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The iron isotopic composition of some deep-sea sediments from the oceanward approaches to western Pacific and northern Indian ocean trenches: Implications for the iron isotopic composition of arc magmas?

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Despite their more oxidised state relative to MORB, basalts from the subduction-related arcs of the west Pacific have iron isotopic compositions that are unexpectedly lighter (lower $d^{57}Fe$ and $d^{56}Fe$) than MORB [1]. To investigate what if any role subducted sediment could possibly have, 54 samples of previously analysed [2, 3] deep-sea pelagic clay-mud sediments were taken from DSDP and ODP drill cores from the oceanward approaches to western and southwestern Pacific trenches and from the Indian ocean near the Java Trench.

Unexpectedly almost all the samples have $d^{57}Fe$ values < MORB ($d^{57}Fe$ = +0.15 ‰, [4]). Values range from very 'light' -0.62‰ up to +0.18 ‰ with a mean of -0.13 ± 0.24‰. These results show a positive correlation $d^{57}Fe$ and SiO_2 wt. % and a negative correlation with total Fe. Some of the samples with very light $d^{57}Fe$ values are very Fe-rich (25% FeO).

Covariation of $d^{57}Fe$ and eNd provides insight into relations within the sample set. Those with relatively heavier $d^{57}Fe$ (> -0.05‰) show wide variation in eNd (+8 to -12) while all the samples with $d^{57}Fe$ < -0.05‰ have a very narrow range in eNd (eNd = -6 ± 2). This implies that the samples with higher $d^{57}Fe$ are strongly influenced by a mixture of volcaniclastic and continentally derived detrital sources, whereas those with $d^{57}Fe$ < -0.05‰ are partly hydrogenous, influenced by seawater exchange. A further subdivision of the isotopically light subgroup is highlighted by Mn covariation, identifying two trends. Both trends lead to equally light Fe isotopic compositions. One subgroup is defined by low (~0.2% MnO) and invariant Mn. This may be a diagenetic, euxinic trend influenced by pyrite growth. The other trend shows strong Mn enrichment up to values > 20wt% MnO and is due Mn-Fe nodular growth.

Given these results it is possible that sediment subduction can contribute to the shift to isotopically lighter Fe in arc basalts.

[1] Foden et al. (2018) EPSL 494

[2] Plank and Langmuir (1998) Chem Geol 145

[3] Vervoort et al. (2011) GCA 75

[4] Sossi et al. (2016) EPSL 452