Noble gas isotopic composition of basaltic glasses from Segment 1 of the South Chile Ridge: Origin of the anomalous neon isotopic composition

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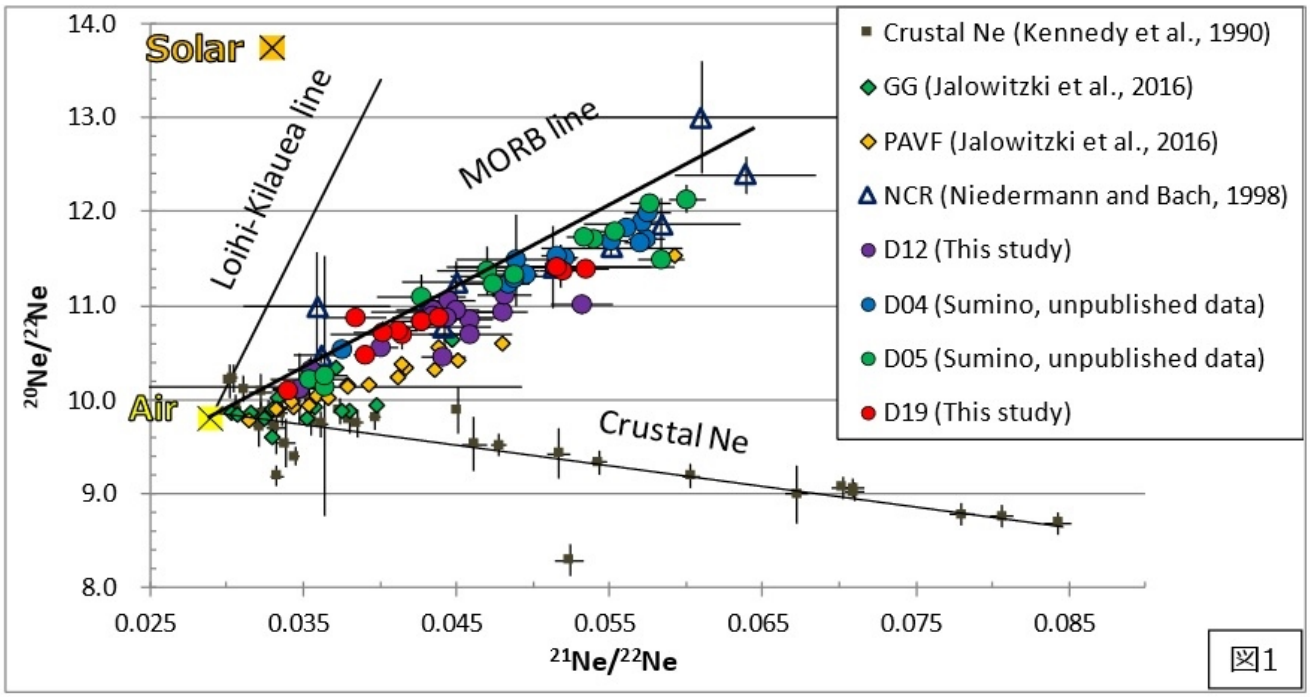
Noble gases are chemically inert, and the diffusion rates of "light" elements with low mass are large, and their presence in the Earth's interior is small, as the name "noble gas" implies, resulting in large variations in elemental and isotopic ratios through physical processes (e.g., Matsuda, 1996; Sumino et al., 2005). Because of these characteristics, noble gases are very effective indicators of mass transfer in the mantle. In southern Chile, the Chile Ridge is subducted into the western margin of the South American continent around 46˚S, forming the Chilean Triple Junction (CTJ) (e.g., Herron et al., 1981), which is a trench-trench-ridge type. The axis of extension of the Chilean Ridge extends about 2,000 km northwest from the CTJ and is divided into the North Chile Ridge (NCR) and the South Chile Ridge (SCR) by the Valdivia Fracture Zone. Niedermann and Bach (1998) were the first to report a higher $^{21}Ne/^{22}Ne$ ratio in MORB glass from the NCR than that of normal median ridge basalts (N-MORB). They interpreted this anomaly as an increase in the $^{21}Ne/^{22}Ne$ ratio due to the remelting of the residual solid phase after partial melting and degassing at the former East Pacific-Antarctic Ridge (PAR) during NCR formation and mixing with the N-MORB source. On the other hand, Strum et al. (1999) reported the Sr, Nd, and Pb isotopic compositions as well as the He isotopic compositions of MORBs collected from segments 1 to 4 in the SCR, but the isotopic compositions of other noble gases have not been measured so far. However, the isotopic compositions of other noble gases have not been measured. Numata (2020BS) measured the noble gas isotopic compositions of MORB glasses in the southern part of SCR segment 1, and clarified the anomalous Ne isotopic composition, although it is close to the atmospheric Ne isotopic composition. In this study, we also determined the major and trace element compositions and the noble gas isotopic compositions of MORBs collected in the northern and central parts of SCR Segment 1 in order to determine the Ne isotopic anomaly with higher precision and to compare it with other noble gas isotopic compositions and major and trace element compositions. In addition, the cause of the anomalous Ne isotopic composition in SCR segment 1 was discussed by comparing the results with those of NCR.
The isotopic composition of Ne in the MORB glass of SCR segment 1, which was newly analyzed in this study, showed a stronger effect of ^{21}Ne from nuclear reactions than that of N-MORB, and some of the effects were even stronger than that of NCR. On the other hand, the $^{3}He/^{4}He$ ratios were within the compositional range of N-MORB and not significantly different from those of NCR, while the maximum values of $^{40}Ar/^{36}Ar$ ratios tended to be lower than those of NCR. The major element compositions showed N-MORB characteristics, and trace elements also showed N-MORB except for some parent lithophile elements. These results are consistent with those of Strum et al. (1999), and it is unlikely that the mantle source in SCR segment 1 has higher concentrations of U and Th than the N-MORB source. These results suggest that the Ne isotopic anomaly in the MORB glass of SCR segment 1 is due to remelting of the PAR-derived mantle source, which has a high $(U+Th)/^{22}Ne$ ratio due to degassing, as pointed out by Niedermann and Bach (1998) in NCR.

