A SECOND OCCURRENCE OF DZHALINDITE

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ABSTRACT

Dzhalindite ($In(OH)_3$) has been discovered at Mount Pleasant, New Brunswick, Canada, where it is associated with calcite, galena and quartz in fractures in sphalerite containing exsolved chalcopyrite and stannite. Electron microprobe analyses indicate substitution of indium by tin (7.4 wt.%), zinc (1.6 wt.%) and iron (1.7 wt.%).

The Mount Pleasant complex sulphide-cassiterite body, situated approximately 35 miles southwest of Fredericton, New Brunswick, Canada, is noted for the indium-rich character of the sulphide minerals. (Boorman & Abbott 1967, Sutherland & Halls 1969).

The geological setting of the deposit, which is associated with brecciated and greisenized acidic volcanic porphyries of Mississippian Age, has been summarized by Ruitenberg (1967). He considered that the subvolcanic environment, structure and xenothermal mineralization of the assemblage resembles that of some of the Bolivian tin deposits. Petruk (1964) described the general mineralogy and identified more than 40 minerals : sulphides, oxides, native metals and silicates of which the most abundant are sphalerite, arsenopyrite, pyrite, chalcopyrite and galena, with minor, cassiterite and stannite.

Investigations in the synthetic system ZnS-In_2S_3 (Boorman & Sutherland 1969) showed that of the Zn-In-S ternary compounds that might occur in nature in co-existence with sphalerite, the phase $Zn_9In_8S_{21}$ seemed the most probable. While searching for this phase, the mineral roquesite ($CuInS_2$) was found (Sutherland & Boorman 1969) and subsequently the mineral dzhalindite ($In(OH)_3$).

Genkin & Murav'eva (1963) first described dzhalindite from the Dzhalind tin deposit in eastern Russia. They attributed its occurrence to the supergene alteration of indite ($FeIn_2S_4$) with which it was intimately associated in cracks throughout the colloform cassiterite (Figs. 1 and 2), photographed on a sample kindly provided by A. D. Genkin (IGEM, USSR). Their microspectrographic analyses gave an indium to iron weight ratio of 0.78:0.16 but they believed the iron to be present as admixed iron hydroxide rather than in the mineral structure. The silica detected in their analyses was attributed to quartz impurity. The

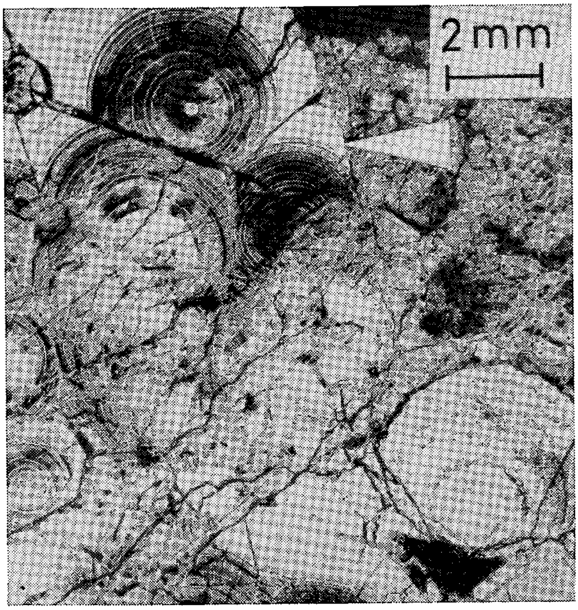

FIG. 1. Fragmented and brecciated colloform cassiterite. The dzhalindite occurs in cracks and between the adjacent cassiterite spherules. Dzhalind, U. S. S. R.

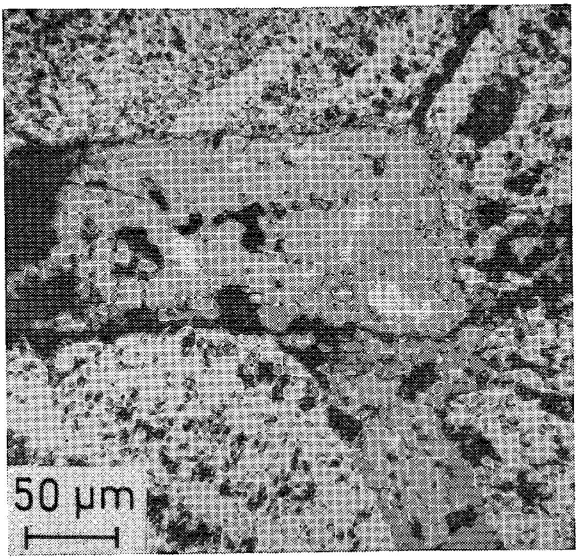

FIG. 2. Dzhalindite (grey) and Indite (white) occupying the space formed at the junction of three cassiterite spherules (arrowed in Fig. 1). U.S.S.R.

sample was free of sulphur. They confirmed their identification by an x-ray diffraction comparison with synthetic $In(OH)_3$.

