SIEVING THE FINEST FRACTIONS OF LUNAR SOILS. S. J. Wentworth¹, A. Basu², and D. S. McKay³.

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Standard procedures for sieving <1 mm lunar soils yield a range of size separates, the finest of which is normally a <10 or <20 μm pan fraction. We have developed a method for sieving these fine fractions even further in order to obtain a better segregation of material for use in studies of fine-grained lunar soils. Our method uses a vacuum system to pull the lunar soil grains through a stack of fine (10, 5, and 1 μm) filters or screens. Ultrapure Freon 113 (or another solvent such as ethanol) is used to agitate and wash the grains through the sieves. Other workers have used similar methods to filter particles from water (e.g., [1]).

In the past, we have tried commercial pre-loaded filter holders with tubing connections for vacuum filtration, but we found these systems less than satisfactory for our sieving. In particular, we could not agitate the grains with a directed stream of Freon during sieving. We also tried methods similar to those for sieving the coarser fractions (i.e., wet sieving using Freon 113 and 3" sieves), attaching a vacuum system to the pan in order to pull the finest grains through the sieves. The major problem with that method was that the sieve screens got clogged, and it was not possible to clean the screens without damaging them. This meant that subsequent samples might be contaminated. Future runs would also be both inefficient and incomplete. Accordingly, we decided to use new sieve screens for each sample.

We switched to smaller sieves (screen diameter 1") and used very small amounts of starting material in order to prevent clogging. We have determined that, for sieving a <10 μm sample, the amount of starting material should be 5 mg or less. Our stainless steel-and-tetlon sieves fit together tightly, and the pan has an outlet which is connected by tubing to an aspirator trap. The trap is, in turn, connected to a pump from a vacuum pick. The aspirator trap prevents Freon and lunar grains from getting into the pump. A 1" diameter cloth screen or Nuclepore membrane filter is sealed by the edges into the sieve with epoxy. There is a wide range of available mesh or pore sizes; for our runs, we used a stack of three sieves with mesh/pore sizes of 10, 5, and 1 μm for each sample. The sample is poured into the top sieve. Sieving is accomplished by adding ultrapure Freon 113 to the top sieve, and turning on the vacuum for a few minutes. The sample can be agitated by squirting Freon directly onto the sieve while the vacuum is on. The freon/vacuum cycle is repeated a few times. Total sieving time is only about 15 minutes. After sieving, size separates can be brushed out of each sieve. The pan fraction cannot be recovered because it goes into the aspirator trap along with the solvent. The used filters and screens are then cut out of the sieves; they make excellent SEM mounts (after carbon coating). The epoxy is removed from the sieves and the screens are cleaned thoroughly before the filters or screens are glued in for the next sample.

In two separate runs, we sieved the <10 μm fraction of Apollo 16 soils 64501,155 and 67701,17. Starting material for each sample was about 14 mg. For 64501, we used a sieve stack containing a 10 μm polyester cloth screen, a 5 μm Nuclepore filter, and a 1 μm Nuclepore filter. Screens for 67701 were the same size, but we used a polyester cloth screen instead of a filter for the 5 μm sieve. For the two samples, surfaces of the filters and screens in the SEM gave similar results. The 10 μm screens retained mostly debris from earlier sieving and handling (e.g., lint), as expected. Figure 1 is an SEM photomicrograph of the 5 μm filter for 64501,155. The blocked holes show that some sample clogging occurred. There is also some material less than 5 μm in size on the screen surface, which indicates that sieving was incomplete. Similar evidence of clogging is found on the 5 μm screen for 67701,17 (not shown). Using less starting material would have prevented this problem. Based on the amount of clogging, 5 mg of starting material is probably an upper limit for good size separation. Figure 2, an SEM photomicrograph of the 1 μm filter for 64501,155, shows that the size separation was quite good for that range.

This sieving technique is promising as an aid in studies of very fine-grained samples. An advantage of the technique is that the screens can be used directly as SEM mounts after they are cut out of the sieves. Also, using new filters for each sample greatly reduces chances of cross-contamination. The major drawback is that only very small amounts (5 mg or less) of material can be sieved effectively at any one time. In addition, the pan fraction is lost; but still finer filters (e.g., 0.1 μm) could be used in order to catch more material. While this technique was developed for lunar soils, it might also be applied to other planetary materials such as interplanetary dust particles (IDPs) or disaggregated meteorites.

Figure 1: SEM image of 5 μm filter, 64501,155

Figure 2: SEM image of 1 μm filter, 64501,155.