
Numerous investigations (e.g.Refs.1-9) demonstrated that volatile elements are enriched on the surfaces of regolith grains. Several possible mechanisms can lead to these enrichments, e.g.impact heating by meteorites and micrometeorites, volcanic processes, and solar heating of the lunar surface. The possibility of a volatilization of Hg, Cd and other volatile elements at lunar day temperatures of ≤130°C was deduced from heating experiments (Refs.8,9,10). If low-temperature volatilization is an important process on the moon one should find higher enrichments of volatiles on surfaces of samples which are permanently shielded from sunlight and remain at relatively low temperatures of ~250 K (Ref.11).

In the present work a comparison is made of the surface concentrations of Br, Cd, Hg, Se, Te, and Zn in grain-size separated aliquots of samples 76240 and 76260. The permanently shadowed (Ref.11) sample 76240 was collected under the north overhang of boulder # 4. 76260 was taken as reference soil just outside the shadow. Both soils are very similar in chemical and mineralogical composition (e.g.Refs.12,13,14).

The samples were irradiated simultaneously during one week at the swimming pool reactor SAPHIR (φth~5·10^{13} n cm^{-2} s^{-1}). They were subsequently separated into grain-size and mineral fractions in a moist N₂-gas stream. For both samples the resulting mineral- and grain-size distributions were very similar and the concentrations for Fe, Sc and Co agreed in corresponding fractions. The agglutinates of 38-75 μm, and the minerals of 38-75 μm, 75-149 μm, 149-350 μm, and 350-~1000 μm were heated at 1000°C in a H₂-gas flow in two subsequent time intervals of 30 s applying the techniques of Refs.8 and 15. The residues of the heated samples were analyzed by a wet-chemical procedure (Ref.16).

The results for Hg and Cd are graphically represented for the mineral fractions 38-75 μm of the two samples (Fig.1). A comparison of the results demonstrates that the surface concentrations of Hg and Cd are considerably higher in the shadowed sample. For the rest of the investigated volatile elements no significant differences were observed. Since the two samples differ only in the storage temperature during the last 10⁴ y (Ref.11) the difference in the concentrations of Hg and Cd must be the result of the shadowing.

Based on the present investigation and our earlier heating experiments (Refs.8,9) it can be concluded that Hg and Cd, and probably other equally volatile elements and/or compounds are mobilized by solar heating of the uppermost lunar soil and are trapped in cold places of the moon. Thus, in addition to meteoritic, micrometeoritic, and volcanic processes, solar heating of the lunar surface plays an important role for the distribution and redistribution of very volatile elements and compounds on the lunar surface.

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VOLATILIZATION FROM SOLAR HEATING

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References


Volatilization of Hg and Cd in H₂ from the minerals 38-75 μm of samples 76240 (shadowed) and 76260 (reference) at T = 1000°C. A = 1st heating of 30 s, B = 2nd heating of 30 s, C = Concentration in residue (wet-chemistry). Note different scale for the Hg concentrations.

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