O isotopes in titanite and apatite. A new tool for crustal evolution?

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Zircon ($ZrSiO_4$), by way of U-Pb dates and Hf-O isotopes in particular, has provided evidence of crustal formation processes back into the Hadean (4.4 Ga; e.g., Wilde et al., 2001, Bell et al., 2011) and constraints on continental crustal growth (Kemp et al., 2007). Recent high spatial-resolution in-situ radiogenic and stable isotope zircon datasets have greatly improved our understanding of crustal growth rates and mechanisms by linking sedimentary and igneous records (e.g. Dhuime et al., 2012; Belousova et al., 2010). Zircon trace-element composition is, however, generally not sensitive enough to record evolving magmatic conditions or to allow the source rock-type to be identified, (e.g. Hoskin & Ireland, 2000, Hoskin & Schaltegger, 2003). Despite the impressive amount of zircon data available today, our knowledge has so far been restricted to the information offered by the limited utility of elements commonly present in zircon in measurable concentrations (mainly HREE, U, Pb and Hf).

Recent studies have demonstrated that the trace element and isotopic composition of other accessory phases (titanite, apatite) have the potential to give significant insight into the petrogenesis of a given granitoid.

In this contribution, we expand the use of a range of underexplored accessory phases (titanite and apatite) by developing geochemical indicators involving O isotopes and trace element concentrations to investigate crustal evolution. These minerals have the advantage over zircon of being present in less evolved magmas and being more responsive to igneous processes and crustal metamorphism. We present new data on titanite, apatite, zircon from various granitoids through geological time: a BADR suite (Guernsey, Channel Island), Archean sanukitoids (Karelian Province) and their "modern" equivalent (high Ba-Sr granites, Scotland). We demonstrate that O isotopes, trace element analysis and detailed petrographic work on these phases gives direct access to the petrogenesis and magma type of the host magmas.

References: Bell et al. (2011), GCA, 75, 4816-29; **Belousova et al.** (2010), Lithos, 119, 457-66; **Dhuime et al. (**2012), Science, 335, 1334-36; **Hoskin & Ireland** (2000), Geology, 28, 627-30; **Hoskin & Schaltegger**, (2003), MSA, 27-62; **Kemp et al. (2007**), Science, 315, 980-83; **Wilde et al.** (2001), Nature, 409, 175-78.