

ANALYSIS

MCI # 6043

Object(s): Gold Fragment: CL-3-45. MIT-5136
Artist/Manufacturer: Unknown
Geog./Cult. Source: Panama

Material(s): Gold colored fragment, possible gold alloy or mixture.
Approximate overall dimensions: ca. 12 mm L x 25 mm x 1 mm thick.

Object Date: Unknown
Requestor: Republic of Panama

Date In: 8/01/06
Completed: 9/30/06

Requested Action: EDS Analysis, Secondary and Backscattered SEM imaging.

Procedure:

- A section of sample the sample approximately 3.1 mm wide x 6.0 mm deep x 1mm thick was removed using the Buehler Isomet low-speed saw and di-ionized water as a lubricant.
- After ultrasonic cleaning and drying in methanol, the sample was embedded in Buehler Epo-Thin low viscosity epoxy.
- After 12 hours curing time, the embedded sample was sectioned into two approximate halves with the Buehler Isomet low-speed saw . Di-ionized water was again used as a cutting fluid.
- After sectioning. One half of the embedded section was next ground and polished using the Buehler Minimet polishing system.
- Due to minor charging caused by the embedding plastic, the cross-section was carbon coated to increase conductivity under the electron beam. The coating was applied with an Edwards E306A Vacuum Coating Unit.

EDS Analysis:

The examination was broken down as follows:

Section A, SEM/EDS analyses and imaging of the sample's **matrix** material and estimated element weight percent for major elements detected.

Section B, SEM/EDS analyses and imaging of the sample's **bright phase** material and estimated element weight percent for major elements detected.

Section C, SEM/EDS analyses and imaging of (6) randomly picked **inclusions** embedded within the sample's matrix and estimated element weight percent for major elements detected. (see EDS spectra and Excel work sheets enclosed).

- All SEM/EDS data were collected at 25 kV for 120 seconds at a working distance of 39mm. The Magnification used was 5000X.
- A series of (10) EDS analyses were run on the cross-section's matrix material.
- A series of (10) EDS analyses were run on the cross-section's bright phase material.
- A series of (18) EDS analyses were run for (9) inclusions.

- The instrument used was a JEOL JXA-840A Scanning Electron Microscope (SEM) with a ThermoNORAN TN-5502 energy dispersive analytical attachment and, NORAN Vantage spectrum processing software. The system is also fitted with a low atomic number detector (Pioneer Premium detector with a Norvar window).

Photography:

- (18) SE and backscattered SEM image details were taken of the cross-sectioned sample.
- (9) SE and backscattered SEM image details were taken of inclusions in the matrix.

Roland H. Cunningham
Sr. Paintings Conservator/Analytical Support Gp.
SCMRE

Bibliography

" The Forensic Examination of Paints & Pigments "
Crown, D.A. 1968: Charles C. Thomas, Pub.

" SEM: A Users Manual for Materials Science "
Gabriel, Barbara A. 1985: American Society for Metals

" Scanning Electron Microscopy & X-Ray Analysis "
J.I. Goldstein, D.E. Newbury, P. Echlin, D.C. Joy, et al .
N.Y.: 1992: 2nd Edition Plenum Press:

SECTION A

SEM/EDS Analysis and Imaging

Gold Cross-section

Matrix Material

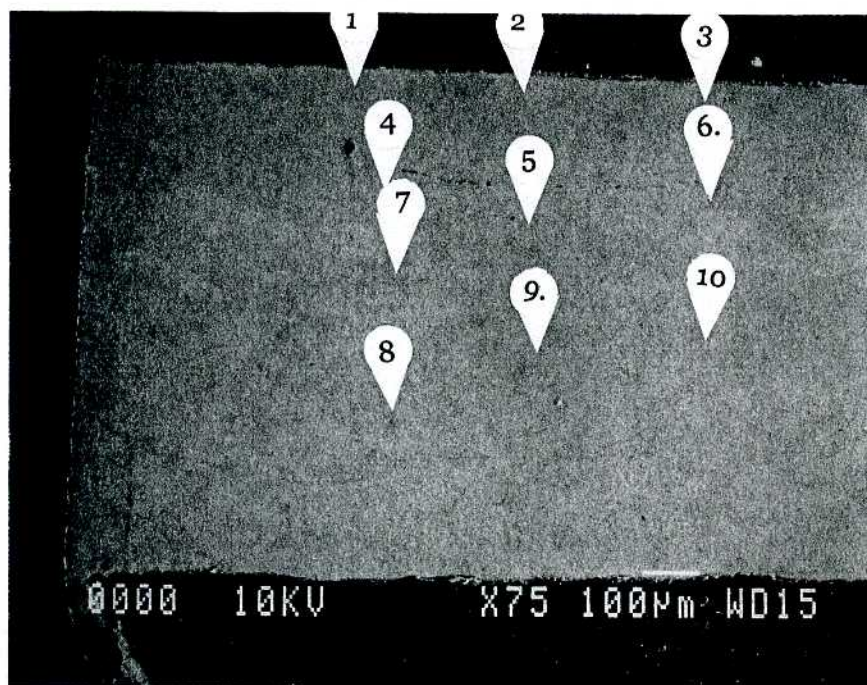
6043

EDS ANALYSIS

CI-3-45 (MIT-5136)

Gold Cross-Section - Matrix Material

25kV Working Distance = 39mm 5000X



Gold Cross-Section

CI-3-45 (MIT-5136)
Matrix Material (probes 1-10)

Work Sheet: Estimated Weight Percent/Element

Project: CI-3-45 (MIT-5136)
(Matrix Material)

