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Oil Charge Preserves Deep-Burial Porosity in Sandstones and Limestones

Debate since 1920, has equivocated over the effects of oil charge on reservoir quality. Regional information and local case-studies from the North Sea, shows sandstones from fluvial, shallow marine and deepwater reservoirs with unusually large porosity at the field crest. Cementation has been prevented, and porosity preserved, in some cases from 2.0 to 4.0km burial. Two gradients of porosity decline exist: a normal cementation gradient at 8%/km, and a rapid gradient of 40%/km. It is a mistake to predict aquifer production quality from information in the oil zone, which can have 40x greater permeability and 10% extra porosity. Prevention of cementation is not due, in these cases, due to clay coating or micro-quartz, but to oil fill preventing the local supply of quartz or other pre filling cements by diffusion through a water-filled pore network. Less than 20% water saturation in clean fine sand is a limiting value.

Limestones often show complex shallow diagenesis, which obscures deeper effects. However chalk reservoirs do not have these problems. Cementation normally destroys porosity by 3km, however many fields have >30% porosity at 4.0km. This is also a process where oil fill has prevented locally-derived cementation, and has preserved porosity from 1km to 4km. Trends of whole-rock oxygen isotope values are a sensitive measure of cementation, and exclude overpressure as the dominant porosity preserving mechanism. As with sandstones, two types of reservoirs exist, those with regional porosity decline and those with raid porosity decline where oil charge overlapped with cementation from shallow burial.