Os isotope constraints on crustal contamination in Auckland Volcanic Field basalts, New Zealand

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Basalts from the monogenetic Auckland Volcanic Field (AVF) have been inferred to derive from the partial melting and mixing of varying proportions of three distinct components from within two mantle sources: (a) ambient asthenospheric mantle consisting of mid ocean ridge-like peridotite containing HIMU-type eclogitic domains (recycled oceanic crust); and (b) a subduction metasomatised lithosphere[1]. However the contribution of lithospheric (mantle and crust) contamination has not been assessed in detail. We present Re-Os isotope systematics of basalts representative of the range in the AVF geochemistry and use the differences of Os isotope systematics between crust and mantle derived lithologies to assess the extent of lithospheric contamination in these data.

Our results show there is a large range in Os concentrations (6-579ppt) and $^{187}Os/^{188}Os$ isotope ratios (0.123-0.547). $^{187}Os/^{188}Os$ vs. $1/^{188}Os$ diagram shows a broad positive trend (decreasing Os concentration and increasing Os isotope ratio). Samples showing only little contamination also display $^{187}Os/^{188}Os$ values (0.128-0.138) similar to or slightly higher than average mantle values (0.121-0.128), consistent with their derivation from partial melting of a peridotitic source containing HIMU-type eclogitic/pyroxenitic domains. The more radiogenic Os isotopic compositions (>0.15) and low Os content, entirely decoupled from tracers of the mantle sources under the AVF are suggestive of contamination of asthenospheric mantle-derived magmas by assimilation of continental crust during ascent.

[1] McGee, L.E., (2012) Melting processes in small basaltic systems: the Auckland Volcanic field, New Zealand. PhD Thesis, University of Auckland.

Ancient thermal events on 4 Vesta recorded in zircon U-Th-Pb-Ti depth profiles from a brecciated eucrite

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Zircons in asteroidal meterorites are rare, but a modest number have been previously documented, including those in the howardite-eucrite-diogenite (HED) achondrite group. The HEDs probably originate from 4 Vesta. Sub-micrometer distributions of trace elements (Ti, U, Th) and $^{235,238}U$-$^{207,206}Pb$ ages were investigated in four zircons (>7-40 μm ∅) separated from bulk samples of Millbillillie, a brecciated eucrite. Ultra-high resolution (sub-μm) ion microprobe depth profiles reveal different age domains correlative to mineral chemistry in cores and mantles within individual zircons. These compositional differences (e.g. $[Th/U]_{zrc}$ and Pb* isotope discordance) can be related to ancient thermal events to the crust of the parent body asteroid. Our results confirm that the crust of 4 Vesta solidified within a few million years after the formation of CAIs (4561±13 Ma), in good agreement with previous work. Subsequent zircon age re-setting occurred less than 40 Myr later (ca. 4530 Ma), which has also been seen in some $^{40-39}Ar$ age plateaux [1]. Analytical modeling shows that for a single impactor to be responsible for this effect, it had to have been ≥10 km in diameter and at high enough velocity (>5 km s^{-1}) to account for the thermal field required to re-crystallize zircon. Model output also shows that the thermal regime from impact could have penetrated at least 10 km into Vesta's crust. Later events at ca. 4200 Ma have been recorded in an HED apatite $^{235,238}U$-$^{207,206}Pb$ age [2] and $^{40-39}Ar$ age spectra [3]. These younger ages, as well as those coinciding with the Late Heavy Bombardment (LHB; ca. 3900 Ma) are not present in Millbillillie zircon. This is attributable to differences in mineral closure temperatures (T_c zircon >> apatite) and changes to the velocity distributions of impactors in the asteroid belt during and after the LHB.

[1] Bogard & Garrison (2003) *Meteor Planet Sci*, **38**, 669-710. [2] Zhou *et al* (2011) *42nd LPSC, Abs*. #2575. [3] Bogard (2011) *Chemie der Erde*, **71**, 207-226.

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