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The electrical conductivity during incipient melting in the oceanic low velocity zone

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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 sometimes ignored; (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 in fact been partly settled 30 years ago, when a petrological LAB has been defined as a 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 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 then 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. We conclude that incipient melts prevail in the LAB, what else?