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Injection-induced seismicity: insights gained from laboratory AE study using sedimentary rocks

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Injection-induced seismicity associated with applications, in which fluids are intensively pressed into deep formations such as Enhanced Geothermal System (EGS), fracking shale gas, geological sequence of CO2, have attracted growing attentions. Motivated by the desire to better understand the mechanism of damaging events so that they can be avoided or mitigated, we have started an integrated study on rock fracturing and fault reactivation in multiscales. In the present paper, we present some preliminary results of an ongoing experimental study utilizing acoustic emission technique in laboratory. Samples of typical sedimentary rocks collected from Sichuan basin, China, where a number of injection-induced seismic swarms with sizable earthquakes ranging up to M4˜5 have been observed in some gas/oil reservoirs. Since most injection-induced earthquakes are located in sedimentary formations of a wide range of lithology and depth, the fracturing behaviors of such rocks are thus important. In order to investigate the role of over pressured fluid in triggering fault instability, the authors carried out two rock fracture tests under tri-axial compression in laboratory. Detailed space-time distribution of acoustic emission due to microcracking was used to examine pre-failure damages and failure behaviors. Our experimental results demonstrate that dolomitic limestone, shale, and porous sandstone from the Sichuan basin show both brittle and ductile fracturing behaviors depending on a number of factors, including drainage condition and confining pressure.

Keywords: Acoustic emission (AE), Microfracture, Rock fracture, Injection-induced earthquake, Sedimentary rocks