Experimental constraints on the CO_2 content of fluids interacting with the subduction mélange

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CO_2 removal through dissolution of carbonates occurring in altered oceanic lithosphere and its sedimentary cover, along with diapirism of slab rocks and/or melts, provides an efficient way to recycle carbon back to the mantle wedge and, ultimately, to the Earth's surface. However, other forms of carbon, such as graphite, often closely associated with silicates, have been reported in slab rocks and in particular in subduction mélanges. Graphite has been considered a refractory sink of carbon in the subduction slab, owing to its lower solubility in aqueous fluids compared to carbonates. However, graphite dissolution mechanisms and solute transport in complex COH fluids at high P are experimentally unconstrained. Estimates of CO_2 in subduction fluids are mainly based on traditional thermodynamic models relying on a very limited experimental ground. Here we present for the first time experimental constraints on graphite-saturated H_2O–CO_2 fluids, synthesized at 1 GPa and 800–900° C in equilibrium either with forsterite + enstatite or quartz, and analyzed both for volatiles and dissolved SiO_2 and MgO. At the investigated conditions, the CO_2 content in fluids exceeds the amounts retrieved by traditional thermodynamic models of ternary graphite-saturated COH fluids by up to 40 mol%. Our results suggest that the interaction of deep aqueous fluids with silicates in the presence of graphite, as occurs in a subduction mélange, exerts a major role in controlling the volatile composition of the resulting COH fluid, thereby promoting the dissolution of graphite and enhancing the CO_2 content towards unpredicted values. As a consequence, the deep CO_2 transfer from the slab-mantle interface to the overlying mantle wedge is sustained by this new mechanism, most favorable in cold subduction zones, where fluids are thought to be stable over melts.