ABSTRACT
Examination of specimens from the type locality (Vashegy, now Železník, Czechoslovakia) and two other occurrences shows that vashegyite is an orthorhombic sheet phosphate with variable properties. This mineral is biaxial negative, \(2V = 67-74^\circ\), \(\alpha = 1.470-1.479\), \(\beta = 1.477-1.488\), \(\gamma = 1.482-1.490\); \(X = c, Y = b, Z = a\). Its ideal composition corresponds to \(\text{Al}_1(\text{PO}_4)(\text{OH})_6 \cdot 38\text{H}_2\text{O}\) (type locality) and \(\text{Al}_6(\text{PO}_4)(\text{OH})_3 \cdot 23\text{H}_2\text{O}\) (Chvaletice, Czechoslovakia). The main dehydration occurs between 140 and 190°C (DTA). Some dehydration curves show two maxima, and recrystallization to \(\text{AlPO}_4\) is observed in the form of an exothermic peak at 860°C. Loss-of-weight curves indicate that OH groups are expelled immediately before recrystallization. Infrared-absorption spectra resemble those of variscite. Unit-cell dimensions vary with water content; for the specimen from Chvaletice (air dried; Weissenberg and powder photographs), \(a = 10.754(3), b = 14.971(5), c = 22.675(6)\) Å, space group \(Pnam\) or \(Pna_2_1\), \(Z = 4\), \(\rho_{\text{calc}} 2.005, \rho_{\text{meas}} 1.994(2)\) g/cm\(^3\). For the specimen from Železník (Vashegy), \(a = 10.773(3), b = 14.971(5), c = 20.626(6)\) Å, \(Z = 2\), \(\rho_{\text{calc}} 1.934, \rho_{\text{meas}} 1.930(1)\) g/cm\(^3\). Under vacuum, the \(c\) parameter becomes 19.0(1) Å. Differences in stacking, possibly irregular, are deemed responsible for the observed variations of properties. The sheet structure is indicated by Weissenberg photographs and the flaky habit accompanied by perfect (001) cleavage visible in SEM. A polytypoid relationship for the varieties is suggested; sasaite and vashegyite are possibly identical phases.

Keywords: vashegyite, sheet Al phosphate, crystallography, thermal analysis, optical properties, polytypoids, sasaite, Chvaletice, Železník(Vashegy), Czechoslovakia.

INTRODUCTION
The mineral vashegyite was discovered by Zimanyi (1909) in the oxidation zone of the siderite-ankerite deposit at Vashegy, Hungary (now Železník in Czechoslovakia). The original description of this mineral is limited to some data on physical properties and a chemical analysis carried out by J. Loczka. Additional data on vashegyite from the type locality were published by Ulrich (1922), who noticed that the mineral is predominantly isotropic under the microscope and hence probably amorphous, although it displays incipient crystallization in places. Ulrich, in the same paper, also mentioned a new occurrence of vashegyite at Chvaletice, Czechoslovakia.

Koč & Sarudi (1963) examined vashegyite from Železník by electron microscopy and performed chemical analyses; they postulated that the mineral is amorphous despite the appearance of their
electron micrographs, which indicate stacks of parallel units separated, possibly, by cleavage traces. This discrepancy was also observed by McConnell (1974). An X-ray-diffraction or electron-diffraction study was not attempted by Koch & Sarudi (1963). These authors also proposed to attribute the name vashegyite to an Al-phosphate accompanying vashegyite, noted already by Zimanyi (1909), arguing that the analyses of this mineral gave more congruent results. This mineral had been determined by Ulrich (1922) as wavellite on the basis of a microscopic study. Koch & Sarudi (1963) ascribed the formula \( \text{Al}_3(\text{PO}_4)_3\cdot\text{AlO} \cdot \text{OH} \cdot 12\text{H}_2\text{O} \) to this mineral, which is rather unusual and hardly warranted because their chemical data correspond without much difficulty to \( \text{Al}_3(\text{PO}_4)_3\cdot6\text{H}_2\text{O}, \) i.e., to the formula of wavellite as given by Fu (1966). This formula, which has one molecule of water more than normally reported for wavellite, is not unfounded, in view of the chemical composition of some wavellite samples (Bouška & Povondra 1969). Thus it appears that Ulrich's identification of the mineral is correct, even if it is impossible to confirm at this stage. In any case, the suggestion of Koch & Sarudi has to be rejected.

