Improving analytical precision and spatial resolution of SIMS baddeleyite geochronology

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Baddeleyite is the most important mineral for dating crystallization of Si-undersaturated igenous rocks by U-Pb method. Due to crystal orientation effects that bias SIMS Pb/U measurement, baddeleyite can only be dated by SIMS Pb/Pb measurement which is difficult to date Phanerozoic ones. In addition, SIMS dating at a <5 μm scale has been a challenge to the geoscience community. Using the large radius magnetic sector Cameca 1280 SIMS, we performed a series of Pb/Pb measurements on baddeleyites using the multi-collector mode. Oxygen flooding to the sample chamber enhances Pb^+ sensitivity by a factor of seven. The secondary ion yields of each EMs were calibrated using a constant Zr_2O^+ signal relative to the axial EM, and further fine-tuned against repeated Pb/Pb measurements of Phalaborwa baddeleyite standard. This multi-collector SIMS technique can date baddeleyite as young as ~200 Ma with ~1% precision. In addition, we found that the oxygen flooding used in Cameca 1280 SIMS can significantly depress the U-Pb orientation effect down to 2-3%, making SIMS U-Pb dating available for Cenozoic baddeleyite with precision better than 3%. A focused Gaussian mode primary O_2^- probe of <5 μm in diameter, with beam intensities of ~100 pA, can be obtained by optimizing the primary column. Secondary ion optics was optimized to ensure a high Pb^+ sensitivity, producing >24 cps/ppm/nA using O_2^- probe for baddeleyite (with oxygen flooding). Baddeleyites can be successfully dated with 1-5% precision using a primary beam spot of <5μm.