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Comparison of the Mantle Potential Temperature of Ancient Mars and the Earth

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Basaltic igneous rocks shed light onto the chemistry, tectonic, and thermal state of planetary interiors. For the purpose of comparative planetology, therefore, it is critical to fully utilize the compositional diversity of basaltic rocks for different terrestrial planets. For Mars, basaltic compositions have been analyzed in situ on the surface at three different landing sites, from orbit providing global geochemistry, and in the laboratory for specific Martian meteorites [1-4]. This provides a range in chemistry and age of Martian rocks. Terrestrial mafic to ultramafic igneous rocks have a range in chemistry across different tectonic regimes and different ages [5-8]. These differences in chemistry and age of planetary basalts may reflect changes in the conditions of partial melting in the planetary interiors. Therefore, here we compare estimates of basalt genesis conditions for Mars with rocks from the Noachian (Gusev Crater, Meridiani Planum, Gale Crater, and a clast in the NWA 7034 meteorite [9, 10]), Hesperian (surface volcanics [11]), and Amazonian (surface volcanics and shergottites [11-14]), to calculate an average mantle potential temperature for different Martian epochs and investigate how the interior of Mars has changed through time. We also calculate formation conditions for terrestrial komatiites and Archean basalts to calculate an average mantle potential temperature during the Archean. Finally, we compare Martian mantle potential temperatures with petrologic estimate of cooling for the Earth to compare the cooling history for Mars and the Earth.

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