MARS MANTLE CONVECTION: INFLUENCE OF PHASE TRANSITIONS ON CORE ACTIVITY. Nathalie C. Michel[1], Olivier Forni[2,3] and Steven A. Hauck, II[1] . [1]Dept. of Earth, Environmental, and Planetary Sciences, Case Western Reserve University, Cleveland, OH 44106 (nathalie.michel@case.edu); [2]Université de Toulouse; UPS-Observatoire Midi-Pyrénées; IRAP; Toulouse, France; [3]CNRS; Institut de Recherche en Astrophysique et Planétologie; 9 Avenue du Colonel Roche, BP 44346, 31028 Toulouse Cedex 4, France.

Introduction: Altough Mars currently has no global dynamo-driven magnetic field, crustal remnant magnetization [1] indicates that Mars had a global magnetic field early in its history with an active core dynamo [2]. Early work suggests that the dynamo was active for a few hundred million years [3,4] and ceased during the early Noachian. However, it has also been suggested that magnetic field may have briefly reappeared after its first disappearance [5]. More recently, [6] found inconsistencies with the magnetic signatures recorded over younger and smaller impact and younger structures that challenge thinking on the magnetic field timeline of Mars and place the cessation at ~3.8 Ga.

The presence of mineralogical phase transitions in the Martian mantle has been recognized to play an important role in the style of mantle convection [e.g., 7], and the dynamo of the planet [8]. While the exothermic phase transitions tend to accelerate mantle flow and influence volcanic evolution, the endothermic spinel to perovskite phase transition tends to inhibit convection [9] and induces layered convection [10]. Increasing in depth due to mantle cooling, the spinel to perovskite phase transition may disappear and be responsible for a reactivation of a core dynamo [5].

Model: To analyze the effects of phase transitions in the mantle and the consequences on the planet's thermal evolution, we have employed the axisymmetric, spherical shell, mantle convection code CITCOM [11] extended to account for secular cooling of the core [12]. We consider five cases (Figure 1) with varying core sizes, between 1360 km to 1700 km [8, 13-18].

Results: Due to the secular cooling of the core, CMB temperatures, and hence core heat flux, generally decrease with time. Eventually, the heat flux falls below the critical value required to sustain a core dynamo. An increase in the core heat flux is observed in models with a small (SC) or a large core (LC) but only when the activation energy is very low . Our simulations demonstrate that this sudden increase of the heat flux is not necessarily attributable to the displacement of an endothermic phase transition, but solely depends on the onset of convection in the mantle, which increases the efficiency of planetary cooling.

Conclusion: Our simulations demonstrate that it is difficult to rejuvenate a dynamo, even when a perovskite layer occurs in planet with a small core. However, disapperance of an endothermic phase transition is not necessarily the only mechanism able to increase the core heat flux as it depends rather on the time when convection begins. Indeed, in models with a low activation energy and a cold initial mantle, a core dynamo reactivation as suggested by [5], or even a late core dynamo cessation as in [6], are possible.

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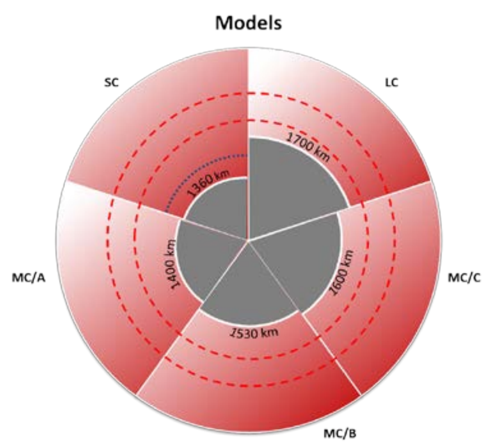

Figure 1. Schematic view of the models studied. The core is indicated in gray. The blue dotted line indicates the position of the endothermic phase transition while the red dashed lines are the locations of the exothermic phase transitions. See [12] for a detailed description.