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Experimental evidence for pressure solution of quartz aggregate with small effective stress (0.5 MPa) at 25 - 45C

Kazuya Miyakawa[1*], Tianshi Yang[1], Iwao Kawabe[1]

[1]Nagoya University

Dissolution rates of pressure solution (PS) of quartz sand in 0.002 M $NaHCO_3$ solution were experimentally determined at low temperatures (25? to 45?C) and low effective stresses (0.32 to 0.51 MPa) under conditions far from equilibrium. They were 1.5+/-0.4 x 10^{-15} (25?C), 2.1+/-0.3 x 10^{-15} (35?C) and 2.7+/-0.7 x 10^{-15} (45?C) (Si mol/cm^2/sec), respectively. The ratios of the dissolution rates of PS to those of quartz sand at zero effective stress were 4.0+/-1.2 (25?C), 3.0+/-0.6 (35?C) and 2.4+/-0.6 (45?C), respectively. In response to a step-like increase of applied uniaxial loads, the dissolution rates of PS increased definitely at first, but the dissolution rate decreased gradually in the course of keeping the effective stress constant. After the effective stress was removed, there was a tendency that the dissolution rate increases more or less again. The apparent activation energy of our PS experiments was calculated to be approximately 24 kJ/mol, and this value is smaller than that of dissolution reaction of quartz sand at effective stress = 0. Our results clearly show that even at such low temperatures and low effective stresses, Si release into solution as a result of PS can be detected. Actually, when the stress is applied to a cracked granitic medium involving a groundwater flow system, the Si concentration in groundwater may be increased as a result of PS. This is interesting if there are available monitoring data as to dissolved Si in the groundwater for the purpose of earthquake prediction. We suggest that our study would help formulate a new method for the geochemical earthquake prediction study on the basis of pressure solution of SiO_2.

Keywords: pressure solution, quartz dissolution, earthquake prediction