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Thermal conductivity anomaly in spin-crossover ferropericlase under lower mantle conditions and implications for heat flow across the core-mantle boundary

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Abstract

Iron in ferropericlase experiences a spin crossover from a high spin to a low spin under lower mantle conditions, which generates anomalies in many properties such as the heat capacity and sound velocity. In this study, the effect of the spin crossover on thermal conductivity was evaluated by considering the effects of the spin crossover on P wave velocity and heat capacity at constant volume but ignoring the effect on the mean free path. The spin crossover completely changes the conventional pressure and temperature dependences of the thermal conductivity. The spin crossover can significantly reduce the thermal conductivity of ferropericlase. The pressure dependence of the thermal conductivity of ferropericlase will show a double-valley feature across the spin-crossover region at the appropriate temperature (e.g., 1000 K). In contrast to the conventional decrease in the thermal conductivity with temperature, the thermal conductivity of ferropericlase in the Earth's *D″* layer may increase with temperature in some temperature regions. The unusual effect of spin crossover on the thermal conductivity can be expected in other minerals with spin crossover. The spin crossover effect needs serious consideration when estimating the thermal conductivity at the core-mantle boundary.

Keywords: Thermal transport, spin transition, high pressure, ferropericlase, thermodynamics, sound velocity