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High precision Sr isotope analyses in apatite by LA-MC-ICP-MS: from mineral inclusions in zircon to crustal evolution models

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Apatite is one of the most abundant accessory minerals in felsic rocks and is frequently encapsulated as solid inclusions within zircon grains. The Sr isotopic signature of apatite inclusions can represent the primary isotopic composition of the magmatic source and be directly correlated to the degree of evolution of the host rock. The integrated study of both the zircon and the apatite inclusions records can therefore bring new insights into the growth and evolution of the continental crust through time.

One major limitation for measuring Sr isotopes by LA-MC-ICP-MS is the presence of polyatomic interferences, specifically the influence of $^{40}Ca^{31}P^{16}O^{+}$ ($CaPO^{+}$) and doubly charged REE, such as Yb, Er, Lu and Hf on all the Sr isotopic masses. Efficiently correcting for these interferences is key to obtaining both precise and accurate $^{87}Sr/^{86}Sr$ ratios, especially at low-intensity ion beams (e.g., typically for laser ablation spot sizes <30 μm in diameter).

Here we present a new routine procedure to analyse Sr isotopes in apatite minerals and mineral inclusions in zircon by LA-MC-ICP-MS using spot sizes down to 10 μm and less. We used a Thermo Scientific Neptune XT with a number of different cups and amplifiers (both 10^{11} Ω and 10^{13} Ω) configurations, coupled with a Teledyne Cetac Analyte Excite+ 193 nm laser ablation system equipped with the ARIS fast washout accessory and the X-Y Theta dynamic aperture. A model for obtaining precise and accurate $^{87}Sr/^{86}Sr$ ratios as a function of the volume of material ablated ($200x10^3$ to $1x10^3$ μm^3) and the Sr and REE contents of apatite is presented.

As a case study, we present preliminary results on apatite inclusions in zircons from selected granitic rocks from Western Australia with crystallisation ages ranging from 3.45 to 2.6 Ga. Our new data provide insights into the composition of the juvenile continental crust and the timing for the onset of plate tectonics in this area.