Geochemical investigation of gabbroic xenoliths from Hualalai Volcano, Hawaii

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The 1800-1801 Kaupulehu flow from Hualalai Volcano, Hawaii, contains abundant gabbroic and ultramafic xenoliths. These xenoliths provide insights into the plumbing systems of Hawaiian volcanes as well as constraints on the composition of the ~110 Ma Pacific crust and lithosphere upon which the Hawaiian Islands are constructed.

Clinopyroxenes from the majority of the Kaupulehu gabbros have convex-upward REE patterns consistent with derivation through fractional crystallization from LREE-enriched Hualalai magmas with little trapped interstital melt. Calculated parental melts have REE patterns spanning the entire range of Hualalai lava compositions. A small subset of xenoliths with LREE-enriched clinopyroxenes appear to be trapped Hualalai melts that crystallized as a closed system. The Hualalai-derived xenoliths have Sr-Nd-Pb isotopic compositions that span the full range reported for Hualalai lavas. These gabbros provide a nearly complete record (minus the stratigraphic context) of Hualalai magmatic history.

A small subset (~15%) of the Kaupulehu gabbros have LREE-depleted pyroxenes that crystallized from melts with MORB-like compositions. These xenoliths have unradiogenic $^{87}Sr/^{86}Sr$ (~0.7025-0.7028) and radiogenic $^{143}Nd/^{144}Nd$ (0.5130-0.5132) and overlap the field defined for Pacific MORB. Lead isotope compositions ($^{206}Pb/^{204}Pb \approx 18.0$-18.4) are generally less radiogenic than present-day Pb-isotope values reported for MORB from ODP Site 843 west of Hawaii, which suggests that the ODP 843 lavas may not be representative of the composition of the lower, less altered portions of the local Pacific crust beneath Hawaii. In particular, the MORB-related gabbros have lower $^{208}Pb/^{204}Pb$ for a given $^{206}Pb/^{204}Pb$ than the trend defined by Site 843 lavas [1], and overlap with post-erosional lavas from the Honolulu Volcanic Series. If the MORB-related gabbros are isotopically similar to the lithospheric mantle beneath Hawaii, then a role for lithospheric mantle in the generation of post-erosional lavas cannot be excluded based on the Pb-isotope compositions of Site 843 lavas, as some studies have previously concluded [2].

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Sudbury asteroid impact triggered the emplacement of endogenous magma that produced a giant Ni-Cu-PGE deposit

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The Sudbury impact structure, Canada, comprises the up to 5 km thick Sudbury Igneous Complex (SIC) that is widely interpreted as an impact melt sheet produced by melting of target crustal rocks [1-6]. The Sudbury structure is renowned for showing clear evidence of asteroid impact and for hosting the largest known reserves of Ni, Cu and PGE sulfides that are closely associated with the SIC [6]. Two groups of igneous bodies closely associated with the SIC are thought to be representative of its initial magma composition. These are glassy dykes and sills that occur in the roof rocks (Onaping melt bodies) and dioritic dykes that cut the underlying basement rocks (Offset dyke). However, these two groups of igneous bodies have distinctly different major and trace element compositions, posing the question as to which magma produced the SIC. The quenched glassy texture of the Onaping bodies is indicative of their formation as superheated melts generated by asteroid impact [7]. Compositional changes of this initial impact melt by subsequent intra-chamber processes such as fractional differentiation [8], assimilation [9] or liquid immiscibility [4, 6, 10-11] do not lead to the magma compositions parental to the Offset dykes. The Offset dykes can therefore only represent an external, endogenous magma from below [12] that mixed with an impact melt to form the hybrid magma parental to the SIC. Identical ages for the SIC and Offset dykes indicate that emplacement of the endogenous magma was initiated by the Sudbury impact event. This suggests that Sudbury asteroid impact triggered endogenous magmatism that gave rise to formation of a giant Ni-Cu-PGE deposit.

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