Trigger action of the thermal impact on propagation of rock structural defects formed during the mechanical pre-loading

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In the paper, it investigates trigger (initialing) action of thermal impact on growth of microdefects (cracks), pre-formed in rock sample under mechanical loading.

We experiment with samples of sandstone and sandstone-like rocks of metaterrigenous origin (partially metamorphosed under high pT-conditions sandstone). The pre-mechanical loading was carried out on laboratory press in uniaxial mode to a load close to fracturing, but before appearance of macroscopic faults. The thermal impact was carried out on a specially designed laboratory setup, which provides controlled heating and cooling of the rock sample up to 700°C. Control of development of thermally stimulated destruction was realized by registration of thermoacoustic emission. Identification of events of growth of previously formed cracks was based on clustering of detected impulses of the thermoacoustic emission. Check experiments with thermal effect on rock samples that were not subjected to preliminary mechanical loading were carried out separately.

The experimental results showed that in case of pre-loaded samples it is possible to distinguish several clusters of thermoacoustic emission impulses. Presumably, each cluster corresponds to its own crack. The distribution of impulses from the clusters in time and amplitudes during heating indicates both different moment and activation threshold of the corresponding cracks, and different intensities of crack growth events. Impulses from the clusters are observed both during heating and during cooling of the samples. On the check samples of not only sandstones, but also other rocks, it was not possible to identify stable clusters of impulses in process of thermal impact.

Analysis of the results suggests a possible initiating effect of thermomechanical stresses on the growth of cracks previously formed in rock samples under mechanical loading. Dynamics of impulses from the clusters during the heating shows that some cracks grow steadily during the entire thermal impact, while growth of others is activated at some stage of heating. Beginning of crack growth corresponds to a different temperature, which is possibly related to different level of the stress state around cracks. In pre-loaded samples, cracks were observed visually, but it isn't possible to identify them with growing during thermal impact cracks. Absence of impulse clusters for the non-loaded check samples indicates a difference in mechanisms of thermal failure without prior mechanical loading and after it.

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