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伊豆小笠原弧における希ガスとハロゲンのリサイクル
Noble gas and halogen recycling at the Izu-Ogasawara subduction zone

角野 浩史 [1*], Deborah Chavrit[2], Lisa Jepson[2], 清水綾 [3], 木村 純一 [4], Ray Burgess[2], Chris J. Ballentine[2]
Hirochika Sumino[1*], Deborah Chavrit[2], Lisa Jepson[2], Aya Shimizu[3], Jun-Ichi Kimura[4], Ray Burgess[2], Chris J. Ballentine[2]

[1] 東京大学大学院理学系研究科地殻化学実験施設, [2] マンチェスター大学, [3] 東京都立産業技術研究センター, [4] 海洋研究開発機構・地球内部ダイナミクス領域
[1]GCRC, Graduate School of Science, University of Tokyo, [2]SEAES, University of Manchester, [3]Tokyo Metropolitan Industrial Technology Research Institute, [4]IFREE, JAMSTEC

Recent findings of subducted halogens and noble gases with seawater and sedimentary pore-fluid signatures in exhumed mantle wedge peridotites and eclogites from the Sanbagawa-metamorphic belt, southwest Japan [1,2], as well as seawater-derived heavy noble gases (argon, krypton, and xenon) in the convecting mantle [3], challenge a popular concept that the water flux into the mantle wedge is controlled only by hydrous minerals in altered oceanic crust and sediment (e.g., [4]). Serpentinized lithosphere of subducting oceanic plate would transport noble gas and halogens acquired from pore-water in the overlying sediment [1,2,5]. To verify whether and how such subduction fluids modify the composition of the mantle beneath subduction zones, we determined noble gas and halogen compositions of olivines in arc lavas of the northern Izu-Ogasawara subduction zone and IODP sediments and basalts recovered from northwestern margin of the Pacific plate.

MORB-like $^{3}He/^{4}He$ and halogen ratios of the Izu arc olivines indicate insignificant contribution to the mantle wedge of radiogenic ^{4}He and pore fluid-like halogens both observed in the subduction fluids in the Sanbagawa samples exhumed from a depth ranging from 30 to 100 km [1,2]. On the other hand, systematically higher contribution of atmospheric argon in volcanic front lavas than in rear-arc lavas of the Izu-Ogasawara subduction zone suggests progressive decrease in flux of subducted argon from the slab according with distance from the Izu-Ogasawara Trench. Distinct halogen and heavy noble gas elemental ratios of altered oceanic basalts indicate their minor contributions to the Izu arc magma and the Sanbagawa subduction fluids. On the contrary, high I/Cl ratios of oceanic sediments well explain elevated I/Cl ratios of the Sanbagawa subduction fluids compared to sedimentary pore fluids [1].

The significantly smaller contributions of subducted noble gas and halogen in the Izu-Ogasawara arc than those in the Sanbagawa belt may result from a difference in P-T condition of the subducted slabs. A hotter mantle wedge than those of mature subduction zones is proposed for the Sanbagawa subduction system [6], in contrast the Pacific slab subducting in the Izu-Ogasawara subduction zone is relatively cold and would therefore lose relatively little water at equivalent depths to other slabs [7]. This implies a relatively small amount of the pore water subduction fluids would be released from the Pacific slab at a sub-arc depth (150-200 km) resulting in further subduction to great depths in the mantle.

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