Geophysical Research Abstracts, Vol. 9, 07927, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07927

Concepts and instruments for low-cost lunar surface missions

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There has been a renaissance of interest in the Moon. Many questions were unanswered by the plethora of lunar missions that took place during the early 1970s (including Apollo and Luna sample returns, the last of which, Luna 3, occurred in 1976). While samples of lunar material are available from 9 sites these lie along a relatively narrow range of mid-latitudes and are confined to the near-side. Moreover, important results from recent remote sensing missions and ground based observations demand a return to the Moon. Initially, return to the moon will involve robotic exploration although, in the longer term manned missions will be necessary and can be expected.

Developments in technology including commercial small satellites and miniaturisation of sensor packages have brought forward the real possibility that such low-cost missions could be extended into a planetary context. The natural place to start is the Moon.

This paper takes as its starting point key scientific questions regarding the moon, such what is the nature of the lunar interior? How and by how much has the lunar crust been differentiated? What were the processes that were occurring (both internally and externally generated) during the early evolution of our solar system? Is there water ice (and other volatiles) at the lunar poles? – and what is its composition and origin, and are there any implications to astrobiology? .... From these questions and in the context of low-cost lander missions (and technological readiness) instrumentation payload options are suggested for two generic lander concepts – penetrators and soft landers. The characteristics, track records, advantages and disadvantages of these two general approaches will be explored.

In-situ robotic study of the Moon is likely to include: seismology which leads to information about the internal structure (core, mantle and thickness of the crust) and origin of moon-quakes; heat flow measurements which relate to the degree of inhomogeneity of the crust; geochemical analysis including the detection of water ice and compounds therein; and imaging – providing both spectral and morphological information regarding lunar geology.

Reference will be made to the recent UK MoonLITE and MoonRaker studies that are related to low-cost penetrator and soft-lander missions respectively.