Секция 4. Геологические и географические аспекты изучения пиродно-ресурсного потенциала

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SHALE AND ORGANIC CARBON CONTENT VARIATIONS IN THE LOWER SILURIAN SUCCESSION IN THE CENTRAL PART OF BALTIC SILURIAN BASIN (WESTERN LITHUANIA)

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В этом докладе анализируются тенденции распределения глинистого материала и органического углерода в нижнесилурийских породах. Для исследования было выбрано 6 скважин в Западной Литве. при помощи программы "GeoGraphix" были виведения кривые распределения глинистого 6 материяла разрезах скважин и сделана корреляция разрезов между скважина и, в которых отражаетса распределение глины и органического углерода. Результату этой интерпретации может быть спользованы при дальнейшем исследовании потенциала сла́нцевого газа в нижнесилурийских породах Западной Литвы.

The Baltic Silurian Basin is a sedimentary basin, situated on the Western margin of the East European Craton (EEC) (Lazauskiene et al., 2003). Flexural bending on the margins of the EEC occurred in response to the collision of Eastern Avalonia and Baltica in Silurian times, creating an asymmetrical foreland basin (Poprawa et al., 1999). This resulted in the Silurian sediments varying from ~5 km in the west and to ~50-100 m at the basin margin in Lithuania. Maximum extent of the basin occurred towards the end of the Llandovery which coincided with the greatest period of subsidence and global sea level rise (Lazauskiene et al., 2003). The Silurian system is widely distributed and is exposed in the northern and north-western parts of the basin (Estonia, Gotland), while the most stratigraphically complete section is in the western part of Lithuania. The studied Early Silurian sediments were deposited in a deep-shelf marine environment and comprise a succession dominated by organic-rich graptolite shales. The formation is rather variable in facial composition as well as organic-richness. Whilst, the Silurian succession is one of the best explored in the Baltic region - previous studies implied that only Llandovery organic matter-rich black graptolite shales could be considered as the major potential shale oil/gas plays in the basin. A number of important parameters of organic richness, maturation, lithofacial distributions, sequence stratigraphic framework etc. of the Llandovery shales have been outlined in the

previous studies (Zdanaviciute, Lazauskiene, 2009). Meanwhile, studies of the clayey section and key shale properties still remain episodic. Little is known about 1) the Silurian distribution of clay content and its relationship to content of organic carbon; 2) trends of distribution of these parameters in the different parts of the basin both laterally and, especially, in the cross-sections. As the Lower Silurian is considered as a promising in terms of shale gas potential, this implies the need for more detail studies of the variation of organic carbon and clay content. This study is devoted to the examination of relationship between clay and organic carbon contents in the Lower Silurian succession of the Lithuanian part of the Baltic Silurian Basin. The shale content variation in six wells from Western Lithuania has been calculated from the gamma-ray logs by adopting the standard procedures.

The shale (clay) content (Vshl) of the upper Silurian was calculated using the standard equation:

$$V_{shl} = \frac{GR - GR_{clean}}{GR_{shl} - GR_{clean}}$$

where – GRclean - minimal natural gamma-ray curve value reflecting pure limestone radioactivity (in our case it was 2-4 mcR/h); GRshl – radioactivity value of shale (15-20 mcR/h).

After recalculation to Vshl in case of ”pure“ limestone the value is 0 and in case of shale is 1. The cross-sections of clay content were compiled interpolating Vshl values in plane between the wells. The shale content data have been correlated with the distribution of the organic carbon in order to study the relationship of these parameters. Previous studies implied that increased content of the organic carbon shows clear linear correlation with increased Gamma-ray values in the Silurian sections in the Baltic Basin (Poprawa, 2010; Lazauskiene et al., 2014). The regularities of variation of the shale content were studied separately for the Lower and Upper parts of the Silurian. The study was mainly focused on the Lower Silurian, because there the highest values of the organic carbon were observed from previously done analyses. The data used for this study was taken from the industrial reports available at Geological Survey of Lithuania. The highest organic carbon content values were found for the middle and upper Llandovery in Usėnai-3 well (Corg values from 0.5 to almost 2%). It was established that calculated shale content in Usėnai-3 – Rukai-2 – Geniai-1 wells is relatively high (Fig. 1). It was observed that shale content values are more than 0.8 in the Middle and Upper Llandovery sediments. Thus, in the mentioned interval shale content is higher than average, while organic carbon content variation is high. The data of organic carbon content is not available for the Lower Llandovery, while calculated shale content is up to 0.3. Just one organic carbon value (equal to 1.8%) is available for Wenlock strata in this well and shale content is quite low in this layer. Very similar organic carbon and shale content variation trend is observed in Rūkai-2 well. The amount of the organic carbon varies from ~1% to more than 8% within this section. The highest organic carbon content (up to 8.3%) was in the Middle and Upper Llandovery. There was also found rather low value (1.5%) which suggests a very high heterogeneity of the organic carbon in well section even within rather narrow interval. Shale content within this interval exceeds 0.6%, which indicates very good correlation with enlarged organic carbon content in the same interval. In the Lower Llandovery there just one organic carbon value equal to 1% was

