DATOLITE AND ASSOCIATED MINERALS FROM THE IWATO COPPER MINE, MIYAZAKI PREFECTURE.

(Supplement to the Studies on Japanese Boron Minerals)

By

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1. Introduction.

The Iwato copper mine is situated in Kawachi, Iwato village, West-Usuki County, Miyazaki Prefecture and is about 6 kilometers southwest of the Mitate tin mine.

The geologic structures of this district, the geologic relations of the ore deposits and the principal minerals in the ore deposits were investigated and described by K. MATSUSHITA[1] of the Kyushu University and T. MAKI[2] of this Department.

The rocks of this district comprise limestone, clayslate and quartzite, all of Palaeozoic age. The Palaeozoic rocks are intruded by granite. At the contact of the granite with the limestone, the copper ore bodies and groups of skarn minerals and of pneumatolytic minerals have been developed.

The minerals, being found in this mine, are chalcopyrite, cubnite, pyrite, pyrrhotite, galena, zincblende, molybdenite, arsenopyrite, calcite, magnetite. garnets, epidote, wollastonite, vesuvianite, axinite, lievrite, hedenbergite, tourmaline, diopside, datolite and prehnite.

Three crystals of the datolite were first collected by K. TAKIMOTO of the Kyushu University in January of 1941. I visited the university in April of the same year and observed them. Later I made a tour of collection of minerals at the mine. At that time, the mine was already ceased its works. I could not enter the adits, nor collect a fragment of the datolite in the mine dumps. But fortunately I collected five

(1) K. MATSUSHITA : Jap. Jour. Assoc. Petrol. Miner. Econ. Geol. 15 (1935), 115-123. Res. Rep. Fac. Sci., Kyushu Imp. Univ., Geol. 1 (1941), 1-13.

(2) T. MAKI : Graduation Thesis of this Department. (1937).

datolite crystals which were picked up, from the caretaker of the mine. Two years later I visited to the mine again and collected two datolite crystals which were found two years ago from the villagers.

It was said that about ten datolite crystals were found from the mine, sothat I was to collect half of them.

2. Datolite.

In Japan, datolite has been found in following localities:

i) Nakagoya, Obira mine, Hasegawa village, Oono County, Ooita Prefecture.

ii) Nikudaki, Noborio, Iwato village, West-Usuki County, Miyazaki Prefecture.

The occurrence of datolite is limited in small district in Japan, only in the central region of Kyushu. Later we have heard very scarce about them. The above mentioned new locality is in the same village of (ii) locality.

The datolite crystals from both localities form the same pseudo-rhombohedral crystal, being principally composed of x (102) and ε ($\bar{1}12$), and are flattened tabular, parallel to the form x (102). The marked characteristic of the crystal is the unusual development of x (102).

Physical, optical and chemical properties of datolite crystals from Noborio were studied by the author[3].

The color of the datolite from the Iwato copper mine is pale bluish white to colorless and tranparent to translucent. Crystal faces differ in brilliancy by the degree of etching and x (102) is always dull and rough.

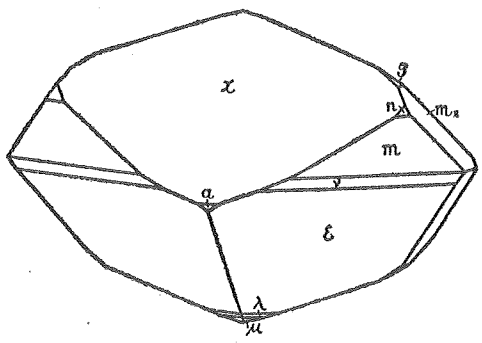

Fig. 1. Crystal of datolite, showing all the forms observed at this locality.

Forms.

The crystals were well formed, but examinations on the goniometer show the faces to be rough, so that crystal measurements were not entirely satisfactory. Following forms were noted.

x (102)	ε ($\bar{1}12$)	m_x (011)
g (012)	a (100)	m (110)
n (111)	ν ($\bar{1}11$)	λ ($\bar{1}13$)
μ ($\bar{1}14$)		

(3) Z. Harada: Journ. Fac. Sci., Hokkaido Imp. Univ., Ser. IV, 4 (1938), 475-485.

The dominant forms are x (102) and ε ($\bar{1}12$). Both occur in all crystals. x (102) is always dull and rough by natural etching. Forms m (110) and m_x (011) come next to the above two forms. Forms a (100), g (012), n (111), ν ($\bar{1}11$), λ ($\bar{1}13$) and μ ($\bar{1}14$) are small and narrow, but they are brilliant. m (110) has numerous vicinal faces parallel to [110].

