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The Occurrence of Cowlesite from Kuniga, Oki Islands, Japan

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Introduction

Cowlesite, $Ca[Al_2Si_3O_{10}]\cdot 6H_2O$, is a new zeolite recently described by WISE and TSCHERNICH (1975) from six U. S. and one Canadian localities as an amygdule mineral in basalts. The original authors pointed out its thin tabular habit as one of the most characteristic features by presenting the scanning electron micrographs. During the course of descriptive works on levyne from Kuniga, Oki Islands, Japan by the first two authors (TIBA and MATSUBARA, 1977), they took many scanning electron micrographs of levyne and associated zeolites, and some of them displayed the existence of a tabular zeolite readily identified as cowlesite, and the identification was supported by subsequent X-ray powder diffraction and optical studies, leading to the first find of this mineral in Japan. Although they introduced the cowlesite occurrence in their paper in the form of simple enumeration of name, here the first report dealing with the results of identification works is presented with a brief consideration about the implication of the occurrence.

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Occurrence

The cowlesite locality is an outcrop of trachybasalt flow along a road-cut about 750 m NW of Kuniga tunnel, Nishi-no-shima, Dōzen, Oki Islands, Japan and the same as that of levyne described by TIBA and MATSUBARA (1977) (Fig. 1).

The trachybasalt flow is partially very rich in amygdules filled with zeolites including chabazite, thomsonite, levyne, phillipsite, cowlesite and analcime with a chloritic mineral and calcite in the order of abundance. The amygdules are generally oval in shape with 1 to 10 cm across and some of them exceed 10 cm in dimension.

Cowlesite (NSM. M–21101) is found as very thin felt-like rimming material on amygdule walls commonly with hexagonal levyne tablets overlying the cowlesite felt (Fig. 2, left). The felt is less than 0.5 mm thick and exclusively composed of very minute cowlesite tablets. Under the cowlesite rim is always a light yellow brown thin chloritic film, which makes the separation of a pure material for wet chemical

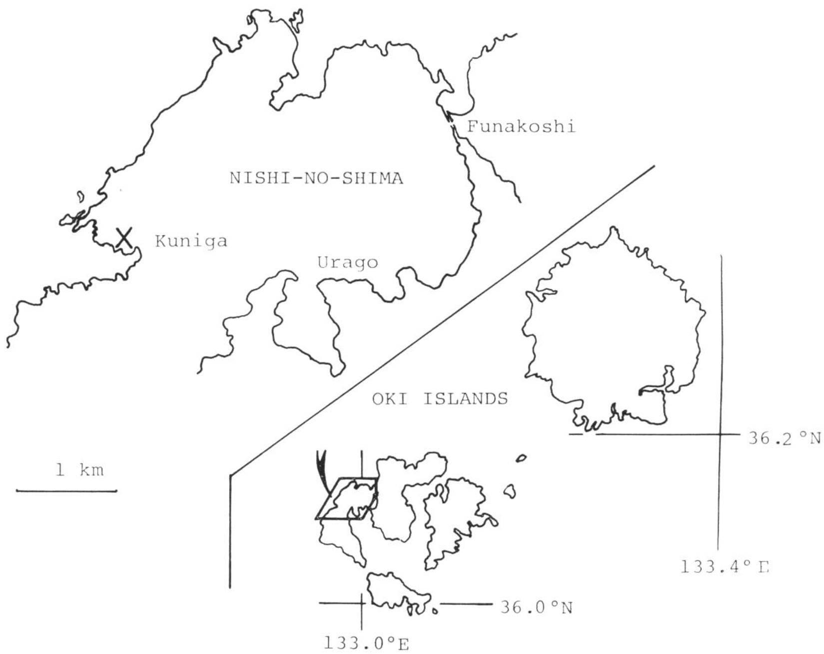

Fig. 1. Index map of cowlesite locality (cross mark).

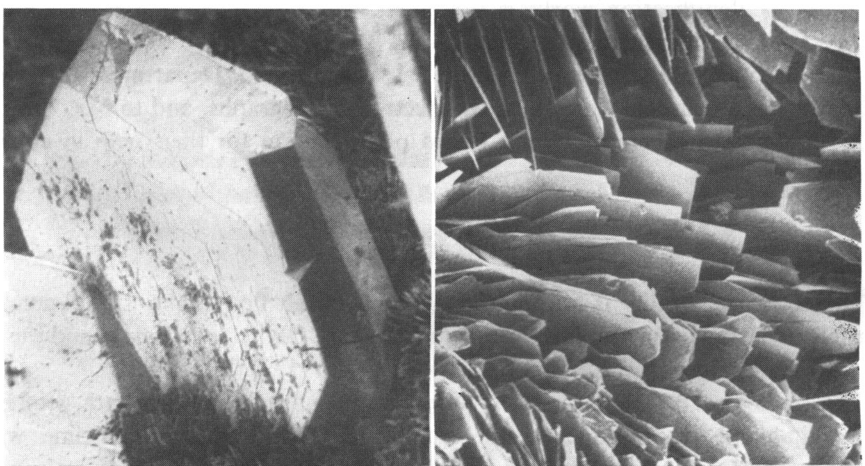

Fig. 2. Scanning electron micrographs of cowlesite aggregates associated with levyne (left, bar 0.2 mm) and of cowlesite tablets (right, bar 0.04 mm).

analysis impossible. According to the microscopic and electron microscopic observation, the tablets are elongated to one direction (c-axis) and flattened to another direction (b-axis) and with near rectangular termination (Fig. 2, right). The maximum dimension of the tablet reaches about 0.2 mm long.

