TRANSFORMATION OF BIOTITE INTO OPAL IN THE SOILS OF NORTHERN KARELIA

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Translation of "Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva
Series 2, Vol 85, pp. 585-586, 1966

GPO PRICE $ ________

CFSTI PRICE(S) $ ________

Hard copy (HC) 3.00

Microfiche (MF) .65

ff 653 July 65

Translated for:

[JET] PROPULSION LABORATORY
Pasadena, California 91103
October, 1967

N68-15448 (ACCESSION NUMBER)
3 (PAGES)
CL-92552 (NASA CR OR TMX OR AD NUMBER)
(THRU)
1 (CODE)
13 (CATEGORY)
FACILITY FORM 602

NAS 7-100

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In an investigation of the mineralogical composition of the upper levels of podzolic soils of Northern Karelia it was found that biotite was transformed into opal. /585*

Among the minerals of these soils falling into the group with specific gravity <2.20 are the transparent isotropic lamellae of an opal material with an index of refraction of N = 1.458. The proof that these lamellae are nothing but transformed biotite is the presence of the sagenitic lattice with the characteristic intersection of the lines at a 60° angle both in opal lamellae (Fig. 1) and biotite lamellae which have not yet lost their original properties, as well as the presence of a number of transitional forms from biotite to opal.

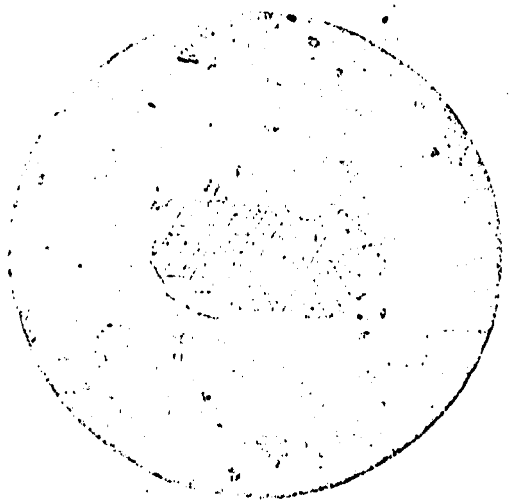

Figure 1. Opal Lamella with Sagenitic Network (Magnification 80).

In the rock underlying the soil -- granite -- the original biotite is olive green; its indices of refraction are N_g = = 1.665 - 1.669, N_p = 1.610; specific gravity is >2.75. In the soil the biotite suffers severe changes; the olive green lamellae are rarely encountered here -- their coloration changes to brownish yellow and they even become colorless. The specific gravity begins to vary -- in gravatational analysis of the soil, biotite falls within the groups whose specific gravity ranges from >2.75 to <2.20; the indices of refraction of biotite from the soil are always lower than those of the mineral from rock, and they become smaller as the specific gravity goes down: from N_g = 1.654 in the fractions of specific gravity 3 - 2.75 and to N_g = 1.458 in a fraction with specific gravity <2.20.

The decolorization of biotite, the reduction of its specific gravity, and the lowering of its index of refraction indicate that during the process of soil formation it loses iron for the most part, while its final conversion into opal also indicates the loss of all the elements comprising it except SiO_2 (and apparently part of the aluminum).

*Numbers in the margin indicate pagination in the original foreign text.

Further investigation made it clear that in many biotite lamellae with a specific gravity less than the original characteristic microorganisms like fungi have developed. Their hyphae, in growing, form solid columns consisting of rounded and somewhat elongated cells (Fig. 2) partially or completely covering the biotite lamella (Fig. 3). About 25 - 30% of the lamellae are populated by these columns.

The fact that microorganisms of this species here populate only biotite lamellae and are not encountered on others which do not contain iron (quartz, microcline, plagioclase) possible indicates a particular selective absorption of iron on their part. On the other hand, the fact that they are chiefly disseminated on biotite may be explained by the comparatively low stability of this metal, which makes it possible for microorganisms to extract from it the mineral nutritive elements which they require -- potassium above all.

The question of whether the loss of color by the biotite is caused by the direct absorption of iron by the microorganisms can be solved only by specific experimentation with the inoculation of a culture on different nutritive media. But their indirect effect is likewise not excluded: liberation of iron from the crystal lattice of the mineral may occur with destruction of the lattice in the process of absorption of other elements by the microorganisms. Under acid soil-formation conditions, the iron may dissolve and migrate with natural waters. In /586 both cases, however, there is no doubt that microorganisms participate in transformation of the mineral. The fact described serves as new material to supplement the familiar conclusions by B. B. Polynov as to the geological role of the organisms (1947, 1953). It is also of interest in that it indicates to us one more source for the accumulation of silica in the upper levels of podzolic soils in the form of opal as the residual product of mica breakdown.

Figure 2. Gungous Hyphae (Magnification 400).

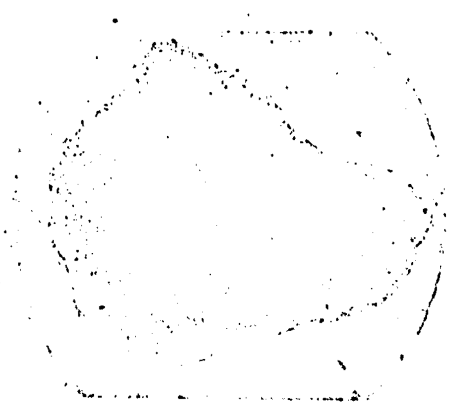

Figure 3. Biotite Lamella Completely Covered with Hyphae (Magnification 80).

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