

HINGGANITE-(Yb), A NEW MINERAL FROM AMAZONITE PEGMATITE OF THE KOLA PENINSULA

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Translated from "Khinganit Itterbiyevyy—Novyy mineraliz amazonitovykh pegmatitov kol'skogo poluostrova," *Doklady AN SSSR, Mineralogiya*, 1983, vol. 270, No. 5, pp. 1188–1192. The authors are with the Geological Institute of the Kola Branch of the Academy of Sciences of the USSR, the Institute of Geochemistry and Physics of Minerals of the Academy of Sciences of the USSR, Kiev. The article was selected for translation and publication because it describes a new mineral from granite pegmatites, the first known in which ytterbium is the predominant rare earth element. *M.F.*

The mineral was found in amazonite pegmatites of the Kola Peninsula and named hingganite-(Yb),¹ according to the classification of rare-earth minerals accepted by the International Mineralogical Association [1].

The mineral forms spherical aggregates of fine acicular crystals, which grow on faces of crystals of plumbomicrolite amidst platy albite and quartz and is also located in violet fluorite (Fig. 1). The maximum diameter of the aggregate is 2 mm.; the width of separate individuals is 0.1–0.2 mm.

The mineral is colorless, transparent. Luster vitreous. Cleavage is absent. Hardness 6.5–7. Density 4.83 (calculated from the empirical formula) and 4.72 g/cm³ (according to the Gladstone-Dale rule). In ultraviolet light has no luminescence, does not slow in cathode rays. The mineral is optically biaxial, positive, $2V = 65^\circ$, $\alpha 1.725$, $\beta 1.738$, $\gamma 1.760$, $Z_{Ac} = 23^\circ$, $X_Aa = 20^\circ$. Plane of optic axis (010).

The chemical composition of the mineral is given in Table 1, where for comparison is given the composition of hingganite-(Y)

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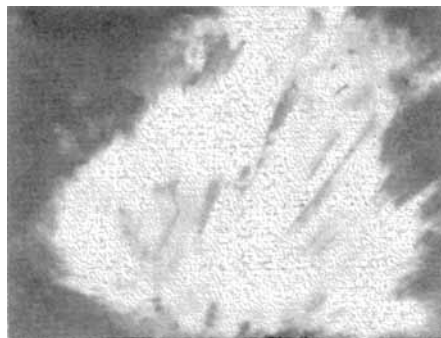


FIGURE 1. Radiating aggregate of crystals of hingganite-(Yb) in fluorite; oblique illumination, X95.

from amazonite pegmatite of the Kola Peninsula. Other elements of atomic number higher than 11, besides those mentioned in Table 1, were not found in the mineral. The minerals were analyzed in several samples, at not less than 10 points in each sample (time of each measurement 10 seconds). Calculation of the relative intensities to concentration was made on the EVM "Nairi-2" according to an original program [4]. The content of BeO was determined by A. I. Kozlenkov on an x-ray-micro-analyzer of original construction in the institute of Metallurgy, Academy of Sciences, U.S.S.R., using gadolinite and beryl as standards [3].

TABLE 1. Chemical Composition of Hingganite-(Yb)

Oxides	Hingganite	Hingganite-(Yb)			
		Wt. %	AK _K	AK _O	K _K
Y ₂ O ₃	24.83	8.56	0.0758	0.1137	0.20
Yb ₂ O ₃	17.02	34.07	0.1729	0.2593	0.45
Er ₂ O ₃	6.47	8.22	0.0429	0.0644	0.11
Dy ₂ O ₃	2.13	2.47	0.0132	0.0198	0.03
Gd ₂ O ₃	0.45	0.11	0.0006	0.0009	—
Lu ₂ O ₃	1.87	4.50	0.0226	0.0339	0.06
Tm ₂ O ₃	1.38	3.10	0.0160	0.0241	0.04
Ho ₂ O ₃	0.21	1.03	0.0054	0.0081	0.01
Tb ₂ O ₃	0.33	0.05	0.0002	0.0004	—
CaO	2.38	1.14	0.0203	0.0203	0.05
Fe ₂ O ₃	1.46	—	—	—	—
PbO	0.52	—	—	—	—
Al ₂ O ₃	0.10	—	—	—	—
SiO ₂	26.43	22.11	0.3679	0.7359	0.96
BeO	10.50	10.90	0.4358	0.4358	1.13
H ₂ O	3.92	3.74	0.4163	0.2081	1.08
Total	100.00	100.00		1.9247	

