DGMK/ÖGEW-Frühjahrstagung, Fachbereich Aufsuchung und Gewinnung
Celle, 25./26. April 2019

Structural and Diagenetic Controls on Reservoir Quality of Tight Formations

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Abstract

The Upper Carboniferous fluvial sandstones and Zechstein Ca2 carbonates represent important hydrocarbon reservoir units in the Lower Saxony Basin, NW Germany, with production of more than four decades and a great exploration potential. In those tight, gas-producing formations, significant exploration and development risks are attributed to their spatial variability of reservoir quality due to depositional heterogeneities, variations in their structural characteristics and the presence of temperature anomalies. With a focus on the Upper Carboniferous sandstones, this study compares three outcrops in the southern part of the Lower Saxony Basin with analogous reservoirs situated approximately 50 km to the north. Petrophysical and petrographic data sets are linked to the burial history of the sandstones to derive control factors on the reservoir quality evolution.

Results indicate similar matrix permeabilities of two outcrops and the two studied reservoirs (field A and B) but matrix porosities vary. Such differences can be related to differences in their burial histories. Higher matrix porosities of field B compared to field A are explained by a lower amount of quartz cementation as the result of stronger basin inversion related uplift of field B. Further increases in matrix porosities of the outcrop sandstones are related to carbonate cement dissolution during the late stages of uplift to the surface. However, a third outcrop reveals significantly reduced reservoir quality which can be associated with intense additional cementation processes due to high temperature anomalies in the vicinity of a fault. In contrast, faulting and natural fracturing enhances the reservoir quality of field B by providing migration pathways for fluids.