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## SHORTER COMMUNICATIONS

# A STANNITE-KESTERITE EXSOLUTION FROM BRITISH COLUMBIA

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During a mineralogical investigation of a tin-rich lead-zinc-silver ore submitted to the Mineral Processing Division of the Mines Branch for beneficiation tests by Stannex Minerals Limited, an example of a stannite ($Cu_2FeSnS_4$)-kesterite ($Cu_2ZnSnS_4$) intergrowth was observed. Samples of the ore originated from a prospect located 19 miles northeast of Revelstoke, British Columbia, in the vicinity of the Snowflake mine from which Gunning (1931) reported a zincian stannite.

The ore consists chiefly of sphalerite, pyrite and galena with lesser, but appreciable, amounts of stannite-kesterite; the remainder of the minerals — cassiterite, pyrrhotite, rutile, scheelite, argentiferous tetrahedrite, chalcopyrite, covellite, cerussite, a tellurium-bearing canfieldite, and two other silver-tin-bearing minerals — occur in very small, to trace, amounts.

In hand specimen, the stannite-kesterite occurs as black, coarsely crystalline masses (up to 2 inches diameter) associated with pyrite in a matrix of milky quartz. Although the property has not been visited by the authors, the hand sample indicates a vein-type origin. All fragments of stannite-kesterite mounted in polished sections exhibit exsolution textures which varied from extremely fine-grained (Figure 1) to the coarser textures shown in Figure 2. In some cases, the exsolution features could only be distinguished by etching with a 1:1 $HNO_3$ solution, which preferentially etches the stannite phase. However, in the majority of the sections, the two phases could be readily distinguished by their differences in anisotropism. Stannite is strongly anisotropic while kesterite is nearly isotropic.

The two phases were analysed with an electron microprobe and the results are listed in Table 1. The microprobe was a Materials Analysis

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Company (MAC) model operated at 25 kilovolts. Pure tin, synthetic sphalerite, and chalcopyrite were used as standards and the required corrections applied using Rucklidge's computer program (1967).

The microprobe analyses show that the finer exsolved phase has a zinc:iron ratio of about 0.7:1, while the matrix has a ratio of about 1.8:1, which fall in the compositional fields of the minerals stannite and kesterite, respectively. The compositions correspond to 40 mole per cent kesterite in the stannite and 35 mole per cent stannite in the kesterite.

## *Discussion*

Although this is the first reported occurrence of stannite-kesterite exsolution in Canadian ores, the association has been previously reported from another locality. Oen (1970) described exsolution textures of stannite, hexastannite (renamed stannoidite, Kato 1969) and kesterite in the Mangualde Pegmatite, North Portugal. Ramdohr (1960) has likewise mentioned

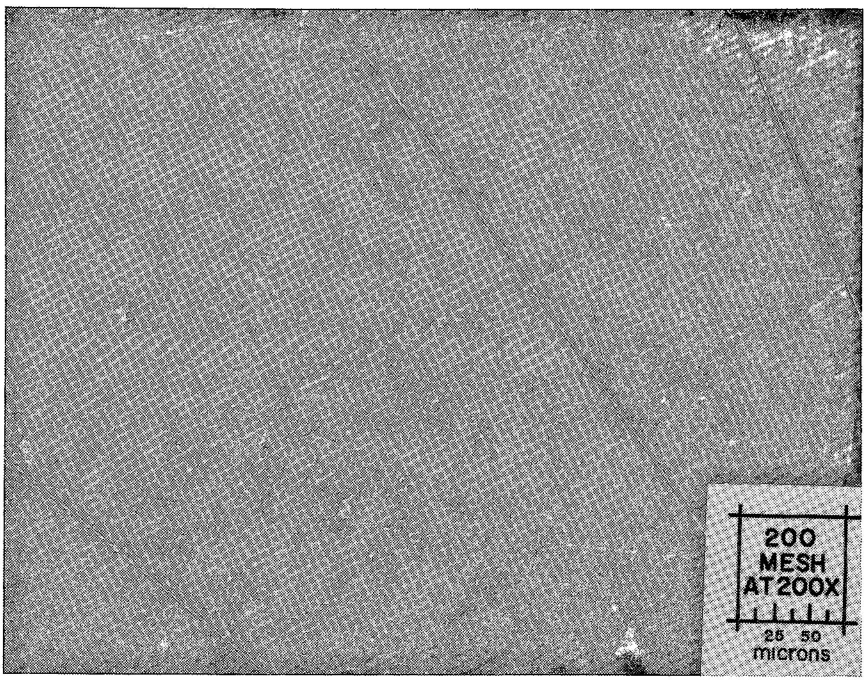


FIG. 1. Photomicrograph showing the finer-grained exsolved stannite (white) in a matrix of kesterite, (Crossed Nicols $3\frac{1}{2}°$ from extinction).

exsolutions in stannite, although exsolution of one kind of stannite in another was not confirmed.

