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## Aluminian xanthophyllite and paragonite from Japan

XANTHOPHYLLITE<sup>1</sup> from the 900-m level of the Dōshinkubo ore deposit, Chichibu mine, Saitama Prefecture, Japan, was described by Harada, Kodama, and Sudo (1965). Very similar material occurs in the 800-m level of the same mine as a constituent of pre-ore skarn, closely associated with diopside, wollastonite, idocrase, ellestadite, calcite, and thaumasite (Harada, Nagashima, Nakao, and Kato, 1971). The atomic ratios show that it has more dioctahedral character and is richer in aluminium than any xanthophyllite hitherto described. Chemical, optical, and X-ray data are included in Table I, with those of a margarite from the Shinkiuura mine, Ōita Prefecture (Aoki and Shimada, 1965) for comparison. The optical absorption spectrum of this xanthophyllite is shown in fig. 1. In analogy with the assignments of Faye (1968) for the spectra of biotite, phlogopite, and chlorite, the 25300  $\text{cm}^{-1}$  and 22300  $\text{cm}^{-1}$  bands of the xanthophyllite may be spin-forbidden  $d-d$  bands of octahedrally coordinated  $\text{Fe}^{2+}$ , the 11800  $\text{cm}^{-1}$  and 9800  $\text{cm}^{-1}$  bands may be spin-allowed  $d-d$  transitions of  $\text{Fe}^{2+}$ , and the 14500  $\text{cm}^{-1}$  band charge-transfer between  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ . The weakness of this last

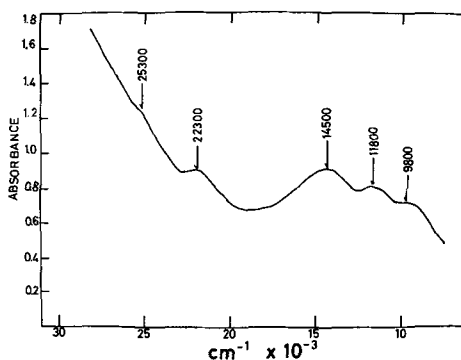


FIG. 1. Absorption spectrum of xanthophyllite; crystal flake 0.31 mm thick.

<sup>1</sup> This name is used here in its original sense, as a variety of clintonite low in Si, rather than the optical definition given by Deer, Howie, and Zussman (1962); there is no evidence that xanthophyllite from the type locality differs from clintonite in its optical orientation.

TABLE I. Chemical, optical, and X-ray data for aluminian xanthophyllite, paragonite, margarite, muscovite, and albite. H. Sekino, analyst

	1	2	3	4	5		1'	2'	3'	4'
SiO <sub>2</sub>	17.13	27.20	44.82	44.52	67.10	Si	1.204	1.800	2.870	2.943
Al <sub>2</sub> O <sub>3</sub>	45.46	51.35	39.37	35.31	20.17	Aliv	2.796	2.200	1.130	1.058
Fe <sub>2</sub> O <sub>3</sub>	0.06	Nil	Nil	1.63	—	Alvi	0.969	1.804	1.841	1.692
FeO	1.34	1.88	1.11	1.11	—	Fe <sup>3+</sup>	0.003	—	—	0.081
MnO	tr.	Nil	tr.	0.47	—	Fe <sup>2+</sup>	0.078	0.094	0.059	0.061
MgO	17.48	0.04	0.06	Nil	0.04	Mg	1.830	0.004	0.006	—
CaO	13.89	12.77	0.45	Nil	—	Mn	tr.	Li 0.021	Mn —	0.026
Na <sub>2</sub> O	0.02	0.53	8.11	1.06	11.97	Σoct	2.880	1.904	1.896	1.860
K <sub>2</sub> O	0.17	0.13	0.43	9.86	—	Ca	1.046	0.905	0.031	—
Li <sub>2</sub> O	Nil	0.08	Nil	Nil	—	Na	0.003	0.068	1.006	0.136
H <sub>2</sub> O	4.20	6.00	5.51	5.88	—	K	0.015	0.011	0.035	0.831
F	0.08	0.05	0.10	0.01	—	Σint	1.064	0.974	1.072	0.967
Sum	99.83	99.98	99.96	99.84	99.29*	OH	1.968	2.647	2.352	2.951
Less										
O ≡ F	0.03	0.02	0.05	—		F	0.017	0.010	0.020	0.002
Total	99.80	99.96	99.91	99.84		ΣOH, F	1.985	2.657	2.372	2.953
						O	10.015	9.343	9.628	9.047
<i>a</i>	5.210(12)	5.121(4)	5.140(4)	5.207(6)	—	α	1.652	1.637	1.577	1.566
<i>b</i>	9.014(6)	8.894(7)	8.909(9)	9.022(5)	—	β	1.663	1.648	1.607	1.597
<i>c</i>	9.827(6)	19.232(6)	19.357(8)	20.077(7)	—	γ	1.664	1.650	1.612	1.605
β	100.23(12) <sup>o</sup>	95.46(1) <sup>o</sup>	94.58(1) <sup>o</sup>	95.74(6) <sup>o</sup>	—	2 <i>V</i> <sub>α</sub>	17.0 <sup>o</sup>	60.5 <sup>o</sup>	47.5 <sup>o</sup>	41.0 <sup>o</sup>
Sp. gr.	3.087	3.041	2.927	2.869	—					
Type	1M	2M <sub>1</sub>	2M <sub>1</sub>	2M <sub>1</sub>	—					

