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EPMA characterisation and geochemistry of cassiterites from the Kuala Lumpur area

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Abstract: The Kuala Lumpur area used to be a major tin producing area in the last century. The purpose of this study is to characterise the cassiterite in the Kuala Lumpur area using the EPMA and petrological microscope. This study involves primary and alluvial cassiterite from past and present mines in the Kuala Lumpur area, namely, the Ulu Klang, Kampung Pandan, Setapak, Pudu Ulu and Puchong areas.

EPMA study show that the cassiterites in the Kuala Lumpur area have, on the average, Sn contents of 68.0526 to 75.3848 wt%. The average Sn content for cassiterite from the Ulu Klang area is 73.5696–74.9022 wt%, the Kampung Pandan area is 71.6597–74.1387 wt%, the Setapak area is 68.0526–69.2089 wt%, the Pudu Ulu area is 73.5723–74.3704 wt% and the Puchong area is 73.0738–75.3848 wt%.

Cassiterites from Kampong Pandan show strong reddish pleochroism. EPMA analysis show that the reddish areas are higher in Sn, Fe, Ti and Nb.

The cassiterites in the Kuala Lumpur area are also characterised by inclusions of native bismuth and bismuth-containing minerals, namely, rooseveltite ($BiAsO_4$) and bismuthinite (Bi_2S_3) in the Ulu Klang area. Wodginite [$(Ta, Nb, Sn, Mn, Fe)_{16}O_{32}$] and native bismuth inclusions were found in cassiterites from Kampong Pandan while cassiterites from Puchong showed inclusions of andalusite (Al_2SiO_5).

INTRODUCTION

In the days when Malaysia was the main producer of tin in the world, the Klang Valley, where the Kuala Lumpur area is situated, was one of the main areas where alluvial and primary tin was mined (Willbourn, 1922).

The present study is aimed at characterising the cassiterite from the various areas in the Kuala Lumpur area with the aid of the EPMA (Electronprobe Microanalyzer).

MATERIALS AND METHODS

Tin mineralisation in the Kuala Lumpur area has been well-studied (Yeow, 1969; Wong, 1970; Khoo, 1970; Yew, 1971, Leong, 1973; Goh, 1975; Wan Hasiah Abdullah, 1983; Hosking, 1973; Yeap, 1969). The tin mineralisation has been ascribed to the intrusion of granite (Late Permian & Late Triassic) and its associated hydrothermal solution which has given rise to the many mineralised veins and dykes (Hosking, 1973).

The samples for the study include primary and alluvial cassiterites from the Department's Collection (from Ulu Klang, Kampong Pandan, Setapak, Pudu Ulu, Puchong) and those from two mines that are still operating in the Puchong area, namely, Marijuana Maju Sdn. Bhd. and Metreco Industries Sdn. Bhd. (Cheng, 2001) (Fig. 1).

The cassiterites from the different areas were studied together with their associated heavy minerals. Initial observations were made using the hand lens, followed by a the binoculars, the petrological microscope and finally the EPMA. Under the EPMA, the minerals grains were