MCI #: 6043

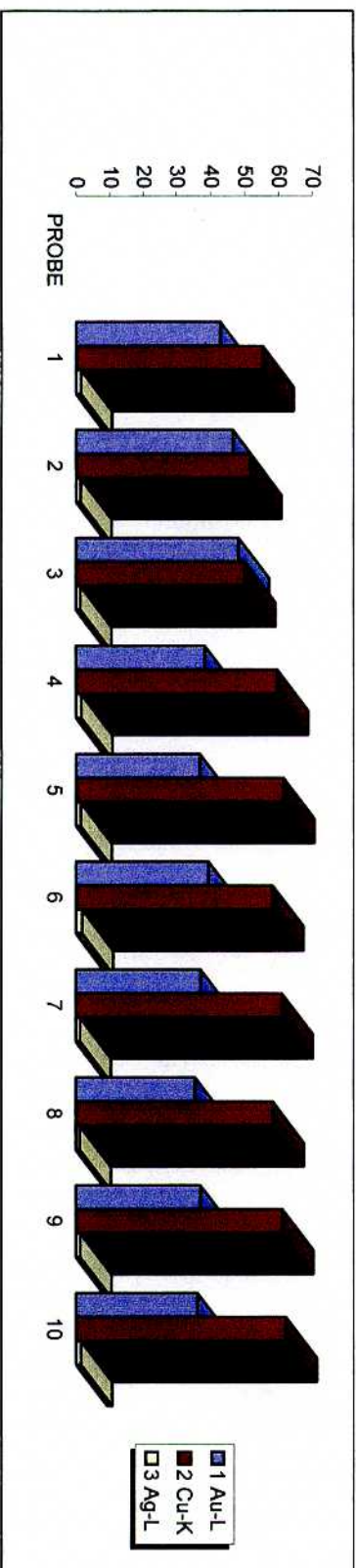
KV: 25

W.D.: 39 mm

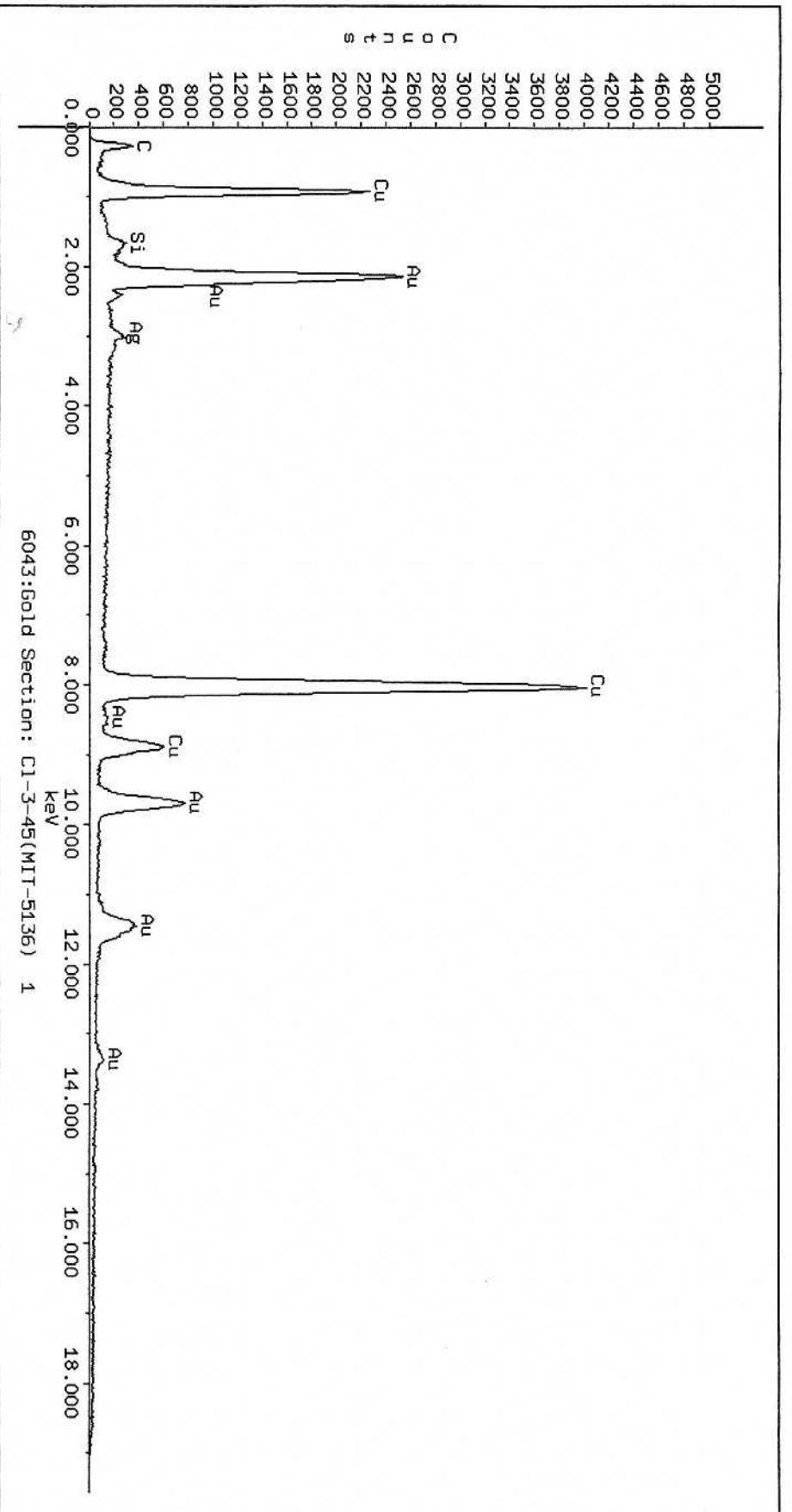
Mag.: 5000X

ELEMENT WEIGHT PERCENTAGES FOR ELEMENTS DETECTED

PROBE	1 Au-L	2 Cu-K	3 Ag-L
1	42.87	55.49	1.46
2	46.58	51.91	1.29
3	48.27	50.14	1.27
4	38.31	59.74	1.59
5	36.92	61.58	1.42
6	39.35	58.35	1.88
7	37.11	61.11	1.25
8	35.47	58.4	1.22
9	36.98	61.18	1.31
10	36.14	62.21	1.44
	398	580.11	14.13



Thermo NORAN



6043:Gold Section: C1-3-45(MIT-5136) 1

Accelerating Voltage: 25KeV

Take Off Angle: 58.3506°

Live Time: 120 seconds

Dead Time: 34.098 seconds

Fri Jul 28 15:57:10 2006

6043:Gold Section: Cl-3-45 (MIT-5136) 1

Refit Si-K' Si-K"

Filter Fit Method

Chi-sqd = 2.29 Livetime = 120.0 Sec.

