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In situ Lu–Hf geochronology with LA-ICP-MS/MS analysis

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Lu–Hf geochronology is useful for constraining the evolution of geological systems. In this study, *in situ* LA–ICP–MS/MS Lu–Hf dating technique was successfully applied to Paleozoic-Precambrian xenotime, apatite and garnet. For the iCap TQ ICP-MS/MS instrument (Thermo Fisher, USA), high-purity NH_3 was more effective in the reaction than the commonly used 1:9 NH_3–He mixture, and a 180% improvement in sensitivity was achieved using an N_2 flow rate of 4.0 mL min^{-1}. Lutetium, Yb and Hf reaction products were identified in the mass range from 175–300 amu. The high-order reaction product (+82, $^{176}Hf\,^{14}N_5{}^1H_{12}{}^+$) was measured for separation of ^{176}Hf from ^{176}Lu and ^{176}Yb. Lutetium and Yb have a weak reaction rates at mass + 82 of ~0.0034% and ~0.00036%, respectively, which is necessary to correct for samples (e.g., xenotime) with extremely high $^{175}Lu/^{177}Hf$ and $^{172}Yb/^{177}Hf$ ratios. A matrix-induced bias of $^{176}Lu/^{177}Hf$ ratios was observed between NIST SRM 610 and samples, which required further correction using the matrix-matched reference material. For xenotime, the accuracy and precision of the common-Hf corrected single-spot-ages are generally better than 1.5%, comparable to those obtained by *in situ* U-Pb analysis, and for apatite, they were in a range of 2.5%–7.5%. For garnet, the analytical uncertainties of the isochron age are in a range of 3.5%–10%, and that for the common-Hf-corrected single-spot-ages are in a range of 1.0%–2.7%. This could be further improved using the sensitivity-enhanced instrument and/or enlarged sampling volume. The novel *in situ* Lu-Hf technique may be useful in dating of the samples with complex temporal records or non-bearing traditional U-rich accessory minerals (e.g., zircon).