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A new model of the asthenosphere

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Asthenosphere is characterized by (i) homogeneous depletion of incompatible elements, and (ii) some geophysical ”anomalies” including low velocities, high attenuation of seismic waves and high electrical conductivity. In addition to these well-known features, some new observations have been reported including (i) a sharp and large velocity drop at the lithosphere-asthenosphere boundary and (ii) the nearly global presence of a low velocity layer above the ”410”. In this presentation, I will propose a new model to explain these features. A key element of this model is partial melting just above the ”410” discontinuity, and the upper mantle is considered, in this model, to be a residue of this partial melting. This provides a natural explanation for the homogeneously depleted composition of the upper mantle. Once one accepts partial melting at 410, then one must have partial melting in all parts of the upper mantle (except for the lithosphere). However, the influence of partial melting on geophysical parameters is not large in the shallow upper mantle because (i) the melt fraction is low ($<$0.1 %) and (ii) melt does not well grain-boundaries. However, the situation is different in the deep upper mantle, where melt is expected completely wet grain-boundaries. The low velocity layer above the 410-km discontinuity is likely caused by the complete wetting by a small amount of melt.

Keywords: asthenosphere, water, partial melting, seismic wave velocities, electrical conductivity