Apatite inclusions in Eoarchaean zircon: Imaging and analysis

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Apatite inclusions in zircon contain a wealth of geochemical information (trace elements, U-Pb, Sr, Nd isotopes) that can be used to fingerprint primary magmatic sources. We are developing a SIMS technique for routine, precise Sr isotope analysis of 10μm apatite inclusions in zircon as a means to trace early crustal evolution. Data on reference apatites shows that geologically useful (≤1 permil) precision on the $^{87}Sr/^{86}Sr$ ratio is achievable from suitably small analytical spots in reasonable counting times.

Inclusions must be demonstrably primary and undisturbed, and any accumulations of Sr at grain boundaries or in composite, Rb-bearing inclusions must be avoided. Apatite inclusions in Eoarchaean zircons from Western Australia [1] are suitable primary targets for Sr analysis. They have prismatic shapes often aligned with the host zircon's magmatic growth zones. EBSD imaging reveals them to be single crystallographic domains, and the data from SIMS rastered ion images of composite host+inclusion subdomains (Fig.1) show that both zircon and apatite preserve the same primary U-Pb age to within analytical uncertainty. The latter result represents the first application of the methodology developed by Bellucci *et al.* [2,3] to date multiple minerals simultaneously from composite ion images.

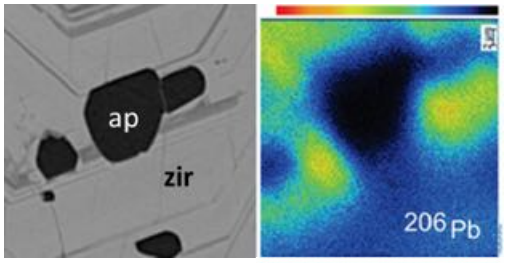

Figure 1: ^{206}Pb ion image (right) of zircon and included apatite from Eoarchaean Meeberrie gneiss [1].

[1] Kinny *et al.* (1988) Precambrian Research **38**, 325-341.
[2] Bellucci et al. (2016) Chemical Geology **438**, 112-122.
[3] Bellucci et al. (2018) Chemical Geology **476**, 469-480.