Mn, Ni and the roles of pyroxenite and peridotite in the mantle sources of oceanic basalts

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Chemical heterogeneities are produced in the mantle by subduction of oceanic lithosphere. Assuming that subduction has been relatively long-lived the mantle may contain a significant fraction (~5%) of recycled crust [1]. An outstanding question is: how do such mantle heterogeneities contribute to subsequent magmas generated by mantle melting? Interestingly, the answer appears to depend on which elements are considered: elements that are incompatible in silicate minerals suggest that recycled oceanic crust is an important contributor [e.g., 2], whereas compatible elements generally suggest it is not [e.g., 3].

Recently, Ni and Mn in primitive olivines in erupted magmas were used to infer that these magmas are mixtures of partial melts of peridotite and metasomatic pyroxenites (formed by reaction between partial melts of recycled oceanic crust and peridotite) [4]. As a test of this hypothesis, we constructed a model to predict the Ni and Mn contents of olivines crystallized from partial melts of peridotite produced at different pressures and temperatures. Our melting model operates by combining modal abundances, phase compositions, and pressures and temperatures from peridotite partial melting experiments [5], with partitioning expressions for Ni and Mn constructed by fitting a large database of experiments and well-equilibrated xenoliths [6]. We find that observed olivine compositions (Ni and Mn contents) are consistent with melting of fertile peridotite at various pressures—importantly, melts from metasomatic pyroxenites are not required. Thus, although recycled materials are likely present in the mantle source regions of some basalts [7], the Mn and Ni data can be explained without such a contribution.

[1] Stracke et al. (2003) *G³* 4, 8003. [2] Pietruszka et al. (2013) *EPSL* 361, 298–309. [3] Putirka et al. (2011) *J. Pet.* 252, 279-313. [4] Sobolev et al. (2007) *Nature* 316, 412-417. [5] Walter (1998) *J. Pet.* 39, 29-60. [6] Matzen et al. (2017) *Nature Geo.* 10, 530-535. [7] White (2010) *Ann. Rev. Earth Planet. Sci.* 38, 133-160.