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Evaluating CO_2 mineralization capacity of sedimentary rock Using BCR sequential extraction procedures

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To relief the high concentration of carbon dioxide in the atmosphere, carbon capture and storage (CCS) is gradually becoming an important concept to reduce greenhouse gas emissions. In IPCC Special Report on CCS, the storage mechanisms for geological formations are categorized into structural/stratigraphic, hydrodynamic and geochemical trappings. Geochemical trapping is considered as a storage mechanism, which can further increase storage capacity, effectiveness and security in terms of permanent CO_2 sequestration. The injected CO_2 can have geochemical interactions with pore fluid and reservoir rocks and transform into minerals. It is important to evaluate the capacity of reservoir rock for sequestrating CO_2.

In this study, sedimentary rock samples were collected from a 2-km-deep well in Midwestern Taiwan; and, the BCR sequential extraction experiments developed by European Union Measurement and Testing Programme were conducted. BCR was designed for extracting three major phases from soil, including exchangeable phase and carbonates (the first stage), reducible phase (the second stage) and oxidizable phase (the third stage). The chemistry of extracted solutions and rock residues were measured with ICP-MS and XRF, respectively. According to the results of XRF, considerable amounts of calcium and iron can be extracted by BCR procedures but other cations are negligible. In general, shale has a higher capacity of CO_2 sequestration than sandstone. The first stage of extraction can release about 6 (sandstone) to 18.5 (shale) g of calcium from 1 kg rock, which are equivalent to 6.6 and 20.4 g CO_2/kg rock, respectively. In the second stage extraction, 0.71 (sandstone) to 1.38 (shale) g/kg rock of iron can be released and can mineralized 0.56 to 1.08 g CO_2/kg rock. However, there are no considerable cations extracted in the third stage of BCR as shown by the XRF analysis. In addition, the results of ICP-MS show that Mg can be released in the order of 10^{-3} g from 1 kg rock while cations of Zn, Co, Ni, Cd, Pb, Cu and Ba are in the order of 10^{-4} g.