In an attempt to demonstrate the existence of sheet phosphates, McConnell (1974) studied vashegyite by X-ray powder diffraction using a specimen from the British Museum of Natural History. His X-ray powder-diffraction data differ somewhat from the first powder pattern of vashegyite produced by the British Museum and available in the powder-diffraction file since 1944 (PDF 2-0040). Assuming a crystal structure analogous to that of kaolinite, McConnell succeeded in indexing the powder pattern of vashegyite using a large orthorhombic cell. However, it has to be pointed out that some of McConnell's speculations are founded on the data of Koch & Sarudi, and in particular on the chemical formula for their "vashegyite" (which is, in fact, wavellite, as mentioned above).

The examination of vashegyite presented in this paper arose from an X-ray-diffraction analysis of this mineral from Chvaletice (Ulrich 1922, Slavík 1928), during which it was realized that the present state of knowledge of this mineral clearly is inadequate.

**SAMPLES STUDIED**

The following specimens were used in this investigation: (1) Vashegy (Zeleznik), Czechoslovakia: British Museum of Natural History (BMNH), London (specimen 1910, 101). This specimen, sent to the Museum by Zimanyi, can be considered a cototype; the type specimen was destroyed in Budapest in 1956. (2) Zeleznik, Czechoslovakia: mineral collection of the Department of Mineralogy and Crystallography, Charles University, Prague, Czechoslovakia (DMUC, specimen 10188). (3) Zeleznik, Czechoslovakia: mineral collection of F. Souček, Prague. (4) Vashegy (Zeleznik), Czechoslovakia: mineral collection of Ecole Nationale Supérieure des Mines, Paris (ENSMP, specimen 18544). (5) Fish Creek Range, Nevada, U.S.A.: mineral collection of Ecole Nationale Supérieure des Mines, Paris (ENSMP, specimen 18916). (6) Chvaletice, Czechoslovakia: private collection of P. Povondra.

X-ray examination showed that specimen 18544 is amorphous to X rays. Other specimens gave X-ray powder-diffraction patterns of different quality consistent with their respective degree of crystallinity; after a preliminary examination, our attention was thus focused on a detailed study of specimens BMNH 1910, 101, DMUC 10188 and vashegyite from Chvaletice.

**PHYSICAL PROPERTIES**

In Zeleznik (Vashegy), vashegyite always occurs as chalky white polycrystalline aggregates filling cavities in a limonitic boxwork. It is often associated with variscite. The specimen from Chvaletice occurs in the form of small, millimetre-sized, pale greenish white crystals arranged in hemispheric aggregates with radial structure. The crystals possess a perfect basal cleavage. The homogeneity of the specimens BMNH 1910, 101 and DMUC 10188 was checked by selected-area electron diffraction: a hexagonal phase with \( a = 9.2 \) Å and rare irregular particles giving a strong diffraction maximum at 3.5 Å, were revealed as impurities. The hexagonal phase was attributed to a mineral of the apatite group, whereas the second phase was tentatively identified as a member of the smectite group. Under the microscope, we observed tiny particles of iron hydroxide finely dispersed on cleavage planes of vashegyite, particularly in specimen DMUC 10188. The specific gravity was measured several times by degassing specimens immersed in carbon tetrachloride in a vacuum and then weighing them in carbon tetrachloride. The results are as follows: BMNH 1910, 101: 1.930(1), DMUC 10188: 1.980(1), Chvaletice: 1.994(2).

