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MNSM: What we can learn from heat flow measurements and the detection of geological activie regions on Mars

D. Breuer (1), A. P. Rossi (2), M. Grott (1), T. Spohn (1), and MNSM Team ()

(1) DLR, Institut für Planetenforschung, Berlin, Germany (doris.breuer@dlr.de, +49 30 67055 303), (2) Jacobs University Bremen Campus Ring 1, 28759 Bremen, Germany

The future Mars Network Science Mission (MNSM) will provide heat flow measurements at three landing sites together with seismic, geodetic and atmospheric measurements. The average heat loss from a planetary surface reflects, at the most basic level, its bulk composition in terms of its content of radiogenic elements and thus provides a key constraint on the composition of the material from which the planet formed. Current estimates of paleo-heat flow on Mars are derived from estimates of elastic lithosphere thickness, interior evolution models, models of the decay of radiogenic elements, and simple plate cooling models; however, large uncertainties are associated with all of the above approaches.

Although heat flow on Mars is unlikely to produce the large difference measured on Earth, some geographical variations depending on such factors as the enrichment of radioactive elements and crustal thickness are expected. Planetary heat flow is also intimately connected to the bulk abundance of heat producing elements in the planetary interior, and the Waenke and Dreibus (WD) compositional model, which is derived from element correlations observed in the SNC meteorites, is currently the most generally accepted. Planetary heat flow reflects contributions from heat produced by radiogenic elements and the loss of heat via secular cooling. The ratio of radioactively produced heat to total planetary heat loss can be expressed in terms of the Urey ratio Ur, which can be estimated using thermal evolution models. The present day Ur is close to 0.7 irrespective of the initial conditions. The small uncertainties associated with Ur on Mars enable a comparison between measured heat flow and compositional models. Extrapolation of the three heat flow measurement using these models will yield an estimate for the total planetary heat loss, given core size and crustal thickness from seismological investigation and given abundance ratios for K/Th and Th/U from observations and cosmochemical models, a model for the Martian bulk composition can be derived.

Most geological activity on Mars took place in the Noachian, decreasing in later times. However, volcanism and tectonism appear to vary locally and e.g. Tharsis could very well be active although in a limited way. Moreover, geological evidences do point towards very recent tectonic activity within parts of the chaotic terrains – the tectonic activity in both regions could be identified by the seismic network. Heat flow measurements close to the volcanic provinces, i.e. Tharsis or Elysium, in addition to the seismic measurements, can place further important constraints on the feasibility of present-day active volcanism on Mars.