Standardless Analysis

Element	Relative k-ratio	Error (1-Sigma)	Net Counts	Error (1-Sigma)
C -K	---	---	2744 +/-	67
Cu-L	---	---	24732 +/-	211
Si-K	0.00105 +/-	0.00017	551 +/-	87
Au-M	---	---	43863 +/-	446
Ag-L	0.01013 +/-	0.00135	2492 +/-	333
Cu-K	0.62396 +/-	0.00482	77230 +/-	596
Au-L	0.36486 +/-	0.00892	22087 +/-	540

Adjustment Factors

	K	L	M
Z-Balance:	0.00000	0.00000	0.00000
Shell:	1.00000	1.00000	1.00000

PROZA Correction Acc.Volt.= 25 kV Take-off Angle=58.35 deg

Number of Iterations = 5

Element	k-ratio (calc.)	ZAF	Atom %	Element	Wt % Err. (1-Sigma)
Si-K	0.0010	1.837	0.61	0.19	+/- 0.03
Ag-L	0.0100	1.458	1.22	1.46	+/- 0.19
Cu-K	0.6158	0.901	78.59	55.49	+/- 0.43
Au-L	0.3601	1.190	19.59	42.87	+/- 1.05
Total			100.00	100.00	

Fri Jul 28 15:56:01 2006

6043:Gold Section: Cl-3-45(MIT-5136) 1

Livetime : 120.0 Sec.

Technique: Least Squares Fit

Elements Present:

C(6), Si(14), Cu(29), Au(79)

Possible Additional Elements:

Ag(47), Rb(37)

Energy (keV)	Intensity (counts)	Element Present	Element Possible
0.273	2499	C Ka	
0.937	21397	Cu La1	
1.683	668	Si Ka	
2.157	37491	Au Ma1	
2.443	925	Au Mg	
*2.999	1213		Ag La1
8.036	73278	Cu Ka1	
8.486	700	Au L1	
8.897	9728	Cu Kb1	
9.697	13556	Au La1	
11.450	4200	Au Lb1	
*13.371	1266	Au Lg1	
			Rb Ka1

* Check peak labels manually, or acquire additional data for better statistics and re-run Automatic Ident.

SECTION B

SEM/EDS Analysis and Imaging

Gold Cross-section

Bright Phase Material

6043

EDS ANALYSIS

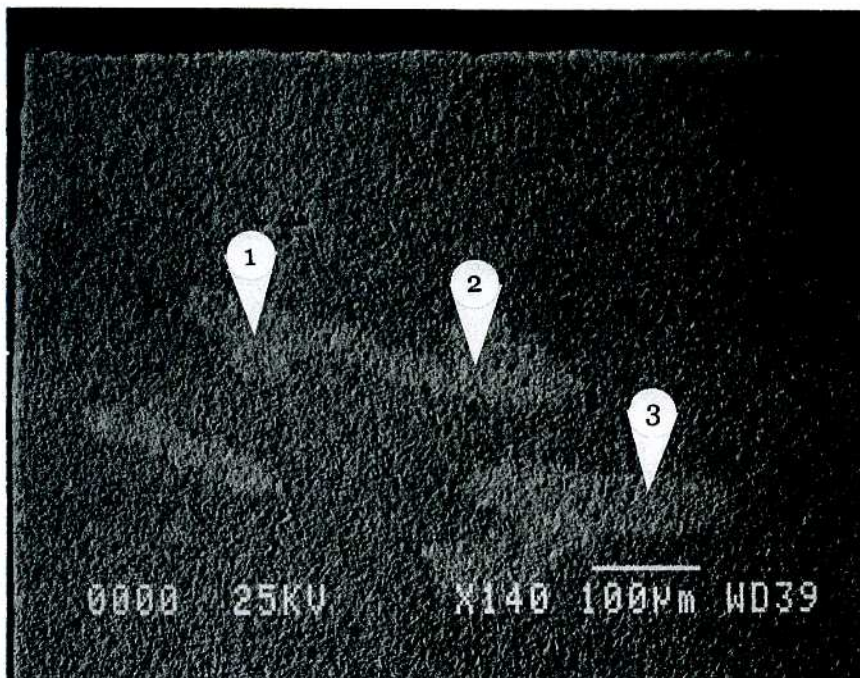
Cl-3-45 (MIT-5136)