Tabular and pseudo-rhombohedral habit is dominated by development of forms x (102) and ε ($\bar{1}12$).

Crystal I. (Fig. 2.)

The largest flattened pseudo-rhombohedral crystal (4.0 cm × 5.4 cm × 1.4 cm) with following crystal faces:

x (102)	n (111)	m (110)
a (100)	m_x (011)	g (012)
ε ($\bar{1}12$)	λ ($\bar{1}13$)	μ ($\bar{1}14$)

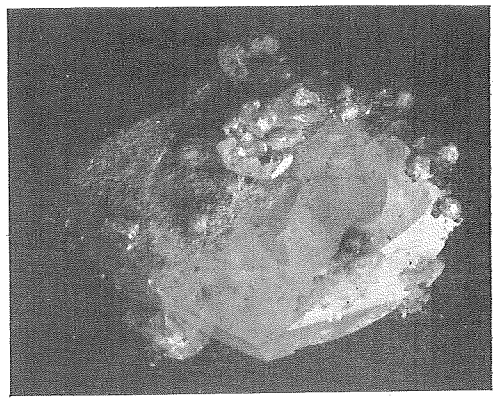

Fig. 2. Flattened pseudo-rhombohedral Crystal I. natural size.

It is pale blue colored and translucent with numerous cracks inside. The surfaces of the crystal are covered with clusters of minute crystals of garnets, diopside, datolite and calcite.

Crystal II. (Fig. 3.)

It is the second large flattened pseudo-rhombohedral crystal (2.3 cm × 3.2 cm × 1.2 cm), lacking the left half portion.

x (102)	m (110)	ν ($\bar{1}11$)	g (012)
m_x (011)	ε ($\bar{1}12$)	λ ($\bar{1}13$)	

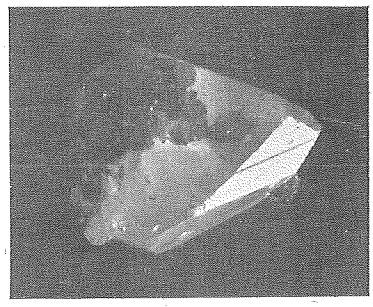

Fig. 3. Flattened pseudo-rhombohedral Crystal II. natural size.

The minute crystals of garnets, diopside and calcite are implanted on the crystal.

Crystal III and IV.

Two crystals are penetrated each other. On the Crystal III (1.7 cm × 2.5 cm × 1.0 cm), x (102), m (110) and ε ($\bar{1}12$) are dominant and small face of m_x (011) is observed.

The Crystal IV is flattened pseudo-rhombohedral with x (102) and ε ($\bar{1}12$), but small faces of m (110), ν ($\bar{1}11$), a (100), λ ($\bar{1}13$) and μ ($\bar{1}14$) are formed.

Crystal V.

Small colorless datolite crystal (1.0 cm × 1.4 cm × 0.9 cm) with x (102), m (110), ν ($\bar{1}11$) and ε ($\bar{1}12$) is embedded on an aggregate of garnets.

Crystal VI.

The crystal (1.0 cm × 1.5 cm × 0.4 cm) is colorless and in simple from with x (102), m (110), ε ($\bar{1}12$) and λ ($\bar{1}13$).

Crystal VII. (Takimoto Collection)

The crystal (2.5 cm × 3.3 cm × 1.0 cm) is imbedded in aggregates of garnets, diopside and calcite. Following faces are observed:

x (102)	a (100)	m (110)	n (111)
ν ($\bar{1}11$)	ε ($\bar{1}12$)	λ ($\bar{1}13$)	μ ($\bar{1}14$)

It is tranlucent with fracture inside.

Crystal VIII. (Takimoto Collection)

Tranparent crystal (1.0 cm × 1.5 cm × 0.5 cm) is found on the same skarn mass of the Crystal VII x (102), m (110), ε ($\bar{1}12$) and λ ($\bar{1}13$) are recognized.

Crystal IX. (Takimoto Collection)

The crystal (2.4 cm × 3.5 cm × 1.0 cm), with x (102), a (100), m (110), ν ($\bar{1}11$), ε ($\bar{1}12$), λ (113), μ ($\bar{1}14$) and m_x (011), is tranlucent and covered with minute crystals of calcite.

