Fracture development in high pressure experiment of shale in Texas, USA

ThanapongVanichnatee and Waruntorn Kanitpanyacharoen

Department of Geology, Faculty of Science, Chulalongkorn University;
Tel.: 081-5567590, e-mail: vanichnatee.t@gmail.com

Abstract: Organic-rich shale has been generally considered as a source rock in hydrocarbon reservoir. With the advancement of horizontal drilling and hydraulic fracturing techniques, recently shale formation can be directly extracted for hydrocarbon. Despite the extensive studies of shale characteristics, there is little information about mechanical behavior and fracture system of shale during hydraulic fracturing process. This study thus aims to simulate the high pressure and high temperature conditions of hydraulic fracturing process and investigate microstructual and mechanical changes of the Barnett Shale from Texas, USA. The multi-anvil press D-DIA apparatus equipped with synchrotron X-ray diffraction (SXRD) technique is used to compress shale to 240 MPa while simultaneously heated to 100 ºc, and monitor compositional various. Moreover, synchrotron X-ray tomographic microscopy (SRXTM) is further used to investigate three-dimensional (3D) microfractures, pores, and organic material of compressed shale. SXRD results show that the sample is mainly composed of quartz (~30%), illite-mica (~20%), and illite-smectite (~20%). Minor minerals include kaolinite (~3%) and pyrite (~7%). Upon increasing pressure and temperature, the volumes of illite-smectitedecrease due to dehydration. Differential stresses of clay minerals and quartz are determined from diffraction patterns, suggesting illite-smectite is the softest mineral due to the highest stress (~2-3 GPa) whereas quartz is the most stiff mineral. Differential stresses also correspond with mineral preferred orientation as evident by the weak degrees of orientation illite-smectite (~2-3 m.r.d.) follow with illite-mica (~3.5-5 m.r.d.) and kaolinite (~7-8.5 m.r.d.). In addition, SXRTM results provide the 3D morphology and distribution of micropores/fractures and kerogen. Before compression of anvils, micropores (0.31 vol.%) are mostly rounded and scattered in the sample. The total organic content is about 2.06 vol.% and mostly aligned parallel with micropores. After compression, unloading of anvils bring about microcracking in the sample. These fractures (1.27 vol.%) have about 2 planes propagating intersect with bedding plane. Permeability is increasedby fracturing. The 3D information can be also illustrated the transport properties of the sample.

PS 026