A stable isotope journey through crustal recycling

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Isotopic analyses arguably provided the first ‘smoking gun’ for recycling of subducted sediments by measurement of excess cosmogenic ^{10}Be in arc lavas [1]. Improvement in the precision of analytical techniques has led to a vast, and sometimes bewildering repertoire of stable isotope systems to employ in further investigation of crustal recycling processes. Research is largely at a pioneering stage: determining what key information can be learned from various ‘new’ stable isotope systems. For instance, lithium isotopes appeared to hold much promise as a tracer of crustal recycling [2], however, rapid isotopic diffusion rates in this system largely negates direct application to tracing crustal inputs (e.g., [3]).

How can we better constrain recycling processes and amounts of recycled material? Using case studies from the Mariana and Aleution arc, thallium (Tl) isotopes are highlighted as potentially the most sensitive stable isotope tracer of recycled crustal material. The invarient Tl isotopic composition of arc lavas and sediment inputs in the Marianas strongly suggests that Tl isotopes are not fractionated during subduction processing [4]. Building upon the Mariana results, new data from the Aluetian arc display large, systematic variations along strike that can then be interpreted in terms of crustal recycling.

In contrast to thallium isotopes, vanadium isotopes in the same arc lavas yield markedly different information. Vanadium isotopes likely respond to changes in oxidation state, rather than specific slab inputs [5]. The Marianas are once more typified by negligible isotope variation in primitive lavas. In contrast, Aleutian lavas display resolvable, systematic V isotope variation.

Whilst matching isotope systems with specific research questions achieves a high level of understanding, employing a multi-isotopic approach paints a more complete picture of the interplay between recycling and the physical conditions of a subduction zone.

[1] Brown et al., 1982. *Nature*, **299**, 718-720.
[2] Elliott et al., 2004. *EPSL*, **220**, 231-245.
[3] Jeffcoate et al., 2007.. *GCA*, **71**, 202-218.
[4] Prytulak et al., 2013. *Chem. Geol.* **345**, 139-149.
[5] Prytulak et al., 2013. *EPSL*, **365**, 177-189.