southwest and is 940 ft (287 m) below the surface within the northwest part of the study area and 1,330 ft (405 m) below the surface in the southwest part of the study area.

The areas containing high concentrations of sandstone form two elongated trends within the study area. The sandstone trends strike N55°E, and trend axes lie approximately 1 mi (1.6 km) apart. The sandstone bodies are approximately ¾ mi (1.2 km) across and 5 mi (8 km) long, and range in thickness from 3 to 40 ft (~1 to 12 m).

The sandstone bodies may represent shallow marine offshore bar or strandline deposits.

BRANT, RUSSELL A., and NORMAN C. HESTER, Kentucky Geol. Survey, Lexington, Ky.

Coal Geology and Resources of Eastern Kentucky

In 1979, 107 million tons of coal were mined in the Eastern Kentucky coal field; of this total, 50 million tons came from surface-mining operations. Original resources are estimated at about 33.5 billion tons, with remaining coal estimated at approximately 29 billion tons. Recoverable-coal estimates cannot be reported because of lack of reliable data particularly in the area below principal drainage.

Major production comes from Big Sandy, Hazard, and Cumberland River Coal Reserve Districts. These areas are an important source of low-sulfur (1 to 2%), high-volatile A and B coal, often used for blending in coke production; however, the larger part of production supplies the compliance coal market.

Physical and chemical characteristics of the coal and associated rocks vary geographically and stratigraphically, reflecting the controls of sedimentary environments. In general, the following relations have been recognized: high-sulfur conditions in coal and related overburden are associated with rocks having marine or brackish-water affinities; splits are commonly associated with crevasse splays; and bad roof conditions are frequently associated with paleochannels and related slumps.

The eastern Kentucky coal resources program, operated jointly by the Kentucky Geological Survey and the Institute for Mining and Mineral Research, is in its third year, due for completion in 1982. Detailed geologic maps resulting from the recently completed Kentucky cooperative geologic mapping program provide the stratigraphic framework for this project. A more accurate assessment of coal tonnage, a better understanding of coal stratigraphy, and the development of models for determining mineability are the major goals of this project.

The deep mining potential looks promising for the northeast-southwest trending "Appalachian Trough" in southeastern Kentucky. Experiments with longwall mining are presently being conducted in this area.

BROOKFIELD, MICHAEL E., Guelph Univ., Guelph, Ontario, and CARLTON E. BRETT, Univ. Rochester, Rochester, N.Y.

Middle Ordovician Shelf Carbonate Sedimentation Around Bathymetric Highs in Southwestern Ontario: A Persian Gulf Analogy

Sedimentation patterns around three classes of bathymetric high in the Persian Gulf vary according to regional setting and diameter of the high. Around basin-center highs, the sedimentation patterns are concentric but become progressively asymmetric toward the coast (coastal highs) due to accretion of bioclastic sand on windward sides. Where the diameter of the high exceeds 5 km, downwind tails of bioclastic sand enclose muddy lagoonal-type sediments. Highs submerged below 10 m favor active submarine lithification on their crests, while emergent highs favor beach-rock lithification without dolomitization.

The Persian Gulf bathymetric high model can be directly applied to the Middle Ordovician carbonate rocks of southwestern Ontario and can be used to explain the complex biofacies and lithofacies relations, as well as the location of Ordovician hardgrounds. Both Persian Gulf and Ontario Ordovician hardgrounds occur predominantly on bioclastic and intraclastic sands, deposited in shoaling areas around the islands or highs where rates of deposition are low, especially on accretion tails. Both hardground occurrences exhibit certain faunal similarities, for example, encrusting bryozoans, sponges (stromatoporoids), abundant browsing gastropods (associated with algal mats); similar large branching burrow tunnels are present at omission surfaces in both examples. However, the abundance of pelmatozoan echinoderms and the absence of encrusting corals and bivalves in the Ordovician of southwestern Ontario contrast with recent hardground faunas.

A preliminary justification of the Ordovician-Persian Gulf comparison is presented in terms of general lithofacies and biofacies comparisons and location of hardgrounds. Unfortunately the study is handicapped by poor exposure and lack of precise stratigraphic control; a program of shallow drilling is needed to test some of the inferred sediment distributions around Ordovician submarine highs.

CASEROTTI, PHILLIP M., C. E. Brehm Drilling & Producing Co., Mt. Vernon, Ill.

Geology and Geophysics of Middle Mississippian (Valmeyeran), Ewing Area, Jefferson and Franklin Counties, Illinois

Since 1976, significant new oil reserves have been discovered in the Ewing area of Jefferson and Franklin Counties, Illinois. One new field and three deeper pool discoveries contain oil reserves in excess of 1.2 million bbl. These oil reserves are in Middle Mississippian limestone at depths of less than 4,000 ft (1,219 m).

Spring Garden field, discovered in November 1977, was drilled on a seismic prospect and has 600 acres (240 ha.) under production from the McClosky Limestone Member of the Ste. Genevieve formation. A study of a core from the field indicates the reservoir was deposited in an oolite bar or beach environment similar to present-day deposition at the Lily Bank oolitic shoal in the Bahamas. The trap at Spring Garden field is formed by the updip pinch-out of porous oolitic limestone into a tight micritic lime mud on a structural nose. The field has primary recoverable reserves of 600,000 bbl of oil.

