Dissolution experiment of zircon by low-temperature alkaline hydrothermal fluid toward a better understanding of the material migration during serpentinization

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Zircons have been used to decipher the geological record through various isotopic and trace element analyses, including U-Pb dating, because of their high closure temperature and high resistance to geochemical abrasion. However, due to high-grade metamorphism or hydrothermal alteration, zircons often recrystallize or newly crystallize as metamorphic zircons and losing their primary information. The existence of hydrothermal zircons occurred during the serpentinization, which crystallize at ca. 300 ˚C, is extremely unique, but they are widely found in metasomatic rocks associated with serpentine such as rodingite and chlorite rock. In order to simulate the serpentinization reaction, this study conducted reaction experiment of zircon with $Ca(OH)_2$ and $CaCl_2$ solutions at 300 ˚C; 50 MPa. In previous studies, reactions of zircon with NaOH or $Ca(OH)_2$ solution have been studied to investigate high-grade metamorphism, such as 450 ˚C; 200 MPa~1000 ˚C; 2000 MPa. The reaction of zircon with Ca-rich alkaline solution at low temperature similar to serpentinization fluid, has not been investigated. The zircon used in the experiments was a megacryst of ca. 3 cm in diameter from a pegmatite deposit in Malawi, which was crashed to about 300 μm. Several grains of the zircon and the solution were sealed in a gold tube container (~0.3 cc), and then heated and pressured for 100 days. After the experiments, the zircons were collected by pure water rinsing, mounted on epoxy resin, and observed by SEM-EDS. For the zircons in the experiment using $Ca(OH)_2$ solution, a reaction rim of ~5 μm thick was formed, but those using $CaCl_2$ solution no reaction rim was observed. In the reaction rim, Ca, Zr, and a small amount of Si were detected. On the other hand, when zircons were reacted with solution of $Ca(OH)_2$ and $CaCl_2$ mixed by equal weight, a porous reaction rim with a thickness over 50 μm was produced. From the reaction rim, Ca and Zr were detected, while Si was almost undetectable. These results suggest that strong alkalinity and the presence of Cl are important for the dissolution of zircon at low temperatures such as in the serpentinization reaction. In the future, we plan to identify the phases of the reactants and measure the changes in trace element composition.

Keywords: zircon, serpentinite, hydrothermal fluid

