Experimental Study on Mechanical Properties of Heat-Treated Hot Dry Rock Samples Under Combined Actions of Triaxial Stress and Pore Pressure

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Hot dry rock (HDR), which is usually buried depth in 3-10 km, contains abundant heat energy for heating the house and making the electricity. Hydraulic fracturing is an effective technology to develop the geothermal resources. In hydraulic fracturing, a large amount of cold water is injected to generate the artificial fractures in subsurface. However, in previous studies, the study on the mechanical properties of HDR under the combined action of triaxial stress and pore pressure is still in its infancy and an exhaustive investigation is lacking. In this study, we experimentally investigated the heat-treated HDR samples with the integrated consideration of confining pressure and pore pressure.

A total of eight cylindrical specimens were smoothly cored from the granite outcrops at Yan-jiao town in north China, with approximately 25mm in diameter and 50 mm in thickness. These HDR specimens were heated at different temperatures (20℃, 400℃, 600℃ and 800℃), and then they were respectively loaded on the triaxial compression device under the same strain rate (0.04 mm/min) with a constant confining pressure 50 MPa and a constant pore pressure 5 MPa. Meanwhile, a R16α ultrasonic transducer from the Physical Acoustics Corporation was directly glued on each rock sample to monitor the corresponding acoustic emission (AE) feature.

Our main preliminary results are shown as follows: (1). the pore pressure, i.e., the existence of fluid in the fractures and pores, will enhance the mechanical strength of heat-treated HDR samples. In other words, with the increase of heated temperature, the failure strength of these samples is very close, while the rupture morphology is becoming complex; (2). for the heated temperature samples, there are more AE events before the failure than that for the samples at room temperature (20℃), which is caused by the friction/compression of thermal cracks; (3). for the heated temperature samples, the b-value calculated by the Gutenberg and Richter formula has an abrupt change compared to that for the HDR samples at room temperature before the failure; (4). for the heated temperature samples, their Power spectra curves obtained by the wavelet fast Fourier transform (WFFT) analysis perceive a downward tendency compared with the samples at room temperature. With the increase of loading stress, their main frequency (100KHz) will become larger than the value (50 KHz) at the initial loading stress.

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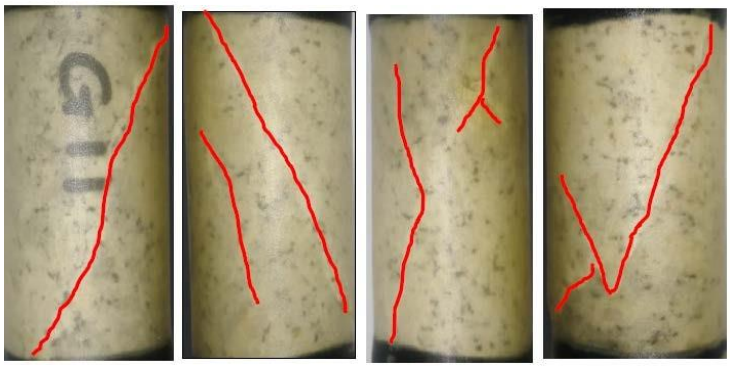

Figure 1: The rupture morphology of HDR samples at different heat-treated temperatures

Keywords: Mechanical properties; pore pressure; hydraulic fracturing; hot dry rock

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