Whereas specimens BMNH 1910, 101 and Chvaletice are very pure, specimen DMUC 10188 contains 2 wt.% FeOOH and 0.6 wt.% apatite (Table 1). After subtracting the density of these impurities (\( \rho \) of goethite 4.3, \( \rho \) of apatite 3.09 g/cm\(^3\)), the value for DMUC 10188 becomes 1.926, which is very close to the value for BMNH 1910, 101. A similar correction can be applied to the value 1.964 g/cm\(^3\) measured on the type specimen by Zimanyi (1909), as the chemical composition in his paper indicates the presence of 1.32 wt.% FeOOH. The corrected value is 1.933 g/cm\(^3\). We can therefore con-
include that the specific gravity of vashegyite from the
type locality is 1.93, a value that is lower than the
specific gravity of the specimen from Chvaletice.

Under the microscope, in transmitted light,
vashegyite is colorless, and its crystals are generally
so small that the determination of optical proper-
ties is impossible in most cases. Optical determina-
tions were only carried out on specimen DMUC 10188
and the one from Chvaletice. Lozenge-shaped
platy crystals flattened along the basal plane display
straight extinction. The indices of refraction in γ _{Na}
are given in Table 2. A larger range in error for
specimen DMUC 10188 is due to the small crystals;
it is of the same order as is the error of the measure-
ment of α, carried out on sections along (010) or
(100) rendered extremely thin by the (001) cleavage,
upon the specimen from Chvaletice.

Vashegyite is biaxial negative, X = c, Y = b, Z
= a. The axial plane is parallel to (010). The optical
orientation is represented in Figure 1.

### CHEMICAL DATA

After dissolving purified specimens used for the
specific gravity determination (200 to 400 mg) in
0.6M HCl and separating cations from anions by an
ion-exchange resin, Al was determined by
chelometric titration, Fe by photometry, Ca by
atomic absorption; P_2O_5 and H_2O were done by
gravimetric analyses. The results of chemical analyses
of the three selected specimens are given in Table 1.

For vashegyite from Chvaletice, the most probable
elementary formula that can be derived from these data (on
the basis of 11(Al + Fe + P)) is (Al_5.956Fe_3.047
P_2O_5.027(OH))_2.838H_2O, which is very close to
Al_8(P_2O_5)_3(OH)_23H_2O. This formula is in good
agreement with unit-cell dimensions (Table 2) and
the measured specific gravity. The calculated specific
gravity for Z = 4 is 2.005, compared with the
measured value of 1.994. For vashegyite from Zeležnık,
the formulae calculated on the same basis are:

\[
\text{Al}_6(\text{PO}_4)_{3.042}(\text{OH})_{1.378}2.37\text{H}_2\text{O}
\]

and

\[
\text{Al}_6.027(\text{PO}_4)_{3.042}(\text{OH})_{1.373}2.37\text{H}_2\text{O}
\]

for specimens BMNH 1910, 101 and DMUC 10188, respectively.
Unfortunately, for Z = 4 and the unit-cell dimen-
sions of Table 2, the calculated densities are 2.136
(BMNH 1910, 101) and 2.095 g/cm^3 (DMUC
10188). These values disagree with the measured den-
sity, which is close to 1.930 g/cm^3.

For a 6:5 ratio of Al and P, the closest agreement
is obtained for the formula A_16(PO_4)_{3.130}2.37H_2O,
which leads to a \( \rho_{calc} \) of 1.948 g/cm^3. Not only is
this value far from the measured value but the
theoretical chemical composition corresponding to
this formula (Al_6O_3 31.34, P_2O_5 36.36, H_2O 32.30
wt.%) is also vastly different from the actual com-
position (Table 1). The difference is so great that it
cannot be accepted unless we postulate in the
specimens the presence of a great quantity of an
amorphous phosphate having the same Al/P ratio
and a higher water content than vashegyite. The
amount of this substance, then, should be constant
in all specimens investigated, which is obviously an
tenable proposition.

