LA-ICP-MS U-Pb dating of zircons: error assessment

ZHAOSHAN CHANG[1], J.D. VERVOORT[2], W.C. MCCLELLAND[3], AND C. KNAACK[2]

[1] Centre of Excellence in Ore Deposits (CODES), University of Tasmania, Hobart, TAS 7001, Australia; zhaoshan.chang@utas.edu.au

[2] Department of Geology, Washington State University, Pullman, WA 99164-2812; vervoort@wsu.edu; knaack@wsu.edu

3 Department of Geological Sciences, University of Idaho, Moscow, Idaho 83844-3022; wmcclell@uidaho.edu

The ability of LA-ICP-MS to determine U-Pb zircon ages has been demonstrated by several labs over the past decade. The uncertainties come from multiple sources and need to be incorporated into the final error assignment but several are difficult to quantify. Nevertheless, realistic reporting of errors is needed to integrate results with those from the established TIMS and SHRIMP methods.

In this study we measured 5 zircon samples of known age (~1800 Ma to ~50 Ma), using a ThermoFinnigan Element2 magnetic sector ICP-MS coupled with a New Wave Research UP-213 laser system at Washington State University. The laser ablation pit sizes ranged from 30 to 40 µm in diameter. Laser-induced time-dependent fractionation was corrected by normalizing measured ratios in both standards and samples to the beginning of the analysis using the intercept method. Static fractionation, including those caused during laser ablation and due to instrumental discrimination, was corrected using external zircon standards.

Total uncertainty for each laser analysis of an unknown is combined quadratically from the uncertainty in the measured isotope ratios of the unknown and the uncertainty in the fractionation factors (FF) calculated from the measurement of standards. For stand-alone samples such as detrital zircons the FF error is added to each spot analysis. For zircons formed in the same event, e.g. igneous zircons, FF error is added to the weighted mean of multiple spot analyses.

For individual analyses, we estimate that the accuracy and precision is better than 4% (2δ), with the largest contribution in uncertainty from the measurement of the standards. Accuracy of age determinations in this study is ~ 1%, comparing the LA-ICP-MS ages with the TIMS ages. Due to unresolved contributions to uncertainty from the lack of a common Pb correction and from potential matrix effects between standards and unknowns, however, this estimate cannot be universally applied to all unknowns. Nevertheless, the results provide an example of the type of precision and accuracy that may be possible with this technique under ideal conditions. In summary, this technique, using a magnetic sector ICP-MS, can be used for zircons with a wide age range and is especially well suited to reconnaissance geochronologic and detrital zircon studies.