Ikaite from cold spring water at Shiowakka, Hokkaido, Japan

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In a calcareous sinter precipitated from cold saline spring water at Shiowakka, Hokkaido, Japan, ikaite ($\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$) was found in winter, subsequent to the finding of monohydrocalcite with calcite in the previous summer. The formation of the ikaite was favored by low temperature, while that of the monohydrocalcite was favored by green algae inhabiting the interface of water and air (Ito, 1993). Ikaite precipitates in weak flows, forming rimstone and encrustation embedded in ice. The idiomorphs of ikaite are dissimilar to glendonite-type calcite pseudomorphs, but the pointed termination of the calcite pseudomorphs can be accounted for the combination of planes of ikaite crystals observed by scanning electron microscope.

Keywords: Ikaite, Monohydrocalcite, Vaterite, Calcite, Calcite pseudomorph.

I. Introduction

Ikaite was first found from the skerries rising in cold seawater at Ika Fjord, Greenland (Pauly, 1963), and subsequently in deep-sea sediment (Suess *et al.*, 1982; Stein and Smith, 1986; Jansen *et al.*, 1987) and in the precipitation of Mono Lake, California (Bischoff *et al.*, 1993b; Council and Bennett, 1993).

The discovery of ikaite at Shiowakka was guided by that of monohydrocalcite in summer 1992 (Ito, 1993) based on the knowledge that synthetic $\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$ is produced from calcium carbonate gels subsequent to the dissolution of $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ at 3–5°C (Dickens and Brown, 1970). X-ray powder studies of pale yellow granular material collected from the bottom of the snow and in icicles were made under the laboratory temperature condition of approximately 13°C, and this provided the pattern corresponding to the data for ikaite (JCPDS Card No. 37-416), which presented the first example of the occurrence of monohy-

drocalcite and ikaite in the same locality. If the climatic conditions of these localities involve near-freezing temperatures, they could be candidates for ikaite occurrence.

Since the discovery of ikaite idiomorphs from the Antarctic (Suess *et al.*, 1982), the precursory nature of ikaite to glendonite-type calcite pseudomorphs has been accepted by researchers (e.g. Shearman and Smith, 1985) as the solution to one of the most long-standing mineralogical enigmas.

On account of the unstable nature of ikaite at room temperature, a limited number of sketches and photographs of natural and synthetic crystals of ikaite have been obtained. The ikaite in these visual materials appears to be dissimilar to the glendonite-type pseudomorphs. However, some of the combinations of forms observed in this study make it possible to account for the pointed termination developed by the pseudomorphs.

Fig. 1. Locality map of the Shiwakka cold springs.

II. Geological setting

Shiwakka cold saline springs are located at Rawan, Ashoro-cho, Hokkaido (Fig. 1), at approximately $43^{\circ} 20'N$ latitude by $143^{\circ} 53'E$ longitude and 340 m above sea level. The average temperature at Ashoro was $16.3^{\circ}C$ for July and $-4.3^{\circ}C$ for December, 1993 (Hokkaido Office of the Japan Weather Association, 1993).

In the Rawan area, some cold springs flow out along fault fissures and planes of unconformity between pre-Cretaceous sedimentary rocks and Pliocene rocks (Mitani *et al.*, 1958). The spring water at Shiwakka flowed out from two round outlets (1.2×1.1 m and 0.6×0.6 m in diameter) and has formed a dome with a flat top. The little amount flowing water from the cold springs ran down with slow velocity of sheetflow and formed flowstone in summer (Ito, 1993). In winter, most water soaked away into snow and along the boundary of ice and ground.

The chemical composition of the spring water is given in Table 1. A high iron content of the water is supposed from the presence of brown colored sediments of iron hydroxide in the pools nearby the flows. The temperature of the water is roughly constant, around $14 \sim 18^{\circ}C$ in summer and about $11^{\circ}C$ in winter.

III. Mode of occurrence

Ikaite was at first found in icicles on the calcareous, snow-covered sinter dome in 1993. In the following year, a year of unusually light snowfall, ikaite was observed as rimstone and encrustation (rimstone dam) embedded in ice at foot of the sinter dome (Fig. 2). The rimstone has a rough surface owed to loose aggregates of ikaite crystals. In the sunlight, the thin ice-cover on the tall rimstones has melted away and the rimstones were submerged in water. Ikaite was crystallizing in a cold water, and at the end of the winter the rimstone accumulated to 2 cm in thickness. Because the course of flow from the spring has changed in the last summer, there was not the encrustation which precipitated on the floor before this time.

