Implications of Two Martian Dynamo Episodes for Interior Evolution

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A martian dynamo requires convection in the liquid core, which is most likely to occur when the heat flux removed by the mantle is greater than the conductive heat flux through the core. Crustal magnetization records the presence or absence of the internally-generated field, and through stratigraphy and crater counts a time series of dynamo activity can be extracted. Lillis et al. (in review, 2005) argue that the record of magnetism in martian volcanoes shows not one but two episodes of dynamo activity. This has many implications for astrobiology, including shielding the atmosphere from solar wind erosion, and the for internal dynamics of the planet (which govern the magma and volatile flus to the surface). Here we focus on the implications of two episodes for the internal evolution of Mars. We use a two-dimensional Cartesian mantle convection code to explore parameter space to determine the pattern of core heat flux under various conditions. We vary the Rayleigh number Ra, the buoyancy number B (the ratio of thermal and chemical buoyancy forces in a stratified mantle), and the relative initial temperature of the mantle and core. When the mantle starts cooler than the core the heat flux starts relatively high and decreases. Heat flux increases at the onset of convection. The dense layer creates a delay between the onset of convection and increase in heat flux that increases with B. Increasing Ra decreases the time to the onset of convection and the interval between onset and the peak in heat flux.