On the basis of 20(Al + Fe + P), the formulae be-
come (Al_10.009Fe_3.007(PO_4)_{6.904}(OH))_{6.576}37.51H_2O,
Al_10.958(PO_4)_{6.042}(OH)_{5.746}37.02H_2O and, ideally,
Al_16(PO_4)_{3.373}37.38H_2O. Then, assuming Z =
2 and \( V = 3326.6 \text{ A}^3 \) (Table 2), the calculated den-
sity for the ideal formula with 38H_2O, as above, is

### TABLE 1. CHEMICAL COMPOSITION OF VASHEGYITE SPECIMENS

<table>
<thead>
<tr>
<th>Specimen Chvaletice</th>
<th>BMNH 1910, 101</th>
<th>DMUC 10188</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al_2O_3</td>
<td>27.09</td>
<td>5.956</td>
</tr>
<tr>
<td>Fe_2O_3</td>
<td>0.12</td>
<td>0.017</td>
</tr>
<tr>
<td>CaO</td>
<td>0.72</td>
<td>0.017</td>
</tr>
<tr>
<td>P_2O_5</td>
<td>31.83</td>
<td>5.027</td>
</tr>
<tr>
<td>H_2O</td>
<td>40.01</td>
<td>49.787*</td>
</tr>
<tr>
<td>insol.</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99.55</td>
<td>99.20</td>
</tr>
</tbody>
</table>

1 wt.% (P. Vovk, analyst); 2. after subtracting CaO and P_2O_5 of apatite and Fe_2O_3
of goethite; recalculated to 100%; 3. number of atoms calculated on the basis of
11(Al + Fe + P); 4. number of atoms calculated on the basis of 20(Al + Fe + P);*expressed as
OH.

### TABLE 2. UNIT-CELL DATA AND OPTICAL PROPERTIES OF VASHEGYITE

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>10.754(3)</td>
<td>10.764(3)</td>
<td>10.773(3)</td>
<td>10.757(3)</td>
</tr>
<tr>
<td>γ</td>
<td>22.652(6)</td>
<td>20.526(6)</td>
<td>20.626 (6)</td>
<td>20.604(6)</td>
</tr>
<tr>
<td>V (Å³)</td>
<td>3650.6</td>
<td>3303.9</td>
<td>3326.6</td>
<td>3322.6</td>
</tr>
<tr>
<td>sp.gr.</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Z</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>( ρ_{calc} )</td>
<td>2.005</td>
<td>1.948</td>
<td>1.934</td>
<td>1.937</td>
</tr>
</tbody>
</table>

### TABLE 3. UNIT-CELL DATA AND OPTICAL PROPERTIES OF VASHEGYITE

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>10.725(3)</td>
<td>10.814(3)</td>
<td>10.762(3)</td>
<td>10.726(3)</td>
</tr>
<tr>
<td>γ</td>
<td>19.038(6)</td>
<td>19.136(6)</td>
<td>18.931(6)</td>
<td>18.931(6)</td>
</tr>
<tr>
<td>V (Å³)</td>
<td>3060.0</td>
<td>3095.6</td>
<td>3049.5</td>
<td></td>
</tr>
<tr>
<td>α</td>
<td>1.470(8)</td>
<td>1.479(8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>1.477(2)</td>
<td>1.489(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>γ</td>
<td>1.490(5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V= α+ β+ γ</td>
<td>3.016</td>
<td>0.011</td>
<td>74.85*</td>
<td>67.55*</td>
</tr>
</tbody>
</table>
1.935 g/cm³ (1.926 for 37.5H₂O), which is in very good agreement with the measured value. For the specimen from Chvaletice the calculation carried out on the basis of 20(Al + Fe + P) gives

\[(Al_{10.829}Fe^{3+}_{0.03})\cdot(PO_4)_{9.140}(OH)_{5.160}\cdot42.68H_2O\]

which, if one assumes the ideal formula

\[Al_{11}(PO_4)_{9}(OH)_{4}H_2O\]

yields a \(\rho_{calc}\) of 1.844 g/cm³. This value is completely incompatible with the measured value.

