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Experimental evidence for perovskite and post-perovskite coexistence throughout the whole D'' region

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Since the phase diagram for (Fe,Al)-bearing MgSiO3 compositions at the P-T conditions of the core-mantle boundary remains ambiguous, we investigated the Fe distribution among the silicate perovskite (Pv) and post-perovskite (PPv) polymorphs using tandem synchrotron analyses of X-ray diffraction and X-ray absorption spectroscopy. We performed measurements at the Fe-Kedge of the partitioning of iron between Pv and PPv up to more than 150 GPa after annealing at about 3300 K. We obtain a unique solution for KFePv/PPv of 4.2 (+/- 0.5). Our results evidence that the two silicates should coexist over the whole D'' region, with the main post-perovskite phase being largely depleted in Fe compared to the perovskite.
As Fe and Al have a dominant effect on the phase diagram, these new results challenge recent determinations of the temperature profile in the lowermost mantle based on the Clapeyron slope of the Pv to PPv transition for pure MgSiO3 composition. Also, it appears clear that variations in the molar fractions of perovskite and post-perovskite phases should be expected radially or laterally in the D'' region in relation with thermal or compositional heterogeneities. This can help explaining the seismological anomalies observed for this mantle region. Finally, we predict a significant increase of the FeO activity in the D'' region, which should greatly affect the chemical exchange between mantle and core.