Notes—H₂O content by difference AK_K is the atomic amount of cations; AK_O is the atomic amount of oxygen; K_K is the number of atoms calculated to 5 atoms of oxygen. The analyses were made on the electron micro-analyzer MS-46 "Cameca", impressed voltage 15 kV (25 kV for Y and Pb), current of probe 40 nA; analytical lines: K α for Ca, Fe, Al, Si, Y; L α for Yb, Er, Dy, Gd, Pb, Lu, Tm, Ho, Tb; synthetic compound Y₃Al₅O₁₂ (Y and Al), PbSe(Pb), LiRE(MoO₄)₂ (RE = Yb, Er, Lu, Tm, Gd, Th); LiRE(WO₄)₂ (RE = Dy, Ho).

Calculation of the chemical composition of hingganite-(Yb), taking O = 5, leads to the formula

(Yb_{0.45}Y_{0.20}Er_{0.11}Lu_{0.06}Ca_{0.05}Tm_{0.04}Dy_{0.03}Ho_{0.01})_{0.95}H_{1.08}Be_{1.13}Si_{0.96}O₅. The idealized formula of the mineral is (Yb, Y)BeSiO₄(OH), where Yb > Y.

X-ray single-crystal photographs on the automatic diffractometer PI "Syntex" show that the mineral is monoclinic, space group P2₁/a, unit cell parameters: a₀ = 9.888(5), b₀ = 7.607(3), c₀ = 4.740(2)Å, β = 90.45(4)°, Z = 4. The x-ray powder photograph of the mineral is analogous to that of the synthetic compound H₂Y₂Be₂Si₂O₁₀ [2]. The interplanar spacings of the mineral and the compounds mentioned are given in Table 2.

The infra-red spectrum of the mineral contains absorption bands: 35,00 3450, 1620,

1420, 100, 980, 907, 795, 770, 710, 573, 495, 450, and 430 cm⁻¹. (emphasis on the most intensive). In its configuration the infra-red spectrum is similar to those of gadolinite and the synthetic compound H₂Y₂Be₂Si₂O₁₀ [2]. The absorption bands with maxima 3500 and 3450 cm⁻¹ are valence oscillations of hydroxyl (Y₃OH). The absorption bands at 1620 and 1420 cm⁻¹ are apparently explained by small admixtures in the mineral of carbonate and molecular water. Three more intense absorption bands of the infra-red spectrum are at 1000, 980, and 907 cm⁻¹ (Fig. 2) and are referred to valence oscillation Y₃ of Si-O bonds, indicating deformation of the forms of SiO₄ tetrahedra in the structure of the mineral. Possibly the maximum at 907 cm⁻¹ corresponds to deformational vibration of the OH-group. The intense absorption band with two maxima at 795 and 770 cm⁻¹ correspond to valence oscillations Be-O₄. The bands of medium intensity

