Geochemical linkage between HIMU-FOZO-PREMA OIB and compositional diversity of recycled oceanic crust

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Geochemical modeling of the origin of high-μ (HIMU), focal zone (FOZO), and prevalent mantle (PREMA) was conducted taking into account the compositional diversity of subducted oceanic crust. We classified MORBs into two groups. One is moderately differentiate MORB with high frequency (common MORB) and the other is highly differentiated MORB with low frequency (differentiated MORB). Chemical compositions of these types of MORBs are estimated and their isotopic evolution after 1.0, 1.5 and 2.0 Gyr are calculated. The results suggest that the common MORBs without chemical modification at subduction zones could evolve to have isotopic signatures of PREMA after ca. 1-2 Gyr. It follows that subduction modification is unnecessary for the production of PREMA and suggests the importance of recycling of “dry” MORB. In contrast, intensively hydrated common MORB can produce the FOZO isotopic signatures by dehydration at subduction zones. Thus, the FOZO-PREMA isotopic array can be explained by the recycling of common MORB that release various amounts of water beneath subduction zones, which is consistent with the common occurrence of ocean island basalts (OIB) on the PREMA-FOZO array. For the production of HIMU isotopic signature, strong dehydration is required. Furthermore, for the production of the bend of the OIB isotopic array on the $^{208}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ plot, continuous dehydration from low to high pressure might be a necessary. Difference in dehydration pressure changes nature of released liquid from aqueous fluid to supercritical liquid, producing the bend of the OIB isotopic array on the $^{208}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ plot. In addition, only the strongly dehydrated differentiated MORBs can produce extreme HIMU isotopic signature. This may explain the rare occurrence of the HIMU basalts because the differentiated MORB occur less frequently compared to the common MORB.