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MINERALOGICAL NOTES

PLUMBIAN IKUNOLITE FROM KINGSGATE, NEW SOUTH WALES

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INTRODUCTION

The bismuth sulfide mineral ikunolite (Bi_4S_3) was first described by Kato (1959) from the Ikuno mine, Hyogo Prefecture, Japan. A second occurrence of this mineral has recently been found in specimens from the bismuth-molybdenite pipes at Kingsgate in the New England district of New South Wales. The following note gives details of its mode of occurrence and chemical composition.

The general features of the many pipe-like deposits of bismuth-molybdenite ore in eastern Australia are well known through the work of Andrews (1916), Blanchard (1947) and Garretty (1953). Mineralization occurs in a series of irregular pipes in granite that are localized along a granite-sedimentary rock contact. At Kingsgate some seventy pipes have so far been found. They are composed dominantly of quartz together with a little fine-grained sericite and altered feldspar.

MINERALOGY

Molybdenite, bismuth and bismuthinite are the three principal metallic minerals at Kingsgate with galenobismutite, cosalite, ikunolite, joseite A, joseite B, pyrrhotite, pyrite, arsenopyrite, galena, chalcopyrite, sphalerite, wolframite and cassiterite present in minor to trace amounts (Lawrence and Markham, 1962).

The ikunolite itself occurs as well developed plates and foliated masses up to 3 cm. in dimension associated particularly with native bismuth and molybdenite. It shows the perfect {0001} cleavage and splendent lead-gray color characteristic of all minerals of the tetradymite-joseite group.

Polished section study reveals that ikunolite is associated with bismuth, bismuthinite, joseite A, molybdenite and gold. The most common assemblages recorded are:

1. Ikunolite-bismuth
2. Ikunolite-bismuth-bismuthinite
3. Ikunolite-bismuthinite
4. Ikunolite-bismuth-bismuthinite-joseite A

though any combination of the above four minerals may be present in portions of the sections (Figs. 1, 2). The assemblages noted above give no clear-cut textural evidence of disequilibrium. Ikunolite and bismuthinite are commonly intergrown.

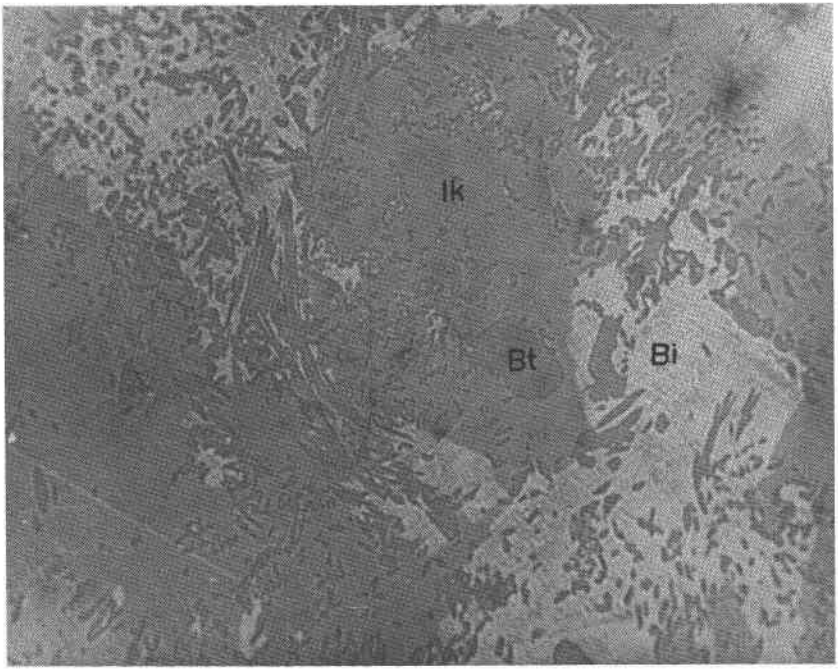

FIG. 1. Ikunolite (ik) in association with bismuth (bi) and bismuthinite (bt). ×150.

The optical properties of Kingsgate ikunolite agree well with those given by Kato (1959). Although possessing a grayish-white color intermediate between that of bismuthinite and joseite A its positive identification in polished section necessitates using *x*-ray methods.

