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Mineral composition and preferred orientation of minerals in shales from Palaeozoic Baltic Basin

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Ordovician and Silurian rocks from the Palaeozoic Baltic Basin in northern Poland, often described simply as “shale”, embrace a wide range of siliceos and argillaceous rocks. The little knowledge that is available about their detailed mineralogical is mainly limited to qualitative data, so the main aim of this work was to obtain their quantitative mineral composition, based on analysis of thin sections with SEM, FIB and EDS techniques supported by XRD data. The mineral composition of shales dictates their chemical properties and is also a major factor determining their physical properties, especially relating to their stability during drilling, hydraulic fracturing, and hydrocarbon production. Knowledge of the mineral composition of different shales plays a very important role in identifying optimal proppants, fracture fluids and pumping schedules. The mineralogy of the shale is an important influence on total gas capacity. Carbonate-rich shales indicate adjacent carbonate platform and embayment succession origins, and commonly have a lower organic carbon content and porosity, and a corresponding lower gas capacity, than shales with lower carbonate content. All samples show a rather complex mineralogical composition with illite, micas, quartz, calcite, dolomite and chlorites as major minerals. It was possible to point out the microzones that contain higher amount of brittle minerals and therefore should be especially prone to cracking.

Anisotropy in clay-rich sedimentary rocks is receiving increasing attention. This feature is very important for the prospecting for hydrocarbon deposits and for hydraulic fracturing. Anisotropy of diffusion has become relevant for environmental contaminants, including nuclear waste. In both cases, the orientation of component minerals is a critical ingredient. In this study I also show the orientation of different mineral components in shales with image analysis methods that allow me to characterize the shape of grains and its preferred orientation with respect to their elongation quantitatively. It is clear that not only clay minerals but also brittle minerals (quartz, carbonates, feldspars) contribute to anisotropy of shales.