obtained. Shale content is quite low in this layer as well and is up to 0.2. Shale content does no exceeds 0.38 in Wenlock section that implies rather low shale content in the Wenlock section, but there were no organic carbon content measured earlier for correlation. The data very well indicates higher shale content in case of higher organic carbon content and conversely, that implies linear correlation between shale and organic carbon content in the section.

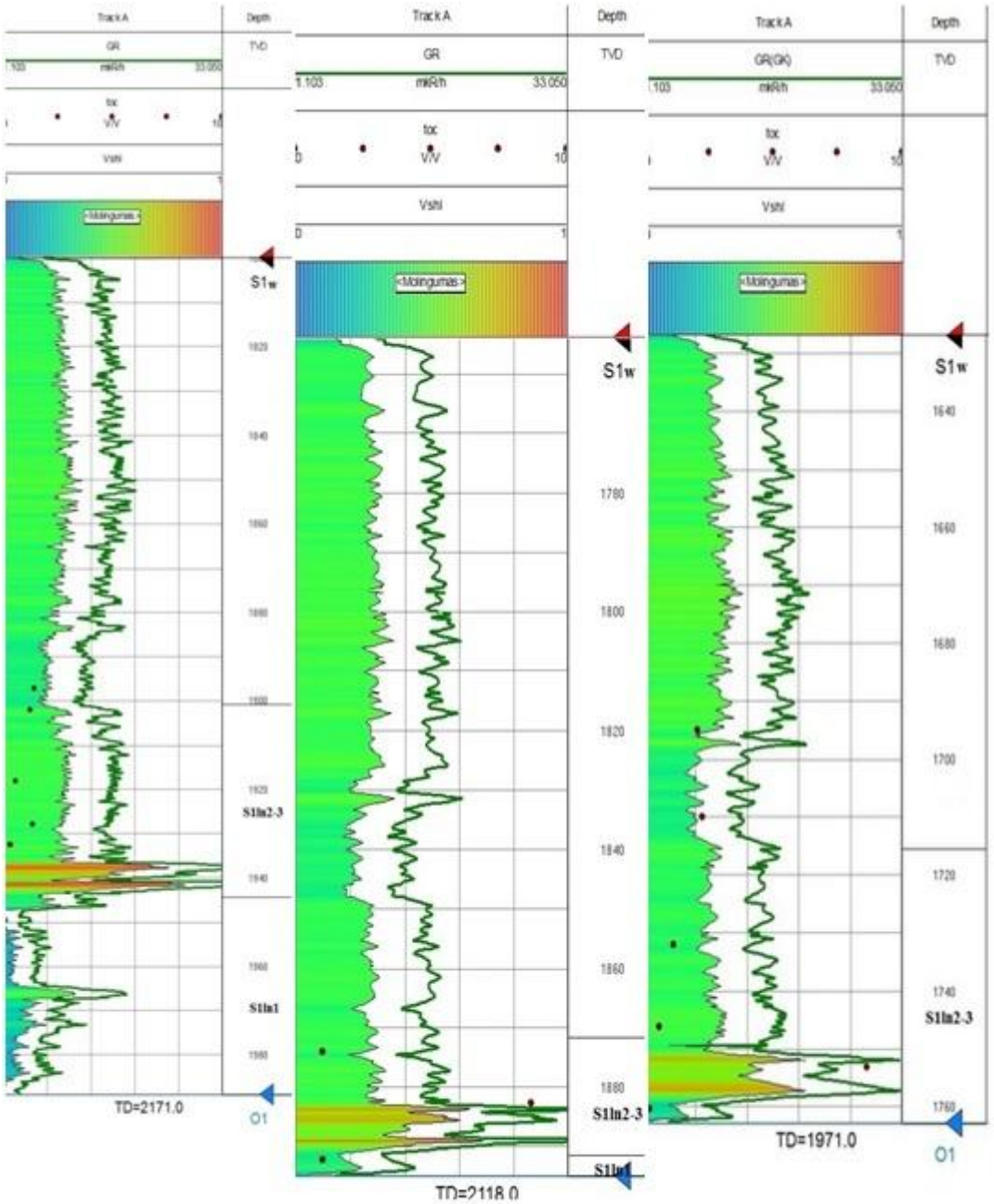
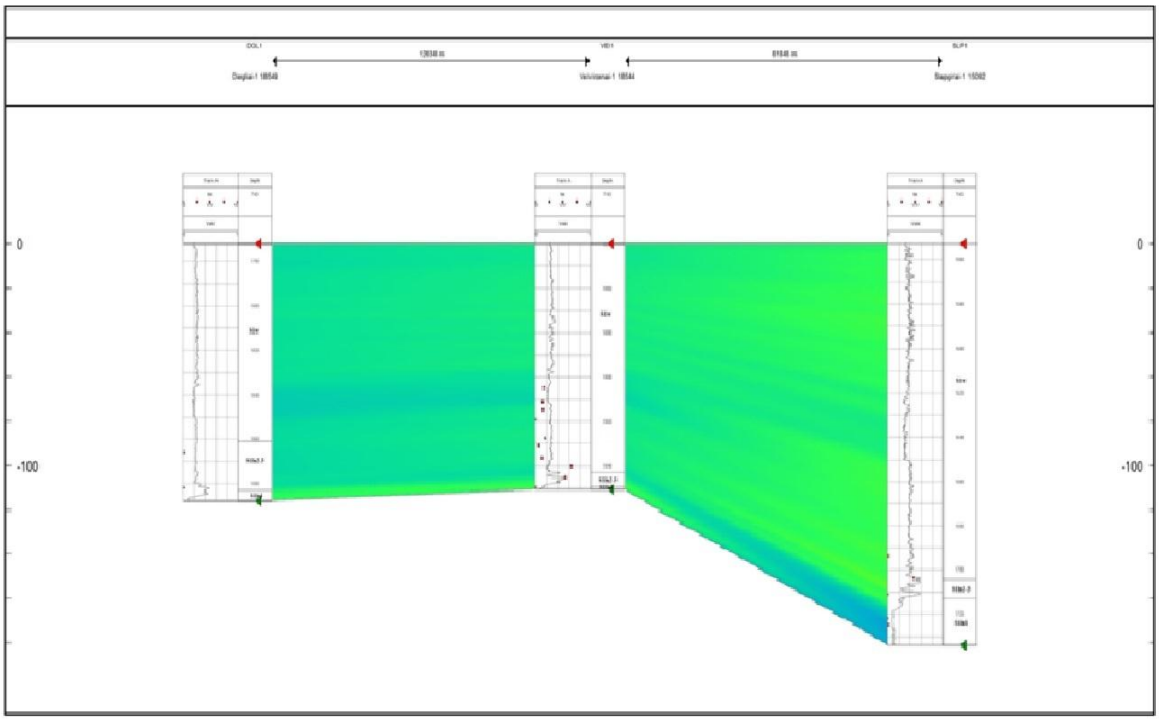


Fig. 1. Shale content alternation in the cross-section Usėnai-3 – Rūkai-2 – Geniai-1.