Gold Cross-Section - Bright Phase Material

25kV

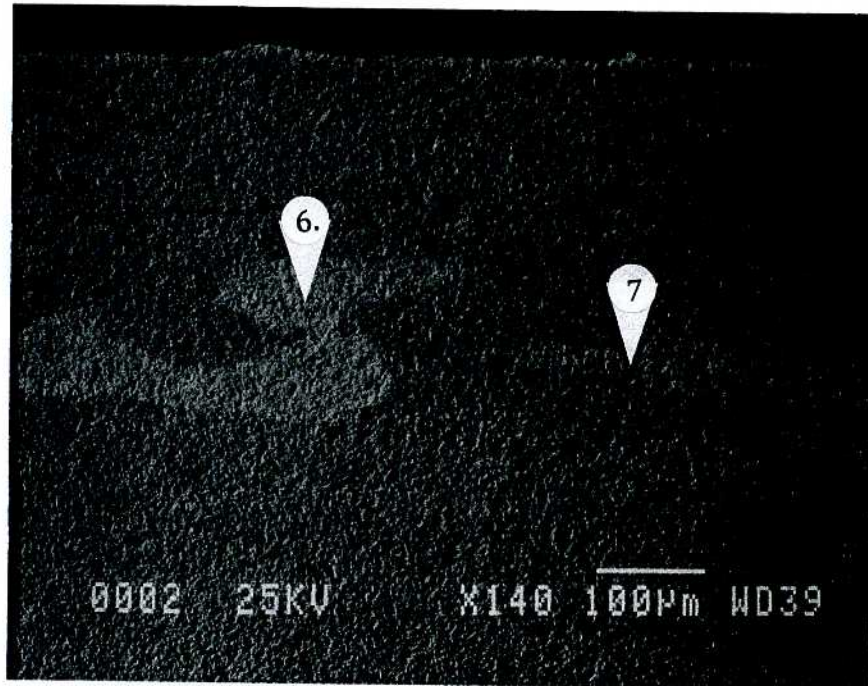
Working Distance = 39mm

5000X

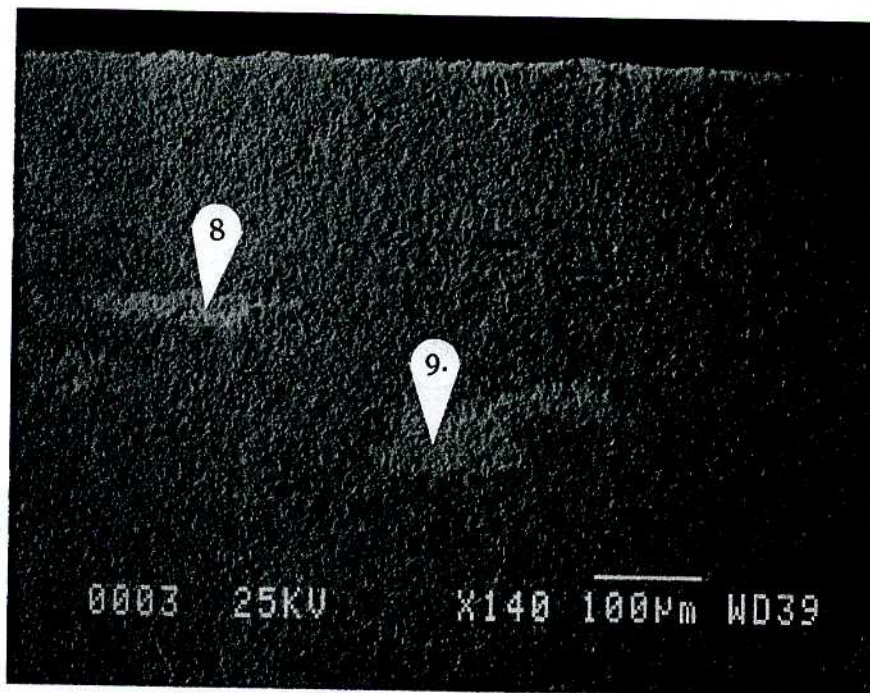


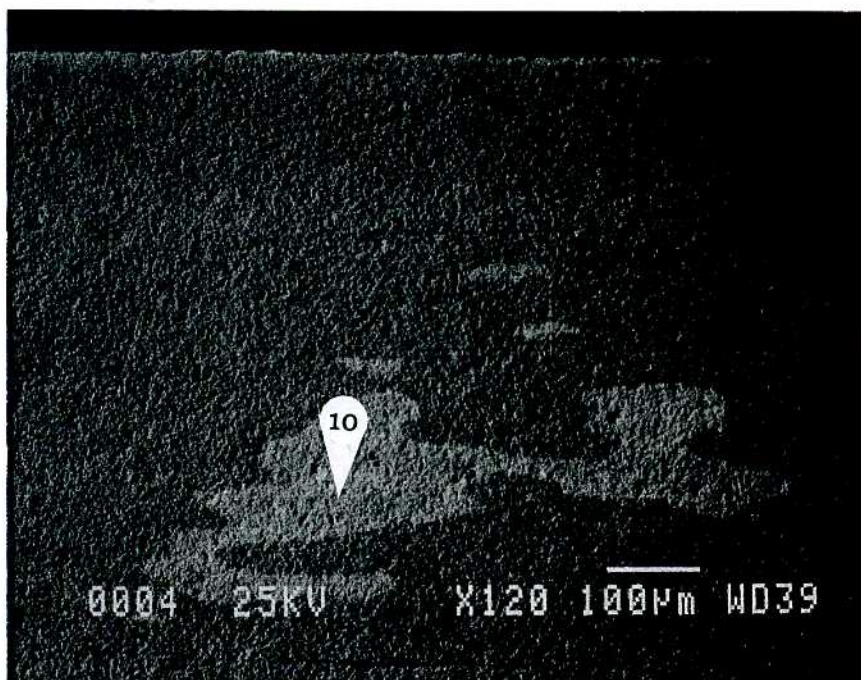
**Gold Cross-Section
Backscatter Photo
CI-3-45 (MIT-5136)
Bright Phase Material (probes 1-5)**





**Gold Cross-Section
Backscatter Photo
CI-3-45 (MIT-5136)
Bright Phase Material (probes 6-9)**





**Gold Cross-Section
Backscatter Photo
CI-3-45 (MIT-5136)
Bright Phase Material (probe 10)**

Work Sheet: Estimated Weight Percent/Element

Project: CI-3-45 (MIT-5136)
(Bright Phase Material)

MCI #:

