

Paper Number: 3010

Characteristics of the Early Silurian organic-rich black shales in central part of the Baltic Silurian Basin: implications for shale oil(gas) reservoir quality

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The evolution of the Baltic Sedimentary Basin near the W margin of the East European Craton (EEC) commenced during the Late Vendian - Early Cambrian and underwent the main subsidence during the Silurian - Early Devonian. Flexural bending on the margins of the EEC occurred in response to the Eastern Avalonia and Baltica collision in the Silurian times, creating an asymmetrical foreland basin according to Poprawa et al. [1]. This resulted in the Silurian sediments being c. 5 km thick in the west (Poland) and thinning to c. 50-100 m at the eastern basin margin in Lithuania. Maximum extent of the basin was at the end of the Llandovery and coincided with the greatest basin subsidence and the global sea level rise [2].

The examined Early Silurian succession was deposited in a deep-shelf, epicontinental marine environment and is dominated by dark coloured, finely laminated, graptolitic, locally bioturbated shales, with minor limestone and siltstone beds at the base of Llandovery. The upward-deepening Llandovery succession is dominated by slabby to flaggy, graptolite-rich shales, with common centimeter to meter thick, crystalline to locally bio-clastic limestone beds at the base of the section. Pyrite nodules are common throughout.

The Llandovery Formation is rather variable in thickness as well as organic-richness. Faulting and folding associated with the Caledonian Orogeny affected the thickness, richness and facies distributions in the central part of the Baltic Basin.

Previous studies have shown that only organic matter-rich, black graptolite Llandovery shales could be considered as the major potential shale oil/gas plays in the basin. A number of important parameters such as organic richness, maturation, lithofacial distributions, sequence stratigraphic framework etc of the Llandovery shales have been outlined in the previous studies by Zdanaviciute and Lazauskiene [3]. However, some key shale properties that are very important for determining reservoir quality of the Early Silurian shale play, such as detail sedimentological analysis of the mudstone-rich Silurian strata and basic trend of porosity have not been determined during the previous studies.

Wedge thin sections were prepared for the most of organic-rich shale intervals in the examined wells from southwestern part of Lithuania. They were examined by variable SEM facilities. The obtained results were used for evaluation of rock porosity and reservoir quality.

The SEM data indicates that inter-particle pores of 200-300 nm in diameter predominate the shale sections; micron-scale pores are also present. Rare, intra-particle pores were observed within the organic matter with few exceptions in some studied wells. Organic matter is characterised by absent or moderate organic nanoporosity. In some cases, authigenic clays restrict the pore connectivity. To sum up, the total inter-connective porosity ranges from 1.4(5,0) to c. 10.0%.

References:

[1] Poprawa et al. (1999) *Tectonophysics* 219: 95-239

[2] Lazauskiene et al. (2003) *Geol Soc of London, Spec Public* 208:95-115

[3] Zdanaviciute O and Lazauskiene J (2009) Baltica 22(2): 89-98.

