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"Probing" mantle source compositions and melt evolution beneath the northern East Pacific Rise using olivine geochemistry

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As a major mineral phase in Earth's mantle and during mantle-derived melts crystallization, olivine shows great potential to trace mantle source compositions and magma differentiation. We investigated the chemical composition of olivines in a suite of geochemically diverse lavas (picritic basalts, DMORB, NMORB, EMORB) from the off-axis 8°20' N Seamounts and the nearby Siqueiros Transform to constrain mantle source characteristics and melt evolution beneath East Pacific Rise (EPR). 18 major and trace elements were analyzed in representative olivines by combined EPMA and LA-ICP-MS *in-situ* techniques. Divergent trends are revealed by Sc, V, and P versus Fo content (Mg/(Mg+Fe)) plots, where one trend shows increasing Sc (V and P) with decreasing Fo whereas the other presents a flat trend (Fig. 1). These divergent trends depict two fractional crystallization (FC) paths of olivine, plagioclase and clinopyroxene (Cpx) during magma differentiation, where Cpx only crystallized in highly enriched EMORBs. Mineral-melt equilibrium FC modeling on two melt endmembers were done to seek best-fit models that match the observed Ni-Fo and Ca-Fo variations in olivines. Results indicate that the very depleted lavas (picritic basalts and DMORBs) crystallized under lower pressure (1-5kbar) and derived from a depleted peridotite mantle source, whereas the highly enriched EMORBs and some extremely "enriched" (or evolved) olivine antecrysts crystallized under higher pressure (5-10kbar) and show close correlation with an enriched hotspot-related melt source. However, the restricted Mn/Fe and Zn/Fe ratios of all olivines indicate a peridotite mantle source, with no evidence for pyroxenite source involvement (Fig. 2). In addition, we find notable Ca enrichment (>1800 ppm, generally <700ppm) in some Siqueiros mantle olivines, which can be related with mantle metasomatism by carbonate-silicate melts derived from oxidized melting of pyroxene-rich assemblages [1]. We therefore interpret that the peridotite mantle beneath the northern EPR might have been metasomatized by hotspot-related enriched melt sources, potentially correlated with oceanic crust recycling.

Reference

[1] Foley, S.F., Prelevic, D., Rehfeldt, T. and Jacob, D.E., 2013. Minor and trace elements in olivines as probes into early igneous and mantle melting processes. Earth and Planetary Science Letters, 363, pp.181-191.