High temperature thermochronology and the relationship between lead diffusion, composition and structural defects in apatite

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High temperature (>350ºC) thermochronological measurement can be made by exploiting the loss of Pb from accessory minerals such as apatite, titanite and rutile, assuming that lead is lost by thermally activated volume diffusion. Studies within man-made and natural laboratories support this assumption. Some studies have proposed that interaction with aqueous fluids dominates daughter isotope loss from crystal lattices, although Cochrane et al. (2014) unambiguously showed that Pb loss from some apatites is a function of temperature, and aqueous interaction is not required. Cochrane et al. (2014) also showed that meaningful t-T paths can be obtained by modeling volume diffusion of Pb through apatite by combining the diffusion parameters of Cherniak (1991, 2010), U-Pb dates, grain sizes and the distribution of U within the apatite. The aims of this study are i) to generate t-T paths from apatites of various lithologies and composition using HeFTy V1.8.0, ii) to investigate the relationship between Pb diffusion in apatite, titanite and rutile, and composition, iii) to examine the nature of Pb loss by comparing in-situ (MC-LA-ICPMS) and bulk (ID-TIMS) dates and iv) investigate the effect of metamictization in low-U bearing accessory minerals by Raman mapping. The Sr isotopic composition of single apatite grains dated by ID-TIMS will be used to differentiate between metamorphic and magmatic apatites.