

Evidence for small-scale recycled materials in Pacific upper mantle unrelated to plumes

Shiki Machida[1]; Naoto Hirano[2]; Jun-Ichi Kimura[3]

[1] ORI, Univ.Tokyo; [2] LEC., Univ. Tokyo; [3] Dept. Geosci., Shimane Univ.

Petit spot is a new type of volcano that is not related to plumes on the northwestern Pacific plate. An important aspect of petit-spot is that this provides a unique window for mantle source material beneath the oldest Pacific plate. To investigate the geochemical features of upper mantle unrelated to plumes in northern hemisphere, we have determined Sr, Nd, and Pb isotopic compositions of basalts collected from petit spots.

The isotope compositions of petit spot lava fall within the range of compositional variations in MORB. However, the lava is higher in $^{87}\text{Sr}/^{86}\text{Sr}$, lower in $^{206}\text{Pb}/^{204}\text{Pb}$ and $^{143}\text{Nd}/^{144}\text{Nd}$, and higher in $^{207}\text{Pb}/^{204}\text{Pb}$ and $^{208}\text{Pb}/^{204}\text{Pb}$ at a given $^{206}\text{Pb}/^{204}\text{Pb}$ than those of Pacific MORB or Depleted MORB Mantle (DMM). Remarkably, the isotopic compositions are equivalent to Indian and southern Atlantic MORB with strong Dupal signature (MORB from the southwest Indian ridge at 40E, 43.4S, and the southern mid-Atlantic ridge at 10-14W, 46-49S), and are almost identical to the composition of the EM-1 endmember. We propose that recycled material from an ancient subduction system or crustal delamination resides throughout the upper mantle of the Pacific Ocean as minor blobs.

Our model of 'small-scale recycled material melting' consistently explains geochemistry and noble gas isotopic composition of magma, and volume of petit spot volcanism. Furthermore, our results strongly suggest that the Earth's upper mantle is essentially heterogeneous, but its gross composition is controlled by abundances of blobs of recycled material. Upper mantle located beneath (such as the Indian, Atlantic, and possibly Arctic oceans) or on the periphery (such as the Philippine Sea) of the Pangea supercontinent includes abundant recycled material, in contrast to the Pacific Ocean. Because the Dupal signature was discovered in the northern hemisphere, the nature of the Dupal signature must be reconsidered as involving recycling of the entire solid Earth.