Evaluating 238U/235U in U-bearing accessory minerals: implications for U-Pb geochronology

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U-daughter (U-Pb, Pb-Pb, and U-series) geochronology and cosmochronology utilise the absolute value of the present day 238U/235U ratio to determine U/Pb and Pb/Pb isotope ratios and compare derived dates. For decades, this value has been assumed to be invariant and equal to 137.88, but recent experiments indicate that there is potential for per mil level variation in 238U/235U in natural materials, hypothesized to be the result of redox reactions. These studies have largely focused on materials formed in low-temperature environments (e.g. speleothems, corals) and U ore deposits. At present there are no published high-precision high-accuracy 238U/235U data for U-bearing accessory minerals commonly used for U-Pb geochronology.

We present accurate and precise 238U/235U determinations (absolute uncertainties of ~200 ppm) for a suite of common U-bearing accessory minerals (zircon, monazite etc.), from a variety of geological environments and ages. Measurements have been made by multi-collector thermal ionization mass spectrometry and multi-collector inductively coupled plasma mass spectrometry, accurately correcting for mass fractionation using the IRMM 3636 233U-236U double spike. These results indicate that accessory mineral 238U/235U ratios are generally lower than the ‘consensus’ value of 137.88 and record limited but resolvable variation.

Systematic discordance has been observed in 238U-206Pb and 235U-207Pb dates obtained for closed-system minerals, and has been used to reassess the relative decay constants of 238U and 235U (Mattinson, 2000, 2010; Schoene et al., 2006). These studies derive λ235U relative to λ238U by assuming equivalence between 238U-206Pb and 235U-207Pb dates and using assumed values (i.e., 137.88 or 137.80) for the present-day 238U/235U ratio. Our new determination of coupled 238U/206Pb, 235U/207Pb and 238U/235U measurements on the same closed system zircons permits further refinement of λ238U/λ235U estimates using parameters whose values and uncertainties are all traceable to SI units.


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