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Uncertainty propagation and traceability in LA-ICP-MS/MS Rb-Sr geochronology

ALEXANDER SIMPSON, NICK M. W. ROBERTS AND MATTHEW HORSTWOOD

British Geological Survey

Uncertainty propagation of LA-ICP-MS data for isotopically homogeneous minerals, such as zircon, is relatively straightforward to implement and there is community-led guidance for U-Pb geochronology. For minerals that are isotopically heterogeneous but isochronous, uncertainty propagation is more nuanced and lacks well-defined principles. This is exemplified in Rb-Sr geochronology, where multiple minerals may be used to define a single isochron-based age, natural reference materials are typically characterised using isochron ages rather than isotopic ratios, and some age estimates currently rely on different isotope systems.

Analytical uncertainties are dictated by count-rate and measurement time, and thus can vary dramatically between single-collector versus multi-collector instrumentation. However, despite the opportunity for precise measurements on the latter, it is the systematic uncertainties that typically limit the achievable precision of *in situ* geochronology. For the U-Pb system, these include long-term excess variance of the validation materials (typically 1-3% 2s), and the uncertainty of the reference material isotopic ratios (<0.5% for zircon but >2% 2s for some carbonates, rutiles and other minerals). Quantifying and understanding the contribution of these uncertainties is critical for robust uncertainty propagation onto final ages, but is not straightforward for isotopically heterogeneous materials such as mica and feldspar.

Using a range of synthetic and natural materials, we here aim to: 1) quantify the analytical and systematic uncertainty components within Rb-Sr isochron ages; and 2) quantify the variable contribution of these to both low and high Rb-Sr minerals, for both single collector (quadrupole) and multi-collector instrumentation. To facilitate visualisation and propagation of analytical and systematic uncertainties, we present a workflow diagram for traceability and uncertainty propagation of Rb-Sr data, as well as a flexible Iolite DRS that separately constrains the uncertainty on the Rb/Sr (including downhole fractionation correction) and Sr/Sr ratios. Ultimately, Rb-Sr geochronology should strive to follow the principles of data reproducibility and traceability that the EARTHTIME initiative drove for U-Pb.