AGAGU, O. K., and C. M. EKWEOZOR, Univ. Ibadan, Ibadan, Nigeria

Petroleum Geology of Senonian Sediments in Anambra Syncline, Southeastern Nigeria

More than 2,500 m of predominantly terrigenous Senonian sediments have been penetrated in the Anambra Syncline. These sediments define three cycles of fluviodeltaic and shelf units, namely the Awgu Shale–Agbani Sandstone cycle, the Ogugu Shale–Owelle Sandstone cycle and the Nkporo Shale–Mamu–Ajali–Nsukka cycle. This depositional mechanism has resulted in successive alternations of potential source, seal, and reservoir units propitious for petroleum generation and accumulation. Potential source and seal beds are better developed for the Agbani and Owelle sandstones.

Total organic content (TOC) ranges between 0.22 and 4.16%, soluble organic matter (SOM) between 84 and 1,850 ppm, and saturated hydrocarbon (SHC) between 9 and 240 ppm in the Senonian shale units. Awgu and Nkporo shales appear to have the better source-rock characteristics.

Senonian sandstones in the basin are predominantly mature quartzarenites but lose porosity drastically with depth due to cementation by calcite, chert, and quartz overgrowth. The coarser grained, probably fluviatile sandstone facies have a dominant quartz cement and are generally more porous than the finer grained, probably deltaic sandstones cemented predominantly by calcite and chert.

Both diastrophic and synsedimentary, non-diastrophic structures abound in the Senonian sections here. These and possible stratigraphic pinch-outs in the sandstone units constitute potential entrapment features. However, successful exploration in the hitherto unproductive Upper Cretaceous units here will require a careful integration of structural, stratigraphic, geochemical, and diagenetic analysis.

AGAGU, O. K., A. B. GILES, and D. H. WOOD, Bur. Econ. Geology, Univ. Texas at Austin, Austin, TX

Petroleum Accumulation Trends in East Texas Salt Dome Area

Three main genetically related classes of salt domes can be recognized relative to the regional structures in the East Texas basin—anticlinal, synclinal, and flank domes. The anticlinal domes are deep seated while the synclinal and flank domes occur at shallow and intermediate depths. High dome maturity and associated flank bed configurations were achieved in the synclinal domes such as Hainesville and Bethel, only partly achieved in some flank domes such as Grand Saline, while other flank domes such as Keechi and presumably the anticlinal domes are immature.

The largest oil and gas accumulations in the east Texas dome region occur in crestal anticlines of the deep-seated anticlinal domes. The shallow domes on the regional flanks and synclines have all been nonproductive from their crestal anticlines probably because they do not uplift adequate sedimentary sections. The synclinal and flank domes therefore appear to have poor potentials except for entrapment beneath overhangs and porosity pinch-outs on the flanks when the evolution of the domes promotes these features. Patchy carbonate porosity and sandstone pinch-outs may develop around elevated dome flanks during the immature earlier history of the mature synclinal domes and throughout the history of the immature flank and anticlinal domes. Salt overhangs appear to be better developed in the more mature domes.

This model highlights the potential targets around salt domes in east Texas and can be used to reevaluate both the producing and nonproducing domes in the basin. The genetic basis for the model also underscores its applicability in other halokinetic basins.

ALEMÁN, ANTENOR, Louisiana State Univ., Baton Rouge, LA

Early Cretaceous Arc Sedimentation and Volcanism in Coastal Ranges, Central Peru

The late Valanginian Pucusana Formation in central Peru consists of more than 800 m of pyroclastic breccias, lapillistones, tuffs, and interbedded flows of intermediate to basic composition. Minor amounts of limestone, marl, and laminated gypsum occur toward the top of the formation. This unit records the construction and lateral facies relations of a single arc vent and its stratovolcano cone.

Field evidence indicates volcanism under subaerial to subaqueous conditions. Four facies in the formation represent different processes and environments of deposition. Facies A is non-welded structureless pyroclastic debris up to 50 cm in diameter. The largest size of the clasts was controlled not only by the distance from the volcanic vent but also by differences in the eruption style. The lack of welding is indicative of emplacement of these breccias in a cool state, probably by air fall and debris flowage very close to volcanic vent. Facies B consists of massive pyroclastic breccias in units showing reverse grading and matrix support. The material was deposited by debris flows originating on the flanks of the volcano. Facies C includes well-stratified lapilli and pyroclastic debris, generally less than 6 cm in diameter, deposited subaqueously around the volcano by high-density turbidity currents. Facies D consists of well-stratified fine-grained tuff and granule to pebble breccia deposited by relatively diluted turbidity currents. Near the top of the section, there are some interbedded fossiliferous and oolitic limestones and laminated gypsum representing a more distal marine facies. These facies document lateral changes from proximal subaerial to distal subaqueous conditions and a secular decrease in the rate of volcanic activity.

Modal analysis indicates a relatively homogeneous composition of an intermediate calc-alkaline magma. The volcanic source was apparently related to Cretaceous subduction beneath western South America. This sequence provides an excellent example of vent-to-basin facies in an arc setting.

