EGU21-899, updated on 25 Jan 2022
https://doi.org/10.5194/egusphere-egu21-899
EGU General Assembly 2021

Fluid Initiation of Fracture in Dry and Water Saturated Rocks

Tatiana Kartseva[1,2], Vladimir Smirnov[1,2], Alexander Ponomarev[1], Andrey Patonin[1,3], Anna Isaeva[2], Natalia Shikhova[1,3], Maria Potanina[1,2], and Svetlana Stroganova[1]

[1]Schmidt Institute of Physics of the Earth, Russian Academy of Sciences (IPE RAS), Laboratory of Eartquake Physics and Rock Instability (avp@ifz.ru)

[2]Faculty of Physics, Moscow State University, Earth Physics Department (ti.kartceva@physics.msu.ru, vsmirnov@physics.msu.ru)

[3]Geophysical Observatory "Borok", IPE RAS (patonin_borok@mail.ru)

We present the results of the laboratory studies on fluid-initiated fracture in the samples of porous-fractured rocks that have been initially saturated with a pressure-injected fluid and then tested under increasing fluid pressure in saturated rocks. The tests were conducted at the Geophysical observatory “Borok” of Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences. The laboratory is equipped with electrohydraulic press INOVA-1000. The experiments were conducted on the rock samples with substantially different porosity. The tested samples were made of Buffalo sandstones, granites from the well drilled in the area of Koyna-Warna induced seismicity, and of granites from the well in the Voronezh crystalline massif. The permeability of granite samples was varied by their controlled artificial cracking by successive heating and cooling. A preliminarily dried sample was initially subjected to uniaxial loading in uniform compression (confining pressure). Loading was performed at a constant strain rate until the moment when the growth rate of acoustic emission (AE) activity began to accelerate which indicated that the stress level approaches ultimate strength. Since that, the loading rate was decreased by an order of magnitude, and water was infused into a sample from its top face. The bottom end of a sample was tightly sealed and impermeable to water. After this, the pore pressure in the sample that had got saturated with water to that moment was raised in steps whose amplitudes were varied. The obtained results of the laboratory studies show that the character and intensity of fluid initiation of fracture markedly differ under primary fluid injection into the dry porous-fractured samples and under the subsequent increases of the pore pressure in the saturated samples. The time delay of acoustic response relative to fluid initiation and the amplitude of the response proved to be larger in the case of water injection into dry samples than in the case of raising the pore pressure in saturated samples. The theoretical analysis of fluid propagation in a pore space of an air-filled sample in the model with piston-type air displacement has shown that in the case of water injection into a dry sample, the fluid pressure front propagates more slowly than in the saturated sample.

Investigation of the acoustic activity and GR b-value responses to the cyclic variations of the pore pressure in the fluid saturated rocks was studied in addition. The changes of b-value were found both for increasing and decreasing of the pore pressure. Obtained laboratory results are similar to

results from the investigations of the seasonal variations of the induced seismicity in the area of Koyna-Warna water reservoirs.

The work was supported partly by the mega-grant program of the Russian Federation Ministry of Science and Education under the project no. 14.W03.31.0033 and partly by the Interdisciplinary Scientific and Educational School of Moscow University «Fundamental and Applied Space Research».