TABLE 2. Interplanar Spacings of Hingganite-(Yb), A

Hingganite-(Yb)				H ₂ Y ₂ Be ₂ Si ₂ O ₁₀ [2]		
I	d _{meas}	d _{calcd}	hkl	I	d	hkl
7	6.06	6.03	110	20	6.021	110
2	4.96	4.94	200	5	4.924	200
6	4.76	4.74	001	15	4.724	001
4	4.16	4.14	210	10	4.137	210
6	3.74	3.73	11 $\bar{1}$, 111	20	3.724	111
				20	3.709	1 $\bar{1}$ 1
5	3.57	3.55	120	20	3.545	120
6	3.45	3.43	201, 20 $\bar{1}$	20	3.420	201
				20	3.401	2 $\bar{0}$ 1
10	3.13	3.13	211, 21 $\bar{1}$	80	3.120	211
				80	3.106	2 $\bar{1}$ 1
4	3.03	3.02	310	15	3.013	310
5	2.97	2.97	021	20	2.960	021
10	2.85	2.845	12 $\bar{1}$	100	2.835	1 $\bar{2}$ 1
8	2.572	2.557	31 $\bar{1}$	50	2.552	311
8	2.542	2.541	311	50	2.538	3 $\bar{1}$ 1
2	2.465	2.456	130	10	2.461	130
4	2.378	2.369	002	15	2.361	002
4	2.355	2.350	410	20	2.344	410
5	2.262	2.256	230	25	2.254	230
6	2.206	2.210	32 $\bar{1}$	30	2.203	321
		2.200	321	30	2.194	3 $\bar{2}$ 1
1	2.133	2.130	202			
2	2.103	2.099	411			
1	2.038	2.040	23 $\bar{1}$	10	2.038	231
		2.034	231	10	2.033	2 $\bar{3}$ 1
1	2.016	2.010	330	5	2.007	330
8	1.977	1.973	12 $\bar{2}$	30	1.968	122
		1.968	122	30	1.962	1 $\bar{2}$ 2
2	1.907	1.902	040	10	1.900	040
5	1.878	1.872	31 $\bar{2}$	20	1.855	3 $\bar{1}$ 2
5	1.857	1.853	33 $\bar{1}$	20	1.850	331
6	1.776	1.770	430	5	1.770	430
3	1.759	1.754	520	5	1.751	520
2	1.706	1.704	402	5	1.698	402
1	1.682	1.675	41 $\bar{2}$	10	1.668	412
5	1.665	1.663	41 $\bar{2}$	10	1.660	4 $\bar{1}$ 2
5	1.656	1.655	431	30	1.654	431
5	1.641	1.641	521			
5	1.633	1.631	23 $\bar{2}$			
2	1.567	1.565	42 $\bar{2}$			
2	1.552	1.552	601			
2	1.511	1.512	620			
2	1.486	1.484	53 $\bar{1}$			
4	1.447	1.448	051			
2	1.438	1.438	44 $\bar{1}$			
1	1.418	1.418	242			
2	1.409	1.405	522			
2	1.396	1.396	313			
4	1.329	1.328	63 $\bar{1}$			
2	1.282	1.280	052			

TABLE 2. (cont'd)

Hingganite-(Yb)				$H_2Y_2Be_2Si_2O_{10}$ (2)		
I	d_{meas}	d_{calcd}	hkl	I	d	hkl
2	1.271	1.270	622			
1	1.259	1.257	160			
3	1.247	1.248	451			
1	1.239	1.239	$50\bar{3}$			
3	1.217	1.217	$70\bar{2}$			
2	1.197	1.197	632			
2	1.191	1.191	352			
2	1.185	1.184	004			
2	1.181	1.181	243			
2	1.152	1.152	722			
1	1.136	1.136	603			
1	1.125	1.124	$12\bar{4}$			
2	1.113	1.113	$53\bar{3}$			
1	1.098	1.098	$46\bar{1}$			
3	1.091	1.091	$26\bar{2}$			
2	1.063	1.061	911			
3	1.038	1.038	$54\bar{3}$			

Notes—Conditions of photography: RKU-camera 114.6 mm., Fe-radiation, internal standard NaCl.

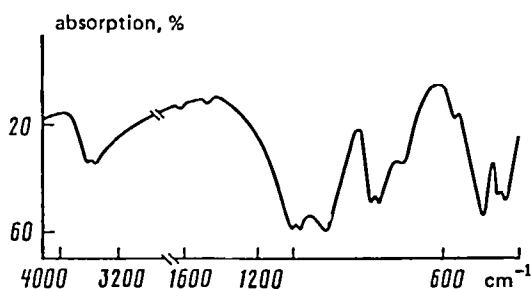


FIGURE 2. Infra-red spectrum of hingganite-(Yb).

with maxima 495, 450, and 430 cm^{-1} belong to deformational vibration of SiO_4 bonds. It is not excluded, however, that in the latter two bands there are also hidden some bands of valence vibrations (Yb, Y)- O_8 .

Hingganite-(Yb) is one of the late minerals of amazonite pegmatite and is formed as the

result of alteration, in all probability, of gadolinite, under conditions of selective enrichment of the solution in ytterbium. It occurs in association with a diorthosilicate of ytterbium, having the structure of thortveitite.

Standard samples of hingganite-(Yb) are preserved in the Mineralogical Museum, Acad. Sci. U.S.S.R., Moscow.

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