinois (described by Swan in 1963, across Gibson and Daviess Counties, Indiana, using electric logs and sample descriptions from 84 wells. The Ste. Genevieve Limestone is subdivided into four members and the Cedar Bluff Group into three formations. Six cross sections and nine isopach maps based on 300 wells show that these units comprise a succession of alternating fine- and coarse-grained carbonate rocks with only minor interruptions of sandstone and shale. Two complete coarsening-upward cycles are apparent, and a third cycle is incomplete. Each cycle consists of a lower sequence of lime mudstones and wackestones, and an upper sequence of oolitic and skeletal grainstones. These cycles are the record of successive shoaling-upward cycles of sedimentation on a shallow marine platform. The lower mudstone-wackestone sequence represents deposition in a shallow subtidal environment, and the upper oolitic-skeletal grainstone unit represents development of oolite shoals and tidal channels in very shallow waters. Terrigenous clastic sediments brought into the basin by the Michigan River periodically encroached into the marine environment. Dolomitization of the fine-grained carbonate sediments is largely restricted to areas which are overlain by oolitic grainstones. In eastern Daviess County, identification of the individual stratigraphic units in this interval is somewhat tenuous, but tracing the units from eastern Illinois into Indiana made correlation and identification of the individual stratigraphic units possible by using electric logs and sample descriptions.

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Small-Scale Basin-Slope Carbonate Cycles in Trenton Limestones (Middle Ordovician), Southern Ontario

The Middle Ordovician marine transgression is marked by a simple stratigraphic sequence from supratidal and tidal-flat carbonates, through lagoonal and shoal carbonates, into offshore and finally deep-shelf carbonates.

Within the offshore carbonate succession, contemporary peninsulas, islands, and shoals complicate the detailed facies distributions, but show features similar to the basin-slope carbonate models proposed for other carbonate deposits, albeit on a smaller scale. Two end-member cycles are