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.

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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

proposed. The proximal cycle consists of coarse pebbly biosparites, commonly showing the characteristics of grain flows, passing up into cross-bedded, fine-grained biosparites, which then are overlain by micrite and calcareous shales. Calcareous shales occur interbedded throughout the cycle. This cycle is interpreted as having been deposited in bypass channels on slopes around the Middle Ordovician islands or shoals. The distal cycle consists of poorly washed biosparite passing up into interbedded micrite and calcareous clay, and is interpreted as being deposited near the base of the slope or in the adjacent basin.

Both types of cycles have hardgrounds on their coarser units, indicating long periods of nondeposition and/or erosion after deposition.

A close analogy can be made, both in microfacies and depositional environment, with the Holocene Arabian shelf of the Persian Gulf. Furthermore, both have similar tectonic situations—carbonate shelves on ancient shields undergoing collision with a magmatic arc.

BURK, MITCHELL, K., Marathon Oil Co., Bridgeport, IL, and JOHN UTGAARD, Southern Illinois Univ., Carbondale, IL

Facies and Depositional Environments of Energy Shale Member (Carbondale Formation, Pennsylvanian), Southwestern Jefferson County, Illinois

The Energy Shale directly overlies the Herrin (No. 6) Coal Member in southwestern Jefferson County. Five facies of the Energy are recognized in the study area. The depositional environment is interpreted as a large quiet-water bay into which periodic influxes of coarse-grained sediments from the nearby Walshville channel were deposited as crevasse splays. The bay-fill deposits include a nonmarine and a brackish-marine facies; the latter has higher sulfur and boron contents and a sparse marine fauna. Both bay-fill facies are faintly laminated gray shales, and both grade laterally into and underlie deposits of the distal portion of crevasse splays. The distal splay facies is dominantly siltstone with lenticular bedding. The proximal splay facies grade laterally into and are interbedded with the distal splay deposits, and are divided into a channel facies (characteristically a well-sorted sandstone that contains microcross-bedding, clay drapes, contorted bedding, and a shale clast lag-deposit) and an interchannel facies (characterized by massive and flaser-bedded sandstones). Sulfur and boron content of the proximal and distal splay deposits is considerably less than that of the brackish-marine bay deposits, suggesting a nonmarine origin. Energy Shale facies have a direct influence on the sulfur content of the underlying Herrin (No. 6) Coal. In areas where thick (> 20 ft, 6 m) nonmarine bay-fill deposits overlie the coal, the sulfur content of the coal is less than 1%. Where the coal is overlain by thick proximal splay deposits, the sulfur content is 2 to 3%. This increase in sulfur content is attributed to downward percolation of sulfate-rich marine waters of a later transgression through the permeable sandstone. Where the coal is overlain by thin brackish-marine Energy or by the Anna Shale, the sulfur content averages 4 to 5%.

CHOU, CHEN-LIN, Illinois State Geol. Survey, Champaign, IL

Inorganic Geochemistry of Illinois Basin Coals

Chemical and mineralogical compositions of more than 100 samples of Illinois basin coals have been examined from an existing data base. Multivariate statistical analysis of the data shows that variation of many trace elements is related to mineral impurities in coal, including pyrite, clay minerals, calcite, sphalerite, and quartz. Organic sulfur, germanium, and boron are associated primarily with organic matter. The high sulfur content in most Illinois basin coal results from seawater permeation immediately following peat deposition. Low-sulfur coal (< 2.5% total sulfur) occurs in restricted areas where the coal is overlain by a thick fluvial gray shale (such as the Energy Shale Member that overlies the Herrin Coal Member). The gray shale, which predates marine transgression, acted as an impermeable barrier that effectively reduced infiltration of seawater into the peat. The interpretation is consistent with sulfur-isotopic data indicating that bacterially reduced sulfate is a principal source of sulfur enrichment. High-sulfur coal is significantly enriched in molybdenum, boron, mercury, uranium, iron, and thallium relative to low-sulfur coal. Seawater is a possible source of the high molybdenum, boron, mercury, and uranium contents in high-sulfur coal. Concentrations of iron and thallium in seawater are very low, suggesting that these two elements were probably derived from a terrigenous source and transported to the swamp by rivers. Positive correlation between sulfur and all these trace elements in Illinois basin coal indicates that their variations are also related to the postdepositional sedimentary environment.

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Geology of Principal Australia Coals and Coal Basins: A Review

Bituminous or subbituminous coals are known from nearly all parts of Australia. Those of greatest economic importance today are found in the Permian and Triassic Bowen and Galilee basins of Queensland and the Sydney-Bowen basin of New South Wales, with some coalfields of lesser significance in the Clarence-Moreton basin in Queensland and New South Wales. The lesser known fields also include the Permian Collie coalfield and Perth (Permian-Cretaceous) and Canning (Permian-Triassic) basins of Western Australia; the Bonaparte basin (Permian), mostly offshore in the Darwin area of Northern Territory and Western Australia; the shallow Permian coals of the large Arckaringa basin, and the smaller Triassic-Jurassic Leigh Creek basin in South Australia; the Early Cretaceous of the Gippsland basin, Victoria; and the Permian and Triassic coals of the Tasmania basin, particularly the Fingal area. Structural, sedimentary, and paleobiologic features of the coal-bearing strata and regional trends of various coal characteristics of some of the principal economic or geologically interesting basins and coals are reviewed and illustrated. These include the Hail Creek syncline, Goonyella, Peak Downs, German Creek, Blackwater, Baralaba, Tolmeis and Moura Mines of the Bowen basin of Queensland and the unique Blair Athol mine at the far western edge of Bowen basin. In New South Wales these include the Hunter Valley area Singleton Coal Measures represented by the Foyebrook-Liddell Seam and Ravensworth mines; the Newcastle area; the Ulan Seam of the Goulburn Valley area; the western shelf area and Sydney-Wollongong region represented by the Illawarra (Permian) Coal Measures which are overlain by the thick Triassic Narrabean Series, Hawksbury Sandstone, and Wianamatta Group. A paleobiologic analysis of the thick brown coal sequences in the Yallourn, Latrobe Valley, and Bacchus Marsh areas of Victoria, and the significance of tectonics in the development of these great coal swamps will be reviewed.

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Illinois Mined-Out Coal Areas—Map and Data System

The Illinois State Geological Survey has completed a digitized file of outlines and locations of all known abandoned mines in Illinois (more than 5,500) and a computerized file of mining methods, mining conditions, geological conditions, and historical and geographical data for each mine site. The files were compiled in response to increasing requests for such information from public and private agencies involved in urban planning, coal resource evaluations, and mine subsidence investigations.

The mine outlines were digitized from original mine maps and/or microfilm copies of the maps. ILLIMAP, an Illinois State Geological Survey-designed computer-based mapping system, was modified to manipulate the digitized data. Maps generated by this system show mine outlines, portal locations, and index number assigned to each mine.

The end products of this project will be a comprehensive Illinois coal-mine data file and two sets of mined-out-area maps, one set consisting of overlays for the U.S. Geological Survey topographic map series in the coal areas, the other of county base maps. Mine index numbers on the maps will be used to retrieve information from the coal-mine data file. Overlays will be housed at Illinois Abandoned Mined Land Reclamation Council offices.

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Sauk Sedimentation Patterns in Indiana and Adjacent States

The Sauk Sequence in Indiana and adjacent states is composed of two supergroups in mutual facies relationship, the Potsdam below and the Knox above. The Potsdam Supergroup contains, in ascending order, predominantly siliciclastic rocks that include the Mount Simon Sandstone,