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Lawsonite from Quartzofeldspathic Schist in the Sangun Metamorphic Belt, Shikuma, Shimane Prefecture

by

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Introduction

Lawsonite is a calcium-aluminosilicate characteristically occurs in the high pressure — low temperature type metamorphic terranes. It occurs ubiquitously in pelitic, psammitic, and mafic rocks with sodic amphibole in the typical high P/T type metamorphic terranes such as Franciscan and New Caledonia (MIYASHIRO, 1973; TURNER, 1980, etc.). However, in the Sangun metamorphic belt of which mineral assemblages represent lower pressure type of glaucophanitic metamorphism, lawsonite was thought to occur only in a part of mafic rocks and a part of psammitic rocks (SAKAKI & YAMAMOTO, 1967; HASHIMOTO & IGI, 1970; NISHIMURA & OKAMOTO, 1976).

The occurrence of lawsonite is very rare, so its stability range in the zonation of the Sangun metamorphism is not yet established. The rare occurrence is considered to be delicately controlled by bulk chemical compositions of small domains of centimeters or millimeters scale. According to the detail description by Nishimura & Okamoto (1976), lawsonite has close relation with chlorite-albite assemblage.

In quartzofeldspathic schists, lawsonite was not recognized at all in the Sangun belt by any petrologists. The mineral assemblages in these schists, especially in the low grade area of the Sangun belt, were considered to be monotonous as compared with those in mafic rocks. However, the authors have recently found lawsonite in quartzofeldspathic schist of the Sangun belt from Shikuma, Shimane prefecture.
As quartzofeldspathic schists distribute most extensively in the Sangun belt although some different lithofacies are recognizable, the consideration on genesis of lawsonite in quartzofeldspathic schists is important to fully understanding of the Sangun metamorphism.

In this paper, the authors will give brief description of occurrence of lawsonite in Shikuma, Gotsu city, Shimane prefecture and a consideration on its genesis.

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Locality of lawsonite and outline of geology

Shikuma area is situated in the eastern part of Gotsu city and is about 10 km east from the Gotsu station of National Railway (Fig. 1). The area is composed mainly of quartzofeldspathic schists, so called blackschists, and mafic schists with minor siliceous schists and serpentinites.

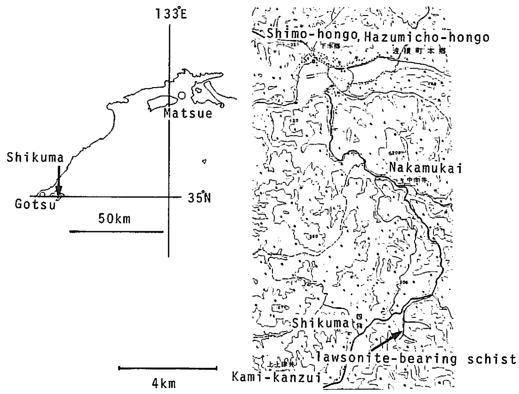

Fig. 1. Location of Shikuma and locality of lawsonite-bearing quartzofeldspathic schist.

Some of mafic schists have crossite-epidote-chlorite-albite-quartz assemblage and are much suitable to be called as blueschists. Actinolite-epidote-chlorite-albite-quartz assemblage is also recognized in mafic schists.

The area composed of these crystalline schists, extending some 7 km in E-W direction and some 4 km in N-S direction, is surrounded by granites of Mesozoic — Paleogene, andesitic volcanic and volcaniclastic rocks of the same age, and Neogene Tertiary sediments.

The metamorphic age is unknown, but it is believed to be latest Paleozoic or early Mesozoic.

Main trends of schistosity and lineation are E-W or NW-SE direction, but repeated deformation is generally recognized in quartzofeldspathic schists.

