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Shale Facies and Seal Variability in Deep Marine Depositional Systems

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Fine-grained lithotypes are dominant components of deepmarine depositional systems. Analyses of Tertiary-aged samples from wells in deep marine basins reveal the common presence of 8 major shale types: 1) well-laminated organicallyenriched shales; 2) slightly silty, weakly laminated shales; 3) silty shales 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 which ultimately control the migration and distribution of hydrocarbons. Mercury injection capillary pressure data indicate these shale facies comprise six distinct seal types. Seal types 1, 2 and 6 have significantly greater critical seal pressures relative to seal types 3, and 4. Seal type 5 consistently has the lowest sealing capacities. 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. Individual shale facies appear to have different bulk moduli and to be mappable on seismic surfaces. Silt-poor shales can have excellent to exceptional sealing behavior. Increased percentages of silt-sized detrital grains (> 20%) allow preservation of relatively large-diameter pore throats thereby inducing 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 (depth/porosity) trends. Consequently, using an "average" compaction trend can result in erroneous interpretations of burial history and timing of hydrocarbon migration events from basin models.