MEMOIRS OF THE FACULTY OF SCIENCE, KYOTO UNIVERSITY, SERIES OF GEOL. & MINERAL.
Vol. XXXIV, No. 2, pp. 75–82

Wollastonite and Parawollastonite from Japan

By

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(Received Dec. 25, 1967)

Abstract

Parawollastonite and wollastonite can be distinguished from each other by the odd layer equi-inclination Weissenberg photograph about b-axis. Parawollastonite is not a rare mineral, although PEACOCK (1935) thought it might be rare. Devon type modification, first observed by JEFFERY (1953), has been generally considered to be rare too. But, it is also not rare.

Introduction

KATAYAMA and NAKAMOTO (1935) suggested, studying wollastonite from Hookizawa, Japan, that there might exist two forms in the naturally occurring calcium silicate ($CaSiO_3$). PEACOCK (1935) is the first to find the two forms, one being triclinic and the other monoclinic. To the former he assigned the name wollastonite and to the latter parawollastonite. He studied specimens from Crestmore, California and from Monte Somma, Italy. The specimens from Crestmore were triclinic and the specimens from Monte Somma were mostly monoclinic but partly triclinic. In some of the specimens from Monte Somma the two forms occasionally occurred in an intimate association. PEACOCK thought that the triclinic form was a common one and the monoclinic form a rare one. Further he said "the European occurrences were mainly parawollastonite while wollastonite was the principal material in the described American deposits".

BARNICK (1935) studied a specimen from Cziklova, Hungary by using X-ray. The specimen was parawollastonite, space group of which was $P2_1/a$. He observed that there exists in the X-ray reflexions of parawollastonite an extra rule, in addition the space group criteria, that is, hkl reflexions disappear when $2h+k=4n+2$. The extra rule was later confirmed by ITO (1950) and JEFFERY (1953). ITO examined wollastonite from Hookizawa, Japan, previously studied by KATAYAMA and NAKAMOTO, space group of which being revealed to be $P\bar{1}$. JEFFERY observed a singular effect in the X-ray reflexions of a specimen from Devon, England, that is, odd layer Weissenberg photographs showed streaks parallel to the direction of the a^* axis and in some cases rather diffuse spots could be seen on the streaks.

TOLLIDAY (1958) studied parawollastonite from Crestmore and said that the space group of parawollastonite was $P2_1$ and that of wollastonite was P1, the latter being derived from the former. Thus although the argument concerning the space group of the two minerals has not yet been setteled, recently the authors have examined the specimens from Japan, covering thirteen localities, whether they are wollastonite or parawollastonite. In the following details will be given.

Discrimination method between wollastonite and parawollastonite

Prior to entering into experimental, discrimination method between wollastonite and parawollastonite will be described.. According to JEFFERY (1953) cell-dimensions and axial angles are as follows: $a=7.88$ Å, $b=7.28$ Å, $c=7.03$ Å, $\alpha=90°$, $\beta=95°16'$, $\gamma=103°25'$ for wollastonite and $a=15.33$ Å, $b=7.28$ Å, $c=7.03$ Å, $\beta=95°24'$ for parawollastonite. Relationship between the two cells is shown in Fig. 1A, and in Fig. 1B is shown the relationship between two reciprocal cells derived respectively from the direct cells above described. In Fig. 1B open circles denote the reciprocal lattice points for triclinic form and solid circles the reciprocal lattice points for monoclinic form. It is noticeable that reciprocal lattice points

