BENSON, D. JOE, Univ. Alabama, University, AL, B. L. BEARDEN, State Oil and Gas, Board, University, AL, and E. A. MANCINI, Univ. Alabama, and State Oil and Gas Board, University, AL

Porosity/Depth Relations in Smackover Formation, Southwest Alabama

In recent years a number of models have been developed relating porosity to depth of burial in carbonates. These models illustrate a progressive decrease in porosity as burial depth increases, with porosity values decreasing to less than 10% at depths below 10,000-12,000 ft (3,000-3,700 m).

To test the applicability of these general models to carbonates in southwest Alabama, porosity values of the Jurassic Smackover Formation were tabulated from 40 wells. These wells included both productive and nonproductive wells at depths of 10,500-19,750 ft (3,200-6,020 m). Although the data show trends similar to those predicted by the general models, the Smackover in southwest Alabama possesses significantly more porosity at depth.

Limestones show a very apparent decrease in porosity with increased depth of burial. Below 13,000 ft (3,900 m), limestones typically have porosities less than 10%. Dolomites, on the other hand, do not show any significant trends between porosity and burial depth, possessing porosities of more than 20% at depths in excess of 18,500 ft.

Petrographic analysis indicates that abnormally high porosities at depth in the Smackover of southwest Alabama can be related to favorable shallow diagenesis and the existence of significant amounts of mesogenetic secondary porosity which is related to migration of basinal brines and hydrocarbon maturation and migration.

These data indicate that significant amounts of porosity can exist at depths in excess of 15.000 ft (4,500 m) and that care must be exercised when applying general porosity/depth curves to specific areas.

BENSON, RICHARD N., and ROBERT G. DOYLE, Delaware Geol. Survey, Univ. Delaware, Newark, DE

Inner Margin of Baltimore Canyon Trough: Future Exploration Play

A structure contour map derived from interpretation of offshore seismic reflection profiles and onshore well control shows the configuration of the pre-Mesozoic age (crystalline) basement of the inner margin of the Baltimore Canyon trough (coastal plain and near offshore) from the Long Island platform to Cape Hatteras. Major structural features are north-south aligned grabens and half-grabens (rift basins) that contain probable Triassic-Jurassic age continental and lacustrine sedimentary rocks that were truncated and later onlapped by the sedimentary fill of the Baltimore Canyon trough. Other fault structures appear to be associated with the hinge zone of the Baltimore Canyon trough and its landward structural sag called the Chesapeake-Delaware embayment.

Many of the structural features of the basement are at depths shallow enough (< 20,000-25,000 ft, 6,100-7,500 m) to be tested by drilling. Closely spaced seismic-reflection profiling would be required to provide detail for locating petroleum prospects. Likely petroleum source beds are the lacustrine shales of the rift basins and, farther offshore, the more deeply buried organic carbon-rich shales in the sedimentary fill of the Baltimore Canyon trough. Potential structural-stratigraphic traps might be found within the rift basins. Petroleum prospects in the overlying section might include drape over basement highs, pinch-outs against basement, and growth fault structures controlled by basement faults.

BETHKE, CRAIG M., Univ. Illinois, Urbana, IL, J. D. PRUITT, ARCO Oil and Gas Co., Dallas, TX, and MARY H. BARROWS, Illinois State Geol. Survey, Champaign, IL

Petrographic, Geochemical, and Paleohydrologic Evidence of Nature of Petroleum Migration in Illinois Basin

Detailed studies of the petrography and geochemistry of petroleum source rocks, the geochemistry of petroleum accumulations, and the paleohydrology of the Illinois basin suggest an episode of long-range migration of Devonian-sourced petroleum during a period of regional groundwater flow.

Petrographic analyses of samples of the New Albany Shale group (Devonian/Mississippian) were used to define lateral and vertical variation in composition and thermal maturity of organic matter within the basin. These data delineate likely New Albany Shale group petroleum source areas.

GC, GCMS, and carbon isotopic analyses of thermally mature New Albany Shale in southeastern Illinois and Silurian-reservoired petroleum samples from central Illinois were used in making oil-oil and oil-source rock correlations. These correlations indicate long-range lateral and downward cross-stratigraphic net migration.

Compaction-driven and elevation head-driven ground-water flows within the basin were numerically modeled using available stratigraphic, structural, and hydrologic data. Calculations based on compaction-driven flow show the possibility of down-stratigraphic migration. Compaction-driven flow, however, cannot explain the amount of lateral transport inferred. Regional ground-water flow due to the uplift of the Pascola arch could explain the long-range lateral migration.

Calculations of the effects of advective heat transport by elevation head-driven flow agree with estimates of temperatures made from fluid inclusions in basin mineralization.

