PHASE TRANSITION EVOLUTION AND CONVECTION STYLE IN THE MARTIAN MANTLE. T. Ruedas, *Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington DC, USA (ruedas@dtm.ciw.edu)*, P. J. Tackley, *Institut für Geophysik, ETH Zürich, Switzerland (ptackley@ethz.ch)*.

We present preliminary models of mantle convection in Mars over a timespan of several billions of years. We have combined the mantle convection program STAG3D [e.g. 9] with a parameterized thermodynamic model of martian mantle mineralogy and carried out calculations of convection in a 2D compressible model of the planet's mantle. The model fully takes into account the thermoelastic properties of the mantle, including p,T-dependent density, expansivity, heat capacity, thermal conductivity and phase transitions of olivine and non-olivine phases; mineral endmember data are mostly taken from *Saxena et al.* [8]. All models are heated from below by a cooling core, and two of them are also heated from within by the radioactive decay of ^{40}K, ^{235}U, ^{238}U, and ^{232}Th, whose concentrations were taken from *Wänke and Dreibus* [10]. The viscosity of the mantle is temperature and pressure-dependent. The radius of the martian core, and hence the depth of the mantle, is only known to within a few hundred kilometers; we ran models with mantle depths of 1700 and 2000 km, which essentially cover the range of possible values.

The higher iron content of the martian mantle as compared to Earth's mantle results in a mineralogy and phase transition pattern which is somewhat different to that of the Earth; for instance, ringwoodite appears already at lower pressures than wadsleyite. Moreover, the two-phase loops in the Mg_2SiO_4–Fe_2SiO_4 system are broader and their position and width seem to be more sensitive to changes in temperature. We have parameterized phase diagrams for this system [5–7] in terms of p, T, and Mg#; for the non-olivine phases, which are more complicated and less well investigated, and for the general phase proportions we have used the results by *Bertka and Fei* [1], supplemented by data on endmembers for the Clapeyron slopes of phase transitions [e.g. 2, 3]. Water and melting have not been considered in these models.

The core-mantle boundary in Mars happens to lie at about the depth of the ringwoodite–(perovskite+ferropericlase) transition. Previous studies [e.g. 4] have already demonstrated the possibility that Mars had a perovskite layer at the base of its mantle which may have disappeared during the history of the planet as a consequence of secular cooling. Here we show the evolution of the phase transition patterns, i.e. the changes in position and width of transitions and the mineralogical changes, as a consequence of secular cooling and discuss their effect on the long-term convection style of the martian mantle.

The models with a big core have no pv+fp layer, whereas in the models with a small core, such a layer exists for the first 2.5–3 Ga; it thins during this time and finally disappears; in the small-core models, there are also intermittent appearances of γ+2fp+st at the bottoms of cold downwellings near the CMB at this stage. All models display a transition from an early two-layer convection regime with a lifetime of roughly 1.5 Ga to a regime with more extensive flow throughout the whole mantle. Due to secular cooling, the stability field of ringwoodite expands with time at the expense of the olivine and the perovskite layers in all models.

References

[1] Bertka, C. M., and Y. Fei, *J. Geophys. Res.*, *102*(B3), 5251–5264, 1997.

[2] Fei, Y., J. Van Orman, J. Li, W. van Westrenen, C. Sanloup, W. Minarik, K. Hirose, T. Komabayashi, M. J. Walter, and K.-i. Funakoshi, *J. Geophys. Res.*, *109*(B2), B02305, doi:10.1029/2003JB002562, 2004.

[3] Gasparik, T., *Phase Diagrams for Geoscientists*, Springer, 2003.

[4] Harder, H., and U. R. Christensen, *Nature*, *380*, 507–509, 1996.

[5] Ito, E., and E. Takahashi, *J. Geophys. Res.*, *94*(B8), 10,637–10,646, 1989.

[6] Katsura, T., and E. Ito, *J. Geophys. Res.*, *94*(B11), 15,663–15,670, 1989.

[7] Katsura, T., H. Yamada, O. Nishikawa, M. Song, A. Kubo, T. Shinmei, S. Yokoshi, Y. Aizawa, T. Yoshino, M. J. Walter, E. Ito, and K.-i. Funakoshi, *J. Geophys. Res.*, *109*(B2), B02209, doi:10.1029/2003JB002438, 2004.

[8] Saxena, S. K., N. Chatterjee, Y. Fei, and G. Shen, *Thermodynamic Data on Oxides and Silicates*, Springer, Berlin/Heidelberg, 1993.

[9] Tackley, P. J., in *The Core–Mantle Boundary Region*, edited by M. Gurnis, M. E. Wysession, E. Knittle, and B. A. Buffett, no. 28 in Geodynamics Series, pp. 231–253, AGU, Washington, 1998.

[10] Wänke, H., and G. Dreibus, *Phil. Trans. R. Soc. Lond.*, *A 349*, 285–293, 1994.