Changes in porosity structure when the elastic nature of rock deformation is disturbed.

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The authors in a number of works have investigated changes in the pore space structure of rocks in preparation for rock fracture [Zhukov, Salov, and Kuzmin, 1991; Zhukov and Kuzmin, 2003], and showed that the presence of cracks in rocks significantly affects their physical properties [Zhukov, 2012, Zhukov, Semenov, and Kuzmin, 2018; Zhukov and Kuzmin, 2020]. But to date, even at the laboratory level, various aspects of the influence of the porosity structure and, in particular, the ratio of intergranular and fracture porosity of rocks on the nature of deformation and fracture preparation of rocks have not been fully investigated.

This work considers changes in the porosity structure of sandstone when the elastic nature of deformation and fracture preparation is disturbed under conditions simulating reservoir conditions [Zhukov et al., 2021]. The samples were separated according to the type of deformation and fracture. The characteristic samples were used to show the differences in the character of changes in their total porosity and its components (intergranular and fracture). It has been revealed that the character of changes in the total porosity and its intergranular component with increasing axial compression has a character similar to the character of changes in volumetric deformation.

Separate analysis of the fracture and intergranular porosity components allowed us to reveal that the deformation processes occurring in the sample during the transition from elastic deformation to fracture are accompanied by both compaction of rock due to a decrease in the volume of intergranular pores and decompaction due to an increase in fracture porosity. It has been revealed that the components of total porosity (intergranular and fracture porosity) respond differently to changes in the stress state and the nature of deformation of samples. It is shown that the initial fracture porosity of specimens has a significant effect of differences in the fracture preparation of sandstone specimens. Changes in crack porosity, despite its much smaller values compared with intergranular porosity, exhibit a modulating (controlling) character during the transition from elastic (linear) deformation to brittle, elastic-plastic and dilatant nature of deformation of samples before their fracture. It is suggested that sharp changes in the value of crack porosity and its share in the total porosity should be taken as precursors or triggers of these transitions.

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