BHATTACHARYYA, AJIT, Rensselaer Polytechnic Inst., Troy, NY (present address: Jadavpur Univ., Calcutta, India), and GERALD M. FRIEDMAN,* Rensselaer Polytechnic Inst., Troy, NY

Experimental Compaction of Ooids under Deep-Burial Diagenetic Temperatures and Pressures

Modern ooid sand particles were experimentally compacted at temperatures of 150° and 200°C (302° and 392°F) and at pressures varying between 824 and 1,565 kg/cm^2 (11,700-22,250 psi) consistent with pressures caused by 3.5-6.5 km (11,000-21,000 ft) of overburden. Bulk volume reductions of 21-26% under the above experimental conditions were more substantial than usually considered reasonable.

Particle breakage and deformed particle contacts developed that are comparable to those reported for similar lithologic characteristics from the rock record.

Pressure solution can be produced successfully on compaction in ooid sand particles. This demonstrates that initial pore-volume reduction through mechanical grain adjustments and ultimate pressure solution are the major processes in the diagenetic evolution of limestones. This appears to solve the problem of mass balance. Additionally, ooids were noted to have been plastically deformed, giving rise to longitudinal and concavo-convex contacts.

BIGGERS, BARBARA, Texas Tech Univ., Lubbock, Texas

Reef to Back-Reef Microfacies and Diagenesis of Permian (Guadalupian) Tansill-Capitan Transition, Dark Canyon, Guadalupe Mountains, New Mexico

In Dark Canyon, the transition from Capitan reef facies to Tansill back-reef facies occurs across a distance of 150 m (500 ft). Detailed 3-dimensional sampling of the transition reveals facies based on biota content and textural changes. Also revealed are postdepositional modifications owing to diagenesis.

Three microfacies (A, B, and C), defined by the presence of a few diagnostic biota, occur between the Capitan reef and Tansill back-reef deposits. Several constituent biota occur throughout the zone, including calcareous sponges, gastropods, ostracods, problematic *Tubiphytes,* and foraminifera. Grading from Tansill shelf deposits to the Capitan reef, the facies are: (1) Tansill sensu stricto: dasyclad alga *Mizzia,* large gastropods, and brachiopods; (2) facies A; massive colonies of *Collenia,* bivalves, and red alga *Parachaetetes;* (3) facies B: large gastropods, bivalves, brachiopods, and bryozoans; (4) facies C: heads of *Archaeolithoporella,* and *Mizzia;* (5) Capitan reef: *Archaeolithoporella,* crinoids, and *Mizzia.* the reef proper is an algal boundstone, while back-reef facies are packstones-grainstones.

Submarine cements that have been modified diagenetically are dominant. The majority of the biota has been micritized. Large voids are filled by fibrous aragonite which has been replaced by botryoidal radial fibrous calcite. Many reef and near-reef limestones are extremely recrystallized. Back-reef areas have undergone several stages of dolomitization, whereas the actual reef is limestone. Some anhydrite moldic porosity is occluded by sparry calcite. More recent episodes of cementation have left some gravitational voids.

BILLINGSLEY, LEE, Independent, San Antonio, TX

Influence of Various Fold Mechanisms on Fold Geometry in Growth Faulted Areas

Growth faults and associated folds are the dominant structural features along many passive margins, including the U. S. Gulf Coast. Most of the exploration effort in these areas is directed toward prediction of fold geometry and location of fold crests. Previous attempts to explain geometry have focused on only one folding mechanism per fold. A new concept presented in this paper is that multiple folding mechanisms are operative and variously contribute to the geometry of each fold. Recognition of the dominant fold mechanism enhances prediction of fold geometry.

Folding caused by growth faulting, or tectonic folding, causes fold crests to shift basinward with depth. Drape compaction causes vertical alignment of fold crests, and differential compaction puts fold crests in the area of greatest sandstone percentage. Folds dominated by tectonic folding lie within the concave trace of growth faults. Tectonic folds bulge upward above regional dip, a phenomenon here termed "upfolding." An isopach of an interval above an upfold reveals thickening in all directions away from the fold crest. If upfolds have sufficient relief, shallower layers may align vertically due to the dominance of drape compaction. Subsurface studies of gas fields along the central Texas Gulf Coast provide examples of the contribution of various mechanisms to a single fold. Separating the contribution of fold mechanisms aids in prediction of fold geometry and has important implications for hydrocarbon exploration.

BOOTH, JAMES S., and JAMES M. ROBB, U. S. Geol. Survey, Woods Hole, MA

Stress Release, Joints, and Instability on Submarine Slopes

Mass movements related to gradual stress release within a sediment section may be quantitatively important on submarine slopes, particularly when such stress release involves joint sets. The sequence of events that promotes this phenomenon has been established by numerous terrestrial studies. The process involves: (1) mass wasting or erosion to remove vertical stress (overburden) or lateral stress (such as through canyon cutting); (2) consequent elastic rebound of the unloaded section; and (3) opening of existing joints and/or formation of new joint sets. The presence of joints, which constitute planes of weakness within the sediment section, controls and reduces the stability of the affected slope; that is, the stability of the slope may no longer be dependent on the inherent strength of the sediments.

