Giant impacts on early Mars and the cessation of the Martian dynamo

James H. Roberts[1], Robert J. Lillis[2], Michael Manga[2]
[1]*Johns Hopkins University Applied Physics Laboratory*, [2]*University of California, Berkeley*

Although Mars currently has no global dynamo-driven magnetic field, widespread crustal magnetization provides strong evidence that such a field existed in the past. The absence of magnetization in the younger large Noachian basins suggest that a dynamo operated early in Martian history, but stopped in the mid-Noachian. Within a 100 Ma period, 15 giant impacts occurred coincident with the disappearance of the global magnetic field.

Here we investigate a possible causal link between the giant impacts during the early and mid-Noachian and the cessation of the Martian dynamo at about the same time. We developed three-dimensional spherical mantle convection models including internal heating from giant impacts by modifying *CitcomS* version 3.0.2, obtained from the Computational Infrastructure for Geodynamics (CIG). We find that impact heating associated with the largest basins (diameters > 2500 km) can cause the global heat flow at the core-mantle boundary to decrease significantly (10-40%; see Fig. 1). We suggest that such a reduction in core heat flow may have led to the cessation of the Martian dynamo.

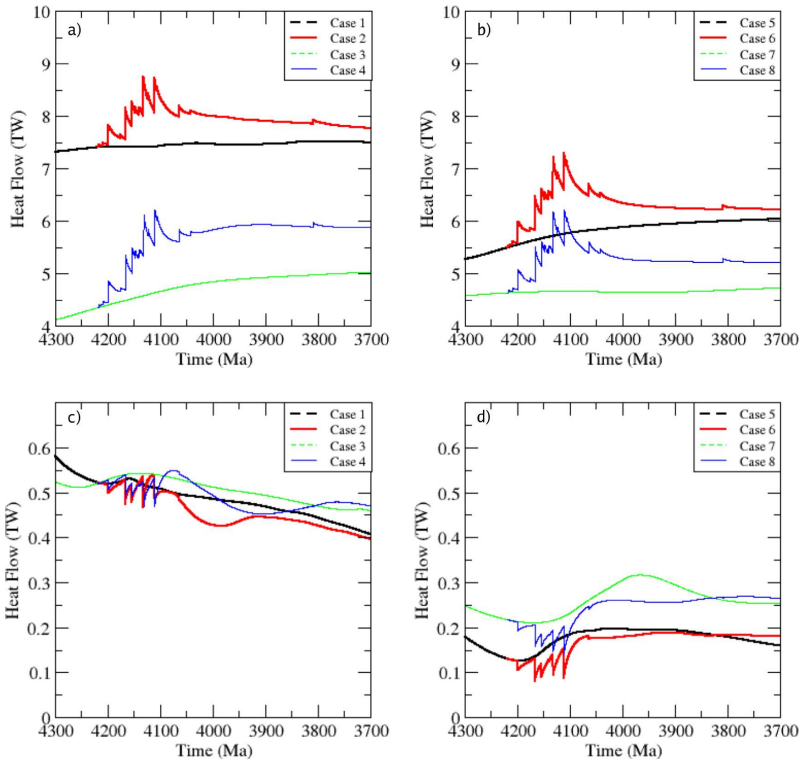

Figure 1: Total global heat flow at the surface (a-b) and CMB (c-d) vs. time for cases 1-4 with $Ra = 3.05 * 10^7$(a,c) and cases 5-8 with $Ra = 6.1 * 10^6$ (b,d). Each impact causes a strong perturbation to the surface heat flow. Relatively little heat is deposited at large depths. Only impactors forming basins > 2500 km in diameter cause a significant drop in the CMB heat flux, but these drops can be large ($>$10 - 40%).

Reference: Roberts, J. H., R. J. Lillis, and M. Manga (2009), Giant impacts on early Mars and the cessation of the Martian dynamo, *J. Geophys. Res.*, doi:10.1029/2008JE003287, in press.