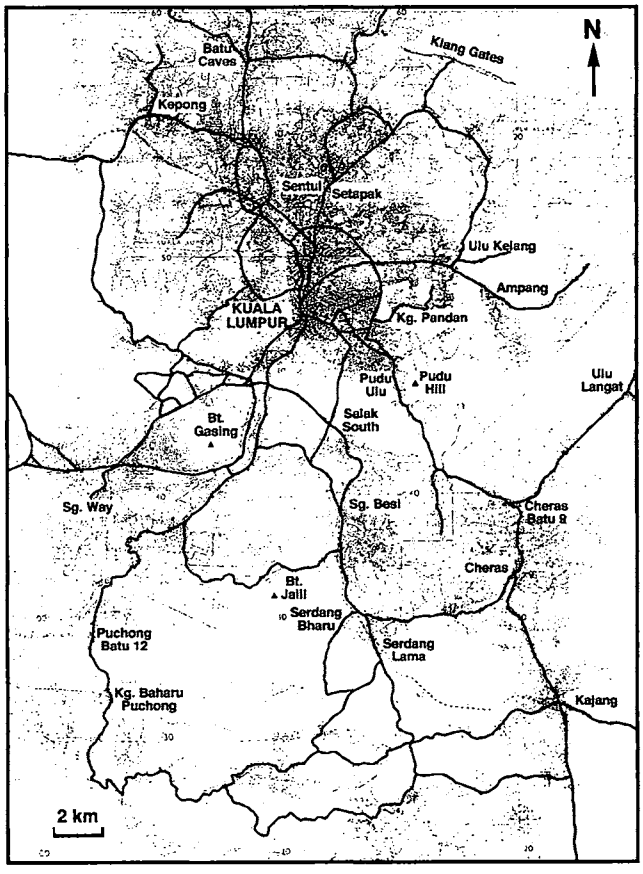

Figure 1. Location map of the Kuala Lumpur area.

Table 1. EPMA analysis of cassiterite grains for different localities in the Kuala Lumpur area (normalised wt%).

Element	Ulu Klang		Kampung Pandan			Setapak		Pudu Ulu		Puchong	
	569	579	775	413	407	P.t.s.	302	426	724	M5	710
Sn	74.9022	73.5696	74.1387	71.6597	72.6722	69.2089	68.0526	73.5723	74.3704	75.3848	73.0738
Fe	0.0273	0.0777	0.1162	0.1742	0.0005	0.9053	0.1415	0.0680	0.0520	0.3560	0.0252
Ti	0.0305	0.0406	0.0494	0.3300	0.0513	0.0445	0.0326	0.0045	0.0156	0.0000	0.0588
Nb	0.0171	0.1428	0.0021	0.0502	0.0493	0.0027	0.0229	0.0000	0.0104	0.0000	0.0000
Ta	0.0000	0.0000	0.0945	0.0522	0.0000	0.0721	0.0119	0.0000	0.0104	0.0014	0.0613
W	0.1527	0.0541	0.4490	0.0413	0.0402	0.1155	0.0018	0.0287	0.0000	0.0063	0.0788
Si	0.0053	0.0015	0.0055	0.0069	0.0161	0.0045	0.0178	0.0166	0.0541	0.0253	0.0189
Al	0.0000	0.0000	0.0259	0.0079	0.0000	0.0000	0.0024	0.0000	0.0000	0.0029	0.0000
S	0.0042	0.0116	0.0096	0.0049	0.0126	0.0227	0.0150	0.0086	0.0229	0.0113	0.0000
Zr	0.0000	0.0095	0.0373	0.0261	0.0387	0.0014	0.0086	0.0111	0.0130	0.0000	0.0538
As	0.0500	0.0491	0.0093	0.8112	0.0619	0.0254	0.0385	0.0061	0.0369	0.0224	0.0718
Hf	0.0226	0.0000	0.0096	0.0384	0.0262	0.0000	0.0359	0.0000	0.0000	0.0040	0.0000
Cu	0.0063	0.0191	0.0011	0.0000	0.0146	0.0000	0.0178	0.0000	0.0000	0.0170	0.0289
Zn	0.0163	0.0586	0.0031	0.0000	0.0337	0.0671	0.0196	0.0559	0.0206	0.0071	0.0000
Mg	0.0514	0.0000	0.0528	0.0463	0.0493	0.0435	0.0634	0.0639	0.0993	0.0521	0.0613
Ca	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mn	0.0000	0.0070	0.0038	0.0030	0.0594	0.0041	0.0057	0.0000	0.0000	0.0021	0.0114
In	0.1039	0.0561	0.1011	0.1092	0.0739	0.1332	0.0887	0.2401	0.1034	0.0795	0.1092
O	24.6106	25.9480	24.8910	26.6385	26.8001	29.3511	31.3896	25.9242	25.2200	24.0178	26.3324
Total	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

studied using the SE (secondary electron) image to confirm their morphology and then the BSE (backscattered electron) image to differentiate the different compositions of the grains.