The combinations on the above nine crystals of the datolite from the Iwato copper mine are:

Crystal I	$x\ \varepsilon\ m\ \lambda\ m_x\ \mu\ n\ a\ g$	(Fig. 4.)
II	$x\ \varepsilon\ m\ \lambda\ m_x\ \nu\ g$	(Fig. 5.)
III	$x\ \varepsilon\ m\ m_x$	
IV	$x\ \varepsilon\ m\ \lambda\ \mu\ \nu\ a$	(Fig. 6.)
V	$x\ \varepsilon\ m\ \nu$	(Fig. 7.)
VI	$x\ \varepsilon\ m\ \lambda$	(Fig. 8.)
VII	$x\ \varepsilon\ m\ \lambda\ m_x\ \mu\ n\ a$	(Fig. 9.)
VIII	$x\ \varepsilon\ m\ \lambda$	
IX	$x\ \varepsilon\ m\ \lambda\ m_x\ \mu\ \nu\ n$	

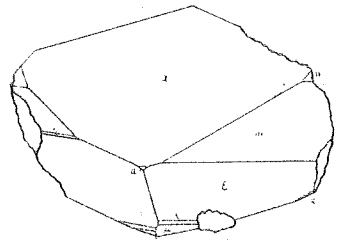

Fig. 4. Crystal I

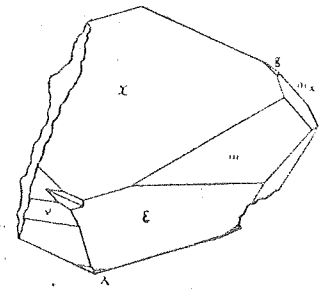

Fig. 5. Crystal II

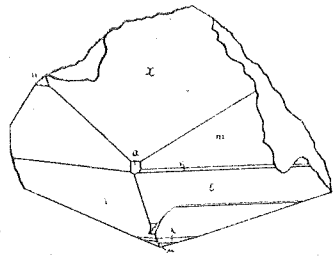

Fig. 6. Crystal IV

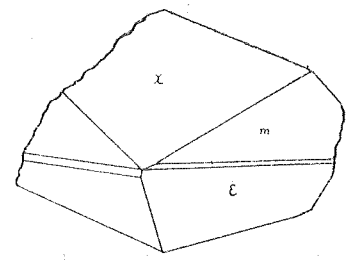

Fig. 7. Crystal V

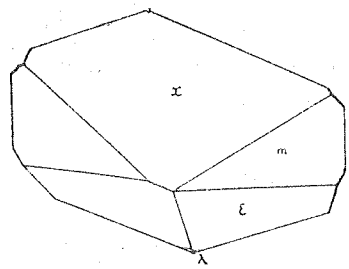

Fig. 8. Crystal VI

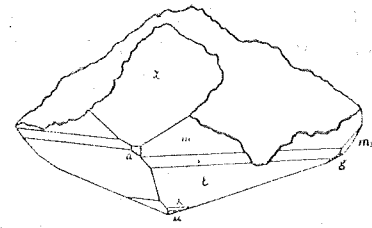

Fig. 9. Crystal VII

Fig. 4–9.

Crystals of datolite. Crystal I, II, IV, V, VI and VII.

Physical and optical properties.

It is optically biaxial and negative. $(-)2V = 74' \pm 1°$, $\alpha_D = 1.626 \pm 0.003$, $\beta_D = 1.654 \pm 0.003$, $\gamma_D = 1.670 \pm 0.003$. The specific gravity is $\delta = 2.996 \pm 0.002$.

Chemical composition.

The colorless crystal (No. III) was analysed in the laboratory of the Geological Survey of Japan. The analysis, the molecular proportion

and the atomic ratios are given in the following table:

Analysis of Datolite from the Iwato copper mine, Miyazaki Prefecture.

(K. Isono analyst)

	wt %	mol. prop.	atomic ratio			
SiO_2	37.52	625	Si	625		1.0003
Al_2O_3	0.38	4	Al	8		
FeO	0.31	4	Fe	4	624	0.9987
MgO	0.65	16	Mg	16		
CaO	32.44	596	Ca	596		
Na_2O	0.13	2	Na	4		
K_2O	0.12	1	K	2	624	0.9987
B_2O_3	21.53	309	B	618		
H_2O (+)	5.70	316	H	632		1.0115
H_2O (−)	0.20		O	3124		5.0000
Total	99.89					

The atomic ratios, derived from this analysis as shown in the table, would lead to the formula $H_{1.0115}Ca_{0.9987}B_{0.9987}Si_{1.0003}O_{5.0000}$. Datolite is expressed by the following formula[4),(5),(6)]: $HCaBSiO_5$, $Ca(SiO_4)(OH)$ or $Ca_2B_2(SiO_4)_2(OH)_2$. The formula, being obtained from the analysis, shows very close ageement with the above formula.

