The effect of liquid composition on Ni partitioning: Ni in olivine as an indicator of melting depth

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Introduction: Since olivine (*ol*) is a major constituent of the upper mantle and a liquidus or near-liquidus phase for nearly all mantle partial melts [e.g., 1], elements compatible in *ol*, like Ni, can be used to infer crystallization processes and source region mineralogy [e.g., 2, 3]. The temperature (*T*)-dependent partitioning of Ni between *ol* and liquid (*liq*) (D_{Ni}=(NiO^{ol}/NiO^{liq}, by wt.) [4] can provide constraints on the *T*s at which mantle melting and *ol* crystallization from primitive mantle melts occurs.

Isolating the temperature effect: Most experiments designed to measure *ol-liq* D_{Ni} have been conducted at 1 atm. In these experiments, variations in *T* correlate with variations in melt composition, making it difficult to separate the effects of *T* and melt composition on observed variations in D_{Ni} [e.g., 2]. Matzen et al [4] presented D_{Ni} data from a series of experiments where *T* and *P* were changed in concert, keeping the liquid composition constant (~18 wt.% MgO) over a range of *T*s and *P*s. Here, we present the results of similar sets of experiments designed to measure the *T* dependence of D_{Ni} on liquids with different compositions (MgO contents of ~12, 15, 21 and 25 wt.%). Experiments were conducted using starting materials and techniques similar to those of [4] at *T*s and *P*s from 1300–1650°C and 1 atm–3.0 GPa; data were fit using an exchange model [4]. D_{Ni}s from experiments with ~15, 21, and 25 wt.% MgO^{liq} show *T* dependences within error of those of [4] for 18 wt.% MgO^{liq}. Thus, the *T* dependence of D_{Ni} is independent of liquid composition for our experiments. Globally, a constant *T* dependence of D_{Ni} is consistent with the difference between *T* in the source region and the *T* of low-pressure crystallization being an important factor for Ni enrichment in early crystallizing *ol* phenocrysts. The correlation (R^2=0.74) between the NiO contents of Mg-rich olivines from MORBs and OIBs [3] and the depth of the lithosphere-asthenosphere boundary at the time of their eruption [5] could be largely a consequence of the higher *T*s of melt segregation in deeper source regions [4].

[1] Stolper (1980) *CMP* **74**, 13-27 [2] Hart & Davis (1978) *EPSL* **40**, 203–219 [3] Sobolev *et al* (2007) *Science* **316**, 412-417 [4] Matzen *et al* (2013) *JPet* **54**, 2521-2545 [5] Dasgupta *et al* (2010) EPSL **289**, 377-392