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Occurrence of Bismuth and Selenium in the Sulphide Ores of Ingaldhal and Kalyadi, Karnataka

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SEM examination of a set of sulphide ore samples from Ingaldhal and Kalyadi mines has revealed the frequent occurrence of a suite of Bi and Se bearing minerals as small inclusions (measuring around 15-20 microns), largely confined to the main sulphide ore minerals, viz., pyrite and chalcopyrite. The inclusions are of widespread occurrence specially in the Ingaldhal sulphide ore, having been recorded in all the samples collected from the mine levels 3, 10 and 12. These inclusions are easily distinguished by their very bright appearance under incident light. EDS analysis of a large number of inclusions has indicated that they comprise of complex chemical gradations from almost pure *native bismuth* and *galena* (Fig. 1) into *clausthalite* (Pb Se), *bismuthinite* (Bi_2S_3), *galenobismuthinite* ($PbBi_2S_4$) and *cosalite* ($Pb_5Bi_2S_5$). Ag, Te and Sb are sometimes recorded in significant amounts. Zoned crystals with native Bi cores and Bi-selenosulphide/Bi-Pb selenosulphide outer portions are not uncommon.

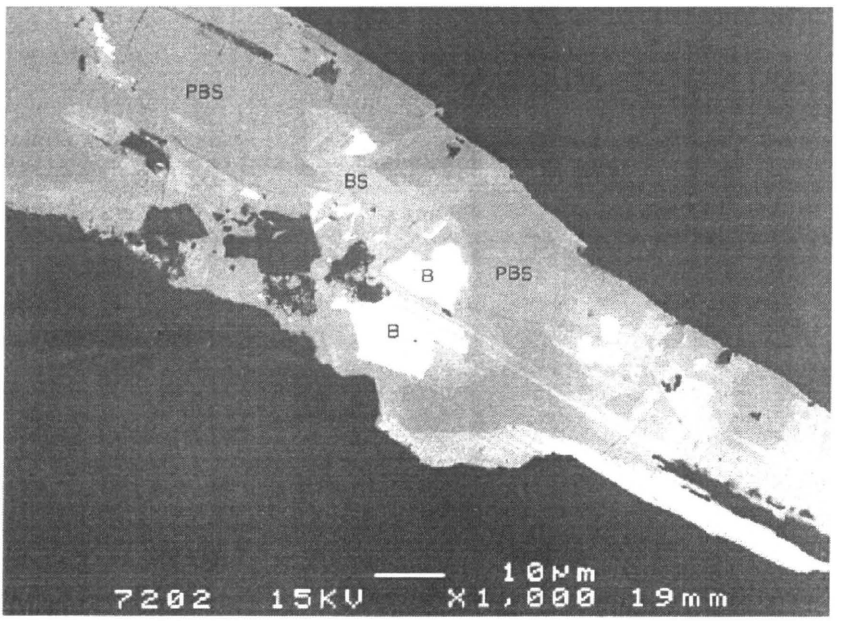

Fig.1. Back scattered electron micrograph of Ingaldhal sulphide ore showing the occurrence of Bi-Pb selenosulphide with complex chemical variation from native bismuth (B) to Pb-Bi-Sb selenosulphide (PBS) through bismuth selenide (BS). The surrounding dark looking mineral is largely quartz.

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Although no analyses of bulk sulphide ore samples for Bi and Se have been obtained, on the basis of visual frequency of occurrence of Bi and Se bearing inclusions, specially in the Ingaldhal ores, it appears that these elements are in high enough concentrations for extraction as by-products.

As far as the authors are aware, there are no previous reports of Bi and Se minerals either from Ingaldhal or Kalyadi ores. It is hoped that the present finding together with the reported occurrence of Co, will add to the value of these sulphide ores, which have temporarily lost market for their main metal content viz., Cu but gaining importance for their recoverable Ag and Au contents.

JEOL SEM fitted with Link AN 10,000 attachment, available at the Department of Electron Optics, University of Oulu, Finland, has been utilised for the present study. We thank Miss Ulla E. Komppa for her help with SEM analysis and Mr. Seppo Sivonen, Director of the Department, for extending the analytical facilities.

Table I. Analyses of selected Bi and Se minerals from Kalyadi and Ingaldhal.

	1 (11/94)	2 (3F/94)	3 (12/94)	4 (4/94)	5 (21C/93)	6 (3F/94)	7 (3A/94)	8 (3B/94)
Bi	97.81	95.86	81.14	79.00	58.92	33.85	28.56	4.04
Pb		4.33	4.20	5.01	2.89	47.22	46.60	76.04
Fe	1.34					0.47		0.50
Se		0.24	7.77	11.90	4.27	12.64	2.55	8.72
S			5.19	3.51	33.91	3.07	14.03	8.59
Ag						1.04	1.48	1.00
Te			1.69	0.59				
Cu							1.62	1.10
Rh						1.84		
Sb							5.17	

1 and 3 from Kalyadi mine; 2 and 4 to 8 from Ingaldhal mine.

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