

ART. XI.—*Communications from the U. S. Geological Survey, Division of the Rocky Mountains. VIII. On Ptilolite, a new Mineral; by WHITMAN CROSS and L. G. EAKINS.**

THE mineral described beyond occurs in cavities of a more or less vesicular augite-andesite which is found in fragments at a certain geological horizon in the conglomerate beds of Green and Table Mountains, Jefferson County, Colorado. The formation to which this conglomerate belongs is of Tertiary age and will be described in the report upon the geology of the Denver coal-basin now in preparation by the U. S. Geological Survey. For the present article it is sufficient to say that the conglomerate in question is chiefly composed of worn pebbles and bowlders of andesitic rocks, embracing various types. The rock containing the new mineral has been found at several different places upon the mountain slopes, at approximately the same horizon in the series, and its fragments are not so worn and rounded as are those of other rocks in the conglomerate. Various structural modifications of this andesite have been found, ranging from the compact massive rock to that which is decidedly vesicular.

The massive rock is dull ashen-gray in color, exhibiting a few dark augite prisms and tabular feldspar crystals as the only macroscopic constituents. A microscopical examination shows the rock to consist of a network of small plagioclase microlites with irregular augite grains in very small quantity between them. In spots there seems to be a development of quartz in clusters of minute grains. No glassy base was seen, but certain yellowish globulitic masses are apparently devitrification products. Porphyritic crystals of augite, biotite and plagioclase are comparatively rare. Chemical analysis of the massive rock gave the following result:

* Read before the Colorado Scientific Society, May, 1886.

SiO ₂	59.26
Al ₂ O ₃	23.63
Fe ₂ O ₃	.30
FeO	.57
CaO	5.93
MgO	.31
K ₂ O	4.78
Na ₂ O	4.94
H ₂ O	.74

 100.46

Analyst, L. G. Eakins.

The various porous or amygdaloidal fragments found evidently represent material from different positions in the original rock-mass, and according to the former position of each specimen there is a certain development of minerals in the vesicles or pores. A reddish-gray, finely cellular rock contains in some cavities creamy, banded opal, upon which a decided play of reddish color was noticed in certain spots. Chalcedony and quartz fill many cavities completely. Another rock specimen, in which the pores are all round and small, exhibits no minerals in its cavities. A third specimen is very porous, the pores being irregular though never greatly distorted. More than half of these cavities contain a banded deposit of opal and chalcedony, the banding having in all a parallel direction. A few pores are filled by clear chalcedony. All cavities not entirely filled in this manner show a crust of small, clear heulandite crystals of tabular form, with minute white globulitic masses of unknown character scattered over and between them. A still more porous rock in which the cavities are irregular shows traces only of the creamy opaline deposit, while heulandite and white globules of the unknown substance form a distinct crust. As a still more recent formation there appear in the pores of this rock small tufts of a white mineral. These are very delicate and could not be procured in sufficient quantity for chemical examination. The resemblance to mesolite, as it occurs in the basalt of Table Mountain, was so marked that for a time the identity of the two substances seemed possible, but these tufts belong to the new mineral, found more abundantly in other specimens.

On the north slope of Green Mountain there are fragments of this augite-andesite in some of which the white mineral in tufts is specially well developed. The rock is light reddish-gray and very vesicular, the pores being drawn out cylindrically in a certain direction. Many of these pores have been completely filled by a solid mass of chalcedony and quartz, the latter occupying the center. In other cavities there is merely a thin coat-

ing of pale bluish chalcedony, and upon this is deposited the above mentioned white mineral in most delicate tufts and spongy masses composed of short hair-like needles, loosely grouped together. These needles when examined under the microscope are found to be colorless, transparent prisms, the average diameter of which is less than 0.001^{mm} . The terminations of unbroken prisms are square, indicating the probable presence of a basal plane, parallel to which there are transverse fissures, as of cleavage. The extinction of the stouter prisms in polarized light is parallel to the prismatic axis, but the multitude of smaller ones are so delicate that they do not affect polarized light perceptibly.

