CONTRIBUTIONS OF AN LGO MISSION TO THE SOLUTION OF LUNAR GEOPHYSICAL ISSUES; L. L. Hood, Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721.

Major lunar geophysical issues that are potentially addressable using measurements to be obtained by the planned Lunar Geoscience Orbiter mission include: (i) the existence and size of an iron-rich core; (ii) the value of the globally averaged surface heat flow and the nature of lateral variations; (iii) the nature of lithospheric thickness variations, both spatially and in time; (iv) the origin(s) of lunar paleomagnetism; and (v) the form of the mantle electrical conductivity profile (relatable to the temperature profile). The extent to which these issues can be resolved by LGO will depend, to a large degree, on the eventual payload commitment (instrument selection) and on whether LGO will be coordinated with other planned U.S. and foreign missions. The nominal SSEC strawman payload consists of a visual and infrared mapping spectrometer (VIMS), an X-ray/γ-ray spectrometer (XGRS); a radar altimeter (ALT), and radio science (providing nearside Doppler tracking for gravity field anomalies). Enhancements to the payload suggested by the SSEC consist of a magnetometer (MAG), an electron reflectometer (ER), and an imaging system (SSI). Additional instruments considered by the LGO workshop as candidates for an LGO payload were a microwave radiometer (MRAD), a spacecraft gravity system (SGS), and a thermal infrared mapping spectrometer (TIMS).

If the actual spacecraft retains only the nominal SSEC payload, the mission would be very valuable from a geochemical standpoint and would have several limited but useful geophysical applications. In particular, the resulting global altimetry would allow further investigations into such topics as the departure of the Moon from a hydrostatic state and the precise value of the center-of-figure/center-of-mass offset. The acquisition of accurate nearside gravity data for latitudes greater than 30^o combined with the altimetry data would allow further lithospheric flexure studies which are in turn useful for constraining the thermal history of the Moon. However, the other major geophysical issues listed above would not be addressed.

If the spacecraft payload includes the magnetometer and electron reflectometer enhancements, then studies relating to the existence and size of a possible metallic core and to the origin of lunar paleomagnetism would become possible. Constraints on core size would be obtained by measurements of the induced lunar dipole moment at times when the Moon is in the relatively quiet environment of the geomagnetic tail lobes. Measurement of a significant negative induced moment (caused by exclusion of the geomagnetic tail lobe field from the highly conducting core) would yield an estimate of core size. Previous estimates of the lunar induced moment using Apollo subsatellite magnetometer data yielded evidence for a highly conducting core with radius $>$ 400 km although questions were raised about possible effects of ambient plasmas on the moment estimates. The LGO electron reflectometer would have the capability of monitoring the ambient plasma environment to identify time periods that are optimal for such measurements. It will be of interest to see whether LGO data provide evidence for a metallic core that is consistent with the Apollo results. Constraints on the origin of the paleomagnetism would be provided by the first global map of the distribution and direction of crustal magnetic anomalies. Both the magnetometer and the ER instrument would have complementary capabilities in producing such a map.

If the payload includes an imaging system enhancement, then geophysical studies of lithospheric flexure will be improved since high-resolution imaging is needed to map tectonic features associated with lithospheric loads. In addition, studies of the correlation of surface geologic features with magnetic anomalies require imaging for interpretation purposes. For example, the strongest observed anomalies mapped with the Apollo subsatellite magnetometers are associated with the Reiner Gamma swirls whose origin is poorly understood. Selective high-resolution imagery of swirls may provide further geologic constraints on their origin which, combined with detailed magnetic anomaly modeling, may yield further insights into the origin of lunar paleomagnetism. More generally, imagery is needed to improve geodetic control for mapping purposes and to support basic geologic studies including those that are needed for interpretation of geochemical anomalies.

If the payload includes a microwave radiometer, then it will be possible, in principle, to measure the global mean surface heat flow to within an accuracy of $\sim$0.4 μW//cm^2. This would represent a significant improvement over current estimates derived from two Apollo surface measurements. In addition to providing a basic constraint on the lunar temperature profile, such a measurement can, with certain assumptions, be related to the global abundance of uranium and hence to the general issue of whether or not the Moon is enriched in refractory elements. Further, an LGO MRAD instrument would investigate the nature of lateral variations in surface heat flow providing constraints on local variations in the abundances of radioactive

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isotopes in the upper 100 km. Acquisition of this data base combined with additional later direct surface heat flow measurements will provide an optimal means for accurately determining the mean global heat flow.

If the payload includes a spacecraft gravity system, then high-resolution mapping of farside gravity would become possible for the first time allowing an important extension of lithospheric flexure studies to the far side. It should be noted that both gravity and magnetic measurements will be significantly enhanced if the spacecraft altitude is reduced to at least $\sim$50 km for a portion of the mission.

Finally, if other (U.S. or foreign) spacecraft are in lunar orbit during the LGO mission, then a cooperative effort could result in an augmentation of geophysical measurements in several ways. First, such a spacecraft could act as a communication link allowing acquisition of farside gravity data without the addition of the SGS. Second, if, as is likely, such a spacecraft carries a magnetometer and charged particle instruments, then electromagnetic sounding of the mantle electrical conductivity profile would become possible, as was the case during the Apollo program. These instruments could also serve to monitor external magnetic field variations and plasma conditions allowing improved mapping of crustal magnetic anomalies.