Stratigraphic distribution and lithofacial variations of Carboniferous shales

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The lithofacial and chemical characteristics of organic-rich Carboniferous mudstones were related to sequence stratigraphic units of a rifting basin. The composition of the analysed black shales reflects the conditions of sedimentation, post-rifting subsidence, water chemistry and thermal conditions of the Carboniferous succession (ULMISHEK et al., 1994). Examination area is the north-western part of the Dniepr-Donets Basin (Ukraine). The analyses of bore core samples from 12 wells provide an overview of the cyclic deposition of siliciclastic and carbonaceous sediments in fluvial, lagoonal and shallow-marine environments from the Devonian to the Serpukhovian period (SACHENHOFER et al., 2010). South-east of the Srebnen Depression the well Rud 2 allows a detailed stratigraphic analysis because of the sample density. The well intersects 1500 m of Upper Visean to Tournaisian layers of sandstone, shale and carbonate. 101 bore core samples of black shales originate from the productive horizons V-16 to T-5.

Qualitative and quantitative mineralogical analysis was carried out by X-ray diffraction analysis. X-ray fluorescence spectroscopy delivered the chemical data and served for the validation of the XRD-data. Leco and Rock Eval parameters provided information concerning the percentages of TOC, sulphur, calcite and thermal maturity data (SACHSENHOFER et al., 2012).

Within the productive horizons of the Upper Visean (V-16 to V-23), Lower Visean (V-24 to V-25) and Tournaisian (T-3 to T-5), the major mineralogical phases of the black shales are represented by kaolinite-group minerals, mica-group minerals and quartz. In minor quantities expandable clay minerals (primarily illite-smectite), chlorite-group minerals, feldspar, pyrite and siderite exist, whereby the increased values of Fe-sulfide and -carbonate in Upper Visean and Tournaisian occur. Different transport properties mainly caused the observed selective mineral concentration of illite and kaolinite.

The uppermost part of the Upper Visean succession can be distinguished by the occurrence of chlorite and a higher amount of diagenetic plagioclase. In the Upper Visean horizons V-19 and V-22 the increasing content of expandable clay minerals indicates post depositional heat flow. In horizons V-23 (Rudov Beds) and V-22 a maximum TOC content of up to 5 % occurs and can be related to three different sedimentation patterns of the main mineral phases kaolinite, quartz, illite, siderite and pyrite. In the Lower Visean carbonate contents up to 90 % indicate a major transgression. The upper part of the Tournaisian is characterized by carbonate-quartz-rich layers. In a depth of 5500 m the change of the sedimentation conditions are visible by a significant lithofacial change, represented by the high increase of the kaolinite content and after a further 100 m in a maximum content of siderite.

A correlation between the weight percentage of Si, K, Al and Fe and the main mineral phases could be observed. A weak correlation exists between the ratio of Zr/K plotted against quartz percentages. A further weak correlation was found between Ti and Al as well as TiO_2 versus Zr. A weak correlation between Cr and V suggests a similar source for both elements. The K/Al ratio correlates well with the ratio of illite/kaolinite.

References:

SACHSENHOFER, R.F., SHYMANOVSKYY, V.A., BECHTEL, A., GRATZER, R., HORSFIELD, B. & REISCHENBACHER, D. (2010): Paleozoic Source Rocks in the Dniepr-Donets Basin (Ukraine).- Petroleum Geoscience, 16, 377-399.

SACHSENHOFER, R.F., PRIVALOV, V.A. & PANOVA, E.A. (2012): Basin evolution and coal geology of the Donets Basin (Ukraine, Russia): An overview.- International. Journal of Coal Geology, 89, 26-40.

ULMISHEK, G.F., BOGINO, V.A., KELLER, M.B. & POZNYAKEVICH, Z.L. (1994): Structure, stratigraphy, and petroleum geology of the Pripyat and Dnieper-Donets basins, Byelarus and Ukraine.- In: LANDON, S.M. (ed.): Interior rift basins. American Association of Petroleum Geologists Memoir, 59, 125-156.