Enhanced CO_2 mineralization in a basalt-water-$NaHCO_3$ hydrothermal system

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Efforts must be made to avoid the negative effect of climate change and ocean acidification which are partially caused by the continuous increase in atmospheric CO2. Mineralization of the CO2 by Ca and Mg-bearing rocks has been considered one of the most promising means for CO2 reduction. To mitigate the main problem left by previous studies for CO2 mineralization, i.e., low mineralization rate, here we report a novel experimental study of enhanced CO2 storage in a basalt-water-NaHCO3 hydrothermal system. Basalt is used as the feedstock for CO2 storage, which is composed of plagioclase, pyroxene, and olivine, etc., and NaHCO3 solutions were used as the carrier of CO2 as well as to maintain a weakly alkaline condition for carbonation.
First, Ca-rich anorthite, which is also common in basalt, was used to study the feasibility of the proposed system. As a result, a large portion of anorthite was carbonated at 300 °C in 5 days, with the production of calcite and cancrinite as the secondary minerals. The addition of NaHCO3 accelerated the hydrothermal alteration and carbonation of anorthite. After that, experiments on basalt-water-NaHCO3 hydrothermal alterations under various reaction times and temperatures were conducted. At 300 °C, calcite was identified as the dominant CO2 mineralization product, besides, smectite was produced in 5 days, and analcite was only found after 10 days reaction. The amount of calcite produced in 10 days was 5 times higher than that produced in 5 days. Reaction temperature also significantly affected the CO2 mineralization rate. The amount of calcite produced was 6 times higher at 230 °C than at 200 °C, and 9 times higher than that at 300 °C, indicating that the mineralization of CO2 can be greatly enhanced at higher than 230 °C. Furthermore, it was shown that the basalt system can mineralize CO2 more efficiently than the anorthite system.

Keywords: Basalt-water-NaHCO3, CO2 mineralization

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