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Earth's core as a reservoir and source of volatile elements: Insights from Baffin Island lava geochemistry

FORREST HORTON

Woods Hole Oceanographic Institution

Presenting Author: fhorton@whoi.edu

Mantle-derived lavas contain noble gases thought to be captured during planetary accretion. Their abundance and distribution inform our understanding of planet formation and mantle evolution. Exceptionally high $^{20}Ne/^{22}Ne$ ratios in some ocean island lavas are considered evidence of solar nebula incorporated into planetary precursors during the earliest stages of accretion [1–2]. Although the nebula-like component—characterized by anomalously high $^{3}He/^{4}He$ and $^{20}Ne/^{22}Ne$—is conventionally considered intrinsic to the mantle, the core is gaining renewed attention as a potential alternative reservoir [3–6]. The competing mantle and core hypotheses, although not mutually exclusive, have implications for our understanding of terrestrial accretion.

Baffin Island lavas have the highest known magmatic $^{3}He/^{4}He$ [7] and neon isotopic compositions linked to the nebular component in the Iceland plume [8]. Isotopic relationships among light noble gases and lithophile elements in Baffin Island lavas suggests that, in the modern mantle, a nebular component exists in reservoirs characterized by incompatible trace element depletion. This is consistent with a scenario in which oceanic mantle lithosphere (i) subducted to the core-mantle boundary, (ii) entrained core-derived volatiles, and (iii) became incorporated into the Iceland mantle plume. The tungsten isotopic anomalies observed in Iceland lavas are not apparent in Baffin Island lavas, which might indicate that core-derived material is diffusively stratified in the lowermost mantle [9]. The viability of the core hypothesis raises the possibility that, during planetary accretion, nebular gases were shielded from outgassing in the core. If so, transfer across the core-mantle boundary potentially influences the abundances of volatile elements in the mantle.

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