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Constraints on dynamics and evolution of the deep Earth from mineral physics data

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The observed mantle phase transformations and measured physical properties of mantle minerals at high pressure and temperature are the essential data for interpreting the seismic observations of the Earth interior. It is generally accepted that the phase transformations of (Mg,Fe)2SiO4 from olivine to wadsleyite and from ringwoodite to (Mg,Fe)SiO3-perovskite plus (Mg,Fe)O-ferropericlase are responsible for the observed seismic discontinuities near 410 and 660 km depth, respectively. The D layer is likely associated with the recently discovered post-perovskite transition at P-T conditions corresponding to the base of the lower mantle. Although the major structure features of the mantle derived from seismic data correlate well with the petrologic and mineral physics data, increasingly detailed image of the mantle with seismic tomography and sophisticated geodynamic modelling demand more high-quality mineral physics data in a realistic mantle composition over a wide P-T range. Significant advances in in-situ measurements at high P and T have led to high-precision phase equilibrium data and P-V-T equations of state of mantle minerals. In this study, I present new experimental data on P-V-T equations of state of (Fe,Al)-bearing silicate perovskites and (Mg,Fe)O-ferropericlase. The latest measurements cover the P-T conditions of the entire mantle. We can now model the density profile of the mantle without any extrapolation. These data support some degree of chemical stratification between the upper and lower mantle, and compositional gradient of the lower mantle, bearing important implications for mantle evolution and dynamics. Finally, I present spin transition data in ferropericlase and discuss their implications for mantle models.