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In situ Lu – Hf geochronology of garnet, apatite, and xenotime by LA ICP MS/MS

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Lu-Hf geochronology is a powerful method to constrain the temporal evolution of geological systems. Traditional application of this dating method requires time consuming chemical separation of the parent (^{176}Lu) and daughter (^{176}Hf) isotopes that is commonly accompanied by loss of textural context of the analysed minerals. In contrast, In-situ (laser-ablation based) Lu-Hf geochronology offers a number of advantages including rapid analysis with high spatial resolution, as well as control on textural relationships of the analysed mineral. However, laser-ablation based Lu-Hf geochronology has been hindered by isobaric interferences that have effectively masked reliable determination of ^{176}Lu and ^{176}Hf. We present a methodology that resolves these interferences using laser ablation tandem inductively coupled mass spectrometry (LA-ICP-MS/MS) and NH_3 gas to separate Hf from Lu. Both Lu and Hf react with NH_3 to form a variety of product ions. By measuring high order reaction products, we demonstrate that ^{176}Hf can be measured interference-free from both ^{176}Lu and ^{176}Yb with sufficient sensitivity to yield useful geochronological age data.

The novel in-situ Lu-Hf technique has been successfully applied to a variety of Palaeozoic and Precambrian-aged garnet, apatite and xenotime samples, including published reference materials. The resulting age uncertainties are as low as ~0.5% (95% conf. interval). The technique has the potential to obtain spatially resolved Lu-Hf ages in garnet-bearing samples that would be difficult to obtain by conventional techniques. The method also offers the opportunity for rapid “campaign style” geochronology in complex terrains that record poly-metamorphic histories. For apatite, the probable higher closure temperature of the Lu-Hf system compared to the commonly used U-Pb system enhances the likelihood to obtain crystallization ages for metamorphosed and/or U-poor samples, as well as high-temperature thermal history reconstructions. Furthermore, given that apatite and xenotime are commonly associated with mineralizing fluids, the in-situ Lu-Hf method may become a valuable addition to the mineral exploration toolbox.