

Essential Elements of a Deep-Water Petroleum System

By

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A petroleum system describes the naturally occurring process of converting organic material into moveable hydrocarbons and trapping the products into measurable accumulations. The essential elements of any petroleum system are a source rock and sufficient sediment overburden to provide maturation, migration, and a trap.

The source rock must be rich in carbon and hydrogen and to be effective it must be concentrated to provide enough hydrocarbons to be expelled out of the source rock pore space. The heat flow of a basin and the thermal blanket effect of the sediment overburden matures the source rock. The overburden may also supply the interconnected pore space for migration and reservoir and the seal to form a trap.

In most onshore and some shelf margins basins the source rocks are found at outcrop or in well penetrations and they have also been geochemically fingerprinted to the hydrocarbons discovered. Through the use of traditional exploration tools, the petroleum systems of these basins is relatively well understood. The source rocks are documented, the basin modeling can be matched to the thermal maturity of the source rock, and the timing of reservoir deposition, hydrocarbon expulsion, and trap formation can be demonstrated.

Deep-water petroleum systems are challenging because the stratigraphic data necessary to constrain assumptions about the source rocks and depositional history of a basin is not directly available. In many cases the deep-water seismic data cannot be tied to the known onshore and shelf geology without significant age and facies uncertainties. The explorer is forced to consider what cannot be known when defining the potential petroleum system and to be creative in reconstructing its history within the limits of the factual observations available.

West Africa and Offshore Brazil are good analogs for reconstructing the generic stratigraphy of a deep-water petroleum system. The Early Cretaceous rift to transition phase source rocks deposited during the early phase of the formation of the passive margins and the subsequent Tertiary progradation of the Campos shelf and Zaire fan into deep-water demonstrates how the systems work and what their upside potential can be.

The same petroleum system elements can be found in deep-water Nigeria, the Gulf of Mexico, and Trinidad. The task for explorers in the next 75 years of the Houston Geologic Society is to discover where the next deep-water petroleum systems may be found.