Origin of Oil in the Gulf of Mexico: Exploration Significance

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Knowledge of the number and nature of petroleum systems present in the greater Gulf of Mexico Basin is an important “first issue” in producing more accurate predictive solutions for exploration and production activities. The assembly, analysis, and digital storage of a large oil geochemical data set for the region provide an opportunity to build or continue to develop an increasingly more sophisticated understanding of hydrocarbon genesis in the basin. The data set makes practical a novel strategy for the identification of potential new plays. Oils poorly represented in the general data set can represent under-explored or under-exploited petroleum systems, and provides a basis for the construction of “more focused” exploration strategies for regions in which limited success has previously been enjoyed. The different genetic oil families relate to variations in oil quality (e.g., %S, ppm metals, API gravity) in various parts of the basin.

Oils believed to have been derived from Tertiary and Cretaceous units usually possess geochemical characteristics associated with shale-rich sources. Oils derived from Jurassic units more characteristically possess compositions compatible with carbonate- or marl-rich sources. Tertiary sources occupy the coastal region and “near” offshore of the Northern Rim, the Burgos Basin, and extend to the offshore of the Tampico Basin of Mexico. Four major oil families comprise Tertiary oils in the on- and offshore of the northern part of the Gulf o Mexico Basin. Distal marine shale sediments in the Wilcox are the sources of the easternmost Tertiary oils. Updip, lateral migration has been proposed to charge many of the reservoirs containing oils derived from the Wilcox. An east to west shift occurs in the chemistry of Tertiary oils and results from lateral facies changes from intervals containing deep-water marine shales to intervals containing greater amounts of higher plant material deposited in more proximal paralic to deltaic environments.

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Oils derived from Cretaceous sources most commonly occur in the northern part of the greater Gulf of Mexico Basin and adjacent offshore. Oils interpreted to have been derived from Upper and Lower Cretaceous sources occur in the onshore Northern Rim. Oils associated with the Lower Cretaceous occur sparingly onshore; however, oils that have compositions similar to onshore Lower Cretaceous oils characterize the offshore, and oils having Upper Cretaceous compositions are uncommon in the offshore. The western limits of Cretaceous petroleum systems result from a number of phenomena. The onshore termination of oil-rich Cretaceous petroleum systems reflects the transition in to the gas-prone Sabinas and Burgos basins of northern Mexico. Oils attributed to Cretaceous sources occur from the Texas offshore (High Island area) eastward to the Main Pass-Viosca Knoll areas of offshore Louisiana, Mississippi, and Alabama. The observed occurrence of Cretaceous oils in the offshore extends farther east than the occurrence of oils associated with the Jurassic. Oils believed to have been derived from Cretaceous sources are the main oil types observed occurring east of Ewing Bank.

Jurassic-derived oils occur in the Northern Rim (Oxfordian families), the southern Rim (Tithonian and Oxfordian families), and in the offshore (probably Tithonian oils). Oils associated with tithonian sources occur in all Mexican basins containing Mesozoic-derived oils. Oxfordian oils apparently are more limited in their occurrence in Mexico, but have been identified on the Campeche Shelf and from the southern part of the Reforma Block. Northern Rim Jurassic Smackover oils (Oxfordian) consist of two major families. The observed occurrence of oils having Smackover compositions abruptly ends near the western margin of the East Texas Basin and the coast of Mississippi / Alabama.

Two major compositional oil families occur in the shelf and deep-water areas of the northern offshore Gulf of Mexico (Families SE1 and SE2). These families compositionally correlate more closely to Jurassic oils from the Southern Rim than to Jurassic oils associated with the Smackover. Oils obtained by piston core from surface seeps tend to have compositions that are most closely correlative to oils from southeastern Mexico (Family SE2) and occasionally occurs in wells. Compositional Family SE1 generally is found in shallower shelf-slope areas and the oils in this family mostly come from wells. The seeps (Family SE2) possibly represent relatively pristine samples of one of the sources for oils in the offshore because of their similarity to Mexican source facies (end-member composition). The “end-member” may be preserved in seeps because dispersive processes act to minimizing mixing that characteristically occurs in reservoirs. Oils in Family SE1 can be interpreted to be compositionally intermediate between Jurassic-derived oils (carbonate-marl, Family SE2) and Cretaceous oils from shales. The Jurassic end-member of the Family SE1 postulated mix is occasionally represented in wells. The Cretaceous end-members may be represented in the High Island area of offshore Texas and along the northern boundary of oils having mainly Jurassic chemistries.