Fig. 2 is a route map along a creek occurring the lawsonite-bearing schist. Lawsonite-bearing quartzofeldspathic schist is intercalated with lawsonite-free quartzofeldspathic schists and the former is slightly rich in leucocratic layers consisting of calcite-albite-quartz aggregates as compared with the latter. The former has comparatively flattened schistosity and show slightly light colur due to the fact that it is rich in leucocratic layers. Thus, the lawsonite-bearing schist described here is discriminated in field from lawsonite-free schists. The maximum thickness of the lawsonite-bearing schist is about 1 meter. Small scale fold is observable under the microscope

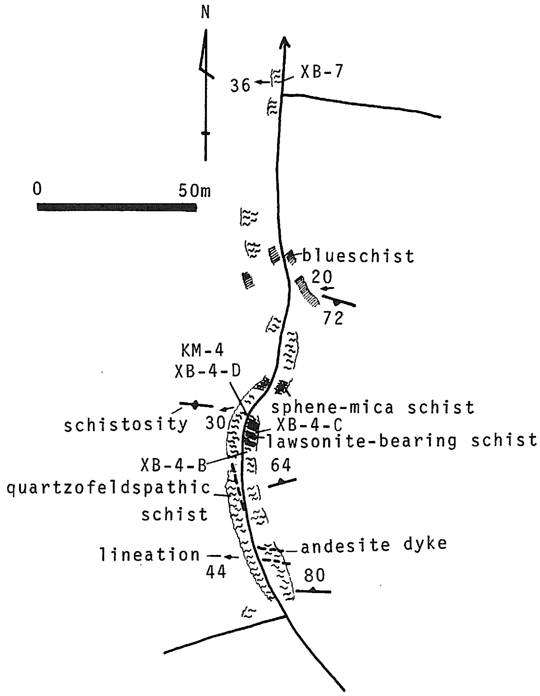

Fig. 2. Route map along a creek occurring the lawsonite-bearing schist.

for the lawsonite-bearing schist as well as lawsonite-free schists though axial plane cleavage is poorly developed as compared with those of lawsonite-free schists.

Description of the lawsonite-bearing schist

The lawsonite-bearing schist has distinct mineral foliation discriminated by micaceous layer and calcite-albite-quartz layer and its mineral assemblage is lawsonite-white mica-chlorite-epidote-albite-quartz-sphene-apatite-opaque minerals (including carbonaceous material). Carbonaceous material is not contained so much as lawsonite-free quartzofeldspathic schists.

Lawsonite having its characteristical rectangular shape occurs on micaceous layer (Fig. 3). $2V_z$ of lawsonite is about 80° and the grain size ranges from 0.1 to 0.5 mm in the elongated direction. The chemical composition is listed in Table 1.

As compared with lawsonite found in mafic schists (Nishimura & Okamoto, 1976), it is worthy to note that FeO content is very low notwithstanding coexistence with epidote, containning high ferric iron.

The difference of FeO (as total iron) content in lawsonite may important, as the stability field of low iron lawsonite is assummed to extend to high pressure and/or

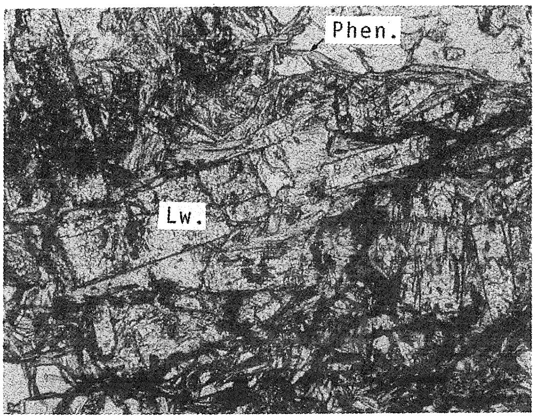

Fig. 3. Lawsonite on micaceous layer.
Lw. Lawsonite Phen. Phengite

Table 1. EPMA analyses of lawsonite

	KM–4	Nishimura & Okamoto
SiO_2	38.09	38.59
Al_2O_3	32.06	31.33
FeO*	0.25	1.53
CaO	17.72	17.08
K_2O	0.0	0.06
Total	88.22	88.59**

* Total Fe as FeO
** 10.62 wt % of H_2O is estimated on the basis of calculation for ideal chemical composition of lawsonite.

high temperature side. Except for a few points, lawsonite is mostly replaced by phyllosilicate mineral.

Coexisting white mica is phengite as it contains 3–4% in each FeO and MgO. Phengite is fine grain and shows often wavy extinction. Phengite is arranged parallel to both S_1 schistosity and S_2 (axial plane cleavage) schistosity.

