Forrat (1957) for the rare-earth aluminum garnets. An explanation of the shape of the curve is given by Espinosa (1962).

The growth habit of YbAlG was examined by optical goniometry. All the growth faces were found to be of the dodecahedron [110] and trapezohedron [112] types. The crystal is similar in appearance to Fig. 135 by Ford (1958).

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NEW ANALYSIS OF GENTH'S VOLBORTHITE[1]

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Genth's Analyses of Volborthite

In 1877 Genth published a paper giving the results of his analysis of volborthite from Woskressenskoi, Perm, U.S.S.R. Genth recognized his analyses as very imperfect, because in the material he worked with volborthite occurred as a crystalline coating on the grains and pebbles, and in the cavities of an argillaceous conglomerate. He found it impossible to pick out the volborthite, so crushed the whole mass to separate the grains of the conglomerate. The material was then treated with very dilute nitric acid. He does not specify the strength of acid used nor the duration or temperature of treatment. The insoluble matter, which amounted to more than 80 per cent of the sample treated, was filtered off, and the solution was analyzed. After such a treatment of an argillaceous

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[1] Publication authorized by the Director, U. S. Geological Survey.

conglomerate, the acid solution would contain not only dissolved volborthite, but also constituents of clay minerals and of any other mineral present that is susceptible to attack by nitric acid. Genth recognized this, and assuming that the SiO_2,Al_2O_3,Fe_2O_3,MgO, and some of the water (obtained by difference) did not belong in volborthite, included in his paper adjusted values for the constituents of volborthite. Genth's analysis of the acid solution, and his adjusted values for the constituents of volborthite, are given in Table 1.

Analyses of the impure solutions, and, in addition, adjusted values based on deduction of only the SiO_2,Al_2O_3, and Fe_2O_3, are given in the 6th edition of Dana's System of Mineralogy (1892, p. 838); Genth's own adjustment of the values for volborthite, based on deduction of SiO_2, Al_2O_3,Fe_2O_3,MgO, and part of the H_2O, are not given. Dana's recalculations are also given in Table 1.

Table 1. Analyses of Volborthite from Woskressenskoi, Perm, U.S.S.R.

	Genth's solutions			Dana's recalculations 6th ed.		New analysis by Foster.	
	1	2	as adjusted by Genth	1	2		adjusted
V_2O_5	13.62	13.59	19.63	14.74	14.55	34.1	35.1
CuO	34.04	38.01	38.41	36.84	40.70	39.7	40.9
CaO	4.29	4.49	6.77	4.64	4.80	—	
BaO	4.29	4.30	6.17	4.64	4.60	5.5	5.7
MgO	3.01	1.42	—	3.26	1.52	—	—
SiO_2	1.38	1.36	—	—	—	—	—
Al_2O_3	4.45	4.78	—	—	—	2.6	—
Fe_2O_3	1.77	.45	—	—	—	.3	—
H_2O (by diff)	33.15	31.60	29.02	35.88	33.83	14.0[1]	14.4
Total	100.00	100.00	100.00	100.00	100.00	96.2	96.1
Insol.	81.49	88.43				3.8	

[1] Loss on ignition.

The 7th edition of Dana's System of Mineralogy (1951, p. 819) includes an analysis of one of Genth's solutions, but does not give either Genth's adjusted values for volborthite, or those given in Dana's 6th edition.

Thus, ever since the publication of Genth's paper in 1877, no consideration has been given to Genth's adjusted values for the constituents of volborthite, although his analyses of the impure acid solution have been published repeatedly. These analyses indicated a unique composition for volborthite from Perm, U.S.S.R., differing from all other volborthites in its 2:1 CuO:V_2O_5 ratio and in its very high water content.

New Analyses of Genth's Volborthite

Through the kindness of the late Professor William M. Meyers of the School of Mineral Industries, the Pennsylvania State University, we were able to obtain about 6 grams of Genth's original material. This material, possibly Genth's rejects, consisted of rock with sparsely disseminated volborthite. The rock was crushed to pass 100 mesh, the dust washed out, and the heavier volborthite was concentrated by the use of methylene iodide. The volborthite imparted a yellow-green color (like epidote) to the ground sample, which was especially noticeable in the suspended powder. Repeated separations yielded a 64-milligram concentrate of volborthite. Forty milligrams of this concentrate was digested in 1–2 H_2SO_4 on the steam bath over night. After filtration the insoluble matter was found to amount to 4.7 milligrams, of which 3.2 milligrams consisted of $BaSO_4$, the barium of which came from the volborthite. Thus the insoluble matter extraneous to volborthite amounted to only 1.5 milligrams.

The partial analysis of the solution, and including BaO equivalent to the $BaSO_4$ found in the insoluble matter, is shown in Table 1. Ca was not determined, as it was considered more important to use the small quantity of sample available (representing 38.5 milligrams of the concentrate) for the determination of V_2O_5 and CuO.

