

Finally, the latest method of studying minerals must be mentioned, that of study by the X-rays, according to the methods of Laue, the Braggs, and others. The utility of this has been shown recently in the Geophysical Laboratory, by work done on the pyroxene group, a work that serves also as an example of mutual cooperation, one of us (Merwin) doing the optical part, another the chemical, and a third the X-ray study. It would be unjust to my colleague, Dr. Wyckoff, to steal his thunder by giving here his results, but it may be said that his X-ray studies have shown clearly that certain minerals that for many years have been reckoned as pyroxenes can not belong to this group, their molecular structure being quite different.

Study of minerals along such lines is still in its infancy, but such examples as have come under my notice lead to the conviction that X-ray methods, especially when employed in conjunction with some of those longer known, are not only the most recent but among the most powerful methods of arriving at an understanding of what minerals, as well as artificial crystals, really are, how they are constituted, and how they are related.

It should again be said, in conclusion, that all determinations are to be made on identical material. The motto of Belgium may serve as a fitting summing up of my remarks—"L' Union fait la Force."

STUDIES IN THE MICA GROUP (ABSTRACT)¹

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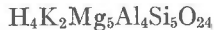
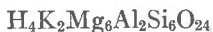
In micas, as in other silicates, each crystal is an aggregate of several intergrown space-lattices which differ decidedly from each other in the size of their atoms. The oxygen space-lattice in mica includes F and H (as OH), but none of the other constituents. The formulas of micas omitting O, H and F, can be deduced from a study of a tabulation of the best analyses calculated into relative numbers of atoms (with the same omission) expressed as percentages.² From such a study it appears that micas are not orthosilicates, nor metasilicates, nor any other single type of silicates,

¹The complete article on the micas will appear in an early number of the *American Journal of Science*.

²This method is more accurate than the ordinary procedure because the determination of the precise percentages of F and H₂O is notoriously very difficult.

since the percentage of silicon is not constant, but shows considerable variation in each kind of mica. Further, it appears that there are two classes of micas, one characterized by seven atoms (excluding O, H and F) in the fundamental unit, as in KAl_3Si_3 , and the other characterized by eight such atoms, as KMg_3AlSi_3 . The first class, with seven atoms, is here named the heptaphyllite system and the second class, with eight atoms, may be called the octophyllite system.

In the octophyllite system the chief variations in composition are from KMg_3AlSi_3 to KFe_3AlSi_3 and from $K(Mg,Fe)_3AlSi_3$ to $K(Mg,Fe)_{2.5}Al_2Si_{2.5}$, or, to avoid fractions, from $K_2(Mg,Fe)_6Al_2Si_6$ to $K_2(Mg,Fe)_5Al_4Si_5$. These two variations imply the existence of four chief molecules in the system, namely, including O and H:



By using these four molecules as the corners of a square, all variations in the system can be shown, a single point representing each analysis. After plotting many analyses (80+) on the square, it is clear that nearly all parts of the system are represented in nature, and that the system is continuous from phlogopite ($H_4K_2Mg_6Al_2Si_6O_{24}$) to siderophyllite ($H_4K_2Fe_5Al_4Si_5O_{24}$), and probably to the other two molecules. The optic properties and their variations in all parts of the system can be shown on the same square by means of lines of the nature of contour lines.

There seem to be four independent molecules in the heptaphyllite system of micas which may be written as follows:—

NAME	WITHOUT OH	WITH OH
Muscovite	KAl_3Si_3	$H_4K_2Al_3Si_3O_{24}$
Polyolithionite	KLi_3Si_3	$H_4K_2Li_3Si_3O_{18}$
Phengite	KAl_2Si_4	$H_4K_2Al_4Si_3O_{25}$
Protolithionite	$KFe_{1.5}Al_2Si_{2.5}$	$H_4K_2Fe_3Al_4Si_5O_{22}$

The variations in tenor of oxygen are considered improbable and unsatisfactory, but, nevertheless, no better solution has been found.

Micas of the heptaphyllite system usually contain three of these molecules, but rarely contain all four of them. Therefore the analyses may be plotted on the four triangular sides of a tetrahedron. When this is done it appears that the heptaphyllite system

is discontinuous, consisting of two parts, namely, muscovite—mariposite, and lepidolite—protolithionite.

The optic properties and their variations in both parts of the system can be shown by the use of lines like contours on the same kind of diagram used for studying the variations in composition.

In general, octophyllite is dark colored and heptaphyllite is light colored, but this distinction is not reliable any more than any corresponding color distinction in other silicate groups of minerals. Colorless mica may belong to the octophyllite or biotite system and black mica may belong to the heptaphyllite or muscovite-lepidolite system. In fact, in several cases, micas have been called "biotite" because of their color, which actually belong to the heptaphyllite system.

In nearly all cases octophyllite has the optic plane parallel to (010) and the optic angle smaller in red light than in blue light, while the reverse conditions are found nearly always in heptaphyllite.

MEMORIAL OF THOMAS L. WATSON

H. RIES, *Cornell University*

In the death of Thomas L. Watson, State Geologist of Virginia, and Head of the Department of Geology at the University of Virginia, geology and mineralogy have suffered a severe loss.



THOMAS L. WATSON
1871-1924

When Doctor Watson graduated from the Virginia Agricultural and Mechanical College in 1890, it had been his original intention to enter chemistry as a profession, but his strong interest in geology together with a feeling that his native state, Virginia, possessed valuable resources which afforded a great field for study and development, turned him aside from his original plan.

It was therefore not unexpected to find him taking his graduate work in geology first at the University of Virginia, and later at his alma mater, where he received his Master's degree in 1893. In 1895 he went to Cornell University, and took his doctorate there in 1897.