of 20 to 50 atm, the eastern Devonian shales are a viable source of synthetic liquid or gaseous fuels. Experimental work, in equipment capable of processing up to 1 ton/hour of shale, has confirmed the technical and economic feasibility of above-ground hydroretorting of oil shales. Work done to date on nearly 500 samples from 12 states indicates that the HYTORT process can give organic carbon recoveries from 2 to 2.5 times those of conventional retorting of the Devonian shales, so that the HYTORT process yields 25 to 30 gal/ton on syncrude at many localities, compared with 10 to 15 gal/ton using Fischer Assay retort methods.

Criteria for inclusion of shale in estimates of recoverable resources for the HYTORT process are (1) organic carbon of at least 10% by weight, (2) overburden of less than 200 ft (59 m), (3) volumetric stripping ratios of less than 2.5 to 1, and (4) stratigraphic thickness of 10 ft (3 m) or more.

Resource estimates include: Kentucky (Ohio, New Albany, and Sunbury Shale), 190 billion bbl; Ohio (Ohio and Sunbury Shale), 140 billion bbl; Tennessee (Chattanooga Shale), 44 billion bbl; Indiana (New Albany Shale), 40 billion bbl; Michigan (Antrim Shale), 5 billion bbl; and Alabama (Chattanooga Shale), 4 billion bbl. Recoverable resources have not been identified in West Virginia, Georgia, Oklahoma, Illinois, Arkansas, or Missouri outcrops. Co-production of uranium and metals is a possibility in the areas favorable for syncrude production.

KATZ, DONALD L., Univ. Michigan, Ann Arbor, Mich.

Absence of Connate Water in Michigan Reefs Attributed to Anhydrite

Dehydrated gas stored in depleted reef reservoirs behaves uniquely in that the gas comes out essentially as dry as when injected. This observation leads to the conclusion that the major part of the reservoir does not contain connate water. However, the base of the reservoir, usually of low porosity, is filled with brine.

Reef rocks contain anhydrite. A study of anhydrite occurrence leads to the relation of gypsum to anhydrite. A review is made of the controversial views held as to this relation in the earth. One concludes anhydrite in the earth must react with liquid water to form gypsum. Further, it is believed the anhydrite conversion to gypsum forms the seal to project salt layers.

KELLER, STANLEY J., Indiana Geol. Survey, Bloomington, Ind.

St. Louis and Salem Stratigraphy and Oil Production, Owensville North Consolidated and Mt. Carmel Consolidated Fields, Gibson County, Indiana

Recent oil discoveries in the St. Louis and Salem Limestones of Middle Mississippian age, on the eastern flank of the Illinois basin in Indiana, have been significant enough to stimulate exploration. Most previous oil exploration in the area was confined to depths shallower than the St. Louis and the Salem.

Along with the oil discoveries came problems of stratigraphic identity in Gibson County and adjoining counties. The problems were resolved by a study in which the Salem Limestone and associated rocks were traced from the outcrop area into the subsurface, where geophysical logs and drill cuttings were used for correlation. Within the St. Louis a geophysical log marker—the X marker—and the Sisson Member were introduced as new names.

Two adjoining fields in Gibson County, Owensville North Consolidated and Mt. Carmel Consolidated, were studied in detail in an attempt to determine the conditions for oil entrapment in the St. Louis and Salem reservoirs. Production in both fields abut one another, and therefore the reservoirs are treated as one unit. Production is from the St. Louis (Sisson Member) and the Salem. The Salem reservoir is about 180 ft (55 m) below the St. Louis reservoir, and both produce from porous zones in a calcarenite facies composed of microfossils, fossil fragments, and oolites. Porosity studies of the reservoirs show that the lower limit of producible porosity is 6%, and most oil wells have at least 5 ft (1.5 m) of net porosity greater than 6%. Maximum porosity recorded in the St. Louis was 15%, and in the Salem 21%. Density logs were used for porosity determinations. Salem wells had higher initial production than St. Louis wells. Entrapment is influenced by both stratigraphic and structural conditions.

KNOX, LARRY M., and WILLIAM J. WADE, Div. Geology, Tennessee Dept. Conservation, Knoxville, Tenn.

Geology and Mining of Tennessee Coal

The coal deposits of Tennessee occur in Pennsylvanian strata on the Cumberland Plateau. The southern half of the plateau contains Lower Pennsylvanian strata which are thick, massive sandstones and thin shales. The northern half consists of Lower and Middle Pennsylvanian strata. Relatively thick shales and thin sandstones comprise the Middle Pennsylvanian section. Most of Tennessee's present coal production comes from the northern Cumberland Plateau.

The first recorded production of coal in Tennessee was in 1814. Significant production did not begin until the expansion of the railroads which occurred around 1850. Except for a lapse in production because of the War Between the States, production increased steadily until 1900. Although production has fluctuated, Tennessee has produced approximately 9 million tons per year since that time.

Today there are over 300 operating mines in Tennessee. Of these, about 60% are surface mines. The average production of surface mines in Tennessee is about 6,500 tons per month. Underground mines average about 4,500 tons per month. All of the coal produced in Tennessee is bituminous and is used largely in steam-powered electric plants.

There are several experimental uses of coal being studied in Tennessee. These include synthetic fuel plants, magneto-hydro-dynamics plants, atmospheric fluidized-bed combustion plants, and coal gasification plants. The development of any of these processes could significantly affect coal production in Tennessee.

