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CSIRO

INSTITUTE OF ENERGY AND EARTH RESOURCES

ELECTRON MICROPROBE ANALYSES OF GOLD AND ELECTRUM GRAINS
FROM THE VOYAGER 24 PROSPECT, ELLIOTT BAY, S.W. TASMANIA

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1.

1. INTRODUCTION

At the request of Geopeko Limited, the compositions of several grains of gold and electrum from the Voyager 24 Prospect, Elliot Bay, S.W. Tasmania, have been determined by electron microprobe analysis. The grains were panned from a system of streams draining a unit of thin siliceous rhyolite agglomerate at the top of the Mount Read Volcanics. Particular interest was expressed in knowing the silver content of the grains and the distribution of silver and other metals within the grains.

2. SAMPLES

Two polished slides containing miscellaneous individually embedded grains have been investigated.

Slide KR 8673 contains about 100 grains graded into three size categories -

- 1) Coarse : with an average minimum cross-section of about 650 μm
- 2) Medium : with an average minimum cross-section of about 370 μm
- 3) Fine : with an average minimum cross-section of about 280 μm

Slide KR 8674 contains ten individually identified grains -

- 1) A rounded yellow grain about 1500 μm in diameter
- 2) An irregular yellow grain about 1800 x 1300 μm in cross-section
- 3) An elongate yellow grain about 2600 x 830 μm in cross-section
- 4) A yellow spongy grain about 1000 x 750 μm in cross-section
- 5) An irregular white grain about 830 x 650 μm in cross-section
- 6) A yellow silver about 740 x 180 μm in cross-section
- 7) A rounded yellow grain about 550 μm in diameter
- 8) An equant yellow grain about 650 μm in cross-section
- 9) Two irregular yellow grains each about 275 μm in cross-section
- 10) An irregular white grain about 740 x 370 μm in cross-section.

In both slides the thickness of the grains is considerably less than their cross-sections; probably not more than a few tens of microns.

3. METHOD OF ANALYSIS

Each slide was carbon-coated to provide a conductive film and analyzed in a Cambridge Microscan V electron microprobe equipped with an energy dispersive spectrometer (EDS) and wavelength dispersive spectrometers (WDS).

Because EDS analysis is considerably faster than element by element WDS analysis, all quantitative data were obtained by this method using a LINK Systems 860 multichannel analyzer and ZAF correction programme. This method of analysis also offers the advantage of simultaneous acquisition of X-ray data from all elements in the sample so that no major constituents are likely to be missed. Table 1 lists 95% confidence levels for minor elements in gold under the EDS conditions used. Figures below these values are quoted in Table 2 and Figure captions. These should be regarded as semi-quantitative, but they indicate the element can be detected. WDS analysis would be required where more accurate determination of minor element concentrations is sought.

The microprobe was operated at 20 KV with a beam current of 5 nano-amps. Pure elements were used as calibration standards and a counting time of 100 seconds (livetime) adopted for all analyses.

4. RESULTS

Gold and silver are the only major elements in the grains. Minor constituents include palladium, tellurium, copper and (possibly) mercury. Palladium is present in all the analyzed grains, typically at a level of about 0.2 wt%, but tellurium and/or copper occur only in some. Mercury is a difficult element to determine (by either EDS or WDS analysis) because of the close proximity of major gold lines in the X-ray spectra. However, close inspection of the energy spectra in the region of the Au_L X-ray lines (Fig.1) suggests that minor mercury may be present in some grains. Minor bismuth (about 0.4 wt%) was recorded from Grain 4 in Slide KR 8774.

The results of ten analyses from Slide KR 8673 (4 coarse, 3 medium and 3 fine) are given in Table 2. Each analysis was carried out at the centre of a grain. The silver content ranges from 1.6 to 16.4 wt% and appears to be highest in the medium size grade. One fine grain contains an inclusion (Fig.2) identified as a galena by qualitative WDS analysis. Semi-quantative EDS analysis of this inclusion shows that the galena contains about 1 wt% Ag.

