Noble gas isotope and halogen compositions of Cr-spinels within beach sand from Gorgona Island, Colombia

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Gorgona Island, Colombia is a ~90 Ma volcanic island, where picrites and the youngest komatiites known on the Earth are present. The origin of the magmatism of Gorgona is considered to be a part of the Caribbean–Colombian Oceanic Plateau resulting from the initial melting stages of the Galapagos mantle plume head (Trela et al., 2017). Shimizu et al. (2009) reported high chlorine concentrations in melt inclusions in chromian spinels (Cr-spinels) separated from beach sand from eastern coast of Gorgona Island. The melt inclusions were also characterized with high CO_2 and low H_2O contents. However, the origin of the volatiles remains unknown. Here we measured noble gas isotopes and halogens in the beach-sand-collected Cr-spinels from Gorgona to constrain the volatiles' origin. The compositions of trace amounts of halogens (Cl, Br, and I) were determined using a combination of neutron-irradiation and noble gas mass spectrometry (NI-NGMS, Kobayashi et al., 2021), together with K, Ba, and U contents. $^3He/^4He$ ratios of crush-released noble gas from 0.2 g of Cr-spinels showed a systematic decrease from 20 Ra to 3 Ra (where Ra denotes atmospheric $^3He/^4He$) with progress of crushing. This seems resulted from larger contributions of matrix-hosted radiogenic He in the latter crushing steps, which was confirmed by low $^3He/^4He$ ratio (0.3 Ra) obtained with melting of the crushed Cr-spinel powder. Therefore the original $^3He/^4He$ value of the magmatic He is higher than 20 Ra, showing good agreement to reported $^3He/^4He$ ratios of olivines separated from a gabbro and peridotites from the island (8-18 Ra, Révillon et al., 2002). The high $^3He/^4He$ value of the Gorgona komatiite and/or picrite magma is consistent with the involvement of Galapagos mantle plume, where the highest $^3He/^4He$ of 29 Ra has been reported (Kurz et al., 2009), to their mantle source.
The halogen compositions, Br/Cl and I/Cl ratios were close to those of MORB and OIB sources (Kendrick et al., 2017), indicating mantle origin of halogens and other volatiles. The Cl/K and Ba/K ratios (2.1 and 38, respectively) were similar to those reported for individual melt inclusions in Cr-spinels by Shimizu et al. (2009). On the other hand, high U content (0.3 ppm) determined with NI-NGMS is consistent with high abundance of radiogenic He in the samples, but not with previous observations for individual melt inclusions in Cr-spinels and whole rocks of komatiites and picrites, enriched basalts from the island. Combined with the high $^3He/^4He$ ratio, volatiles in the Gorgona komatiites and/or picrites would be derived from a less-degassed reservoir in the deep mantle, possibly in the core-mantle boundary.

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