The origin of stannite by replacement of cassiterite in the Turkaňk zone of the Kutná Hora ore deposit.

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Summary. The trace-element assemblage of the cassiterite of the Turkaňk and Rejsy zones of the Kutná Hora mining district are typical of a hydrothermal sulphide–cassiterite formation. Polished section studies show replacement of cassiterite by pyrrhotine, with stannite as an intermediate zone.

THE geochemistry of the Rejsy and Turkaňk zones in the northern part of the Kutná Hora mining district has been discussed by J. H. Bernard (1953). He considers that both these zones should be classified as polymetallic veins of the mesothermal-hydrothermal type, although some of the earlier ore minerals may be of catathermal origin. The presence of considerable iron and small but constant amounts of tin, however, suggests that the veins have features in common with those of the so-called sulphide–cassiterite type. The tin in these zones occurs partly as stannite and partly as cassiterite. Stannite was first identified in the Kutná Hora veins by J. H. Bernard, and its characteristics and chemistry have been thoroughly studied by J. Vtělenský (1958). Cassiterite from the Rejsy zone was first described by F. Novák (1961), and its occurrence in the Turkaňk zone—described below—was discovered by both Vtělenský and Novák.

J. H. Bernard considers that in the evolution of both zones the stannite, together with blende, chalcopyrite, pyrrhotine, and galena, belong to the second period of crystallization. Blende is the oldest ore mineral in this period, and most of the stannite is very closely associated with it, but their mutual relationship in order of succession is not quite clear. Stannite is much less common than blende, and is usually intimately intergrown with it, occurring only as allotriomorphic grains and aggregates. Stannite from the Old Bohemian zone (Vtělenský, *ibid.*) contains Cu 25·85 %, Fe 14·22, Sn 24·37, S 29·72, Zn 3·51, As 1·13, Cd 0·03, total

98·83 %, with spectrographically determined traces of Ag, Ca, In, Mn, Sb, Si, Al, Bi, Ga, Ge, Mg, Pb, and Ti.

The first period of crystallization (J. H. Bernard, 1953) in the Kutná Hora veins includes cassiterite, pyrite I, arsenopyrite I, and quartz I, and the present authors' observations show that cassiterite and quartz I are among the oldest minerals in the zones investigated. Cassiterite rarely occurs in considerable quantities, but recent observations show that its distribution is quite extensive in these zones and that its paragenesis is possibly the highest catathermal phase.

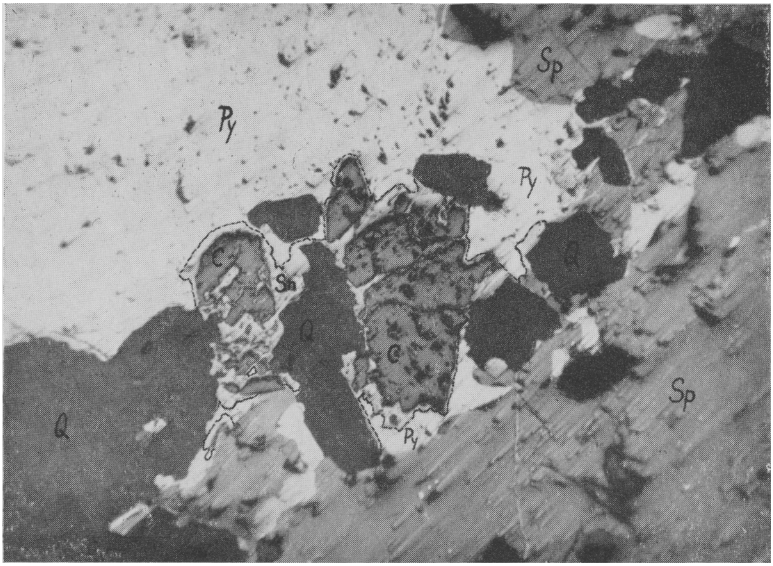

FIG. 1. Replacement of cassiterite by stannite and pyrrhotine. Sn, stannite; C, cassiterite; Py, pyrrhotine; Sp, blende; Q, quartz.

