

The Occurrence of Liebigite from Tsukiyoshi Orebody of the T $\hat{o}$ n $\hat{o}$ Mine, Gifu Prefecture, Japan

By

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Introduction

Liebigite, $\text{Ca}_2[\text{UO}_2(\text{CO}_3)_3] \cdot 10\text{H}_2\text{O}$, is a supergene uranium mineral formed from alkaline solutions including uranyl and carbonate ions, and is found in near surface parts of uraniferous sedimentary rocks and ore deposits.

The first liebigite occurrence in Japan is here described from Tsukiyoshi orebody of the T $\hat{o}$ n $\hat{o}$ mine, Gifu Prefecture. It is found as a precipitate from a circulating underground water in association with andersonite and gypsum. They occur as efflorescence on adit wall composed of sandstone and conglomerate occasionally including such zeolites as clinoptilolite and chabazite overlying a granite body.

The present paper reports the mode of occurrence, X-ray powder pattern and optical data including the determination of optical orientation.

The studied materials were collected during the field trip planned by Geological Society of Japan in April 1976, under the guidance of Dr. Koji WATANABE of Shinshu University, Dr. Hiroshi TAKASE and Mr. Kiyozumi HIRAKAWA of Ch $\hat{u}$ bu Survey Office, Power Reactor and Nuclear Fuel Development Corporation, to whom the author expresses his sincere thanks. He is also very much indebted to Dr. Akira KATO, National Science Museum, for his many useful advices pertinent to the descriptive work.

The Mode of Occurrence

The studied materials were obtained from the unique exploitation adit of Tsukiyoshi orebody of the T $\hat{o}$ n $\hat{o}$ mine. The orebody is located near Shizugahora, Mizunami City, Gifu Prefecture (Fig. 1), and is the largest one in the mine in dimension. It is developed in the basal conglomerate of a Miocene sedimentary sequence, which covers Cretaceous biotite granite belonging to Naegi-Agematsu type granite (ITOIGAWA, UEMURA and KIKUCHI, 1967). The original uranium-bearing mineral in the orebody has not yet been found, but uranium is remarkably concentrated in a loose sand forming the matrix of the basal conglomerate. The uranium contents of ores near the collection site range from 0.1 to 0.15 U_3O_8 weight percent after the unpublished data of the T $\hat{o}$ n $\hat{o}$ mine.

Liebigite occurs as thin yellowish green earthy to translucent efflorescence of

less than 1 cm across on less greenish andersonite (after the unpublished data of the Tōnō mine) and gypsum. The maximum size of individual crystals reaches 0.1 mm. The other close associates are quartz, clinoptilolite and chabazite.



Fig. 1.

Fig. 1. The index map of the Tōnō mine, Gifu Prefecture
Cross hatched: exposed biotite granite. Shaded: underground and exposed uranium ore-body. Crossed hammar mark: location of exploitation adit of the Tōnō mine.

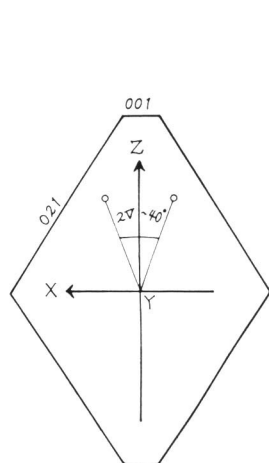


Fig. 2.

Fig. 2. The idealized drawing of the optical orientation of liebigite

Liebigite and andersonite are obviously of current formation from the circulating underground water under nearly definite temperature, about 20°C, and very high humidity. Although it is not certain whether liebigite is a direct precipitate from the circulating water or secondarily derived product from andersonite, liebigite is always found on andersonite efflorescence.

Physical Properties

Liebigite is yellowish green and somewhat deeper in colour than the associated andersonite allowing the sight discrimination. It is strongly fluorescent as andersonite under long and short wave ultraviolet lights giving off bluish green colour like andersonite.

The refractive indices measured by the immersion method are $\alpha=1.498$ (2), $\beta=1.502$ (calculated), $\gamma=1.542$ (2), $\gamma-\alpha=0.044$, (+)2 V about 40°, dispersion $r>v$ distinct. Optical orientation is determined as shown in Fig. 2 from the measurement of interfacial angle under the microscope.

