Experimental determination of zircon-melt D_{Th} and D_U

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Zircon ($ZrSiO_4$) is a chemically resistant silicate mineral that has the propensity to incorporate U into its crystal structure. This geochemical nature makes zircon an ideal mineral for the dating of zircon-bearing igneous rocks by U-Pb methods. However, it is important to predict how zircon incorporates Th with respect to U (zircon-melt D_{Th}/D_U) because if a zircon does not crystallize with ^{238}U and its intermediate daughter isotope, ^{230}Th, in secular equilibrium, a correction to the measured age must be made. This presents a major challenge in dating young zircons and calibrating the geologic time scale. Previous zircon-melt D_{Th} and D_U determinations have not been precise enough to be used for this correction and consequently limit its accuracy, particularly for young rocks.

We present here preliminary results on a high precision experimental determination of zircon-melt D_{Th} and D_U for a variety of melt compositions over a wide range of temperature, pressure, volatile content, and oxygen fugacity (fO_2) space that encompass conditions relevant to most natural systems. Compositions were chosen to span the range of rock types that are commonly used for U-Pb dating. A basaltic andesite, andesite, and rhyolite were thus chosen and doped with $ZrSiO_4$ and trace levels of Th and U. Zircon was synthesized in multiple series of one-atmosphere and piston-cylinder experiments for each composition. In certain one-atmosphere experiments, cooling rates were varied to investigate potential sector zoning of U and Th. Additionally, oxygen fugacity was varied by nine log units from ΔQFM-4 to ΔQFM+5 to examine the effects of the melt oxidation state on zircon-melt D_{Th} and D_U. In piston cylinder experiments, H_2O was added and fO_2 was controlled at the Ni-NiO buffer using a modified double capsule technique.

Quantitative analysis of zircons for U and Th, as well as coexisting melt, were performed via EPMA, AES, and ICP-MS. These high-precision zircon-melt D_{Th} and D_U can be directly applied to the ^{230}Th-correction algorithm of [1] and increase its accuracy.

[1] McLean *et al.* (2011) Geochemistry, Geophysics, Geosystems **12.6**.

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