Cyclostratigraphic Control on Lithofacies and Their Influence on Source Rock Characteristics in Westphalian Mudstones of the Campine Basin (North East Belgium)

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ABSTRACT

Research and exploration of shale reservoirs mainly focus on marine black shales. Recent studies suggest that continental mud deposits may also be able to produce considerable amounts of hydrocarbons. This study examines whether Westphalian mudstones in the Campine Basin (NE Belgium) can be defined as a possible target for shale gas and oil. Special attention was given to the influence of lithofacies and the cyclic nature of sedimentation on source rock characteristics. Three cyclothems of the KB172 Gruitrode and KB186 Lommel-Kerkhoven drill core have been studied and sampled, based on their lithology, organic-richness, mineralogy and sedimentary features. A source rock characterisation was carried out. Mineralogy was determined quantitatively by means of x-ray diffraction and Rietveld refinement. TOC measurements and Rock-Eval pyrolysis were carried out to determine the organic richness, composition and maturity of the samples and to evaluate them as source rocks. Five different lithofacies were identified, namely riverine sand bodies, swamp deposits, proximal and distal flood plain deposits and high-stand mud deposits. Channels formed by erosion of the underlying sediments are filled with river sediments, forming sand bodies. The surrounding areas were regularly flooded. Grain size decreases away from these channels, with pronounced fine sands and silts with fining-upward sequences in the proximal floodplain. The distal floodplain is characterised by fine-grained sediments with signs of soil formation. Sediments in swampy depressions are organic-rich fine-grained muds, due to the absence of oxygen in the environment. When these swamps drown due to a renewed transgression, high-stand mud deposits are left behind. These are fine-grained clay-rich sediments, rich in organic matter and iron. Swamp and high-stand mud deposits show on average the highest TOC and S2 values. In other words, lithofacies influences source rock characteristics. It was also found that these facies mainly occur at the bottom of new cyclothems during maximal transgression, or at the top just before peat formation. In case of the Westphalian C mud deposits it can be stated that the most interesting source rocks are situated around the coal deposits, forming a nearly continuous reservoir that can be targeted for combined coal bead methane and shale gas production. To conclude, source rock characteristics are facies dependant, of which the occurrence is cyclostratigraphically controlled.