

Zircon ^{206}Pb - ^{238}U geochronology by low mass-resolution ion microprobe

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A key application of Secondary Ion Mass Spectrometry is Pb-U-Th dating of high-U minerals such as zircon (Zr_2SiO_4) and monazite ($[\text{Ce},\text{La},\text{Nd},\text{Th}]\text{PO}_4$). An advantage of Pb-U-Th dating is that three radioactive parents ^{238}U , ^{235}U and ^{232}Th , decay to the coupled daughters ^{206}Pb , ^{207}Pb and ^{208}Pb respectively, with ^{204}Pb the only non-radiogenic isotope of naturally occurring Pb. Geochronology by ion microprobe has principally applied radiogenic $^{207}\text{Pb}/^{206}\text{Pb}$ dates, as those based on inter-element ratios, such as $^{206}\text{Pb}/^{238}\text{U}$, were previously considered too susceptible to instrument parameters to be useful for geochronology. However, the attainable precision and accuracy of ion-microprobe $^{206}\text{Pb}/^{238}\text{U}$ dates have recently improved to the stage that they are routinely applied to Phanerozoic timescale investigations [1]. Sputtering using focused primary ions produces a complex secondary-ion spectrum that includes multiply-charged and molecular isobaric interferences and the usual approach has been to operate the secondary-ion analyzer at a mass resolution that resolves all major interferences apart from hydrides, which require $M/\delta M > 30,000$. But when operated at a mass resolution sufficient to resolve the isobars HfSi^+ and HfO_2^+ from Pb^+ mass peaks ($M/\delta M > 4900$), the transmission efficiencies of smaller ion probes, such as those of Cameca's f-series design, are so reduced that $^{204}\text{Pb}^+$ count rates are insufficient to determine the correction to the other Pb peaks for the presence of common Pb. An alternative approach using an f-series ion probe is to determine $^{206}\text{Pb}/^{238}\text{U}$ ratios for geochronology at lower operating mass resolution but to quantify molecular interferences on the ^{206}Pb peak by applying targeted energy filtering. This approach has previously not been investigated because the $^{206}\text{Pb}/^{238}\text{U}$ ratio is determined using its within-session correlation with $^{238}\text{U}^{16}\text{O}^+/^{238}\text{U}^+$ and energy filtering will disrupt this correlation. Instrument design and software improvements have now enabled application of different energy offsets to each peak measurement and to measure the same peak with and without an offset, facilitating the investigation of this novel approach.

[1] L.P. Black et al., *Chem. Geol.* **205**, 115 (2004)