The results of twenty analyses from Slide KR 8674 (2 from each grain) show that the silver content ranges from about 2 wt% to 27 wt% (Fig.3) but there is no significant variation within individual grains. The analyses are summarized in Figs. 4 to 13. The circled areas indicate the locations (but not the size) of the regions analyzed in each grain.

5. DISCUSSION

The data are too limited to permit detailed discussion of the origins of the grains. However, the presence of included galena in one grain suggests that at least some of the gold has its origins in sub-volcanic base metal mineralization. The wide range in silver content, including the presence of electrum, would also suggest that the gold is not the result of growth during surface transport.

The minor element concentrations are to be regarded only as semi-quantitative orders of magnitude (see Table 1). Accurate determination of the levels, distribution and associated detection limits of Pd, Te, Cu and (?)Hg would require more extensive investigation using element by element WDS analysis.

The low totals (about 96%) that characterize all the analyses are probably due to the thinness of the embedded grains. Analysis of X-rays generated in thin particles is not always amenable to routine ZAF correction procedures as there may be a loss of X-ray intensity if the volume excited by the probe exceeds the thickness of the target. Since the EDS system provides a visual display of the entire X-ray spectrum, it is impossible that any major metallic or non-metallic constituent has been missed. It would be permissible to normalize all totals to 100%, if desired for comparative purposes.

TABLE 1: 95% CONFIDENCE LEVELS FOR TRACE ELEMENTS IN GOLD BY EDS ANALYSIS

	wt%
Ag	0.46
Pd	0.42
Te	0.28
Cu	0.27

Values below these limits must be regarded as semi-quantitative only.

TABLE 2: COMPOSITION OF GOLD GRAINS IN SLIDE KR 8673

Element	COARSE				MEDIUM			FINE		
	wt%				wt%			wt%		
Au	94.45	90.01	87.95	87.57	93.53	85.87	79.64	91.86	91.44	91.00 [#]
Ag	1.63	6.34	8.07	7.82	2.75	11.44	16.45	4.22	4.03	5.54
Pd	0.25	0.05	0.27	0.16	0.02	0.19	0.04	0.18	0.15	0.20
Te	0.03	0.09	0.02	0.20	nd	0.18	nd	nd	0.11	0.03
Cu	0.08	0.17	0.03	0.05	0.09	0.04	0.04	0.03	0.03	0.02
Total	<u>96.44</u>	<u>96.67</u>	<u>96.35</u>	<u>95.80</u>	<u>96.39</u>	<u>97.73</u>	<u>96.18</u>	<u>96.30</u>	<u>95.78</u>	<u>96.79</u>

[#]Note: this grain contains an inclusion of galena (see Fig.2).

nd = not detected

For trace elements, see cautionary note in Table 1. See text also for comment on low totals.

Fig. 1 : X-ray energy spectrum in the region of the Au_L lines showing the presence of suspected Hg_L lines.

