# Depletion and accumulation of $CO_2$-rich melts in the convecting asthenosphere

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Recent study suggests that incipient $CO_2$-rich melts, known to be broadly stable in the entire asthenosphere, could explain low seismic velocities and high electrical conductivities supposed to delineate the lithosphere-asthenosphere boundary [1]. The carbon content required to trigger the appropriate amount of $CO_2$-rich melt is at the upper bound of the (wide) range inferred by various geochemical models. Additionally, such incipient melts are very mobile due to their unusual physical properties. The consequence of this mobility, so far poorly investigated, challenges geochemical models and certainly impacts on the geophysical signals.

Here, we have used a two-phase flow mathematical formulation [2] [3] (i.e. simultaneous melt migration and solid compaction) to build a one-Dimensional numerical model. This 1-D model includes melting and crystallization bounds of $CO_2$-rich melt as recently defined by experimental phase diagrams and advection by thermal convection of the two-phase region of interest. It allows computing the temporal evolution of melt fraction as a function of depth into the Earth mantle and evaluating the role of convection and melt and mantle properties (density, viscosity, permeability) on the dynamics of melt rise, depletion and accumulation.

Our model indicates that $CO_2$-rich melt migration and mantle compaction induce melt segregation and rapid ascent in the form of compaction waves, that is, melt rich layers in a melt-depleted mantle. The layer of high melt fraction (>1%) formed by this process at and below the Lithosphere-Asthenosphere Boundary (LAB) could explain the seismological and electrical observations and participate to the formation of a low viscosity layer at the base of the lithosphere. In addition, these melt-rich layers constitute mobile mantle zones being strongly enriched in incompatible elements and in $CO_2$.

[1] Sifré *et al* (2014), *Nature* **509**, 81-85. [2] Bercovici & Ricard (2003), *G.J.Int* **152**, 581–596. [3] Richard *et al* (2007), *G.J.Int* **168**, 1291-1304.