range from < 1 to 6%. Sulfur values are much higher for thin pyrite-rich units. Siderite nodules are common in Pennsylvanian shales, but little siderite is found in the New Albany. Dolomite, commonly ferroan, and calcite in a variety of forms are the dominant carbonates in the New Albany. Some Pennsylvanian shales may contain large fossils or mica flakes, but such coarse-grained features are uncommon in the New Albany Shale.

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Geothermal Gradients in Mississippi Embayment

A statistical analysis of bottom-hole temperatures from oil and gas wells in the northern Mississippi embayment suggests that the geothermal gradient below a depth of 1 km is low (22.2°C/km) and for the New Madrid seismic zone, it is even lower (15.7°C/km). These data support the tentative conclusion of Swanberg et al that ground-water convection is the source of near-surface heat in shallow water wells of the region. Research by Mitchell et al had suggested a high geothermal gradient in the crust and upper mantle beneath the New Madrid seismic zone as a plausible explanation for the lower than average compressional wave velocities observed there. Warmer than normal wells in the northern Mississippi embayment are scattered at random and may be attributed to random error in the data. Deep wells in the southern Mississippi embayment are substantially hotter than wells at a comparable depth farther north. The regional geothermal gradient below a depth of 1 km from northern Louisiana to central Mississippi is 26.9°C/km. From central Mississippi to central Alabama, the geothermal gradient (23.1°C/km) is comparable to that of the northern Mississippi embayment.

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Field Investigations in Arkansas Valley Seismic Swarm Area

Field and air photo investigation of the Arkansas Valley seismic swarm area in 1982 resulted in the detection of a northeast-trending lineament which dissects the swarm region and may be indicative of the fault which is the source of the recent seismicity. The linear coincides with the alignment of portions of several drainage systems along much of its length, and in other places it is defined by escarpments a few feet high. The possible relationship of the linear to local and regional structures and seismicity will be discussed. Additional features consisting of ground cracks, sinks, and a relatively fresh-appearing scarp in the vicinity of a known fault in the swarm area will also be discussed. This study was funded by the Arkansas Geologic Commission and the Geology Department of Southern Illinois University.

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Structural Relationships Between Cottage Grove and Shawneetown Fault Systems, Southeastern Illinois, as Inferred from Gravity Data

Gravity measurements, extensive field mapping, and drill hole data have been used to determine the structural relations between the Cottage Grove and Shawneetown fault systems of southeastern Illinois.

The Cottage Grove structure is an east-west-trending, right-lateral wrench fault which extends across southern Illinois. The Shawneetown fault is the western extension of the Rough Creek fault system of Kentucky and consists of several high-angle reverse and normal faults. Both fault systems are part of Heyl's 38th Parallel lineament; however, the relation between them has been obscured by Pleistocene lacustrine and fluvial sedimentation.

Over 400 new gravity stations, with approximate 0.5 km (0.3 mi) spacing, were occupied in eastern Saline and western Gallatin Counties. The data were reduced to the Bouguer values, contoured, and selected profiles were two-dimensionally modeled. The new data, in conjunction with coal mine, drill hole and field mapping data, suggest an eastward extension and bifurcation of the Cottage Grove system. The northern segment continues eastward, dying out just west of the north-south Wabash Valley fault system. The southern segment trends southeastward, possibly merging with the Shawneetown fault system in a complexly faulted zone.

The use of gravity data in conjunction with other structural information may provide a useful tool for defining structure obscured by unconsolidated deposits in southern Illinois and other parts of the Illinois basin.

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Correlation of Fractural Reservoir Productivity with Fracture Intersection Quadrants

Higher success rates for discovery of gas and oil in naturally fractured reservoirs can be achieved by correlating discoveries and productivities with fracture intersection quadrants. These fracture intersection quadrants are formed by the intersection of the two predominant fracture directions. Higher success rates in a particular quadrant appear to be related to greater fracture density resulting from the downdip extensions of the fractures in the stratigraphic zone of interest. Plunge of the intersection should be considered to insure that the drill hole penetrates the projected intersection within the stratigraphic zone of interest.

Observations in Kentucky have shown success rates can be improved three-fold when drilling in the most favorable quadrant as opposed to the least favorable quadrant, and when the drill hole is located a proper distance from the fault intersection to allow for the downdip projection to the zone of interest.

