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GIESSENITE FROM GIESSEN NEAR BINN, SWITZERLAND: NEW DATA

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ABSTRACT

The sulfosalt mineral *giessenite* from the type locality in Binnatal, Switzerland, was restudied to check its chemical and crystallographic relationship with the new species *izoklakeite*. The single-crystal X-ray study yielded the following unit-cell parameters: *a* 34.51(3), *b* 38.18(5), *c* 4.080(8) Å, in excellent agreement with the previous determinations. The orthorhombic space-group $P2_12_12_1$ in the original description must be corrected to monoclinic $P2_1/n$. The average of three electron-microprobe analyses gave Cu 1.2, Pb 47.5, Bi 29.8, Sb 4.2, S 16.5, total 99.2 wt.%, corresponding to $Cu_{4.27}Pb_{51.75}Bi_{32.19}Sb_{7.79}S_{116.18}$ based on 96 cations. The theoretical formula is $2[Cu_2Pb_{26}(Bi,Sb)_{20}S_{57}]$. The new data suggest that giessenite and izoklakeite are members of a solid-solution series; giessenite represents the Bi-rich member, and the composition of izoklakeite is close to that of the Sb-rich member.

Keywords: giessenite, izoklakeite, Binnatal, Switzerland, X-ray data, electron-microprobe analysis.

SOMMAIRE

La *giessenite*, sulfosel de la localité type de Binnatal, en Suisse, a été réexaminée dans le but d'en comparer les relations, chimique et cristallographique, avec la nouvelle espèce minérale *izoklakéite*. L'étude aux rayons X d'un cristal unique a permis d'en déterminer les paramètres réticulaires: *a* 34.51(3), *b* 38.18(5), *c* 4.080(8) Å, en accord excellent avec les déterminations antérieures. Le groupe spatial $P2_12_12_1$ de la description originelle est à remplacer par $P2_1/n$. Trois analyses à la microsonde électronique ont donné, en moyenne, Cu 1.2, Pb 47.5, Bi 29.8, Sb 4.2, S 16.5, total 99.2% (en poids), ce qui correspond à $Cu_{4.27}Pb_{51.75}Bi_{32.19}Sb_{7.79}S_{116.18}$ pour 96 cations. La formule idéale est $2\,[Cu_2Pb_{26}(Bi,Sb)_{20}S_{57}]$. Les nouvelles données indiquent que giessenite et izoklakéite font partie d'une même série de solutions solides; la giessenite représente le pôle riche en Bi, et la composition de l'izoklakéite est proche du pôle riche en Sb.

Mots-clés: giessenite, izoklakéite, Binnatal, Suisse, données aux rayons X, analyse à la microsonde électronique.

INTRODUCTION

The Binnatal region in southern Switzerland became famous for Pb–As sulfosalts more than a hundred years ago. During a comprehensive study of these minerals, which occur in a white, sugary dolomitic rock (Graeser 1965), a new mineral species was found that turned out to be the first, and at that time the only, Pb–Bi sulfosalt known from the region. Although the mode of occurrence is equal to that of the very famous sulfosalt locality Lengenbach, the new mineral was found in a dolomite outcrop about 2 km further to the west beside the road connecting the villages Binn and Giessen. The mineral was described under the name *giessenite* (Graeser 1963). Because only one sample was found, with very small poorly developed crystals intimately intergrown, it was not possible at that time to unequivocally determine the space-group symmetry. Ten years later, a second occurrence of giessenite was reported in northern Norway by Karup-Møller (1973). Recently, another occurrence of giessenite was found in the eastern part of Switzerland by Armbruster *et al.* (1984). The finding at Izok Lake, Northwest Territories, of the Pb–Sb–Bi sulfosalt *izoklakeite* (Harris *et al.* 1986), which shows a clear chemical and crystallographic relationship to giessenite, led to a re-study of the type material.

X-RAY STUDIES

Re-examination of the type giessenite was undertaken by Weissenberg single-crystal technique. Table 1 shows the newly determined single-crystal data as well as the original published data. The results show that although the unit-cell parameters remain virtually unchanged, the symmetry is monoclinic, space group $P2_1/n$. The deviation from orthogonal symmetry is small and only evident at high angles on overexposed Weissenberg photographs.

At the same time, attempts were made to obtain better X-ray powder-diffraction data for type giessenite using Debye–Scherrer and Gandolfi camera methods. The results, although better than the earlier published data, are not as high in quality as those published for giessenite by Karup-Møller (1973) and Armbruster *et al.* (1984). Hence the data are not published here.

CHEMICAL COMPOSITION

A thin mineral fibre of the type giessenite material

TABLE 1. X-RAY SINGLE-CRYSTAL DATA FOR GIESSENITE

	a	b	c	β	V	symmetry	space-group
Graeser (1963)	34.5 Å	38.3 Å	4.08 Å	-	5391Å^3	orthorhombic	$P2_12_12_1$
This study	34.51(3) Å	38.18(5) Å	4.080(8) Å	≈ 90°	5376Å^3	monoclinic	$P2_1/n$

TABLE 2. CHEMICAL COMPOSITION FOR GIESSENITE

	Cu	Pb	Bi	Sb	S	total wt.%
Graeser (1963)	1.3	44.4	28.5	4.0	22.3	100.4
This study (Ave. of 3)	1.2	47.5	29.8	4.2	16.5	99.2

was used for the preparation of a new polished section. The mineral was analyzed with a MAC electron microprobe at the Geological Survey of Canada, Ottawa using the same analytical conditions as reported by Harris *et al.* (1986) for izoklakeite. Results for giessenite are reported in Table 2. Based on 96 cations, the analytical results give $Cu_{4.27}Pb_{51.75}Bi_{32.19}Sb_{7.79}S_{116.18}$. The theoretical formula for giessenite is $2(Cu_2Pb_{26}(Bi,Sb)_{20}S_{57})$, with Bi > Sb. The near-identical crystallographic data and similar chemical formula suggest that giessenite and izoklakeite are members of the same series. Further discussions on the crystal-chemical aspects of the giessenite–izoklakeite series are given by Zakrzewski & Makovicky (1986). In the series, giessenite represents the Bi-rich monoclinic member and izoklakeite the predominantly Sb-rich orthorhombic member. Because the definite difference in symmetry between monoclinic giessenite and orthorhombic izoklakeite is not easily recognized, the exact location of the compositional break in the solid-solution series is not known. A recent discovery of "giessenite" reported by Armbruster *et al.* (1984) that has orthorhombic symmetry, but a composition with Bi slightly in excess of Sb, indicates that orthorhombic izoklakeite extends to at least 60 atomic % Bi in the Bi:Sb positions. In 1983, a second find of a giessenite–izoklakeite-like mineral was made by Dr. A. Burkhard (Basel) at the type locality for giessenite. Further studies on this new occurrence are planned to confirm its true identity by microprobe and single-crystal analyses.

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