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Investigation of the relationship between CO_2 reservoir rock property change and the surface roughness change originating from the supercritical CO_2-sandstone-groundwater geochemical reaction at CO_2 sequestration condition

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Lab scale experiments were performed to investigate the property changes of sandstone slabs and cores, resulting from the $scCO_2$-rock-groundwater reaction for 180 days under CO_2 sequestration conditions (100 bar and 50 ºC). The geochemical reactions, including the surface roughness change of minerals in the slab, resulted from the dissolution and the secondary mineral precipitation for the sandstone reservoir of the Gyeongsang basin, Korea were reproduced in laboratory scale experiments and the relationship between the geochemical reaction and the physical rock property change was derived, for the consideration of successful subsurface CO_2 sequestration. The use of the surface roughness value (SRrms) change rate and the physical property change rate to quantify $scCO_2$-rock-groundwater reaction is the novel approach on the study area for CO_2 sequestration in the subsurface.
From the results of SPM (Scanning Probe Microscope) analyses, the SRrms for each sandstone slab was calculated at different reaction time. The average SRrms increased more than 3.5 times during early 90 days reaction and it continued to be steady after 90 days, suggesting that the surface weathering process of sandstone occurred in the early reaction time after CO_2 injection into the subsurface reservoir. The average porosity of sandstone cores increased by 8.8 % and the average density decreased by 0.5 % during 90 days reaction and these values slightly changed after 90 days. The average P and S wave velocities of sandstone cores also decreased by 10 % during 90 days reaction. The trend of physical rock property change during the geochemical reaction showed in a logarithmic manner and it was also correlated to the logarithmic increase in SRrms, suggesting that the physical property change of reservoir rocks originated from $scCO_2$ injection directly comes from the geochemical reaction process. Results suggested that the long-term estimation of the physical property change for reservoir rocks in CO_2 injection site could be possible from the extrapolation process of SRrms and rocks property change rates, acquired from laboratory scale experiments. It will be aslo useful to determine the favorite CO_2 injection site from the viewpoint of the safety.