6043

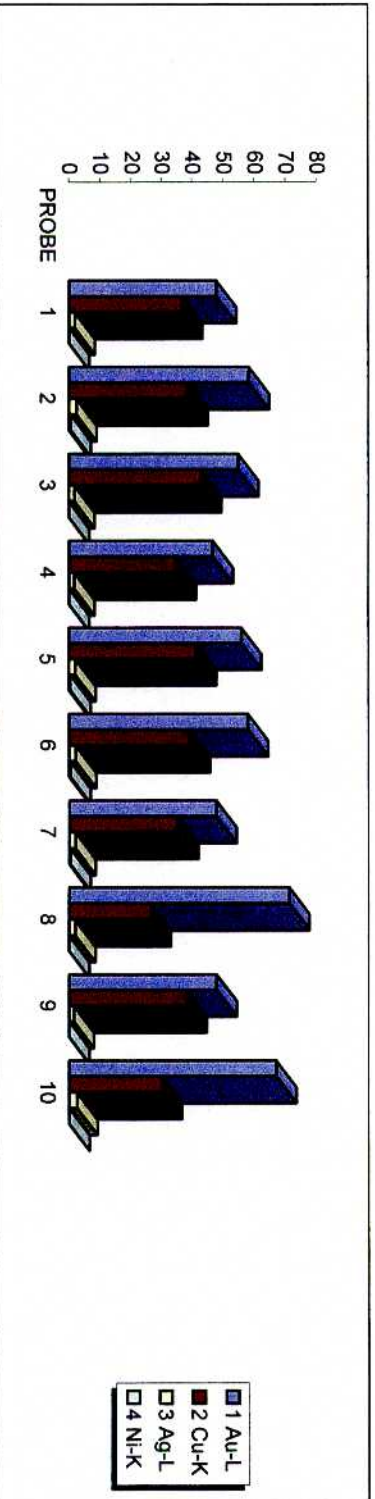
kV: 25

W.D.: 39 mm

Mag.: 5000X

ELEMENT WEIGHT PERCENTAGES FOR ELEMENTS DETECTED

PROBE	1 Au-L	2 Cu-K	3 Ag-L	4 Ni-K
1	47.81	36.81	1.83	-
2	58.27	38.57	2.44	0.59
3	54.89	42.9	1.8	-
4	46.71	34.74	1.79	-
5	55.87	41.28	2.08	0.45
6	57.99	39.29	2.17	0.39
7	47.83	35.35	2.02	0.3
8	71.21	26.56	1.98	-
9	47.82	38.2	1.49	-
10	67	30.2	2.57	-
	555.4	363.9	20.17	1.73



SECTION C

SEM/EDS Analysis and Imaging

Gold Cross-section

Random Inclusion Sites in Matrix Material

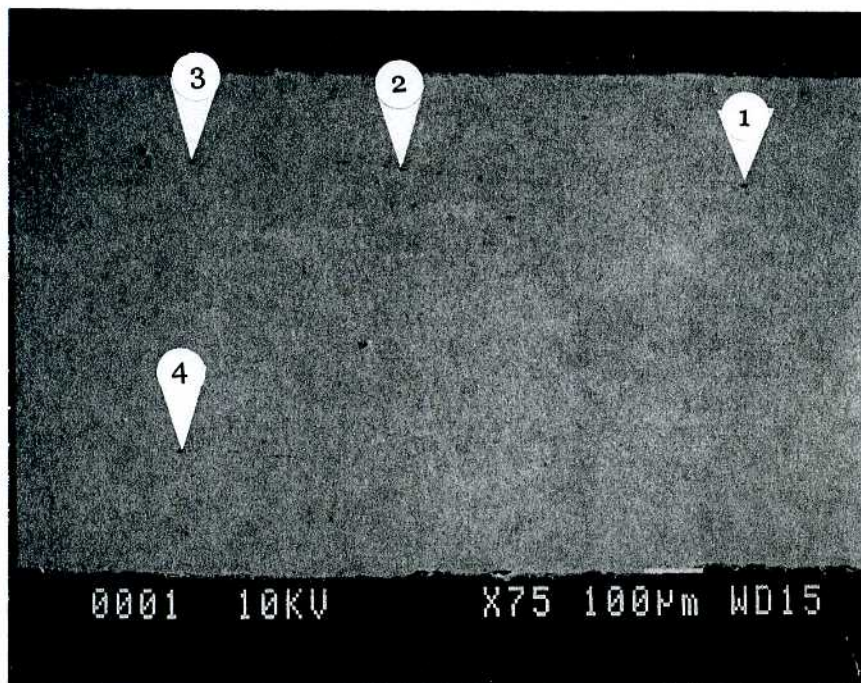
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EDS ANALYSIS

CI-3-45 (MIT-5136)

Gold Cross-Section - Inclusions (1a-1c)

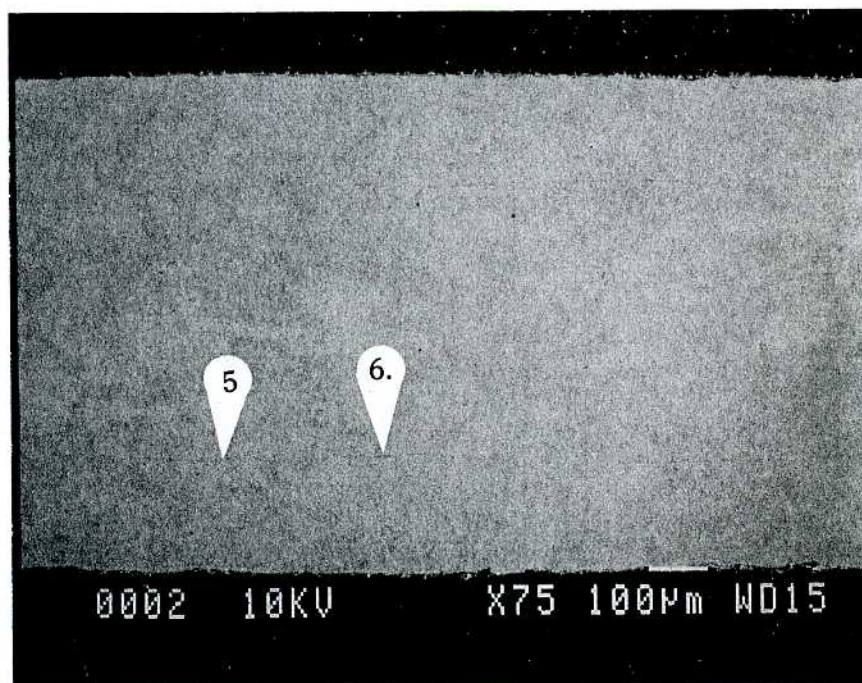
25kV Working Distance = 39mm 30,000-70,000 X

