Geophysical Research Abstracts
Vol. 13, EGU2011-12253, 2011
EGU General Assembly 2011

Paleomagnetic Studies from a Mars Rover

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Remanent magnetization on Mars provides records of an ancient core dynamo. The history of the Martian dynamo in turn has major implications for planetary thermal history, atmospheric loss and climate change. Remanent magnetization can also used to characterize past tectonic activity and, through magnetostratigraphy, as a relative chronometer. However, a key limitation is that the spacecraft exploration of crustal magnetization in the solar system has thus far been mostly limited to orbiter and flyby missions. Only once have continuous robotic field measurements been taken across a planetary surface (the Moon), and never has an in situ magnetometer uniquely measured the magnetic moment of individual rock samples on another body. The dearth of landed magnetometers on Mars has limited our knowledge of the planet's crustal magnetization in three important ways: (1) There is almost a total lack of knowledge about the fine-scale (meter to tens of kilometers) structure of the Martian crustal field. Such data are essential for constraining the magnetization source regions and origin. (2) Direct measurements of the magnetization of individual, isolated rocks have been restricted to meteorites whose geologic context is mostly unknown. Such paleomagnetic data are critical because they uniquely determine the net magnetic moment of the samples. (3) Measurements of the absolute paleodirection of Martian fields have never been conducted; only paleointensity measurements have been achievable. To redress these deficits, we are developing magnetometers for deployment on a Mars lander optimized for measuring remanent magnetic fields. Upcoming Mars rovers, including NASA's proposed Astrobiology Cacher-Explorer (MAX-C) mission in 2018, are the primary platform targeted by the proposed instrument. The Science Analysis Group for the MAX-C mission recently listed paleomagnetic studies as one of the two top secondary science objectives for the rover.