Accurate and precise U/Pb dating of baddeleyite single crystals by quadrupole LA-ICP-MS

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Baddeleyite (ZrO_2) is an accessory mineral that crystallizes in silica undersaturated magmatic systems. Like zircon it incorporates U in its crystal lattice but virtually no common Pb, making it a key mineral for U/Pb geochronology. Baddeleyite typically forms in thick mafic dikes and gabbroic rocks that tend to cool slowly, nevertheless most baddeleyite crystals are small and in low abundance. In this study we show that *in-situ* LA-ICP-MS is a powerful and time-efficient technique for dating minute baddeleyite grains.

We analyzed baddeleyite from the Phalaborwa intrusion (South Africa) and the Sorkka sill (Finland), with a 193 nm excimer laser coupled to a Thermo XSeries2 quadrupole mass spectrometer. FC-4b baddeleyite from the Duluth complex in Minnesota was used as an external standard for the standard sample bracketing method. Four fractions of baddeleyite were dated by U-Pb ID-TIMS. The analyses plot ca. 1% discordant with a weighted $^{207}Pb/^{206}Pb$ age of 1098.7 ± 1.7 Ma, which is identical with the previously reported zircon age of 1099.1 ± 0.5 Ma [1] for this intrusion. Analytical parameters included a spot size of 25 μm, laser frequency of 10 Hz and laser energy density of 4 J cm^{-2}. The external standard was analysed 10 times, and the two samples 20 times each. Data were processed using the VizualAge procedure in Iolite which allows for down hole fractionation correction.

With this set-up FC-4b yields a concordia age of 1099.2 ± 7.5 Ma, Phalaborwa 2059.9 ± 6.4 Ma (published age 2059.8 ± 0.8 Ma; [2]), and Sorkka 1256.0 ± 6.3 Ma (published age 1256.2 ± 1.4 Ma; [3]). These results show that quadrupole LA-ICP-MS can produce accurate U-Pb ages of baddeleyite-bearing samples at a precision of ± 0.3 to ± 0.7 %.

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