Coupled chemical osmosis and rock deformation processes in semipermeable mudstone— theoretical and experimental approaches—

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Slow groundwater flow and mass transport processes in mudstone sometimes exhibit non-Darcian flow. For example, it is known that some mudstone shows semipermeable properties because of its negative charge of clay minerals and narrow pore throats (Marine and Fritz, 1981). In such formations, osmotic flow, water flow driven by osmotic pressure, occurs and it induces pore pressure change in low-permeability or hydraulically isolated area (Marine and Fritz, 1981). If large pore-water concentration difference exists in tight and clay-rich formation, osmosis-induced pore pressure can reach to about 20MPa (Neuzil, 2000). Change of pore pressure causes deformation of porous medium. Osmosis-induced pore pressure change can cause deformation of porous medium (Greenberg et al., 1973; Noy et al., 2004) and it is possible that large concentration difference causes rock deformation or destruction in semipermeable formations.

The purpose of this study is to establish a model which describes pressure behavior, solute transport, and deformation of semipermeable mudstone and to discuss the validity of the model through comparing the model result and the results obtained from laboratory experiments. The numerical model is established by coupling the equations of solute transport and pressure behavior in semipermeable mudstone (for example Malusis et al., 2012), and that of poroelasticity (for example Wang, 2000). For laboratory experiments, core samples with 50mm in diameter and 30mm in height were prepared from mudstone samples collected from Neogene formation in Japan. NaCl solution with 10 g/L higher than that of pore water was contacted to one of the surfaces of the sample, and all the other surfaces were sealed with silicone rubber. Longitudinal deformation of the sample surface was measured. Here, optical fiber sensing technique was used to measure strain behavior, and hence, it was possible to measure strains at multi point of the sample. The measurement was continued more than 240hr.

In the presentation, the comparison of results obtained from experiments and calculations will be shown and the significance will be discussed.

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