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Abstracts

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Development and Distribution of Rift Systems

Rifts are elongate depressions overlying places where the lithosphere has ruptured in extension. Rift basins are rifts filled with sedimentary and (to a lesser extent) volcanic rocks and are becoming recognized as containing a substantial proportion of hydrocarbon resources. Rifts occurring at slowly spreading oceanic centers are not considered here.

Intraplate earthquakes and in-situ stress measurements indicate that plate interiors are generally in compression. Rifts form within those, relatively unusual, environments in which intraplate stresses result in extension rather than compression. Various tectonic conditions can lead to local extension within plates. A simple treatment relates these to the stages of the Wilson cycle of ocean opening and closing. A distinction has also been drawn between "passive rifts" in which stresses applied at plate boundaries establish the environment, and "active rifts" in which stresses applied to the plate from above or below (perhaps by uplift over a mantle plume) lead to extension. The Neogene and Quaternary rifts of Africa are examples of active rifts while rifts formed at continental collision, e.g., Upper Rhine, Baikal, Aegean rifts, and the rifts underlying the West Siberian basin are examples of passive rifts. Interpretation of these collisional rift systems commonly requires determination of the direction of "continental escape."

In whatever way rifts originate, their development is similar because the processes of rift extension are similar. Recent studies have emphasized the importance of listric and other types of normal faulting in the lithosphere during rifting. The base of the lithosphere is often within the crust during rifting and the lower continental crust, forming part of the asthenosphere, deforms by high temperature creep. By analogy with oceanic rifts the base of the lithosphere during rifting may have been close to the lower limit of ground-water circulation.

Rift subsidence and thermal history have been simply analyzed by assuming that the lithosphere thins vertically beneath the rift in proportion to the amount of horizontal rift extension. Refinements of this type of treatment involve assessing the relative importance of dike injection and thinning by flow beneath the rift as well as considering the possible effects of pre-rift lithospheric thinning and conduction sideways from the rift.

The sedimentary development of rifts is complex and varied. Many rifts contain subaerial and lacustrine deposits especially near the base of the rift-fill. Evaporites are common where climatic conditions are appropriate, and marine sediments show the influence of such factors as global sea level change and the interaction of subsidence and sediment-supply rates. Sediment-starved rifts are rare.

A common property of rifts is that potential reservoir rocks lie near the base of the sediment fill and that possible source rocks lie higher up the sequence. Migration of oil and gas into places where basal reservoir rocks occupy structurally high areas is common. Many rifts are overlain by broader basins in what is often called "the steer's head condition." In some places, though not all, this relationship can be accounted for by post-rift cooling. Although rifts are numerous and varied, they have features in common largely because of the uniformity of extensional processes that makes them worth treating as a class.

Rifts are widespread within continents ranging in age back to three billion years, and the older the continent the more rifts it is likely to contain. Rift structures are commonly reactivated and rift reactivation is a major process in intraplate tectonism.

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Comparative Cenozoic Petroleum Geology of Major Deltas—Mississippi, Niger, and MacKenzie

Oil and gas are produced from Tertiary sandstone reservoirs in deltaic and related depositional systems in the United States Gulf Coast, Niger, and MacKenzie-Beaufort basins. In each area there is an orderly, predictable interrelationship of sedimentation, stratigraphy, depositional environment, and structure, with the characteristics, ages, and distribution of producing trends.

In comparing and contrasting the three areas, it is apparent that they have many aspects in common, resulting from the fact that they are relatively young, subsiding paralic basins on "Atlantic-type" margins. They contain thick accumulations of deltaic sediments that have prograded in regressive basin-filling sequences as the basins subsided. Therefore each has a vertical gross lithologic sequence that has shale at the base, overlain by interbedded sandstones and shales, overlain by massive sandstones. The vertical sequence is repeated laterally from basin to land. In each basin the stratigraphic units thicken basinward across a series of normal, listric, down-to-the-basin syndepositional faults, with which are associated "rollover" anticlines that form traps. Trapping associated with diapiric structures is also characteristic.

Significant differences are related to the different geologic settings and geologic histories of the basins. For example, the presence of salt in the Gulf Coast basin has resulted in a wide variety of salt-dome-related trapping mechanisms in addition to the shale diapirs and rollover anticlines common to all three areas. Pre-Tertiary tectonic settings, different in each case, control basin configurations and affect structural trends. Vertical and lateral differences in depositional systems and sequences, and in sandstone geometries, result from variations in ratios of rates of sedimentation to rates of subsidence that are, in part, tectonically controlled.

The framework for the occurrence of oil and gas is well understood in the maturely explored and intensively studied Gulf Coast Tertiary basin. Concepts developed there can be applied to developing the less-explored Niger basin and to exploring the frontier Mackenzie-Beaufort basin.

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Character of Ancient Petroliferous Lake Basins of the World

The principal oil- and gas-bearing lacustrine rocks in the world were formed from sediments deposited in or peripheral to ancient stratified lakes, of a variety of ages, which for millions of years maintained a size comparable to that of modern inland seas. In these lake systems, both lipid and woody organic matter were developed and preserved in large quantities. The lacustrine rock system commonly constitutes a depositional complex that includes indigenous hydrocarbon source, reservoir, and trap units.

Lacustrine strata of China consist primarily of siliciclastic rocks; those of Brazil, Angola, and Cabinda are principally of siliciclastic rocks with abundant carbonate units; those of the