At Mount Pleasant, dzhalindite has been found at one location at the south end of the adit in the north zone. It occurs associated with calcite, galena and quartz along fractures in the sphalerite which is charged with finely exsolved chalcopyrite and rare stannite (Fig. 3). The development of this mineral along fractures is indicative of a later and, possibly, supergene origin.

The dzhalindite is dark grey in reflected light with a reflectance visually estimated by comparison with that of the associated cassiterite (approximately 12%) and quartz (approximately 5%), of close to 7% in air. It is sensibly isotropic but the surface optical effects under crossed nicols are masked by strong internal reflections. In the Russian sample the internal reflections vary from pale buff to reddish brown close to the indite and are probably related to the content of admixed iron hydroxide in the dzhalindite; the reddish brown colouration occurs where the iron hydroxide is most abundant.

Electron microprobe analyses of the Russian dzhalindite and indite and of the Mount Pleasant dzhalindite and associated sphalerite are presented in Table 1. The analyses were made on an Acton Cameca M.S. 64 microprobe at a constant excitation voltage of 20 kv. The samples of dzhalindite, indite and the co-existing sphalerite at Mount Pleasant

TABLE 1. COMPOSITION OF DZHALINDITE AND ASSOCIATED SPHALERITE AT MOUNT PLEASANT AND OF DZHALINDITE AND INDITE, DZHALIND, U. S. S. R.

	Mount Pleasant			Dzhalind, U. S. S. R.		
No. of analyses		3	5	67		33
averaged	*$In(OH)_3$**	*Dzhalindite* a.	*Sphalerite* a.	*Dzhalindite* a.	*(Range)*	*Indite* a.
Zn		1.65 (.48)	62.51 (1.52)	n.d.	—	n.d.
In	69.24	61.59 (1.66)	0.56 (.12)	63.06 (5.62)	45.98-70.34	57.17 (.54)
Sn		7.36 (1.73)	0.20 (.15)	n.d.	—	n.d.
Fe		1.74 (.18)	2.89 (1.82)	5.06 (3.69)	1.42-16.94	11.50 (.35)
Cu		n.d.	0.30 (.38)	n.d.	—	n.d.
S		n.d.	34.23 (.70)	0.21 (.61)	n.d. - 3.87	31.27 (.41)
Totals	69.24	72.34	100.69	68.87		99.94

* Theoretical Composition.

7 Analyses of a synthetic $In(OH)_3$ gave an average composition of 69.73 wt.% In.

a. Standard deviation.

n.d. = not detected.