The mode of accumulation is fairly dense and composed of euhedral ikaite crystals the maximum size being 2 mm and, generally, $200 \sim 300 \mu m$ in diameter. The crystals are transparent and light cream in color, but some of them are stained reddish brown due to the presence of ferric hydroxide. The appearance of disintegration of aggregation into wet calcite at laboratory temperature is the same as that of ikaite from deep-sea sediments (Pauly, 1963 ;

Table 1. Water chemistry of Shiwakka cold springs

	W.T. ($^{\circ}C$)	pH	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	SO ₄ mg/l	PO ₄ mg/l	SiO ₂ mg/l	NH ₄ mg/l	Total CO ₂ mg/l
Present study(1)	17.8	6.67	299	190	4060	141	4073	15.6	0.18	85.0	20.16	4,880*
(2)	14.5	6.47			3724	135	3630	3.5	0.10	85.3	15.39	

(1) Spring at left, (2) at right. *: Mitani *et al.* (1958). From Ito (1993).

Fig. 2. Occurrence of ikaite.

- a: Calcareous sinter dome at Shiowakka
 b: Rimstone of ikaite embedded in clear transparent ice.
 (The minimum scale on a ruler graduated in 0.1 centimeter)

Suess *et al.*, 1982; Stein and Smith, 1986; Jansen *et al.*, 1987). Aggregation of ikaite crystals in the air dries and converts to white

powdery calcite and vaterite overnight at room temperature.

The rimstone composed of four layers (from base to top), calcite to calcite + monohydrocalcite to calcite + ikaite and to ikaite (Fig. 3). These layers correspond to the seasonal precipitation of calcium carbonate according to the change from summer to winter. The third assemblage, calcite + ikaite, is seen exclusively along the boundary between aggregates of calcite and that of ikaite. Note the absence of coexistence of monohydrocalcite + ikaite. The minerals directly associated with ikaite are known to be aragonite (Stein and Smith, 1986) and gaylussite (Bischoff *et al.*, 1993b; Council and Bennett, 1993), but neither of them could be detected in the rimstones by an X-ray powder study.

Fallen leaves were often found at the boundaries of layers between ikaite and calcite, where ikaite idiomorphs perched on calcite layers. The precipitation of ikaite is proved to be discontinuous due to the presence of thin reddish-brown layers impregnated with ferric iron hydroxide at 2~3 mm intervals, implying that the precipitation of ikaite was interrupted more than 5 times. In spring, the precipitated

Fig. 3. Schematic cross sections of rimstone, pisolite-like sinter and fallen leaf coated with sinter crusts showing the mineral sequence of calcium carbonates at Shiowakka cold spring (Ika, ikaite; Cal, calcite; MHC, monohydrocalcite).