All this indicates that the chemical compositions of vashegyite from Chvaletice and from Železník are very close but not identical. This discrepancy can be explained on the basis of an X-ray study, as is shown later.

The comparison of physical specific refractivity \(K_r\) for specimens DMUC 10188 and Chvaletice with their chemical specific refractivity \(K_C\), calculated using 0.195 (Al₂O₃), 0.183 (P₂O₅) and 0.340 (H₂O) as Gladstone–Dale constants (Mandarino 1981), gives a compatibility index \(1-(K_r/K_C)\) of 0.033 and 0.032, respectively, in the “excellent” category of compatibility on the scale proposed by Mandarino (1979).

**THERMAL ANALYSIS**

All three specimens were analyzed by differential thermal analysis, and the resulting curves are presented in Figure 2. The specimen BMNH 1910, 101 was available only in very small quantity, and the thermal analysis was thus carried out in a micro-DTA apparatus using 10 mg of the sample. This explains a somewhat different format of the curve A in comparison with the other curves, which were obtained with a conventional device (Erdey, Paullik & Paullik derivatograph). All three curves are simple and similar to curves of other hydrated aluminum phosphates such as variscite, wavellite and evansite Čech & Slansky 1965, Ivanova et al. 1974; all display one large endothermic reaction in the low-temperature range. This reaction starts almost immediately after the temperature begins to rise during heating and stops between 300 and 350°C. The peak temperature varies from 150°C (BMNH 1910, 101) to 190°C (DMUC 10188). The specimen from Chvaletice shows two maxima, one at 140°C and the other at 170°C (curve D). These maxima are well resolved on the differential thermogravimetric curve (E) of the specimen. A similar feature is also poorly distinguishable on the differential thermogravimetric curve of specimen DMUC 10188 (C).

The endothermic reaction signifies the removal of water molecules from the specimens. This loss of water may occur in two stages, most of the water being expelled at the higher temperature. Another feature is an exothermic maximum at 860°C clearly visible on curve D (Chvaletice) and absent on the other curves. This effect, when taking into consideration the differential thermogravimetric (E) and thermogravimetric (not illustrated) curves, appears to correspond to two reactions: the expulsion of OH groups and the simultaneous recrystallization producing AlPO₄, which has the tridymite structure. The escape of OH groups is accompanied by a loss of 2.8% (by weight), which is in good agreement with the theoretical value (2.45 wt.%) calculated from the
chemical formula (Table 1). The formation of AlPO$_4$ was established by X-ray powder diffraction.

**INFRARED ABSORPTION SPECTRA**

Owing to a lack of material, only two specimens were analyzed, BMNH 1910, 101 and Chvaletice. The infrared absorption curves (Fig. 3) were obtained with a Beckmann spectrometer using 0.1 wt.% of sample in a KBr pellet. The interpretation of the absorption spectra is given in Table 3. The assignments are based on the data of several authors, compiled by Ross (1974). It is apparent from Figure 3 and

![Fig. 2. Results of thermal analyses of vashegyite. A. DTA analysis of the specimen BMNH 1910, 101 (Zelezník), B. DTA analysis of the specimen DMUC 10188 (Zelezník), C. differential thermogravimetric analysis of the same specimen, D. DTA of the specimen from Chvaletice, and E. differential thermogravimetric analysis of the same specimen.](image-url)
Table 3 that the specimens produce almost identical spectra, which resemble those of other Al phosphates such as variscite (Čech & Slansky 1965).

