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The thermochemical structure of Mars - a seismological perspective on phase transitions, low-velocity layers and convection in the deep interior

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The deep thermal and chemical structure of Mars has been shaped by many processes, including impacts, core-mantle segregation, convection and volcanism. This structure is currently poorly constrained; improved constraints will help us better understand the planet's thermal, chemical, dynamic and magnetic evolution.

The InSight mission landing on Mars in 2018 will deploy a seismometer on Elysium Planitia, providing us with single-station three-component measurements of Martian seismicity, illuminating its interior structure. These measurements are subject to perturbations due to the significantly aspherical structure of the Martian crust, source location uncertainties, lander and environment noise, and due to waveform distortions due to yet unknown scattering properties of the Martian upper mantle and crust. In preparation for this mission, we build on earlier models of Mars structure (e.g. Mocquet et al, 1996; Sohl and Spohn, 1997; Gudkova and Zharkov, 2004; Khan and Connolly, 2008; Zharkov et al, 2009; Rivoldini et al, 2011) to investigate the effects of specific unknowns on seismic travel times and waveforms which we expect to be recorded during the mission (Nissen-Meyer et al., 2015; Hempel and Garcia, 2017).

In this study, we link model parameters such as average crustal thickness, mantle temperature, composition and convective vigour with seismic observables such as travel times and ray parameters. We discuss the trade-offs between the model parameters based on ray theoretical predictions, focusing on the effects of low-velocity layers in the uppermost and lowermost mantle, the absence or presence of triplications indicating the sharpness of phase transitions within the Martian mantle and the effects of core size and composition on seismic observables.