

NOTES

ROGGIANITE, A NEW SILICATE MINERAL

Introduction

A calcium aluminium silicate with a high water content, retained at temperatures as high as 875° C, is presented as a new mineral, which has been approved prior to publication by the Commission for New Minerals and Mineral Names of the International Mineralogical Association.

Occurrence

The first samples of roggianite were found in a sodium feldspar dyke cutting across the gneiss at Alpe Rosso in Val Vigizzo, about 1.5 km south of Orcesco, commune of Druogno, Novara Province, Italy (Tavoletta Trontano, F° 15 II NE). There are normally some greenschists between the dyke and the gneiss. The dyke cuts across the stream, Rio Rabbi. From 1946 to 1963 the feldspar was exploited in a quarry, and was brought to Orcesco by a cableway; in 1963 the quarry was abandoned and the dyke was hidden by detritus; nevertheless the mineral can still be found in the discharge near the cableway station at Orcesco.

Roggianite occurs as whitish-yellow fibrous aggregates coating fractures of the feldspar dyke; thomsonite may be associated.

Crystallography

The fibrous aggregates of roggianite cannot be resolved under the binocular microscope; good rotating crystal X-ray photographs can easily be obtained, but every trial with moving-film methods was unsuccessful. Measurements of the rotation diagram gave a tetragonal cell with the dimensions $a = 18.37 \pm 0.07$ Å, $c = 9.14 \pm 0.04$ Å (fibre axis). (A first interpretation gave $a = 26$ Å $= 18.37 \times \sqrt{2}$; Dr J. A. Gard suggested adopting the smaller value.)

Density was determined using a torsion microbalance with toluene. The result was 2.02; this value is certainly too low, in view of the non-compact character of the aggregates. The indices of refraction, measured in Na light with the temperature variation method are:

$$\varepsilon = 1.535 \pm 0.001$$

$$\omega = 1.527 \pm 0.001$$

Interference figures could not be obtained. An electron diffraction study of roggianite is published in this issue by Gard (1969).

The X-ray powder data are collected in Table 2; the indexing takes into account the space groups proposed for roggianite by Gard (1969). The pattern changes neither after heating up to 650° C, nor after glycerol treatment.

Differential thermal analysis

The DTA curve of roggianite, obtained on a sample of 2 mg with a Du Pont thermal analyser, is reproduced in Fig. 1. The main features are as follows: at about 110° C there is a small endothermic peak due to loss of adsorbed water; between 200 and 500° C, a very broad exothermic reaction occurs, probably due to the burning of some occluded organic matter (see chemical analysis); at 874° C a sharp endothermic peak indicates the main loss of water; and at about 910° C a sharp exothermic peak is due to the recrystallization of the dehydrated substance. The last two features are very typical; their temperature is relatively high. Only serpentine and sepiolite minerals show similar reactions on heating but at somewhat lower temperatures; no framework silicate has a similar DTA curve.

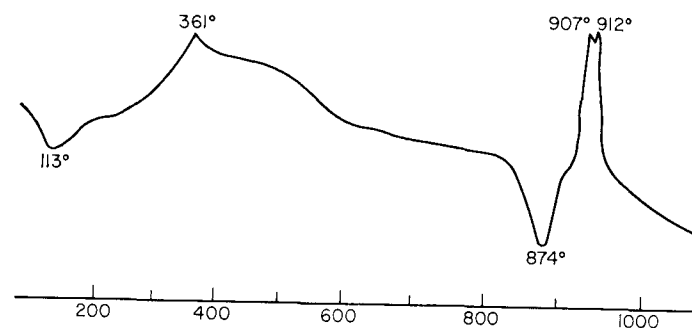


FIG. 1. DTA curve of roggianite.

TABLE 1. The chemical analysis of roggianite

SiO ₂	36.58	
Al ₂ O ₃	22.34	
Fe ₂ O ₃	0.42	
MgO	0.87	
CaO	14.73	
Na ₂ O	0.94	
K ₂ O	0.76	CO ₂ absent
H ₂ O (110° C)	4.49	P ₂ O ₅ absent
H ₂ O (1000° C)	17.14	Traces of Mn and Ti
SO ₃	0.32	
F	0.10	
Cl	0.05	
H	0.19	
C	1.43	
Total	100.36	
— O for F and Cl	0.05	
	100.31	

Chemical analysis

The analysis (Table 1) was performed on a sample of 200 mg, which contained small quantities of an unknown organic contaminant, which is also revealed by the carbonization which occurs when the sample is treated with concentrated sulphuric acid. The percentage of organic C can be considered exact, as no CO₂ is present in the sample; the percentage of H, on the contrary, is uncertain in view of the high water content, which in turn should not be affected by an important error, being more abundant than the organic impurity. Water loss from 110° C to 650° C is only 0.62% (see DTA curve). The mineral is readily soluble in strong acids.

