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Coupled K-Ca and Rb-Sr dating by LA-ICP-MS/MS – reaction gas optimisation and geological applications

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The K-Ca decay system, where the parent ^{40}K decays to ^{40}Ca, can be used to date high K, low common Ca minerals such as biotite, muscovite and some K-felspars. Due to similar chemical behaviour and ionic radii, Rb often substitutes for K in these minerals, hence the same minerals that are suitable for K–Ca dating also have potential for Rb–Sr dating.

The development of LA-ICP-MS/MS has enabled direct in-situ analysis of these beta-decay geochronometers via chemical separation with reactive gases within the mass-spectrometer. As well as rapid analysis, the main advantage of in-situ K–Ca dating is that Ca- and Sr-bearing inclusions can be avoided, which are a limiting factor for conventional bulk mineral dating via TIMS. Both Sr and Ca are highly reactive with both SF_6 and N_2O to form M-F, M-O or M-OH reaction products, while K and Rb are unreactive with either gas, enabling efficient separation of parent-daughter isotope pairs ^{40}K–^{40}Ca and ^{87}Rb–^{87}Sr [1]. Additionally, mixing a small amount of H_2 with SF_6 or N_2O very efficiently eliminates ^{40}Ar based interferences. Here we compare the efficacy of reaction gas mixtures for coupled K-Ca and Rb-Sr geochronology, including for minimisation of ^{40}Ca and ^{39}K backgrounds, and maximising sensitivity.

Both the K–Ca and Rb–Sr isotopic systems can be reset at low temperatures and can be used to determine cooling ages or to improve the understanding of low temperature diagenetic processes [2]. We present preliminary results on the relationship between the isotope systems including isotopic disturbances and decoupling of the geochronometers in micas and feldspars and investigate the geological meaning of this decoupling.

Reference: [1] Hogmalm et al., 2017, JAAS, 32, 305. [2] Gopalan, 2008, Chemical Geology, 247, 119-123