Delhayelite, a new silicate from the Belgian Congo.

By TH. G. SAHAMA and KAI HYTÖNEN, M.A.

Institute of Geology, University of Helsinki, Finland.

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Summary. The complex kalsilite-bearing melilite-nephelinite from Mt. Shaheru in the Belgian Congo with götzenite, combeite, and kirschsteinite contains yet another new silicate for which the name *delhayelite* is proposed.

Delhayelite is orthorhombic with *a* 6·53, *b* 24·65, *c* 7·04 Å. Possible space-groups $Pmn2_1$ and $Pmmn$. Weak super-cell with doubled *a*-axis. Distinct cleavage parallel to (010). Birefringence weak. $\alpha \approx \beta \approx \gamma = 1{\cdot}532$. $2V_\alpha = 83°$. Optical orientation: $a = \alpha$, $b = \gamma$, $c = \beta$. Sp. gr. 2·60. Chemical composition corresponds to the tentative formula $(Na,K)_4Ca_5Al_6Si_{32}O_{80}.18H_2O.3(Na_2,K_2)(Cl_2,F_2,SO_4)$.

FROM a complex kalsilite-bearing melilite-nephelinite lava from Mt. Shaheru, Nyiragongo area, North Kivu in the Belgian Congo, three new silicates have been described by Sahama and Hytönen (1957 *a* and *b*), viz götzenite, combeite, and kirschsteinite. Further petrographic data for the rock have been given by Sahama and Meyer (1958). The same rock specimen, numbered S. 80, still contained a constituent the microscopic identification of which could not be made. This mineral, which occurs in the rock in very minute amounts, was studied by optical and X-ray methods as well as chemically. The data obtained were not consistent with those for any known species. For that reason the mineral was temporarily put aside.

Recently, however, Mountain (1957) and Gard and Taylor (1957) published descriptions of a new mineral from the Bultfontein mine, Kimberley, which they named rhodesite. A comparison of the data for rhodesite with those for the Shaheru mineral discloses the fact that, though representing distinctly different species, the two minerals are closely related to each other. It therefore seems pertinent to give a description of the Shaheru mineral, for which the name delhayelite is proposed. This name is after the Belgian geologist F. Delhaye, a pioneer in the geological exploration of the North Kivu area.

Delhayelite occurs in the rock as elongated crystals the shape of which is not fibrous but platy as is schematically indicated in fig. 1. The axis of elongation was taken as the *c*-axis. Rotation and Weissenberg photographs about all three crystallographic axes proved the mineral to be orthorhombic with a primitive cell. The following conditions limiting possible reflections were found: *h*00, *h*0*l*, and *hk*0 with no restrictions; 0*k*0 with $k = 2n$; 00*l* with $l = 2n$; 0*kl* with $k+l = 2n$. Possible space-groups are $Pmn2_1$ and $Pmmn$. Unit-cell dimensions are: *a* 6·53±0·03 Å.; *b* 24·65±0·2 Å.; *c* 7·04±0·03 Å. This cell is, however, only a sub-cell. The *a*-axis rotation photograph shows extremely weak layer-lines that correspond to a doubled *a*-axis, viz *a* 13·05±0·06 Å. A doubling of the *c*-axis could not be seen but is possible. The true cell might be non-primitive as found for rhodesite by Gard and Taylor (op. cit.). The extra reflections defining this larger true cell are too weak for establishing the true space-group. An electron microscope not being available to the authors, the electron diffraction method could not be used for closer characterization of the superlattice.

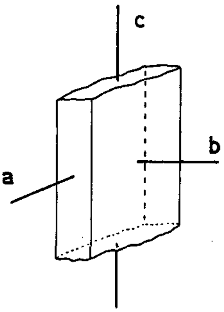

FIG. 1. Schematical shape of the delhayelite crystals.

The powder data of delhayelite, recorded with the Philips Norelco diffractometer, are reproduced in table I. The indexing was based on the dimensions of the super-cell given above.

