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Elastic properties of Fe-bearing Akimotoite at mantle conditions: Implications for composition and temperature in lower mantle transition zone

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The pyrolite model, which can reproduce the upper-mantle seismic velocity and density profiles, was suggested to have significantly lower velocities and density than seismic models in the lower mantle transition zone (MTZ). This argument has been taken as mineral-physics evidence for a compositionally distinct lower MTZ. However, previous studies only estimated the pyrolite velocities and density along a one-dimension (1D) geotherm and never considered the effect of lateral temperature heterogeneity. Because the majorite-perovskite-akimotoite triple point is close to the normal mantle geotherm in the lower MTZ, the lateral low-temperature anomaly can result in the presence of a significant fraction of akimotoite in pyrolitic lower MTZ. In this study, we reported the elastic properties of Fe-bearing akimotoite based on first-principles calculations. Combining with literature data, we found that the seismic velocities and density of the pyrolite model can match well those in the lower MTZ when the lateral temperature heterogeneity is modeled by a Gaussian distribution with a standard deviation of ~100 K and an average temperature of dozens of K higher than the triple point of $MgSiO_3$. We suggest that a harzburgite-rich lower MTZ is not required and the whole mantle convection is expected to be more favorable globally.