The reason why the Ne isotopic anomaly in the MORB glass of SCR segment 1 is larger than that of NCR is that the distance between SCR and PAR is about twice as large as that of NCR, and thus the PAR-derived mantle, which is affected by the longer time effect in SCR, was remelted. On the other hand, the Ar isotopic compositions of the MORB glasses of SCR segment 1 obtained in this study did not reveal any significant radiogenic features as seen in the NCR. The former may be due to the equilibration with the N-MORB source, the athenospheric mantle, due to the large diffusion coefficient of He. The MORBs in the NCR and SCR segment 1 underwent equilibrium degassing in the mantle before the magma was formed. The MORBs in the NCR and SCR segment 1 undergo equilibrium degassing in the mantle before magma formation, and solubility-dependent fractionation in the post-eruption gas loss, where Ne and Ar are lost to He by gas-liquid separation. These can be evaluated from the He-Ne-Ar elemental ratios, and the effects of equilibrium degassing and gas loss are larger in SCR segment 1 basalts than in NCR basalts.

Keywords: Noble gas, Ne isotope anomaly, Chile Ridge, gas loss



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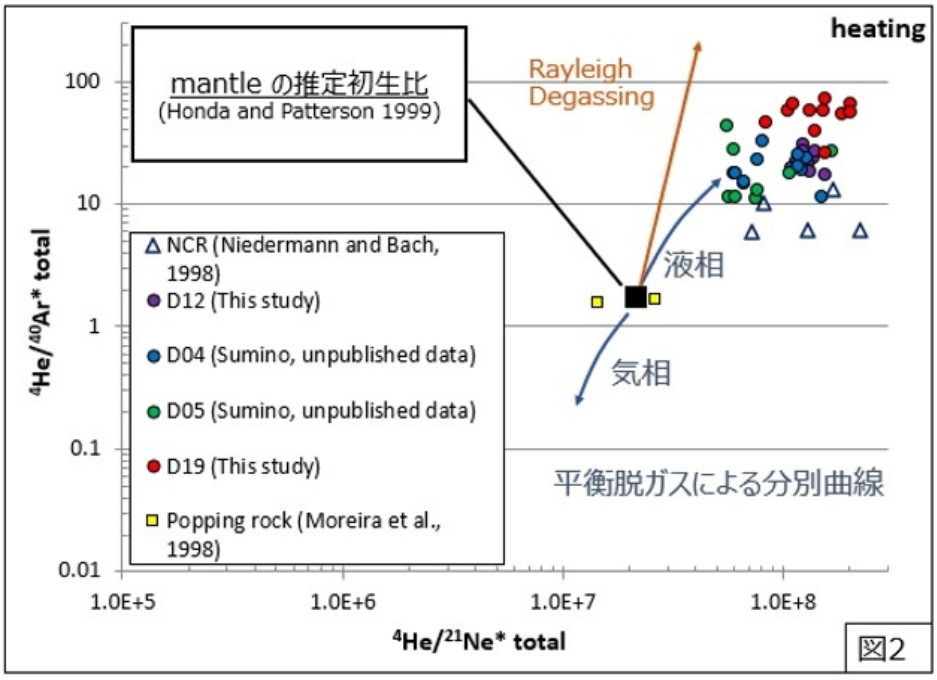

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