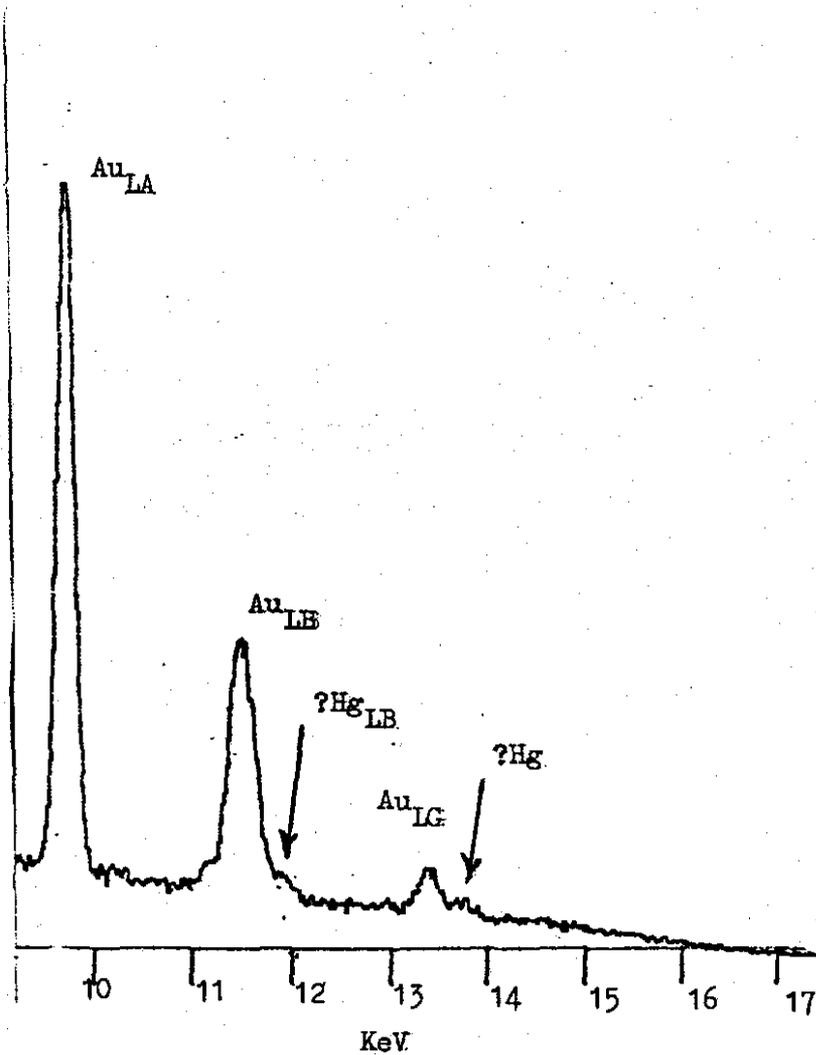


Figure 2: Back scattered electron image of a fine gold grain
(Slide KR 8673) containing an inclusion of galena.

