

Heterogeneity of shales in different scales and its implications to laboratory analyses - examples from sedimentology and organic geochemistry study of the Lower Paleozoic shales from shale gas exploration well located in the Baltic Basin, Poland.

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We present the litho-sedimentological, organic geochemical results and organic porosity estimation of the Ordovician and Silurian shales in the SeqWell (shale gas exploration well located in the Pomerania region, Poland). The most perspective black and bituminous shales of the Upper Ordovician and the Lower Silurian may seem to be homogeneous. However, our results reveal that these shales show heterogeneity at different scales (m to mm). For example, in most cases the decrease of TOC content in the m scale is related to pyroclastic rock intercalations and "dark bioturbations" with no color difference when compared with surrounding sediments. While in cm scale heterogeneity is related to bioturbations, density of organic-rich laminas, or abundance of carbonates and pyrite. Without a detailed sedimentological study of polished core surfaces and Rock-Eval analyses those observations are rather invisible. The correct interpretation of results requires the understanding of rock's heterogeneity in different scales. It has a critical importance for laboratory tests applied on few cm long samples, especially if the results are to be extrapolated to wider intervals. Therefore in ShaleSeq project, a detailed sedimentological core logging and analysis of geochemical parameters of perspective formations in m to mm scale was performed for the first time. The results show good correlation between bioturbation index (BI) and organic geochemical indicators like organic carbon content (TOC) or oxic deposition conditions indicator (oxygen index - OI) leading to the assumption that environmental conditions may have played a crucial role in organic carbon preservation. The geochemical analyses of 12 samples showed that even within the few cm long sections shale can be really diversified. Eight out of twelve analyzed samples were considered geochemically mostly homogeneous, whilst four of them showed evident heterogeneity. Concluding, the sampling should be preceded by detailed sedimentological study, as it allows to control if the chosen samples are representative for wider intervals and give opportunity to place the laboratory results in the wider context.

An attempt to estimate organic porosity using Rock-Eval data was based on Marathon Oil company study of the Polish Lower Paleozoic shales. The results of this study and suggested equations were used to calculate hypothetical organic porosity of the most perspective shales in the SeqWell. Calculated organic porosities in % bulk volume of rock suggested that organic porosity for Upper Ordovician and Lower Silurian shales in SeqWell may be at the level of 0,1-2,9% in bulk volume of rock. These results would suggest that organic porosity doesn't play a major role in total porosity system in these shales at the certain thermal maturity level. The hypothetical organic porosity values were not validated by the microscopic study though.

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