GROWTH OF THE HEMISPHERIC DICHOTOMY AND THE CESSATION OF PLATE TECTONICS ON MARS. A. Lenardic, M. Collier, *Department of Earth Science, Rice University, Houston, Texas, (adrian@esci.rice.edu)*, F. Nimmo, *Department of Geological Sciences, University College London, UK*, L. Moresi, *School of Mathematical Sciences, Monash University, Australia*.

Plate tectonics may have operated early in Martian history [1,2], with important consequences for the history of both melt production [3] and magnetic field generation [4]. However, the mechanism by which plate tectonics stopped is unclear. Here we show that the growth of a thick crust, which renders the lithosphere buoyant, will shut plate tectonics off once the fraction of positively-buoyant lithosphere exceeds approximately 50 %. This effect occurs because the insulating properties of the lithosphere reduce the mantle viscosity, so that the convective stresses no longer exceed the lithospheric yield strength, and plate tectonics stops.

Geological observations [1,5] , petrological inferences [6] and magnetic data [2] have been used to suggest that plate tectonics operated early in Mars' history, though all these interpretations have been challenged [7,8]. An early period of plate tectonics could explain the behavior of the Martian dynamo [4] and avoid early massive melting on Mars [3]. However, the mechanism by which plate tectonics stopped is not clear. Sleep [1] proposed that the cessation of melting at mid-ocean ridges led to the cessation of plate tectonics. Here we consider an alternative: that the growth of thick crust in the southern highlands resulted in positively buoyant lithosphere which in turn (as described below) caused plate tectonics to stop.

The crust of Mars is probably 50km thick on average, and 20-30km thicker in the south than in the north [9]. Although there are considerable uncertainties in both lithospheric thickness and crustal density, it is likely that the lithosphere in the southern hemisphere (at least) is positively buoyant and unlikely to subduct [10]. It is clear that the southern highlands are ancient [11]. Though their growth history is not well constrained, they probably formed over the same time interval that the magnetic field was present.

We develop a model that relates crustal insulation to convective stress within the mantle and use it with the constraints above to test the conditions under which our hypothesis is viable. Conceptually, our model assumes a plate tectonic-like mode of mantle convection to have operated early in Mars' history at a time when the southern highlands were forming. At some stage the southern highlands grew beyond a critical extent. At this stage, the mantle insulation and resulting higher mantle temperature caused convective stresses to drop below the level required to cause lithospheric failure and the early stage of active-lid mantle convection was, effectively, locked. We have quantified these ideas via a scaling theory and tested our scaling arguments against numerical simulation results. We will discuss the uncertainties and application of our scaling and numerical simulation results to Mars and to other planets, particularly Earth. The implications for melt generation within the Martian mantle, subsequent to the end of an early stage of active-lid mantle convection, will also be explored.

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