The Effect of Oil Emplacement on Quartz Cementation in a Deeply Buried Sandstone Reservoir

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ABSTRACT

Quartz is an important, porosity-occluding cement in sandstone reservoirs that have been subjected to elevated temperature for a substantial period of time. The effect of oil emplacement on quartz cementation in reservoir sandstones is controversial; some studies have concluded that early oil emplacement can inhibit quartz cementation leading to the preservation of porosity, while other studies have concluded that quartz cementation appears to be largely unaffected by oil emplacement. Here we have studied shallow marine, Upper Jurassic sandstones from Ula Field, Norwegian North Sea, with reservoir temperatures of about 150 deg C, to determine whether oil emplacement had a significant impact on diagenesis. Following sedimentological description of cores, samples above and below the oil-water contact have been collected, adjacent to core analysis plug points. These samples then underwent a series of studies, including SEM-EDS (QEMSCAN) and point counting. These data were then integrated with routine core analysis and petrophysical log data. Density and resistivity log data were used to determine the precise oil saturation of each sample. The distributions of all potential controls on porosity and permeability, such as grain size, sorting, matrix clay content, degree of bioturbation, and the presence of grain coatings, as well as the amount of quartz cement, have been assessed. Primary oil inclusions within quartz cement shows that oil ingress into the Ula reservoir commenced prior to the onset of quartz cementation. Very fine-grained, matrix-rich, bioturbated and microquartz-cemented sandstones have uniformly low quartz cement contents irrespective of oil saturation. Medium-grained, graded, matrix-poor, microquartz-poor sandstones have quartz cement ranging from 1 % to greater than 17 %, associated with core porosities of about 22 % and 7 %, respectively. Higher oil saturations equate to higher porosities and permeabilities in the medium-grained, graded, matrix-poor, microquartz-poor sandstones, which cannot be explained by any control other than the amount of quartz cement as a function of pore fluid type. Oil emplacement therefore appears to have inhibited quartz cementation at high oil saturations and can be viewed as a significant control on reservoir quality. The significance of this study is that the presence of oil in a sandstone reservoir, at the time that quartz cement was growing, can have a considerable impact on reservoir quality.