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# Evidence for olivine-free mantle source of Hawaiian tholeiites

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### Problem

Extensive data on lavas and melt inclusions in high-Mg olivines from Mauna Loa, Mauna Kea, Kilauea and Koolau volcanoes show that primitive Hawaiian tholeiites significantly differ from other mantle plume tholeiites and komatiites by considerably higher concentrations of Si at the same high Mg#. These Si contents are too high for equilibrium with both olivine and garnet, although they show unequivocal garnet signatures in their sources (buffered Yb and low HREE/MREE). Additionally, NiO contents of many high-Mg Hawaiian olivine phenocrysts (Fo89-90.5) are in the range 0.45-0.55 wt%, significantly exceeding NiO in most known mantle olivines or high-Fo phenocrysts in basalts. None of the models reconciling the coexistence of high Si contents and garnet signature of Hawaiian tholeiites [e.g.1-3] explains the exceptionally high Ni in Hawaiian olivines. Here we suggest that high Si and Ni contents of primitive Hawaiian tholeiites, together with their garnet signatures, can be explained by a hybrid origin and an olivine-free source composition.

### Hypothesis

Similar to ref. [4] we suggest that the source of Hawaiian tholeiites is produced by reaction of high-Si melts, originating in recycled eclogites, with peridotitic mantle. However, our new model requires a significantly higher proportion of high-Si reactive melt (roughly equal to the mass of peridotite). Quantitative modeling predicts that replacement of olivine by pyroxenes due to this reaction significantly lowers the bulk partition coefficient for Ni and thus increases the Ni content in equilibrium melts. Also, this reaction delivers the required amounts of incompatible elements and Si into the Hawaiian source mantle. Thus we suggest that primary Hawaiian melts have originated by high degrees of melting of hybrid garnet pyroxenites which, in turn, are generated by melting of recycled oceanic crust and infiltration into the surrounding peridotite. During ascent, the primitive melts become saturated with high-Mg-Ni olivine only at shallower depths due to the well known property of the olivine stability field expanding with decreasing pressure.

### References

[1] Hauri E.H. (1996) *Nature* **382,** 415-419.
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[3] Wagner T.P & Grove T.L. (1998) *CMP* **131**, 1-12.
[4] Sobolev A.V., Hofmann A.W & Nikogosian I.K. (2000) *Nature* **404**, 986-990.

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# High-pressure partial melting of gabbro and the preservation of "ghost plagioclase" signatures

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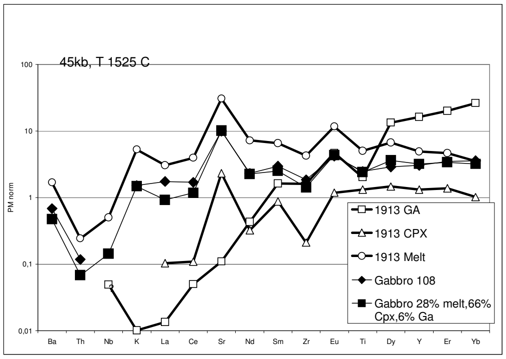
Rare Sr-rich melt inclusions in olivine phenocrysts from Mauna Loa lavas were interpreted as a "ghost plagioclase" signature derived from interactions between siliceous partial melts of recycled oceanic gabbro (eclogite), and peridotite in the Hawaiian source [1].

To test this model, we partially melted the natural oceanic gabbro Gb108 (ODP 176-735B-169R3:108-118) at 3.5 and 4.5GPa. The starting material was glassed and ground to fine powder. Run products were analysed by EPMA and SIMS.

The solidus was 1350–1375°C at 3.5GPa, and 1450–1475°C at 4.5 GPa. The subsolidus assemblage was minor garnet and coesite, with abundant Jd+CaTs-rich clinopyroxene. Low degree partial melts coexisted with ga+cpx+co and had 63–64wt% $SiO_2$. Co-out was at 1375–1400°C at 3.5GPa and 1475–1500°C at 4.5GPa. Partial melts at T>co-out were less siliceous (56–62wt% $SiO_2$).

Quenched liquids' trace element patterns exhibit strong positive Sr anomalies, and are similar to the Sr-rich Mauna Loa inclusions [1]. Mass balance calculations indicate the accuracy of the measured liquid trace element abundances (see Figure).



Thus, partial melts of discrete gabbroic (eclogite) bodies in intraplate volcanics' sources may generate anomalously Sr-rich, high-Si liquids. These melts may react with olivine-bearing lithologies, producing source compositions parental to Sr-rich melts which were later trapped as inclusions by crystallising olivine phenocrysts [1].

### References

[1] Sobolev A.V., Hofmann A.W. and Nikogosian I.K. (2000) *Nature* **404,** 986-990.