3. Associated minerals.

Of the associated minerals, the most abundant is vesuvianite which occurs in beautiful prismatic crystals. They are already described by K. Matsushita[1].

In this paper, occurrences and crystal forms of prehnite, diopside, magnetite and cubanite are described.

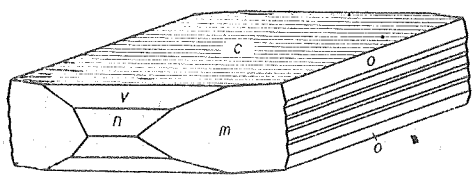

Fig. 10. Crystal of prehnite.

Prehnite

Prehnite is found in white coarse aggregates in druse with datolite, calcite, diopside and

(4) W. L. Bragg: Atomic Structure of Minerals. 1937, 162.
(5) H. Strunz: Z. Krist. A. 93 (1936), 146–150.
(6) H. Berman: Amer. Mineral. 22 (1937), 363

garnets. Single crystals of prehnite in typical form were obtained on the skarn crystals.

Form : *c* (001) *b* (010) *m* (110) *v* (304) *n* (302) *o* (061)

Most prehnite crystals are single plate, some of them are grouped sub-parallel to [010]. Usual fan shaped aggragates are rare. Some single crystals are maxium 5mm in diameter, commonly 1~2mm.

The prehnite crystals are commonly colorless and transparent and of glassy luster. The crystals are tabular parallel to the base.

c (001) is dominant and generally striated parallel to the zone axis [010]. The similar striation is recognized on *v* (304) and *n* (302) respectively, but they are not so distinguished. *o* (061), being repeated, looks like *b* (010) with striation.

Diopside

Pale green or white diopside in granular aggregates, is associated with datolite, garnets and calcite. Minute crystals of the diopside are clustered on the face of garnets. Individual crystals of the diopside are rare.

Form : *c* (001) *b* (010) *a* (100) *m* (110) *p* (101) *s* (111) *k* (312)

Two types of combination on the crystals of the diopside are seen.

i.	*c*	*b*	*a*	*m*	*p*	*k*	(Fig. 11.)
ii.	*b*	*a*	*m*	*s*	*k*		(Fig. 12.)

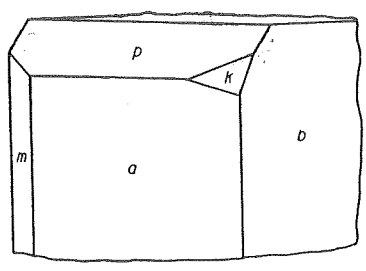

Fig. 11. Crystal of diopside. Type i.

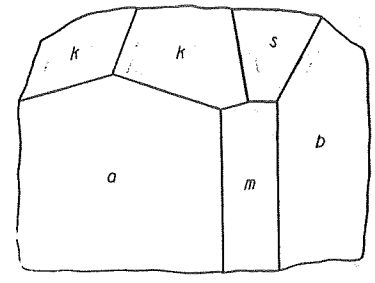

Fig. 12. Crystal of diopside. Type ii.

Magnetite

Magnetite, being disseminated in limestone, is associated with vesuvianite, axinite and garnets.

Form: d (110) o (111) m (311) n (211)

Combinations on crystals of the magnetite are as follows:

i. d
ii. d o m (Fig. 13.)
iii. d n (Fig. 14.)

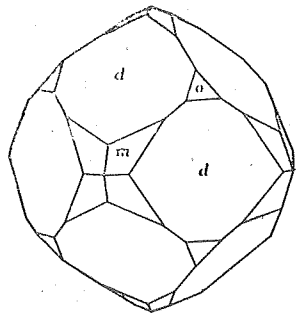

Fig. 13. Crystal of magnetite. Type ii.