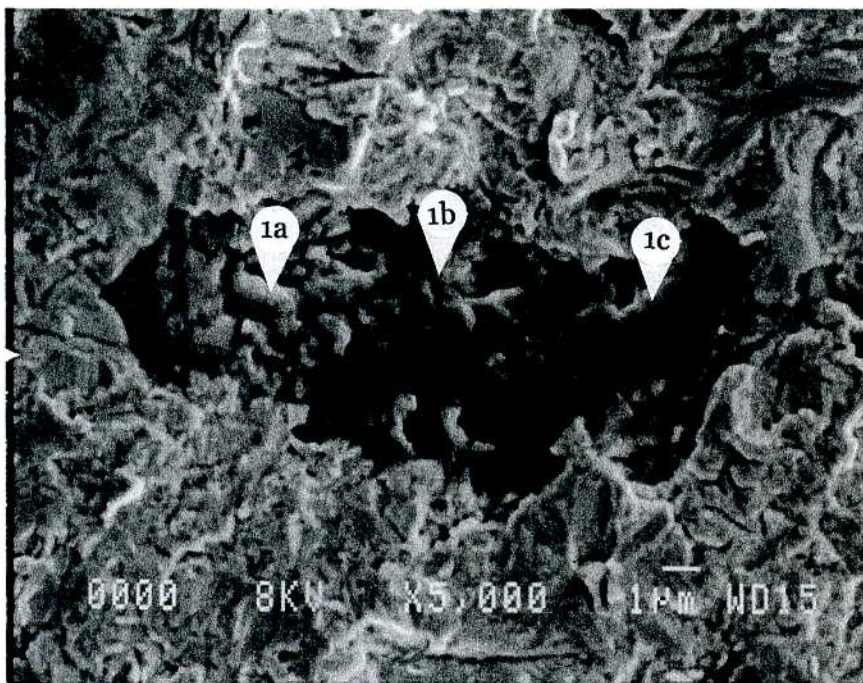


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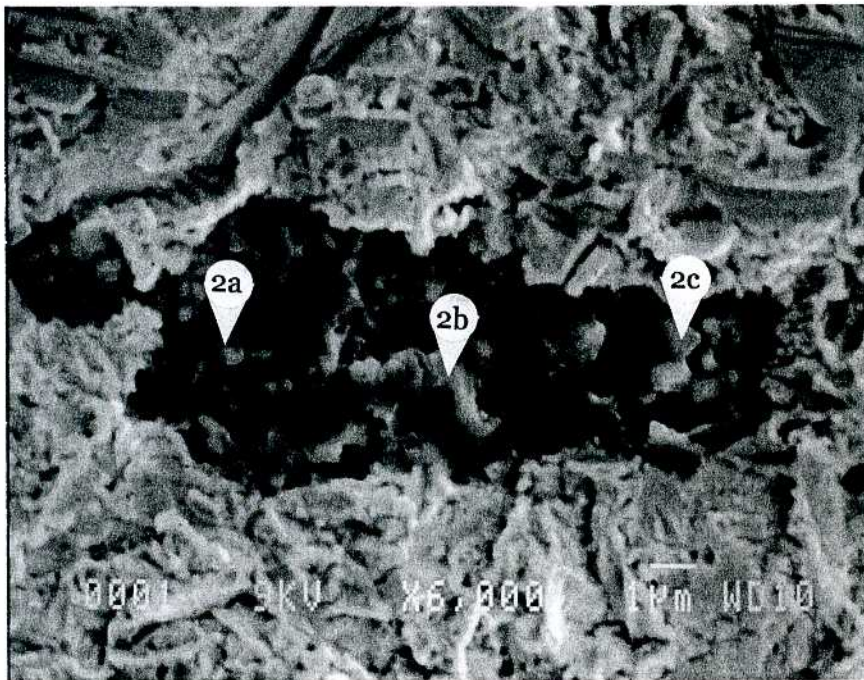
Gold Cross-Section CI-3-45 (MIT-5136)

2° images show locations of (6) inclusions selected for probing





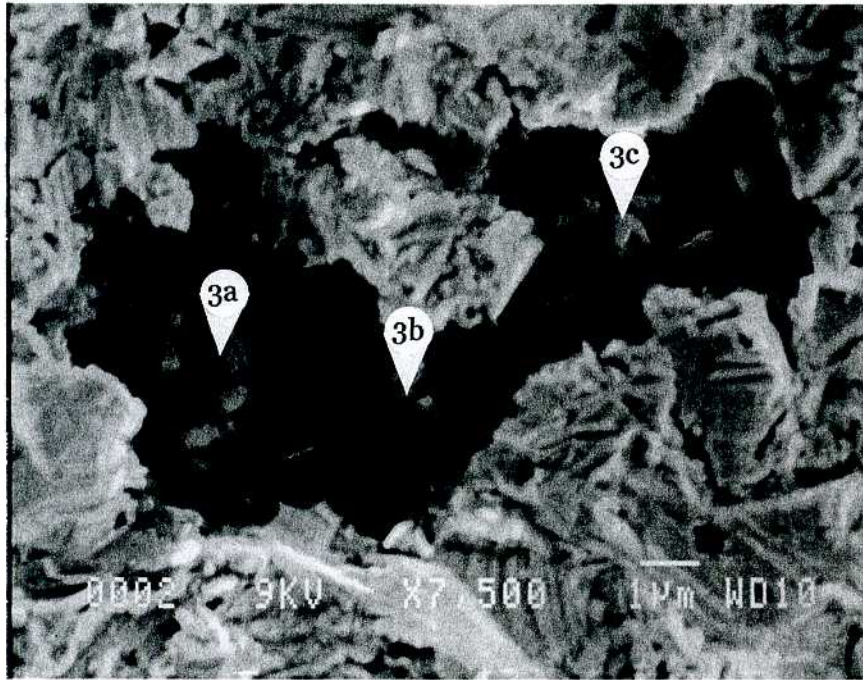
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Gold Cross-Section CI-3-45 (MIT-5136)
2° image showing probe locations