The initial elemental compositions of the different minerals present were investigated using EDS (energy dispersive spectrometry) and then their actual compositions obtained using WDS (wavelength dispersive spectrometry).

The chemical compositions of the cassiterite from the different localities were analyzed using the EPMA (Teh & Hutchinson, 1986), including crystals showing strong pleochroism, and inclusions within the cassiterite grains.

X-ray mapping was also performed where necessary to better display areas with variations in composition.

RESULTS AND DISCUSSION

On the whole, the cassiterites in the Kuala Lumpur area average 68.0526 to 75.3848 wt% Sn (Table 1). The Ulu Klang area has 2 generations of cassiterite with 74.9022 and 73.5696 wt% respectively with one generation (PS 569) having higher W and Mg contents.

The Kampong Pandan area has 3 generations of cassiterite with 74.1387, 71.6597 and 72.6722 wt% Sn respectively. One generation (PS 775) has high Fe, Ta and W contents, another (PS 413) has high Fe, Ti and As contents while the third has no significant contents of Fe, Ta, W, Ti or As.

The Setapak area has 2 generations of cassiterite, one (Pts) with 69.2089 wt% Sn containing higher Fe, Ta and In compared to the other generation (PS302) which contains 68.0526 wt% Sn.

The Pudu Ulu area appears to have only one generation of cassiterite with Sn contents of 73.5723 (PS 426) and 74.3704 wt% (PS 724) respectively even though sample PS 426 posted the highest In content (0.2401 wt%) in the area.

The Puchong area has two distinct generations of cassiterite with 75.3848 (PS M5) and 73.0738 wt% (PS 710) respectively. While one sample (PS M5) has distinctly higher Sn, the other (PS 710) has significantly higher Ti, Ta, W and Zr contents.

The Kampong Pandan area also showed cassiterite with the most intense reddish-brown pleochroism. EPMA analysis (Table 2) and X-ray mapping (Fig. 2) showed the intense reddish areas to be significantly higher in Sn, Fe, Ti and Nb contents compared to the light brown areas.

Inclusions were found in the cassiterite from Ulu Klang, Kampong Pandan, Pudu Ulu, and Puchong. Of

