of Johnson, Bretschneider, and Sverdrup and Munk. Whereas the curves are of the same form, there is a great amount of discrepancy. Burling's line is 15-25 percent below the other lines. Data from Lake Okeechobee, Florida, indicate that there is a transitional region between deep water and shallow water, where the wave height is affected by combinations of wavelength and depth of water.

The data from Lake Okeechobee align closely with Burling's results. However, Burling's observations were from a reservoir where the maximum fetch was about one km. In Okeechobee the fetch ranges up to 60 km. The Okeechobee study reveals that the proper method to define shallow-water waves should include fetch and wind velocities as well as the depth of water. The wave heights are lower than expected for lower wind velocities and higher than expected for higher wind velocities in shallow water, with limited fetch.

NORWOOD, E. M., JR., and D. S. HOLLAND, Pennzoil Co., Marine Division, Houston, Tex.

Lithofacies Mapping, a Descriptive Tool for Ancient Delta Systems of Louisiana Outer Continental Shelf

Rocks of the Pliocene and Pleistocene Systems of the Louisiana outer continental shelf are divisible into three rock facies—massive sand, alternating-sand-shale, and massive shale. Similar to older Tertiary rocks of the inner shelf and coastal plain, these facies are related genetically to delta depositional systems. A description of the facies distribution for a discrete time interval can indicate the location of deltaic progradations and the approximate shape and seaward extent of their delta plains. The mapping technique requires a working definition of the individual rock facies to facilitate division of log-correlative time intervals into component facies. Separate isofacies contour maps are drawn simultaneously for each time interval, recognizing that deltaic progradations are shown by the massive sand isofacies map. The final lithofacies display map shows data relating to all three rock facies and thickness contours showing the distribution of massive sand and alternating-sand-shale facies.

An important interrelation exists between rock facies, structure, abnormal pore-fluid pressure, and the presence of hydrocarbons. Seismic techniques reliably can predict structure and abnormal pressure, and this knowledge can be integrated qualitatively into facies mapping where well control is lacking. Optimum sites for hydrocarbon accumulation can be localized by the recognition of deltas, the locale of their stillstands, and favorable structural and hydrodynamic trapping mechanisms.

OIVANKI S. M., Pennzoil Producing Co., Houston, Tex.

Paleodepositional Environments in Upper Jurassic Zuloaga Formation (Smackover), Northeastern Mexico

The Zuloaga Formation (Late Jurassic) is well exposed in the mountains of northeastern Mexico. It is stratigraphically equivalent to the Smackover Formation of the northern Gulf Coast. From 16 Zuloaga outcrops and a petrographic analysis of samples 12 distinct lithofacies are recognized within the formation.

The lithofacies and their inferred depositional environments are as follows (numbers 1 through 9 are shallow-water to supratidal deposits): (1) detrital facies—littoral marine to marginal marine to arid playa; (2) clean oolite facies—high-energy bar, shoal, or shelf; (3) muddy oolite facies—lagoon or shelf, washover; (4) clean pellet-fossil facies—medium to high-energy shoal and storm washover; (5) muddy pellet-fossil facies—intertidal to shallow subtidal; between shoals; (6) burrowed lime-mud facies—low-energy lagoon or low-energy shelf; (7) algal-laminated facies—very shallow subtidal to intertidal, possible supratidal; (8) oncolite facies—medium- to low-energy subtidal; (9) limestone-breccia facies—intertidal to supratidal storm deposit; (10) dolomite facies—environment unknown, possibly intertidal to supratidal; (11) evaporite facies—environment unknown, probably shallow, restricted lagoon; and (12) pelagic fossil lime-mud facies—low-energy shelf, deeper than facies 1 through 9.

The general range of paleoenvironments suggests a very shallow, slowly subsiding, trough-shaped epicontinental sea, the Mexican "geosyncline." A sequence of depositional environments, similar to those represented in the Mexican geosyncline area, may be expected east of the Tamaulipas Peninsula in the Mexican Gulf coastal plain. The Zuloaga Formation was deposited during a major marine transgression with many minor sea-level fluctuations.

The Zuloaga and Smackover Formations are very similar in lithology and depositional environments. Detailed studies of the Zuloaga may aid in defining facies relations in the Smackover, which is more difficult to examine because it does not crop out.

OVERTON, H. L., Petroleum Engineer, Houston, Tex.

Anomalous Brine Maps Yield Rapid Prospect Leads

Sediments in predominantly sand-shale basins have abnormally high salinity near faults and in the edgewater surrounding hydrocarbons. Anomalies can be seen readily when countywide maps are prepared on brine concentration at the top of the hydrocarbon-bearing zone. Faulting tends to yield a linear zonation of strong brines, whereas hydrocarbon anomalies appear similar to structural contours. About 80 percent of Gulf Coast fields have anomalous salinity waters in edge wells which are no more than 2,000 m from commercial production. Productive wells have redox potential which reduces SP and prevents accurate analysis.

Water composition is just one of the major variables used to evaluate a subsurface system. When combined with pressure gradients, temperature gradients, and redox-potential data, the hydrocarbon environment may be located within 2,000 m and classified with a rough production-probability index. Temperature gradients are influenced strongly by faulting and geopressure, whereas pressure anomalies correlate with the occurrence of gas and condensate production. For example, some counties in the Wilcox trend have most productive fields located over geopressure anomalies. The brine anomalies are on the edge of the abnormal pressure-gradient anomaly, which is opposite to the source of migration.

OXLEY, M. L., and DANIEL E. HERLIHY

Bryan Field—a Sedimentary Anticline

Although the Bryan field has existed as a producing structure since 1958, this is the first published data detailing the geologic history and origin of the structure. Drilling of the discovery well for the Jurassic (Cotton Valley) sediments was preceded by a detailed seismic program, which outlined an anticlinal feature corresponding to the shallow (Cretaceous) production.

On the assumption that the structure was a salt-cored anticline, the discovery well was permitted for 17,000 ft but was drilled to 21,105 ft before reaching salt. A reevaluation of the data reveals the Bryan field as a classic example of the sediment-cored anticline or turtleback structure. An unusual thickness of Haynesville sediments and a continued outward flow of salt into nearby salt-cored anticlines combined to produce the sedimentary structure which is the subject of this study.

PAMPE, W. R., Lamar Univ., Beaumont, Tex.

Preliminary Survey of Freshwater Early Tertiary Invertebrates from Trans-Pecos Texas

Freshwater invertebrates of early Tertiary age have been collected from eight scattered locations in Presidio and Brewster Counties in Trans-Pecos Texas. Most specimens are internal