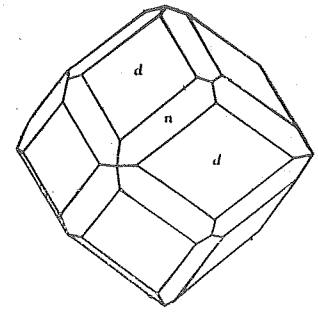

Fig. 14. Crystal of magnetite. Type iii.

The magnetite occurs in crystals, dominantly rhombic dodecahedron d (110) and massive form. The trapezohedron n (211) was seen only one crystal with distinct faces. Forms m (311) and n (211) appear rarely on Japanese magnetite crystals.

It is very similar in appearance to garnets, from which, without a chemical analysis, it can be distinguished only by its black streak and magnetism.

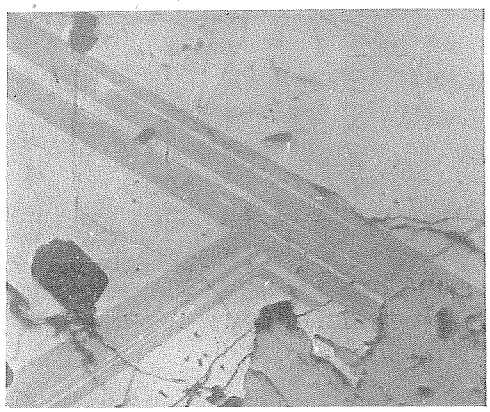

Fig. 15. Crystallographic intergrowth of cubanite (cu) and chalcopyrite (ch). one nicol. Oil-immersion. ×200.

Cubanite

Cubanite is found scarce throughout Japan.Only following two localities have been reported.

Yagoshi mine, Yagoshi village, East-Iwai County, Iwate Prefecture.

Tenryū mine, Yaekawati village, Simoina County, Nagano Prefecture.

This locality is reported the third in Japan.

The ore of the Iwato copper mine is composed of mainly chalcopyrite and pyrrhotite, associating with arsenopyrite and zincblende.

Polished specimens of the ore are under the ore microscope revealed that the ore is an irregular aggregate of pyrrhotite, being partially replaced by arsenopyrite and marcasite, chalcopyrite and small amount of zincblende. Also lath shaped cubanite is associated in the chalcopyrite. (Fig. 15.)

Observations on the Polished Cubanite.

Polishing	good
Color	pinkish cream
Anisotropism	strong
Hardness	almost equals to that of chalcopyrite, scratched easily by steel pin.
Reagents:	
KNO_3 (1 : 1)	positive, tarnish pale brown.
HCl (1 : 1)	negative
KCN (20%)	„
$HgCl_2$ (5%)	„

Polysynthetic twinnings are observed.

4. Summary

Datolite has been found in the Iwato copper mine, Iwato village, West-Usuki County, Miyazaki Prefecture, the third recorded occurrence of this mineral in Japan.

It occurs in ore bodies which are developed in limestone near its contact with an intrusive granite and are of contact-metamorphic origin.

It is associated most closely with abundant well formed crystals of vesuvianite. Other associated minerals are chalcopyrite, cubanite, pyrite, pyrrhotite, galena, zincblende, molybdenite, arsenopyrite, lievrite, magnetite, calcite, garnets, epidote, wollastonite, axinite, hedenbergite, tourmaline, diopside and prehnite.

The datolite is monoclinic, showing flattened pseudo-rhombohedral crystal with 10 forms.

Its indices of refraction are $\alpha_D = 1.626 \pm 0.003$, $\beta_D = 1.654 \pm 0.003$, $\gamma_D = 1.670 \pm 0.003$. $(-)2V = 74^\circ \pm 1^\circ$. The specific gravity is $d = 2.996 \pm 0.002$.

Chemical analysis of the datolite from the mine is given yielding the formula $HCaBSiO_5$.

Of the associated minerals, prehnite, diopside, magnetite and cubanite are described.

Acknowledgement.

I am indebted to Prof. K. TAKIMOTO of the Kyoto University for information concerning the locality and for generous lending of the datolite crystals, which he has collected, to Prof. K. MATSUSHITA and Mr. Y. OKAMOTO of the Kyushu University for kind suggestions, to Dr. S. YAMANE, former director of the Geological Survey of Japan, for the chemical analysis, to Mr. S. SATO, head-master of the Nakakumi Primary School in Iwato village, for acquisition of the datolite crystals, to Mr. T. MAKI for help in collection of the datolite crystals, to Mr. T. HATTORI for crystallographic mesurements and in preparations of some of the figures of crystals.