Effects of CO_2(g)-soil-water interactions on the leaching behaviors of major metals at the atmospheric P_{CO2}(g) of 1 bar

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Recently, carbon dioxide capture and sequestration (CCS) into geologic storage reservoirs have attracted attention to mitigate the global climate changes. However, the environmental impact of unintentional leakage of CO_2(g) from the storage sites could pose potential risks of CCS techniques. This study examined the factors controlling the rate and extent of elemental leaching from soil by CO_2(g)-soil-water interactions and focused on the intrinsic effect of CO_2(g) on the mobilization of major metals as a result of the interactions.

Soil samples were collected from the Environmental Impact evaluation Test facility (EIT) sites in Republic of Korea and characterized for physico-chemical properties. Batch experiments were carried out using 63-μm-sieved soil samples and deionized water at a soil-to-water ratio of 1:20 under varying atmospheric conditions; a specially designed CO_2-glove box (92-95 vol.% CO_2, 1-2 vol.% O_2), a N_2-glove box (95 vol.% N_2, 5 vol.% H_2) or open to the atmosphere. Various factors including solution pH (uncontrolled, P_{CO2} controlled or HNO_3/NaOH controlled), partial pressure of O_2 (P_{O2} = 0, 0.01-0.02 or 0.21 bar) or CO_2 (P_{CO2} = 0, $10^{-3.4}$ or 0.95 ± 0.01 bar) were considered to compare the leaching behaviors of major metals from the soil samples. The mineralogical and the geochemical compositions of the soil samples did not change significantly during 21 d under all experimental conditions. Acidification of solution mainly due to CO_2(g) dissolution caused an increase in metal mobilization by a factor of 4.4, 4.4, 2.6, 2.5, and 1.1 for Ca, Mg, Mn, K, and Si, respectively. In addition, CO_2(g) itself exerted supplementary effects on the elemental leaching besides the acidification effect. Sequential extraction of the soil samples indicated that the major cations were likely released from the easily leachable fractions such as of exchangeable, carbonates, and Fe-Mn oxides.