

Storage of C in olivine and carbonated melting in the MORB source region

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Unlike H₂O, negligible C is thought to reside in mantle silicate minerals. Early studies in the 1980s found conflicting evidence for C storage in olivine, but were hampered by high detection limits. Shcheka et al. (2006) found appreciable C only in forsterite precipitated from Na carbonate melt near the limit of its stability (13 ppmw, 11 GPa), and considerably less at lower pressure (<4 ppmw, 7 GPa, < 0.4 ppmw, 1.5 GPa). This seemed to confirm that the ~15-40 ppmw C (50-150 ppmw CO₂) in MORB-source mantle is chiefly in accessory minerals (e.g., carbonate, graphite, etc.), except in the deepest upper mantle (350-400 km). However, compared to Shcheka et al. (2006) at similar pressures, Rosenthal et al. (2015) found greater C in minerals grown from carbonated basalts up to 3 GPa. To investigate further, we performed experiments at 3, 4.8, and 6.6 GPa and 1250-1550 °C, growing olivine from ¹³C-doped carbonate rich melts in Re (10 experiments) or graphite (1 experiment) capsules. Large (>100 μm) olivine (and in one case, cpx) crystals were grown from melt by cooling at 0.5 or 1°C/min and then held at 24 h at the final temperature prior to quench. Preserved melts vary from CO₂-rich (10 wt.%) silicate (33 wt.% SiO₂) glass to quench-crystallized carbonatite (~4 wt% SiO₂). NanoSIMS analyses indicate up to 5.5 ppmw in olivine at 3 GPa and up to 10 ppmw at 6.6 GPa. Variations in mineral C contents from experiments under similar conditions leaves open the possibility that mineral-melt equilibrium has not been approached. However, if the experiments are near equilibrium, then for a depleted source with 60% olivine and 15-40 ppm C, much (15-40%) of the C in the oceanic mantle may be hosted in silicate at 200 km and less (8-25%) at 100 km. Though decomposition of accessory phases may dominate C release to melts, progressive extraction of C from silicates yields small fractions of deep carbonated melt over a finite depth interval during upwelling beneath ridges. Marginal solubility of C in silicates indicates that the C contents of small-degree melts are controlled by silicate mineral/melt partitioning (rather than simply dilution) and that the effective *D_C* during melting is small but finite. The apparent *D_C* for mantle/carbonatite is ~3-5 X 10⁻⁵, which is smaller than that for mantle/basalt. This could reflect non-Henrian substitution of C in silicate minerals. **References:** Rosenthal et al. (2015) EPSL 412: 77-87. Shcheka et al. (2006) EPSL 245:730-742.