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# Small amounts of $CO_2$-$H_2O$-rich melt in the lithosphere-asthenosphere.

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A low viscosity layer at the Lithosphere-Asthenosphere Boundary (LAB) is certainly a requirement for plate tectonics but the nature of the rocks presents in this boundary remains controversial. The seismic low velocities and the high electrical conductivities of the LAB are attributed either to sub-solidus water-related defects in olivine minerals or to a few volume percents of partial melt but these two interpretations have shortcomings: (1) The amount of $H_2O$ stored in olivine is not expected to be high enough due to several mineralogical processes that have been so far ignored, including partial melting; (2) elevated melt volume fractions are impeded by the too cold temperatures prevailing in the LAB and by the high melt mobility that can lead to gravitational segregation.
All this has long been discussed (30 years ago) when petrologists have defined the petrological LAB as the region of the upper mantle impregnated by incipient melts; that is small amounts of melt caused by small amount of $CO_2$ and $H_2O$. We show here that this incipient melting is a melting regime that is allowed in the entire P-T-$fO_2$ region of the LVZ. The top of the oceanic LVZ (LAB) is best explained by a melt freezing layer due to a decarbonation reaction, whereas the bottom of the LVZ matches the depth at which redox melting defines the lower boundary of stability of incipient melts.
Based on new laboratory measurements, we show here that incipient melts must be the cause of the high electrical conductivities in the oceanic LVZ. Considering relevant mantle abundances of $H_2O$ and $CO_2$ and their effect on the petrology of incipient melting, we calculated conductivity profiles across the LAB for various ages. Several electrical discontinuities are predicted and match geophysical observations in a consistent petrological and geochemical framework. Incipient melts most likely trigger both the seismic low velocities and the high electrical conductivities in the upper part of the asthenosphere.