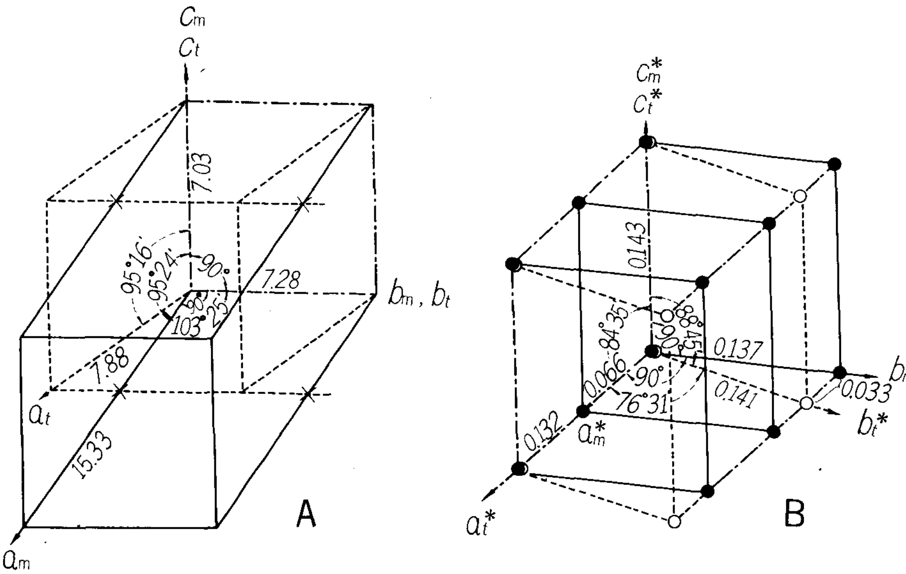
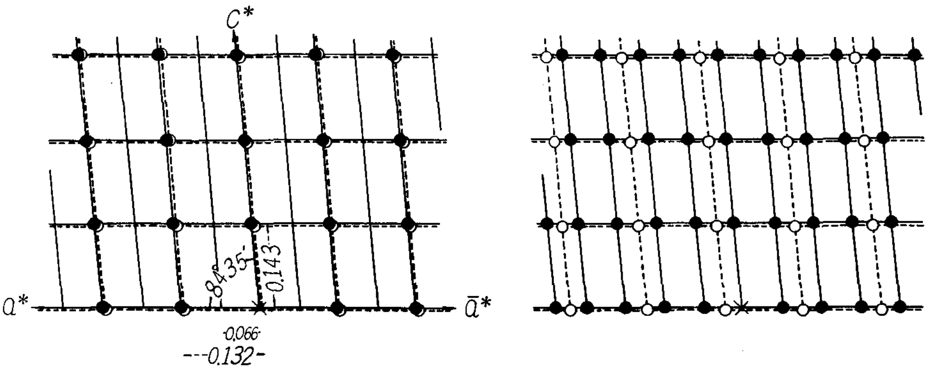


Fig. 1. Relationship between the unit cells of parawollastonite (solid lines) and wollastonite (brocken lines). A. Direct cells, cross marks denote the intersecting points of edges of the two cells. B. Reciprocal cells, there are two reciprocal cells of parawollastonite.



A B

Fig. 2. Reflexions which should appear in the equi-inclination Weissenberg photographs about b-axis when the photographs are taken with parawollastonite and wollastonite. Solid circles denote reflexions for parawollastonite and open circles reflexions for wollastonite. A. The zero layer. B. The 1st layer.

hkl, where $k=2n$, of the triclinic form fall on every other reciprocal lattice point *hkl*, where $k=2n$, of the monoclinic form and reciprocal lattice points *hkl*, where $k=2n+1$, of the triclinic form fall on every other half way between reciprocal lattice points *hkl*, where $k=2n+1$, of the monoclinic form. Since reflexions *hkl* disappear when $2h+k=4n+2$ and reflexions $0k0$ when $k=2n+1$ in the monoclinic form, eliminating reciprocal lattice points which yield no reflexions, we get reciprocal lattice nets as shown in Fig. 2. (In a case when space group of the monoclinic form is $P2_1/a$, reflexions $h0l$ disappear when $h=2n+1$. This rule is, however, included in the extra rule.) These reciprocal lattice nets correspond to the zero and 1st layer equi-inclination Weissenberg photographs about b-axis. Thus, in the even layer the spots of the triclinic form appear at the same positions as the spots of the monoclinic form appear. While, in the odd layer the spots of the two forms appear at different positions. Moreover, the spots along the reciprocal lattice lines parallel to the a^*-axis are sparse for triclinic form, whereas they are dense for monoclinic form. Then, two forms, triclinic and monoclinic, will be able to distinguish from each other by taking odd layer equi-inclination Weissenberg photographs about b-axis.

