SCIENCE FROM THE SURFACE OF THE MOON: A ROVER TRAVERSING A CRUSTAL MAGNETIC ANOMALY. David T. Blewett[1], Dana M. Hurley[1], Brett W. Denevi[1], Joshua T.S. Cahill[1], Rachel L. Klima[1], Jeffrey B. Plescia[1], Christopher P. Paranicas[1], Benjamin T. Greenhagen[1], Edward W. Tunstel, Brian A. Anderson[1], Haje Korth[1], George C. Ho[1], Jorge I. Núñez[1], Charles A. Hibbitts[1], Sabine Stanley[1], Lauren Jozwiak[1], Terik Daly[1], Jeffrey R. Johnson[1], Michael I. Zimmerman[1], Pontus C. Brandt[1], and Joseph H. Westlake[1]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, Md., USA. (david.blewett@jhuapl.edu).

Introduction: The Moon does not presently possess a global, internally generated magnetic field, but the lunar crust contains areas of magnetized rocks ("magnetic anomalies"). Understanding the origin of the anomalies will shed light on major planetary processes. In addition, the anomalies provide a natural laboratory for investigating the interaction of the solar wind with the surfaces of airless silicate bodies. The magnetic fields produce "mini-magnetospheres" that have been detected through analysis of the flux of neutral atoms, electrons, and solar-wind protons.

There are multiple hypotheses for the origin of the magnetic anomalies. Remnant magnetization of basin ejecta or igneous intrusions may be the source of some anomalies. Another hypothesis contends that the anomalies were created by plasma interactions during impact of a cometary coma with the lunar surface.

The crustal magnetic anomalies are often correlated with unusual, sinuous, high-reflectance markings called lunar swirls. There are several hypotheses for the origin of the swirls. One states that the magnetic anomaly limits the flux of solar wind particles that reach the surface, inhibiting normal soil darkening process (space weathering) to which unshielded areas are subjected. Others suggest that impact of a cometary nucleus/coma or meteoroid swarm could disturb the surface to produce the bright swirl markings by changing the structure and particle-size distribution of the uppermost regolith. Alternatively, the magnetic field could alter the trajectories of levitated, charged dust leading to accumulation of high-reflectance dust in the swirls or disturbance of the uppermost regolith structure and thus produce high reflectance.

An in situ investigation of magnetic anomaly regions would directly address at least five major sets of questions in planetary science:

(a) *Planetary magnetism*: What is the origin of the magnetized material? What is the source depth: surficial (comet impact), or deep (magnetized intrusion or basin ejecta)? What are the implications for an ancient dynamo? (b) *Space plasma physics*: What are the fluxes of the particles that actually reach the surface within the magnetic anomaly by energy and species? How does the anomaly interact with the incident plasma to form a standoff region? How does the solar wind/magnetic field/surface interaction change with time of lunar day? (c) *Lunar geology*: What are the nature and origin of lunar swirls? Are swirls ancient or recent? Has levitated dust or cometary material modified the surface? (d) *Space weathering*: Space weathering alters the optical and chemical properties of airless surfaces across the Solar System. What is the relative importance of ion vs. micrometeoroid bombardment and what roles do these agents play in modifying the surface? Lunar magnetic anomalies offer some control on one of the key variables, solar wind exposure. (e) *Lunar water cycle*: How does the OH-H_2O feature at ~2.8 µm vary across spatially and with field strength?

In addition, measurements within a magnetic anomaly could help to address Strategic Knowledge Gaps (SKGs) for human activities on the Moon. SKG Themes include: Theme I, Resource Potential: I-D, temporal variability and movement dynamics of surface-correlated OH and H_2O. Theme II, Lunar Environment: II-B, radiation at the lunar surface. Theme III, Living and Working on the Lunar Surface: III-B-1, lunar geodetic control. III-C-2, lunar surface trafficability. III-E, near-surface plasma environment.

A Rover Mission: A rover traversing one or more of the major magnetic anomalies could provide answers to the important questions listed above. We have named our rover mission concept *Lunar Compass*.

Baseline payload instruments include a vector magnetometer to map the intensity and direction of the local field, allowing the depth of the source to be defined. A solar wind spectrometer (p^+, e^-, α) will directly measure the flux reaching the surface. Mast-mounted instruments include a stereo color imager and a VNIR spot spectrometer for mineralogy and detection of adsorbed OH/H_2O. An arm would carry a microscopic spectral imager to provide particle size distribution, regolith texture, and spectral-compositional properties.

Payload enhancements might include: an XRF/XRD or APXS to determine elemental abundance; a Mössbauer spectrometer to measure soil nanophase iron content; a traverse gravimeter to detect subsurface density variations that could correlate with the magnetized body; a detector for slow-moving dust; and an electric-field meter to assess the role of E-fields in plasma interactions and dust motion.