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Metasomatic alteration of zircon in high pH fluids under high-grade conditions

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In nature zircon is one of the principle accessory minerals used for the dating of geologic processes. As a consequence, the stability of zircon in the presence of various possible metamorphic fluids under a range of P-T conditions and its subsequent instability with respect to some of these fluids has begun to be explored experimentally as well as speculated upon in a series of studies of metasomatised zircons in nature (see review in Geisler et al., 2007). Natural alteration of zircon takes place via one of two metasomatically induced processes: diffusion-reaction or coupled dissolution-reprecipitation. Both processes result in the zircon being either partially or totally replaced by either a new re-equilibrated zircon composition or a totally new zircon-related phase. In this study, fragments (50 - 200 μm) from a large, inclusion-free, clear, light brown, euhedral zircon collected from a nepheline syenite pegmatite (Seiland magmatic province, northern Norway) are experimentally reacted in 20 mg batches with a series of high pH fluids plus a Th source (5 mg ThO_2 + $ThSiO_2$) in sealed Pt capsules at 900 ^{o}C and 1000 MPa for 8 days in the piston cylinder press using a CaF_2 setup. Fluids included 5 mg 2 N NaOH , 5mg 2 N KOH, 10 mg $Na_2Si_2O_5$ + 5 mg H_2O, and 5 mg $Ca(OH)_2$ + 5 mg H_2O. The results of these experiments indicate that only the fluid containing $Ca(OH)_2$ reacted with the zircon. This reaction took the form of partial replacement, via dissolution-reprecipitation, of the majority of the zircon grains with baddeleyite (ZrO_2). The rims of the remaining zircon grains are partially replaced by zircon enriched in Th. The replaced rims are characterized by a sharp compositional boundary between the altered and original zircon as well as by a micro-porosity. The preliminary results from these experiments suggest that in nature,

one possible high pH fluid responsible for the alteration of zircon under high-grade conditions could be one with a substantial $Ca(OH)_2$ component.

Geisler, T., Schaltegger, U., and Tomaschek, F. (2007) Re-equilibration of zircon in aqueous fluids and melts. Elements 3, 43-50.