Association Round Table

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Abstracts

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Plate Tectonics, Organic Matter, and Basin Evaluation for Petroleum Potential

Application of plate-tectonic concepts to sedimentary basin development has been important in petroleum geology. Physical aspects have been stressed, but a complete classifiction must include the amount, type, and distribution of organic matter because this is the material that generates petroleum. Organic matter can be classified into two broad categories: (1) land-derived ("terrestrial") organic matter that may include major amounts of lignin and surface coatings which give gas or waxy crudes respectively, and (2) aquatic organic matter which commonly is dominantly of algal origin and generates normal crudes. The relative amounts of these two types of organic matter, and hence the relative amounts of oil and gas, depend on the depositional environment and this can be related to plate-tectonic setting.

Rifts that form in the early stages of continental breakup receive high percentages of terrestrially derived organic matter initially, but aquatic organic matter becomes quantitatively more significant as the rift widens and marine conditions develop. Thus pull-apart continental margins develop a vertical profile from terrestrial organic matter deep to aquatic organic matter shallow. The deeper continentally derived sedimentary sections of these margins produce waxy crudes, gas, and some condensate reflecting the character of the organic matter. Pull-apart margins and rifts with waxy crudes were within 20° of the equator at the time of rifting. They include the Sirte, Cambay, Reconcavo, Gabon, and Cuanza basins. When rifting occurred farther from the equator, gas-dominated provinces were developed, such as northwest Australia, offshore Newfoundland, Baltimore Canyon, and the central Viking graben.

Rivers transport continental sediments and organic matter to continental margins, and the association of transported terrestrial organic matter with clastic sediments makes deltas one of the most gas-prone depositional environments. Organic materials are not distributed uniformly in deltas because terrestrial organic matter has its highest concentration nearshore whereas aquatic material is also produced in large amounts offshore. This separation and distribution lead to gas fields near paleoshorelines and oil farther out. As the delta progrades, terrestrial organic matter is deposited over the previously deposited aquatic organic matter. This profile of organic matter type is exactly the opposite of that developed on passive continental margins and leads to the opposite trend for the distribution of oil and gas with depth.

Although organic-matter type exercises initial control over the nature of the hydrocarbons generated, the composition may be changed later by maturation and migration. Maturation is the thermally induced trend from oil to gas and the depth for this conversion will depend on geothermal gradient. Migration distance is also controlled by plate-tectonic setting with distances in excess of 100 km being well documented for structurally simple interior basins. In contrast, migration distances are much shorter when migration pathways are interrupted, for example, by block faulting in rifts and growth faults in deltas.

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Applying Modern Geologic Methods to Petroleum Exploration and Development—Case Study of Jurassic Reservoirs in East Texas, North Louisiana, and South Arkansas

The stratigraphic and structural framework of the Cotton Valley and Smackover can be divided into distinct producing trends. Each trend has predictable producing characteristics and geographic limits.

The Cotton Valley producing trends lie in four different areas: (1) a semicircular belt of lower Cotton Valley limestone reservoirs along the west flank of the Sabine uplift covering parts of Rusk, Shelby, Smith, Upshur, and Cass Counties, Texas; (2) a northeast-trending belt of lower Cotton Valley limestone reservoirs on the west flank of the East Texas basin covering parts of Henderson, Navarro, Freestone, Limestone, and Robertson Counties, Texas; (3) an arcuate belt of "blanket" strandline sandstones in north Louisiana centering in Lincoln Parish; and (4) a broad circular area covering most of the Sabine uplift where very fine-grained upper Cotton Valley sandstones produce from a 1,400-ft (427 m) stratigraphic interval. Minor Cotton Valley sandstone production is developing on the west flank of the East Texas basin from low-permeability Bossier sandstones. Cotton Valley reservoirs are generally low-permeability (less than 1 md) and require fracing for commercial flow rates. Higher gas prices and improved fracing techniques have caused a high level of exploration for Cotton Valley reservoirs.

Smackover producing areas are in six different trends: (1) updip fault traps along the Mexia-Talco fault system; (2) salt anticlines along the flank of the salt basins; (3) basement structures updip from the salt anticline and fault system; (4) stratigraphic traps near the Arkansas-Louisiana state line downdip from the salt anticlines; (5) complex graben-fault traps associated with more intense salt features deeper within the basin; and (6) updip from the Mexia-Talco fault trend, a possible new trend opened in western Henderson County, Texas, by a recent highly significant discovery of McFarlane Oil Co.

The five producers (and no dry holes) drilled to date in the new trend show only very slight structural turnover at the Smackover level in an area of regional east dip into the basin with the possibility of minor (under 100 ft or 30 m) fault interruptions. Current interpretation is that the trap is due to a