Mapping of localized magnetic anomalies using nanophase iron. G. N. Iles[1]. [1]Space Physics Group, School of Science, RMIT University, Melbourne, VIC 3000, Australia gail.iles@rmit.edu.au

Introduction: Lunar Prospector was designed for a low polar orbit investigation of the Moon, to map surface composition including polar ice deposits, measurements of magnetic and gravity fields, and studies of lunar outgassing events [1]. One of four scientific instruments on board, the Magnetometer and Electron Reflectometer (MAG/ER) measured particularly strong fields in the regions antipodal (on the exact opposite side of the Moon) to the large Mare Imbrium and Mare Serentatis basins. The field antipodal to Mare Imbrium is so strong it can deflect solar wind particles and form its own small magnetospheric system [2].

The origin of crustal magnetic anomalies and the nature of the original magnetizing fields are only partially understood. It is generally accepted that the lunar magnetic anomalies originated from natural remanent magnetization of the lunar crust acquired in a certain ambient magnetic field, however, paleomagnetic studies of Apollo return samples suggest thermoremanent magnetization or shock remanence in some ambient field. Current theories revolve around basin-forming impact, comet impact and existence of a global magnetic field from an ancient lunar dynamo [3].

Space weathering refers to the process whereby materials exposed to the harsh space environment are gradually altered in both physical and compositional properties to some degree. Space weathering processes can be loosely grouped in two broad categories related to (i) random impacts by small particles or debris found throughout the solar system or (ii) irradiation by electromagnetic radiation or atomic particles from the Sun, galactic sources, or magnetosphere. Further phenomena, which may or may not be related, involve the measurement and observation of nanophase iron, created from space weathering. On the Moon, space weathering has been attributed to the creation of tiny particles of metallic iron denoted npFe0 in the literature [4].

An *in situ* study of the nanophase iron, in the location of the magnetic anomalies, would provide a unique tool for measuring the behaviour and characteristics of the anomalies. There is potential for the nanophase iron to become suspended within the mini magnetospheres and align their individual magnetic moments within the local field. The iron particles could be used as multiple mini compasses, mapping out the exact nature of the anomalies.

Landing Sites: Four sites are identified as significant for this study. Two nearside and two farside sites with the highest strength magnetic fields have been chosen. On the nearside, Reiner gamma and the Descartes crater are identified. Strong anomalies on antipodes of the lunar basins correspond to the chosen farside landing sites at Crisium antipode and Ingenii. All four sites are estimated to have 15 nT magnetic field strength at an approximate altitude of 30 km derived from Lunar Prospector vector magnetometer data [5].

Of these four sites, the most important is the impact crater Reiner on the Oceanus Procellarum. At 7.0°N 54.9°W it lies well within the most Fe abundant region of the Moon. According to the Clementine Fe map of the Moon, the low latitude regions contain up to 14 wt% iron and thus provide the most likely location of finding (and utilising) nanophase iron for local field mapping.

Another important consideration is the precise installation of any CLPS to these locations. The Reiner and Descartes craters are relatively small locations (30 km and 48 km in diameter, respectively) and so precise landing and deployment of any instrument payload is necessary.

Unique Science: Science objectives that can be uniquely achieved at these sites relate to geology; looking at origins of the moon and its formation; use of localized magnetic anomalies for magnetosphere/space weather models; measurement and characterisation of nanophase iron for potential ISRU of magnetic materials. Harvesting of magnetic materials for use in devices for thermal management of habitable bases.

Capabilities: The instruments would need to survive through the night as continuous measurements are required. No mobility is necessary, the instruments can remain in one place. Analytical techniques would include neutron spectroscopy (utilising neutrons liberated by the lunar surface), Mossbauer spectroscopy [6], iron sample collection for bulk magnetization and/or susceptibility and radiation detection capable of distinguishing between different types of ionizing radiation. No sample return is necessary.

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