Optical Studies

Under the microscope it is colourless with refractive indices $\alpha=1.505$ (2), $\beta \doteqdot \gamma=$ 1.509 (2) by the immersion method. It is biaxial negative with 2V=30 (5)° without discernible dispersion. The extinction is parallel to the outline and the sign of elongation is positive. Thus, the optical orientation, a=X, b=Y, c=Z, is same as that described by Wise and Tschernich (1975). Between crossed polars the crystals show grey colour with a little greenish tint, which may be an anomalous interference colour, though the reason cannot be satisfactorily explained for the present time.

X-ray Powder Study

X-ray powder diffraction study of material carefully purified under the binocular was made for positive identification and measurement of unit cell parameters by the diffractometer method using Cu/Ni radiation. Although the obtained powder pattern includes a tendency of preferred orientation along {010} due to its habit and perfect cleavage along it, it is very similar to that obtained by Wise and Tschernich

Table 1. X-ray Powder Data for Cowlesites.

	1		2				1		2		
hkl	d	I/I_0	dobs.	dcalc.	I/I_0	hkl	d	I/I_0	dobs.	dcalc.	I/I_0
010	15.2	100	15.3	15.2	100	050	3.052	20	3.048	3.049	15
001	12.6	5	12.7	12.7	4	051	2.964	35	2.953	2.964	25
100	11.3	5				150				2.942	
101	8.40	10	8.47	8.42	2	331	2.934	25			
020	7.62	15	7.64	7.62	10	024			2.927	2.927	20
121	5.67	7	5.70	5.65	2	043	2.819	5	2.825	2.830	8
102	5.52	5				400				2.822	
030	5.08	17	5.08	5.08	8	410			2.773	2.775	2
031	4.70	7	4.71	4.71	3	143			2.738	2.745	3
122	4.50	3	4.50	4.47	6	224			2.600	2.598	3
202	4.16	5				243			2.529	2.529	2
040	3.81	35	3.811	3.810	30	352			2.220	2.218	2
300	3.75	15	3.763	3.761	15	334			2.189	2.188	2
310	3.65	10	3.651	3.651	10	362			1.996	1.998	5
141			3.461	3.471	4	080			1.905	1.905	2
042			3.262	3.265	5	090			1.693	1.693	4
321	3.25	5		3.260		516			1.534	1.535	3
004	3.16	10	3.177	3.170	8	0100			1.524	1.524	4

1. Goble, Oregon, U. S. A. (Wise & Tschernich, 1975)
2. Kuniga, Oki Islands, Shimane, Japan

(1975) as given in Table 1. After the reference to their data, the unit cell parameters of present cowlesite are calculated as $a_0=11.29\,(2)$, $b_0=15.24\,(2)$, $c_0=12.68\,(3)$ Å, which are very close to those by the original authors. Seeing from the appearance of (h00), (0k0) and (00l) where h, k, $l \neq 2$ n, the possible space group of this mineral is considered as P222, Pmm2, or Pmmm, provided that the obtained cell parameters are for true cell and that the crystal symmetry is orthorhombic.

Mineralogical Implications of the Occurrence

The mode of occurrence of the present cowlesite is very similar to those in U. S. and Canadian localities, especially that in Beech Creek, Oregon, where the earlier formation of cowlesite in the amygdules and its close and exclusive association with levyne are noted (WISE and TSCHERNICH, 1975). This suggests that an appropriate condition favouring the formation is not so rare. And seeing from its silica poor composition, the condition may be developed in such silica poorer rocks as basalts and alkali basalts.

Apart from this matter, another implication can be deduced. As reported by TIBA and MATSUBARA (1977), some amygdules in the trachybasalt carry calcite, which is not found in those including cowlesite and levyne. It is highly probable that the formation and survival of cowlesite and levyne in this locality might have been favoured by lower CO_2 pressure in the amygdules at and after the time of formation. But the calcite-bearing amygdules are found within a few centimeters distance from those including cowlesite and levyne. This is interpreted as the result of local concentration of CO_2 pressure without destructing cowlesite and levyne in the same rock. That the mineralogical constituents of individual amygdules are very variable irrespective of their close co-existence in the rock suggests that the chemical differences of fluids precipitating zeolites and calcite resulted from the existence of effective chemical barriers between amygdules and that they correspond to groundmass with plagioclase phenocrysts. The rather fresh nature of groundmass and phenocryst plagioclase in the trachybasalt (TIBA and MATSUBARA, 1977) will explain the efficiency as chemical barriers.

It seems that there is a general tendency that when Japanese younger basalts and andesites with rather unaltered groundmass have amygdules, difference zeolite assemblages in amygdule-by-amygdule may be developed within such a small unit as hand specimen. During the stage of zeolite formation, the groundmass acted as chemical barrier to fluids responsible for the precipitated minerals in amygdules now filled with zeolites, calcite, and some such hydrous silicates akin to zeolite as apophyllite, gyrolite, tacharanite, and tobermorite.

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