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Alpha / Mendeleev Ridge and Chukchi Borderland $^{40}Ar/^{39}Ar$ Geochronology and Geochemistry: Character of the First Submarine Intraplate Lavas Recovered from the Arctic Ocean

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At least three episodes of magmatic activity have been recognized on the basis of $^{40}Ar/^{39}Ar$ age determinations in the submarine basaltic samples dredged, drilled or grabbed with a manipulation arm from Alpha / Mendeleev Ridge and Chukchi Borderland of the Arctic Ocean by US Coast Guard Icebreaker Healy, in August-September 2008, and Russian research vessel Captain Dranitsin in August-October 2012: ca. 112 Ma, ca. 100 Ma and ca. 85-73 Ma. Major-oxide and trace-element concentrations, and Pb, Sr, Nd, and Hf isotopic ratios of the recovered lavas provide important constraints on the composition and sources for the original melts. Lavas erupted at ca. 112 Ma (Group 1) have alkali basalt major-oxide compositions. Their low degree of rare-earth-element (REE) fractionation (CeN/YbN = 1.7-2.5), combined with high overall HREE (22-24 times chondrite) and Mg# ∼54, suggest derivation from a garnet-free source followed by only minimal crystal fractionation for this group. Pb-Sr-Nd-Hf isotopic systematics of the lavas ($^{206}Pb/^{204}Pb$ = 18.73-18.79; $^{207}Pb/^{204}Pb$ = 15.54-15.56; $^{208}Pb/^{204}Pb$ = 38.28-38.35; $^{143}Nd/^{144}Nd$ = 0.512594-0.512610; $^{87}Sr/^{86}Sr$ = 0.709458-0.709601; $^{176}Hf/^{177}Hf$ = 0.283224), together with ratios of highly incompatible trace elements (Th/Ce = 0.09-0.11; Ce/Nb = 2.58-3.09; Th/Nb = 0.24-0.33), point toward a lithospheric source for the magmas.

Eruptions at ca. 100 Ma and 85-73 Ma produced two types of lavas: low-Ti tholeiitic basalts – LT, and high-Ti alkali basalts – HT, both assigned to Group 2. This distribution of low- and high-Ti lavas is common in continental flood basalt (CFB) provinces elsewhere, and has been attributed to plume activity in some studies. The trace-element abundance patterns for these Group 2 Arctic lavas are also very similar to those of CFBs elsewhere. Their low degrees of REE fractionation (CeN/YbN = 2.0-3.3) accompanied by progressively decreasing Mg#s (from 53 to 33) suggest a garnet-free source, with the derivative magmas experiencing significant crystal fractionation prior to eruption. Both LT and HT basalts have Sr, Nd and Hf isotope ratios that fall between MORB and Bulk Silicate Earth ($^{143}Nd/^{144}Nd$ = 0.512669-0.512919; $^{87}Sr/^{86}Sr$ = 0.703820-0.704764; $^{176}Hf/^{177}Hf$ = 0.283128-0.283191), and are thus characterized as depleted, most likely originating in a subcontinental asthenospheric source. Contamination of these lavas with small amounts of lithospheric components is a distinct possibility. HT basalts, generally the younger of the two lava types in Group 2, are more depleted in their Nd and Sr isotopic compositions than the older LT basalts. Measured Pb-isotopic ratios plot mostly along and above the Northern Hemisphere Reference Line or NHRL ($^{206}Pb/^{204}Pb$ = 18.59-19.37; $^{207}Pb/^{204}Pb$ = 15.55-15.60; $^{208}Pb/^{204}Pb$ = 38.31-38.99). Volume estimates between the Group 1 and Group 2 lavas are not yet possible to determine. However, the composition-time relationships for the lavas suggest inception of melting in the Amerasia Basin sub-continental lithospheric mantle (SCLM) – probably due to rift-related decompression – followed later (at 100 Ma and 85-73 Ma) by asthenospheric melting that may or may not be associated with a plume.