The Oceanic Mantle Plume Database and the tale of two superplumes

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The two dominant features in the present-day mantle are the antipodal African and Pacific Large Low Shearwave Velocity Provinces (LLSVPs), or superplumes. How were these two structures formed? Are they fixed and long-lived through Earth history, or dynamic and linked to the supercontinent cycles? Such first-order questions concerning how geodynamics operates on long time scales remain.

Paleomagnetic data and the global mantle plume record during the cycles of supercontinent assembly and break-up suggest that the antipodal superplumes are related to whole mantle convection due to circum-supercontinent subduction [1]. However, before 300 Ma, the mantle plume history is predominantly preserved as a continental record (dominated by continental large igneous provinces) due to the destruction of oceanic crust and associated oceanic large igneous provinces (O-LIP), ocean island basalts (OIB) and seamounts in subduction zones. As a result, we have a continental-biased view of the superplume-supercontinent link for Rodinia and Nuna, the two previous supercontinents.

For the past decade, more oceanic mantle plume activities, such as O-LIP, OIB, and seamount, have been identified in ophiolites around the world, which is allowing us to improve the reconstruction of the record of mantle plume activities in the oceanic realm for the last 2 billion years, spanning three supercontinent cycles. Here, we present the Oceanic Mantle Plume Database, a GIS-based database that reports the O-LIP, OIB and seamount occurrences, including geochemistry, geotectonic and age variations. Age peaks and cycle analysis reveal that plume activity in the continent and oceanic realms seem to be similar, cyclic, and coeval with supercontinent cycles since Rodinia ca. 1000 Ma, which argues for a dynamic LLSVPs: the supercontinents control the appearance of antipodal superplumes and therefore their times and positions. The recorded gap of mantle plume activities in the ocean from ca. 1000 to ca. 1900 Ma remains unresolved, but it may have resulted from (i) preservation bias, or (ii) suppressed lower mantle plume activity during the “Boring Billion”, or (iii) the occurrences of mantle plume activity has not been identified yet. In the future, we will use paleogeography to help us to spacially constrain oceanic mantle plume activity and mineral deposits. [1]Li and Zhong (**2009**), PEPI, 176, p143-156