Chemical Composition:

Ikunolite from Kingsgate has the following chemical composition

	1	2	3
Bi	83.24	79.69	89.68
Pb	5.49	—	—
S	10.41	8.89	10.32
Se	0.27	1.98	—
Te	0.78	0.1	—
Fe	0.04	—	—
Rem	—	9.44	—
Total	100.23	100.00	100.00

1. Ikunolite, Kingsgate. Analyst: J. Pyle
2. Ikunolite, Ikuno mine, Japan. Kato (1959).
3. Bi_4S_3

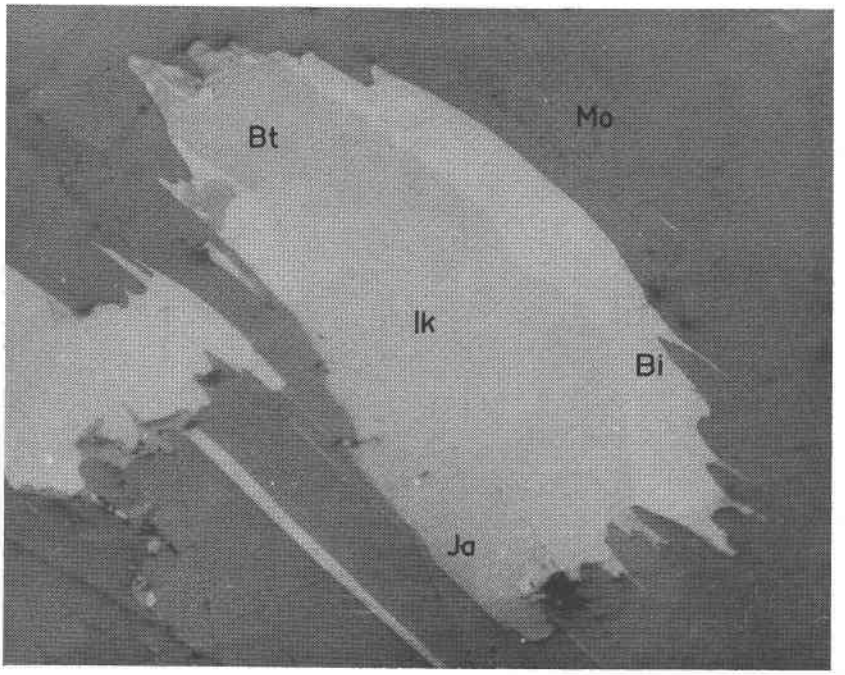

FIG. 2. The association ikunolite-bismuth-bismuthinite-joseite A in molybdenite (Mo). ×150.

This yields a calculated formula $(Bi\ Pb)_{3.82}$ (S, Se, Te)$_3$ which may be compared with $Bi_{3.79}$ (S, Se)$_3$ for the type material from Japan. The most noticeable feature of the new analysis is the high content of lead which appears to be in atomic substitution for bismuth in the structure.

X-RAY DATA

Powder photographs of Kingsgate ikunolite have been taken using Co $\kappa\alpha$ radiation. The d-spacings and intensities agree well with those listed by Kato. Spacings and intensities of the strongest lines are 3.02 (10), 2.21 (6), 6.55 (3), 4.36 (3), 3.53 (3), 2.07 (2) and 1.87 (2).

DISCUSSION

The compound Bi_4S_3 has not been reported in the artificial system Bi-S (Hansen, 1958) but may be a stable phase at very low temperatures. On the assumption that ikunolite has a field of stability in the binary system Bi-S, phase rule considerations suggest that some of the Kingsgate assemblages are clearly not in equilibrium. This is particularly so in the case of assemblages bismuth-ikunolite-bismuthinite (Fig. 1) and bis-

muth-ikunolite-bismuthinite-joseite A (Fig. 2). The rarity of ikunolite and the commonly reported association of bismuth with bismuthinite suggest that very special conditions are necessary for its formation. Ikunolite may, perhaps, be stable over a limited P-T range or form only in the presence of significant amounts of selenium and tellurium. A solution to this problem, however, must await a detailed study of the system Bi-Bi_2S_3-Bi_2Te_3.

Acknowledgements

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THE DISTRIBUTION OF Ni, Co, Cr, Cu, Ba AND Sr BETWEEN BIOTITE-GARNET PAIRS IN A METAMORPHIC SEQUENCE

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Introduction

One of us (Phinney, 1962) has made a systematic study of the mineralogy and major element chemistry of a sequence of rocks from a regional metamorphic terrane in Nova Scotia. The rocks, collected from St. Paul Island and Cape North, Nova Scotia, are represented by one from the garnet zone, 19 from the staurolite zone, two from the kyanite isograd, and one from the kyanite zone. The results of that study indicate that though the rock as a unit might represent an equilibrium facies characteristic of the temperature and pressure under which it was formed, there