Experimental

Specimens examined in the present study are from the localities as follows:

Aotani, Kashihara-shi, Osaka Pref.
Azukuji, Inuyama-shi, Aichi Pref.

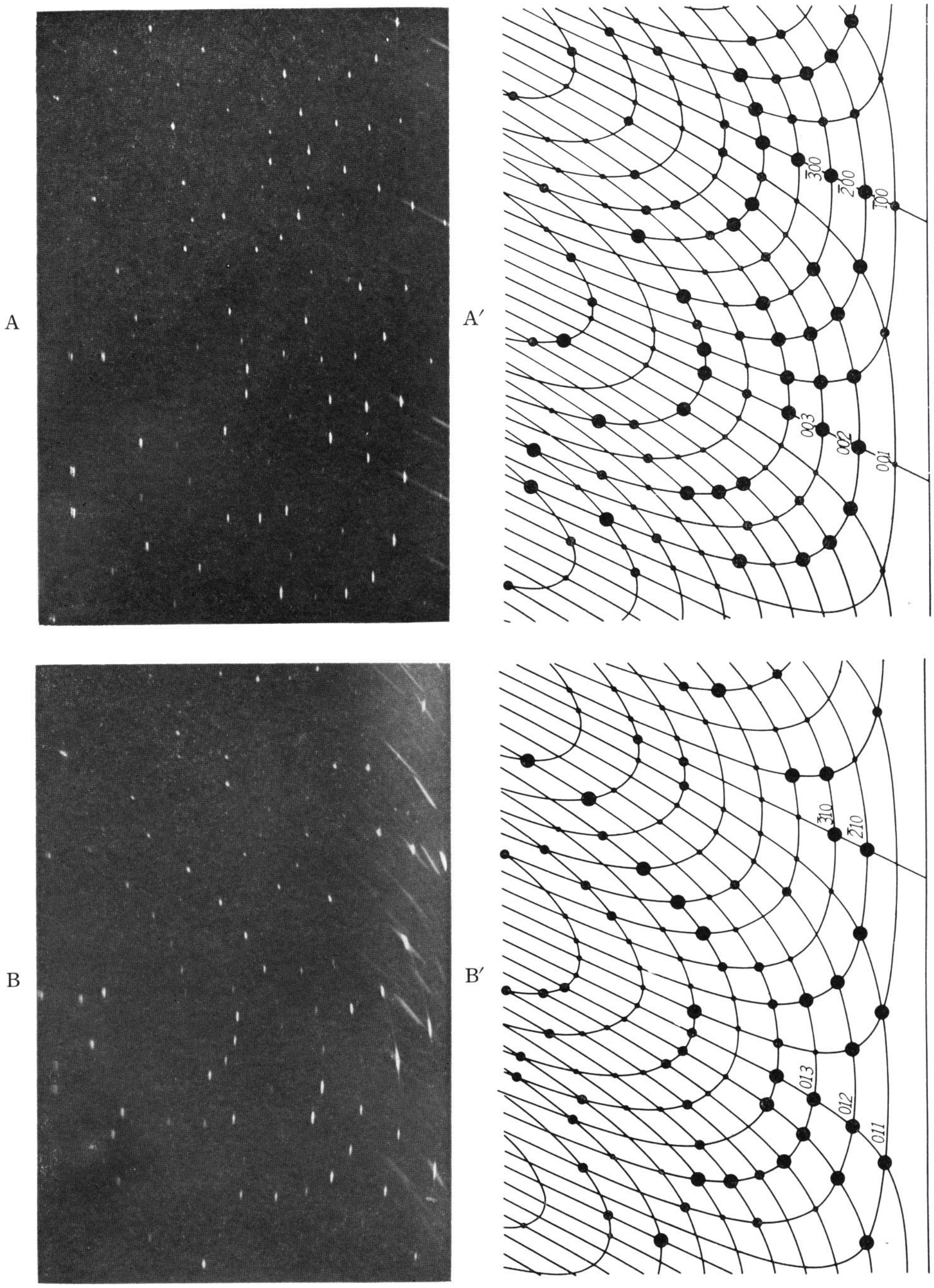


Fig. 3. Equi-inclination Weissenberg photographs of a specimen from Aotani. A, A'. The zero layer. B, B'. The 1st layer.

