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AMSTERDAM - ST. PAUL HOTSPOT HISTORY

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Abstract

The Amsterdam St. Paul hotspot (Indian Ocean) interacts with a regional depleted mantle containing some DUPAL-like blobs. Its lateral motion velocity is about 1-2 cm/yr. The plume induced the construction of a volcanic chain and of an oceanic plateau through two pulses of more intense magmatic activity. The intraplate plate activity appears partially controlled by some tectonic stress induced by the diverging motion of the Australian and Capricorn plates along a diffuse boundary.

Introduction

The Amsterdam-St Paul (ASP) plateau results of the excess of melting induced by the interaction between the ASP hotspot and the South-East Indian Ridge. The ASP plume was originally located beneath the Capricorn-Australian plates and its interaction with the SEIR began about 10 Ma ago. The intraplate activity of the ASP hotspot resulted into the construction of the chain of seamounts (the Chain of the Dead Poets: CDP) (cf. fig.). This volcanic chain is thus a unique opportunity to study the hotspot chemical characteristics prior to its interaction with the SEIR and its evolution since. A sorrow inspection shows that CDP is built near by the diffuse opening boundary between Capricorn and Australian plate, which has consequences on its morphology.

Main

An exhaustive study of the ASP hotspot products prior to its interaction with the SEIR provides acces to its geochemical composition while studying products of its interaction with the SEIR (i. e. ASP plateau) provides indirect knowledge on the Indian Ocean regional upper mantle.

The ASP plume exhibits a very variable enriched isotope composition with $^{86}\text{Sr}/^{87}\text{Sr} \approx 0.7039$, $^{143}\text{Nd}/^{144}\text{Nd} \approx 0.51280$, $^{206}\text{Pb}/^{204}\text{Pb} \approx 18.8$ to 19.5 and $^{208}\text{Pb}/^{204}\text{Pb} \approx 39.1$ to 39.8 for the extreme endmember. In addition, a large variation at volcano scale is also observed i. e. $^{208}\text{Pb}/^{204}\text{Pb}$ varying from 39.13 to 39.43 for La Fontaine seamount. This variability is interpreted in terms of contamination of hotpot derived melts with the heterogeneous Indian Ocean upper mantle. As proposed by Maia et al. [2008] the ASP hotspot seems to be weak plume that had pulses of activity within the last 10 My. Two periods of increased magmatic production have been identified between 10 and 6 My and during the last 3 My years. These two periods has resulted with the construction of two generations of seamounts northward of the ASP. Their elongated morphologies suggest a construction influenced by tectonic stress and likely due to the regional diverging motion between the Australian and Capricorn plates oriented N150°.

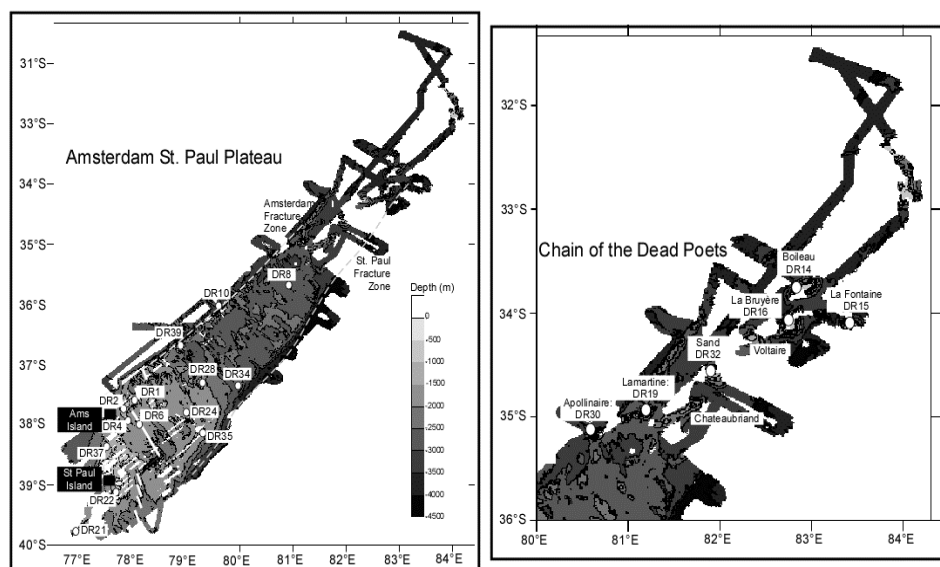
The isotopic compositions of the ASP plateau have reveal that the Indian Ocean upper mantle is extremely heterogeneous. The hotspot related melts mixed variably with the local Depleted Mantle which containing a poor component in radiogenic Pb, having a DUPAL-type composition. Nicolaysen et al. [2007] have shown that the DUPAL-type signature in the SEIR lavas is spatially limited to the segment I2 and J1/J2 crossing ASP plateau. They proposed that (1) the ASP hotspot is partially zoned, (2) the hotspot source contains components with different solidus temperatures or (3) a high proportion of DUPAL-type material is present within or beneath the plateau. Our data support the last model because we evidenced the existence of long-lived component with a restricted lateral extension



from SW to NE, which has contaminated the plateau and SEIR lava during the 1 M. Consequently, we assume that the local upper mantle might resemble the “Plum-pudding” of Morgan & Morgan [1999]. When the SEIR approaches the ASP hotspot, some plume derived material mixes with the depleted surrounding mantle and/or DUPAL blobs, leading to the variability formed in ASP plateau lavas. K-Ar dating on ASP samples reveals that the absolute motion of the Australian plate calculated with respect with a fixed ASP plume is of about 77 km/My toward the NE. With a spreading rate of about 6-7 cm/yr the accretion at the SEIR axis cannot account for this velocity.

In consequence, an absolute motion of the ASP plume of about 10-20km/My to the SW, comparable in velocity to that of Hawaii [Tarduno et al. 2003], could account for this discrepancy.

In summary, the ASP hotspot is a plume, emplaced in an heterogeneous upper mantle, showing pulses of activity and partially controlled by regional tectonic settings....



Bathymetry (in grey scale) of the ASP plateau with a focus on CDP mapped during the MD157/PLURIEL cruise. White circles represent basalts samples with the related dredge (DR) number. On the CDP name of seamounts are given. Seamounts without dredge could not be successfully dredged. Black squares are Amsterdam (Ams) and St Paul islands. Grey dotted lines are the Fracture Zones limiting the ASP plateau to the NW and the SE.

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