

The Magnetic Field of Mars: Past, Present and Future

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Presently, Mars possesses no intrinsic global magnetic field but experimental evidence from Mars Global Surveyor suggests that one similar to that of Earth's once existed in its distant past. This evidence is based on the existence of strong crustal magnetization in the ancient terrain of the highlands south of the dichotomy boundary. The deficiency in magnetization in surrounding volcanic provinces and impact basins suggests that the crust gained its magnetic remanence early on via an internal dynamo that became dormant by the time of the last major impacts. This unique timing of the epoch of dynamo cessation has important implications for the history of Mars atmosphere, ionosphere and volatiles. Ion pick-up becomes a significant atmospheric loss mechanism operating for billions of years, enhanced by the low gravity environment and corresponding large scale height that allow the solar wind to interact with exospheric neutrals over an extended volume of space. The MGS magnetic field measurements explored $< 20\%$ of the surface at periapses ranging from 100 km to 400 km during the aerobraking and mapping orbits. A major question raised by the observations is what is the true spatial scale of the intense magnetic anomalies and missions such as ARES (Mars airplane) as well as others using balloons are being proposed to resolve this major puzzle from low altitude platforms. Although Mars Express does not measure magnetic fields directly, the activation of the MARSIS experiment has revealed an unexpected source of scalar in-situ magnetic field data that coupled to the complementary data acquired by the ASPERA and other MEX investigations will allow a significant extension of the MGS and PHOBOS results.