Apatite fission track analysis by laser-ablation: A novel fast grain mapping approach using the map interrogation tool 'Monocle'

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One of the main drawbacks of the apatite fission track (AFT) method is that not every sample yields sufficient high-quality, unzoned apatite grains with high spontaneous fission track densities. Counting zoned or damaged grains is thus sometimes unavoidable, while grains with low-track densities (low-U and/or very young apatites) cannot be excluded as this may bias the resultant fission track age.

Current approaches to AFT dating by LA-ICPMS typically employs a spot ablation approach [1]. This method works extremely well when the U distribution is homogenous, and this rapid approach can also produce multi-element data (e.g. REE, Cl, other trace elements) which yields extra information on annealing kinetics or apatite provenance. However in cases of U zoning or low-U grains where there are too few spontaneous fission tracks to detect zoning, it can be difficult to know where to place a representative LA-ICPMS spot. In contrast, a major strength of the external detector method (EDM) is that data are collected from identical areas on apatite grains and their mirror images in the muscovite detector, and therefore within-grain U heterogeneity is accommodated by this technique.

An alternative to spot analysis is to produce apatite U-distribution maps by LA-ICPMS which can then be spatially linked to the fission-track density. In this study, fission tracks were counted on apatite standards (Durango, Fish Canyon Tuff) and unknowns with (i) complex U zonation; (ii) cracks; or (iii) a low U-content; all previously dated by EDM. Uranium maps were then aquired using a Photon Machines Analyte Excite laser with an aerosol transfer device (ARIS; [2]) coupled to an Agilent 7900 ICPMS. Elemental maps were made using Iolite [3] and interogated using the Monocle tool [4] for sub-domains of variable size within the zone of counted tracks. This mapping approach could represent a new benchmark for the AFT method by LA-ICPMS.

[1] Chew and Donelick 2012, *Min. Assoc. of Canada Short Course 42, 219-247.* [2] van Malderen et al., 2015, *J. Anal. At. Spectrom., vol. 30 (1), 119 – 125* [3] Paton et al., 2011, *J. Anal. At. Spectrom., vol.26, 2058 – 2518* [4] Petrus et al., 2017, *Chem. Geol., vol. 463, 76 – 93*