Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09291, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09291
EGU General Assembly 2008
© Author(s) 2008

Towards self-consistent modelling of the Martian dichotomy: The influence of degree-1 convection on crustal thickness distribution

T. Keller and P. J. Tackley

Institut für Geophysik, ETH Zürich, Switzerland (keller@erdw.ethz.ch / Fax: +41 446331065 / Phone: +41 446332777)

In order to find a possible explanation for the origin of the Martian crustal dichotomy, a number of recent papers have examined the effect of layered viscosity on the evolution of a degree-1 mantle convection, e.g. Roberts & Zhong (JGR 2006) and Yoshida & Kageyama (JGR 2005). It was found that a mid-mantle viscosity jump in the Martian mantle, combined with highly temperature- and depth-dependent viscosity, are effective in developing a degree-1 convection within 200-300 Million years of core formation. Such a layered viscosity profile could be justified by Martian mineralogy.

However, the actual effect of a degree-1 convective planform on the crustal thickness distribution has not yet been demonstrated. So far, it has not been obvious whether a thinner crust, due to sublithospheric erosion and crustal thinning, or a thicker crust, due to enhanced crustal production, would form above the hemisphere of mantle upwelling. Also, the general shape of the dichotomy, which is not symmetrically hemispherical, has not yet been fully investigated.

Here we model, using the finite-volume multigrid code Stag3D, the crustal patterns produced by models of Martian mantle convection. By using tracer particles to track composition, a self-consistent treatment modelling melting and chemical differentiation has been added to models of three-dimensional thermal convection. This allows us to obtain model maps of the crustal thickness distribution as it evolves with time on the whole planetary surface.

Although many questions still remain, the obtained results demonstrate that it is indeed possible to form a crustal dichotomy as a consequence of degree-1 mantle convection very early in the planet's history and, furthermore, that some of the observed patterns also show intriguing and unexpected first order similarities to the general shape of the Martian dichotomy. In all models, the region of thick crust came to be located over the region of mantle upwelling, which itself proves not to be strictly hemispherical, but in some cases rather ressembles a ridge-like structure spread over more or less one half of the planet's body. Ongoing work focuses on the effect of a combined intrusion-extrusion magmatic model.