# Global Distribution of Crustal Magnetization Discovered by the Mars Global Surveyor MAG/ER Experiment

M. H. Acuña,[1] J. E. P. Connerney,[1] N. F. Ness,[2] R. P. Lin,[3] D. Mitchell,[3] C. W. Carlson,[3] J. McFadden,[3] K. A. Anderson,[3] H. Rème,[4] C. Mazelle,[4] D. Vignes,[4] P. Wasilewski,[1] P. Cloutier[5]

Vector magnetic field observations of the martian crust were acquired by the Mars Global Surveyor (MGS) magnetic field experiment/electron reflectometer (MAG/ER) during the aerobraking and science phasing orbits, at altitudes between ~100 and 200 kilometers. Magnetic field sources of multiple scales, strength, and geometry were observed. There is a correlation between the location of the sources and the ancient cratered terrain of the martian highlands. The absence of crustal magnetism near large impact basins such as Hellas and Argyre implies cessation of internal dynamo action during the early Naochian epoch (~4 billion years ago). Sources with equivalent magnetic moments as large as $1.3 \times 10^{17}$ ampere-meter$^2$ in the Terra Sirenum region contribute to the development of an asymmetrical, time-variable obstacle to solar wind flow around Mars.

The primary science goals of the MAG/ER investigation are the detection and characterization of the magnetic field of the planet and the study of its interaction with the solar wind. Vector measurements of the ambient magnetic field are acquired by a twin fluxgate magnetometer system. An electron reflection analyzer is used to remotely sense magnetic fields of planetary origin at the top of the martian atmosphere and to provide information about the local electron distribution function (*1*, *2*). Measurements made early in the mission established unambiguously that Mars does not currently possess a significant global magnetic field, with an estimated upper limit for a Mars dipole moment of $\sim 2 \times 10^{18}$ A-m$^2$.

At the same time the detection of strong, small-scale crustal magnetic sources associated with the ancient, heavily cratered terrain revealed that Mars must have had an internal active dynamo in its past, which is now extinct (*1*).

The first part of the aerobraking phase of MGS (AB1) was carried out between September and November 1997 and was followed by aerobraking hiatus orbits (AHO) and science phasing orbits SPO1 and SPO2 from March to July 1998. The latter were designed to allow the heliocentric motion of Mars to bring the spacecraft orbit plane into the desired alignment with the Mars-sun direction before initiating the second aerobraking phase AB2 and "pop-up" maneuver which would raise periapsis to achieve the final mapping orbit. These recently com-

[1]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA. [2]Bartol Research Institute, University of Delaware, Newark, DE 19716, USA. [3]Space Sciences Laboratory, University of California, Berkeley, CA 94720, USA. [4]Centre d'Etude Spatiale des Rayonnements, 31028 Toulouse Cedex 4, France. [5]Department of Space Physics and Astronomy, Rice University, Houston, TX, 77005, USA.