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Top seal character and sequence stratigraphy of selected marine shales in Gulf Coast style basins

Abstract

Marine shales are top seals for approximately seventy percent of documented hydrocarbon accumulations, but they represent one of the least studied elements of petroleum systems. Sealing capacity is determined from laboratory measurements of high-pressure mercury injection capillary pressure (MICP), which are used to calculate hydrocarbon column heights. The largest interconnected pore throats control seal capacity.

Pore throat size is influenced by numerous compositional (mineralogy, total percentage of clay, organic enrichment) and textural (fissility, silt content, degree of compaction) aspects of shales. Mineralogical analyses indicate an average composition of 65% clay, 19% quartz, 4% feldspars, 5% pyrite, and 7% accessory constituents (authigenic carbonates, glauconite, bioclasts, and carbonaceous debris).

The total organic carbon (TOC) of these shales ranges from 0.79 to 4.00 wt%. In general, seal capacity increases with increasing clay and organic content and decreases with increasing detrital silt content. The 140 Tertiary shale samples we analyzed were deposited in middle neritic to outer neritic/bathyal paleoenvironments. MICP data indicate that maximum top seal capacity ranges from 735 ft to 2,305 ft (oil column) with hydrocarbon saturations in the seal of 10 percent.

Calculated seal capacity typically exceeds hydrocarbon column heights by a factor of 5 to 20 times. Consequently, top seal capacity is not a significant risk in structures having four-way closure. The interpretation of seal analysis data within a sequence stratigraphic context reveals a systematic trend in top seal capacity. Shales occurring in the uppermost transgressive systems tracts and maximum horizons are excellent top seals. Shale samples from the lower part of transgressive systems tracts are good to excellent seals, whereas shales within highstand systems tracts have moderate to good sealing capacity. Some condensed intervals contain exceptional top seals.

Biographical sketches

William C. Dawson is a senior research associate with Texaco Upstream Technology in Houston, Texas, where he has worked since 1984. Previously he was employed by Eason Oil Company and HJH, Inc. His specialty areas are seal and reservoir sedimentology and diagenesis and their use in basin analysis. He has extensive experience in rift basin studies with emphasis on international exploration. Dawson is a former associate editor of the *AAPG Bulletin* and currently a participant in the AAPG Visiting Geologists Program.

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