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Shale Facies and Seal Variability in Deep Marine Depositional Systems

William C. Dawson, William R. Almon and Kelly Dempster

Fine-grained lithotypes are dominant components of deep marine depositional systems. Analyses of Tertiary-aged samples from wells in deep marine basins reveal the common presence of eight major shale types: 1) well-laminated organically enriched shales; 2) slightly silty, weakly laminated shales; 3) silty, weakly laminated shales; 4) distinctly mottled silty shales; 5) very silty shales and argillaceous siltstones; 6) calcareous shales and claystones; 7) shale clast conglomerates; and 8) shales with contorted laminae. Most importantly, these fine-grained strata are baffles and barriers to fluid flow and ultimately control the migration and distribution of hydrocarbons. Mercury injection capillary pressure (MICP) data indicate these shale facies comprise six distinct seal types. Seal types 1, 2, and 6 have significantly greater critical seal pressures than seal types 3 and 4. Seal type 5 consistently has the lowest sealing capability. Shale facies and seal character vary systematically and exhibit a strong correlation with sequence stratigraphic position, suggesting that at least some depositional parameters influence sealing capacity. Silt-poor shales can have excellent to exceptional sealing behavior. Increased percentages of silt-sized detrital grains (greater than 20%) allow preservation of relatively large-diameter pore throats, resulting in lower sealing capacities. Well-developed laminar fabrics, organic matter, and early marine carbonate cementation can significantly enhance seal character, whereas bioturbation generally degrades overall seal behavior. Because of variations in fabric and texture, these shale types have different compaction trends (in terms of depth and porosity). Consequently, using an “average” compaction trend can result in erroneous interpretations of burial history and timing of hydrocarbon migration events from basin models.

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