As a result of this discovery, an investigation into the phase relations of the synthetic system $Cu_2FeSnS_4$-$Cu_2ZnSnS_4$ was carried out by Springer (1972). In addition to the experiments in the synthetic system, samples of the stannite-kesterite were heated at various temperatures. After the treatment at 300°C, only remains of the stannite exsolution were visible, and after annealing at 350°C the samples appeared to be completely homogenized. Results of this work support those of Springer who showed in the synthetic system that if a stannite-kesterite solid solution is cooled to the two-phase region, a segregation of an iron-rich and a zinc-rich phase can be expected. On the basis of the phase diagram, Springer estimated that the two stannites of 40 and 65 mole per cent kesterite content must have equilibrated at a temperature of about 200°C or less.

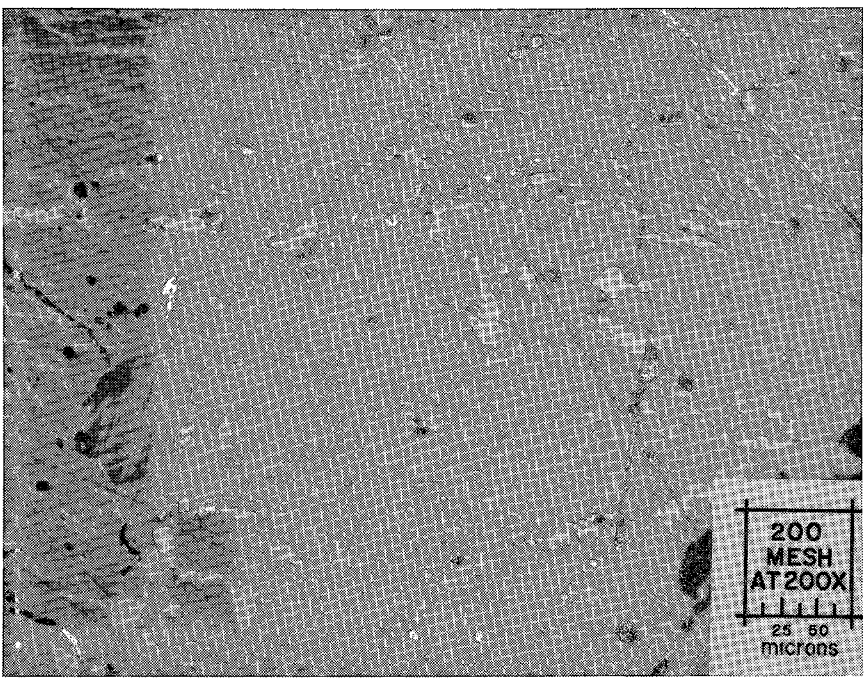


FIG. 2. Photomicrograph showing the coarser-grained exsolved stannite (white-dark grey) in a matrix of kesterite. (Crossed Nicols 2° from extinction).

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TABLE 1. ELECTRON MICROPROBE ANALYSIS OF STANNITE AND KESTERITE, near Revelstoke, British Columbia.

| | Exsolved Phase | Atomic Proportions * | | Matrix | Atomic Proportions * | |
|---|---|---|---|---|---|---|
| Cu | 29.88 ± 0.5 | 2.06 | | 29.93 ± 0.5 | 2.07 | |
| Zn | 5.85 ± 0.1 | 0.40 | 0.97 | 9.40 ± 0.1 | 0.63 | 0.97 |
| Fe | 7.35 ± 0.1 | 0.57 | | 4.38 ± 0.1 | 0.34 | |
| Sn | 27.54 ± 0.5 | 1.02 | | 27.66 ± 0.5 | 1.02 | |
| S | 28.99 ± 0.5 | 3.95 | | 28.74 ± 0.5 | 3.94 | |
| Total | 99.71 | 8.00 | | 100.11 | 8.00 | |

* Atomic proportions calculated to total 8 atoms.

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