A Laboratory Experiment on Dissolution of Limestones: the Effects of Temperature and CO2 Concentration

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The purpose of the present study is to reveal effects of temperature and CO2 concentration on dissolution of limestones. Closed-system laboratory experiments were carried out using four kinds of limestone: Abukuba (Ab), Akiyoshidai (Ak), Kuzuu (Ku), Ryukyu (Ry). A tablet for each sample with a diameter of 3.5 cm and a thickness of 1 cm was treated with distilled water of 250 ml in containers. Temperature was controlled at the three conditions of 5, 20, and 50 degrees centigrade under the normal air condition (CO2 concentration being 0.03 %). Carbon dioxide concentration was controlled at 0.03, 3, and 30 % under the room temperature of about 20 degrees centigrade. An electric conductivity (EC) of the aqueous solution in containers was measured at about 24-hour interval until the solution becomes saturated. After finishing the dissolution experiments, the concentration of ions was analyzed, and the weight of each tablet was measured.

Experimental results show that an electric conductivity strongly correlates with the concentration of Ca2+ in aqueous solution and the rate of loss in weight of each tablet. Changing curves in the value of EC with time for all samples are adapted to the following equation:

EC = A [1-exp(-bt)]

where EC is electric conductivity, A is saturated value in electric conductivity, b is a coefficient, which indicates the dissolution rate in the initial stage of experiments, and t is duration. Results show A-values become smaller and b-values become larger with increasing temperature. This indicates that saturated solubility becomes smaller, and initial dissolution rate becomes larger with increasing temperature. The result that saturated solubility is smaller with increasing temperature was agreement with the existing finding saturated solubility of pure calcite minerals. When CO2 concentration becomes higher, both A-value and b-value become larger. That is, saturated solubility and initial dissolution rate are larger when CO2 concentration is larger.

For the case of Ku-sample containing dolomite, the degree of influence of temperature and CO2 concentration on dissolution is the lowest. This suggests that the degree of influence of temperature and CO2 concentration on dissolution depends on the amount of magnesium contained in limestones.