Magnification X2000

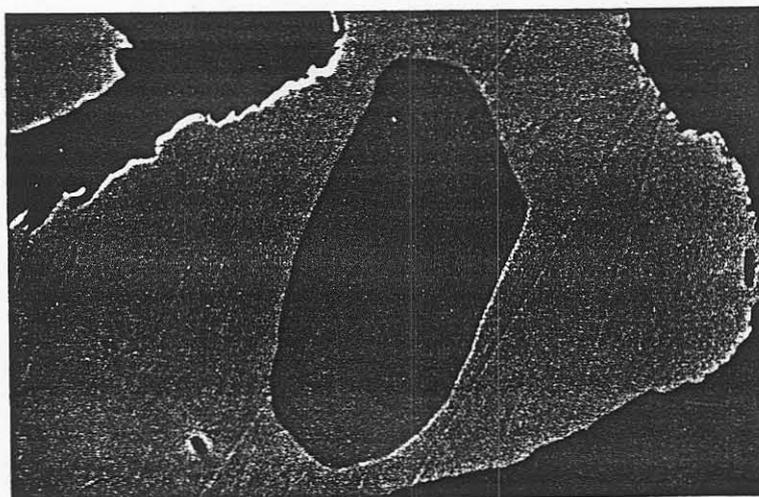
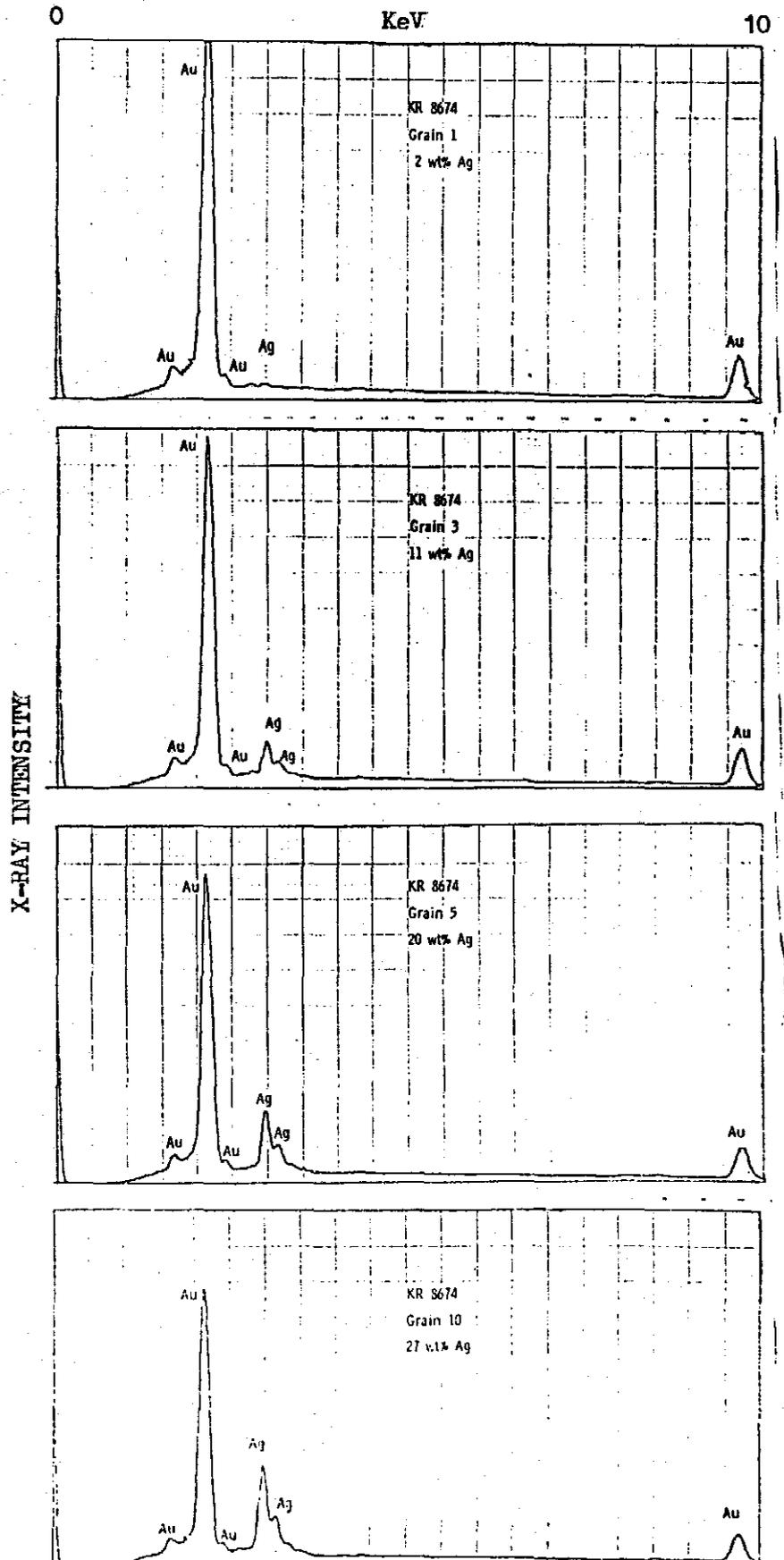


