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In-situ Rb-Sr dating

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The recent commercial introduction of mass spectrometers with a reaction cell sandwiched between two quadrupoles opens up the field of beta-decay based dating to detailed in-situ studies. For Rb-Sr dating, the principle is relatively simple; Rb^+ ions are inert towards most gases, while Sr^+ easily gives off an electron and therefore reacts with several gases either forming SrO^+ (e.g., with O_2, N_2O) or SrF^+ (e.g., SF_6, CH_3F). Restricting access of one mass (in detail m/z) at a time by the first quadrupole to the reaction cell and distinguishing between unreacted ion and reaction products with the second quadrupole gives full control over such ion-gas reactions, and therefore allowing separation of two chemically different ions with the same mass “on the fly”.

In this contribution, several recent advancements are presented that ultimately can make in-situ Rb-Sr dating a viable alternative even to U-Pb zircon dating. First, thorough testing leaves N_2O as the most viable, yet easy-to-use reaction gas if it comes to separate Sr from Rb. Here, almost 80% of the original Sr^+ signal when using no reaction gas is transferred to SrO^+, allowing routinely to analyze typical Rb-rich minerals (e.g., biotite, muscovite, Kfs) with spot sizes of 50 micron or smaller.

Furthermore, the preparation of nano-powder pressed pellets from mineral standards for matrix-matched reference materials is giving the opportunity to normalize obtained data with an accuracy currently reaching 1.2% [1]. While the reference powder is homogeneous <0.5% in Rb/Sr and <0.2% in $^{87}Sr/^{86}Sr$, the largest error is currently coming from the uncertainty of the age of the biotites from where the current primary standard (Mica-Mg) is derived from. Work is underway analysing the new reference materials at high-precision with state-of-the art TIMS and MC-ICP-MS. The aim is to achieve age errors of <1% in routine in-situ analysis of typical geological samples using normal thin sections.

[1] Hogmalm et al. (2017) JAAS 32, 305-313.