Polynesia: a weak and disorganized superplume

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Ocean island basalts originate through melting of hot material from deep in the mantle. Such plume activity produces large volumes of lavas and lasts for tens of millions of years in strong plumes such as Hawaii or Reunion. Other plumes are much weaker, with a much more sporadic surface expression. This is the case of the Polynesian island chains.

The volcanic activity in Polynesia is puzzling in many ways. While sitting above a very large mantle anomaly called the “South Pacific Superswell”, its surface expression consists of four small volcanic chains, the Marquesas, Society, Pitcairn-Gambier and Cook-Australs whose volcanic activity lasted variable times between 5 and 20 My. In each chain, the present-day volcanic activity occurs at the southeastern end of the chain but in the Cook-Austral chain, active volcanism also occurs in other locations. In addition, while the Society, Cook-Austral and Gambier-Pitcairn islands are roughly aligned along the direction of plate movement, this is not the case of the Marquesas Archipelago which is oblique to plate movement.

From a geochemical perspective, Polynesian volcanism is also exceptional. Not only the most extreme Pb and some of the highest Sr isotopic compositions known in OIB are defined by Polynesian basalts but also, in each island chain, a very large range exists. All together, the isotopic diversity is the most extreme of all OIB chains. Whether the isotopic diversity has systematic patterns remains unclear, however: isotopic stripes were reported for the Marquesas (Chauvel *et al* 2012; Huang *et al* 2011) and suggested for the Societies (Payne *et al* 2013) but new high-precision isotopic analyses show clearly that isotopic stripes are far from systematic.

Relating the isotopic pattern displayed by Polynesian lavas to sampling of two different deep mantle sources on the edge of the Pacific LLSVP, as suggested for Hawaii (Weis *et al* 2011), does not appear consistent with the isotopic variations observed within Polynesia. In contrast, we suggest that they originate in small-scale heterogeneities within a deep superplume below the South Pacific and that distinct heterogeneities were sampled simultaneously at various locations.

[1] Chauvel *et al* G-cubed 2012 [2] Huang *et al Nature Geosc*. 2011 [3] Payne *et al Geology* 2013 [4] Weis *et al Nature Geosc*. 2011.