Fig. 3 : X-ray energy spectra of gold grains from Slide KR 8674

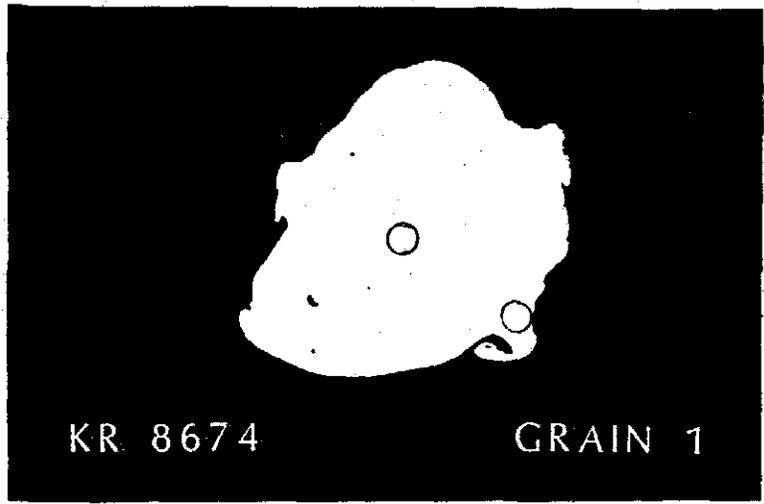
showing the range in observed silver-content.



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Figure 4: BSE image and analyzed compositions of Grain 1 (Slide KR 8674).

Magnification X100



wt%

Au	Ag	Pd	Te	Cu	Total	
94.39	1.78	0.18	0.16	0.25	96.76	Centre
94.40	1.65	0.18	0.03	0.05	96.31	Edge

See Table 1 regarding trace elements.

Figure 5: BSE image and analyzed compositions of Grain 2 (Slide KR 8674)

Magnification X100



						wt%	
Au	Ag	Pd	Te	Cu	Total		
91.99	3.55	0.13	nd	0.15	95.82	Centre	
92.39	3.63	0.16	0.03	nd	96.21	Edge	

nd = not detected

See Table 1 regarding trace elements

Figure 6: BSE image and analyzed compositions of Grain 3
(Slide KR 8674)

Magnification X100



						wt%	
Au	Ag	Pd	Te	Cu	Total		
83.54	11.30	0.18	0.13	nd	95.15	Centre	
83.30	11.64	0.36	nd	nd	95.30	Edge	

nd = not detected

See Table 1 regarding trace elements

Figure 7: BSE image and analyzed compositions of Grain 4
(Slide KR 8674)

Magnification X100



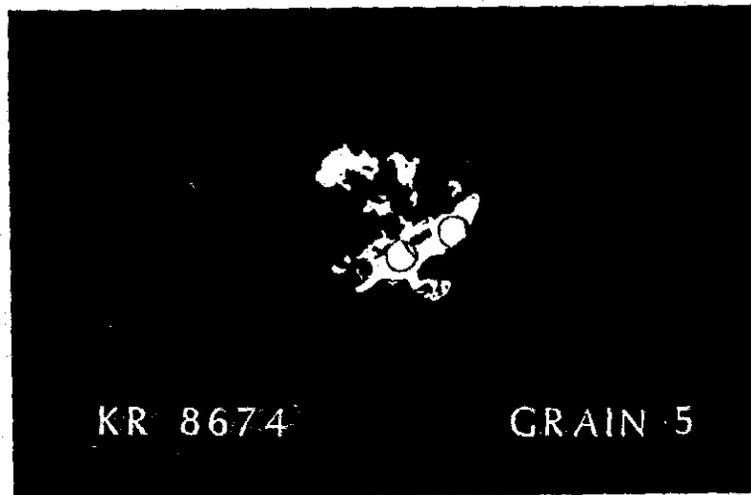
wt%						
Au	Ag	Pd	Te	Cu	Bi	Total
92.93	2.63	0.13	nd	0.11	nd	95.80
93.82	2.32	0.01	nd	0.09	0.37	96.61

nd = not detected

See Table 1 regarding trace elements

Figure 8: BSE image and analyzed compositions of Grain 5
(Slide KR 8674)

