Eustatic and authogenic controls on fluvial-dominated deltaic systems – an example from the Toarcian-Aalenian of the North German Basin.

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During Toarcian and Aalenian times the North German Basin (NGB) was a widespread siliciclastic coast that generated numerous oil and gas bearing reservoirs in the west (Schleswig-Holstein, Lower Saxonia). By contrast, the Aalenian of the eastern NGB contains no marine index fossils and therefore considered eroded or not deposited.

This contribution describes first results of an ongoing study that concentrates on the Toarcian-Aalenian in NE Germany (Mecklenburg-Vorpommern, Brandenburg, Saxony-Anhalt). The data base comprises 13 cored wells (1150 cored meters) and approximately 150 loged wells. Core description foccussed on the analysis of lithofacies and ichnofacies. In addition, studies on micropalaeontology, palynology, whole-rock geochemistry, clay mineralogy and poro-perm properties are applied.

Lithofacies analysis revealed 14 lithofacies types that are grouped into seven facies associations: (i) anoxic shaly prodelta, (ii) oxic shaly prodelta; (iii) distal mouth bar, (iv) proximal mouth bar crest, (v) sand bar of lateral mouth bar shift; (vi) main distributary channel and (vii) terminal distributary channel. Due to repeated sea-level fluctuations the Toarcian-Aalenien shows a complex pattern of facies associations. The general transgressive trend culminated in the Lower Toarcian maximum flooding with wide spread distribution of prodelta associations from the western NGB up to the Mecklenburg area to East. Accordingly sandy deltaic associations are limited to the NE part of Mecklenburg and Vorpommern. Especially the Upper Toarcian comprises thick sandy associations in the East. The Early Aalenian transgression is superseded by basin-wide eastward thinning sandy lithofacies associations. The spatial distribution of facies associations suggests a fluvial-dominated deltaic system.

Marine environments are ideal for biostratigraphic correlation. Key index fossils for the Jurassic include ammonites, ostracodes and foraminifers. Such fossils are rare in brackish environments. We therefore include a palynological study to enable biostratigraphic correlation in the eastern part of the NGB.

For Toarcian and Aalenian times, sequence-stratigraphy correlation conforms with the results of facies analyses and the distribution of distinct sand bodies. Five 3rd order sequences have been recognized between the Toarcian and the Bajocian transgression. For basin-wide correlations, Gamma-Ray [GR], Self-Potential [SP] and Resistivity (R, mostly short normal [SN]) logs have been analysed.

Although the Toarcian/Aalenian marine deltaic system was dominantly controlled by eustatic sea-level fluctuations, we demonstrate that authigenic facies variations played an important role in the deposition of potential reservoirs (e.g. oil/gas or geothermal). Eustasy triggered the formation of several sandstone units, deposited either as proximal mouth bar crests or distributary channel systems. Differential compaction led to authigenic shifting of active and inactive areas of the deltaic system. Furthermore, there is evidence from spatial facies variations and sequence-stratigraphy that thick deltatop/deltafront sandstone units, deposited during the Toarcian in the east of Mecklenburg-Vorpommern, led to an authigenic shift of the active deltaic system from the east towards the west of Mecklenburg-Vorpommern in Aalenian time.