

MOONLITE*: SCIENCE CASE AND TARGETING CONSIDERATIONS. I. A. Crawford¹ (i.crawford@ucl.ac.uk), A. Smith², R. A. Gowen², K. H. Joy¹, and the UK Penetrator Consortium³. ¹School of Earth Sciences, Birkbeck College, London, WC1E 7HX, UK, ²Mullard Space Science Laboratory, University College London, UK. (www.mssl.ucl.ac.uk/pages/general/news/UKLPC/UKLPC.pdf). *MoonLITE is a UK-led initiative which is currently the focus of a joint UK-NASA Phase-A study.

Introduction: MoonLITE is a proposal for a UK-led mission to the Moon that will place four instrumented scientific penetrators in the lunar surface to make geochemical and geophysical measurements that cannot be made from orbit [1,2]. It has the potential to make major contributions to lunar science, while at the same time providing knowledge that will be of central importance in the planning of future human missions to the Moon. In December 2008 the British National Space Centre (BNSC) announced that it would fund a Phase-A study for MoonLITE, and this is expected to start in April 2009. Following discussions with NASA, it is intended that there will be a significant US contribution to this study, in the expectation that MoonLITE will be a major vehicle for UK-US collaboration in lunar exploration (as envisaged by the 2007 NASA-BNSC Joint Working Group [3])

Scientific objectives: The principal scientific objectives of the MoonLITE penetrator mission are:

- To further our understanding of the origin, differentiation, internal structure and early geological evolution of the Moon;
- To obtain a better understanding of the origin and flux of volatiles in the Earth-Moon system;
- To obtain ‘ground truth’ geochemical data to complement orbital remote-sensing observations;
- To collect *in situ* surface data that will help in the planning of future lunar exploration.

As described in [2], these top-level science objectives require that the penetrators emplace instruments capable of contributing to several different areas of scientific investigation, including seismology, heat-flow, geochemistry, and volatile detection. These scientific objectives were reviewed by an International Peer Review Panel in July 2008, which found that “the scientific potential of the MoonLITE penetrator network concept to be exceptionally high in the context of the international exploration activities” [4].

Site targeting strategy: Current thinking calls for MoonLITE penetrators to be targeted as follows: one into a permanently shadowed south polar crater, one into a shadowed north polar crater, one into the central farside highlands, and one into the central nearside within the area covered by the Apollo network. Such a distribution would provide global coverage for the seismic, heatflow and geochemistry measurements,

while at the same time sampling two permanently shadowed craters and providing some benchmarking against the earlier Apollo measurements. However, the nature of the MoonLITE mission, with penetrators being deployed from a polar orbiting spacecraft, ensures that it is very flexible with regard to site selection. This is a strength of the mission concept because it means that sites could, in principle, be chosen in response to the distribution of other surface assets (e.g. the nodes of the International Lunar Network, ILN) in such a way as to maximise the overall scientific return.

Importance of LRO: The high spatial resolution of the LROC WAC (75 m/pixel) and NAC (50 cm/pixel) cameras will be invaluable in the detailed planning of MoonLITE site selection. Whereas the regional locations of the impact sites can be defined by combining scientific considerations with the distribution of other surface networks, as discussed above, the final choice of specific target locality for each penetrator will require a detailed knowledge of the local terrain and associated hazards. The penetrator impact target ellipse is currently envisaged as having a width of 2-3 km, which means that relatively flat areas of this extent, free from surface boulders, and having local regolith depths of at least 5 m, will need to be identified to maximise the chance of penetrator survival. It is envisaged that LROC images will be able to contribute to impact site hazard assessment in each of these respects – the spatial resolution will be sufficient to map the distribution of surface boulders directly, and local regolith depth may be determined from a close analysis of small impact crater ejecta morphology [5]. Targeting within permanently shadowed craters will require special care, and we anticipate that LROC, and other LRO instruments, will be invaluable in this respect.

Conclusion: The UK-led MoonLITE mission provides an exciting opportunity to advance lunar science through UK-US collaboration. One aspect of this will be provided through the unique capabilities of LRO in selecting safe and scientifically valuable impact sites for the MoonLITE penetrators.

References: [1] Gao, Y., et al., *Planet. Space Sci.*, 56, 368, (2008). [2] Crawford, I.A. & Smith, A., *Astron. Geophys.*, 49, 3.11, (2008). [3] NASA-BNSC Joint Working Group Report, 2007 (<http://www.bnsc.gov.uk>). [4] MoonLITE IPR Report, 2008 (<http://www.bnsc.gov.uk/7304.aspx>). [5] Wilcox, B.B., et al., *MAPS*, 40, 695, (2005).