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A thoughtful review by Class (2008) and a new article by Albarede (2008) provide a new context for re-examining potential relationships between excess temperatures (\(T_{ex}\)) and \(^{3}\He/^{4}\He\) (Putirka, 2008). The issue is to explain why high \(^{3}\He/^{4}\He\) mantle (HHM) is tapped by ocean island basalts (OIB), but not by the depleted mantle (DM) that feeds mid-oceanic ridge basalts (MORB). Two possibilities (not mutually exclusive) are HHM is physically segregated from DM and tapped only by OIB-specific dynamics (e.g., plumes), or HHM is intermixed within a DM matrix but partially melts at a lower or higher temperature.

A new merged data set (Putirka, 2008, Figure 3; Abedini et al., 2006; Jackson et al., 2007) yields nine new \(^{3}\He/^{4}\He\) maxima compared to my 2008 data (Putirka, 2008): Azores, 11.3; Cape Verde, 15.7; Galapagos, 27.4; Hawaii, 35; Iceland, 37.7; Kerguelen, 18.3; Reunion, 14.9; Samoa, 33.8; and Tahiti, 17. Also added are data from the Cook-Austral chain: \(^{3}\He/^{4}\He_{\text{max}}\) = 7 (Mukhopadhyay, 2007), \(T_{ex} = 1535\ °C, T_{cm} = 139\ °C, F = 8.03\%, \) and \(H_{2}O = 0.93\%\). The correlation coefficient (R) between \(T_{cm}\) and \(^{3}\He/^{4}\He\) is now 0.67 (Fig. 1A). Galapagos is excluded in this new data set, as in Putirka (2008), because its \(T_{cm}\) and parental melt fraction (F) are not well known. We also now compare \(^{3}\He/^{4}\He\) to F, a proxy for \(T_{cm}\) calculated independent of T (Putirka, 2008), and positively correlate F with \(^{3}\He/^{4}\He\) (Fig. 1B), allowing a quantitative illustration of certain premises in Putirka (2008).

Class noted that “because enriched components contribute radiogenic \(^{3}\He\)” they “allow for any combination of \(T_{cm}\) and \(^{3}\He/^{4}\He_{\text{max}}\).” However, if enriched components are fertile, only partial melts generated at low T and low F can have high \(^{3}\He/^{4}\He\) (upper dashed curve, with negative slope; Fig. 1), even while some low-F melts may have low \(^{3}\He/^{4}\He\) (lowermost dashed curve). High-F melts should also merge toward DM (\(^{3}\He/^{4}\He = 8\)) or some DM-HHM mixture, depending on whether HHM (the fertile source) is exhausted. But OIB with high F and \(T_{cm}\) are observed to have high \(^{3}\He/^{4}\He\).

What if HHM is the most refractory mantle component (Albarede, 2008)? Could selective fusion of a refractory component explain...