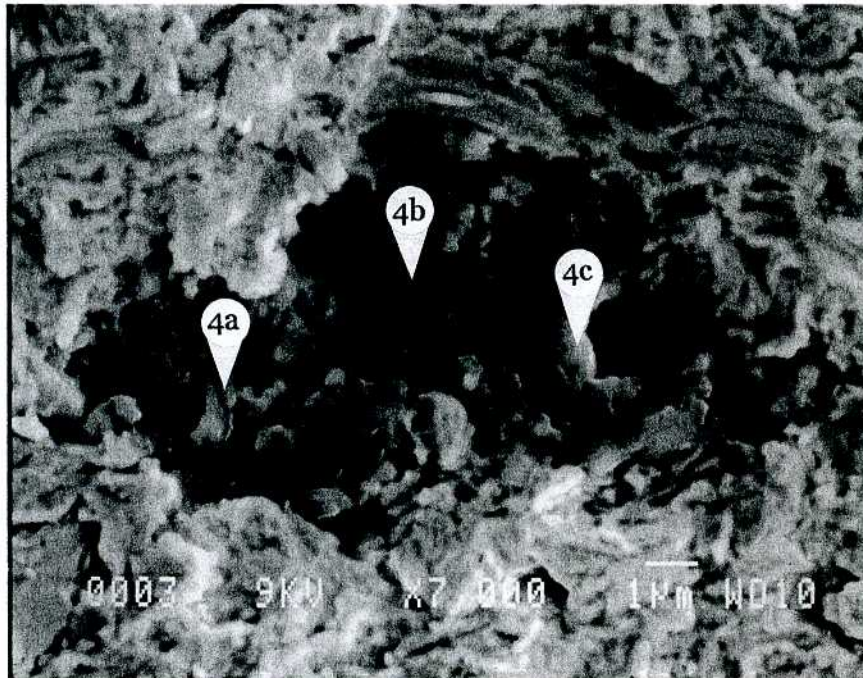
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Gold Cross-Section Cl-3-45 (MIT-5136)

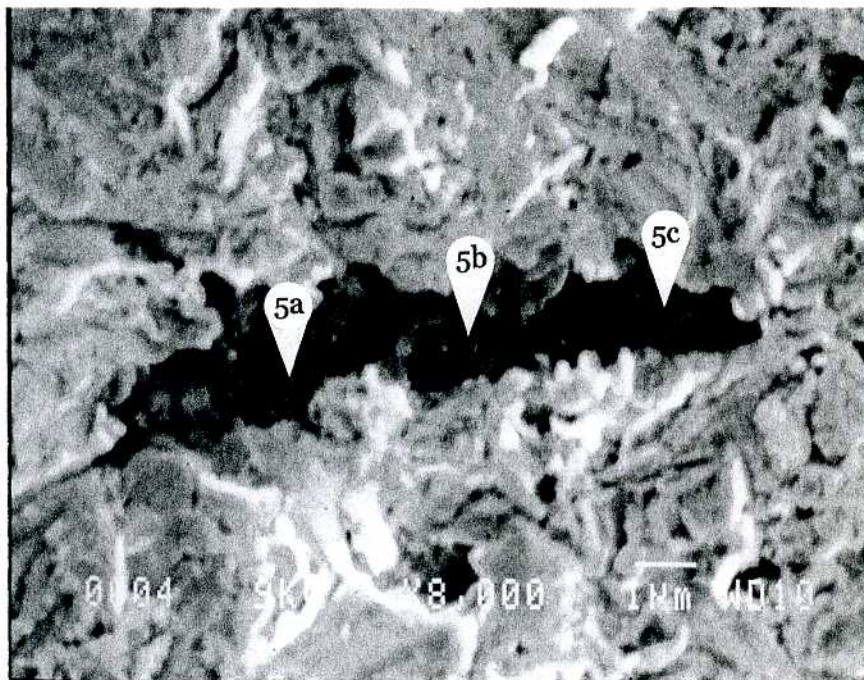
2° image showing probe locations



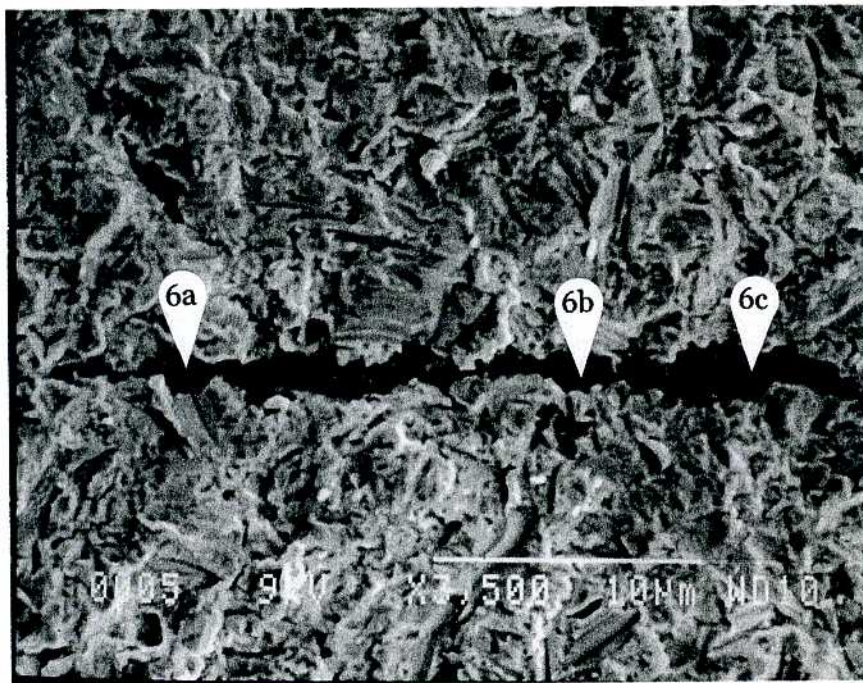
6043
Gold Cross-Section CI-3-45 (MIT-5136)
2° image showing probe locations



