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Effect of confining pressure on the chemico-osmotic property of sedimentary rock

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Precise characterization of groundwater flow system is necessary for performance assessment of geological disposal of radioactive waste. In low-permeability sedimentary formations in coastal regions, heterogeneous salinity distributions may induce chemical osmosis, causing fluid pressure anomalies from hydrostatic pressures. In order to characterize the groundwater flow systems with salinity gradients, the magnitude of chemical osmosis needs to be identified by an approach with the combination of experiments and numerical modeling. This study developed a laboratory apparatus for chemical osmosis experiments that simulates in-situ lithostatic pressures, and performed a series of experiments using a siliceous mudstone, taken from Horonobe area in Hokkaido, under confining pressures ranging from 1 to 20 MPa. The measured pressure differences between the ends of disc-shaped rock sample range from 9.1 to 26.4 kPa. The salinity differences are almost consistent in a series of experiments, and range from 0.110 to 0.118 M NaCl. From the measured salinity and pressure differences, the reflection coefficients approximated from van't Hoff equation ranges from 0.020 to 0.049, and show the correlation with the confining pressure. Based on the results derived from this study, potential osmotic pressures induced by the salinity differences between fresh and saline waters should be examined using the field scale numerical model for further studies.

Keywords: sedimentary rock, chemical osmosis, osmotic pressure, laboratory experiment