Geochemistry of organic matter from Lower Ordovician Dictyonema Shale (Podlasie Depression, NE Poland)

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Lower Ordovician Dictyonema Shale occur in the Podlasie Depression (NE Poland). The succession comprises from about a dozen cm to 4.0 m (2.7 m at the average) of black claystones passing gradually upwards into the brownish ones. The rocks display U-V-Mo mineralization (black shale type).

20 samples were covered by geochemical studies, including TOC, bitumen fractions, saturated hydrocarbons, aromatic hydrocarbons. Moreover, vitrinite reflectance measurements and maturity calculations were made on vitrinite-like matter.

TOC content ranges from 3,86 do 11,5% which shows shale samples also show good to very good hydrocarbon generating potential of the studied samples. This is confirmed by generation of significant amounts of hydrocarbons, ranging from 450 do 2,860 ppm. The share of hydrocarbons in bitumens ranges from 11% to 36,6%, being lower than that of asphaltenes and resins. The amounts of aromatic hydrocarbons predominate over those of the saturated ones. The coefficient of migration is low (from 0.002 to 0.013), showing that labile components are syngenetic with sediment. Analysis of n-alkanes indicated that the organic matter is here of the sapropel type. Detailed analysis of compounds of the terpane group showed low level of maturation of organic matter. This is confirmed by results of measurements of thermal maturation of authigenic organic components. Average vitrinite reflectance values range from 0,46 to 0,61% Ro, being not related to depth of burial of these rocks. The obtained data indicate low temperature diagenesis (of the order of 50-800C at the most).

Lower Ordovician Dictyonema Shale series are rich in solid organic matter and may be treated as very good parent rocks for hydrocarbon generation. At the same time they are rich in labile components. The organic matter is of marine origin and represents products of decay of algae and bacteria. Degree of its alteration is low, corresponding to early stage of oil window. Therefore, these rocks and the overlaying ones do not appear promising as a target in search for shale gas reserves.

Resolving the gap between laboratory and field rates of weathering

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The rate of minerals' weathering is a key factor in many environmental problems such as the relationship between silicate weathering and global climate over geological timescales, the availability of inorganic nutrients in soils, geological carbon sequestration, global geochemical cycles, and the distribution of porosity and permeability in hydrocarbon reservoir rocks [1]. Weathering rates of silicate minerals observed in the lab are up to five orders of magnitude higher than those inferred from field studies. The many differences between experimental conditions in the lab and natural conditions in the field have been thoroughly discussed in previous studies, but the gap was not fully resolved.

This study is using a novel method to determine dissolution rates in a single point batch experiment by measuring the change of silicon stable isotopes ratio of a spiked solution with time. The silicon isotope ratio method is used in the present study to measure weathering rates of feldspar under ambient temperature and circum neutral pH [2]. It is for the first time that albite dissolution rate (or any silicate mineral) is described as a function of deviation from equilibrium under ambient temperature and circum neutral pH. The new experimental data confirm the extrapolation of high temperature data and numerical modeling exercise [3,4,5], and fully resolve the gap between lab measurements and field estimates. The agreement between the confirmed rate law and the field data indicates that the extensive debate on the gap reflects the so far inability to measure the dissolution rates under typical field conditions, using standard laboratory experiments.

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