

Melting induced extraction of C-O-H volatiles at mid-ocean ridges

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The onset of partial melting is of great importance to geochemical and geophysical processes beneath divergent plate margins and also controls the release of deep volatiles to the exosphere. Experiments on natural carbonated peridotite from 3 to 10 GPa demonstrate that beneath oceanic ridges, trace concentrations of CO₂ induce small amounts (0.03% melt for 100 ppm CO₂) of carbonatitic partial melts as deep as 300 km. Extraction of such carbonatitic melts from great depths may leave the peridotite residue carbon-free but likely leaves 80-90% H₂O in the source as the fraction of melt is much smaller than the likely peridotite/melt partition coefficient for H₂O.

Additional experiments at 3 GPa were performed to explore the transition from near-solidus carbonatite to carbonated silicate melts with increasing temperature. These suggest that reaction between percolating carbonatite and peridotite induces significant silicate melting beneath ridges at depths exceeding the dry or damp peridotite solidus. For a given bulk CO₂ content, carbonated silicate melt fractions are significantly greater than the deeper carbonatite melts and so the carbonated silicate melts may remove most (>50%) H₂O from the peridotite matrix. If CO₂ and H₂O could be considered independently, extrapolation of our data indicates that for a source with 100 ppm H₂O and 100 ppm CO₂, CO₂ would initiate the first 0.2-0.3% of silicate melting and H₂O might be responsible for higher degrees of melting only (see Figure). In fact, dehydration of upwelling mantle beneath ridges likely results from the combined effects of CO₂ and H₂O, rather than by simple dehydration melting of nominally anhydrous minerals in peridotite.