A

B

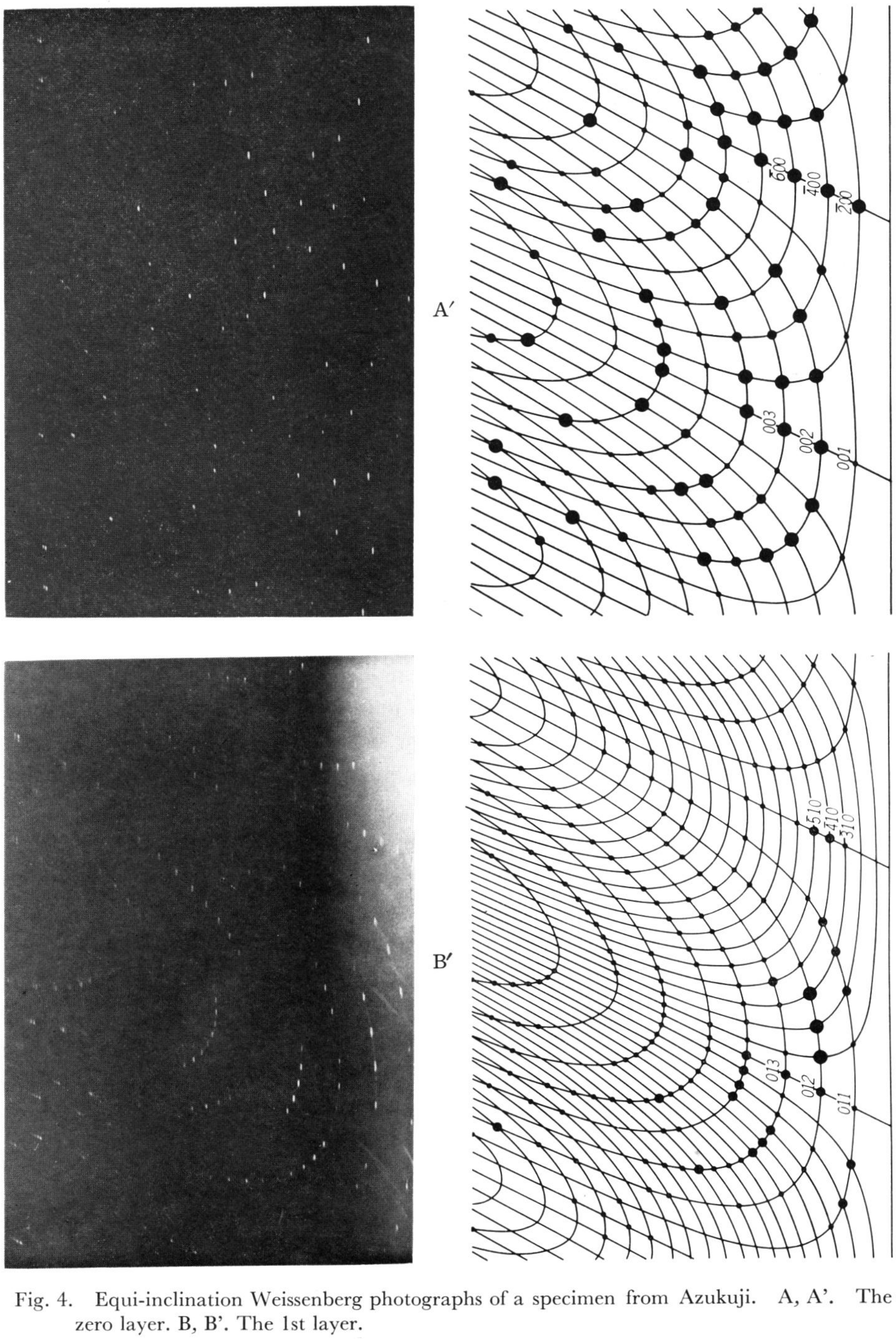


Fig. 4. Equi-inclination Weissenberg photographs of a specimen from Azukuji. A, A'. The zero layer. B, B'. The 1st layer.