Table 1. X-ray powder data for liebigites from Joachimsthal, Bohemia and Tônô mine, Gifu Prefecture, Japan

1.			2.				
d (Å)	I	hkl	d (Å)	I	Qobs	Qcal	hkl
8.68	90	020	8.82	80	0.0129	0.0130	020
8.27	10	200	8.40	40	0.0142	0.0143	200
6.81	100	002	6.836	100	0.0214	0.0211	002
		121				0.0219	121
6.11	20	220	6.087	25	0.0270	0.0273	220
5.40	90	022	5.407	90	0.0342	0.0341	022
		202					
4.95	10	311					
4.55	60	222	4.539	40	0.0485	0.0484	222
4.17	10	400					
4.04	20	410	4.055	65	0.0608	0.0605	410
		141				0.0607	141
3.95	10	123	3.941	15	0.0644	0.0641	123
		232				0.0646	232
3.75	20	420					
			3.705	20	0.0728	0.0729	042
3.58	30	402	3.564	35	0.0787	0.0784	402
3.33	50	151	3.343	100*	0.0895	0.0894	341
						0.0899	151
3.31	50	422	3.302	50	0.0917	0.0914	422
3.19	10	204					
		511					
3.10	60	143	3.112	60	0.1033	0.1029	143
3.02	10	333					
		440					
			2.988	25	0.1120	0.1118	224
2.84	10		2.824	10	0.1254	0.1255	161
2.77	10						
2.66	10		2.684	25	0.1388	0.1388	115
2.57	30		2.574	20	0.1509	0.1506	244
2.44	10		2.443	20	0.1676	0.1675	315
2.37	20		2.361	5	0.1794	0.1793	632
2.30	20		2.295	15	0.1899	0.1901	006
2.26	20		2.214	20	0.2040	0.2044	206
2.15	40		2.162	15	0.2139	0.2135	604
			2.145	15	0.2173	0.2174	226
2.10	10		2.086	20	0.2298	0.2294	800
2.02	10						
1.998	50		1.992	25	0.2520	0.2522	165
			1.985	25	0.2538	0.2537	812
1.957	10						
1.911	10		1.901	25	0.2767	0.2767	290
1.884	10		1.883	20	0.2820	0.2812	840
1.830	10						
			1.800	25	0.3086	0.3086	921

Table 1. (Cont'd)

1.			2.				
d (Å)	I	hkl	d (Å)	I	Qobs	Qcal	hkl
			1.784	20	0.3142	0.3139	804
1.716	50		1.720	10	0.3380	0.3379	008
1.670	30		1.671	15	0.3581	0.3584	10.0.0
			1.665	15	0.3607	0.3612	294
			1.618	15	0.3820	0.3819	773
1.561	20						
1.533	10						
1.484	10						
1.473	20		1.464	10	0.4666	0.4666	0.12.0
$a_0=16.71 \text{ \AA}$			$a_0=16.70 \text{ \AA}$				
$b_0=17.55 \text{ \AA}$			$b_0=17.57 \text{ \AA}$				
$c_0=13.79 \text{ \AA}$			$c_0=13.76 \text{ \AA}$				

1. Liebigite, Joachimsthal, Bohemia. Cu/Ni radiation. JCPDS Card No. 11-296. Indexed by L. G. BERRY.
2. Liebigite, Tsukiyoshi Orebody, Tōnō mine, Gifu Prefecture, Japan. Cu/Ni radiation. Diffractometer method. (*intensity is enhanced due to admixed quartz)

X-ray Studies

The X-ray powder pattern obtained by the diffractometer method employing Ni-filtered Cu radiation is given in Table 1, in which that of Bohemian liebigite is compared. The unit cell parameters calculated from the obtained pattern referring to the space group Bba2 are $a_0=16.70 \text{ \AA}$, $b_0=17.57 \text{ \AA}$, $c_0=13.76 \text{ \AA}$.

X-ray fluorescent analysis was made on the same material as studied by X-ray powder method. It showed that calcium and uranium were the essential components of this mineral, and strontium and barium were not found.

References

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