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Studying of shale organic matter structure and pore space transformations during hydrocarbon generation

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Due to the increased interest in the study of the structure, composition, and oil and gas potential of unconventional hydrocarbon resources, investigations of the transformation of the pore space of rocks and organic matter alterations during the generation of hydrocarbon fluids are getting attention again. Due to the conventional hydrocarbon resources decreasing, there will be a necessity to develop new unconventional hydrocarbon resources. Study of the conditions and processes of hydrocarbon generation, formation and transformation of the pore space in these rocks is pivotal to understand the mechanisms of oil formation and determine the optimal and cost effective ways for their industrial exploration.
In this study, we focus on organic matter structure and its interaction with the pore space of shales during hydrocarbon generation and report some new results. Collected rock samples from Domanic horizon of South-Tatar arch were heated in the pyrolyzer to temperatures closely corresponding to different catagenesis stages. X-ray microtomography method and SEM were used to monitor changes in the morphology of the pore space and organic matter structure 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. This work was partially supported by RSF grant 14-17-00658.