Baba, Kanta-cho, Fukuoka Pref.
Saimyoji, Hino-cho, Shiga Pref.
Yoshihara Mine, Kitakyushu-shi, Fukuoka Pref.
Kotsubozawa, Rikuzentakata-shi, Iwate Pref.
Nakatatsu Mine, Izumi-mura, Fukui Pref.
Mitsuka, Kasuga-mura, Gifu Pref.
Nyoigadake, Kyoto-shi, Kyoto Pref.
Sannodake, Kawara-cho, Fukuoka Pref.
Yamato Mine, Miné-shi, Yamaguchi, Pref.
Tsukide, Nishiasai-mura, Shiga Pref.
Bodaiji, Kousei-cho, Shiga Pref.

These specimens are white in colour, silky in luster and finely fibrous in shape. They are from contact zones except for the specimens from Yoshihara Mine, Nakatatsu Mine and Yamato Mine which are hydrothermal deposits. X-ray powder patterns of these specimens obtained by using Norelco diffractometer revealed nothing particular to distingusih them from one another.

Rotation photographs about *b*-axis showed that odd layers reflexions were always weak as compared with even layers reflexions in intensity. In some specimens odd layers reflexions were hardly observable on the photographs despite of the long exposure. Therefore, odd layer equi-inclination Weissenberg photographs were taken being exposed for a time twice as long as the time for even layer equi-inclination Weissenberg photographs. In Fig. 3 are shown the zero and 1st layer equi-inclination Weissenberg photographs which were taken with a specimen from Aotani. As will be seen in Fig. 3B the reflexions along the reciprocal lattice lines parallel to the a^*-axis are sparse. The specimen from Aotani is, therefore, triclinic, viz. wollastonite. In Fig. 4 are shown the zero and 1st layer equi-inclination Weissenberg photographs which were taken with a specimen from Azukuji. As will be seen in Fig. 4B the reflexions along the reciprocal lattice lines parallel to the a^*-axis are dense. The specimen from Azukuji is, therefore, monoclinic, viz. parawollastonite.

In Fig. 5 are shown the zero and 1st layer equi-inclination Weissenberg photographs which were taken with a specimen from Baba. As will be seen in Fig. 5B the odd layer reflexions are very singular, though the even layer reflexions are normal. JEFFERY (1953) first observed such a curious phenomenon as said above. Although the spots on the odd layer equi-inclination Weissenberg photographs are drawn out along the direction parallel to the a^*-axis to form streaks, there are very weak spots on the streaks. The very weak spots can be divided into two sets by their locations. One set of spots are located on the same positions as the spots of monoclinic form and the other set of spots are located at the middle

