The early stages of slab decarbonation

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Carbon long-term cycling is a subject of recent controversy as new mass balance calculations [1] suggest that most carbon is transferred from the slab to the mantle wedge by fluids during subduction, limiting the efficiency of carbon recycling to the deep mantle. Here, we examine the mobility of carbon during subduction using new isotopic tracers, namely iron and zinc stable isotopes, in slab relicts (Queyras, Western Alps). We demonstrate that during subduction there are several stages of carbonate precipitation and dissolution at metasomatic interfaces between metasedimentary and ultramafic rocks in the slab. During the early stages of subduction, before the slab reaches the 300-400°C isotherm, the infiltration of sediment derived fluids in ultramafic lithologies enhances carbonate precipitation in antigorite bearing serpentinites. The subsequent storage of this element in serpentinites therefore acts as a temporary reservoir of carbon in subduction zones. This episode is accompanied with a decrease in iron isotope composition (δ^{56}Fe) and an increase in the concentrations of fluid mobile element (e.g. B, Li, As) in serpentinites. At higher temperatures (> 400 °C), carbonate leaching from the serpentinites by fluids leads to a decrease in serpentinite zinc isotope composition (δ^{66}Zn) suggesting the release of a carbonate bearing fluid with an isotopically heavy δ^{66}Zn signature. Thermodynamic considerations show that the sudden mobility of carbon in fluids is due to a change in aCO_2 of the slab derived fluid, shifting from sediment to serpentinite dominated dehydration. The release of carbon under oxidized form (e.g. CO_2), isotopically light Fe, heavy Zn and fluid mobile elements in slab derived fluids could therefore be triggered before the slab reaches eclogite facies P-T conditions, corroborating a strong mobility of carbon in fluids during the early stages of subduction. Such fluids are a potential metasomatic agent for the serpentinized fore-arc mantle wedge (or slab/mantle interface).

[1] Kelemen & Manning (2015) *PNAS* **112**, E3997–E4006.