

## ANALYSIS OF RAMSAYITE AND LORENZENITE

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On an expedition to Southern Greenland in the year 1897 Flink discovered a new mineral from Narsarsuk, Julianehaab District, which he named lorenzenite. Later,<sup>1</sup> he published a detailed crystallographic, optical, and chemical study of this mineral. Of the mineral, occurring in a nepheline syenite, he gave the following chemical analysis, made by the eminent Swedish analyst R. Mauzelius:

SiO <sub>2</sub>	34.26%
TiO <sub>2</sub>	35.15
ZrO <sub>2</sub>	11.92
Na <sub>2</sub> O	17.12
K <sub>2</sub> O	0.37
H <sub>2</sub> O	0.77
	99.59%

The material being very rare, Mauzelius had only 0.5727 g. of the mineral available for the analysis.

In the year 1922 A. E. Fersman's expedition found a related mineral in the nepheline syenite of the Kola Peninsula. This mineral, called ramsayite, was first described by E. Kostyleva and later by W. Gerassimowsky and a general mineralogical summary of it is given in the general description of the Kola Peninsula minerals edited by Fersman.<sup>2</sup> Previously Kostyleva pointed out that the two minerals, lorenzenite and ramsayite, show very marked similarities in the crystal forms as well as in their chemical composition. She suggested that they represent the same mineral species. The best analysis of ramsayite thus far, made by K. Beloglazov, is as follows:

SiO <sub>2</sub>	34.06%
TiO <sub>2</sub>	46.26
Al <sub>2</sub> O <sub>3</sub>	0.90
FeO	1.03
MnO	0.02
CaO	0.35
Na <sub>2</sub> O	16.20
K <sub>2</sub> O	0.28
Rare earths	0.32
Loss on ignition	0.33
	99.75%

<sup>1</sup> Flink, G., On the minerals from Narsarsuk on the Firth of Tunugdliarfik in Southern Greenland: *Medd. om Grönland*, Bd. 24, 1 (1901).

<sup>2</sup> Fersman, A. E., Minerals of the Khibina and Lovozero Tundras: *Lomonossov Institute of the Acad. Sci. USSR, Moscow and Leningrad (1937)*.

The first description of ramsayite by Kostyleva appeared in 1923. The refractive indices given by her deviated considerably from those of lorenzenite given by Flink. However, Barth and Berman<sup>3</sup> showed in the year 1930 that the refractive indices given by Flink were erroneous and that the true indices of ramsayite and lorenzenite were practically identical. Later Kraus and Mussgnug<sup>4</sup> determined the dimensions of the orthorhombic unit cell and found exactly the same values for both minerals.

Thus, the only circumstance in which ramsayite and lorenzenite differ from each other is in the chemical composition; lorenzenite, according to the analysis by Mauzelius, containing zirconium apparently in the place of titanium in the lattice. Zirconium has, however, not been found in ramsayite.

In a previous paper dealing with the chemistry of the mineral titanite,<sup>5</sup> I have presented a general mineralogical classification of the titanite group. In connection with this work I was interested in ramsayite. Professor Pentti Eskola placed at my disposal a very beautiful specimen of the mineral from the collections of the Institute of Geology of the University of Helsinki. The analysis by Beloglazov given above being somewhat incomplete, I asked Mr. Oleg v. Knorring, M. A., to make a chemical analysis of this specimen of ramsayite. In addition, Mr. Oiva Joensuu, M. A., made a number of spectroscopic determinations of those elements which could not be determined chemically. This analysis was made in order to determine whether water and fluorine could be thought to play similar roles in the ramsayite lattice as seems to be the case in titanite. In order to compare lorenzenite in this respect with ramsayite and titanite, I asked Professor Arne Noe-Nygaard of Copenhagen for some lorenzenite specimens. He very kindly sent me three samples of the mineral. From one of these samples I separated a very pure fraction of lorenzenite, amounting to about 3.3 g. Mr. v. Knorring and Mr. Joensuu analyzed this mineral also.