TABLE 2. X-ray powder data for roggianite

<i>d</i> _{obs} (Å)	<i>I</i>	<i>hkl</i>	<i>d</i> _{calc} (Å)	<i>d</i> _{obs}	<i>I</i>	<i>hkl</i>	<i>d</i> _{calc}
13.08	vs	110	12.987	2.26	w	{ 552	2.259
9.27	s	200	9.185			{ 712	2.259
6.13	s	211	6.112			{ 811	2.212
5.81	mw	310	5.810	2.19	vw	{ 741	2.212
4.33	w	{ 330	4.329			{ 660	2.165
		{ 112	4.315			{ 613	2.145
				2.14	vw	{ 750	2.137
4.12	mw	{ 420	4.110			{ 732	2.134
		{ 202	4.092			{ 840	2.055
3.74	w	222	3.738	2.05	vw	{ 802	2.053
3.60	ms	{ 510	3.602			{ 404	2.046
		{ 312	3.593			{ 910	2.028
3.41	ms	{ 431	3.410	2.02	vw	{ 334	2.021
		{ 440	3.247				
3.22	mB	{ 402	3.240	1.93	mw		
		{ 521(?)	3.197	1.85	m		
				1.82	w		
3.13	m	{ 530	3.151	1.79	mw		
		{ 332	3.144	1.72	mw		
2.88	mB	{ 620	2.905				
2.82	m	{ 611	2.869	1.70	vw		
2.67	w	{ 512	2.830	1.52	w		
2.62	vw	{ 442	2.648				
		{ 631	2.624				
2.57	vw	{ 323	2.615				
		{ 550, 710	2.597				
2.53	mw	{ 532	2.595				
		{ 640	2.548				
2.45	mw	{ 602	2.545				
		{ 413	2.515				
2.37	vw	{ 622	2.452				
		{ 721	2.433				
2.31	mwB	{ 433	2.346				
		{ 800	2.297				

The calculation of the chemical formula, as represented in Table 3, has been done for numbers of oxygen atoms which are multiples of four, the mineral being tetragonal. Bearing in mind that obviously the exact formula will be known only after the solution of the structure, the formula with 92 oxygens is preferred for the following reason: the experimental value of the density is 2.02, but the real value must be somewhat higher, because of the porous nature of the sample; with 92 oxygens one gets $D = 2.12$ and with 96 the value is $D = 2.21$, which is probably too high. The water lost at 110° C has not been taken into consideration in the chemical formula, because it is presumably only adsorbed moisture. This opinion is supported by the following experiment; the thermogravimetric curve shows a water loss of about 10% at 300° C, but after cooling the sample readsorbs water strongly from the atmosphere until the weight loss is reduced to about 4.5%, which is almost exactly the value found for water loss at 110° C with the standard procedure.

With 92 oxygens, the formula could be

$$(K_{0.67}Na_{1.28}Ca_{11.02}Mg_{0.90})_{tot} = 13.87 (Fe_{0.22}Al_{15.96})_{tot} = 16.18$$

$$(Al_{2.43}Si_{25.57})_{tot} = 28.00 (O_{92}39.95H_2O), \text{ or } Na_2Ca_{12}Al_{16}(Si_{26}Al_2)O_{92} \cdot 40 H_2O$$

As the 40 water molecules of this formula are lost only at 875° C, they belong to hydroxyls and the formula then becomes $Na_2Ca_{12}Al_{16}[Si_{26}Al_2]O_{92}(OH)_{80}$. In these formulae K, Na, Ca and Mg are grouped together, as is usual both in zeolites and sheet-silicates. The author does not think that roggianite is a zeolite or a framework silicate, since the ratio aluminium: cations is far from the theoretical value for these mineral, also the DTA curve is completely different from those given by the above mentioned minerals, and is similar to those given by sepiolite and serpentine.

In the proposed formula, the coefficients for (Si, Al) and for (Al, Fe^{III}) are multiples of four, whereas the coefficient of (K, Na, Ca, Mg) is a multiple of two. Twofold positions are possible in many tetragonal space groups, also the possibility of an incomplete cation occupancy of some positions in the cell can not be discarded. A complete structure determination is in progress.

TABLE 3. The chemical formula of roggianite

	Atomic ratio		Unit cell contents			
	%					
Si	17.10	0.6088	23.91	24.46	25.57	26.68
Al	11.82	0.4381	17.20	17.60	18.39	19.19
Fe ^{III}	0.29	0.0052	0.21	0.21	0.22	0.23
Mg	0.52	0.0214	0.84	0.86	0.90	0.94
Ca	10.53	0.2627	10.31	10.55	11.02	11.50
Na	0.70	0.0304	1.20	1.23	1.28	1.34
K	0.63	0.0161	0.63	0.64	0.67	0.70
O	35.05	2.1906	86.00	88.00	92.00	96.00
H ₂ O	17.14	0.9514	37.36	38.22	39.95	41.69
<i>D</i> _{calc}			1.98	2.03	2.12	2.21

Name

The mineral name is from Aldo G. Roggiani, a teacher of natural sciences in the 'Liceo' of Domodossola, an enthusiastic mineralogist and an expert on the mineralogy of Val d'Ossola, who first found the mineral and called the author's attention to it.

Acknowledgments

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REFERENCE

GARD J. A. (1969) *Clay Miner.* 8, 112.