

Rate of K-feldspar dissolution in acid solution at room temperature and pressure -- influence of organic acid and reactor type

Yasuyuki Hirayama[1], Masato Fukuoka[2]

[1] Integrated Arts and Sci., Hiroshima Univ, [2] Integrated Arts & Sci., Hiroshima Univ.

[Introduction]

The dissolution of silicate minerals is one of the most significant processes of the chemical weathering of rocks. The granite are widely distributed in Japan and thus, to clarify the dissolution rate and mechanism of minerals that comprised granite is important to know the weathering process as well as to discuss the environmental problems, for example acidification of soils, rivers and lakes, in the areas underlain by granite. We studied the kinetics of K-feldspar dissolution as the basic research for the study of weathering processes on granite.

[Experimental Procedures]

K-feldspar of pegmatite, from Miyajima area in Japan, was used in the experiments. K-feldspar was coarsely crushed to be less than 5 mm in length and picked to avoid impurities. The selected K-feldspar grains were grounded by cup mill and then were sieved to obtain the 45-90 micrometers size fraction. Fines were removed by repeatedly washing the fractions in an ultrasonic bath, using deionized water and acetone. The surface area was measured with 5-point BET method.

Two types of reactor, continuously-stirred flow-through type and single path flow-through type, were used for dissolution experiments. The former type was made of teflon bottle. The volume of solution in the reactor was 40 ml and 4 g of K-feldspar fraction were used. Continuously, solution was added and removed with peristaltic pump at about 0.1 ml/min, and stirred with magnetic stirrer. The latter type was made of teflon tube and measured 6 x 100 mm (i.d. x length). It was filled with 3 g of K-feldspar fraction. Reacted solution passed through the reactor at about 0.02 ml/min. Reacted solutions, pH 4 and 5, were prepared with dilute HNO₃ and oxalate, respectively. The conditions for all experiments were as follows; temperature: 25 +/- 0.5 degree with the constant temperature water bath, pressure: room pressure. The concentration of Na, K, Al and Si in the output solution were determined by ICP-AES, and then the dissolution rates were calculated.

[Results]

Dissolution rates of minerals are usually calculated as a function of steady-state Si concentration. So, we defined subsidiary steady-state as the point at which relative release ratio (RRR) appeared unchanged with time.

1) Continuously-stirred flow-through reactor:

The dissolution rates of Si release into HNO₃ solution were as follows; at pH 4: 3.7, at pH 5: 0.95 (10⁻¹² mol/m²sec). This result coincides with that obtained by other studies. At pH 4, the dissolution rates of each element into oxalate solution were approximately three to four times those into HNO₃ solution. At pH 5, the dissolution rates of Si and K into oxalate solution and those into HNO₃ solution were the same. Contrary to the above results, the rate of Al into oxalate solution was eleven times that into HNO₃ solution.

2) Single path flow-through reactor:

Dissolution rates of Si and Al into HNO₃ solution at pH 4 were approximately half of that using continuously-stirred flow-through reactor. On the other hand, there was not a significant difference with reference to the dissolution rates, regardless of the reactor type. At present stage, the experiments at pH 5 are under examination.