Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HRE28-20 Room:105 Time:May 25 16:15-16:30

Wellbore integrity assessment of CO2 sequestration site from the geochemical reaction using well composite samples

NAKANO, Kazuhiko[1*] ; MITO, Saeko[1] ; XUE, Ziqiu[1]

[1]Research Institute of Innovative Technology of the Earth

We studied to the geochemical interaction between CO_2, well cement and sandstones for the long-term wellbore integrity in a CO_2 sequestration. To simulate the wellbore system, we prepared well composite samples consisting of steel casing, Portland cement (API ClassA), and sandstone. Using the samples, batch experiments were conducted at 50 ℃ and 10 MPa of CO_2 pressure corresponding roughly 1 km below the ground surface. The well composite samples were exposed to the CO_2 saturated brine and the supercritical CO_2 and for 56 days.

After the reaction with CO_2, cement alteration zone were clearly observed along the cement-sandstone interface under CO_2 saturated brine condition and wet-CO_2 condition. The cement alteration zone was visibly divided into two layers; one is an orange-colored layer (carbonation zone) in the outer cement, and another is white-colored layer in the inner cement. The carbonation depth under wet-CO_2 condition was larger than that under CO_2-saturated brine condition. However, the carbonation depth was a few millimeters and inner part of cement did not altered within 56 days of the reaction. Based on the results the predicted 30 years carbonation depth evaluated by a logarithmic approximation was estimated at 4.5 mm for wet-CO_2 condition and 0.76 mm for CO_2-saturated brine condition, respectively. The Ca concentration in the carbonation zone increased 13% in comparison to that in the unaltered cement zone while the Mg, Si, and S concentrations decreased significantly. The predominant crystalline phases in the carbonation zone were $CaCO_3$ (calcite, aragonite, and vaterite). On the other hand, focusing on the sandstone side, it was observed that small points rich in Ca distributed in the pore spaces of the sandstone. This suggests that the precipitation of calcium carbonate is as result of Ca^{2+} diffusion out of the cement coupled with inward diffusion of carbonate ion. The formation of $CaCO_3$ reduces cement permeability and increases its compressive strength. These results indicate that the formation of fine carbonate provides an effective barrier to further CO_2 attack.

Keywords: CCS, well integrity, cement, carbonation