Shallow-depth slab decarbonation prevents recharge of the deep carbon cycle

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Long-term oscillations of the Earth’s atmospheric carbon dioxide concentration and climate are intrinsically linked to tectonic plate motion controlling CO₂ uptake in rocks, their transport into the Earth’s mantle and recycling back into the atmosphere by volcanic activity. In this long-term deep carbon cycle, the efficiency of mantle ingassing is controlled by the stability of carbon carrier phases at subduction zone pressure-temperature conditions, during deformation and their interaction with subduction zone dehydration fluids. However, the current understanding of carbonate stability under these conditions is controversial. This is reflected by studies predicting carbonate transport deep into the asthenospheric mantle [1, 2] in contrast to more recently postulated shallow-depth carbon release from subducting slabs [e.g. 3]. Some of this controversy is related to the lack of available field sites that allow for the quantification of subduction-related decarbonation and its driving force. Here we present novel observations on the release of carbon during subduction of previously carbonated, ultramafic, oceanic lithosphere. Our observations are based on a recently discovered, exceptionally well-exposed, outcrop in northern Norway [4] containing frozen-in decarbonation reaction textures at the km scale. Our observations and textural analyses indicate breakdown of magnesium carbonate and serpentine to secondary olivine at depths shallower than 20 km. Secondary olivine is present as up to fist-sized nodules pseudomorphically replacing magnesite and as veins delineating escape pathways for the carbon-bearing aqueous fluid. We present first field observations and reaction textures and will discuss implications for the efficiency of carbon transport into the Earth’s mantle by subduction of carbonate-bearing oceanic lithosphere.