AFM measurements of feldspar dissolution rates under supercritical CO2-water-mineral system

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As a part of the assessment on the underground CO2 storage, feldspar dissolution experiment was performed in supercritical CO2-water-mineral system at 25, 50, 65 and 80C, leaving CO2 pressure constant 10MPa. Atomic force microscope (AFM) was applied for the nanoscale observations of dissolved feldspar surface. In order to measure the dissolution rates from surface retreat, the reference plane, which was inert in the solution, was prepared on a part of the sample surface by Au sputtering.

The temperature effects on the crystal surface conditions during dissolution process were clearly revealed by nanoscale analyses. It was identified that anorthite surface retreated vertically on the non-coating area of the sample at 80C. The reacted parts of the surface were uneven and thus rough compared with the coating plane. At both 25 and 50C, on the other hand, the difference of surface conditions was not clear and the non-coating area was considerably flat. On the samples dissolved at 65C, the reacted surface exhibited moderate roughening.

AFM measurement allows us to obtain any vertical cross section profiles within an observed area. The average dissolution rates of anorthite during 1 week were estimated from surface retreat based on these vertical cross section profiles. As a result, it was shown that anorthite dissolution rates significantly increased with temperature. In a series of experiments varying temperature, no pH buffer was used, leaving only CO2 pressure. Therefore, the dissolved CO2 content regulates the solution pH. However, the calculated results using solubility of supercritical CO2 and equilibrium constant at our experimental conditions revealed that the pH values were almost identical in all cases. This means that the observed differences of dissolution rates were mainly caused from the temperature variations.