LA-ICP-MS/MS single spot Rb-Sr dating

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Rb-Sr ages are traditionally calculated by determining the isotopic composition from several minerals from one host rock and/or multiple LA-ICP-MS/MS data points within one phase. The slope of the resulting isochron defines the age and the intercept the initial $^{87}\text{Sr}/^{86}\text{Sr}$ composition. Here, we present a novel procedure on how to measure, calculate and validate Rb-Sr ages from single-spot LA-ICP-MS/MS data. This approach is especially relevant for dating Rb-rich minerals that lack a paragenetic context (e.g. provenance studies) and for determining Rb-Sr age zonations along profiles and even age maps.

One of the main challenges for calculating single-spot Rb-Sr ages is the estimation of the initial $^{87}\text{Sr}/^{86}\text{Sr}$ composition and its uncertainty. If the initial $^{87}\text{Sr}/^{86}\text{Sr}$ composition is unknown, we propose to use a range of geologically relevant initial $^{87}\text{Sr}/^{86}\text{Sr}$ compositions rather than one fixed value: (1) $0.703 \pm 0.003$ (typical for mantle derived magmatic rocks), (2) $0.715 \pm 0.015$ (typical for enriched magmatic rocks) and (3) $0.730 \pm 0.030$ (typical for crustal rocks). Modelling shows that single-spot Rb-Sr ages calculated from highly radiogenic Rb-Sr isotopic compositions (high $^{87}\text{Sr}/^{86}\text{Sr}$ ratios) are independent on the initial $^{87}\text{Sr}/^{86}\text{Sr}$ composition. However, the chosen initial significantly biases the accuracy and precision of Rb-Sr age data from single-spots with low $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. Depending on the scope of the study, we thus recommend to apply a cut-off with a defined minimum $^{87}\text{Sr}/^{86}\text{Sr}$ composition to avoid misleading interpretation of inaccurate ages with low precision.

Single-spot Rb-Sr dating was tested on several biotite and muscovite grains that are widely used as reference material for Rb-Sr and/or Ar-Ar geochronology. These include nano-powder tablets (MicaMg, MicaFe), biotite grains (Mount Dromedary, LaPosta and McClure Mountain) and one muscovite sample (Högsbo). These samples have a large variety in Rb-Sr isotopic composition and ages and are thus ideal to test the influence of the initial $^{87}\text{Sr}/^{86}\text{Sr}$ composition on the accuracy and precision of single-spot Rb-Sr ages.