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Development of an analytical protocol for solution ICP-MS analysis in (U-Th)/He thermochronometry

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(U–Th)/He thermochronometry is an emerging tool capable to date the cooling of U and Th bearing mineral phases below specific closure temperatures. The two most commonly dated minerals are zircon and apatite, with closure temperatures of ~180°C and ~70°C corresponding, at a typical continental geothermal gradient, to upper crustal depths of approximately 6 km and 2 km, respectively. (U–Th)/He thermochronometrical data can therefore be used to reconstruct the thermal evolution of sedimentary basins, or the exhumation of cratonic plateaus or mountain chains. Furthermore, the timing of past volcanic activity can be constrained due to the ^{4}He, formed by alpha decays in U and Th decay series, starting to accumulate in the crystal lattices upon cooling below the above-mentioned closure temperatures.

Major steps of the analytical workflow in (U–Th)/He thermochronometry are dimension measurements to correct for ^{4}He lost out of the finitely-sized crystals upon decay, heating individual crystals with an infrared laser to release ^{4}He and quantify it with a gas mass spectrometer, dissolving individual crystals, and quantifying U and Th parent nuclides by inductively coupled plasma mass spectrometry (ICP-MS).

At the University of Salzburg, we conduct these ICP-MS analyses with an Agilent 7900 instrument, where we generally achieve sub-ppt detection limits for the most relevant elements. However, we observed mass-dependent sensitivity variations by up to 30% throughout individual, one-day analytical sessions. We therefore present our approach in selecting internal standard elements and isotopes, permitting a precision of typically <2% (1σ SD). Furthermore, we discuss our approach to realistically quantify and account for the remaining sensitivity variations using the Agilent MassHunter software.

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