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Detection of the lower mantle iron spin transition in ferropericlase through vote maps of seismic tomography

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Iron-containing minerals, such as ferropericlase, (Mg,Fe)O, comprise more than 90% of the Earth's mantle. Experimental and theoretical evidence for changes in the spin state of iron in ferropericlase, at lower mantle conditions represents an important recent discovery in mineral physics. A spin transition for Fe2+ cations is promoted by increasing pressure and decreasing temperature and has been proposed to occur in the lower part of the lower mantle. Along a geotherm 500 K below the ambient adiabat, a mixed spin state – in which iron atoms exhibit both low and high spin – is predicted in the 1250-2000 km and 1450-2200 km depth ranges for a harzburgitic and pyrolitic compositions, respectively. Such a spin transition might reduce the viscosity of mantle materials and has been related to the nature of upwellings and sinking slabs. However, partly due to the gradual nature of such a transition, seismic observations have thus far failed to robustly confirm the basic predictions of the high-to-mixed spin transition. We compare multiple global seismic velocity tomography models based on a recent 'vote map' methodology. A decorrelation of shear (S-wave) and compressional (P-wave) wavespeed anomalies in the lower mantle for both fast and slow wavespeed anomalies is indicated at depths greater than 1400 km, thus providing observational evidence consistent with the occurrence of a spin transition in ferropericlase. The presence of such variations suggests that peridotitic material with significant ferropericlase content prevails in both seismically fast and slow regions of the lower mantle.