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LLVPs hinder the cooling of the core: Insights from the thermal conductivity of lower mantle minerals

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Bridgmanite (Brg), post-perovskite (PPv), and ferropericlase (Fp) constitute ~90 % of the lower mantle, and are the main minerals in the Large Low Velocity Provinces (LLVPs). However, their thermal conductivities, as well as the impact of Fe impurities, are highly controversial. Measuring the thermal conductivity of minerals at high P-T conditions remains challenging, and determining the thermal conductivity of minerals by first principles calculations leads to finite size effects due to computational limitations. To overcome computational limitations, we trained machine learning potentials for Fe-bearing Brg, PPv, and Fp with data from first-principles calculations, then investigated their thermal conductivity at high P-T conditions based on the machine learning potential in the large cells with finite-size effects well considered. Incorporating the distribution of minerals, temperature, and iron content obtained through the inversion based on mineral elasticity and seismic tomography models, we found the heat flux is significantly low in the LLVPs regions, which hinders the cooling of the core and has important implications for the thermal evolution of the Earth.