Based on seismic work and well control, deep tests were drilled in three old fields: Bessie, Ewing East, and

Taylor Hill. All three fields had previously produced oil from the O'Hara Limestone Member of the Ste. Genevieve formation. New production has been established in the three fields from the deeper Salem and Warsaw limestone section. Oil in all three fields is found in a combination of structural and stratigraphic traps. New reserves in Ewing East and Taylor Hill total about 400,000 bbl of oil. The Bessie field is currently in the development stage but preliminary indications show the reserves should greatly exceed those of Taylor Hill and Ewing East.

Recent geophysical work in the Ewing area, employing a portable mini-hole seismic crew, indicates several more untested features which occur along the same Middle Mississippian depositional trend that created the producing facies in the above fields. The new portable mini-hole seismic operation has made it possible to survey areas previously unaccessible by deep hole or vibroseis crews.

CLARK, ROBEY H., and DIANNE BROADAWAY, Diamond Shamrock Corp., Amarillo, Tex.

Buried Structures in Marine Exploration

Examples are presented of what most geologists call "buried structures." Improvements in reflection seismograph techniques and data processing have produced deeper penetration and better resolution of data which have led to the location of many "buried structures" in the Gulf of Mexico and other marine areas.

Some of these structures are buried diapirs—some are related to growth fault development. In either situation, local movement ceased and the structures were overridden by sediments prograding over a subsiding basin.

Recognition of these undrilled structures has sparked intense bidding competition in recent offshore lease sales in the Gulf of Mexico and the Atlantic offshore. Buried structures will be important targets in offshore exploration for years to come and will contribute substantially to the nation's reserves of oil and gas.

CLUFF, ROBERT M., Illinois State Geol. Survey, Urbana, Ill.

Paleochannel Across Louden Anticline, Fayette County, Illinois: Its Relation to Cypress (Chesterian) Stratigraphic Entrapment of Petroleum

Structural mapping of the base of the Beech Creek (Barlow) Limestone across Louden oil field, Fayette County, Illinois, reveals a northwest-southeast trending saddle that is more than 1.5 km wide and 6 km long, and is perpendicular to the major axis of the Louden anticline. This depression coincides with the abrupt appearance of a thick, fine-grained, argillaceous limestone (so-called "false Barlow") subjacent to a regionally normal thickness of coarse-grained, bioclastic Beech Creek Limestone. Sandstone beds in the Cypress Sandstone, which generally underlie the Beech Creek, are thin or absent beneath this area of false Barlow.

This feature is believed to be a major tidal channel that breached deposits of shallow marine or eolian sands that had accumulated along the crest of the anticline. The trend of the channel, perpendicular to the anticlinal axis, and the restriction of the channel to the crestal area only, with no apparent extension off-structure, strongly suggest that the Louden anticline was topographically high during Cypress deposition. The channel was filled during latest Cypress deposition by marine shales and fine-grained limestone (false Barlow). During the main phase of sand deposition, the channel profoundly influenced local sandstone depositional patterns; two thick, offshore sand bars or barrier islands accumulated near its southeastern terminus along the flank of the anticline. These flanking sand bodies pinch out updip against lagoonal shales and are true stratigraphic traps that have since produced several million barrels of petroleum.

The recognition of large marine bar sand bodies in the Cypress Sandstone opens new prospects for oil exploration in the Illinois basin. Henceforth, Cypress sandstones should not be viewed as massive blanket sands or overlapping fluvial channel sands, but rather as complex sequences of shallow marine sandstone. Favorable areas to explore for stratigraphic traps in the Cypress include the flanks of major anticlines, areas of thick false Barlow, and near linear gaps in the areal distribution of Cypress production.

COOGAN, A. H., G. M. WALTERS, J. M. AUSTIN, P. H. BROWN, J. C. COX, and C. SUPHASIN, Kent State Univ., Kent, Ohio

Depositional Trends of Lower Silurian "Clinton" Sandstone, Northeastern Ohio

The Lower Silurian clastic rocks of the northeastern Ohio subsurface represent a deltaic sequence of complexly intertonguing sandstones and shales. These rock units overlie Ordovician shales throughout the area. The complexity of sandstone and shale facies resulted from migration of distributary channels during the constructive phase of deltaic progradation. At the close of delta growth, a transgressive pattern of lithofacies occurred, culminating in the deposition of a carbonate unit, the "Packer Shell" (Brassfield) which serves as an overlying distinct marker bed for correlation. The overall thickness of the interval between the base of the Packer Shell and the underlying Ordovician shales is nearly constant, allowing these shales to be used as a lower bounding surface for mapping the sedimentary package of "Clinton" sandstones and shales.

Depositional trend maps were constructed using conventional subsurface techniques and compiled using the SYMAP computer contouring program. The total sandstone lithosome of the Clinton and sandstone quality (based on gamma-ray log deflection) are shown on isopach maps of the Clinton. A total of more than 2,600 wells were used in the study of several counties in northeastern Ohio after conventional stratigraphic work was completed.

The trends show dominant sandstone depositional environments in the deltaic sequence which prograded westward on a low slope across eastern and central Ohio. Cross sections delineate the three-dimensional aspects of sand bodies and show the complexity of the facies changes between distributary and interdistributary deposits. The cross sections also show the effect of the interfingering nature of the Clinton reservoirs over small distances on petroleum production. In addition,