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H_2O and CO_2 devolatilization in subduction zones: implications for the global water and carbon cycles

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Subduction of sediments and altered oceanic crust functions has the potential to recycle significant amounts of water and carbon Upon subduction the water and carbon are released by progressive metamorphic reactions. The carbon release can be strongly enhanced by free fluids. Quantification of the H2O and CO2 release from subducting slabs is important to determine the provenance of volatiles that are released by the volcanic arc and to constrain the flux of carbon and H2O to the deeper mantle. In recent work we used a global set of high resolution thermal models of subduction zones to predict the flux of H2O from the subducting slab (van Keken, Hacker, Syracuse, Abers, Subduction factory 4: Depth-dependent flux of H2O from subducting slabs worldwide, J. Geophys. Res., 2011) which provides a new estimate of the dehydration efficiency of the global subducting system. It was found that mineralogically bound water can pass efficiently through old and fast subduction zones (such as in the western Pacific) but that warm subduction zones (such as Cascadia) see nearly complete dehydration of the subducting slab. The top of the slab is sufficiently hot in all subduction zones that the upper crust dehydrates significantly. The degree and depth of dehydration is highly diverse and strongly depends on (p,T) and bulk rock composition. On average about one third of subducted H2O reaches 240 km depth, carried principally and roughly equally in the gabbro and peridotite sections. The present-day global flux of H2O to the deep mantle translates to an addition of about one ocean mass over the age of the Earth. We extend the slab devolatilization work to carbon by providing an update to Gorman et al. (Geochem. Geophys. Geosyst, 2006), who quantified the effects of free fluids on CO2 release. The thermal conditions were based on three end-member subduction zones with linear interpolation to provide a global CO2 flux. We use the new high resolution and global set of models to provide higher resolution predictions for the provenance and pathways of CO2 release to the mantle wedge and a more robust prediction of the global CO2 and H2O fluxes in subduction.