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Is There a Global Carbonate Layer in the Oceanic Mantle?

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Continuous CO_2 degassing at volcanic centers (arcs, mid-ocean ridges, intraplate) is balanced by recycling at subduction zones, where sediment-bearing altered oceanic plates return to the mantle. Previous studies have modeled carbonate budget in the subduction factory by experimental (as summarized in [1]) or thermodynamic approach [2,3]. Because the detailed carbon transfer mechanisms have seldom been studied, we have combined high-pressure experiments with synchrotron radiation in order to explore the outcome of having CO_2-rich fluids at the slab–mantle interface. By studying a model (Fe-free) system, we were able to reproduce the pressure–temperature conditions of carbon delivery and reaction and to continuously monitor the steps of the phase assemblage modifications using in situ x-ray diffraction.

Carbonates break down at 2.25 GPa and 1100 °C, by reaction with silicates (decarbonation). (In the model, Fe-free system, all temperatures are shifted by ca. >200 °C compared to the natural conditions.) The released CO_2 is trapped at grain boundaries and remains available for further reaction. Further heating to 1300 °C yields no change and it is only after near-isothermal compression above 3 GPa that CO_2-assisted melting occurs in what corresponds to the mantle wedge. The observed carbonate melt formation in the wedge may be a way for continuous carbon introduction and dissemination away from the wedge because of the strong infiltration power of carbonatite melts [4]. Carbon presence has been discussed in a variety of contexts, under the oceanic lithosphere (hotspots, petit spots, and fossil ridges). We suggest the presence of a global carbon-rich layer under the oceanic lithosphere that is steadily fueled by subduction processes. This layer can be the source of mechanical weakening of the lithosphere–asthenosphere boundary under the oceans. Therefore, the reported carbon-induced compression melting may be a key mechanism of modern-style plate tectonics.

[1] Hammouda, T, Keshav, S (2015) Chemical Geology, 418, 171–188.

[2] Molina, J F, Poli, S (2000) Earth Planet. Sci. Lett. 176: 295-310

[3] Gorman, PJ., Kerrick, D.M, Conolly, JAD (2006) Geochemistry, Geophysics, Geosystems, 7, Q04007.

[4] Hammouda, T, Laporte, D (2000) Geology, 28, 283–285.