Chalk reservoirs of the North Sea

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In the North Sea, chalk became a reservoir for oil and gas by a combination of fortunate circumstances. Shortly after burial, chalk in general has a high porosity, but a low permeability. It is a micropore reservoir. For fluids to enter the pore space, pressure is necessary. North Sea Chalk hydrocarbon fields are all located over thick areas of Kimmeridge and Oxford Clay source rocks, on structures which grew during the Tertiary.

Structural growth caused fracturing allowing hydrocarbons, which were generated from as early as Oligocene times onwards, to build up in the fracture systems within structural closures in the Chalk. In this way hydrocarbons were able, by their buoyancy or by the pressure generated from the shales below, to enter the chalk reservoir. In areas where Paleocene sands are present, a closed pressure system was not found and no saturation of the Chalk was possible.

Chalk is composed of the debris of coccolithophorids, which being composed of low magnesian calcite, is of great chemical stability. Burial diagenesis does not start until approximately 1000 m below surface. In the case of North Sea Chalk reservoirs, diagenesis, which will normally reduce porosity from approximately 50% at the sea bed to 10% at between 3000 and 4000 m burial depth, is arrested by three factors: 1) The pressure generated, which partially or wholly supports the overburden, thus reducing or preventing pressure solution. 2) Oil or gas in the pore space which as a chemically inert fluid also largely prevents pressure solution. 3) Magnesium ions present in sea water and in greater concentrations in the pore waters of up-domed beds overlying Zechstein evaporites, poison sites of nucleation of calcite, retarding diagenesis. As a result, all Chalk fields show anomalously high values of porosity, Valhall Field for instance has values of 50% porosity at a depth of 2500 m.

Chalk reservoir quality is controlled by a variety of factors, but four factors predominate: the purity in terms of calcium carbonate of the sediment; the rate of deposition of the Chalk which in turn determines the degree of early frame-work cement; the tectonic setting of the field area during Chalk deposition; and the size distribution of the coccoliths being deposited.

To these four factors nearly all reservoir quality variation can be related. The best Chalk reservoir in the North Sea is undoubtedly the Tor Formation because of its purity. However, the Lower Hod Formation and, in places where the Tor Formation has been re-deposited as allochtonous sheets during its deposition, the Ekofisk Formation, can act as very satisfactory North Sea Chalk reservoirs.

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