Magnification X100

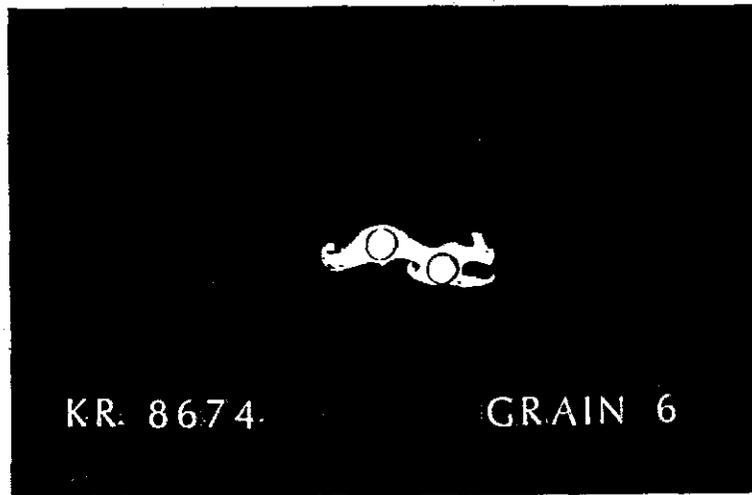


wt%					
Au	Ag	Pd	Te	Cu	Total
75.83	19.61	0.23	0.22	0.15	96.04
75.02	19.15	0.10	0.20	0.03	94.50

See Table 1 regarding trace elements

Figure 9: BSE image and analyzed compositions of Grain 6
(Slide KR 8674)

Magnification X100



wt%

Au	Ag	Pd	Te	Cu	Total
86.71	8.77	0.05	0.11	0.05	95.68
86.12	8.68	0.11	nd	nd	94.91

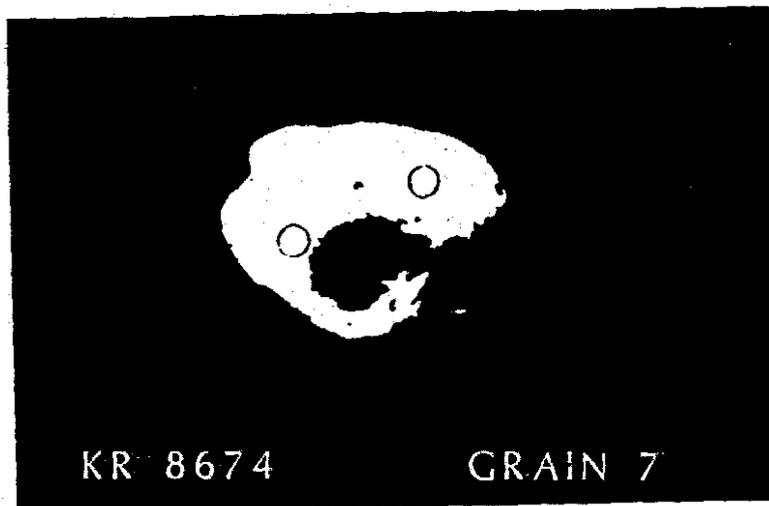
nd = not detected

See Table 1 regarding trace elements

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Figure 10: BSE image and analyzed compositions of Grain 7
(Slide KR 8674)

Magnification X200



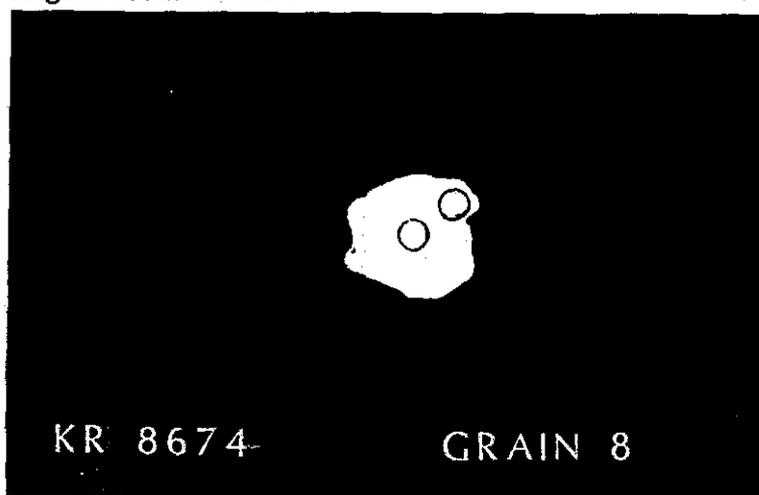
wt%					
Au	Ag	Pd	Te	Cu	Total
93.63	1.88	nd	0.12	0.23	95.86
92.69	1.93	0.23	0.06	nd	94.90

nd = not detected

See Table 1 regarding trace elements

Figure 11: BSE image and analyzed compositions of Grain 8
(Slide KR 8674)