A spectrographic analysis of the concentrated sample by A. Tennyson Myers, U. S. Geological Survey, showed, in addition to the major constituents Cu and V, x.o per cent of Ca and Ba, o.x per cent of Al, Fe, Mg, Si, and Ti; and a trace of Mn. Not present: As, B, Na, P, Pb, and Sn. The x.o per cent of Ca found spectrographically probably accounts for the deficiency in the summation of the analysis. *X*-ray powder diffraction data by Mary Mrose of the concentrated sample are given in Table 2. The d data for the stronger lines of the pattern are in good agreement with those given by Jambor (1960) for volborthite from British Columbia, and by Guilleman (1956) for volborthite from the Cougar Mine, Colorado. However, the pattern of Genth's volborthite from Woskressenskoi, Perm, U. S. S. R., contains many lines not recorded by Jambor and Guilleman. It is uncertain whether any of these may be attributed to an impurity. Single-crystal *x*-ray investigation on volborthite is currently in progress and will be presented by Miss Mrose in a future note.

Discussion

With Al_2O_3 and Fe_2O_3 considered as extraneous to volborthite and as dissolved from impurities present, adjusted values were calculated for V_2O_5, CuO, BaO, and loss on ignition, which are also shown in Table 1.

The 14 per cent ignition loss reported in the new analysis may be misleading with regard to the correct percentage of water in this volbor-

TABLE 2. *X*-RAY POWDER DIFFRACTION DATA FOR VOLBORTHITE (GENTH'S TYPE MATERIAL) FROM WOSKRESSENSKOI, PERM, U.S.S.R.[1]

$d_{meas.}$[2] Å	I[3]	$d_{meas.}$[2] Å	I[3]	$d_{meas.}$[2] Å	I[3]	$d_{meas.}$[2] Å	I[3]
7.17	100	2.887	21	1.822	2	1.428	3
6.93	3	2.854	11	1.791	9	1.415	2
5.31	3	2.716	21	1.770	2	1.363	2
5.13	4	2.641	15	1.740	1	1.323	2
4.95	4	2.563	30	1.732	2	1.308	2
4.61	2	2.495	5	1.710	9B	1.281	2
4.44	5	2.445	2	1.680	9	1.271	2
4.257	9	2.385	25	1.658	1	1.254	1
4.104	11	2.302	6D	1.622	2B	1.240	1D
3.733	5	2.274	6D	1.598	1	1.223	1D
3.585	6	2.222	3	1.572	2	1.203	2
3.453	5	2.134	11	1.550	2	1.174	<1
3.336	2	2.045	11	1.512	11	1.151	1
3.222	18D	1.991	1	1.499	11	1.115	2
3.096	18	1.955	2	1.469	4	1.065	1
3.004	21	1.929	5	1.457	3	1.024	2
2.946	3	1.858	8	1.441	4		

[1] Split of analyzed sample 49-45-CSX.

[2] Average of measurements from four films taken with spindle nos. 4079 and 7821. Shrinkage negligible. Camera diameter 114.59 mm. Ni-filtered copper radiation ($CuK_{\alpha} = 1.5418$ Å). Lower limit 2θ measurable: 7.0° (12.6 Å). Lines due to CuK_{β} radiation omitted.

[3] Estimated visually from film no. 18051 by direct comparison with calibrated intensity strips. D = diffuse, B = broad.

thite. Loss at 110° C. was not determined and the value given for ignition loss may be due in large part to residual methylene iodide not washed out with acetone and remaining between the scales of the volborthite. Even though our value of 14.0 per cent is in the range of 11 to 18 per cent reported for most low calcium volborthites (uzbekite), we do not consider that it necessarily represents the true water content of the volborthite.

A comparison of the adjusted values for the new analysis with Genth's adjusted analysis shows a fair agreement in CuO and BaO content, but a great difference in V_2O_5 content. Genth's adjusted value for V_2O_5 is approximately one-half of the adjusted value for V_2O_5 in the new analysis. It is interesting to speculate that perhaps Genth's very low value for V_2O_5 is due to arithmetical error in calculating his analytical results. Such an error would also account for his very high H_2O values, which were determined by difference.

The new analysis shows that the volborthite from Woskressenskoi, Perm, U.S.S.R., is similar in V_2O_5 and CuO content to volborthite from other localities, and that it is not unique by reason of its low V_2O_5 or high H_2O content, as indicated by Genth's adjusted analysis.

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PITFALL IN DETERMINING 2V IN MICAS

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The value of the optic axial angle 2V in flakes of synthetic mica varies greatly according to whether they are truly single crystals or instead are interlayerings of twinned individuals such as described by Bloss *et al.* (1963). For such interlayerings the value for 2V is likely to be significantly lower than the true value obtainable from a single crystal, a possibility that was recognized early by Reusch (1869). Present day investigators perhaps lose sight of this possibility when they report variations of 2V for a given mica in a thin section without investigating the reason. In such cases the question arises as to whether, for the mica flakes examined, this variation in 2V is the result of variation in (a) composition, (b) degree of interlayering of twinned components, or (c) polytypism.

The various micas synthesized at the Norris Metallurgy Research Laboratory of the Bureau of Mines were from melts of closely controlled chemical compositions. Thus far, the variations in 2V observed for flakes from the same batch appear to be attributable to differences in degree of interlayering. For synthetic phlogopite flakes which are solid solutional variations from the ordinary $K_2Mg_6Al_2Si_6O_{20}F_4$ composition, interlayering seems more the rule than the exception. It is thus understandable why low values for 2V have generally been reported for these, especially be-

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