

The potential of platinum stable isotopes of Fe-Mn nodules and crusts as a paleoceanographic tracer

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Fe-Mn nodules and crusts are slow-growing chemical sediments that form by direct precipitation from seawater, resulting in a record of changing seawater chemistry. In the modern oxic marine environment these sediments are also the primary sink for platinum: 80 times enrichment over pelagic sediments and up to 1300 times over UCC concentrations^[1,2], resulting in concentrations that make them amenable to Pt stable isotopic analysis.

Platinum is a non-bio-essential siderophile transition metal with six naturally occurring isotopes (¹⁹⁰Pt, ¹⁹²Pt, ¹⁹⁴Pt, ¹⁹⁵Pt, ¹⁹⁶Pt, ¹⁹⁸Pt) with a range of oxidation states (Pt⁰, Pt²⁺, Pt⁴⁺). The dominant oxidation state of platinum in seawater is thought to be Pt²⁺, with Pt⁴⁺ also present to an unknown degree^[1,3]. Variations in ocean redox state, together with changes in source fluxes to the oceans, may lead to small variations (< ±1‰) in the stable isotopic composition of marine platinum. We will present the first investigation into the Pt stable isotopic composition of marine Fe-Mn (hydroxy)oxide sediments, to investigate its potential as a paleoceanographic tracer.

A method has been established using MC-ICPMS to precisely measure Pt isotopic compositions using a ¹⁹⁶Pt-¹⁹⁸Pt double spike to correct for instrumental mass bias^[4]. Pt is separated from the Fe-Mn oxyhydroxide component of the sediments by means of anion exchange chemistry, with ≥ 80% yields and ≥ 85% purity, as determined for three natural nodule standards and a Pt standard. Preliminary results from bulk nodules from different ocean basins are indistinguishable within uncertainties but have a measurable isotopic offset from the IRMM standard and three other Pt metal standards^[4] and the suggestion of offsets from other terrestrial reservoirs.

[1] Goldberg *et al.* (1986) *App. Geochem*, **1**, 227-232. [2] Hein, J. R. *et al.* (1997) *Manganese Mineralization: Geochemistry and Mineralogy of Terrestrial and Marine Deposits*, **119**, 123-138. [3] Jacinto & Van Den Berg (1989) *Nature*, **338**, 332-334. [4] Creech, J. *et al.* (2013) *J Anal Atom Spectrom*, in press.

Mafic lavas constrain the chemical variability of the Society plume

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Geochemical investigation of ocean island lavas has shown that in some archipelagoes, lavas are organized in distinct chemical and geographic trends, attributed to sampling by mantle plumes of distinct chemical reservoirs located deep in the mantle [e.g., 1-2].

Here, we present new trace element and Sr-Nd-Hf-Pb isotopic compositions of 40 mafic alkaline shield-building lavas (MgO>8 wt.%) from the main islands of the Society Archipelago (French Polynesia): Mehetia (<1 Myr), Moorea (ca 1.5 Myr), Raiatea and Huahine (ca 2.5 Myr), Bora Bora (ca 3.5 Myr) and Maupiti (ca 4.5 Myr). Isotopic compositions of the mafic lavas cover the entire range known for the Society lavas (⁸⁷Sr/⁸⁶Sr = 0.703894 to 0.706053; ¹⁴³Nd/¹⁴⁴Nd = 0.512613 to 0.512898; ¹⁷⁶Hf/¹⁷⁷Hf = 0.282849 to 0.283042; ²⁰⁶Pb/²⁰⁴Pb = 18.77 to 19.55).

Recently, Payne *et al.* [3] distinguished two groups of islands along the Society chain using the relationship between published Ba/Nb and ¹⁴³Nd/¹⁴⁴Nd data. Our new data do not support this interpretation and show a continuum of compositions rather than two distinct groups. For instance, Maupiti and Huahine, assigned to different groups, not only have similar geochemical signature but also the data points for both islands are spread over the two groups. The geochemical structure of the Society plume is thus complex and the model of two parallel trends reflecting its location with respect to the DUPAL anomaly [3] needs revision.

Our dataset shows that FeO, TiO₂ and CaO decrease and SiO₂ and K₂O increase with ⁸⁷Sr/⁸⁶Sr. These correlations do not result from shallow-level processes but from changing melting depths and lithologies within the plume conduit. They also cover the entire range of major element compositions of ocean island mafic lavas [4] (e.g. SiO₂ = 42-48 wt.%, K₂O/TiO₂ = 0.1-0.7 and CaO/Al₂O₃ = 0.7-1.1). Thus, using average archipelago compositions to discuss mantle end-member lithologies leads to underestimate the internal plume variability. In the Society chain, low ⁸⁷Sr/⁸⁶Sr melts derive from deeper melting and/or from silica-poor sources (e.g., CO₂-bearing peridotite or eclogite) while high ⁸⁷Sr/⁸⁶Sr melts derive from shallower melting and/or from sources richer in SiO₂ (e.g., volatile-free peridotite).

[1] Huang *et al.* (2011), *Nat. Geosci.* **4**, 874-878. [2] Chauvel *et al.* (2012), *G3* **13** Q07005. [3] Payne *et al.* (2013), *Geology* **41**, 19-22. [4] Jackson & Dasgupta (2008), *EPSL* **276**, 175-186.