RECOVERY AND SUBDIVISION OF THE APOLLO 16 SURFACE SAMPLES - A SIMULATION STUDY.

C.T. Pillinger and A.P. Gowar. Organic Geochemistry Unit, School of Chemistry, University of Bristol, Bristol BS8 1TS, England.

Samples collected from the very surface of the lunar regolith are extremely important materials (1). They should provide: (i) fundamental information about the processes involved in lunar surface exposure, such as solar wind and cosmic ray ion implantation, meteorite bombardment and the redistribution of volatile elements, (ii) an understanding of the lateral and vertical transport mechanisms taking place during the formation and build-up of the regolith, and (iii) an absolute ground truth measure of the optical characteristics of the surface of lunar soil.

A special effort was made by the Apollo 16 mission to collect samples of lunar fines from very shallow depths (< 1 mm) within the regolith, using two contact surface sampling devices of adhesive fabrics. The procedures for the recovery of any material adhering to the Apollo 16 Beta cloth (69003) and Velvet cloth (69004) samplers should be designed to obtain the maximum information whilst preserving the integrity of the samples and restricting wastage to a minimum.

The purpose of this paper is to report progress in a simulation study of the proposed processing scheme shown in the Table. It is intended to stimulate suggestions and comments from P.I.'s interested in the analysis of surface samples. The actual practical details for each step outlined in the Table are under investigation using the spare space flight hardware, samples of Beta and Velvet cloth and simulated lunar fines. Special care is being taken to avoid methods which could lead to contamination from rare gases, mercury, organics including carbides, nitrides, iron and sulphur. The only materials to be used in the handling procedures will be stainless steel, teflon and aluminium. Prior to the opening and processing of the collected surface samples, at Houston, a full scale simulation involving actual lunar soil will be performed at Bristol.

The analysis of recovered samples will be performed by a Consortium of investigators set up by LSAPT. Some investigations will be carried out using hand picked grains of known orientation. In order to obtain the maximum scientific return from grains of unknown orientation, only fractions of material appropriate to a particular technique should be analysed by that technique. For example, CH_4 and carbide are concentrated in glassy agglutinates and finest grains (0.5 - 10 μm) but are essentially absent from discrete mineral fragments (2). Therefore, particles of the former types are especially suitable for carbon chemistry investigations; the latter particles are most appropriate for other studies such as track density measurements. Samples of unknown orientation should, therefore, be divided into a number of appropriate fractions by sieving, washing with MeOH and density/magnetic separations (2). This approach has been very successfully applied to the 0.5g samples of Luna 16 and 20 provided to British Investigators by the Russian Academy of Sciences (3).

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Table Processing scheme for the recovery and subdivision of Apollo 16 special surface samples.

Procedure	Methods
1. Sample Opening (to be carried out in nitrogen).	*Remove any dust coating present on outer surfaces of the sample container by brushing or wiping to minimise cross contamination risks. *Remove sample retaining lid and store sampling device in gas-tight container with a transparent glass lid and a nitrogen flushing facility. *Material adhering to the lid should be preserved in known orientation and stored and processed similarly to the primary sample. *Loose material of unknown orientation should be collected for use in experiments not requiring particles of exactly known orientation.
2. Preliminary examination. (to be performed in P.E.T. mode in conjunction with invited Principal Investigators and J.S.C. Physics and Earth Sciences Division personnel).	*Study gross and specific distribution and orientation of the grains - document by photography and graphic art. *Examine the morphology and composition of the collected particles. *Carry out initial microcratering studies. *Measure optical properties such as reflectivity and polarization. *LSAPT review of the amounts and types of material available. *Formation of a Consortium for the analysis of the samples.
3. Separation of posterity sample (to be carried out in nitrogen)	*Remove 50% of material collected and store in sealed vessel under nitrogen.
4. Sample recovery Each surface sampler will be subjected to a series of successively more drastic procedures designed to recover the samples from the adhesive collectors (to be carried out in filtered air).	*Hand pick and record the orientation of all grains $> 250 \mu m$ in size. *Mount a proportion (5-10% total) of the sample with preserved orientation in a suitable resin for the preparation of polished sections. Some material could be collected by a peeling technique used to mount samples for electron microscopy. *Collect weakly-adhering particles by a physical process such as mechanical vibration or magnetic attraction. *Collect strongly adhering material by ultrasonic vibration in pure methanol. The removal of the fabric pile (by shaving in the case of the Velvet cloth) might facilitate the process.

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Table (Continued)

Procedure	Methods
	*Material not collected by any of the above processes could be distributed still located on the sampler fabric by cutting the adhesive surface into appropriate sized fragments.
5. Sample processing (to be carried out in clean filtered air).	*Distribution of aliquots of hand picked grains of known orientation. *Separation of material of unknown orientation into concentrates by sieving, washing with MeOH and density/magnetic separations.

Until the Beta and Velvet cloth samplers are opened it is impossible to judge how much, if any, sample of the very surface of the regolith has been collected. Even if only very small amounts are available some techniques will still provide meaningful measurements. The procedures developed for the surface sample separation and subdivision will be applicable to other materials of great significance, such as aliquots of soil from various stratigraphic units of a drill stem or core tube.

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References

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