Crystallography

Scanning-electron-microscope (SEM) examination of vashegyite from Železník reveals that its microcrystalline aggregates consist of almost euhedral crystals flattened on (001) and showing \{110\}, \{010\} and \{001\} as the most prominent forms (Fig. 4a, b). Two different habits were distinguished on the sample from Chvaletice (Fig. 4c, d). The first, typical of microcrystalline aggregates, is characterized by diamond-shaped crystals, with \{110\} as the most prominent form (Fig. 4c). The second habit shows the combination of \{110\} with \{010\} very prominent, leading to crystals having \{100\} elongate (Fig. 4d). This axis is the radius direction of radiating aggregates whose surface exhibits \{110\} as the atypical form. Simple twins (100) were rarely observed.

The size of vashegyite flakes from Chvaletice made it possible to use single-crystal techniques. By carefully positioning a fragment of vashegyite in a Weissenberg camera, zero-, first- and second-level photographs were obtained using Ni-filtered Cu radiation. An orthorhombic unit-cell was obtained despite the poor quality of diffraction diagrams caused by the deformation of cleavage planes (Fig. 4d). The parameters of this unit cell were refined by the least-squares method using powder-diffraction data from a 76.4-mm-diameter Debye–Scherrer camera (Table 2). The following systematic extinctions were observed: \(0k\ell: k + \ell = 2n\); \(h0\ell: h = 2n\); \(h00: h = 2n\); \(0k0: k = 2n\); \(00l: l = 2n\), corresponding to space groups \(Pnam\) or \(Pna2_1\). The \(hk0\) reflections with \(h + k = 2n + 1\) are very weak and appear only on strongly overexposed photographs. The distribution of intensities on 0- and 2-level photographs is identical.

Another single-crystal approach was electron diffraction. Selected-area diffraction on vashegyite flakes from Chvaletice and Železník with the beam direction parallel to \{001\} gave identical results. The electron-diffraction pattern \(a*b*\) shows, in accordance with the intensities observed on the Weissenberg photographs, only \(hk0\) reflections with

![Fig. 3. Infrared absorption spectra of vashegyite. A. Železník BMNH 1910, 101, B. Chvaletice.](image-url)
Fig. 4. Scanning electron photomicrographs of vashegyite crystals. a and b. Železník, collection of F. Souček; c. diamond-shaped crystals with \{110\} as the most prominent form, Chvaletice; d. macroscopic crystals elongated along \{100\}; Chvaletice, collection of P. Povondra.
The specimen from Chaletica has a larger unit-cell than the three specimens from Železnik (Vashegy). Whereas the \(a\) and \(b\) parameters remain identical, the value of \(c\) of the Chaletica specimen is about 10% larger which, in turn, is partly commensurate with the increased water content of this specimen (Table 1). The unit-cell parameters obtained by least-squares refinement are listed in Table 2. The agreement between measured and calculated spacings is good, although not as good, perhaps, as in the case of better crystallized minerals.

X-ray-powder patterns (76.4 mm camera) of specimens from Železnik are nearly identical (Table 4). The presence or absence of a few weak lines may be explained by variations in the crystallinity of material. However, X-ray-powder patterns of vashegyite from Chaletica and from Železnik (Table 4) reveal noticeable differences in intensities of several lines, particularly in the low-angle region. Besides the \(h\)0 and 00\(l\) having the same intensities in all powder patterns considered, three lines (underlined) with forbidden indices in space groups \(Pnma\) and \(Pna2_1\) (00\(l\): \(k = l + 1 = 2n + 1\); \(h\)0\(l\): \(2n + 1\)) appear in the powder patterns of vashegyite from Železnik. One of these lines, with \(d = 7.04\) \(Å\), is very strong. On the other hand, the strong 022 diffraction line with \(d = 6.26\) \(Å\) in the powder pattern of vashegyite from Chaletica is systematically missing in the X-ray powder diagrams of specimens.
from Zeleznik. These differences in X-ray powder diagrams indicate that vashegyite from Chvaletice and from Zeleznik (Vashegy) have different space-groups.