Table 2. X-ray powder pattern of ikaite

1. Ikaite, syn.			2. This study		3. This study		1.			2.		3.	
hkl	d	I	d obs.	I	d obs.	I	hkl	d	I	d obs.	I	d obs.	I
110	5.853	25	5.893	7	5.893	30	—					*2.286	14
—			5.831	2			314	2.248	6	2.246	2	2.244	16
111	5.724	22	5.726	1	5.793	33	132	2.232	20	2.240	1		
002	5.171	100	5.208	100	5.205	100	402	2.213	9	2.225	<1	2.217	27
			5.148	13						2.208	<1		
111	4.634	2					133	2.196	27	2.192	1		
112	4.448	16	4.460	10	4.491	6	024	2.189	21				
200	4.162	29	4.164	1	4.175	60	114	2.178	7	2.177	<1	2.178	6
					4.143	68	115	2.118	6			2.171	8
020	4.115	6	4.026	<1	3.997	19						*2.094	11
202	3.983	17	3.967	4	3.960	10	312,400	2.084	14	2.064	5	2.079	6
					*3.873	21	040	2.057	10	2.059	3	2.070	9
021	3.823	5								2.039	<1	2.039	4
112	3.479	6	3.468	1	3.488	8	041	2.018	3				
113	3.347	4					223	2.004	17	2.000	3	2.003	8
			*3.026	1	*3.041	26	332,404	1.992	7	1.995	2		
220	2.926	22	2.936	11	2.941	31	315	1.9686	14	1.977	2	1.977	9
202	2.804	50			2.789	17				1.972	1	1.972	5
311	2.774	27	2.775	2	2.771	45	330,422	1.9509	7			1.956	4
					2.755	13	134	1.9433	5				
312	2.733	2					421	1.9345	15	1.931	2	1.932	74
113	2.698	12	2.655	2	2.661	57	225	1.9235	22	1.926	1	**1.927	52
221,204	2.643	85	2.647	4								*1.912	27
310	2.629	70	2.625	5	2.634	17	204	1.9192	17				
130	2.605	27	2.611	4	2.618	33	042	1.9117	15	1.900	2	1.908	16
131	2.594	22			2.593	10						1.899	14
004	2.586	19	2.577	1	2.576	15	423	1.8972	21	1.894	2	1.894	8
223	2.558	12	2.559	1	2.546	9						*1.876	19
313	2.527	12			2.534	9	241	1.8658	5	1.856	<1	1.860	5
					*2.487	18	025	1.8481	21	1.851	<1		
131	2.464	33	2.482	4			240	1.8444	18	1.845	1	1.845	5
132	2.435	2					206,242	1.8280	16	1.834	1	1.841	4
222	2.317	5	2.316	<1	2.318	9							

* : The diffraction pattern of calcite, ** : Overlapping of the diffraction patterns of ikaite and calcite.

1. Ikaite, syn. JCPDS (No. 37-416), 2. Crushed ikaite, 3. Grinded ikaite.

Cu/Ni rad. Diffractometer method (35 kv, 20 mA, slit : 1° -0.15 mm -1°, Scan. speed : 1 deg./min. (crushed), 2 deg./min. (grinded)).

Condition of Lab. : Temperature about 13°C, Humidity about 50% (crushed) and 60% (grinded).

ikaite converts into calcite. No trace of mono-hydrocalcite was observed in the converted products. The calcite phase is exclusively found in newly precipitated materials.

IV. X-ray powder study

An X-ray powder study on crushed ikaite was made under the laboratory condition of humidity 47-73% and temperature about 13°C.

The preparation of data that correspond to the available data (JCPDS Card No. 37-416) led to positive identification. However, the emergence of minor but noticeable differences are recognized in the patterns of subsequent runs composed of intensity change and appearance of new peaks including unexplainable ones. The pattern in the early run of a grinded ikaite is more authentic as shown in Table 2. The

Fig. 4. Transformation of ikaite observed on the x-ray pattern.

(1)~(2) : repeat scan (scanning speed: 2°/min)
 (3) : after 1 hour (ditto: 1°/min)
 (Cal.: calcite; 1~7: vaterite peaks)

grinding urged the decomposition of ikaite forward.

The unstable nature of ikaite and an indefinite structure change in progress of the decomposition probably reflected the absence of some distinct peaks and anomalous strong one in the X-ray powder patterns compared to the JCPDS card. On repeat runs, the appearance of calcite peaks always go ahead the one of vaterite but a relative intensity between calcite and vaterite is not constant (Fig. 4). Vaterite as decomposition products from natural ikaite is the first recognition.

The complete conversion of ikaite to calcite, sometimes with a small amount of vaterite, has perfected for 18 hours at 13°C.

V. Energy dispersive X-ray spectroscopic analysis

Chemical analysis was made at the Center of Applied Research, GEOL by scanning electron microscope JSM-5400LV(JEOL) equipped

with X-ray analyzer ISIS L2001-S/S-ATW(Oxfords)(Table 4). This windowless-type analyzer has been employed for the analyses of fragile calcite transformed from ikaite. The matrix correction in the system is done under the assumption that the analyzed total percentage is 100%.

The complete conversion of ikaite to calcite means that the minor deviation of composition from the theoretical formula of the former was strictly admitted by the latter. Cationic counterparts ($\text{Ca}_{0.981} \cdot \text{Sr}_{0.013} \cdot \text{Mg}_{0.002} \cdot (\text{Na}_2)_{0.004}$) of higher SrO and lower MgO contents compared to previous natural ikaite are specific character of the present ikaite.

