Geophysical Research Abstracts
Vol. 20, EGU2018-4121, 2018
EGU General Assembly 2018

High-precision in-situ Rb-Sr dating

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Currently, "high-precision" ($\leq$0.1%) dating techniques are commonly seen to be restricted to the U-Pb and Ar-Ar systems. However, current advances in reaction cell technology coupled to ICP-MS (coined ICP-MS/MS or QQQ) allow to re-evaluate other dating systems, in particular Rb-Sr (see e.g., Zack & Hogmalm 2016, Chem Geol 437, 120-133; Hogmalm et al 2017, JAAS 32, 305-313).

Here, I demonstrate that precisions of 0.1% and better can be achieved in-situ if minerals are analyzed that contain Rb-contents of >5,000 μg/g. Interestingly, such Rb-contents are typically achieved in lepidolites, found in countless pegmatites. Pegmatites are ideal test cases as they often form late in an orogeny and close to the surface, therefore exhibit simple cooling histories. Furthermore, several U-bearing minerals (e.g., zircon, columbite-tantalite) allow comparison of Rb-Sr with U-Pb ages. Finally, pegmatite veins are important time-markers in orgens due to their cross-cutting relationships.

It needs to be stressed that the daughter isotope ^{87}Sr can be determined simultaneously with the parent isotope ^{87}Rb (via ^{85}Rb analysis, assuming a constant ^{87}Rb/^{85}Rb ratio). As lepidolites have very little common Sr at their formation, measurement can be compared to in-situ U-Pb dating of zircon, where the daughter/parent ratio can in principle be directly related to age, given that a primary standard is available. With roughly 10 times higher ^{87}Rb lepidolite compared to ^{238}U in zircon and a ca 10 times slower radioactive decay of the former, amounts of daughter products are comparable in both systems, however with the two major advantages for the Rb-Sr lepidolite system: (1) lepidolites are >1 cm large and (2) fractionation of parent to daughter isotopes (Rb/Sr vs Pb/U) during ablation are significantly reduced.

Precisions of 0.1% in a rather exotic, although important, mineral are only a stepping stone. Rapid advances are anticipated, as (1) several important reaction gases have not been tested yet, (2) ICP-MS/MS design is undergoing rapid transformation and (3) several companies are actively pursuing to couple reaction cells to multi-collector systems. Rubidium-Sr dating should therefore be considered to be a viable tool for “high-precision” dating.