
Three soils from Apollo 17 (72461, 72501 and 75081) were separated into 9 grain-size fractions with mean diameters between 1 and 540 μm. In order to reduce the risk of contamination during the separation procedure, the samples were irradiated with thermal neutrons (7 days, 5×10^13 cm^-2 sec^-1) prior to handling. Seven size fractions between 1 and 540 μm were obtained from total soil samples (Ø < 1 mm) of 350-500 mg material. Wet sieving in acetone with a semi-automatic procedure was used for the separation of the highly radioactive material. In addition, two fractions of ~1 and 3 μm dia resulted from sedimentation in acetone. Microscopic and electron-microscopic pictures showed a uniform size distribution within each of the fractions obtained by these techniques. 26 volatile and non-volatile elements were measured in each fraction using INAA and RNAA.

A smaller aliquot (about 100 mg) of the bulk samples was separated into similar size fractions in order to determine the major elements Al, Ca, Mg, Na and Ti by INAA. In general the concentrations of the main elements did not change much in the different size fractions. Exceptions from a homogeneous distribution were found for Fe (determined in the main sample) and Ti which increase and Al which decreases with grain-size, Ti showing the largest deviations [1]. These changes in the concentration of main elements suggest variations in the mineralogical composition of the different grain-size fractions which could result mainly from varying amounts of Ilmenite and Plagioclase.

Fig.1a shows the distribution pattern of trace elements in sample 72461. This sample was collected after removing the 0.7 m boulder +3, station 2. The distribution of trace elements in sample 72501 which was exposed to the environment is visible from Fig.1b. No significant differences are found between the two samples neither in the elements shown in Fig.1 nor in the elements Al, Ca, Ce, Co, Cr, Eu, Fe, Hf, K, La, Mg, Mn, Na, Sc, Sm, Tb, Ti, U, V, Yb determined by INAA. Therefore, no noticeable differences in volatilization and condensation processes occurred preferentially only in one of the samples since the time 72461 was covered by the boulder.

The concentrations of volatile trace elements are in general anticorrelated to the grain-size, thus suggesting a surface-
Fig. 1. Distribution of trace elements in grain-size separated samples of Apollo 17 soils 72461 and 72501. 72461 was shadowed by a 0.7 m boulder. The 'Bulk'-value resulted from small aliquots of the unseparated sample. The 'Mean'-value is the weighted average of the individual size fractions. Errors (1σ) are of the order of 10–15%. Note equal scale on ordinate and abscissa.

The deviations found in the coarsest grain-size fraction for In and Hg (72461) could point to sampling problems resulting from a relatively small amount of particles. The concentrations of non-volatile elements such as uranium and rare earths do not reveal a dependency on the grain-sizes. A similar distribution was also found for some of the volatiles and non-volatiles in sample 75081. However, other elements in this sample showed very large and irregular deviations from this pattern; this could only be explained by contamination. Therefore, the results of 75081 are not further discussed.

It can be seen from Fig. 1 that Cd, Hg, In and Zn decrease more or less steadily with increasing grain-size. The enrichment factors between the finest and coarsest material and the concentrations found for Cd, In and Zn are comparable to those found by Boynton et al. [2] for sample 15100. The data for Sb show an irregular dependency on the grain-size, the changes are, however, much larger than the experimental uncertainties of about 10–15%. Ge is enriched in both soils by more than a factor of two in the...
size fractions around 200 μm which also contain the largest amount of agglutinate as shown by Heiken and McKay for 72441 [3]. Furthermore, an enrichment was found in the same fractions for Co. These facts indicate that the higher Ge concentrations could result from extralunar material.

The curves for Zn and Hg obtained in this work cannot be resolved as proposed by Boynton et al. [4] in a pure volume-related compound having volatile element concentrations which are roughly independent of grain-size and a pure surface-related portion having concentrations proportional to the specific surface area of the grains. The slopes of the curves for Zn and Hg are between -0.3 and -0.5 which is close to lower values obtained for noble gases [5]. Several mechanisms can be put forward to explain a deviation from a pure surface correlation:

(1) Partial application of the Rosiwal principle as proposed by Criswell [6] leading to slopes < -1.
(2) Variations in the mineral composition and in the content of glass and/or agglutinate if the concentration in volatile trace elements is different in these components. Indeed, the increases and decreases in the slopes between 11 and 36 μm (see Fig. 1) for almost all the trace elements indicate some change in the composition of the investigated grain-size fractions. The quite large variations for Sb and partly also for In support this assumption.

(3) Effects (1) and (2) could produce our data by super-position.

We, therefore, conclude that additional investigations on grain-size separated mineral fractions should be performed to learn more about processes leading to enrichment of volatile elements in regolith.

References