VI. Observation by scanning electron microscopy

Electron microscopic observation of ikaite crystals from the different parts of accumulation reveals morphological variation to change distinctly by position therein. Namely, the

Table 3. X-ray powder pattern of vaterite

Vaterite after Ikaite		JCPDS Card No.33-268	
d _{obs.}	I/I ₀	d _{obs.}	I/I ₀
1 4.24	15	4.226	25
<u>3.858</u>			
2 3.575	74	3.577	60
3 3.294	100	3.296	100
<u>3.037</u>			
4 2.731	85	2.730	90
<u>2.496</u>			
<u>2.286</u>	50	2.282	2
		2.212	5
		2.161	2
5 2.117	8	2.113	20
<u>2.095</u>			
6 2.063	50	2.063	60
<u>1.928</u>			
<u>1.914</u>			
<u>1.876</u>			
7 1.854	16	1.854	30

Cu/Ni rad. Diffractometer method (35 kv, 30 mA, slit: 1° -0.15 mm-1°).

Numbers (1~7) are the same as in Fig. 4. d-values of calcite is under lined.

materials from basal parts are rich in morphological variation (Fig. 5c), those from the middle are characterized by the dominance of parallel intergrowth of prisms (Fig. 5b), and those from the surface are coarse and composed of skeletal-oriented overgrowth (Fig. 5a).

The form consists of a prism {110} and two pinacoids {100} and {010}. The tabular {001} crystals shown in the synthetic material (Vetter, 1911) are scarcely found at all. An externally observed facial angle of about 110° (Fig. 5a) corresponds to the β angle (110.2°) of synthetic (Dickens and Brown, 1970) and that (110.53°) of natural materials (Hesse *et al.*, 1983). However, no bipyramidal termination (known in glendonite-type pseudomorphs) was observed in the examined materials. In Fig. 6, the combination of crystal forms is reproduced from the scanning electron micrographs of the terminal parts which are along the direction parallel to the elongation. {001} was deter-

Table 4. Composition of calcite after ikaite

	Wt%	atomic prop.
C	12.72	1.059
Ca	40.50	1.010
Sr	1.17	0.013
Mg	0.06	0.002
Na	0.10	<u>0.004</u>
		1.029
O	44.59	
Cl	0.26	
Si	0.59	
Total	100.00	

mined from the direction of striations on {110}.

VII. Discussion

X-ray powder data and chemical composition

Because of the decomposition of ikaite progressed quickly during the X-ray treatment, each peaks are not same precisely. The decomposition rate of ikaite is to be sensitive to the presence of impurities (Hume and Topley, 1927). The X-ray powder pattern has noticeable differences to JCPDS Card (No. 37-416) but that mineral of Shiowakka can be concluded to be ikaite from some collateral evidences. The megascopic features, such as that initially translucent yellowish brown mineral aggregates has disintegrated into wet mass of minute crystals and become cloudy within a few hours, are commonly observed features in a natural ikaite (Pauly, 1963; Suess *et al.*, 1982; Stein and Smith, 1986; Jansen *et al.*, 1987). The coincidence between external angle (about 110°) of rhombic crystals from Shiowakka and β angles of synthetic (Dickens and Brown, 1970) and natural ikaite (Hess *et al.*, 1983) supports above conclusion.

The final products of decomposition, such as vaterite and calcite, depend on the conditions which promote any given sample to the decomposition, and apparently similar conditions do not always lead to the same results (Brooks *et*

Fig. 5. Scanning electron micrographs of Ikaite.

- a: An intergrowth ikaite on a coarse ikaite crystal at the surface of rimstone. Note an obtuse angle ($\sim 110^\circ$) and characteristic shrinking crack at the surface.
- b: Prismatic crystals from the inner zone of rimstone.
- c: A short prismatic crystal with fiber of a plant in the bottom layer of rimstone. The shrinking crack is characteristic at the surface of crystal. Diatom attached at it.
- d: Single crystal in the elongated direction. Note this shape coincide with the top plane view without $(\bar{h}01)$ in Fig. 6.

al., 1950). It is probably that the chemistry of cold spring water which moistened the surface of ikaite and trapped fluid inclusions (Cocul and Bennett, 1993) is significant in this case. Because, vaterite has not been reported from marine ikaite and the phase of synthetic calcium carbonates in the presence of magnesium chloride were calcite, aragonite, gaylussite, monohydrocalcite and ikaite without vaterite (Brooks *et al.*, 1950).

