Storage and Connecting Pore Structure of Mudstone-Shale and Its Effect on Seal Quality

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The storage-connecting pore ratio and pore-size distribution of mudstone and shale depend on grain-size distribution, degree of compaction, diagenetic alteration and cementation. When cementation is insignificant, a critical clay content (CCC) of 15-20 % can divide poor seals (permeabilities (k) of >100 nano-Darcies (nD)) from moderate to good seals (k < 100 nD). Maximum compaction (5-15% porosity) is normally reached between 2000 to 3000 m (CDB - critical depth of burial), except for high sedimentation conditions where delayed fluid expulsion increases the depth (3000-4000 m). For clay contents above the CCC, mudstone-shale would be of medium to high seal quality (1-100 nD) at depths greater than CDB. High seal quality may also be reached at shallower depths if diagenetic cementation takes place, even for clay contents less than the CCC.

Clay contents near the CCC, advanced diagenetic dissolution that weakens the framework, bioturbation, late stage overpressure development and fracturing due to tectonic activity influence the style of interconnected pore development. Seal quality evaluation by k may not be accurate depending on the nature of interconnected pores. Low k values such as 10 nD could miss leakage effects through the seal, in certain cases. Additional electrical measurements may increase evaluation reliability. New seal petrophysical and geophysical evaluation concepts will be presented using mudrock data from Northern and Eastern Canada and other areas.