Diagenesis impacts fluid pressures, reservoir quality, and seal integrity of deep Jurassic targets, Norwegian Sea.

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Abstract

Seal integrity and reservoir quality are key to exploration success in highly overpressured Jurassic sandstones in the Halten Terrace. Due to the link between diagenetic porosity loss and fluid overpressure, diagenesis plays a significant role in both seal integrity and reservoir quality.

The reservoir quality of Jurassic sandstones we have studied suffers due to diagenetic porosity loss. The dominantly subarkosic reservoirs have lost an average of 10 porosity units due to quartz cementation although locally developed clay coatings are observed to inhibit quartz cementation. These coatings preserve a maximum of 5 to 9 porosity units compared to uncoated sandstones, depending on the formation. On the other hand, authigenic illitic clays can bridge pores and reduce permeability. Overpressures developed after most mechanical compaction was complete and therefore do not enhance reservoir quality.

Diagenesis is a principle control on seal integrity. In a representative overpressured exploration well, the Jurassic reservoir and the Cretaceous seal are presently at the fracture pressure. Our models indicate that diagenetic processes generate 25% of the present overpressure. Diagenesis controls the timing and duration of hydraulic fracturing of seals. This is because, in contrast to mechanical compaction, diagenetic reactions contribute to overpressure generation even after overpressures have begun to develop. Compaction contributes to the overpressures; however, it is unlikely to cause hydraulic fracturing of seals.

The diagenetic processes discussed are commonly observed in sedimentary basins world-wide. Therefore, we consider that they will impact overpressure, reservoir quality and seal integrity in similar ways on the NW shelf of Australia. The modeling results we discuss have implications for the distribution of overpressures and for the occurrence and timing of seal failure by hydraulic fracturing across the Carnarvon Basin. These same processes impact reservoir quality of Triassic, Jurassic and early Cretaceous sandstones in the Carnarvon basins and the Timor Sea.

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