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Development of Anisotropic contiguity in deforming, partially molten rocks

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The microstructure of partially molten rocks strongly influences the macroscopic physical properties. Contiguity, a geometric parameter, is a tensorial quantity that describes the area fraction of intergranular contact in a partially molten aggregate. It is also a key parameter that controls the effective elastic strength of the grain network. As the shape of the grains evolve during deformation, so does the contiguity of each grain. In this article, we present the first set of numerical simulations of evolution of grain-scale contiguity of an aggregate during matrix deformation using a Fast Multipole Boundary Elements Method (FMBEM) based model. The initially isotropic contiguity becomes strongly anisotropic due to deformation, as melt films form, preferentially wetting grain boundaries. We also calculate the anisotropy in shear wave speeds from the microstructure. In pure shear deformation simulations, the steady-state microstructure produces nearly 3% anisotropy between shear waves vibrating perpendicular and parallel to the planes of melt films. We demonstrate that the observed global shear wave anisotropy and shear wave speed reduction of the Lithosphere-Asthenosphere Boundary is best explained by 0.1 vol% partial melt distributed in horizontal films created by deformation.