Grain boundary wetness of texturally equilibrated rocks, with implications for seismic properties of the upper mantle

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Melt- or fluid-filled pore geometry in texturally equilibrated aggregates characterized by various dihedral angles and degrees of faceting was investigated quantitatively by measuring the grain-boundary wetness, which is defined as the ratio of solid-liquid boundary area over the total area of interphase boundaries. The wetness (y) increases monotonically with increasing liquid volume fraction (f). For the systems showing no faceting and low dihedral angle, the relation between f and y agrees well with the theoretical prediction from the ideal isotropic model assuming the tetrakaidecahedral packing geometry. This is true for the olivine-basalt system, whereas the partially molten lherzolite shows systematically lower wetness than the simple olivine-basalt system. For the systems showing strong faceting, the wetness is systematically lower than the theoretical prediction. For all systems, the obtained y-f relationship can be fitted well to formulae y=Af^1/2 with fitting parameter A, indicating that the three-dimensional pore shape is a tubular one. Seismic wave velocities are calculated for the model systems in terms of the equivalent aspect ratio (EAR) of the oblate spheroid model based on the above y-f relation. Calculated EARs can be used to predict f in texturally equilibrated rocks using VP or VS data and also to interpret the seismologically observed variation of dlnVS/dlnVP in terms of the variation of pore geometry. Our results show that the seismic wave velocities of partially molten peridotites are not significantly affected by crystal anisotropy and values of dlnVS/dlnVP larger than 1.5 cannot be explained by texturally equilibrated partially molten rocks.