Heterogeneous Domains in Zircon Reference Materials for U-Pb Geochronology by Microanalysis

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Heterogeneous domains are described in four reference zircon – Fish Canyon Tuff (FCT), Plešovice, R33, OG1 – used commonly as primary or secondary standards for microanalysis, particularly by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Failure to recognize and avoid these domains during microanalytical sessions will degrade precision and accuracy, and may represent a significant contribution to the ~2-3% total error budget recognized for LA-ICP-MS U-Pb geochronology. This study determines the typical appearance and sizes of these heterogeneous domains and their analytical responses so that they may be avoided when choosing reference grains for mounting; when selecting spots in the grains for microanalysis; and during post-processing evaluation of data.

Polished epoxy grain mounts of the four zircon were examined by optical light microscopy and SEM-based cathodoluminescence (CL) for mineral and melt inclusions, fractures, overgrowth rims and dark-CL/dark-colored domains. These features, as well as clearer, more homogeneous areas were measured for U-Pb ages on 20-μm spots (8 Hz, 1.5 J/cm^2) using a NWR193 ArF excimer LA system coupled to a Nu AttoM sector field (SF) ICP-MS. Data were reduced in Iolite using an exponential correction for downhole Pb/U fractionation with 91500 zircon as the reference standard.

Preliminary results indicate that dominant heterogeneities in FCT, Plešovice and R33 zircon are mineral and melt inclusions. Spot analyses on these areas give ^{206}Pb/^{238}U ages 3 to 8% older than the accepted age. We recommend careful SEM/optical microscope imaging in order to avoid these domains. Plešovice zircon also contain dark-CL/dark-colored domains enriched anomalously in U (~5000 ppm) that give apparent ^{206}Pb/^{238}U ages 4 to 6% older than the accepted age. These are an analytical artefact of an enhanced downhole laser ablation rate relative to that in low U domains and/or saturation of the AttoM detector by the high U count rates. Dominant heterogeneities in OG1 zircon are spots intersecting mineral inclusions and overgrowth rims that give ^{207}Pb/^{206}Pb ages 1 to 4% younger than the accepted age.