Characterisation of nanoscale Pb mobility and entrapment in zircon using atom probe microscopy

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The mechanisms of Pb mobility at the nanoscale during metamorphism are investigated using TEM and atom probe data from an undeformed, detrital zircon sampled from a kyanite-garnet metapelite (>4.5 GPa, c. 800°C @150 Ma ago) of the Rhodope Metamorphic Complex, Greece. The discordant zircon shows overall Pb loss. However, 20 nm clusters of Pb (~3.5 – 5.0 at.%) yield a $^{207}Pb/^{206}Pb$ date of 2186 ± 93 Ma, consistent with the zircon's crystallisation age. These clusters have a toroidal morphology and are interpreted to form by entrapment of Pb in dislocation loops that formed during the annealing of radiation damage during the Jurassic metamorphic event [1]. To test this model, we have undertaken TEM and atom probe analysis of both natural radiation-damaged zircon and their experimentally annealed equivalents [2]. The results provide insights into the mechanisms of Pb mobility, and the formation of discrete, nanoscale Pb-isotopic reservoirs in zircon. They also demonstrate that geologically meaningful dates can be recovered by atomic-scale isotopic microscopy, even from discordant zircon.

[1] Peterman *et al*. (2016) *Sci. Adv.*, 2: e1601318. [2] Marillo-Sialer *et al*. (2016) *Chem. Geol.*, 438, 11-24.