

AN AMERICAN OCCURRENCE OF MILOSCHITE¹

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Introduction.—An earthy blue mineral resembling chrysocolla but stated to contain no copper was recently submitted to the U. S. National Museum by Mr. G. L. Sheldon of Ely, Nevada.² The locality was given as 6 miles north of Ely, and the occurrence as in a sort of vein, between walls of gossan. Preliminary examination confirmed the absence of copper, and showed that the color was due to the presence of chromium, and as the material did not correspond with any numbered species in Dana's System of Mineralogy, it seemed worthy of further investigation. A sample was accordingly submitted by the Museum to Professor Brown, who has contributed the analytical data here given. The mineral proves to agree with the hitherto imperfectly known miloschite, which is here rescued from oblivion and shown to deserve recognition as a definite mineral species.

History of the mineral miloschite.—This substance appears to have been first mentioned in print by Breithaupt in 1838,³ its properties being described, and the name *serbian*, from the country where it was found (Serbia or Servia), being given to it, altho it was noted that the discoverer of the mineral, von Herder, had named it *miloschin*. Kersten,⁴ who made the first analysis of the mineral, used the latter name. Losanitsch⁵ and Groth⁶ spelled this *milosin*, but the original orthography was *miloschin*, and Doelter⁷ used this form. The exact English equivalent of this name would be *miloschine*, but in accordance with the principle of using the standard termination where in any way possible, Dana⁸ changed the name to *miloschite*, which is here adopted. It may be pronounced mil' ō schīte.

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² U. S. N. M. Cat. No. 92939.

³ *J. prakt. Chem.* **15**, 327, 1838.

⁴ *Ann. Phys. Chem.* **47**, 485, 1839.

⁵ *Chem. News* **69**, 243, 1894.

⁶ *Tab. Uebers. Min.*, ed. 4, 138, 1898.

⁷ *Handb. Min. Chem.* **2**(7), 161, 1915.

⁸ *Syst. Min.*, ed. 6, 697, 1892.

The early descriptions and analyses of miloschite not being entirely concordant, the material was reinvestigated by Losanitsch⁹ and shown to consist of a blue crystalline constituent low in chromium, the true miloschite, admixed with a variable amount of a green amorphous substance containing a somewhat larger percentage of this element, for which Losanitsch proposed the name *alexandrolite*. But neither Dana, Groth, nor Doelter have classed miloschite as a definite mineral.

The published descriptions of miloschite appeared to fit the mineral from Nevada, but it seemed desirable to compare specimens of the two directly. The Serbian miloschite in the Museum collection being of doubtful authenticity, a specimen was borrowed from Col. Washington A. Roebling, of Trenton, N. J., whose collection includes so many rare minerals; our warmest thanks are herewith extended to Colonel Roebling for his kindness in lending us this material. There seemed every reason to regard this specimen as authentic, for it had been obtained from Bertrand over 40 years previously, and agreed closely with the descriptions. It proved to be essentially identical with the Nevada material.

Formal description.—

MILOSCHITE

Named after Prince Milosch of Serbia: von Herder, 1838.
 $H_4M''''_2Si_2O_8$, with $M'''' = Al, Cr, (and Fe)$ MONOCLINIC.

PHYSICAL PROPERTIES

Color pale greenish blue; Ridgway's 43d, calamine-blue (47% green, 30% blue, and 23% white).

Luster waxy to dull.

Translucent.

Hardness $2\frac{1}{2}$.

Specific gravity $2.1+$

Under the microscope seen to consist of aggregates of very minute crystalline grains, with a small amount of amorphous material; color bluish green; pleochroism none; indices of refraction α and $\beta = 1.552$, $\gamma = 1.559$ (all $\pm .003$); biaxial, with axial angle about 90° ; and showing inclined extinction.

CRYSTALLOGRAPHIC PROPERTIES

System, monoclinic.

Class and axial ratios indeterminate.

Habit nearly equidimensional, to tabular.

Cleavage: traces in one direction (under microscope).

Optical orientation: indeterminate.

⁹ *Loc. cit.* (note 5).

CHEMICAL PROPERTIES

Qualitative tests:

Before the blowpipe infusible, becoming brownish; gives reactions for Cr and Si.

In the closed tube at high temperature yields H_2O .

In HCl almost insoluble, altho a little Al, Fe and Cr are extracted.

After fusion with Na_2CO_3 yields reactions for Cr, Al, Fe, and Si.

Composition: discussed below.

Methods of analysis (by Glenn V. Brown).—Material for study was obtained by crushing the mineral fragments to coarse powder and removing all pieces showing any traces of rust stains or variations in color, the resulting sample being uniformly greenish-blue. This was finely powdered in an agate mortar. As the mineral proved to be only slowly and partially soluble in hydrochloric acid, decomposition was effected by fusion with sodium carbonate, Hillebrand's "Analysis of silicate and carbonate rocks" being followed thruout. All precipitations were repeated when possible.

Water was determined by heating the mineral to 300° in a stream of dry air and collecting and weighing in a calcium chloride tube. Chromium oxide was determined volumetrically, colorimetrically, and gravimetrically, the results being respectively 4.11, 3.80, and 3.64, averaging 3.85%. The colorimetric method is undoubtedly the most accurate, and as the result by it closely approximates the average by all three methods, this average is given as the percentage of chromium oxide present. In one sample iron oxide was determined volumetrically, in the other gravimetrically.

