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# Extreme Compositional Variability of Hawaiian Primary Melts: The Clue to the Origin of Classical Mantle Plume?

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The primitive lavas from Hawaii islands show significant range in their composition in major and trace elements and isotopes (Nd, Pb, Sr, Os and O) (e.g. Hauri, 1996; Norman & Garcia, 1999). This may suggest either heterogeneous mantle sources or (and) different scenarios of melting or melt contamination or reaction en rout. However common magma mixing could potentially obliterate original compositional range of primary melts. Here we present the data on melt inclusions in olivines from Mauna Loa and Mauna Kea lavas which show that original variations in the compositions of primitive melts far exceed those recorded in compositions of lavas themselves.

We have studied over 300 melt inclusions in Mauna Loa and 300 melt inclusions in Mauna Kea lavas by EPMA. About 200 inclusions have been analyzed by SIMS for Mauna Loa and 200 inclusions for Mauna Kea. For both volcanoes about 90-95% of inclusion populations are very close in compositions to average lavas although inclusions in phenocrysts of particular lava rarely match bulk rock composition. Around 5% of inclusion populations manifest highly exotic trace element compositions. Majority of them is found in the most Mg-rich olivine phenocrysts (Fo 88-90). They comprise Sr-rich (PM normalized ratios: Sr/Ce norm. = 2.9-5.6) and ultra-depleted (K/Ti norm. = 0.2; La/Sm norm. = 0.3) inclusions in Mauna Loa olivines (Sobolev et al., 2000) and Nb, K enriched (Nb/La norm = 3.2; K/La norm = 3.4) and ultra-depleted inclusions in Mauna Kea olivines (K/Ti norm.= 0.02-0.13; La/Sm norm.= 0.1-0.5). All exotic melt inclusions in both Mauna Loa and Mauna Kea olivines are similar to normal inclusions and lavas in concentrations of HREE and Y, indicating strong buffering effect of residual garnet.

In most of the olivine grains, the composition of the melt inclusions is quite uniform. This has been demonstrated by analysis of up to 30 separate inclusions in a single olivine grain. However, the exotic melt inclusions with either high Sr/Ce or extreme K/Ti, La/Sm or Nb/La ratios are invariably associated with normal inclusions in the same grain. In the most extreme cases the concentrations of Nb, K and Th differ by a factor of more than 50 in melt inclusions separated by a few hundred micrometers of host olivine. These observations show that the exotic melt fractions are small enough in volume to be easily "lost" in the bulk magmas by mixing processes during the residence time of single olivine crystals.

The common association of exotic and "normal" melt inclusions in single olivine grains suggest that magma mixing process is favorable for olivine growth and melt inclusions trapping. This may occur in the thermal boundary layer of olivine saturated magma injected in relatively cold and mixed magma conduit. The extreme range of compositions of trapped "unmixed" melts argues for significant source heterogeneity of Hawaiian plume. At least part of this heterogeneity may be due to the involvement of variety of different recycled components in the deep mantle source of the plume (Hofmann & White, 1982; Hauri, 1996; Sobolev et al, 2000).

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