Magnification X100



wt%						
Au	Ag	Pd	Te	Cu	Total	
92.37	2.97	0.31	nd	0.18	95.84	Centre
91.93	2.83	nd	0.05	nd	94.82	Edge

nd = not detected

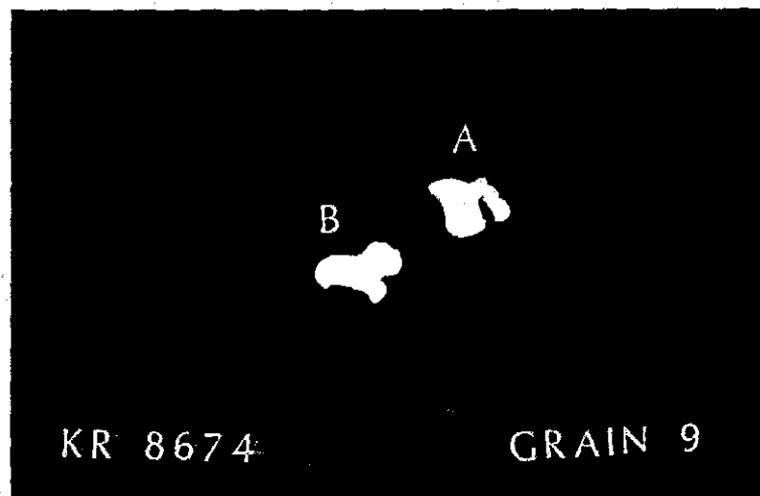
See Table 1 regarding trace elements

020

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Figure 12: BSE image and analyzed compositions of Grain 9
(Slide KR 8674)

Magnification X100



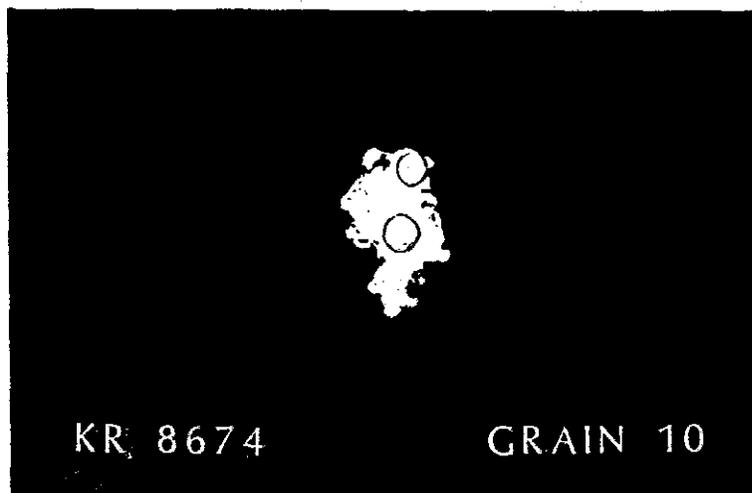
						wt%
Au	Ag	Pd	Te	Cu	Total	
91.21	3.98	0.18	nd	0.14	95.51	Grain A
91.04	3.30	0.02	nd	0.08	94.45	Grain B

nd = not detected

See Table 1 regarding trace elements

Figure 13: BSE image and analyzed compositions of Grain 10
(Slide KR 8674)

Magnification X100



wt%						
Au	Ag	Pd	Te	Cu	Total	
67.78	27.02	0.17	0.25	0.06	95.28	Centre
67.26	27.27	nd	0.18	0.14	94.85	Edge

nd = not detected

See Table 1 regarding trace elements