The same trends as in Rukai-2 well are observed in section of Geniai-1 well. The content of organic carbon is highest (from 1% up to 8.3%) in the Middle and Upper Llandovery and organic carbon content considerably differs in rather narrow interval that implies heterogeneity. Shale content varies from 0.4 to 0.6. Two organic carbon analytical values (~2%) were found for Wenlock sediments, while

the shale content is up to 0.4 there. In Diegliai-1 well in the Middle and Upper Llandovery there were two organic carbon values established: organic carbon content is very low, i.e. 0,1% and 0,2% (Fig. 2). The average of shale content of the Middle Llandovery is 0.5, and 0.2 of the Upper Llandovery. The shale content decreases from 0.4 to 0.1 in Lower Llandovery sediments. The shale content 0.2 on average is in the Wenlock section. Though organic carbon content is low in the mentioned section, the shale content variation tendency is quite similar as in previously described wells. Considerably different trends have been observed in Veiviržėnai-1 well: most of the organic carbon values of Wenlock section are within 0.2-2% interval (Fig. 2). The organic carbon value exceeding 6% has been found in this section. However, average shale content is just over 0.3 in this section. Only one, but rather high, organic carbon value – 5.8% has been found for the Middle and Upper Llandovery, but shale content does not exceed 0.6. Just one organic carbon value (~0.2%) has been found for Lower Llandovery sediments. Analysis of Veiviržėnai-1 well section showed quite high organic carbon content in Wenlock (Fig. 2). In comparison to trend observed in Veiviržėnai-1 well, we see again another picture in Šlapgiriai-1 well: as there were defined much less organic carbon values. There were defined two organic carbon values – 0.2% and 0.4% in Lower Llandovery sediments. Organic carbon content is 0.2% and 4.3% in the Middle and Upper Llandovery, shale content averages around 0.6. There was defined just one organic carbon value – 0.3% in Wenlock, while shale content ranges from 0.3 to 0.4 in this section.

Fig. 2. Sale contnet alternation of cross-section Diegliai-1 – Veiviržėnai-1 – Šlapgiriai-1.



It could be concluded that correlation between shale and organic carbon content may exists in studied wells except in Veiviržėnai 1 well. The most

favourable conditions in terms of organic carbon and shale content composition are observed in shale enriched 5-10 m thick sedimentary layer of the Lower Llandovery and also middle part of the Wenlockian succession where 30-50 m thick, very shaley and homogenous layer of low shale content is located. After the analysis of organic carbon and shale content variations we could conclude, that these two parameters could be related, i.e. in the intervals, where organic carbon content is increased, shale content is also higher, and vice versus - where organic carbon content is lower – shale content is also rather low.

References

1. Lazauskiene, J. et al., Investigations of structure and composition of shaly Lower Paleozoic succession in Lithuanian part of the Baltic Sedimentary Basin. Report of Lithuanian Geological Survey (in Lithuanian). – M., 2014.

2. Lazauskiene J., Sliaupa S., Musteikis P., Brazauskas A. Sequence stratigraphy of the Baltic Silurian succession: Tectonic control on the foreland infill. Geological Society, London, Special Publications. – M., 2003. – 208, 95-115.

3. Poprawa, P., Shale Gas Potential of the Lower Palaeozoic Complex in the Baltic and Lublin-Podlasie Basins (Poland). Przegląd Geologiczny,- M., 2010 – volume 58, p. 226–249 (in Polish).

4. Poprawa P., Sliaupa S., Stephenson R., Lazauskiene J. Late Vendian–Early Palaeozoic tectonic evolution of the Baltic Basin: regional tectonic implications from subsidence analysis. Tectonophysics – M., 1999. – 314, 219-239.

5. Zdanavičiūtė, O., Lazauskienė, I. Organic matter of Early Silurian succession – the potential source of unconventional gas in the Baltic basin (Lithuania). Baltica – M., 2009. – 22 (2), 89–98.

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РАЗРАБОТКА ТЕМАТИЧЕСКОГО АТЛАСА «ВОДНЫЕ РЕСУРСЫ БРЕСТСКОЙ ОБЛАСТИ»

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The article is supposed to give a theoretical basis for atlas mapping, for example, the design of thematic Atlas "Water resources of Brest region".

Карта, как образно-знаковая модель, является наглядным отражением существующей действительности. Кто как ни карта может наглядно отразить свойства, взаимосвязи и особенности картографируемых явлений. Однако если объекты или явления, изображаемые по средствам картографии довольно обширны и многогранны, то изобразить полную картину на одной лишь карте не представляется возможным. Чтобы решить данную проблему, картографы с давних времен научились составлять серии карт, объединенных под одной тематикой, в атласы.