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Seismic constraints on lowermost mantle deformation beneath Siberia

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The discovery of a post-perovskite polymorph of MgSiO3 in the lowermost mantle has provided a potential explanation for many of the seismic properties of this enigmatic region of the deep Earth. Exploring the efficacy of this phase to explain lowermost mantle anisotropy requires knowledge of its deformation mechanism. Recent work (Cordier et al, EOS, 2005; Oganov et al, Nature, 2005; Miyajima et al, EOS, 2005) using different methodologies have suggested three different candidates for the slip system of post-perovskite; however, improved seismological evidence is needed to help discriminate between them. To this end we have assembled a dataset comprising Hindu-Kush events recorded at the NWT-POLARIS array in Northern Canada and Northwest Pacific events recorded on the German Regional Seismic Network. These provide event-station pairs with epicentral distances around 80 degrees. At these distances the S-phase turns just above D'', while the ScS phase samples it. This gives us a seismic dataset which images a region of the lowermost mantle beneath Siberia from two different - nearly orthogonal - azimuths. We apply a differential S-ScS shear-wave splitting technique (Wookey et al, GJI, 2005), extended to use array data, to isolate the anisotropic contribution from the lowermost mantle. This technique also enables the resolution of a more general style of shear-wave anisotropy than is usually assumed, and this is augmented by being able to image two azimuths. The shear-wave splitting we measure is incompatible with the simple, radial style of anisotropy generally assumed for D''. We quantitatively compare our measurements with estimates of anisotropy for the perovskite and post-perovskite polymorphs of MgSiO3 determined using ab initio modelling (Stackhouse et al, EPSL, 2005), assuming the candidate slip systems.