LANGENHEIM, RALPH L., JR., and C. JOHN MANN, Univ. Illinois, Urbana, Ill.

Colmar-Plymouth Conundrum

The Colmar-Plymouth oil field is the only significant field found so far in the northwesternmost Illinois basin. Since its discovery in 1914, it has produced more than 5 million bbl, and still produced almost 28,000 bbl in 1977. Intermittent, but persistent search for additional production since 1914, has been largely unsuccessful. Why have no other significant discoveries been made? Does reexamination of the region considering current concepts and conditions hold any hope for additional hydrocarbon production?

The reservoir at Colmar-Plymouth is the Hoing Sandstone, an isolated lens of well sorted, mature, Devonian shoreline sand. The shoreline borders the northern flank of the contemporaneous Sangamon arch. Oil in the field apparently originated in shale of the Upper Ordovician Maquoketa Group, which is exposed on the pre-Devonian unconformity beneath the reservoir. The field also lies almost on the crest of one of a series of broad northwest-trending structural noses crossing the arch. Consideration of these conditions provides our only geologic key to the Colmar-Plymouth conundrum.

One legacy of the dismal and largely unguided exploration history of the past 70 years in west-central Illinois, is the accumulation of a large mass of sociologically interesting data of unpredictable scientific value. Perceptive analysis and interpretation of these data might well lead to additional discoveries and have a certain entertainment value in its own right.

The shallow depth at which oil occurs in the area, the demonstrated longevity of production, and current market conditions, encourage exploration.

LINEBACK, JERRY A., Illinois State Geol. Survey, Urbana, Ill.

Depositional Environments of Ullin Limestone and Fort Payne Formation (Mississippian), Illinois Basin

The Fort Payne Formation (Valmeyeran, Mississippian) in the Illinois basin in part grades laterally into the Ullin Limestone and in part thins and pinches out under an increasing thickness of the Ullin. The Fort Payne is a deep-water basin facies consisting of dark colored, siliceous, sparsely fossiliferous, micritic limestone. This facies grades laterally into a deep-water shelf facies of the Ullin composed of light-colored, fine- to coarse-grained, crinoid- and bryozoan-rich bioclastic limestone. In Lawrence and Wabash Counties, Illinois, the shelf-basin transition occurs along the western edge of the La Salle anticline. Significant shelf-basin facies changes also occurred in this same geographic area during Silurian and Devonian deposition.

The depositional unit containing the Fort Payne facies thins westward and pinches out at places in Hamilton and Wayne Counties, Illinois. There it is overlain by several hundred feet of light-colored bioclastic Ullin Limestone that is younger than the part of the Ullin that grades laterally into the Fort Payne facies.

MANGUN, MARK B., Univ. Akron, Akron, Ohio

Seismic Refraction Study of Buried Valley Near Peninsula, Ohio

A seismic refraction study of the ancestral Cuyahoga River Valley in Boston and Northampton townships provided data for a structural contour map of the bedrock surface. The results generally agree with previous work, but a narrower valley floor is indicated. Inferences from the seismic velocities were made as to the bedrock type and to the nature of the glacial fill. The data are generally statistically significant for the area except in several locations where problems were encountered in interpreting the proper waveforms in the field.

MANN, C. JOHN, Univ. Illinois, Urbana, Ill.

Illinois Basin, Its Future Petroleum Prospects, and Numbers

The Illinois basin has produced oil for nearly a century and few scientists anticipate significant new accumulations will be discovered in the future. Drilling activity and exploration, although greatly diminished from past levels, continue at an impressive rate largely in response to an enhanced economic condition over the past 5 years. What petroleum reserves and likely sizes of new fields remain to be discovered in the Illinois basin?

Estimates of remaining undiscovered hydrocarbon reservoirs can be made in a variety of ways. Total hydrocarbon production data for the basin are expected to be guassian; thus, future production can be predicted from past production. Frequency distributions of discovered field sizes permit estimates of those field sizes remaining to be discovered. These distributions may be either cumulative or annual plots which when coupled with production by field size data allow estimates of undiscovered reserves to be made.

Conclusions resulting from data for the Illinois part of the basin confirm anticipated, intuitive expectations that only small fields, less than 100 acres (40 ha.) reasonably can be expected in the future although a few medium fields, 100 to 500 acres (40 to 200 ha.) apparently still remain to be found. Most of these undiscovered fields will be stratigraphic accumulations. Total reserves discovered in the future will be small.

Although the days of petroleum exploration by major and minor oil companies, as well as large independent operators, have passed completely or are rapidly disappearing in the Illinois basin, opportunities for small independent operators and individuals are perhaps better today than ever before. More geologic information now is available to them and economics will continue to become increasingly more favorable to them.

MCCOLLOCH, GAYLE H., JR., and B. MITCHELL BLAKE, JR., W. Va. Geol. and Econ. Survey, Morgantown, W. Va.

Coal in West Virginia: Geology and Current Mining Trends

Coal measures of West Virginia range in age from earliest Pennsylvanian to Permian. The state is divided into southern and northern coalfields or basins separated by a zone termed the hinge line. Deposition of the coal measures in the southern basin occurred under conditions of rapid subsidence, while deposition in the northern basin occurred on a relatively stable platform.