The MgO content lower than the other ikaite (all of available data are of marine origin) (Pauly, 1963; Stein and Smith, 1986; Jansen *et al.*, 1987), can be ascribed to the Mg content of Shiowakka spring water (190 mg/l:

Ito, 1993) being lower than that of average seawater (1294 mg: Pytkowicz and Kester, 1971). The higher SrO content in ikaite of shiowakka also reflected on the chemical composition of monohydrocalcite (Ito, 1993).

Genesis

Chemical and physical factors favoring the precipitation of ikaite including of its synthetic analogue from the parent solution are known. The chemical factor is high concentration of Mg (based on seawater: Vetter, 1911) and phosphate (e.g. 200 ppm as glassy form of a sodium-phosphate: Brooks *et al.*, 1950; 400 ppm of polyphosphate: Dickens and Brown, 1970). Of

Fig. 6. Illustration of the termination of ikaite prism derived from scanning electron micrographs (morphological mark is indicated by an arrow).

the two factors, the latter is capable of stabilizing ikaite in nature (Bischoff *et al.*, 1993a) and is strong inhibitor to the nucleation of calcite and aragonite (Brooks *et al.*, 1950).

For the ikaite formation in the Shiowakka spring water, Mg ions and phosphate as inhibitors are probably not significant elements. This is because the PO_4 content of the spring water (0.18~0.10 mg/l: Ito, 1993) is less than that in water of Mono Lake (60 mg/l: Bischoff *et al.*, 1993a) in which ikaite only occurs in the western Great Basin and the Mg/Ca ratio of the Shiowakka spring water (0.64: Ito, 1993) is lower than that ratio of average seawater (3.27: Pytkowicz and Kester, 1971).

The same role of Mg ions and phosphate in monohydrocalcite formation has been suggested by Hull and Turnbull (1973). However, the

precipitation of calcite always precedes that of ikaite and monohydrocalcite at Shiowakka (Fig. 3). Therefore, Mg ions and phosphate in the spring water probably did not work as a strong inhibitor of calcite formation in summer. The formation of monohydrocalcite was favored by presence of green algae and by location at the solution/atmosphere interface (Ito, 1993).

A cold temperature of mother solutions (e.g. below -1°C : Brooks *et al.*, 1950; 3°C : Pauly, 1963; 3 – 6°C : Shaikh and Shearman, 1986) is to be included in a physical factor. Obviously, the temperature condition at Shiowakka is the effective factor for the formation ikaite. The successive mineral sequence at Shiowakka, from calcite to ikaite (Fig. 3), indicates clearly that the seasonal change of water

Fig. 7. Pyramidal termination of calcite pseudomorphs (from the Paleogene mudstone at Konbumori, Hokkaido).
 a: Close-up an apex set in center of the pyramidal form.
 b: Reset a couple of flat face of the pyramid (light colored planes in the photo. a) to be in the vertical to the print.

temperature of the flow promotes the precipitation of these minerals. That sequence coincides with the process of synthetic ikaite formation such as that initially formed $\text{CaCO}_3 \cdot \text{H}_2\text{O}$ has dissolved and after crystals of $\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$ formed (Dickens and Brown, 1970). The growth was favored by the melting of ice directly contact with ikaite in the daytime. The occurrence of ikaite as a rimstone (Fig. 2) suggests that the ikaite has precipitated in the feeble flow as like as a speleothem rimstone formed.

Comparative study of ikaite with glendonite-type calcite pseudomorphs

Many of the calcite pseudomorphs found in the sedimentary rocks are now believed to be pseudomorphs after ikaite (Suess *et al.*, 1982; Shearman and Smith, 1985; Shaikh and Shearman, 1986; Stein and Smith, 1986; Jansen *et al.*, 1987; Shearman *et al.*, 1989; Council and Bennett, 1993; Bischoff *et al.*, 1993a). However, a pointed termination found commonly in glendonite-type calcite pseudomorphs has not been found the natural and synthetic ikaite in the previous papers, except for the big ikaite crystal from Bransfield Strait, Antarctica (Suess *et al.*, 1982). In the present examination, many clear forms of ikaite have been observed by scanning electron microscope, but no pointed termination has been discovered.

The following combination of the crystal planes of ikaite can be proposed in order to accounting for the formation of pointed termination.

