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A magnesium budget for serpentinisation of abyssal peridotite during the Cenozoic

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The marked increase in seawater Mg/Ca during the Cenozoic is poorly understood, due to the limited availability of proxy data and uncertainty in elucidating the respective contributions of Mg sources and sinks through geological time¹. Though established as a potentially large source of dissolved Mg over twenty years ago, the weathering of abyssal peridotites² is a largely unexplored potential source of Mg to oceanic budgets. The release of magnesium from peridotite weathering can occur in high temperature environments, during serpentinisation near the ridge axis³, as well as low temperature off-axis environments where peridotite and serpentinite are altered to clays, carbonates and silicates⁴. The relative magnitude of Mg fluxes from these sources are poorly constrained. Recent studies, however, now provide a general method for estimating bulk crustal lithologies of mid-ocean ridges based on spreading rate (i.e. proportion and mass of basalts, gabbros, peridotites and serpentinised peridotite) through time⁵—enabling us to quantitatively assess potential Mg contributions from these different environments.

We constructed a model for oceanic crustal weathering (proportional to depth below the seafloor) to develop estimates of the mass and isotopic composition of magnesium loss from peridotite during alteration in both high- and low-T environments. As Mg fractionation occurs predominantly in low-T reactions, the primary serpentinisation reaction in near-ridge environments is unlikely to result in isotopic differentiation. Comparably, the secondary low-T alterations, of both remaining peridotites (to clays and iron hydroxides) and serpentinite (e.g. to talc and dolomite) are likely to result in the fractionation of Mg. We extend our analysis to incorporate the fractionation of these systems⁴ and their release of Mg into the ocean. We completed our analysis by presenting a compilation of fluid data for magnesium concentrations in ultramafic bodies from hydrothermal systems, in order to evaluate our model.

References

(1) Staudigel, H. "Chemical fluxes from hydrothermal alteration of the oceanic crust." (2014): 583-606.

(2) Snow, J.E. and Dick, H.J., 1995. Pervasive magnesium loss by marine weathering of peridotite.

Geochimica et Cosmochimica Acta, 59(20), pp.4219-4235.

(3) Seyfried Jr, W.E., Pester, N.J., Ding, K. and Rough, M., 2011. Vent fluid chemistry of the Rainbow hydrothermal system (36 N, MAR): Phase equilibria and in situ pH controls on subseafloor alteration processes. *Geochimica et Cosmochimica Acta*, 75(6), pp.1574-1593.

(4) Liu, P.P., Teng, F.Z., Dick, H.J., Zhou, M.F. and Chung, S.L., 2017. Magnesium isotopic composition of the oceanic mantle and oceanic Mg cycling. *Geochimica et Cosmochimica Acta*, 206, pp.151-165.

(5) Merdith, A.S., Atkins, S.E. and Tetley, M.G., 2019. Tectonic controls on carbon and serpentinite storage in subducted upper oceanic lithosphere for the past 320 Ma. *Frontiers in Earth Science*, 7, p.332.