EXPLORING THE BASALTIC LAVA FLOWS OF OCEANUS PROCELLARUM: REQUIREMENTS FOR AN EXPLORATION ARCHITECTURE THAT OPTIMISES SCIENTIFIC RETURN FROM GEOLOGICAL FIELD ACTIVITIES. I.A. Crawford[1] (i.crawford@ucl.ac.uk), S.A. Fagents[2] and K.H. Joy[1]. [1]Birkbeck/UCL Research School of Earth Sciences, Gower Street, London, WC1E 6BT, [2]Institute of Geophysics and Planetology, University of Hawaii, 1680 East-West Road, Honolulu, HI 96822, USA.

Introduction: One of the principal scientific reasons for wanting to resume *in situ* exploration of the lunar surface is the record it contains of the early geological evolution of a rocky planet, and of early Solar System history more generally [1,2,3]. Accessing this record will be greatly enhanced by a renewed human presence on the Moon, especially if supported by an exploration architecture designed to facilitate geological field activities (of which provision for long-range mobility, e.g, in pressurized rovers, will probably be the most important element).

The example of Oceanus Procellarum: A specific example (albeit only one of many) of how future lunar science would benefit from the speed and efficiency of human explorers in the field would be the study of the young basaltic lava flows in northern Oceanus Procellarum. This area consists of a patchwork of discrete lava flows with estimated crater-count ages ranging from about 3.5 to 1.2 Gyr (Fig 1) [4,5].

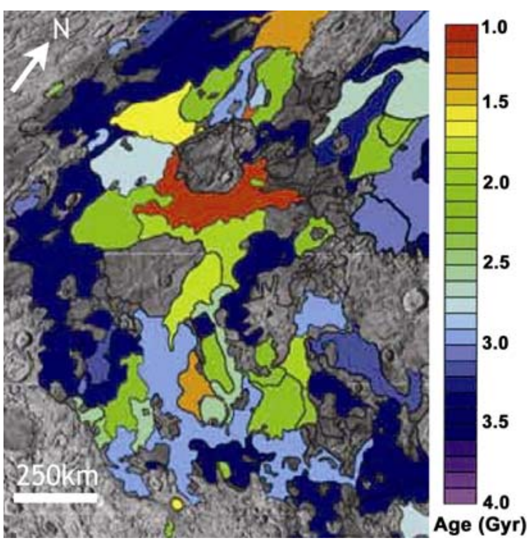

Fig. 1. Estimated ages of lava flows in Oceanus Procellarum (Gyr) based on crater counts, as mapped by Hiesinger et al. [5]. (Image courtesy Dr. H. Hiesinger; © AGU).

This is a far greater range of ages than any basalt samples collected by the Apollo missions (which occupy the narrow age range ~3.8 to 3.1 Gyr). Thus, collecting samples from a number of these different lava flows, and returning them to Earth for radiometric dating, would greatly improve the calibration of the lunar cratering rate for the last three billion years (see [6] for a review of the importance of such an improved calibration). Moreover, geochemical studies of these basalts would yield information on the evolution of the lunar mantle over this time period. Finally, as the younger lava flows are superimposed on older ones, we may expect to find layers of ancient regoliths ('palaeoregoliths') sandwiched between them which may contain a variety of records of the near-Earth cosmic environment through Solar System history [1,7-9]. Taken together, this would be a very rich scientific harvest and the developing exploration architecture should be developed so as to permit extensive geological field activities of this kind.

Implications for the exploration architecture: In order to conduct a sufficiently detailed geological investigation of a range of discrete lava flows, in Oceanus Procellarum, or comparable localities, the exploration architecture would have to support:

- The ability to conduct 'sortie-class' expeditions to non-polar localities.
- Adequate provision for sample collection and return capacity (estimated at several 100 kg/sortie)
- Provision for surface mobility – in the specific case of the Procellarum basalt flows shown in Fig. 1, a range of order 250 km would permit access to a number of different units with a wide range of ages. This implies provision of a pressurized rover (or alternatively a hopping lander of some kind)..
- Provision of the means to detect and sample palaeoregolith deposits. For detection, ground penetrating radar may be a suitable technique (see discussion in [10]). For access, unless suitable outcrops can be found a the boundaries between flows, provision of a drilling capability (perhaps to c. 100m depths) may be required. This implies provision for storage and transport of the drill cores.

References: [1] Spudis, P.D. (1996) *The Once and Future Moon*, Smith. Inst. Press. [2] Crawford, I.A. (2004) *Space Policy* 20, 91. [3] National Research Council (2006) *The Scientific Context for Exploration of the Moon*. [4] Wilhelms, D.E. (1987) *The Geologic History of the Moon*, USGS Prof. Pap. 1348. [5] Hiesinger, H., et al. (2003) *JGR*, 108, E7, 1. [6] Stoffler et al. (2006) *Rev. Min. & Geochem.*, 60, 519. [7] Crawford, I.A., et al. (2007) *LPSC* 38, 1323. [8] Crawford, I.A. (2006) *Internat. J. Astrobiol.*, 5, 191. [9] Rumpf, M. E. et al. (2008) *LPSC* 39, 2259. [10] Sharpton, V.L. & Head, J.W. (1982) *JGR*, 87, 10983.