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Role of microscopic properties in the evolution of large scale internal structure in the UltraLow Velocity Zones

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Seismic observations at the Earth's core -mantle boundary show regions marked by anomalously low shear (30%) and compressional wave (10%) speeds, called UltraLow Velocity Zones (ULVZs). These ULVZs are characterized by their low topography (few tens of km above the core-mantle boundary) spanning few thousand of km in length and possible presence of partial melting, and a 8-10% increase in density compared to the surrounding mantle materials and low viscosity. Current understanding attributes presence of partial melt in the ULVZs for its low viscosity. Recent studies have shown that such rheology can be explained by the presence of Fe-rich phases, which does not require the presence of partial melt in the system. Ascent of such a dense, low viscosity material from the core-mantle boundary is mechanically difficult. Earlier studies have shown mantle convection as the guiding factor in controlling the flow and geometry of the ULVZs, without any quantification about their internal structure. There have been some recent studies in 1D and 2D, which models ULVZs as multiphase system. However, there is no numerical model that shows the evolution of ULVZs in 3D and development of the internal structures within these zones. Rock deformation experiments and theoretical analysis explicitly show that the melt-volume fraction and the dihedral angle have strong effect on the melt topology and seismic properties in partially molten systems like ULVZs. Employing these well constrained microstructural properties, the present study aims to explore the complex three-dimensional internal structure within the patchy ULVZs geometry. Our two-phase finite element model shows that the partial melt segregate within the ULVZ as a function of strong deformation in the matrix.