Furthermore, there are noticeable variations in the powder patterns of the specimens from Zeleznik, as revealed on powder photographs taken in a Guinier-de Wolff camera (Table 5). Of these, the most significant is the presence of reflections 001 and 100 on the powder pattern of specimen DMUC 10188, and the presence of reflection 010 on the powder pattern of specimen BMNH 1910, 101. This indicates changes in the symmetry of the unit cell, probably due to the irregular stacking of individual sheets. Whether this is the result of the generally poorly crystalline nature of the mineral or the consequence of a partial dehydration of the specimens in the vacuum of the Guinier camera is difficult to decide. In any case, this type of disorder leads to lowering of the symmetry of the unit cell and to an inconsistency in the assignment of a space group from one sample to another.

**DISCUSSION**

Our investigation shows that the specimens of vashegyite selected for study are a hydrated Al phosphate having a sheet structure. This type of structure is indicated by the distribution of intensities on Weissenberg photographs and by the flaky habit and perfect cleavage of crystals as seen in the SEM (Fig. 4). Thus the layer structure postulated for this mineral by McConnell (1974) is confirmed. However, no evidence has been found for his analogy with the crystal structure of kaolinite.

Vashegyite is orthorhombic; specimens show a variability in chemical composition that is related to variation in crystal structure. This is demonstrated by some differences in X-ray powder-diffraction patterns; a different space-group symmetry appears to be involved. The most probable reason for the variations is a somewhat different, possibly irregular manner of stacking the structural sheets in each specimen. Thus, among the hydrous Al phosphates examined, there exists a group of chemically and structurally similar phases which, for now, are best designated as vashegyite. Future research may show that the mutual relationship between the varieties of vashegyite is that of polytypoids as defined by Bailey et al. (1978).

A probable member of this group is the mineral sasaite described from West Driefontein Cave, Transvaal, South Africa by Martini (1978). This mineral has a chemical composition very similar to vashegyite, but with a much higher water content. Its chemical formula, given by Martini (1978) as (Al,Fe³⁺)₇₋₈(P₄O₁₃)(SO₄)(OH)·3.5·H₂O, can be rewritten, by analogy to vashegyite from Chvaletice, as (Al,Fe)₇₋₈(SO₄)₅(P₄O₁₃)(OH)·3.5·H₂O or, more simply, (Al,Fe)₇₋₈(P₄O₁₃)(SO₄)(OH)·3.5·H₂O.

Martini’s unit cell (hydrated form of sasaite) obviously is related to the unit cell of vashegyite in the following manner: a/2ₚₛₚ = a₁/νₚₛₚ, b/2ₚₛₚ = b₁/νₚₛₚ; c/2ₚₛₚ = c₁/νₚₛₚ or 21.5/2 = 10.75; 30.04/2 = 15.02; 92.06/4 = 23.015. In Table 5, it can be seen that divided values of parameters of sasaite are extremely close to those of vashegyite from Chvaletice. In indexing the powder data for hydrated sasaite, the best fit was obtained with: a 10.75, b 15.02 and c 46.03 Å (Table 6). These parameters give twice the volume of the unit cell of vashegyite and, with Z = 6, give a calculated density of 1.780 g/cm³. This value can be considered in fair agreement with the value of 1.75 determined by Martini (1978), taking into consideration the ease with which this mineral loses water. The calculated density given by Martini, 1.747 g/cm³, is inconsistent with his Z value, which should obviously be doubled. Twenty formula units with 83H₂O per unit cell do not seem to be a probable suggestion. This, and the similarity with vashegyite, casts doubt on the validity of sasaite. However, without investigating the type material, a final decision as to the recommendation for the removal of sasaite from the list of valid mineral species cannot be reached.

**TABLE 6. X-RAY DATA OF HYDRATED SASAITE (MARTINI 1978)**

<table>
<thead>
<tr>
<th>hkl</th>
<th>d meas</th>
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REFERENCES


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