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Shape Preferred Orientation of iron grains compatible with Earth's uppermost inner core hemisphericity

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Constraining the possible patterns of iron fabrics in the Earth's Uppermost Inner Core (UIC) is key to unravel the mechanisms controlling its growth and dynamics. In the framework of crystalline micro-structures composed of ellipsoidal, aligned grains, we discuss possible textural models of UIC compatible with observations of P-wave attenuation and velocity dispersion. Using recent results from multiple scattering theory in textured heterogeneous materials, we compute the P-wave phase velocity and scattering attenuation as a function of grain volume, shape, and orientation wrt to the propagation direction of seismic P-waves. Assuming no variations of the grain volume between the Eastern and Western hemisphere, we show that two families of texture are compatible with the degree-one structure of the inner core as revealed by the positive correlation between seismic velocity and attenuation. (1) Strong flattening of grains parallel to the Inner Core Boundary in the Western hemisphere and weak anisometry in the Eastern hemisphere (2) Strong radial elongation of grains in the Western hemisphere and again weak anisometry in the Eastern hemisphere. Both textures can quantitatively explain the seismic data in a limited range of grain volumes. Furthermore, the velocity and attenuation anisotropy locally observed under Africa demands that the grains be locally elongated in the direction of Earth's meridians. Our study demonstrates that the hemispherical seismic structure of UIC can be entirely explained by changes in the shape and orientation of grains, thereby offering an alternative to changes in grain volumes. In the future, our theoretical toolbox could be used to systematically test the compatibility of textures predicted by geodynamical models with seismic observations.