In removing the mineral from the cavities, for chemical analysis, a small amount of chalcedony from the underlying coating, which scales off readily, was unavoidably mixed with the fine hairs. A separation was effected by throwing the unpowdered material into water and stirring, the spongy aggregates resolving readily into a cloud of minute white spicules which remained suspended while the solid particles of chalcedony with attached needles sank. After standing a few moments the supernatant liquid was poured off, this still containing in suspension the greater portion of the needles, which did not completely settle for several hours. Separation of the needles from other substances was thus made very complete and more than 0.5 gram of pure material secured for analysis. The result, with derived ratio, is as follows (L. G. Eakins):

SiO ₂	70.35 ÷	60 = 1.1725	or	10.06	or	10
Al ₂ O ₃	11.90 ÷	102 = 0.1166		1.00		1
CaO	3.87 ÷	56 = 0.0691	}	11.16	0.96	1
K ₂ O	2.83 ÷	94 = 0.0301				
Na ₂ O	0.77 ÷	62 = 0.0124				
H ₂ O	10.18 ÷	18 = 0.5655		4.86		5
<hr/>						
99.90						

Special care was taken with the water determination of the above analysis. The mineral began to lose water at a very low temperature and even on drying in the air bath at 100° C. there was a noticeable loss; the amount thus lost, however, was found to be regained upon exposure to the air, and before the analysis was made the material was allowed to remain loosely covered for several days.

The loss of water, beginning at 100° C., continued steadily until at a temperature between 300° and 350° C. all the water was expelled, and continued heating at full redness occasioned no further loss. No line of demarkation could be detected at which the loss temporarily ceased, to begin again at a higher temperature, and thus no ground would seem to exist for con-

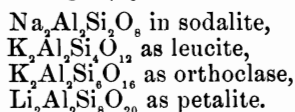
sidering any definite portion of this water basic, although a high temperature is necessary for its total expulsion.

Heated before the blowpipe a tuft of the mineral shrinks considerably and fuses to clear glass. Hydrochloric acid, even boiling, has little or no action, but by strong sulphuric acid it is gradually decomposed. Of course in a mineral of this description a determination of hardness is impossible and one of specific gravity would be too inaccurate to be of any value.

We propose as the name for this mineral, *Ptilolite*, derived from *πτίλον*, *down*, in reference to the light, downy nature of its aggregates.

Referring to the molecular ratio derived from the analysis, it is seen that the empirical formula for this mineral is $RO, Al_2O_3, 10SiO_2 + 5H_2O$, R representing Ca, K, and Na. The substance belongs among the aluminosilicates of which no previously described hydrate contains so high a percentage of silica. Perhaps the nearest allied hydrous mineral is stilbite, the composition of which may be expressed by the formula $H_4CaAl_2Si_6O_{20} + 4H_2O$.

While the structural formulæ for the complexer silicates are as yet hypothetical, it is of interest to note the place assumed by ptilolite in the scheme for the classification of the aluminosilicates adopted by Tschermak* and others. By the combination of the hydrous oxide $H_2Al_2O_4$ with two molecules of metasilicic acid, H_2SiO_3 , through the elimination of $2H_2O$, there results a simple aluminosilicic acid with the empirical formula $H_2Al_2Si_2O_8$. By combining the same hydroxide with 4, 6, 8, 10, etc., molecules of H_2SiO_3 , there results a series of aluminosilicic acids, the following anhydrous salts of which are known:



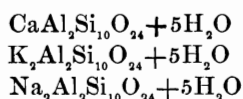
Other series are obtained by starting with other hydroxides of alumina.

Petalite stands alone in the above series as the representative of its type, and members with higher contents in silica are yet unknown. Now the zeolites are in many cases simply hydrates of the above or closely allied salts, although the water may be in part basic. No hydrate of petalite or of any corresponding salt is known, but ptilolite is found to be the hydrate of $RA_2Si_8O_{24}$, which will be seen to be the next member in the above series, following petalite.

If such a classification of aluminosilicates be adopted, ptilolite must be considered as the first member of a new group of

* G. Tschermak, *Lehrbuch der Mineralogie*, 2te Aufl., 244, 438, 490.

hydrous minerals, and as R is composed of Ca, K₂ and Na₂ we can assume the possible existence of the pure lime, potash and soda compounds :



The theoretical composition of an isomorphous mixture of these three compounds, in the ratio derived from the analysis of ptilolite, is given below in comparison with the analysis. The molecular weight of the mixed RO molecule was calculated to be 66·92.

	Calculated.	Found.	Difference.
SiO ₂	69·86	70·35	+ 0·49
Al ₂ O ₃	11·87	11·90	+ 0·03
CaO	4·04	3·87	- 0·17
K ₂ O	2·95	2·83	- 0·12
Na ₂ O	0·80	0·77	- 0·03
H ₂ O	10·48	10·18	- 0·30
	<hr/> 100·00	<hr/> 99·90	

The rare mineral milarite, although possessing a ratio RO: Al₂O₃=3:1, may yet be compared with ptilolite on account of its exceedingly high percentage in silica. Its formula is HK Ca₂Al₂Si₁₂O₃₀, requiring 72·66 per cent SiO₂.