Carbon uptake during seafloor weathering and a revised carbon budget in AOC

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Carbon uptake (as carbonate minerals) by altered oceanic crust (AOC) is an important process to fix free carbon in the atmosphere and oceans to the lithosphere. The carbon budget in AOC is a key parameter to model the long-term carbon cycling between the crust and mantle. Previous estimates on the C budget in AOC have been relied on carbonate concentrations in representative samples from each section (i.e., pillow basalt, sheeted dike, gabbro, and peridotite) of oceanic crust recovered from seafloor by DSDP/ODP/IDOP drillings.

In this study, we revisited some of the representative samples and obtained both concentration and carbon and oxygen isotope compositions of bulk carbonate in the samples. We found that the carbonate in all lithologies show a mixing pattern between normal marine carbonate and biogenic carbonate (both precipitated at low T), which should not occur in the deep sections (gabbros to peridotite) of oceanic crust. Accordingly, we argue that previous studies overestimated the carbonate budget in AOC. A revised carbonate budget in normal AOC is estimated as 238ppm carbon on average, about 56% less than previous estimates. In addition, we discovered that, in some localities, carbonate in oceanic crust can be dominated by biogenic origin (with $\delta^{13}C$ value as low as -25‰). If such AOC is subducted, it could produce diamonds with organic-like $\delta^{13}C$ values but normal mantle $\delta^{15}N$ values. This may provide an alternative interpretation for decoupled $\delta^{13}C$ and $\delta^{15}N$ values observed in some diamonds.

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