# Experimental study on the mechanical properties of pelitic rock during super critical $CO_2$ flooding

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In this study, we evaluated the mechanical properties of pelitic rock during super critical $CO_2$ injection under hydrostatic pressure. Considering the low permeability of pelitic rock as the cap rock in $CO_2$ geological sequestration sites, laboratory measurements were carried out to investigate the mechanical effects in this rock accompanied with the super critical $CO_2$ injection through triaxial tests. In the triaxial test, we used the Boso pelitic rocks of the Otadai Formation in the Kazusa Group, Chiba prefecture, Japan, and monitored the migration of pore fluid in the pelitic rock measuring the compressional wave velocity, strain and fluid flow rate in the confining pressure conditions of 12 - 18 MPa. The pore pressure and temperature conditions were set at 10 MPa and 40 deg.C in order to be the in super critical $CO_2$. A sample length was cut into about 50 mm diameter core and doubly polished to a length of about 125 mm. In the triaxial test, rock samples were saturated with water at a confining pressure of 5.0 MPa, a syringe pump pressure of 2.0 MPa in injecting-side and 0.1 MPa in ejecting-side. In the injecting-side of rock samples, the compressional wave velocity increased after about 12 hours passed, and gradually increased until about 40 hours passed as the result of the migration and saturation of pore water injected into the rock sample. Then, it became nearly constant. In the ejecting-side, the slight ejected water into the syringe pump was observed after about 45 hours passed, and the compressional wave velocity gradually increased, then it became nearly constant after about 65 - 70 hours passed. The injection of liquid $CO_2$ into the rock samples at pore pressure of 10 MPa were carried out by the displacement of water and $CO_2$. At differential pore pressure of 1.0 MPa between the injecting- and ejecting-side, the flow rate in the ejecting-side kept 0 ml/min (no flow) and the compressional wave velocity and strain hardly changed although the $CO_2$ was injected for 120 hours. At differential pressure of 2.0 MPa, the flow rate of injecting and ejecting-side increased gradually and slightly, respectively. However, the compressional wave velocity and strain hardly changed for 50 hours. On the other hand, at differential pressure of 3.0 MPa, the compressional wave velocity and strain remarkably decreased (about -10 %) and increased (about $+700 \times 10^{-6}$Strain), respectively, accompanied with the gradual increase of the flow rate. The compressional wave velocity and strain of ejecting-side became constant after about 130 hours passed. As for the similar results, other $CO_2$ injection tests in this study were also observed. It is inferred that the threshold pressure of the pelitic rock in the Otadai Formation is about 3.0 MPa. In the triaxial compression test, the water-saturated rock sample was brittle and the peak strength showed 15.7 MPa at a confining pressure of 12 MPa and pore pressure of 10 MPa. At a confining pressure of 18 MPa and pore pressure of 10 MPa, rock sample was ductile and the peak strength showed 15.5 MPa. The super critical $CO_2$-saturated rock sample was ductile and the peak strength showed 16.3 MPa.