



Source potential and sequence stratigraphic characterization of microbial evaporitic mudrocks: Upper Permian Zechstein Group, Northern Germany

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Microbial evaporitic carbonate mudrocks are important source rocks throughout much of the earth history. Some of the largest hydrocarbon provinces are potentially sourced by evaporite source rocks such as the Cretaceous and Jurassic in the Middle East, the Tertiary in Spain, the Permian in northern Germany, the Devonian in Canada, and the Pennsylvanian in the USA. Carbonate mudrocks deposited under mesosaline conditions are often over-looked and dismissed as potential source rocks. However, preservation and accumulation of organic matter in salinity-layered intraplatform epeiric depressions and restricted basin centers are significant. These mudrocks may not only constitute the source but also exhibit reservoir qualities. Slope and basin laminated mudrocks were investigated for their source and reservoir potential using sequence stratigraphic and geochemical techniques to investigate the exploration potential of the northern German Upper Permian Zechstein Formation.

The lower Zechstein cycles Z1 and Z2 are characterized by calcareous to argillaceous, laminated, organic-rich mudstones with TOC (total organic carbon) contents ranging mostly <1% in the Z2 and >6% in the Z1 cycle. Maturities range from 0.9 to >3% Ro depending on depth of burial for these two cycles. While the Z1 mudrocks deposited above the Rotliegend clastic section are more argillaceous and clay-rich grading upward from calcareous mudstones to intraclast, coated grain, thrombolitic wacke- and packstones into coated-grain grainstones, the Z2 mudrocks are dominated by calcareous to dolomitic laminated mudstones. Both cycles are characterized by microbially bound carbonates ranging from thrombolytic to crenulated laminated structures that are overlain by anhydrite and salt. Stacking patterns of the Z1 3rd-order cycle reveal three 5th-order parasequences stacking into two 4th-order sequences; Z2 3rd-order cycle is composed of three 4th-order parasequences that first deepen and then shallow upwards. Sediments associated with deepening events contain the highest amount of TOC and maturities along the slope and basin. The configuration of the two Zechstein cycles within this epeiric basin favored accumulation of microbial source rocks, carbonate reservoirs and evaporite seals.