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Tectonic History of Mississippi Embayment and Surrounding Areas

Recently published U.S. Geological Survey gravity and magnetic maps constitute powerful tools for interpreting the tectonic nature and history of the northern part of the Mississippi embayment. Perhaps the most striking feature of the maps is a set of alternating, roughly coincident gravity and magnetic anomalies that bear northeastward and extend from the northwestern edge of the embayment to Alabama. Positive anomalies in this set are viewed, using the model of McKensie, as zones of stretching, thinning, and subsidence of the continental lithosphere. Gradients between positive and negative anomalies may mark the position of listric faults, which blocked out grabens and horsts within the basement rocks, forming a low-relief crustal mosaic.

This mosaic was jostled by the Ouachita collision during the Late Pennsylvanian. A horst on the northwestern flank of the embayment was pushed slightly northeastward and uplifted at its northeastern end to form the Pascola arch. Potential field maps provide no evidence that the Pascola arch connected the Ozark and Nashville domes. Older structures athwart the region trend of the mosaic, such as the Ste. Genevieve and Rough Creek faults, were reactivated as thrust faults up on their southern sides. In the Early Permian, alkalic dikes were intruded in the region of the Illinois Mineral District providing the earliest evidence of a lens of low velocity mantle rock beneath the embayment. Radiometric dates suggest alkalic igneous activity peaked in the Cretaceous.

In this scenario, the Reelfoot region evolved from a broad complex graben to a true rift during the late Paleozoic. Mesozoic igneous events and present seismicity suggest that the Reelfoot is not a dying rift; it is instead being born.

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Drowned Barrier Bar and Tidal Inlet Sequences in Buckner-Sesser-Valier Fields, Franklin County, Illinois

Nearly 400 electric logs, using spontaneous potential and resistivity curves, were analyzed in a study of the Aux Vases Formation in the Buckner-Sesser-Valier fields of Franklin County, Illinois. Subsurface mapping procedures incorporated data from core descriptions, scout tickets, and electric logs in constructing structure maps on marker beds directly above and below the formation, and isopachs of producing and nonproducing sandstones within the formation.

Three lithofacies were recognized in the Aux Vases Formation; in ascending order they are: Facies A, a thin, nonproductive calcareous sandstone with a southwest-northeast sand body orientation; Facies B, a low permeability, rippled, 0 to 25 ft (8 m) thick, glauconitic sand also oriented in a southwest-northwest direction, and Facies C, a high-angle (20° to 30°) cross-bedded, permeable, producing sand oriented in a northwest-southeast direction ranging from 0 to 18 ft (5 m) thick.

Facies A sands may represent the remains of a thin progradational beach sequence ending in production of a thin shale. Facies B sands are interpreted as the erosional remnants of a "drowned" barrier-bar system with successive parallel bars, each 1 to 3 mi (2 to 5 km) wide, up to 20 mi (32 km) long and oriented southwest-northeast. The bars are incised by tidal channel-tidal delta deposits, approximately 0.25 mi (0.4 km) wide and 1 to 4 mi (1.6 to 6 km) long, oriented northwest-southeast. Between the barriers are sandy shales, shales, and limestones, representing back-barrier deposits, with very thin (< 5 ft, 1.5 m) facies B sands. No evidence of permeable facies C sands are recorded between bars. The sequence is analogous to modern barrier bar-tidal inlet sequences proposed by Kumar and Sanders for the Fire Island area of New York.

Oil producing tidal channel-tidal delta sands show evidence of migration to the north based on (1) a wedge-shaped isopach thickening to the north across the width of the channel, (2) a slight bowing to the northeast in reaction to longshore currents, and (3) isolated fossil-hash lime bodies paralleling the long direction of the channels to the north, representing fill in deposits of the last position of the channel that was inundated by a transgressive sea.

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* Denotes other than senior author.

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Burial Diagenesis and Reservoir Development in North Haynesville (Smackover) Field, Louisiana

Smackover carbonates were deposited on a regional ramp which was locally affected by salt-generated paleotopography and basement structures. The paleobathymetry at North Haynesville field was a salt-generated high on which oolite grainstones accumulated. These shoals consisted of tide-dominated sand waves that were flanked by algal-rich grainstones and packstones which, in turn, were surrounded by open marine, peloidal wackestones.