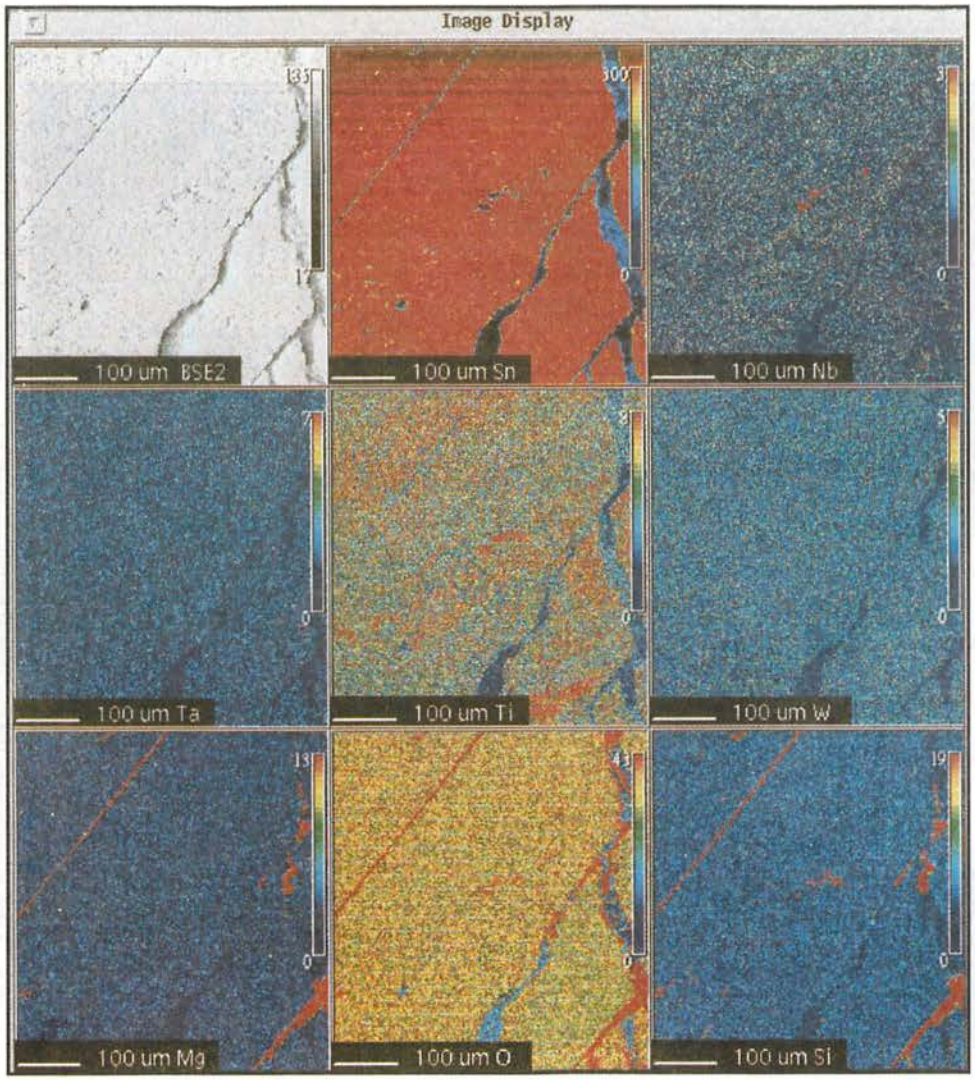

Figure 2. X-ray map of the reddish, pleochroic portion of cassiterite showing distinctively higher Nb and Ti. Kampong Pandan.

Table 2. EPMA analysis of highly pleochroic cassiterite grains from Kampung Pandan, Kuala Lumpur (normalised wt%).

Element	Pleochroic Colour of Cassiterite				
	Reddish		Light Brown		
	Point 1	Point 2	Point 1	Point 2	Point 3
Sn	76.1599	76.7175	72.0780	71.2351	71.6962
Fe	0.1053	0.1016	0.0193	0.0317	0.0697
Ti	0.0521	0.1694	0.0365	0.0236	0.0000
Nb	0.3649	0.2463	0.0000	0.1494	0.0000
Ta	0.0020	0.0925	0.1155	0.2173	0.0367
W	0.0000	0.0376	0.0000	0.0000	0.0707
Si	0.0120	0.0064	0.0174	0.0263	0.0346
Al	0.0331	0.0037	0.0055	0.0000	0.0000
S	0.0120	0.0037	0.0000	0.0000	0.0028
Zr	0.0331	0.0604	0.2154	0.0000	0.0404
As	0.0000	0.0000	0.0000	0.1204	0.0000
Hf	0.0000	0.0000	0.0000	0.0617	0.0000
Cu	0.0007	0.0000	0.0000	0.0000	0.0000
Zn	0.0007	0.0000	0.0156	0.0000	0.0358
Mg	0.0642	0.0256	0.0440	0.0480	0.0404
Ca	0.0000	0.0000	0.0000	0.0000	0.0000
Mn	0.0100	0.0037	0.0000	0.0000	0.0000
In	0.1043	0.1099	0.1503	0.0500	0.1193
O	23.0567	22.4217	27.3029	28.037	27.8535
Total	100.0000	100.0000	100.0000	100.0000	100.0000

