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Progress in the Application of Laser Ablation Microprobe (LAM)-ICP-MS to in situ U-Pb Zircon Geochronology

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Laser ablation microprobe (LAM)-ICP-MS is a very powerful tool for moderate resolution *in situ* determination of trace element in minerals at very low concentrations. It also has a demonstrated capability of performing fast and accurate U-Pb age dating of zircons (Hirata *et al*., 1995; Jackson *et al*., 1997) using spot sizes as small as 20-30 microns. The major analytical problem associated with making LAM-ICP-MS U/Pb age determinations with geologically useful precision is the significant and dynamic fractionation of U with respect to Pb during the ablation and transport processes. Procedures such as "active focussing" (Hirata *et al*., 1995) and "spot cooling" (Jackson *et al*., 1997) have been shown to reduce the magnitude of the fractionation but both are specialised procedures that have inherent problems. This study examines the capabilities of LAM-ICP-MS for U-Pb age dating using non-specialised LAM-ICP-MS instrumentation.

The instrumentation used is an in-house built laser ablation microprobe based on a frequency quadrupled Nd:YAG laser operating at a wavelength of 266nm in the UV. A petrographic microscope incorporated into the system provides high quality optics required for viewing and readily locating sample sites in petrographic mounts. The laser ablation cell, which houses several samples, is coupled to a HP4500 quadrupole ICP-MS, which utilises a "shield torch" option to maximise sensitivity. This instrumentation has low ppb detection limits for U and Pb at 30 micron sampling resolution. Focussing the laser beam above the sample substantially reduces relative defocussing of the laser beam during ablation, and minimises fractionation of Pb and U. Helium is used as the sample carrier gas to significantly enhance sample transport and sensitivity, and further reduce elemental fractionation. Instrumental Pb background is minimised by careful attention to system cleanliness. Calibration against a concordant zircon mineral standard analysed under identical ablation conditions to the samples is used to correct residual elemental fractionation and instrumental mass bias.

A method has been developed for calibration of the $^{207}Pb/^{235}U$ ratio, the precision and accuracy of which is commonly limited by low count rates for ^{207}Pb on the zircon standard, particularly when small zircons are analysed. This method, which works by deriving corrections for elemental fractionation and instrumental mass bias from the measured $^{206}Pb/^{238}U$ ratio on the standard zircon, provides $^{207}Pb/^{235}U$ ages with comparable or better accuracy than using the measured $^{207}Pb/^{235}U$ ratio on the zircon standard. No common Pb corrections are applied due to the large Hg isobaric overlap on ^{204}Pb. However, data are acquired in a rapid time-resolved mode, which allows subsequent examination of time-resolved signals and detection of zones containing significant common Pb, together with zones of Pb loss or redistribution within the crystal, and inherited cores. Interactive data reduction software (GLITTER) allows ready selection of signal intervals for integration that provide the most concordant data from each analysis..

The strategies described allow U/Pb ratios to be measured rapidly (3 minutes per analysis) and routinely with precision (1 r.s.d.) down to *ca*. 1.3%, providing accurate zircon ages with comparable, or better, precision. These figures of merit will be demonstrated using data for a suite of zircons analysed by thermal ionisation mass spectrometry.

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