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Structure and Evolution of Mars

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The interior structure of Mars has been modeled using gravity data to calculate the Moment of Inertia (MoI) factor and the composition of the SNC meteorites. In calculating the MoI factor a correction needs to be applied to relate the MoI about the rotation axis to the average MoI. There is little chance to improve on the reliability of these models which in terms of the core radius is about 10% or so. Better estimates will require data from seismic networks. A network mission is being planned for 2020 by the European Space Agency potentially together with NASA which would include heat flow probes and other geophysical instruments in addition to seismometers. The uncertainty in the core radius has a bearing on mantle convection models. For sufficiently small core radii a perovskite layer may exist at the bottom of the mantle that may trigger the formation of superplumes and upon becoming unstable even phases of enhanced core cooling. High resolution stereo images from the HRSC on the ESA Mars Express mission suggest that Mars was volcanically active until a few hundred million years ago which suggests comparatively small cooling rates of the mantle. This may be due to an insulating effect of the crust on the mantle. The easiest explanation of the absence of a present day magnetic field is the absence of a growing inner core which would again point to small cooling rates but may also be caused by a composition of the core close to eutectic. The HRSC images have been used to argue against a widely warm and wet early Mars at least since the late Noachian (approx. 4 Ga ago). Instead, the images suggest dry and wet phases intermittent in time and locally. This observation can be taken to argue against a wide-spread biosphere at the time - at least for Earth like live forms - but primitive life forms may be speculated to have existed in ecological niches and may continue to exist even to the present day.

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