A combination of global relative and absolute plate reconstruction models enables the construction of palaeo-mid-ocean ridge (MOR) positions through time. Reconstructing mid-ocean ridge migration over the mantle, combined with time-dependent seafloor spreading rates, presents an opportunity to investigate their combined influence on the evolution of the geophysical and geochemical state of the upper mantle. Partial melting and the passive upwelling of upper mantle material beneath MORs leads to the preferential removal of incompatible elements and geochemical depletion of the residual melt. The extent to which this occurs depends on both the duration and rate at which material is extracted from the upper mantle. We use MOR migration and full seafloor spreading histories since 140 Ma to present a global map of the relative extent of upper oceanic mantle depletion. Our comparison between predicted depletion and upper mantle seismic velocity anomalies suggests a correlation between anomalously high mantle depletion and anomalously slow P-wave velocity anomalies between 0-100 km depth underneath young mid-ocean ridge flanks in the Pacific. We attribute this to the presence of low-density material resulting from the extraction of heavy incompatible elements during extensive partial melting at the slowly-migrating, fast-spreading East Pacific Rise.

A comparison between maps of mantle depletion and residual basement depth in the East Pacific suggests that anomalously high mantle depletion correlates with anomalously deep basement close to present-day MORs. We attribute this to melt extraction-driven mass deficits in the upper mantle that have not yet been extensively replenished.