A

B

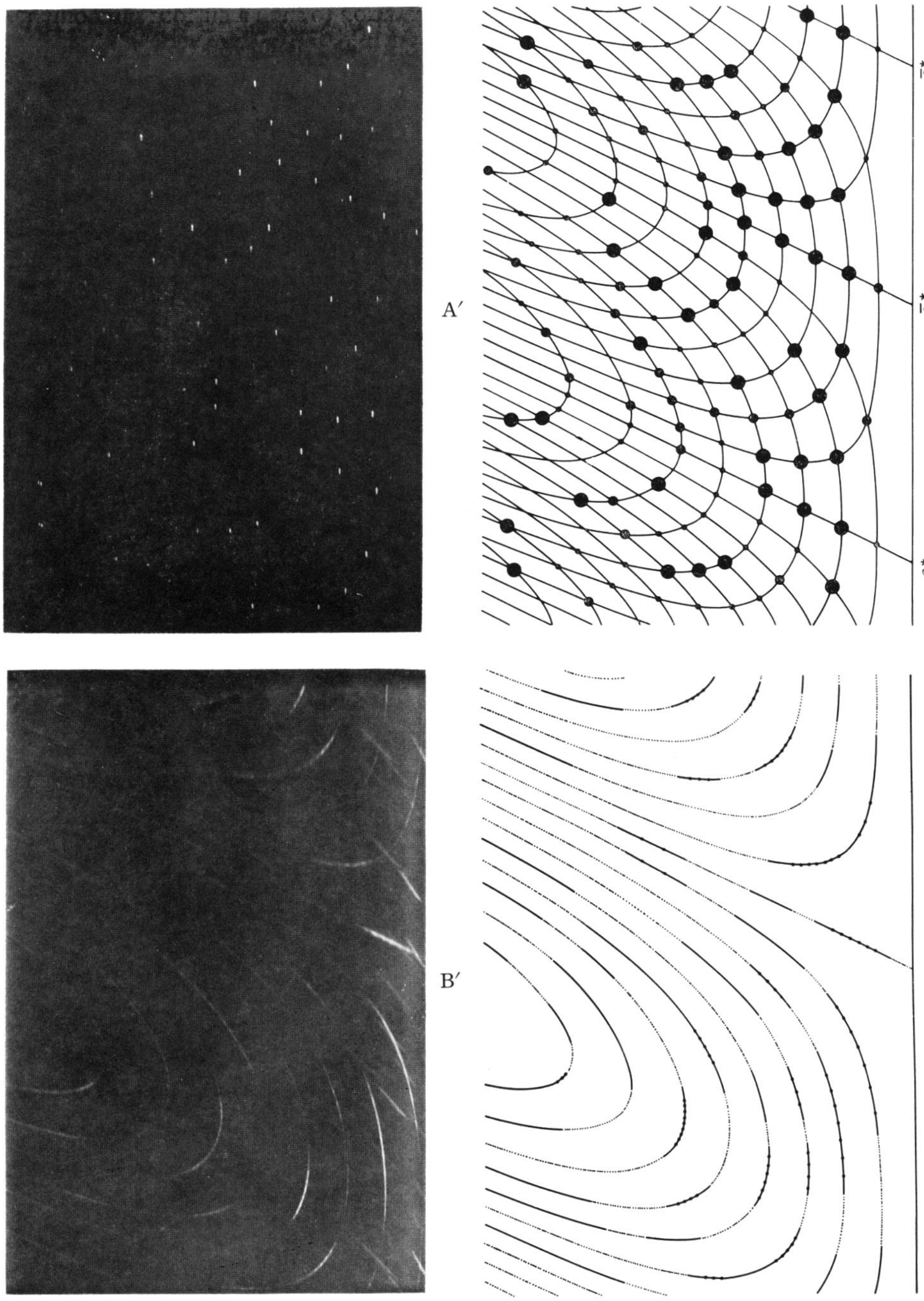


Fig. 5. Equi-inclination Weissenberg photographs of a specimen from Baba. A, A'. The zero layer. B, B'. The 1st layer.

points of the former. JEFFERY gave an interpretation to such a curious phenomenon. The authors distinguish such a specimen as from Baba as Devon type modification.

In order to identify, the authors have taken equi-inclination Weissenberg photographs with all the specimens described above.

Conclusions

PEACOCK (1935) thought that wollastonite was a common form and parawollastonite a rare one and it is generally accepted that Devon type modification is also uncommon. In the present study it has been revealed that neither parawollastonite nor Devon type modification is rare. Among the thirteen specimens described above, specimens from Aotani, Saimyoji and Nakatatsu are wollastonite, specimens from Azukuji, Yoshihara Mine, Sannodake and Yamato Mine are parawollastonite and specimens from Baba, Kotsubozawa and Tsukide are Devon type modification. The rest could not be identified on account of the fact that odd layers reflexions were hardly observable on the photographs despite of the long exposure.

References

BARNICK, M (1935): Strukturuntersuchung des natürlichen Wollastonits. Naturwiss. **23**, 770–771.

ITO, T. (1950): The wollastonite group. X-ray studies on polymorphism, 93–110. Maruzen, Tokyo.

JEFFERY, J.W. (1953): Unusual X-ray diffraction effects from a crystal of wollastonite. Acta Cryst. **6**, 821–825.

KATAYAMA, N. and A. NAKAMOTO (1935): Wollastonite from Hookizawa, Kanagawa Pref. Beiträge zur Mineralogie von Japan, Neue Folge 1, 183–196. Iwanami, Tokyo.

PEACOCK, M.A. (1935): On wollastonite and parawollastonite. Am. Jour. Sci. **30**, 495–529.

TOLLIDAY, J. (1958): Crystal structure of β-wollastonite. Nature **182**, 1012–1013.