Hf isotopes in zircon record sudden rejuvenation in a back-arc magmatic system (Torres del Paine, Patagonia)

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The Torres del Paine Intrusive Complex (TPIC), Patagonia, is a Miocene shallow crustal laccolith in which ~88 km^3 of mafic and granitic magma was emplaced in a backarc setting on short timescales of 162 ± 11 ka [1] [2]. It was built up in successive pulses, with a resolvable age difference between mafic rocks of the so-called 'root zone' (at ~12.6 Ma) and horizontally layered units (the ~12.45 Ma 'sill complex') [1]. Exterior to the main TPIC are numerous intrusive bodies and dikes with ages of ~12–29 Ma.

The Hf isotope compositions of zircons from units within and around the TPIC have been determined by solution and laser ablation MC-ICPMS. Zircons from mafic TPIC units all have Hf isotope compositions that indicate a slightly enriched mantle source. However, zircons from the mafic sill complex units have higher (more juvenile) initial ε_{Hf} than zircons from the older root zone mafic units. The shift towards more depleted Hf isotope compositions in the younger sill complex units indicates the rapid input of new juvenile material into the source region between ~12.6 Ma and ~12.45 Ma. A similar shift is also seen in bulk Nd and Sr isotope data for related samples [3]. Zircons from 16–17 Ma and ~12 Ma units exterior to the main TPIC have consistent, relatively enriched Hf isotope compositions similar to the TPIC root zone mafics. This constant Hf isotope signature over several My is in contrast to the rapid rejuvenation recorded by the TPIC. Intriguingly, the 16–17 Ma intrusives are calc-alkaline while ~12 Ma units are sub-alkaline, yet no Hf isotopic shift is correlated with this significant change in bulk rock chemistry. Instead the major change in Hf isotope composition occurs within the period of sub-alkaline magmatism.

The Hf isotope data for the TPIC demonstrate that significant variability in source composition is possible for sheeted magmatic complexes built up on very short timescales. The geochemical and tectonic implications of the disconnect between changes in major/trace element chemistry and isotope geochemistry will be explored.

[1] Leuthold et al., (2012) *EPSL* (**325**) [2] Michel et al., (2008) *Geology* (**36**) [3] Leuthold et al., (2013) *JPET* (**54**)