Apatite Pb-profiling by LA-MC-ICPMS: An example of lower crustal thermochronometry from the Alps

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Reconstruction of lower-crustal processes can be constrained by thermal history modelling of high-temperature thermochronometer data, such as near-rim Pb diffusion profiles in appropriate U-hosting accessory phases such as rutile and apatite [1]. However, prolonged residence at the relevant partial retention zone temperatures (for Pb in apatite, ca. 375-550 °C [2]) leads to measurable diffusional Pb loss from the grain core, as well as near-rim locations. Thus, diffusion profiles should be measured across the entire grain radius.

Here, we present a simple analytical protocol which utilises laser ablation-multicollector-inductively coupled plasma mass spectrometry (LA-MC-ICPMS), applied to an amphibolite-facies meta-igneous rock from the eastern Alps. We resolve continuous U-Pb age profiles in euhedral apatite grains up to 100 μm in diameter. Downhole fractionation, mass bias, and intra-session instrument drift are satisfactorily resolved using the "VisualAge_UcomPbine" data reduction scheme for the Iolite software package, and high common-Pb content (up to ca. 90%) is corrected for using a ^{207}Pb-based correction [3,4]. Following age profiling, trace element distribution on internal grain surfaces is mapped using LA-ICPMS and cathodoluminescence imaging to texturally and chemically assess whether observed the intra-grain U-Pb age distributions result from diffusion or recrystallisation. Thermal histories are derived by combined modelling of suitable grains using the QTQt software package [5]. The resulting thermal history shows rapid cooling during the late Jurassic, followed by reheating and a second cooling event in the late Cretaceous. We interpret these as recording rift-driven Piedmont-Ligurian crustal thinning, and exhumation associated with the Eoalpine orogen.

[1] Smye, A. J. & Stockli, D. F., *EPSL* **408,** 171–182 (2014). [2] Cochrane, R. *et al., GCA* **127,** 39–56 (2014). [3] Paton, C., *et al., JAAS* **26,** 2508 (2011). [4] Chew, D. M., *et al., Chem. Geol.* **363,** 185–199 (2014). [5] Gallagher, K., *J. Geophys. Res. Solid Earth* **117,** 1–16 (2012).