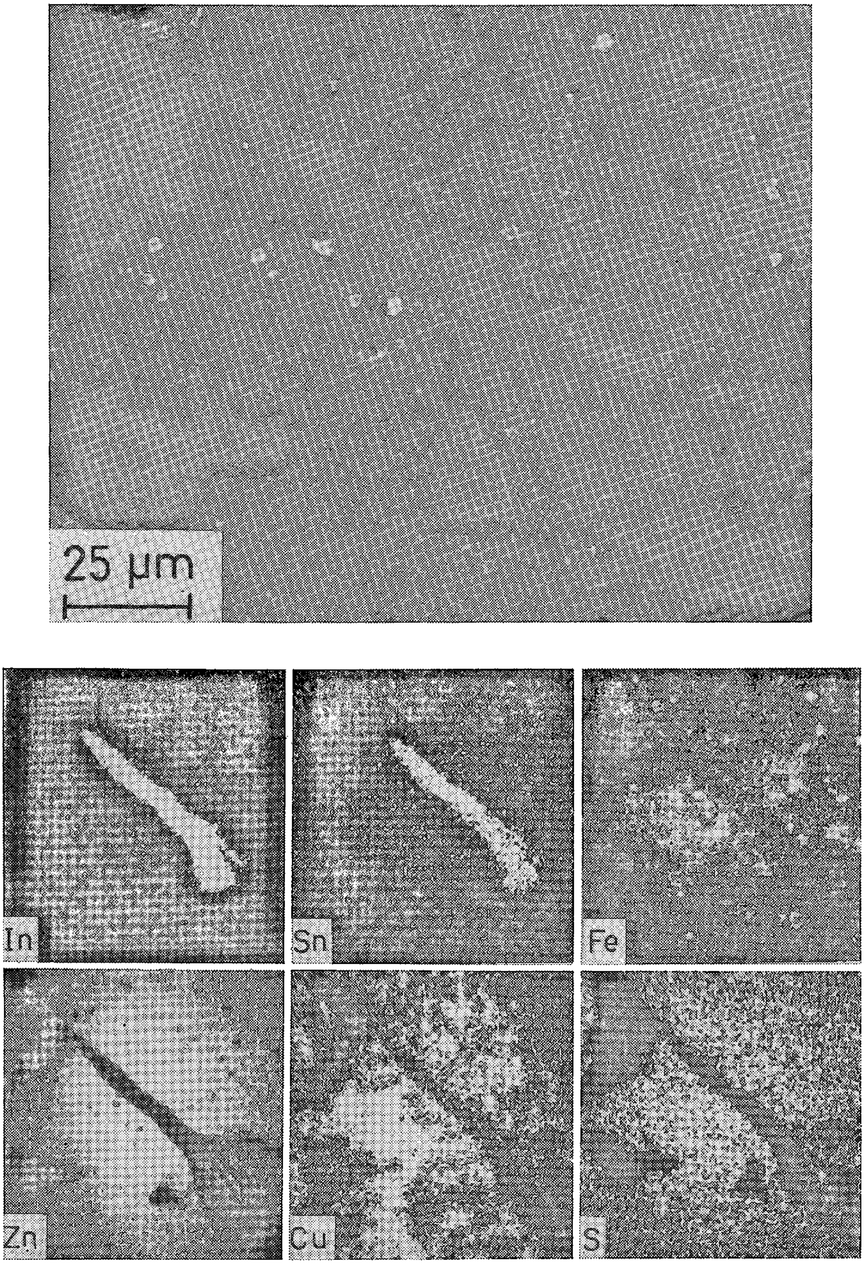

FIG. 3. The Mount Pleasant dzhalindite (grey) in sphalerite. X-ray scanning photographs show the distribution of In, Sn, Cu, Fe, S and Zn.

were standardized against synthetic In_2S_3, synthetic sphalerite of known composition, analyzed natural pyrite and elemental iron, copper and tin. The choice of standards was influenced by the composition of the sample analyzed.

The data was processed by a computer programme (Rucklidge 1967) correcting for over-voltage, dead-time, efficiency of excitation, absorption and fluorescence.

At Mount Pleasant zinc, iron and tin are present in the dzhalindite, but copper was not detected (<0.01 wt.%) suggesting that the mineral was not formed through the alteration of roquesite.

The distribution of the elements in the area analyzed (approximately 10 x 100 microns) is shown on the *x*-ray scanning photographs. Because of the relatively high concentration of zinc in the adjacent sphalerite, the distribution of this element in the dzhalindite is not clear on the *x*-ray scanning photograph for zinc.

Pure dzhalindite does not contain sulphur and the few analyses containing traces of this element were rejected as being contaminated by the adjacent sphalerite. The high standard deviation for the percentage of tin in the analyses suggests the possible contaminating effect of sub-microscopic cassiterite inclusions. Because of the small grain size of the dzhalindite and its rare occurrence, the mineral identification could not be verified by *x*-ray diffraction.

The results of microprobe analyses on the Russian dzhalindite show a wider variation in iron content, from 1.42 - 16.94 wt.%, than Genkin & Murav'eva indicated but none of the analyses contains less than 1.42 wt.% iron. The difficulty of avoiding the intimately associated indite and admixed iron hydroxide is clear from the analyses. Where sulphur is encountered, the Fe:S ratio is always greater than that in indite (Table 1), indicating either the pervasive nature of the iron hydroxide or that the dzhalindite does contain iron, or both. Despite the close association with cassiterite, tin was not detected. As no grains of "pure" dzhalindite free of the influence of either indite or iron hydroxide were encountered, it is not possible to assign a stoichiometric composition to the Russian dzhalindite.

In contrast to the Russian sample, the Mount Pleasant dzhalindite is not associated directly with an indium-rich mineral and there is no evidence for supergene alteration other than that the dzhalindite is later than the sphalerite in which it occurs. The other indium-bearing sulphides, indite ($FeIn_2S_4$), and sakuraiite ($(Cu_{1.6}Zn_{0.7}Fe_{0.3}Ag_{0.2})(In_{0.7}Sn_{0.3})S_{4.2}$) (Kato 1965) have not yet been found at Mount Pleasant.

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