Comparison of the conditions of melting in the Martian mantle from surface basalts and meteorites

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Investigations of the Martian crust by rovers, and analyses of recent meteorite falls, have expanded our knowledge of the composition and age of Martian rocks. The basaltic rocks examined on the Martian surface (at Gale Crater, Gusev Crater, and Merdinani Planum) are older and have significantly different chemistry (higher wt% Al_2O_3, wider range in wt% SiO_2, etc) than the younger shergottites [1-3]. The difference in age and chemistry between the surface rocks, the clasts in NWA 7034, and the shergottites may reflect different conditions of melting within the Martian interior. Therefore, we can combine *P-T* estimates for basalt formation for rocks from the Noachian (Gale Crater, Gusev Crater, Bounce Rock in Meridiani Planum, and a clast in NWA 7034 [4] [5]), Hesperian (surface volcanics [6]), and Amazonian (surface volcanics and shergottites [6-9]), to calculate an average mantle potential temperature (T_P) for different Martian epochs and investigate how the thermal state of the interior of Mars has changed through time.

Estimates for the average global mantle temperature during the Noachian based on analyses in Gale Crater, Gusev Crater, Bounce Rock in Meridiani Planum, and a clast in NWA 7034 are 1450 ± 70 °C. The T_P estimates for the Hesperian and Amazonian, based on orbital analyses of the crust [6], are lower in temperature than the estimates for the Noachian. Our analyses are consistent with convective cooling of the Martian interior. However, the T_P estimates from the young meteorites are significantly higher than the estimates based on surface chemistry and may reflect localized 'hot-spot' melting.

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