tions, it is possible to explain many of their peculiarities of composition in a simple manner as follows: In the feldspar group, the fact that the replaceability of potassium for sodium is limited, but for barium is more complete, the relation being one of double isomorphism, [(Ba, K)+(Al, Si)]; in the leucite group, the significance of the water in analcite, which is not a zeolite, the formula being $(Na+XH_2O+X)(AlSi_2O_6)$; in the pyroxene group, the lack of potassium members, and the improbability of the existence of the Tschermak molecule; in the beryl group, the presence of alkalies as due to solid solution of a pollucite-like substance; in the nephelite group, the probability that the excess silica is silica-of-crystallization, $(Na+XSiO_2)(AlSiO_4)$; in the garnet group, the extensive isomorphism; in the scapolite group, the homology of meionite and marialite, and the reason that sulfate and carbonate groups can enter; in the tourmaline group, the possibility of replacement of Li for Fe″ and Al for Mg; in the zeolite group, non-existence of (Ca,Na_2) and (SiO_4,Si_3O_8) replacements, and the explanation of variability as due to admixture or to non-isomorphism; and finally in the mica group the absence of evidence of (SiO_4,Si_3O_8) replacement, phengite approaching for instance $H_4K_2(Mg, Fe)(Al_4Si_7O_{24})$, which represents double isomorphism [(Al, Mg)+(Al, Si)].

NOTE ON LEUCHTENBERGITE FROM PHILIPSBURG, MONTANA[1]

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A white chlorite occurring in metamorphosed limestones of the Philipsburg district of Montana was mentioned by Calkins[2] under the name leuchtenbergite. Several other white chlorites having been described since the publication of this paper, Mr. Calkins requested that his specimens, which were preserved in the National Museum, be reëxamined. The chlorite has been analyzed in the museum laboratory, and the results of the analysis confirm the original identification, the mineral being a typical leuchtenbergite. The specimens examined are numbered P 480 in the type collection from the Philipsburg district. Since the

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[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Calkins, F. C., Geology and ore-deposits of the Philipsburg Quadrangle, Montana. *U. S. Geol. Survey, Prof. Paper* 78, 161, 1913.

locality gives promise of furnishing leuchtenbergite in abundant finely crystallized specimens, the occurrence is directed to the attention of mineralogists by the following note.

The specimens were collected from the surface near Lost Creek, about 1 mile north of the Silver King Mine. The rocks of this locality are chiefly magnesian limestones which have undergone intense contact metamorphism and contain forsterite, spinel, and humite. They consist of medium grained pure white marble grading into a delicately greenish layer of fibrous appearance and silky luster to which the leuchtenbergite crystals are attached. This silky material is also largely calcite but its structure is determined by the presence of some fibrous silicate which could not be identified because its optical properties are obscured by the minutely intergrown calcite. It is also attacked when the calcite is dissolved by acid. It is probably wollastonite. The chlorite forms well developed tabular hexagonal crystals which reach an extreme diameter of 2.5 cm. with a maximum thickness of 5 mm. Over and around the crystals of leuchtenbergite is a layer of white calcite of flinty texture which is evidently a later deposit and which is easily removed. The chlorite varies from colorless to pale talc green, the luster on the basal (cleavage) plane being pearly while the other faces are dull. The hardness is about 3.5. The cleavage is micaceous and perfect, yielding flexible but inelastic plates. The optical properties as determined by Clarence S. Ross are as follows:—Biaxial, positive (+); $2V = 6°—14°$ the variation being in part due to slight bending in splitting off plates for examination. Refractive indices, $\alpha = \beta = 1.572 \pm .003$, $\gamma = 1.575$. Birefringence $= .003$.

Analyses of Leuchtenbergite

Constituent	1 Philipsburg	2 Zlatoust	3 Mauleon
SiO_2	31.44	30.80	32.10
Al_2O_3	17.62	17.27	18.50
Fe_2O_3	none	1.37	.....
MgO	37.64	37.08	36.70
CaO	trace	.....	.....
FeO	trace	.....	.....
MnO	trace	.....	.....
H_2O (all above 110°C.)	13.19	12.30	12.10
Total	99.89	98.82	99.40

Upon analysis selected flakes free from impurities yielded the results given in column 1 of the following table. In columns 2 and 3 are given, for comparison, the analyses of leuchtenbergites from the original Zlatoust locality and from Mauleon.

The Montana material is free from all but a faint trace of iron. All of the water is basic being liberated only at a red heat. The above analysis yields the following ratios:

RATIOS OF LEUCHTENBERGITE FROM MONTANA

SiO_2	.5214	17.38 x 3	.96 x 3
Al_2O_3	.1724	17.24 x 1	.95 x 1
MgO	.9335	18.67 x 5	1.03 x 5
H_2O	.7328	18.32 x 4	1.01 x 4

These ratios indicate the usual formula, namely $5MgO.Al_2O_3.3SiO_2.4H_2O$, or, as pointed out by Tschermak, one molecule of serpentine plus one of amesite. This interpretation was the foundation for Tschermak's interpretation of the chlorite group, for which he assumed serpentine to be one of the end members. Chemically leuchtenbergite would appear to support this conclusion. It is to be considered, however, that serpentine does not physically resemble the chlorites to any great extent, most of the foliated chlorite-like magnesian silicates having been found, upon investigation, to be talc. In this connection it may be instructive to compare the optical properties of the Montana leuchtenbergite with those of amesite, serpentine (antigorite), and talc as given by Larsen.[3]

OPTICAL PROPERTIES OF LEUCHTENBERGITE, ETC.

LEUCHTENBERGITE	AMESITE	SERPENTINE	TALC.
$\alpha=1.572$	1.597	1.560	1.539
$\beta=1.572$	1.597	1.570	1.589
$\gamma=1.575$	1.612	1.571	1.589
Birefringence= .003	.015	.011	.050
2V=6°—14°	0°	20°—90°	6°—30°
Sign (+)	(+)	(—)	(—)

The data available are inconclusive and the correct interpretation of this complicated group must await further investigation.

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[3] *U. S. Geological Survey, Bull.* **679**, 1921.