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Structural factors affecting pore space transformation during hydrocarbon generation in source rock (shales): laboratory experiments and X-ray microtomography/SEM study

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Oil and gas generation is a complex superposition of processes which take place in the interiors and are not readily observable in nature in human life time-frames. During burial of the source rocks organic matter is transformed into a mixture of high-molecular compounds - precursors of oil and gas (kerogen). Specific thermobaric conditions trigger formation of low molecular weight hydrocarbon compounds. Generation of sufficient quantities of hydrocarbons leads to the primary fluid migration. For series of our experiments we selected mainly siliceous-carbonate composition shale rocks from Domanic horizon of South-Tatar arch. Rock samples were heated in the pyrolyzer to temperatures closely corresponding to different catagenesis stages. X-ray microtomography method was used to monitor changes in the morphology of the pore space within studied shale rocks.

By routine measurements we made sure that all samples (10 in total) had similar composition of organic and mineral phases. All samples in the collection were grouped according to initial structure and amount of organics and processed separately to: 1) study the influence of organic matter content on the changing morphology of the rock under thermal effects; 2) study the effect of initial structure on the primary migration processes for samples with similar organic matter content. An additional experiment was conducted to study the dynamics of changes in the structure of the pore space and prove the validity of our approach.

At each stage of heating the morphology of altered rocks was characterized by formation of new pores and channels connecting primary voids. However, it was noted that the samples with a relatively low content of the organic matter had less changes in pore space morphology, in contrast to rocks with a high organic content. Second part of the study also revealed significant differences in resulting pore structures depending on initial structure of the unaltered rocks and connectivity of original organics. Significant changes in the structure of the pore space were observed during the sequential heating in the range from 260° C to 430° C, which corresponds to the most intense stage of the hydrocarbons formation.

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