Minor amounts of chlorite with weak pleochroism occur among phangite. Epidote occurs as minute granular grains in micaceous layer, often near lawsonite. The maximum size is 0.05 mm in its diameter. Albite, quartz, and calcite make fine grained aggregation of leucoratic layer, though calcite is relatively coarse grains. Minor amounts of sphene, apatite and opaque minerals occur sporadically in the schist, especially around or on micacepous layer. Chemical compositions for both lawsonite-bearing and lawsonite-free quartzofeldspathic schists are listed in Table 2. Mineral assemblage of lawsonite-free schists is phengite-albite-quartz-epidote-chlorite-sphene-apatite-calcite-opaque minerals (mainly carbonaceous material and pyrite). But main assemblage is phengite-albite-quartz-carbonaceous material.

As shown in Table 2, lawsonite-bearing schist is not rich in Al_2O_3, but rich in CaO and Na_2O. In C. I. P. W. norm, lawsonite-bearing schist shows high normative **an** and also high normative **di**.

As chemical composition of lawsonite is the same to anorthite composition except for H_2O and very minor amounts of iron, it is safely concluded the occurrence of lawsonite is essentially controlled by the host chemistry showing high normative **an**.

This conclusion, however, is not adopted for lawsonite in mafic schists. Because, as shown by Nishimura and Okamoto (1976), normative **an** of lawsonite-bearing mafic

Table 2. Bulk chemical compositions of quartzofeldspathic schists
(XB–4–B, XB–4–C, XB–7: lawsonite-free schists)
(XB–4–D, KM–4: lawsonite-bearing schists)
Localities of these schists are shown in Fig. 2.

Sample No.	XB–4–B	XB–4–C	XB–4–D	KM–4	XB–7
SiO_2	65.10	62.57	62.87	63.43	63.15
TiO_2	0.70	0.78	0.58	0.56	0.69
Al_2O_3	16.44	18.01	14.73	14.46	17.40
Fe_2O_3	1.81	1.92	1.16	1.21	1.81
FeO	3.39	3.74	3.13	3.08	4.15
MnO	0.07	0.08	0.06	0.05	0.19
MgO	1.96	2.08	1.93	1.97	1.94
CaO	0.17	0.22	4.28	4.75	0.68
Na_2O	2.41	2.60	4.17	4.35	2.32
K_2O	3.51	3.86	1.87	1.42	3.59
P_2O_5	0.08	0.13	0.04	0.03	0.06
$H_2O^+ + CO_2$	3.83	3.61	5.21	4.53	3.50
H_2O^-	0.10	0.14	0.11	0.11	0.10
Total	99.57	99.74	100.14	99.95	99.58
			C. I. P. W. norm		
Q	32.90	27.58	18.81	19.57	29.30
or	20.74	22.81	11.05	8.39	21.22
ab	20.39	22.00	35.29	36.81	19.63
an	0.32	0.24	15.95	15.74	2.98
C	8.56	9.47	—	—	8.60
di	—	—	4.13	6.26	—
wo	—	—	2.10	3.19	—
en	—	—	1.12	1.73	—
fe	—	—	0.91	1.35	—
hy	8.59	9.32	6.72	5.65	10.17
en	4.88	5.18	3.69	3.18	4.83
fs	3.70	4.14	3.03	2.48	5.34
mt	2.62	2.78	1.68	1.75	2.62
il	1.33	1.48	1.10	1.06	1.31
ap	0.19	0.30	0.09	0.07	0.14
Total	95.64	95.99	94.82	95.31	95.98

by XRF analysis (except for H_2O, CO_2 and FeO)

schists is not high as compared with lawsonite-free mafic rocks. Therefore, in case of mafic rocks, the appearance of lawsonite is considered to be controlled by the local chemical environments as mentioned earlier.

So far as we described here, distinct contrast between lawsonite-free and -bearing quartzofeldspathic schists in bulk chemical compositions is recognized. Lawsonite occurs restrictedly in the schists showing high normative **an**. In this point, occurrence of lawsonite of quartzofeldspathic schists in the Sangun belt is different from that in the Sanbagawa belt (Watanabe et al., 1983), so far as we have studied until now.

Summary

Reported is the first occurrence of lawsonite from quartzofeldspathic schist in the Sangun metamorphic belt.

The appearance of lawsonite is strongly controlled by host bulk chemical compositions showing high normative **an**. In the connection with the bulk chemistry, two kinds of quartzofeldspathic schists having clear difference in their bulk chemical compositions are newly discriminated as shown in Table 2.

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