However, *x*-ray fluorescence analysis indicates the presence of about 2% Sb by weight.

Bournonite twins up to 8 mm across occur with the enargite and andorite but untwinned crystals are rare. The habit of the crystals is simple, and only the following forms were found: c, {001}; b, {010}; a, {100}; m, {110}; o, {101}; and r, {211}. The same forms are found on twinned and untwinned crystals. A single crystal is depicted in Fig. 2.

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REVISED CHEMICAL ANALYSES OF TRASKITE, VERPLANCKITE AND MUIRITE FROM FRESNO COUNTY, CALIFORNIA

John T. Alfors and George W. Putman,
California Division of Mines and Geology,
San Francisco, California.

The chemical analyses of traskite, verplanckite, and muirite (Alfors *et al.*, 1965, Table 2) are revised subsequent to the detection of substantial chlorine in traskite and minor fluorine in all three minerals. In addition, new data were obtained which resulted in a revision of the water content of traskite and muirite, and in a slight revision of the silica and alumina content of all three minerals. The resulting revisions have changed the cell contents of verplanckite and muirite slightly and the cell content of traskite markedly. The revised chemical analyses are given in Table 1 and the revised cell contents in Table 2.

The revised formula for traskite is $(Ba_{25.40},Ca_{1.17},Sr_{0.25},K_{0.08})_{26.90}(Fe_{4.45},Mn_{1.46},Mg_{0.57})_{6.48}Ti_{5.33}(Si_{35.17},Al_{0.49})_{35.66}O_{88.78}(OH_{43.09},Cl_{7.51},F_{1.60})_{52.20}$. This formula can be simplified to $Ba_9Fe_2Ti_2Si_{12}O_{30}(OH,Cl,F)_{18}$ or $Ba_9Fe_2Ti_2Si_{12}O_{36}(OH,Cl,F)_6\cdot 6H_2O$ in which Z is 3. The density calculated from the ideal formula $(Ba_{25.49},Ca_{1.18},Sr_{0.25},K_{0.08})_{27.00}(Fe_{4.12},Mn_{1.35},Mg_{0.53})_{6.00}Ti_{6.00}(Si_{35.51},Al_{0.49})_{36.00}O_{89.73}(OH_{44.58},Cl_{7.77},F_{1.65})_{54.00}$ is 3.75 gms/cc. The measured density is $3.71\pm 0\cdot 02$ gms/cc.

The revised formula for verplanckite (analysis 2, Table 1) is $(Ba_{12.01},Ca_{0.12},K_{0.04})_{12.17}(Mn_{4.32},Fe_{0.93},Ti_{0.76},Mg_{0.14})_{6.15}(Si_{12.24},Al_{0.28})_{12.52}O_{37.16}(O_{1.52},OH_{5.90},Cl_{3.47},F_{1.11})_{12.00}\cdot 17.76H_2O$. This formula can be simplified to $Ba_2(Mn,Fe,Ti)Si_2O_6(O,OH,Cl,F)_2\cdot 3H_2O$ in which Z is 6. To maintain electrostatic balance it is suggested that for each Ti^{4+} ion replacing an Mn^{2+} ion, two 0^{2-} ions replace two $(OH)^{1-}$ ions. The density calculated from the ideal formula $(Ba_{11.84},Ca_{0.12},K_{0.04})_{12.00}(Mn_{4.21},Fe_{0.91},Ti_{0.74},Mg_{0.14})_{6.00}(Si_{11.73},Al_{0.27})_{12.00}O_{35.83}(O_{1.48},OH_{5.94},Cl_{3.47},F_{1.11})_{12.00}\cdot 18.00H_2O$ is 3.46 gms/cc. The measured density is 3.52 ± 0.02 gms/cc. The discrepancy between the measured and calculated densities may be

TABLE 1. CHEMICAL ANALYSES OF VERPLANCKITE, MUIRITE AND TRASKITE FROM FRESNO COUNTY, CALIFORNIA

	Verplanckite		Muirite	Traskite
	1	2	3	4
SiO_2	20.99	20.9	22.15	27.77
Al_2O_3	0.23	0.41	0.53	0.33
TiO_2	2.03	1.72	4.17	5.6
FeO[1]	0.8	1.9	0.4	4.2
MnO	8.7	8.7	2.04	1.36
MgO	0.25	0.15	0.11	0.30
CaO	0.25	0.19	4.67	0.86
Na_2O	n.d.	n.d.	n.d.	n.d.
K_2O[2]	<0.05	<0.05	0.1	<0.05
BaO	52.98	52.33	59.6	51.19
SrO	0.07	——	0.13	0.34
H_2O[3]	10.6	10.6	1.8	5.1
Cl[2]	3.5	3.5	4.5	3.5
F[4]	0.6	0.6	1.4	0.4
$0=Cl+F$	−1.05	−1.05	−1.6	−1.0
Total	100.0	100.0	100.0	100.0

n.d. = not detected. Limit of detection of Na_2O is $<0.5\%$.

G. W. Putman, analyst. Analyses were made by d-c arc emission spectroscopy unless otherwise noted. The analyses have been calculated to 100% from instrumental totals and are the mean of duplicate determinations. The two analyses of verplanckite were made on separate samples.

[1] Iron was determined as Fe°, but is reported as FeO.

[2] K_2O and chlorine were determined by *x*-ray spectroscopy.

