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Helium isotopes in oceanic basalts and seismically observed lower mantle structures

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The location and mechanism for preserving a primordial reservoir, as characterized by low $^4He/^3He$ ratios in several oceanic basalts, is still unknown, but many models have been postulated. Geophysical study of the lower mantle has identified two nearly antipodal large, low shear-wave velocity provinces (LLSPVs). The LLSVPs are inferred to be chemically distinct continent-sized piles sitting atop the core-mantle boundary. Several numerical studies have established these piles can remain isolated for long periods of geologic time with only small amounts of material being entrained by plumes and transported to the Earth's surface. If they are indeed primordial, a systematic relationship between the noble gas compositions (e.g., low $^4He/^3He$ ratio) of oceanic basalts and other geologic parameters (e.g., spatial correlation to LLSVPs) would be expected.

Here we report He isotopic compositions for intraplate volcanism well outside the geographic region encompassed by the LLSVPs. These include analyses of the Balleny islands, a series of basaltic volcanic islands in the Southern Ocean, lying directly between the two LLSVPs, and are characterized by high $^4He/^3He$ ratios from 110,00 to 130,000 (i.e. $^3He/^4He = 5.5\text{-}6.5R_A$). Intraplate volcanism represented by Mount Erebus, the Karoo flood basalts, Guadalupe Island and the Cobb hotspot track are also located outside regions bounded by the LLSVPs and are characterized by $^4He/^3He$ ratios greater than 90,500 (ca. $^3He/^4He = 8R_A$) [1-5]. These initial results indicate that intraplate volcanism that does not overlie the LLSVPs is characterized by $^4He/^3He$ ratios greater than 90,500. Additional measurements (including Ne isotopes) of intraplate volcanism occurring outside the geographic extent of the LLSVPs will be necessary to further test the hypothesis that low $^4He/^3He$ ratios are associated with LLSVP material. [1] Chadwick et al. (2014) *G³* 15. [2] Eiler et al. (1997) *GCA* 61. [3] Heinonen and Kurz (2014) *AGU* V33C-4890. [4] Lupton et al. (1993) *GRL* 20. [5] Parmelee (2014) *Master's Thesis*.