1. Xanthophyllite from the 800-m level of the Doshinkubo, Chichibu mine.

2. Margarite from the Skinkiura mine.

3. Paragonite from Kabo, Oya-machi, Hyogo Prefecture.

4. Muscovite from Arayashiki, Ishikawa-gun, Fukushima Prefecture.

5. Albite from Kabo, Oya-machi, Hyogo Prefecture; obliquity ( $2\theta_{131-1\bar{1}1}$ ) 1.08<sup>o</sup>; α 1.529, γ 1.538. 2*V*<sub>γ</sub> 80 to 85<sup>o</sup>.

\* Including TiO<sub>2</sub> 0.01. Electron-probe analysis by Kô-ichi Tazaki.

All refractive indices ± 0.001.

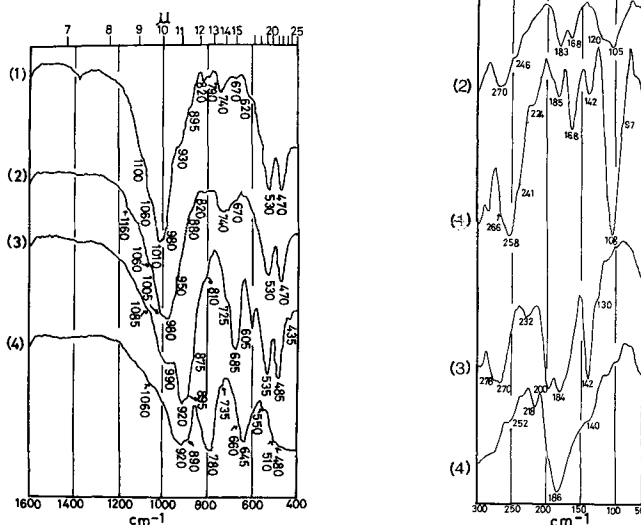


FIG. 2. Infra-red (left) and far infra-red (right) spectra of aluminian xanthophyllite (4), compared with those of margarite (3), muscovite (2), and paragonite (1).

band and the appearance of the spin-forbidden and spin-allowed *d-d* bands of  $\text{Fe}^{2+}$  is in agreement with the chemical analysis, which shows the iron to be almost all ferrous.

A paragonite from Kabo, Ōyamachi, Yabu-gun, Hyogo, Japan, occurring in pale pink crystals averaging 1 cm thick and 2 to 3 cm across, is nearer the end-member than any paragonite hitherto described; it occurs in close association with albite and jadeite in serpentine of the Sangun metamorphic belt. Chemical, optical, and X-ray data for the paragonite and albite are included in Table I, together with data for a muscovite, occurring in crystals averaging 2 cm thick and 15 cm across with albite and microcline in a granite pegmatite at Arayashiki, Ishikawa-machi, Ishikawa-gun, Fukushima Prefecture, Japan.

Infra-red spectra of the xanthophyllite and paragonite are shown in fig. 2 together with spectra of the above muscovite and margarite for comparison. It will be seen that the spectra of paragonite and muscovite differ most widely in the 90 to 150  $\text{cm}^{-1}$  region, where the vibrations of the interlayer cations occur (Ishii, 1969). The spectrum of the xanthophyllite is similar to that published by Farmer and Velde (1973) for material from the type locality, Zlatoust.

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