Co-001 Room: C311 Time: June 7 9:00-9:18

Evidence for distinct primitive mantle sources; a noble gas study of the Reunion Hotspot

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Extensive data sets of He, Ne and Ar isotopes are reported from two volcanoes on Reunion Island and three magmatic series from Mauritius Island. 3He/4He ratios of Reunion and Maurtius (Older Series) are almost constant and higher than MORB value and are almost constant, indicating that Reunion mantle plume includes undegassed component and has been homogeneous for a 8 Myr period. Ne and Ar isotopes combined with He isotopes demonstrate that undegassed endmember of Reunion is distinct from that of Hawaii, indicating that the mantle consists of several relatively undegassed reservoirs that are isolated in the lower mantle.

Noble gas studies of mid-ocean ridge basalts and ocean island basalts have demonstrated that mantle includes two major domains which consist of degassed and undegassed components. The isotopic evidence requires that the undegassed reservoir be unmixed with other materials for a long time scale of mantle evolution, suggesting layered convection in the mantle. Tomography, simulation of mantle convection and some radiogenic isotopes (e.g., Hf), however, do not always support the layered convection model and alternative models to isolate undegassed reservoir in the whole mantle scale stirring have been recently proposed. Here new noble gas data of the Reunion Hotspot will be presented, which demonstrate that Reunion source has undegassed signature but is isotopically distinct from the typical undegassed source observed at Hawaii. Consequently the mantle consists of several relatively undegassed reservoirs that are preserved in the lower mantle.

He, Ne and Ar isotopes were measured for numbers of samples from two volcanoes on Reunion (Piton de la Fournaise, <0.53 Ma; Piton des Neiges, 2 Ma - 0.44 Ma) and three magmatic series from Mauritius (Older, 5-8 Ma; Intermediate, 2-3 Ma; Younger, < 1 Ma). These volcanics thus record 8 Myr activity of the Reunion Hotspot. 3He/4He ratios of Piton de la Fournaise are between 12.5 and 13.5 Ra, in good agreement with data of Graham et al. (1990). 3He/4He of Piton des Neiges are constant regardless of 4He concentration and sample age, and indistinguishable from those of Piton de la Fournaise. The Older Series of Mauritius, corresponding to the shield building stage, has constant 3He/4He around 11.5 Ra, slightly lower than the ratio of Reunion. Samples from both Reunion volcanoes have higher 20Ne/22Ne and 21Ne/22Ne than atmospheric value (up to 12.6 and 0.0395, respectively). These data define a linear trend on a Ne three-isotope diagram with a slope between the Loihi and MORB correlation lines. There is a clear correlation between 20Ne/22Ne and 40Ar/36Ar (up to 4600).

The similarity of 3He/4He and Sr-Nd isotopes between Piton des Neiges and Piton de la Founaise demonstrates that the volcanoes have had a common homogeneous sources over a 2 Myr period. The Older Series of Mauritius also have 3He/4He and Sr-Nd ratios comparable to Reunion. These data suggest that both islands were produced by the same hotspot activity with a constant 3He/4He over a 8 Myr period, i.e. no temporal evolution in plume composition.

The Reunion mantle plume is characterized by radiogenic Sr isotope ratios, 0.7040-0.7044. Coupled with the relatively low 3He/4He (13 Ra) and an intermediate slope in the Ne-three isotope diagram, the source of Reunion magmatism cannot be explained by either crustal contamination or MORB-source mixing with Loihi-type primitive mantle. Thus He-Ne-Ar-Sr-Nd isotopes demonstrate that this plume source is distinct from the Loihi and Iceland source regions, clearly demonstrating that the mantle contains several relatively undegassed reservoirs and not a single primitive source.

A preferred model to account for different isotopic signature of Reunion and Hawaii hotspots is that the source domain of mantle plumes had experienced various degrees of degassing/differentiation in the early stage of mantle evolution. They have been isolated each other and from other components as small scale blobs (Becker et al., 1999) or large scale piles (Tackley, 2000) in the lower mantle.