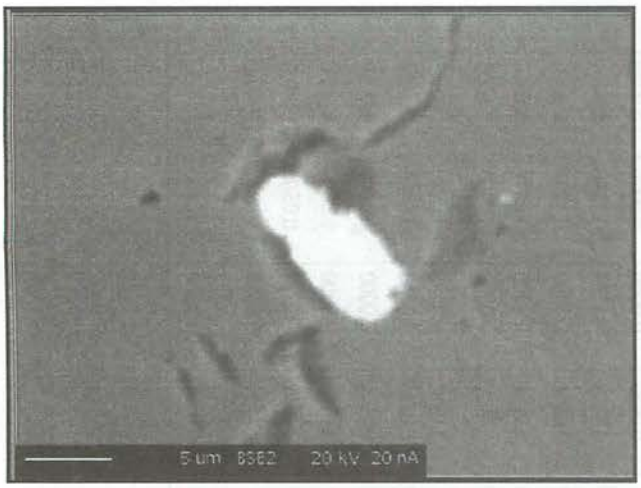

Figure 3. Native bismuth (white) inclusion in cassiterite (grey). Kampong Pandan.

the 4 areas bismuth or bismuth-containing minerals were found in 3 areas, namely Ulu Klang, Kampong Pandan and Pudu Ulu areas (Fig. 3).

The cassiterites of Ulu Klang showed inclusions of native bismuth, bismuthinite (B_2S_3) and the yet-to-be-recorded mineral rooseveltite ($BiAsO_4$) (Fleischer, 1983) (Fig. 4).

The cassiterites from Kampong Pandan which contained native bismuth inclusions besides the yet-to-be-recorded wodginite (Ta, Nb, Sn, Mn, Fe)$_{16}O_{32}$ (Fleischer, 1983) (Fig. 5).

Cassiterites from the Puchong showed inclusions of an aluminosilicate mineral andalusite (Al_2SiO_5) (Fig. 6).

CONCLUSIONS

The EPMA has certainly helped in the characterisation of cassiterites from the Kuala Lumpur area in particular their geochemistry and inclusions. This has resulted in