[3] Water was determined by ignition loss. The ignition loss determination on verplanckite was made by Robert B. Langston, University of California, Berkeley and J. T. Alfors. The determinations on muirite and traskite were made by J. T. Alfors.

[4] Fluorine was determined from BaF band spectra.

All samples are from Sec. 27, T. 11 S., R. 25 E., Mount Diablo Base and Meridian.

due in part to inclusions of fresnoite ($G=4.43$) in the verplanckite.

The revised formula for muirite is $(Ba_{9.82},K_{0.05},Sr_{0.03})_{9.90}Ca_{2.10}(Mn_{0.73},Fe_{0.14},Mg_{0.07})_{0.94}Ti_{1.32}(Si_{9.31},Al_{0.26})_{9.57}O_{29.52}(OH_{5.05},Cl_{3.21},F_{1.86})_{10.12}$. This formula can be simplified to $Ba_{10}Ca_2MnTiSi_{10}O_{30}(OH,Cl,F)_{10}$ in which $Z=1$. The density calculated from the ideal formula $(Ba_{9.92},K_{0.05},Sr_{0.03})_{10.00}Ca_{2.00}(Mn_{0.78},Fe_{0.15},Mg_{0.07})_{1.00}Ti_{1.00}(Si_{9.73},Al_{0.27})_{10.00}O_{29.83}(OH_{4.99},Cl_{3.17},F_{1.84})_{10.00}$ is 3.88 gms/cc. The measured density is 3.86 ± 0.02 gms/cc.

Chlorine analyses were made by *x*-ray spectroscopy. The chlorine content was determined by comparing the chlorine to silicon peak ratios

Table 2. Number of Atoms in Unit Cells of Verplanckite, Muirite and Traskite from Fresno County, California

	Verplanckite	Muirite	Traskite
	2[1]	3	4
Si	12.24	9.31	35.17
Al	0.28	0.26	0.49
Ti	0.76	1.32	5.33
Fe	0.93	0.14	4.45
Mn	4.32	0.73	1.46
Mg	0.14	0.07	0.57
Ca	0.12	2.10	1.17
K	0.04	0.05	0.08
Ba	12.01	9.82	25.40
Sr	——	0.03	0.25
H	41.42	5.05	43.09
Cl	3.47	3.21	7.51
F	1.11	1.86	1.60
0	62.34	34.57	131.87

[1] Specimen numbers correspond to those of Table 1. Values are significant to two digits.

for traskite and an artificial 5% chlorine standard which approximated traskite in composition. Adjustment was made for the small differences in silica content. The indicated coefficient of variation ($100 \cdot s/\overline{x}$) for the chlorine analyses is approximately 5.0%. Chlorine was not detected when traskite was first checked by microchemical tests. The initial failure to detect chlorine is attributed to the relative insolubility of traskite.

Fluorine analyses were made by d-c arc emission spectroscopy. The BaF band head at 4950.8 Å was utilized and thallium (5350.5 Å) was used as the internal standard. The sample was prepared by mixing 1 part mineral, 1 part $BaCO_3$, and 2 parts graphite which contained approximately 0.01% thallium oxide. The sample was loaded into a $\frac{1}{4}$ inch Ultracarbon #3417 electrode and burned at 12 amperes for 30 seconds in a Stallwood jet with a gas mixture of 80% argon and 20% oxygen. Spectra were recorded on Kodak III-F plates. The indicated precision of the fluorine analyses is approximately ±10% of the amount present. The minerals had been checked previously for fluorine by a microchemical test, but fluorine was not detected. Failure to detect fluorine by microchemical methods may be attributed in part to the small samples used and the low fluorine content of the minerals.

The new water analyses for traskite and muirite were determined by ignition loss. Twenty milligrams of traskite and ten milligrams of muirite were used for the determinations. The samples were loaded into platinum or gold tubes ($\frac{1}{8}$ inch in diameter and $\frac{1}{2}$ inch long) and brought to a constant weight at 80° C. The tubes were then placed in a covered graphite crucible ($\frac{1}{4}$ inch inside diameter and $\frac{3}{4}$ inch long) into which was also placed a small ball of steel wool to act as a buffer and heated to approximately 950° C. The samples were placed inside the graphite crucible and buffered with iron in an effort to prevent oxidation. After ignition the samples were buff-colored and oxidation appeared to have been slight. Samples heated in open air were much darker colored. Chlorine and fluorine were detected in the minerals after ignition and are assumed to have been completely retained during ignition. The water analyses appear to have a precision no worse than ±0.5 wt.%.

The silica and alumina contents of all three minerals have been revised slightly. The revisions are based on data derived from new standards. The silica contents have been increased 0.5% to 1.5% and the alumina contents have been reduced by 0.1% to 0.2%.

The spectrographic analyses have been calculated from the instrumental data to yield a 100% total. For example, the two analyses of verplanckite (Table 1, analyses 1 and 2) gave instrumental totals of 100.03% and 96.15% respectively. The difference in the instrumental totals is due simply to errors in weighing out equal amounts of sample and internal standard. The analyses calculated to a 100% total yield similar results except for the higher iron content of analysis 2 which is known to contain a small but unknown amount of iron contamination. No change in the ratio of the spectrographically determined constituents (except fluorine) is involved and no constituent is deleted. The weight per cent of water, chlorine, fluorine and potassium was not changed in the calculation to 100%.

REFERENCE

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