

Oceanic crust as a sink of CO₂: Geochemical results from ODP Site 801

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It has been long believed that production of oceanic crust is one of the most important sources of CO₂ into atmosphere and ocean in global carbon cycle (e.g., Berner, 1991). Since the late 1980's, however, off shore drilling of oceanic crust in DSDP/ODP has indicated that much of carbon is trapped in altered oceanic crust as carbonate minerals (mostly CaCO₃). Alt and Teagle (1999) showed that the amounts of CO₂ trapped in altered oceanic crust as carbonate minerals are about twice as much as that of CO₂ generated at MOR, suggesting that oceanic crust acts as a CO₂ sink rather than a CO₂ source. However, as they also pointed out, some parts of calcium component in the carbonate might originated from re-deposition of carbonate sediment overlying oceanic crust, and its contribution to total amounts of the carbonate is hardly determined. In this study, in order to calculate the net sink of CO₂, we estimated the amounts of Ca discharged from altered oceanic crust, instead of carbonate amounts deposited in the crust.

Studied samples are altered MORB recovered from ODP Site 801, about 800km east of Mariana Trench, which are composed of pillow basalt and massive flow basalt. Pillow basalt exhibits porphyritic texture with plagioclase phenocrysts and olivine pseudomorphs replaced by secondary minerals. Massive flow basalt shows holocrystalline intergranular to ophitic texture with euhedral to subhedral plagioclase and anhedral clinopyroxene. In bulk-rock chemical analysis, the increase of H₂O content (a good indicator of alteration degree) is negatively correlated with Ca depletion, implying discharging Ca during alteration. The amount of discharged Ca is calculated to be 0.44 wt.%, which can trap 0.48 wt.% CO₂ through the precipitation of the discharged Ca as CaCO₃. It is known that the upper part (600m) of oceanic crust contains 2.0 wt% CO₂ as CaCO₃ on average (Alt and Teagle, 1999), and thus our result indicates that about a quarter of the CO₂ in the altered oceanic crust was trapped by the discharged Ca.

The net CO₂ precipitation in altered oceanic crust is estimated to be 1.0×10^{12} mol C y⁻¹. This estimation is the lower limit, because strongly altered parts of pillow basalt and breccia units are mostly lost in drilling operation (Barr et al., 2002). It is considered that CO₂ degassed at MOR is $1.0 - 1.9 \times 10^{12}$ mol C y⁻¹ (Gerlach, 1989). This suggests that the sink of CO₂ into oceanic crust is comparable to the source of CO₂ from oceanic crust.