Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SIT05-09 会場:303 時間:5 月 27 日 10:00-10:15

高 Si 無人岩はリサイクルしたスラブ起源か？
Is high-silica boninite of recycled slab origin?

海野 進 [1*] ; 北村 啓太朗 [1] ; 金山 恭子 [1] ; 草野 有紀 [1] ; 仙田 量子 [2] ; 石塚 治 [3]
UMINO, Susumu[1*] ; KITAMURA, Keitaro[1] ; KANAYAMA, Kyoko[1] ; KUSANO, Yuki[1] ; SENDA, Ryoko[2] ; ISHIZUKA, Osamu[3]

[1] 金沢大学・自然システム学系, [2] 海洋研究開発機構・地球内部物質循環研究分野, [3] 産総研・地質調査総合センター
[1]Division of Natural System, Kanazawa University, [2]Department of Solid Earth Geochemistry, JAMSTEC, [3]Geological Survey of Japan, AIST

Primitive melt inclusions in chrome spinel from the Ogasawara Archipelago comprise two discrete groups of high-SiO_2, MgO (high-Si) and low-SiO_2, MgO (low-Si) boninitic suites with ultra-depleted dish- and V-shaped, and less depleted flat rare earth element (REE) patterns. The most magnesian melt inclusions of each geochemical type were used to estimate the genetic T-P conditions for primary boninites by using [1], which range from 1345 degC-0.56 GPa to 1421 degC-0.85 GPa for the 48-46 Ma high-Si and low-Si boninites, and 1381 degC-0.85 GPa for the 45 Ma low-Si boninite. These T-P conditions for the low-Si boninites lie on an adiabatic melting path of depleted mid-ocean ridge basalt mantle (DMM) with a mantle potential T (MPT) of 1420 degC, which is in agreement with that of the primary proto-arc basalt (PAB) magma preceding boninites estimated by PRIMELT2 [2]. This is consistent with the previous model of the subduction initiation in which the onset of the Pacific Slab subduction at 52 Ma forced upwelling of DMM from the depth of ca. 100 km to yield PAB. The residue of PAB was subsequently fluxed by slab fluids to yield the low-Si boninite at 48-46 Ma [3]. On the contrary, the higher temperatures for the high-Si boninite magma generation cannot be explained by this scheme, but has been ascribed to the involvement of a mantle plume with a MPT $>$1500 degC [4]. However, the ascent of such high-T peridotite to $<$1 GPa should cause extensive decompression melting to produce picritic magmas, which have never been found among the pre-boninite PAB. This discrepancy can be reconciled if the depleted proto-boninite source already existed below the DMM-like PAB source before the subduction began. With the rise of DMM, refractory harzburgite ascended without melting, and hence retained its high temperature. At 48-46 Ma, introduction of slab fluids caused remelting of the PAB residue and high-T harzburgite, resulted in the low-Si and high-Si boninites, respectively. Meanwhile, convection within the mantle wedge brought the less depleted residue of PAB and DMM into the region fluxed by slab fluids, which melted to yield the less depleted low-Si boninite at 45 Ma, and fertile arc basalts, respectively.

The presence of refractory high-Si boninite source is supported by the unradiogenic Os isotopic compositions of chrome spinel derived from high-Si boninite in Ogasawara [5] and harzburgite drilled in the Izu Forearc [6], which experienced melt extraction in Proterozoic age and became the source for the boninite magmas. Such Proterozoic depleted harzburgites are also known to exist below the lithosphere of the Ontong Java [7] and Kerguelen Plateau [8], and are considered to be remnants of recycled slab subducted below the Rodinia supercontinent [7]. The residual mantle experienced up to 25% melting below the Proterozoic mid-ocean ridges descended and stagnated in the transition zone below Rodinia. The refractory harzburgite slab was then brought up to the base of the continental lithosphere at a depth of around 100 km with the ascent of the super plume either during the rifting of Rodinia, or later Gondwana, and was drifted away with the continental fragments and is now spread sporadically below the Pacific and Indian plates. The globally limited occurrence of high-Si boninite is only possible when the remnants of harzburgitic slabs are tapped by a descending slab after subduction initiation and brought upward to the region of flux melting.

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キーワード: 伊豆―小笠原―マリアナ弧, 無人岩, 沈み込み帯発生, メルト包有物, クロムスピネル, スラブリサイクル
Keywords: Izu-Ogasawara-Mariana Arc, boninite, subduction initiation, melt inclusions, Cr spinel, recycled slab