The results of the analyses of ramsayite and lorenzenite made by v. Knorring and Joensuu are given in Table 1. Table 2 contains the corresponding molecular numbers. As to the methods used, I refer to my previous paper on titanite mentioned above. Because of the fact that both ramsayite and lorenzenite are easily fusible on heating, the de-

<sup>3</sup> Barth, T., und Berman, H., Neue optische Daten wenig bekannter Minerale (Die Einbettungsmethode): *Chem. d. Erde*, Bd. 5, 22 (1930).

<sup>4</sup> Kraus, O., und Mussgnug, F., Identität von Lorenzenit und Ramsayit: *Naturwissenschaften*, Jahrg. 29, 182 (1941).

<sup>5</sup> Sahama, Th.G., On the chemistry of the mineral titanite: *Bull. Comm. géol. Finl.*, No. 138; *C.R. Soc. géol. Finl.*, No. XIX (1946) (In print).

termination of  $H_2O+$  was carried out by employing the Penfield tube, without using any fluxing material, as is necessary for titanite.

TABLE 1. ANALYSIS OF RAMSAYITE AND "LORENZENITE"

	Ramsayite Kola	"Lorenzenite" Narsarsuk, Greenland
SiO <sub>2</sub>	34.64	35.40
TiO <sub>2</sub>	45.01	43.16
Nb <sub>2</sub> O <sub>5</sub>	2.14	3.89
Ta <sub>2</sub> O <sub>5</sub>	0*	0*
V <sub>2</sub> O <sub>5</sub>	0.01	0.01
Al <sub>2</sub> O <sub>3</sub>	0.21	0.00
Fe <sub>2</sub> O <sub>3</sub>	0.00	0.00
Cr <sub>2</sub> O <sub>3</sub>	0.00	0.00
FeO	0.42	0.34
MgO	tr.	0.00
Sc <sub>2</sub> O <sub>3</sub>	0.003	0.003
ZrO <sub>2</sub>	0.11	0.07
CaO	0.08	0.19
SrO	0.007	0.010
BaO	0.00	0.00
Na <sub>2</sub> O	16.79	16.23
K <sub>2</sub> O	tr.	0.00
Y <sub>2</sub> O <sub>3</sub>	<0.01	0.02
La <sub>2</sub> O <sub>3</sub>	<0.01	0.01
Ce <sub>2</sub> O <sub>3</sub>	0.05	0.04
MnO	0.024	tr.
F	0.07	0.38
Cl	0.00	0.00
H <sub>2</sub> O+	0.48	0.42
H <sub>2</sub> O-	0.20	0.17
-0	0.03	0.16
Sum	100.22	100.18

\* If present less than 0.1 per cent.

The ramsayite and lorenzenite specimens given in Table 1 show very similar compositions, representing almost ideal sodium titanium silicates. Only the values of niobium are comparatively high, higher than in titanites. This observation for ramsayite is in complete agreement with the observation made by Borowsky and Blochin.<sup>6</sup> They found in ramsayite about 2.8 per cent Nb<sub>2</sub>O<sub>5</sub>, but no tantalum.

<sup>6</sup> Borowsky, I. B., and Blochin, M. A., The analysis of minerals by the  $x$ -ray spectroscopical method: *Bull. Acad. Sci. l'USSR, Cl. Math. Nat.*, Sér. Géol., No. 5, p. 929 (1937). (Russian with English summary).