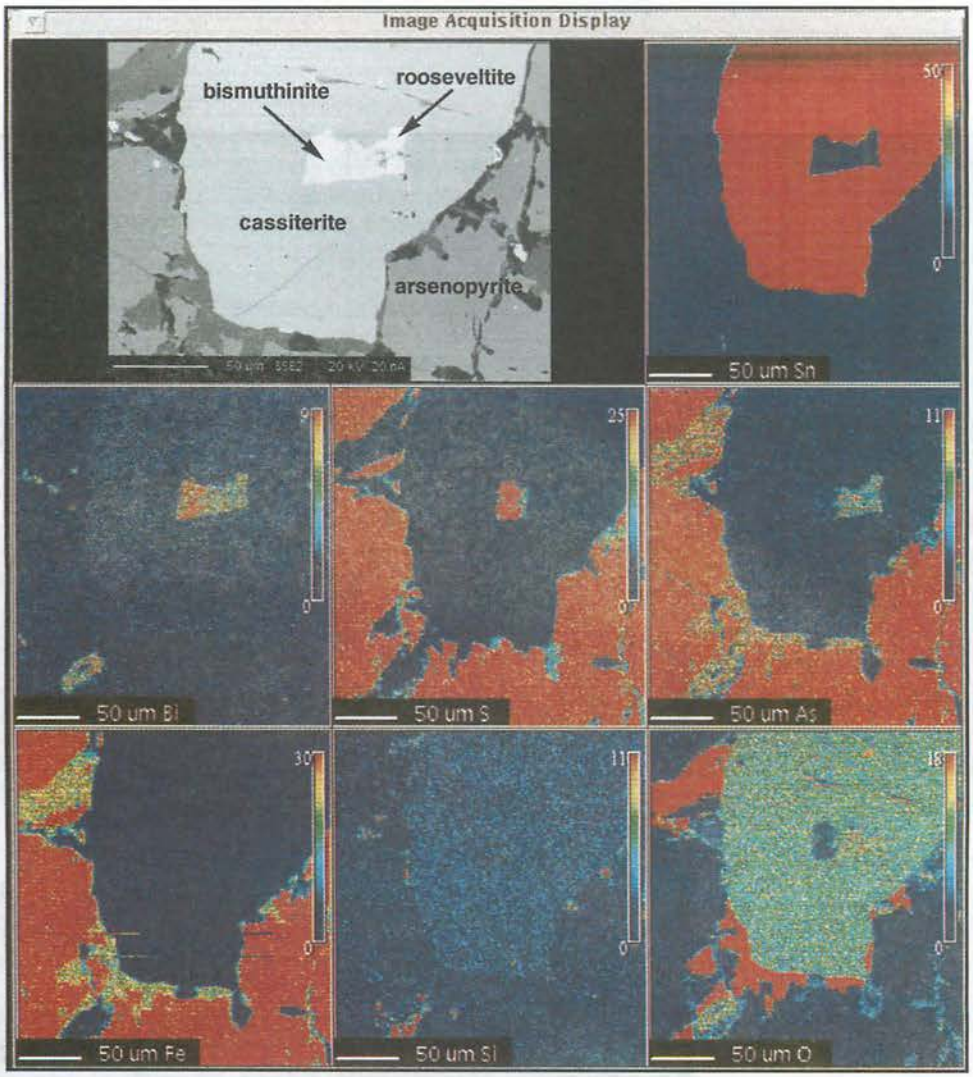

Figure 4. X-ray map showing the presence of bismuthinite (B_2S_3) — rooseveltite ($BiAsO_4$) inclusion in cassiterite. Ulu Klang.

