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Woodbine Palynofacies—Their Relationship to Tuscaloosa of Gulf Coast

A recent palynologic study of the Texas Woodbine and comparison with the Gulf Coast Tuscaloosa have produced some interesting depositional models and increased our basic understanding of the relationship between these 2 petroliferous formations. Although age considerations and environments of deposition for the Woodbine were already determined from previous work, the distribution of palynomorphs is documented in this study. Inasmuch as the Woodbine is exposed in outcrop, several localities were available for detailed collecting. The Woodbine delta is interpreted to be a complex depositional system, and the palynomorph occurrences were sensitive to the ever-changing environments (interpreted from the many facies). Although widely separated geographically, the presence of such diagnostic palynomorphs as the dinoflagellate species *Kiokansium unituberculatum* and the spore *Klukisporites crassiterminatus* in both the Woodbine and the Tuscaloosa established at least a partial Cenomanian stratigraphic equivalence for these formations. While the Woodbine and the Tuscaloosa deposition began in the earliest middle Cenomanian, the Woodbine culminated in the early late Cenomanian, and Tuscaloosa sedimentation continued through late Cenomanian. Strata older than middle Cenomanian are recognized by the occurrence of the dinoflagellate species *Ovoidinium verrucosum* in both formations, suggesting the stratigraphic equivalence of the Texas Grayson Formation and the Louisiana Washita facies. The species associations (palynofacies) seen in the Woodbine and in some places in the Tuscaloosa could aid in the reconstruction of the environments of deposition for the Tuscaloosa Formation.

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Diagenesis, Fracturing, and Production from Monterey Formation, Offshore California

Diagenesis of the Monterey Formation includes the opal-A→opal-CT→ microcrystalline-quartz transformation, dolomitization, and in some places the formation of brittle, vitreous cherts. These diagenetic transformations produce a more brittle rock. Diagenesis is thus considered a major control on the fracture potential of Monterey rocks. Once formed, fractures become excellent fluid migration paths. Fluid migration along fractures creates vuggy porosity adjacent to the fractures and may promote the generation of secondary matrix porosity, primarily in carbonate-rich lithologies.

The Monterey is characterized by high matrix porosity but very low matrix permeability. The vast quantities of hydrocarbons produced from this formation require production from matrix porosity in addition to production from fracture porosity.

A model is suggested in which matrix-bound hydrocarbons migrate into fractures that intersect high porosity-low permeability beds. These fractures either intersect other fractures, the borehole, or stratigraphic breccias; any or all of these conditions should enhance productivity. This model diminishes the problems associated with fluids migrating long distances through a low-permeability matrix. Implications of the model include the following: (1) fractured carbonate-rich rocks with matrix porosity should yield the best production; (2) chert-rich lithologies with no matrix porosity will produce primarily from fractures; (3) high-porosity shales with few fractures are candidates for hydrofracture treatments to enhance productivity.

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Effects of Area-Wide Leasing in Gulf of Mexico

Area-wide lease sales in the Gulf of Mexico over the past 2 yr have received an enthusiastic response from the oil industry. More tracts have been bid upon and acquired per sale, total larger lease bonuses have been paid, and exploratory drilling has rebounded. Several new geologic plays are now under way in Texas, deep-water Louisiana, and the eastern Gulf. Many companies are now involved in offshore leasing and exploration. This activity has returned people to the work force and boosted the economies of effected coastal states. Industry should be able to reduce the reserve and production decline and decrease forthcoming supply shortfalls as a result of area-wide leasing.

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Smackover Reservoirs in Southwestern Alabama

One of the major problems encountered during exploration for hydrocarbons in the Smackover in southwestern Alabama is delineation of porosity trends within the unit. Unlike Smackover reservoirs in Arkansas, Louisiana, and Mississippi, which are dominated by primary interparticulate porosity, much of the porosity in the Smackover in southwestern Alabama is secondary in nature and does not correlate with primary depositional features. Smackover reservoirs in southwestern Alabama can be divided into 3 general classes: interparticulate-moldic reservoirs, dolomitic intercrystalline reservoirs, and vuggy reservoirs. Interparticulate-moldic reservoirs occur in a narrow band that parallels and lies 10-20 mi downdip of the updip limit of the Smackover. Porosity consists of small amounts of interparticulate and moderate amounts of oomoldic or pelmoldic porosity. Interparticulate-moldic reservoirs are characterized by moderate to high porosities (10-20%) but relatively low permeabilities (5-10 md) unless the lithology is dolomitized. Moldic porosity is also associated with large amounts of microporosity, which can significantly affect water saturation. Intercrystalline dolomite reservoirs are common along the updip limit of the Smackover and across several prominent paleohighs such as the Conecuh Ridge and the Wiggins arch. Reservoirs possessing only intercrystalline porosity have highly variable permeability but low porosity (6-8%) and are rarely productive unless fractured or leached to produce vuggy porosity. Vuggy reservoirs are common across paleohighs or along the updip margin. They are characterized by good porosity (10-20%) and permeability (10-100 md), but also possess large amounts of microporosity.

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Naturally Fractured Jambalaya—Analyzing a New Reservoir Type

The difficulty in analyzing naturally fractured reservoirs has in the past been severely hampered by the application of old technology to this jambalaya of geologic, structural, and petrophysical features. Making sense of fractured reservoirs now requires the application of new analytical techniques in combination with computer analysis of the data.

There are two keys to understanding fractured formations like the Monterey Shale, Austin Chalk, or Nugget Sandstone. These keys are the use of full diameter whole-core samples in the analysis process and computerized data acquisition and reduction programs to prepare the results for evaluation and interpretation. Only recently has the capability to analyze 5-in. diameter cores been developed. Determination of all petrophysical properties is no longer limited to plug samples 1 in. in diameter.

The result has been a dramatic increase in the amount of information obtainable on reservoir properties. Permeability can now be measured in up to six horizontal directions versus one from plug samples. The flow capacity of specific fracture morphologies, such as partially mineralized, incipient, and natural open fractures, has been measured at simulated in-situ reservoir conditions. Experimental evidence indicates fracture permeability reductions of greater than three orders of magnitude occur in some lithologies.

By allowing the computer to prepare the time-consuming pole plots, rose diagrams, K vs. ϕ crossplots, and geologic descriptions, the geologist is free to concentrate on analysis and interpretation of the prospect. This significantly improves their productivity and understanding of the reservoir and assists in identification of optimal locations for further drilling.

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Lagoa Feia Formation (Lower Cretaceous), Campos Basin, Offshore Brazil—Rift-Valley-Stage Lacustrine Carbonate Reservoirs

The Lagoa Feia Formation, buried in excess of 3,000 m, is the exploration frontier of the prolific Campos basin. It contains the source beds of