The inclined pyramidal form of ikaite may be introduced by the combinations of $m\{110\}$ and $\{hkl\}$ as shown by the dotted line in the illustration (Fig. 6). The similarity of a face symmetry between the illustrated termination (Fig. 6) and the photographs of calcite pseudomorphs (Fig. 7) is clear.

It is worthy of note that the combinations of $m\{110\}$ and $s\{111\}$ in a pyramidal form of glauberite ($\text{Na}_2\text{Ca}(\text{SO}_4)_2$) crystal (Palache *et al.*, 1951), which has been believed to be the precursor of calcite pseudomorphs (so-called "glendonite"; David *et al.*, 1905) and belongs to monoclinic system just as does ikaite, resembles closely the illustrated termination of ikaite.

The radial arrangement of large elongated and twig-like glendonites forming tufa mounds of Pyramid Lake indicates that the precursor mineral has grown from the center to the outer zone in the lake water (Shearman *et al.*, 1989). On the other hand, from the similarity of the surface pattern between the reticulate surface of ikaite in Mono Lake (Bischoff *et al.*, 1993b: in Fig. 3) and rimstones at Shiowakka (Fig. 2), the size of ikaite crystal grown under weakly moving condition of water in lake is supposed

not to exceed a few millimeter in diameter. This matter requires further consideration to settle the problem of the dimensional discrepancy in which all the glendonite-type calcite pseudomorphs are very large whereas the described single crystals of ikaite are very small except for the case found in the Antarctic (Suess *et al.*, 1982).

If ikaite is the precursor of calcite pseudomorphs, the effective factors in the formation of a large ikaite and a pyramidal habit still remain to be an insoluble problem.

VIII. Summary

Except for aragonite, every calcium carbonate minerals have been found in the calcareous sinter of Shiowakka cold spring and any other mineral was not detected. The seasonal alternation causes ikaite to be formed in winter and monohydrocalcite to be so in summer at Shiowakka cold springs.

Given the occurrence of calcium carbonate minerals, an optimum condition for the precipitation of ikaite is near-freezing temperatures. The occurrence of calcite in summer suggests the inhibitors for calcite nucleation in the ikaite formation at Shiowakka signified little in this case.

From the scanning electron micrographs of ikaite, clear rhombic prisms and tabular crystal forms have been observed, but no shapes similar to calcite pseudomorphs, such as rhombic bipyramid, have been observed. The form proposed from the combination of $m\{110\}$ and $\{hkl\}$ in ikaite crystal planes is highly similar to the pyramidal form of calcite pseudomorphs.

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北海道, シオワッカ冷泉産の ikaite

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氷点下の気温になる冬季間, 北海道足寄町螺湾のシオワッカ冷泉からの弱い流れの中で, ikaite が生じている。積雪の少ない年には, 氷に閉じこめられた産状で ikaite からなる輪縁石ダムが見られた。海洋, 湖沼以外である流水域における ikaite の生成はこれまでは知られていない。先年の夏に同地域から, calcite といっしょに monohydrocalcite の生成が知られたところから, 冬の ikaite の生成が予想された。シオワッカ冷泉石灰華からは ikaite からの転移鉱物の vaterite を加えると, aragonite を除き, 自然界での炭酸カルシウム塩鉱物のほとんど全てが得られた。本地における夏から冬の間の炭酸カルシウム塩鉱物の生成の過程を, 産状から考察した。これらの鉱物の生成における必要条件は, 水質のほか, 水温(ikaite, calcite), 地表面の濡れ(monohydrocalcite: 伊藤, 1993), など, それぞれによって異なる。また, シオワッカ冷泉の水質, ikaite および vaterite の X 線粉末回折線値, ikaite から転移した後の方解石の化学組成を示した。

Ikaite が冷たい海域, 深海堆積物から次々と発見されたことから, 1982 年来, これまで源鉱物の明らかでなかった glendonite や玄能石と呼ばれてきた方解石仮像の源鉱物が ikaite であるとする説が多く出されてきた。しかし, ikaite の結晶形と一般的な大きさはこれまでに知られている方解石仮像と一致しない。ここでは, 方解石仮像に特徴的な四角錐に対応する結晶形が, 走査型電子顕微鏡で観察された ikaite の結晶面の組み合わせによって導かれることを示した。

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