ALLEN, ELIZABETH A., Shell Oil Co., Houston, TX

Evaluation of Temperate Zone Coastal-Marsh Sediments as Hydrocarbon Source Beds

Detailed facies analysis of Holocene marsh deposits in coastal Delaware reveals a variety of environments of varying organic composition. An understanding of the depositional environments and early diagenetic histories of these sediments is necessary to evaluate their potential as source rocks.

Distributions of marsh facies are related to sea-level changes, compaction, shoreline configuration, drainage, sediment supply, and other factors. The overall factor controlling marsh deposition in coastal Delaware is relative sea-level rise. This produces a transgressive sequence of fresh- to brackish- to salt-marsh deposits. Three typical stratigraphic sequences are developed: broad marsh-continuous barrier sequence, broad marsh-discontinuous barrier sequence, and tidal-river marsh sequence. The first two sequences contain predominantly high- and low-marsh sediments. The tidal-river sequence contains thick sections of brackish-marsh sediments. Freshwater and salt-marsh sediments may contribute significant and relatively equal amounts to that sequence.

Degradation of plant fragments can be related to surface conditions in depositional environments as well as to changes that occur with depth. Some marsh sediments are better potential source rocks than others. Carbon values are largest in detrital organic facies, large in brackish-marsh facies, variable in high-marsh facies, and small in low-marsh facies. Noncarbonate carbon values range from 2.33 to 10.9. Premaceral compositions show small amounts of preresinites, presclerotinites, and fusinites, and large amounts of premicrinites. The largest previtrinitic, preresinitic, premicrinitic, and presclerotinitic compositions occur in brackish-marsh facies. Kerogen typing suggests these sediments might produce hydrocarbons with both humic and lipid compositions.

ALLEN, FRASER H., Amoco Canada Petroleum Co. Ltd., Calgary, Alta.

Deep Basin, Alberta

The Deep Basin, Alberta, is the site of a major gas accumulation which will have a profound impact on the North American energy scene. Approximately 20% of the total western Canadian drilling activity over the past year has been within the limits of the Deep Basin.

Hydrocarbons have been found in 20 rock units ranging in age from Permian to Late Cretaceous. The majority of the reserves are contained within the Lower Cretaceous Spirit River Group and the Jurassic Nikanassin formation. Spirit River sediments were deposited in a series of transgressive and regressive cycles which can be mapped by gross lithologic characters and verified by sedimentologic and paleontologic criteria. The most favorable reservoirs are developed in chert-granule and fine-pebble conglomerates and associated medium-grained sandstones which are characteristic of a beach environment. Finer grained, poorly sorted sandstones of the foreshore facies form the reservoir for tight-formation gas. An even larger resource of tight-formation gas is found in the fluvial sandstones of the Nikanassin which present the same technologic challenges to economic development as their Spirit River equivalents. Detailed petrophysical studies have been utilized in the design of drilling and completion programs and the interpretation of potential pay horizons.

The current oversupply of gas in western Canada will result in the deferment of tight-sand gas production until additional markets become available.

ALLMENDINGER, RICHARD W.,* Cornell Univ., Ithaca, NY

Tectonic Significance of Microstructures in Idaho-Wyoming Thrust Belt and Hinterland

Mechanics of foreland thrust belt development can be explained using paleostress orientations from dynamic analyses of microstructures in quartz, calcite, and dolomite. Deformation in the hinterland must also be considered since the two basic models—gravity spreading and lateral tectonic compression—predict substantially different stress fields in this region.

Petrofabric studies in the Meade plate show that compression was dominantly layer-parallel, trending approximately east-west. On overturned fold limbs, compression at 50-80° to bedding suggests a locking angle which agrees well with existing theoretical and experimental analyses of kink-folding. Observed kink-fold geometries may be a necessary result of ramp configurations in the decollement thrust surface. These data are in accord with either of the two principal models.

Dynamic analyses at scattered localities in the southern Idaho hinterland show primarily layer parallel or subparallel, east-west compressson in all demonstrably allochthonous rocks at all structural levels. Fold vergence and local overturning indicate eastward translation along the undated, but probably Mesozoic, younger-over-older thrusts characteristic of this region. Near metamorphic core complexes, Tertiary thermal events may have affected preservation of older microstructures. Parautochthonous Precambrian metasediments between foreland and hinterland record compression at high angles to bedding. The age and origin of these microstructures are unknown at present.

These studies indicate that maximum compression was nearly horizontal and oriented approximately east-west throughout southeastern Idaho during thrust belt activity. Therefore, the lateral tectonic compression model is favored.

ANDERSON, KNUT A., Univ. Wyoming, Laramie, WY

Permian Trace Fossils of Western Wyoming and Adjacent Areas

Burrows are common to abundant in much of the Permian Phosphoria Formation and correlative units in western Wyoming and adjacent states. Surface traces are rare. Coarse phosphorite units are characterized by straight, full-relief traces with fine-grained fillings. They are commonly horizontal but some are vertical. Sandstones contain burrows varying greatly in orientation and regularity. Carbonate rocks and certain cherty units typically contain burrows similar to those of modern crustaceans; the burrows are filled with skeletal material, fine-grained carbonate rock, phosphorite, or chert.