U-Pb monazite geochronology at high spatial resolution using laser ablation magnetic sector ICP-MS

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U-Pb monazite geochronology is a useful tool to constrain the timing of metamorphic events or ages of magmatic rocks. The high U and Th concentration of individual monazite grains coupled with low concentrations of initial common Pb make monazite an ideal geochronometer. Complex chemical zonation is often preserved within individual monazite grains requiring use of high spatial resolution techniques, such as laser ablation ICP-MS, to unravel the geochronologic history preserved within single monazite grains. Advancements in laser ablation ICP-MS technology and methods have improved the limits of spatial resolution for in-situ U-Pb accessory mineral geochronology, yet accuracy is limited by the ability to control Pb-U fractionation over a single analysis. Other challenges common to U-Pb LA-ICP-MS monazite geochronology include correcting for instrument mass bias, availability of suitable reference materials, and the limited detection range of secondary electron multipliers used in single-collector ICP-MS instrumentation.

To test the limits of precision, accuracy and spatial resolution for LA-ICP-MS U-Pb monazite geochronology we analyzed common and in-house monazite reference materials (Trebilcock, 44069, 'Comfort'). Analyses were made using a Nu AttoM sector field ICP-MS coupled to a NWR 193 ArF excimer laser system. Laser spot sizes ranged from 5 to 20 μm with fluences between 1 – 7 J/cm^2 and a constant repetition rate of 5 Hz. Data were reduced in Iolite using an exponential correction for downhole Pb-U fractionation with Trebilcock monazite used as the reference standard. Analytical precisions for individual 15 μm spot analyses were better than 1.9% for both ^{207}Pb/^{235}U and ^{206}Pb/^{238}U after just 10 seconds of ablation and better than 1.7% for both Pb-U ratios after 20 seconds of ablation. Analytical precisions for individual 5 μm spot analyses were better than 3% for ^{207}Pb/^{235}U and ^{206}Pb/^{238}U after 20 seconds of ablation. Accuracies of pooled concordia ages on analyzed monazite reference materials were within 3% of preferred TIMS ages for 15 μm spot analyses and within 5% of preferred TIMS ages for 5 μm spot analyses.