Laser ablation Rb/Sr dating by online chemical separation in a reaction cell

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In-situ dating based on the U/Pb system has flourished in the last decade, allowing reading the geological code on Earth history to unprecedented breadth and precision. Similar advances were not possible for in-situ dating based on the beta decay, e.g. Rb/Sr, as the decay of the parent isotope produces a daughter isotope of the same mass. The only option is to chemically separate both elements.

With the introduction of the Agilent 8800 ICP-MS it has become possible to do such chemical separation "on the fly". Here, a reaction cell is sandwiched between two quadrupoles, so that in the first quadrupole only ions pass having the mass of interest (e.g.,on mass 87 $^{87}Rb^+$ and $^{87}Sr^+$). Those ions can react with a gas in a reaction cell, after which the reaction products separated (e.g., $^{87}Rb^+$ does not react with oxygen, while the new-formed $^{87}SrO^+$ ion is measured on mass 103).

At the Microgeochemistry lab in Gothenburg, we have coupled an Agilent 8800 with a laser ablation system and implemented a procedure for doing in-situ Rb/Sr dating. Using (1) oxygen as a reaction gas, (2) the glass standards NIST SRM610 and BCR-2G for quantification of $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ ratios and (3) biotites from the La Posta intrusion (91.6 Ma) to correct Rb/Sr ratios in biotites (for an update on Rb/Sr corrections, see Karlsson et al., this meeting), it is possible to routinely date a range of different rock types with accuracies comparable to in-situ U/Pb dating. For example, we obtain a Bt-Kfs-Pl isochron of 1260± 13 Ma for the Ulvö gabbro intrusion, Sweden, identical to a TIMS U/Pb baddelyite age of 1256±1 Ma (Hogmalm et al., 2006 GFF 128, 1-6). This confirms not only the reliability of our method, but also proves that the Central Scandinavian Dolerite Group (CSDG) was not thermally reset after intrusion beyond temperatures of ca 350°C (approximate closure temperature of biotite. Additionally, we obtained imprecise, but accurate initial $^{87}Sr/^{86}Sr$ ratios of 0.7044±14, confirming little to no crustal contamination for the CSDG.

In-situ dating holds great promise for the field of Rb/Sr geochronology. Most importantly, it is possible now to avoid inclusions and alteration in micas and feldspars. Furthermore, it will be possible to study expected Sr isotope zonation caused by slow cooling and reheating. Finally, this technique is ideal for provenance studies of pebble-size granite fragments (see Johansson et al., this meeting). Other beta decay systems (Lu/Hf, K/Ca) are within reach.