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Discriminating between causes for D'' anisotropy using reflections and splitting measurements for a single path

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Knowledge of deep mantle deformation is based on seismic anisotropy, the variation of seismic wave speed and polarization with direction. Measuring this directional dependency requires azimuthal seismic coverage at D'' depth – the bottoming few hundred kilometers of the mantle - which is often a limit in retrieving the style of anisotropy. Shear wave splitting is the standard technique for probing mantle anisotropy and recently, reflections from the D'' region have been used to infer azimuthal anisotropy. Here we combine observations and modelling of D'' reflections with shear wave splitting along a given ray path direction in order to constrain a scenario of anisotropy and mineralogy of the lower mantle. From our modelling, a clear distinction between different anisotropic media is possible by using both types of observations together but only one directional path. We focus on the lowermost mantle beneath the central Atlantic Ocean by using south-central American earthquakes recorded in Morocco. We find complex azimuthal and distance variation for both polarities of D'' reflections and shear wave splitting parameters, which rules out a simple style of anisotropy – such a vertical transverse isotropy – for the region. Our preferred model consists of a phase transition from a randomly-oriented bridgmanite to lattice-preferred orientation fabric in post-perovskite, developed in a sub-horizontal plane sheared along a roughly SE-NW deformation direction.