SOME RARE MINERALS IN LUNAR SOILS

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One describes here the results of a systematic investigation of lunar fines for doubtful or rare minerals which have been found previously, sometimes casually: blue rutile(1), silicon carbide(2) and transparent iron oxides(3).

A method has been devised by which rare micron-sized objects interspersed among huge amounts of the common soil components can be handled, selected under the photon microscope(PM) and analysed individually with the help of SEM, EMP and XRD techniques(4).

The problem of genuineness of the questionable minerals can be solved either by finding some individuals bound to genuine lunar components, or by revealing nuclear tracks, whose density is several orders higher in lunar materials than in terrestrial ones, either natural or technological(5).

The concentrations of the described minerals are extremely low \((10^{-5}\) to \(10^{-7}\)) and it is only thanks to their striking optical properties that such low quantities have been detected. Their presence points nevertheless to some very interesting phenomena or confirms some inferences.

The soils that have been investigated are the following: 65501,1-65502,2-65901,5-65902,2. No difference in rare mineral content has been observed between the samples nor has been sought.

1 **Blue Rutile**

This peculiar, yet expected habit of rutile has been found in various shapes and hues in all samples. Irregular, rounded or spherical bodies are easily recognized by their sky-blue to white colour and very high dispersion under reflected light. In transmission, the mineral is transparent in brown or opaque. These bodies are in fact agglomerates of micro-crystals disposed without preferred orientation. Grain size is rather constant in each body but varies between them from 0.2 to 5 microns.

The state of aggregation is diverse: some clusters have decayed over short distances during preparation, whereas others have their components firmly welded. The clusters are sometimes intimately interwoven into a transparent matrix of feldspar- or pyroxene-like composition. A large spherical body welded to a pyroxene
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crystal indicates by his deformation that it grew against it or was plastic at the time of welding. Chemical composition of the rutile is simple, as only Ti is found as major component. Trace amounts of Si, Ca and Fe are sometimes found. XRD gives a rutile structure.

All the properties point to a formation by condensation from a high temperature, Ti-rich, O₂-poor vapor. Fragile, polycrystalline agglomerates of corundum of the same supposed origin have been found in lunar fines(6). Clusters of micron-sized rutiles have been found in the Bosumtwi(7) and in the Henbury(4) impact glasses.

2 Silicon Carbide

Monocrystalline particles of high reflectivity and dispersion and of pale blue colour are easily noticed under reflected light. In transmission, they are almost black, due to extreme relief. The surfaces result always from cleavage and fracture. Transparent inclusions and overgrowths have been observed under the PM. SEM shows one good cleavage and silicate droplets scattered on the surfaces. EMP indicates a major Si composition (C and O are out of range of the instrument). XRD gives a structure of alpha-SiC.

The origin of this mineral cannot be seriously discussed as long as the question of its genuineness has not been solved. As we have not found any SiC attached to a lunar mineral, the nuclear track method will be tried.

3 Transparent Iron Oxides

Rounded particles or even perfect spheres of red colour in transmission have been found: some are deep red with a high reflectivity like hematite, and others are orange-red with a lower reflectivity like goethite. Some of these rounded bodies are found attached to metallic iron particles (cf.3), but more frequently they are found without metallic support. One large, bursten particle shows small lamellar crystals of the same composition standing in a geode. EMP analyses indicate Fe as major and Si, Ca, Ni as minor elements. XRD: hematite spots have been obtained with some of the red particles, but the crystallinity is not equally developed in all individuals.

The question of origin will be left pendant here, but it may be surmised from the SEM-morphologies that both high and low temperatures have been active during their formation.

4 Vapor Deposited Ni-Fe-Sulfide

Regularly disposed spots of an opaque, highly anisotropic
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Minerals are found on glassy spheres and broken crystals of silicates. At first sight, this mineral looks like graphite, but EMP gives a definite Ni, Fe, S composition. Ni contents vary from 5 to 10%, approximately, which is far too high for a lunar troilite. PM properties exclude pentlandite as a possible candidate. XRD has not yet been done on these particles. SEM shows a scaly or spiny texture very different from the globules of troilite described in (6).

The association of the spots with glassy spheres, their disposition on them indicate a deposition from the vapor.

REFERENCES


(4) Jedwab J. (1973) Rare minerals in lunar soils (in preparation)


