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Low-temperature Zr mobility: An in situ synchrotron-radiation XRF study of the effect of radiation damage in zircon on the element release in H_2O + HCl ± SiO_2 fluids

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ABSTRACT

The release of Zr, U, and Pb from nearly metamict zircon and its recrystallized analog and of Zr from fully crystalline and slightly radiation-damaged zircon in H_2O + HCl ± SiO_2 fluids was investigated in situ at temperatures between 200 and 500 °C using a hydrothermal diamond-anvil cell and time-resolved synchrotron-radiation XRF analyses. Dissolution of nearly metamict zircon proceeded much faster than that of zircon with little or no radiation damage and resulted in a 1.5 to 2 log units higher Zr molality in 6 to 7 *m* HCl fluids. Extensive recrystallization of the almost fully amorphous material started at 260 to 300 °C in H_2O + HCl, and at about 360 °C if quartz was added, and was coupled with a decrease of the Zr concentration in the fluid by more than an order of magnitude. Recrystallization in 7 *m* HCl had little effect on the aqueous U and Pb concentrations, whereas addition of quartz caused a more sluggish decrease of the Zr concentration in the fluid upon recrystallization and lowered the release of U. The data presented here support the interpretation that enhanced Zr mobility in low-grade metamorphic rocks may be related to dissolution of metamict zircon by aqueous fluids and illustrate the significance of the silica activity on the kinetics of dissolution and recrystallization during zircon-fluid interaction.

Keywords: High-temperature studies, zircon-aqueous fluid interactions, hydrothermal diamond-anvil cell, in-situ SR-XRF analysis, dissolution kinetics, order-disorder, metamictization, recrystallization, fluid phase, H_2O + HCl ± SiO_2, recrystallization kinetics