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A Semi-quantitative Estimation of CO2 Mineral Sequestration in Miocene Basalt in Northwestern Taiwan

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In IPCC Special Report on carbon dioxide capture and storage, 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 CO2 sequestration. The injected CO2 can have geochemical interactions with pore fluid and reservoir rocks and transform into minerals. Basalt is one of the potential storage reservoirs.
In general, CO2 sequestration by carbonation is estimated by laboratory experiment and geochemical simulation. In this study, evaluation of CO2 sequestration is based on a natural analog study of the Miocene basalt in the Kuanhsi-Chutung area, Northwestern Taiwan. This region has great potential in terms of geological and geochemical trapping of anthropogenic CO2. Outcropping Miocene basalt in the study area shows serpentinization and carbonation. The carbon and oxygen stable isotopes of carbonates demonstrate that carbonation process is mainly controlled by carbonate precipitation from meteoric fluid under low temperature rather than water-rock interaction. According to petrographic observation and electron microprobe analysis, the major products of serpentinization and carbonation include serpentine, calcite, magnesite, dolomite, saponite, nontronite -like mineral and quartz. In addition, diopside grains in basalts and ultramafic xenoliths are resistant to the alteration and the other minerals are readily to be altered and replaced by carbonates. These results demonstrate that the fluid causing alteration is likely enriched with calcium and may have high pH. These derived geochemical properties of the fluid support the late Miocene sandstone and enclosed basalts in the study area as having high potential for being a CO2 sequestration reservoir. Based on the mineral transformation in xenoliths and derived fluid chemistry, the capacity of CO2 mineral sequestration is semi-quantitatively estimated at 94.15 kg CO2 chemically trapped per 1m3 Miocene basalt if the proportion of alteration was 0.2. With this value, total CO2 sequestration capacity can be evaluated by a geophysical survey of the amount of viable Miocene basalt at the potential sites.