

ART. XXXII.—*Description of Rowlandite*; by W. E.
HIDDEN and W. F. HILLEBRAND.

I. *Historical and Descriptive Discussion, by W. E. Hidden.*

ABOUT one kilogram of the mineral described in this paper was found by the writer in rather large lumps among huge masses of gadolinite and yttrialite, in a single shipment of the various yttria-bearing minerals, sent to him some five years ago, from the noted locality in Llano County, Texas.

The alteration products attracted my attention at once by their dissimilarity to those of gadolinite, yttrialite and allanite from the same mine. Several preliminary trials proved the mineral to contain over sixty-one per cent of the "rare earths" having a joint atomic weight of 118.5. The ignited oxalates had a pale straw color and the absorption spectrum of a saturated nitrate solution showed the lines of the erbium and didymium groups very prominent. Ferrous-oxide was found to be present (in one instance estimated at 4.69 per cent) and by the use of ammonium carbonate 0.40 per cent of what appeared to be uranium oxide was separated from the iron

solution. Three determinations of silica gave 25.98 per cent, 26.46 per cent and 25.64 per cent. A small amount of lime was also found. The loss on ignition was 2.01 per cent, but this was then considered as wholly due to hydroxyl and that fluorine was present was not even suspected. The apparent shortage, of nearly 5 per cent, was thought to be due to alkalis, magnesia and other non-essential elements and also to the fact of the hurried character of these preliminary analyses. That the mineral was essentially unlike gadolinite and could not be considered as a non-thoriferous yttrialite seemed proven and so it was laid aside until it could be looked into thoroughly.

Prof. Rowland photographed the spectrum of this mineral and also the "earths" from its oxalates and found them to be not essentially different from those of gadolinite and other minerals rich in yttria. He, however, expressed the opinion that there were at least *a dozen unknown elements* in the so-called yttria group not yet separated. The scale on which he showed its spectrum represented a length of ten feet and over *ten thousand* lines were noticed.

Later, the density was determined as 4.515, on carefully selected fragments. Its color varies from bottle- to pale drab-green when pure and its luster on a fractured surface is decidedly more vitreous than that of gadolinite. It is also more transparent, being perfectly so, in thin splinters. Its alteration product is of a waxy-brick-red color tending towards brown and this is peculiarly characteristic. The alteration has been one of further oxidation of the iron, hydration and partial change to carbonates.

The mineral is isotropic, its hardness is 6, its fracture glassy-conchoidal, its luster vitreous-resinous and the powdered mineral is light greenish gray. It is easily soluble in acids with gelatinization. Before the blowpipe it swells up without appreciable glowing but when strongly heated it emits a brilliant light without fusing. Any change of density was not investigated. The above data warranted me in calling the mineral new and quite distinct from gadolinite with which it is found associated. I proposed therefore, in a note published in this Journal in November, 1891, "the name of *Rowlandite* after Professor Henry A. Rowland, whose spectrographic work on the so-called 'rare earths' is so novel and important."

Through the kindness of Prof. F. W. Clarke, of the U. S. Geol. Survey, it has been possible to complete the description of this new mineral with the analysis and discussion of its composition by Dr. W. F. Hillebrand, given in the following pages.

II. *Analysis and Discussion of composition, by W. F. Hillebrand.*

The specimen of rowlandite, furnished by Mr. Hidden for analysis, was a portion of a mass resembling somewhat amorphous gadolinite. It had a glassy interior surrounded by an uneven thickness of reddish alteration substance, chiefly a carbonate, or carbonates, of the rare earths and lime. The glassy "rowlandite" showed, when broken up, reddish and dark stains in places, the latter being produced by minute black inclusions, perhaps of a titanium mineral. Numerous scarcely visible fissures, filled with foreign matter, traversed the glass. This rendered the selection of pure material an arduous task; the result of several days of labor, however, was a sample possessing a high degree of purity as shown by the microscope. A very small amount of impurity was still present, but much less, apparently, than the analysis seems to indicate. A slight cloudiness in some grains points to incipient change. Its density is the same as that found by Mr. Hidden, 4.513, at 15.5° C. The analysis is as follows:

