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Phase transitions in rocky mantles - influence of composition and temperature

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Mantle convection in Earth's mantle is driven by lateral density variations induced either by heating of mantle material at the core-mantle boundary leading to mantle plumes or downwelling of cold material for example in the form of subducting slabs. In addition, solid-solid phase transitions (for example from ringwoodite to perovskite and magnesiowustite at a depth of appr. 660 km) can accelerate or decelerate convective motion. This is due to the Clapeyron slope, which is defined as entropy change over volume change, and which defines if a phase transition is exothermic (accelerating) or endothermic (decelerating convective motion).

In thermodynamic models of rocky mantles, typically fixed and approximated Clapeyron slopes and phase transition pressures (defined for a specifc reference temperature) are employed. These are typically derived for Earth-like mantle compositions from laboratory experiments or ab initio calculations.

Here we compare the major phase transitions occuring in Earth's mantle (ol->wd, wd->rw, rw->pv+mw, pv->ppv) in the Mg-Si-Fe-O-Al-Ca system using Perple_X for different parameter settings, and show that Clapeyron slopes strongly vary with composition and temperature.