The sand shoals were lithified primarily in the marine phreatic environment, but as they had accumulated significant depositional relief, they became exposed during minor regressions. Consequently, the shoals were affected by early meteoric phreatic diagenesis. Blocky calcite cements and inversion of metastable allochems marked this diagenetic episode.

Subsequent burial diagenetic history can be charted from early to late by the sequential appearance (in order) of the following characteristics: microstylolites, dolomitization, macrostylolites, poikilotopic calcite cements, baroque dolomite cements, and late leaching.

Whole-rock trace element analyses indicate that magnesium, iron, and manganese correlate strongly with dolomitized horizons; strontium correlates with algal-encrusted grains; and aluminum correlates with tight, argillaceous micrites. To an extent, the algal-encrusted grains are also correlated with late, dissolution-enhanced intergranular porosity.

The North Haynesville reservoir is both selective and nonselective for certain depositional microfacies. Selection is for those sand shoals that had the highest primary porosity and permeability and that were affected by dissolution enhancement in the subsurface. However, the same late dissolution processes affected both micrite and allochems in the nonfacies-selective sectors of the reservoir.

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Smackover Platform Sand Bodies: A Bahamas Model

Stave Creek field, a potential multimillion-barrel Smackover oil field in Clarke County, Alabama, owes much of its prolific production to an extensive, 100 ft (30 m) thick buildup of porous ooid and peloid grainstones.

Seismic profiles and residual gravity maps indicate the field is located on the edge of a large, Jurassic, northeast tilted block of approximately 12 mi^2 (31 km^2). The block, which formed a shallow platform for Late Jurassic deposition, is bounded on the west by an older component of the Jackson fault, and slopes eastward into the present graben complex of the Gilbertown and West Bend faults. This location placed the platform in a position between the mouth of the Manila embayment and the eastern edge of the Mississippi interior salt basin. Tidal fluctuation between basins and the open marine conditions to the west had a strong influence on sedimentation across the platform.

Cores from the area indicate a pronounced westward trend in increased carbonate grain stability and sediment winnowing. Smackover sediments from the deeper east side of the platform are composed primarily of peloidal lime mudstones and wackestones. Those of the central platform are peloidal and onchoidal wackestones and packstones. Those of the western edge form a high-energy facies of well-sorted ooid and onchoidal grainstones, e.g., the Stave Creek field reservoir.

A modern analog to the deposition on this Jurassic platform is found along the margins of the Great Bahama Bank, and specifically the north Andros-Joulters Cays area.

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Depositional History and Petroleum Potential of Middle and Upper Ordovician of Alabama Appalachians

Middle and Upper Ordovician deposits occupy a significant position in the Paleozoic sequence in the southern Appalachians, since they represent a transition from passive margin carbonate to active margin clastic deposition. In the Alabama Valley and Ridge these Middle and Upper Ordovician deposits are exposed in two northeast-southwest trending outcrop belts separated by the Helena fault. Units west of the fault are essentially autochthonous, while those east of the Helena have been displaced some distance to the west by late Paleozoic thrusting.

Middle Ordovician units show a transition from shallow-water deposits in the west to deeper water basinal deposits in the east. West of the Helena fault the Middle Ordovician is represented by peritidal to shallow subtidal lithologic characteristics of the Chickamauga Limestone. East of the Helena these shallow-water deposits are replaced by deeper water carbonates of the Lenoir and Little Oak Limestones and graptolitic shales of the Athens Formation. As this deep-water basin filled during the late Middle Ordovician, tectonic uplift generated clastic sediments which prograded into the basin from the east. Red-green mudrocks of the Greensport Formation were deposited in shallow-shelf to tidal-flat environments and were in turn overlain by quartz arenites of the Colvin Mountain Sandstone, deposited as part of a shallow-barrier system.

With continued uplift during the Late Ordovician, additional clastics prograded westward over the filled basin. Early Late Ordovician shallow-shelf to tidal-flat mudrocks of the Sequatchie Formation grade westward into shallow-water carbonates of the Inman and Leipers Formations. With continued input, Sequatchie clastics prograded westward and overrode the westerly carbonates. A relative sea-level rise during the late Late Ordovician was accompanied by deposition of open-marine shelf, bio-