Optimising the spatial resolution, fractionation and temporal precision of monazite U-Pb LA-ICP-MS geochronology.

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Monazite U-Pb geochronology is an important tool in constraining the timing and duration of metamorphic events. Two factors are vital in effective U-Pb monazite geochronology: high spatial resolution and the applicability to intra-grain (mounted and thin-section) applications. LA-ICP-MS is an excellent tool to meet these demands in an accurate, simple and cost-effective manner. Existing publications concerning the monazite technique often fail to provide information concerning the optimisation of the method, have poor spatial resolution and often fail to demonstrate accuracy with respect to other techniques.

In this study a spot size of 15µm diameter is used and laser irradiance (using 213nm Nd:YAG laser) is optimised by varying irradiance on multiple repeats of U and Pb isotopic analyses of monazite standards and NIST 610 silica glass. Results are applied to external standardisation monazite geochronology and also provide information regarding 'tracer-solution' correction methods.

Intra- and inter-elemental isotopic time-dependent fractionation (TDF) stabilises above ~2.5 GW/cm^2. U-Pb and U-U isotopic ratios increase in a manner akin to a logarithmic model. Intrinsic fractionation (IF) is also recognised in these isotopic ratios through variance in T_0 (ie. Sylvester and Ghaderi, 1997) with differing laser irradiances. T_0 isotopic ratios also stabilise above ~2.5 GW/cm^2.

Of interest is the observed systematic difference in T_0 isotopic ratio fractionation for monazite and silica glass matrices. For Pb/Pb isotopic ratios the difference in IF would result in an under-correction of ablation-induced fractionation using the tracer solution method yielding consistently old Pb/Pb ages. However, for laser irradiances above ~3 GW/cm^2 no difference in fractionation is apparent. Differences in U/Pb fractionation between the two matrices will result in an over correction of monazite U/Pb ages (using tracer-solution methods) with resulting old U/Pb ages. Simultaneous aspiration of a tracer solution is required to verify these results but current data suggest tracer solution methods will produce consistently old monazite ages.

External standardisation methods for monazite are demonstrated to be comparable to, and in some cases arguably more accurate than, SIMS isotopic analysis.

Reference:

Sylvester, P. J. and Ghaderi, M.(1997). Chem. Geol., **141**, pp. 49-65.