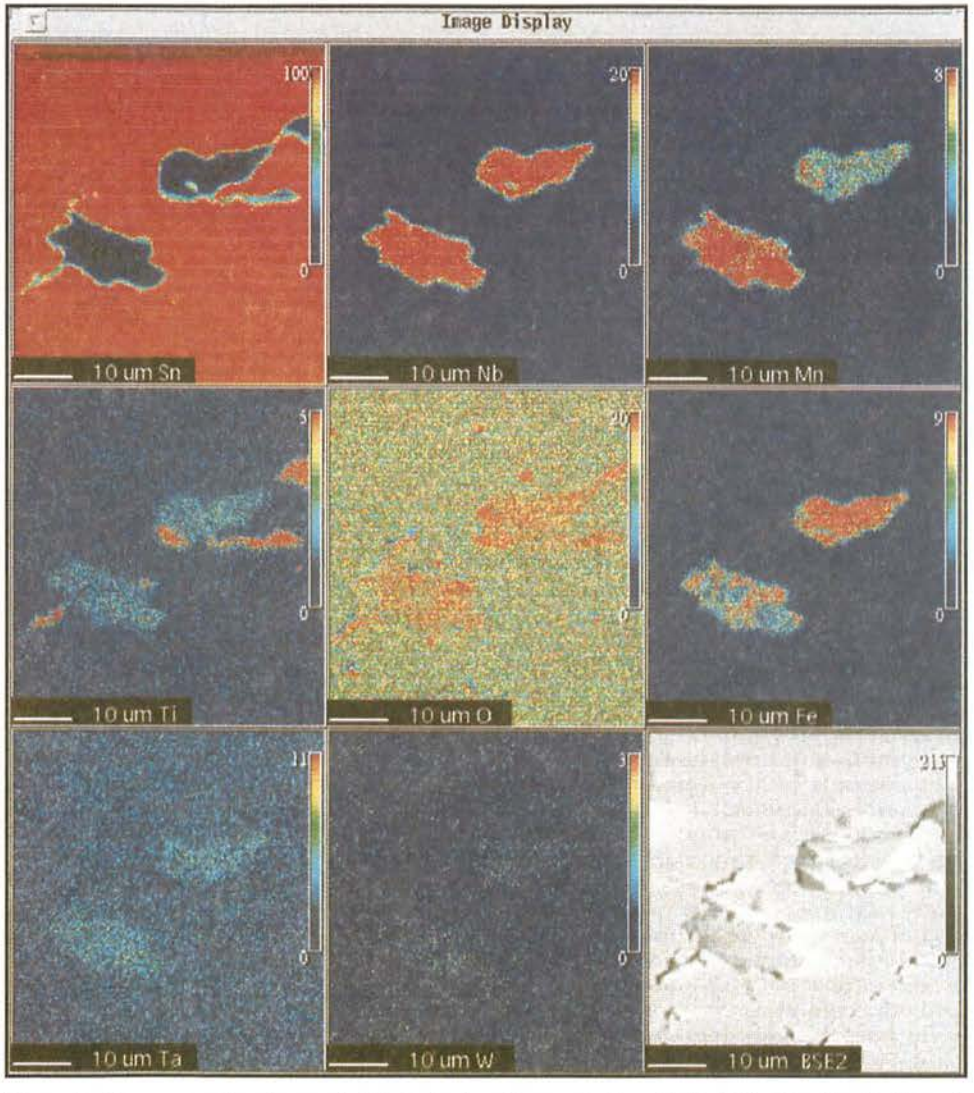

Figure 5. X-ray map showing wodginite inclusions in cassiterite with high Nb, Mn, Ta, Fe, Ti and O. Kampong Pandan.

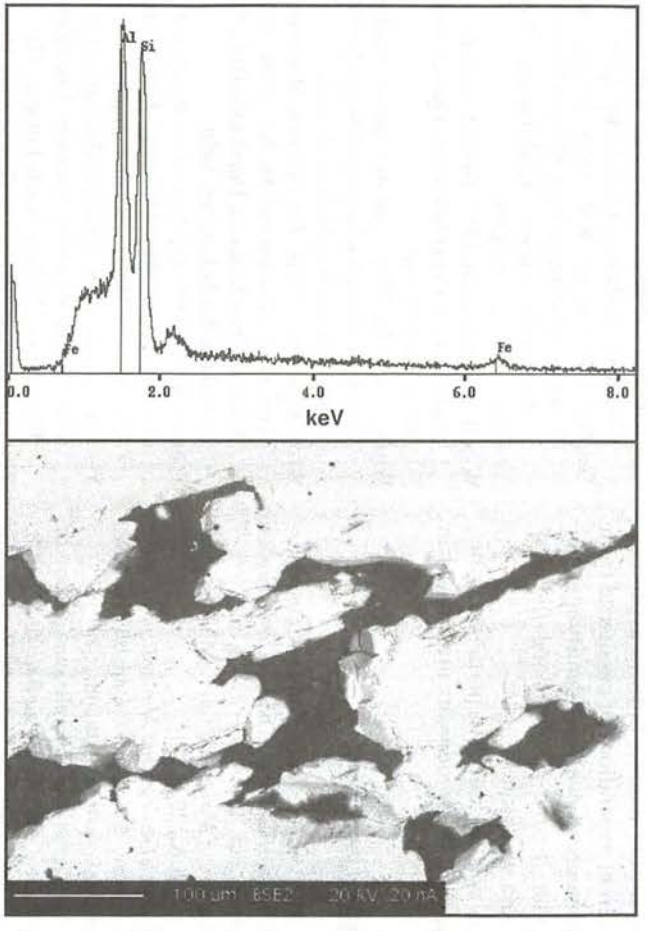

Figure 6. BSE image showing andalusite (Al_2SiO_5 as in EDS scan above) inclusions in cassiterite (white). Puchong.

enhancing our knowledge of he higher contents of Fe, Ti and Nb in highly pleochroic reddish-brown cassiterites, differentiating the different generations of cassiterite from their trace element contents as well as identifying their inclusions, in particular, native bismuth and the new minerals rooseveltite and wodginite.

These information will be useful in particular, when the paragenesis of the various tin deposits are studied in greater detail.

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