As certain portions of the mineral showed slight rust stains it was thought possible that the iron oxide content was due to invisible material of this nature, and an effort was made to extract any iron rust present by means of hydrochloric acid of various dilutions. It was found, however, that the mineral is partially decomposed even by dilute acids, aluminium and chromium entering the solution as well as iron, so that no conclusive evidence of this could be obtained. In any case the amount of iron oxide is so small that no essential difference in the formula of the mineral would result from considering it an impurity instead of as isomorphously replacing the other sesquioxides, as is done here.

Alkalies were determined by the J. Lawrence Smith method, and sodium proved not to be present in weighable amount.

The other elements were determined by standard methods, as outlined by Hillebrand, using all known precautions; and the absence of other constituents than those given was proved by systematic qualitative analysis. The following results were obtained:

TABLE I. ANALYSES OF MILOSCHITE.

	1	2	3	4	5	6
H ₂ O(105°).....	3.3	3.64	3.44	—	—	—
H ₂ O(300°).....	14.1	13.17	13.37	13.85	13.7	13.76
Al ₂ O ₃	33.5	34.35	34.46	35.89	35.6	30.18
Cr ₂ O ₃	5.8	3.85	3.85	4.01	3.9	9.75
Fe ₂ O ₃	0.9	0.94	0.77	0.89	1.0	0.91
CaO.....	—	0.38	0.36	—	—	—
MgO.....	—	0.08	0.15	—	—	tr.
K ₂ O.....	—	0.28	0.28	—	—	tr.
SiO ₂	43.0	43.40	43.54	45.36	45.8	46.37
	100.6	100.09	100.22	100.00	100.0	100.97

1. Preliminary analysis, to determine general character of material, made by several students under the direction of G. V. B.

2 and 3. Analyses by G. V. B.

4. Average of 2 and 3, after removing H₂O(105°), CaO, MgO, and K₂O and recalculating to 100%.

5. Theoretical composition of H₄M₂Si₂O₉, with M=Al:Cr:Fe=45:4:1.

6. Analysis of Serbian miloschite by Losanitsch, added for comparison; over twice as much chromium is present as in the American mineral, but otherwise the compositions of the two are essentially identical.

Discussion of the results.—The ratios shown in these analyses are those of the kaolinite group, of which the general formula is H₄M^{'''}₂Si₂O₉, with M^{'''}=Al, Fe, and Cr. The known members of this group, with certain of their optical properties, are tabulated below; all are probably monoclinic, but as they are mostly microcrystalline, this is not entirely certain.

TABLE II. THE KAOLINITE GROUP.

Name	M ^{'''}	Color	Indices of refraction		
			α	β	γ
Kaolinite.....	Al	white	1.561	1.563	1.567
Faratsihite.....	Al+Fe	yellow	—	?	—
Nontronite (Chloropal).....	Fe	green	1.595	1.595	1.620
Miloschite (with 3.85% Cr)...	Al+Cr	blue	1.552	1.552	1.559
Volchonskite (in part).....	Cr	green	—	1.585	—

In this group end-members as well as isomorphous series are given names since these end-members are known in essentially

pure condition. The unusual colors shown by the metals in this mode of combination are noteworthy: ferric iron, the compounds of which are usually yellow, yield a distinct green color in nontronite; while chromic chromium, which usually produces greens, gives in miloschite a "coppery" blue. The indices of refraction of the last mineral are also somewhat abnormal; when a metal of low atomic weight like aluminium is replaced by one of greater weight, like iron or chromium, the index of refraction usually increases; in miloschite, however, the indices are distinctly less than those of kaolinite. This has been kindly confirmed by Dr. E. S. Larsen, Jr., of the U. S. Geological Survey.

Miloschite is regarded as having as much right to be classed as a mineral species as has fuchsite, for the former is a chromiferous kaolinite, just as the latter is a chromiferous muscovite. It seems best to define it as referring to the isomorphous series of aluminium and chromium compounds irrespective of the relative amounts of these elements, just as wolframite is used for an isomorphous series of iron and manganese compounds, in which now one and now the other element is in excess.

Genesis of miloschite.—The Serbian miloschite is a weathering product of a variety of fuchsite which has been given the apparently unnecessary name of avalite. The Nevada mineral has no doubt been produced in a similar manner, for it is closely associated with weathered sulfides, but the nature of the original chromium-bearing substance and accordingly its exact mode of formation are unknown. Dr. A. C. Spencer of the U. S. Geological Survey, who has made a study of the Ely district, informs us¹⁰ that in that general region sericite is often produced by the action of emanations from igneous rocks on limestones, and suggests that the original mineral of this occurrence may have been a chromiferous sericite of like origin. As no igneous rocks are known there more basic than granodiorite, the chromium in this occurrence, as in certain of those in the Alps described by Dr. R. Canaval,¹¹ and Prof. K. A. Redlich¹² is associated with acidic rather than basic rocks, the usual source of this element.

Miloschite may accordingly be classed with the minerals of weathered silicic hydrothermal deposits.

¹⁰ Private communication.

¹¹ *Z. prakt. Geol.* **16**, 482, 1908.

¹² *Z. prakt. Geol.* **19**, 126, 1911; *Centr. Min. Geol.* **1914**, 65.