Carbon in the Convecting Mantle: Erik Hauri's Legacy

E. Cottrell[1*], K.A. Kelley[2], J.M. Tucker[3], K. Shimizu[3], M. Le Voyer[1], and A.E. Saal[5], E.H. Hauri[3]
[1]NMNH, Smithsonian, Washington, DC, USA
(*correspondence: cottrellE@si.edu)
[2]URI, GSO, Narragansett, RI, USA
[3]DTM, Carnegie, Washington, DC, USA
[5]Brown Univ., Providence, RI, USA

The convecting mantle holds the vast majority of Earth's carbon. Led by Erik Hauri's vision and technical expertise, our team's analysis of MORB and OIB glasses and melt inclusions have resulted in new upper mantle, plume, and ridge segment-specific, carbon budgets and fluxes [1].

MORB suites that are undersaturated in CO_2 display correlated variations of CO_2 with non-volatile incompatible trace elements. Since the effect of partial degassing of CO_2 on these correlations is limited [2], it provides a means to assess primary CO_2 in global MORB samples. Trace elements vary amongst MORB segments by a factor of >20 and correlate with some radiogenic isotopes; this cannot be explained by variations in extent of melting, but instead requires mantle heterogeneity. By analogy, we infer large variations in CO_2 concentrations. We predict MORB mantle CO_2 contents (n = 711 segments) ranging from 10 ppm to 1980 ppm with lognormal distribution (median = 115 ppm, mode (most probable) = 60 ppm) [1]. Primary magmatic CO_2 abundances range from 104 ppm to 1.90 wt% [3]. The distribution is more skewed (median = 1107 ppm, mode = 621 ppm). Fluxes of CO_2 at individual segments vary from 1.52×10^6 to 4.74×10^8 mol/yr/km, with an integrated global flux (magma production rate = 16.5 km^3/yr [4]) of 1.32×10^{12} mol/yr [3].

The primary CO_2 contents of OIBs from Iceland, Azores, Canary, Society, Pitcairn [1] and Hawaii [4] range from 3200 to 11,000 ppm, suggesting a large degree of heterogeneity. However, CO_2 fluxes at the smaller hotspots are more than an order of magnitude lower than the CO_2 flux from Hawaii (8.6×10^{10} mol/yr). Plume mantle CO_2 concentrations are higher than nearly all MORB segments >1000 km away from plumes, and the Hawaiian mantle has ~4x more CO_2 than the MORB mantle [4].

[1] Hauri et al. (in press) *Whole Earth Carbon: Past to Present. Orcutt et al. Eds.* [2] Shimizu et al. (in press) *GCA*. [3] Le Voyer et al. (2019) *G-cubed*, 20. [4] Tucker et al. (in press) *GCA*.