The properties and composition of the Turkaňk and Rejsy cassiterite are similar to those given in the literature we have quoted, which are typical of cassiterites in hydrothermal sulphide–cassiterite formations, especially the high content of Ti and W, and of the chalcophile elements Pb, Ag, Cu, As, Sb, Zn (A. S. Dudykina, 1959). Spectrographic analysis of cassiterite from Turkaňk (4th level, north) gave: Sn; Al, Si, Ti, 1 to 10 %; Ca, Fe, Pb, W, 0·1 to 1·0 %; Ag, Cu, 0·01 to 0·1 %; As, Be. Cr, Ga, Mg, Mn, Nb, Ni, Sb, Sc, V, Zn, $<$ 0·01 %. The absence of indium, a common trace element in hydrothermal cassiterite in sulphide associations, and present in anomalously high concentration in blende from this locality, is remarkable. The traces of Sc and Nb, which frequently occur together in cassiterite (L. F. Borisenka and N. V. Lizunov, 1959), do not refute our classification, and some of the other elements, such as Be, Ga, and V, are commonly found as traces in cassiterites and are not characteristic of any specific genetic type (A. S. Dudykina, *ibid.*). An X-ray study of the cassiterite gave the cell dimensions a 4·737 ± 0·003 Å, c 3·186 ± 0·005 Å.

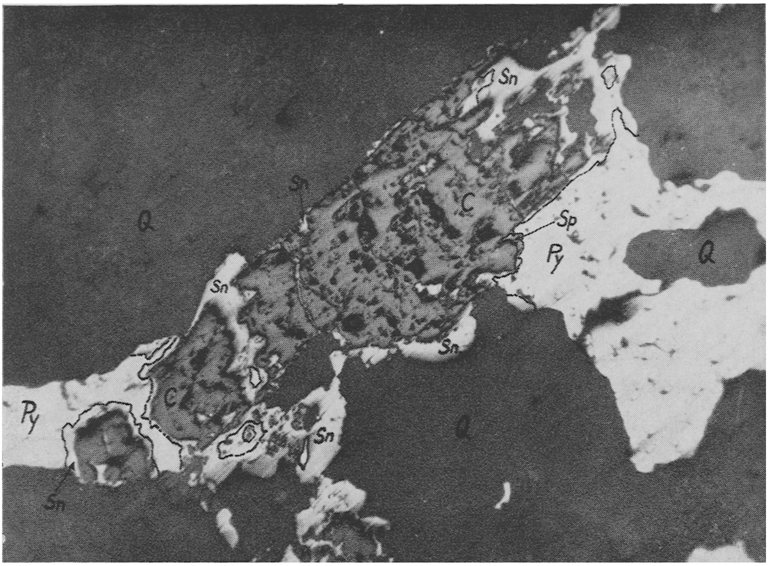

FIG. 2. Replacement of cassiterite by stannite and pyrrhotine. For key to the lettering, see fig. 1.

The study of polished sections reveals interesting genetic relations between cassiterite, stannite, and pyrrhotine from the Turkaňk zone. It has clearly been observed (J. H. Bernard, *ibid.*) that partial replacement of the oldest minerals (quartz I, arsenopyrite I, and pyrite I) by the younger quartz–sulphidic minerals (blende, stannite, chalcopyrite, pyrrhotine, and galena) has taken place, and we have found the interesting and characteristic phenomenon of varying degrees of replacement of cassiterite by blende and pyrrhotine, the predominant sulphides of the younger period. Although crystals of cassiterite show no obvious signs of replacement by the surrounding blende and frequently retain their habit, those surrounded by pyrrhotine exhibit extensive replacement and even resorption. The replacement of cassiterite by pyrrhotine amounts to replacement by stannite, which forms a distinct reaction rim around the partly resorbed grains (figs. 1, 2). The presence of copper in the hydrothermal solutions that produced the pyrrhotine may be presumed from the evidence of abundant chalcopyrite with pyrrhotine in the neighbouring Old Bohemian zone. This phenomenon has been observed, by implication only (L. Baumann, 1958), in analogous veins at Freiberg where similar rims of stannite have probably resulted from the reaction of chalcopyrite replacing cassiterite. We assume that part of the stannite is derived from cassiterite that has been resorbed by the mass of pyrrhotine and chalcopyrite.

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