The results of this process have been observed on the continental slope off the Mid-Atlantic coast of the United States. There, exposed Tertiary sediments have a well-developed joint pattern that has been observed in sidescan-sonar images, from submersible operations, and in a piston core. The measured preconsolidation stress on an Eocene core sample suggests that more than 100 m (330 ft) of overburden may have been removed from parts of the area. Intact Eocene blocks, which represent apparent failure along joint planes, have fallen from canyon walls on the lower slope and moved onto the upper rise.

We suggest that this process has the potential to operate on most deeply eroded surfaces and that exhumed (overconsolidated) sediments do not necessarily represent stable conditions despite their typical relatively high shear strengths.

BOOTHROYD, JON C., Univ. Rhode Island, Kingston, RI and BARRY S. TIMSON, Earth Surface Research, Inc., Augusta, ME

Sedimentary Processes Along Sagavanirktok River, Eastern North Slope, Alaska

The Sagavanirktok River is the second-largest river on the North Slope of Alaska (drainage basin area = 14,364 km^2, 5,500 mi^2; length = 267 km, 165 mi). Maximum discharge recorded during the spring breakup was 2,320 m^3/sec (82,000 cfs); flow ceases during the winter freeze. The river flows through terrain underlain by continuous permafrost ranging up to 300 m (1,000 ft) thick. It is a coarse-gravel, braided river that is degradational through most of its length, becoming aggradational on the last 20 km (12 mi) of delta plain. The active channels contain longitudinal bar complexes and large transverse bars, including T-bars at the ends of chutes incised into the inactive fluvial plain. Chutes form during spring breakup owing to blockage of the river by ice from icings (aufeis), or by ice drives that jam and direct the river laterally onto the inactive fluvial plain.

Relict fluvial systems also exist as terraces elevated 10-30 m (30-100 ft) above the active river. This terrain contains wind-aligned lakes developed in the permafrost active layer. Next to the terrace scarp is an eolian levee composed of silt and fine sand derived from the active river.

Numerous small, high-gradient alluvial fans have formed along hills adjacent to the lower alluvial plain. Coarse gravel is transported downfan to the Sagavanirktok River primarily by debris flows that have prominent sieve lobes at the ends of U-shaped channels. The flows are fed by spring runoff, melting of ground ice during the thaw season, and by ground-water-fed springs (small icings).

BORONOW, THOMAS C., Univ. New Orleans, New Orleans, LA

Petrography and Diagenesis of Upper Smackover Formation (Oxfordian), Atlanta and Pine Tree Fields, Southwestern Arkansas

The upper Smackover Formation (Oxfordian) in Atlanta and Pine Tree fields is a regressive, shallowing-upward sequence that was deposited on the upper part of a carbonate ramp that sloped gently to the south. Low-relief salt anticlines active during upper Smackover deposition led to the localization of high-energy grainstones.

In the study area, the upper Smackover is divided into the following rock types: (1) bioclast-oncoid-ooid grainstone, (2) sandy ooid grainstone, (3) sandy peloid-ooid grainstone, (4) sandy calcareous shale, and (5) well-sorted ooid grainstone. The 5 rock types represent deposition in subtidal to supratidal environments.

The upper Smackover was affected by diagenesis in the marine-phreatic, freshwater-phreatic, freshwater-vadose, and late-burial diagenetic environments. Early cementation in the marine-phreatic and freshwater realm preserved primary interparticle porosity. Dissolution of unstable minerals in the freshwater realm created secondary porosity. Preservation of porosity during late-burial diagenesis was controlled by 2 sedimentologic factors: (1) presence of abundant detrital quartz, and (2) sorting. Porosity was also affected by late-burial cementation.

Atlanta and Pine Tree fields are productive from the upper Smackover Formation and the Schuler Formation. In Atlanta field, the producing zone in the well-sorted ooid grainstone is a structural-stratigraphic trap. The producing zones in the bioclast-oncoid-ooid grainstone in both Atlanta and Pine Tree fields are structural traps.

BOUMA, A. H., Gulf Research and Development Co., Houston, TX, J. M. COLEMAN, Louisiana State Univ., Baton Rouge, LA, and LEG 96 SCIENTIFIC PARTY

Characteristics of Mississippi Fan Sediments, DSDP Leg 96

Sedimentologic, paleontologic, geochemical, and geotechnical studies were conducted on cores drilled at eight sites on the Mississippi fan during the Deep Sea Drilling Project Leg 96. Together with seismic and well log data, these studies allow development of a number of depositional facies within an overall fan-lobe model. The central middle-fan channel of the youngest Mississippi fan-lobe was an effective conduit for the transport of coarse-grained material; only clays and minor amounts of silt spilled over the channel margins. The channel fill deposit is basically an upward-fining sequence, commencing with coarse-grained sands and gravels, overlain by sands, sandy-silty muds, and muds. The basal coarse-grained sediment interval is approximately 134 m (450 ft) thick. The swale deposits, the overbank deposits adjacent to the meandering channel, and the marginal overbank deposits, are characterized by fine-grained turbidites and hemipelagics. Basically, both sites contain a minor upward-coarsening sequence.

Deposits on the lower fan, in the area where the channel shifts position frequently, show alternating sequences of channel fill, levee, and over-