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AN: V43F-2196 [Abstracts]
TI: Lithosphere Thickness Control on the Extent and Pressure of Mantle Melting Beneath Intraplate Ocean Islands
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AB: We have examined island-averaged geochemical data for 115 volcanic islands [1] with known eruption ages and ages of the underlain lithosphere from the Pacific, Atlantic and Indian oceans [2]. These age data allow calculation of the lithosphere thickness at the time of volcanism [2]. After correcting the basalts (< 53% SiO_2) for fractionation effect to Mg# = 0.72 [3], we found that the island-averaged Si_{72} and Al_{72} decrease whereas Fe_{72}, Mg_{72}, Ti_{72} and P_{72} increase with increasing lithosphere thickness. The island-averaged $[La/Sm]_{CN}$ and $[Sm/Yb]_{CN}$ ratios also increase with increasing lithosphere thickness [2]. The correlations of these petrologic parameters with lithosphere thickness become outstanding when the data are averaged into each of the ten 10-km lithosphere thickness intervals regardless of ocean basins and geographic locations, i.e., $R_{Si72-Lithosphere\ Thickness\ (LT)} = -0.825$ (statistically significant at a > 99% confidence level), $R_{Al72-LT} = -0.879$ (> 99.5%), $R_{Fe72-LT} = 0.600$ (> 95%), $R_{Mg72-LT} = 0.751$ (> 99%), $R_{Ti72-LT} = 0.901$ (> 99.5%), $R_{P72-LT} = 0.745$ (> 99%), $R_{[La/Sm]CN-LT} = 0.682$ (> 98%) and $R_{[Sm/Yb]CN-LT} = 0.819$ (> 99%). These significant trends are most consistent with the interpretation that the extent of melting decreases whereas the pressure of melting increases with increasing lithosphere thickness. This is physically consistent with the active role the lithosphere plays in limiting the final depth of intra-oceanic mantle melting (i.e., the *lid effect* [4]). That is, beneath thin lithosphere, a parcel of mantle rises to a shallow level, and thus melts more by decompression with the aggregated melt having the property of high extent and low pressure of melting. By contrast, a parcel of mantle beneath thick lithosphere has restricted amount of upwelling, and thus melts less by decompression with the aggregated melt having the property of low extent and high pressure of melting. This finding demonstrates that oceanic lithosphere thickness variation exerts the primary control on the chemistry of ocean island basalts (OIB). Variation in initial depth of mantle melting as a result of fertile mantle compositional variation and mantle potential temperature variation can influence OIB compositions, but these must have secondary effects because they do not overshadow the effect of lithosphere thickness variation that is prominent on a global scale. *References*: [1] MPI GEOROC database (http://georoc.mpch-mainz.gwdg.de/georoc/); [2] Humphreys & Niu, On the composition of ocean island basalts (OIB): The effects of lithospheric thickness variation and mantle metasomatism, *Lithos*, 2008; [3] Niu & O'Hara, *J. Petrol.*, 49, 633-664, 2008; [4] Niu & O'Hara, *Geochim. Cosmochim. Acta*, A721, 2007.
DE: 1025 Composition of the mantle
DE: 1033 Intra-plate processes (3615, 8415)
DE: 1065 Major and trace element geochemistry
DE: 3619 Magma genesis and partial melting (1037)
DE: 8121 Dynamics: convection currents, and mantle plumes
SC: Volcanology, Geochemistry, Petrology [V]
MN: 2008 Fall Meeting