			Mean.	
SiO ₂	25.77	26.04	26.04*	
X†.....	.39		.39	
ThO ₂	.59		.59	
Ce ₂ O ₃ ‡.....	5.06		5.06	
La group....	9.34		9.34	Mol. Wt. 336.8
Yt group....	47.70		47.70	Mol. Wt. 266.2
Fe ₂ O ₃	.09		.09	
FeO.....	4.39§		4.39	
MnO.....	.70	.64	.67	
CaO.....	.60	.40	.50	
MgO.....	1.58	1.66	1.62	
Alk.....	.32	.24	.28	
H ₂ O.....	.24		.24	
CO ₂	.34		.34	
Fl.....	3.87		3.87	
P ₂ O ₅	trace		trace	
			101.12	
	Less O for Fl,		1.63	
			99.49	

* Certainly more nearly correct than 25.77, since the fluorine must have caused loss of silica on evaporation with hydrochloric acid.

† A mixture of undefinable earths with some uranium and a trace of titanium.

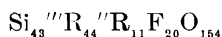
‡ Cerium dioxide cannot be present, if at all, in more than trivial amount, for otherwise much less ferrous oxide would have been found. For the same reason the manganese cannot be present as Mn₂O₃.

§ If the small and undetermined amount of uranium exists as dioxide, the ferrous oxide here given is correspondingly high, but the possible error can have no influence on the formula deduced.

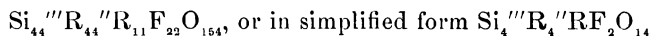
In calculating the molecular ratios a brief consideration shows that CaO and CO₂ may be neglected, and likewise, so far as their effect on the general formula is concerned, the ThO₂ and the group denominated X; also the trace of ferric oxide and the alkalis. For the present the water may also be disregarded. There result then the following molecular ratios:

SiO ₂	26.04 ÷	60 =		.4340	3.91
Ce ₂ O ₃	5.06	328.4	.0154	} .2223	2.00
La group	9.34	336.8	.0277		
Y group	47.70	266.2	.1792		
FeO.....	4.39	72	.0610	} .1109	1.00
MnO.....	.67	71	.0094		
MgO.....	1.62	40	.0405		
Fl	3.87	19		.2037	1.84

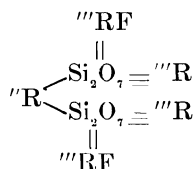
These furnish the following empirical formula, after deducting 10 atoms of oxygen for 20 of fluorine:



The silica is in all probability as much as half a per cent too low through loss occasioned by the presence of fluorine. Furthermore, it is possible that the fluorine, estimated by the Berzelian method, is a little too low; or, if not, that the small amount of water found is in part at least derived from hydroxyl replacing fluorine. The presumption is then strong that the composition of rowlandite is represented by the formula



Structurally this formula may perhaps be written in a number of ways, that which most readily suggests itself being



in which the mineral is to be regarded as a derivative of the acid H₆Si₂O₇. Until, however, the whole group of rare earth silicates is carefully studied and their relations among themselves and to other better known silicates are ascertained, it would be premature to pronounce in favor of this or any other structural formula.

Reducing all the other earths to a hypothetical one having the molecular weight of the yttrium group as found, and the manganese and magnesia to their equivalents in iron, the com-

position of an ideal rowlandite would appear as in the first column below, while the second column shows the percentages required to conform to the above formula.

	Found.	Calculated for $\text{Si}_4\text{Y}_4\text{FeF}_{12}\text{O}_{14}$.
Si.....	12.73	12.93
Y.....	50.83	50.37
Fe.....	6.50	6.46
Fl.....	4.05	4.39
O.....	25.89	25.85
	100.00	100.00

The agreement is very close and becomes much more so if the suggested slight increase in silica and fluorine is allowed.