TABLE 2. MOLECULAR NUMBERS OF THE ANALYSES GIVEN IN TABLE 1

	Ramsayite Kola		"Lorenzenite" Narsarsuk, Greenland
Si	575		587
Ti	562	} 588	538
Nb	16		29
Al	4		—
Fe <sup>II</sup>	6		5
Ca	1	} 542	3
Na	541		523
F	4	} 57	20
OH	53		47

Upon examining the analyses just given, it is, however, very surprising that the "lorenzenite" specimen, in contrast to the analysis by Mauzelius, shows practically no zirconia. The lorenzenite sample, analyzed by my co-workers, is an original one from the collections of Flink called "Type 1." In order to be sure that the mineral really is identical with ramsayite, as determined by Kraus and Mussgnug referred to above, powder photographs of the analyzed ramsayite and lorenzenite were taken. They are reproduced in Fig. 1. The identity of both photographs is evident.

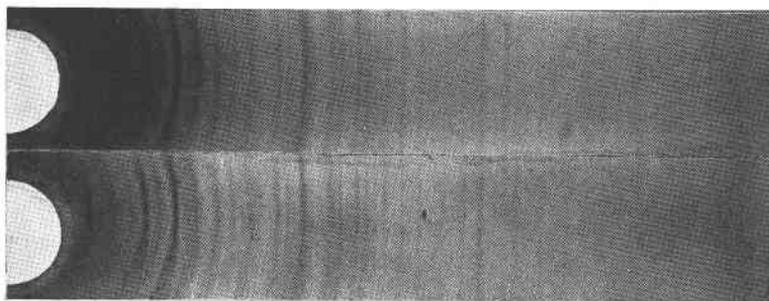


FIG. 1

(Above) Lorenzenite, Narsarsuk, Greenland.

(Below) Ramsayite, Kola Peninsula.

Considering the divergency in the zirconia content of the present lorenzenite analysis and that by Mauzelius, three possible explanations are suggested:

(1) The respective mineral samples analyzed by Mauzelius and studied by me are really different in composition. This would mean that both ramsayite and lorenzenite occur in the Narsarsuk locality.

(2) One of the analyses, either that by Mauzelius or the one by my co-workers, is erroneous. As to the present analysis, zirconium was checked by means of optical spectrography. Only very weak zirconium lines were detected. Hafnium was checked by means of  $\alpha$ -ray spectrography with a negative result. In accordance with this, no phosphate precipitate was obtained in the course of the chemical analysis. Accordingly, it is absolutely certain that the mineral analyzed does not contain any noticeable amounts of Zr or Hf. With regard to the analysis by Mauzelius, no more detailed account is given by Flink of the methods used. The original material used by Mauzelius has not been at my disposal. Therefore, I am not able to make any control determinations. The question whether the analysis of Mauzelius is correct or not, can thus not be answered with certainty.

(3) The material used by Mauzelius was impure. However, taking into account that the amount of zirconia is as high as 11.92 per cent, it is very unlikely that the material of Mauzelius was so impure. It is true, another zirconium mineral, elpidite, occurs in association with lorenzenite in Narsarsuk. This mineral can, however, be separated very easily from lorenzenite.

As seen from the above, it is at present not possible to judge with any certainty whether the validity of lorenzenite as a distinct variety of ramsayite is correct or not. It may very well be that an error has been made in the analysis by Mauzelius and, accordingly, that the name lorenzenite should be dropped from the mineral nomenclature. Mauzelius was, however, a very experienced analyst. Therefore, I would recommend a further control on the basis of new material collected at the respective locality before a definite decision is taken in the matter.

Another fact worth noting in the analyses given above is the slight deficiency of sodium. As seen from Table 2, the molecular numbers of Si and (Ti+Nb+Al+Fe) are practically equal, that of (Na+Ca) being slightly smaller. It might be suggested that the positions of Na in the lattice are partly vacant and a corresponding amount of oxygen atoms are replaced by fluorine or hydroxyl.

Finally, I would express my sincere thanks to all those mentioned above who have helped me in the present work by placing material at my disposal or making the chemical or spectrographical determinations. To Dr. Frans-E. Wickman of the Mineralogical Institute, Stockholms Högskola, Sweden, I am greatly indebted for his kind interest in discussing the matter.