TABLE I. Powder data of delhayelite. Filtered copper radiation.

hkl.	*I.*	2*Θ*.	*d.*	$Q_{\text{obs.}}$	$Q_{\text{calc.}}$
020	35	7·18	12·301	0·0066	0·0066
040	25	14·37	6·1584	0·0264	0·0264
300	1	20·395	4·3506	0·0528	0·0528
260	10	25·56	3·4820	0·0825	0·0828
102	3	26·13	3·4074	0·0861	0·0865
400	3	27·32	3·2616	0·0940	0·0939
080	100	28·985	3·0779	0·1056	0·1056
401	5	30·16	2·9606	0·1141	0·1141
280	5	32·08	2·7876	0·1287	0·1290
004	5	51·915	1·7597	0·3229	0·3227
0.14.0					0·3234
024	3	52·47	1·7424	0·3294	0·3293
0.16.0	5	60·015	1·5401	0·4216	0·4224

The mineral is colourless. In thin section it shows a somewhat wavy extinction with very low interference colours, abnormally bluish grey in sections perpendicular to the *b*-axis. Birefringence 0·002–0·003. $\alpha \approx \beta \approx \gamma = 1{\cdot}532 \pm 0{\cdot}002$. Optically negative. $2V_\alpha = 83° \pm 3°$. The optical orientation was determined with the Berek compensator on a crystal mounted on the goniometer head of the Weissenberg camera. Comparison of optical tests and rotation photographs results in the following relationship between the axes of the unit-cell and of the optical indicatrix: $a = \alpha$, $b = \gamma$, $c = \beta$. Very distinct cleavage parallel to (010).

The separation of the mineral for chemical analysis was rather difficult. In the course of the heavy liquid separation the specific gravity of delhayelite proved to be 2·60±0·03. This value is virtually identical with the specific gravity of kalsilite and only slightly lower than that of nepheline. Both these minerals are present in the rock in amounts greatly exceeding that of the delhayelite. By repeated centrifuging in bromoform and in Clerici solution the main part of the nepheline could be removed. Kalsilite and delhayelite, on the other hand, could not be separated from each other in that way. Both these minerals are easily soluble in diluted hydrochloric acid as well as in strong acetic acid. It was found, however, that the solubility of delhayelite is slightly less in diluted warm acetic acid than that of kalsilite. A treatment of the material with very dilute warm acetic acid dissolved the kalsilite grains and left delhayelite only very slightly attacked. In the analysed material no kalsilite could be detected under the microscope nor by powder pattern. A grain count indicated a contamination of 2 % admixed nepheline that had remained unattacked by the acid treatment. Owing to the small amount of delhayelite available, a pycnometric specific gravity determination could not be made.

TABLE II. Chemical composition of delhayelite.

SiO_2	52·60	CaO	7·99	F	0·33
TiO_2	0·09	Na_2O	3·20	SO_3	1·31
Al_2O_3	9·22	K_2O	9·27		101·02
Fe_2O_3*	2·72	H_2O+	5·93	Less O for F and Cl	1·01
MnO	0·07	H_2O-	3·35		
MgO	1·03	Cl	3·91	Total	100·01

* Total iron.

Table II presents the result of the chemical analysis, corrected for the nepheline admixture. The purity of the analysed material was rather low. Except for nepheline, the impurities mainly consist of pigment, which for a large part represents alteration products of delhayelite. Owing to the relatively low purity of the material and the fact that it was slightly attacked by the acid, the analysis may give only an approximate idea of the composition of the mineral. A new analysis of pure and fresh material is highly desirable.

The scarcity of the material did not permit a differential thermal analysis. The high proportion of total water as H_2O- is noteworthy. Because of the relatively low purity of the analysed material, an accurate calculation of the unit-cell content cannot be given. For the super-cell with the dimensions mentioned above, the analysis yields the following provisional approximation: $(Na,K)_4Ca_5Al_6Si_{32}O_{80}.18H_2O.3(Na_2,K_2)(Cl_2,F_2,SO_4)$.

If *a*- and *b*-axes are interchanged, the unit-cell dimensions for delhayelite become very similar to those for rhodesite. Both minerals have the same cleavage. In optical properties, however, they differ very distinctly from each other. The chemical composition of delhayelite also differs from that of rhodesite, delhayelite containing Al and, in addition, Cl, F, and SO_4.

The properties of delhayelite given above are not consistent with any previously known species. The mineral is found in a holocrystalline lava for which the crystallization occurred in presence of volcanic gases. This mode of occurrence apparently explains the incorporation of Cl, F, and SO_4 in the structure of the mineral.

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