6043
Gold Cross-Section CI-3-45 (MIT-5136)
2° image showing probe locations



6043
Gold Cross-Section CI-3-45 (MIT-5136)
2° image showing probe locations



6043
Gold Cross-Section CI-3-45 (MIT-5136)
2° image showing probe locations

6043: Gold Section
Cl-3-45 (MIT 5136)

kV : 25
W.D.mm: 39
T/Sec.: 120 sec.
30,00-70,000X

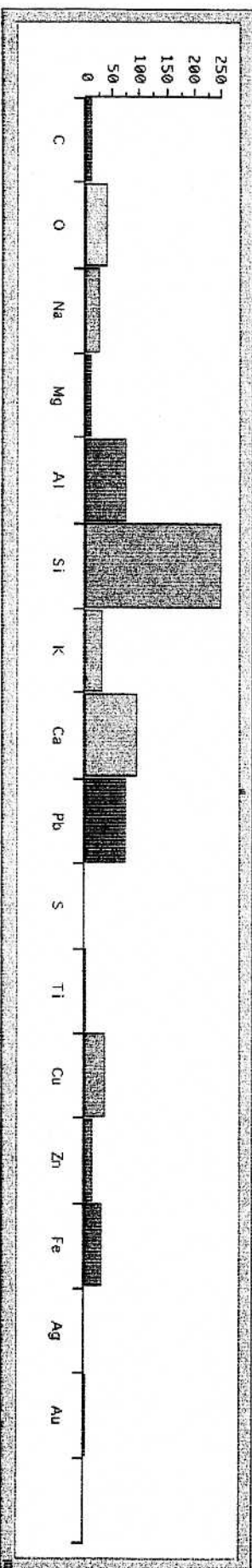
INCLUSIONS

ELEMENT Wt. %															
Probe	Na-K	Ag-L	Cl-K	Mg-K	Al-K	Si-K	K-K	Ca-K	Ti-K	Fe-K	Cu-K	Pb-L	Au-L	Zn-L	As-K
1a	8.54	-	-	2.42	10.35	30.48	5.03	10.21	0.59	6.72	8.83	13.78	3.03	-	-
1b	9.08	-	-	1.69	11.01	29.74	5.26	11.81	0.54	5.95	7.70	14.74	2.48	-	-
1c	-	-	-	2.03	6.85	24.36	3.46	13.70	0.43	5.24	13.27	13.59	5.40	11.66	-
2a	-	1.16	-	-	8.71	18.41	0.99	3.17	-	3.82	41.94	7.58	14.21	-	-
2b	-	-	-	1.02	9.91	23.62	1.38	7.17	0.39	5.27	32.92	12.17	6.16	-	-
2c	-	-	-	1.17	8.68	23.59	0.65	9.65	-	4.66	36.13	4.81	10.65	-	-
3a	-	-		0.23	4.92	28.22	0.68	1.16	-	5.69	45.45	-	12.39	-	1.25
3b	-	-	1.43	0.40	2.90	14.94	0.39	2.17	-	3.99	60.58	3.84	9.37	-	-
3c				0.43	3.85	21.76	0.37	0.94	-	4.49	58.37	-	9.78	-	-
4a	7.17	-	-	-	20.28	32.14	9.57	5.61	-	1.81	12.12	7.30	4.00	-	-
4b	-	-	-	0.72	11.04	29.30	14.56	4.57	0.37	4.29	13.74	16.87	4.55	-	
4c	-	-	-	-	15.15	31.26	18.94	2.31	0.26	1.52	21.87	5.44	3.25	-	-
5a	-	0.43	0.49	1.36	6.23	10.86	-	3.44	-	2.94	51.04	4.79	18.41	-	-
5b	-	0.52	0.39	0.36	8.06	10.08	-	1.51	-	3.51	54.17	5.20	16.21	-	-
5c	-	-	-	1.56	6.76	12.14	-	3.41	0.26	3.43	54.08	-	18.38	-	-
6a	-	-	-	0.96	6.62	13.74	0.18	2.73	0.29	5.78	50.41	3.81	15.48	-	-
6b	-	1.52	-	0.29	3.75	7.57	-	1.60	-	1.65	53.75	4.43	25.44	-	-
6c		1.57	-	0.48	5.17	10.63	-	2.29	-	1.55	54.28	2.90	21.14	-	-

Work Sheet - Averaged Intensity (Counts)/Element
 6043.1 Inclusions: C-3-45 (MTT-5136)
 25 kV, 120 Secs. Working Distance = 39 mm 30,000 - 70,000X

Probe	C	O	Na	Mg	Al	Si	K	Ca	Pb	S	Ti	Cu	Zn	Fe	Ag	Au
1a	4263	15805	12131	5095	29004	92961	11989	27887	25123	-	884	10809	-	11955	-	482
1b	4406	16681	14263	4012	32907	92983	12945	32742	27877	-	827	10183	-	10808	-	376
1c	3608	9649	-	2206	14775	63041	8093	34390	23637	-	861	15820	14181	8873	-	1547

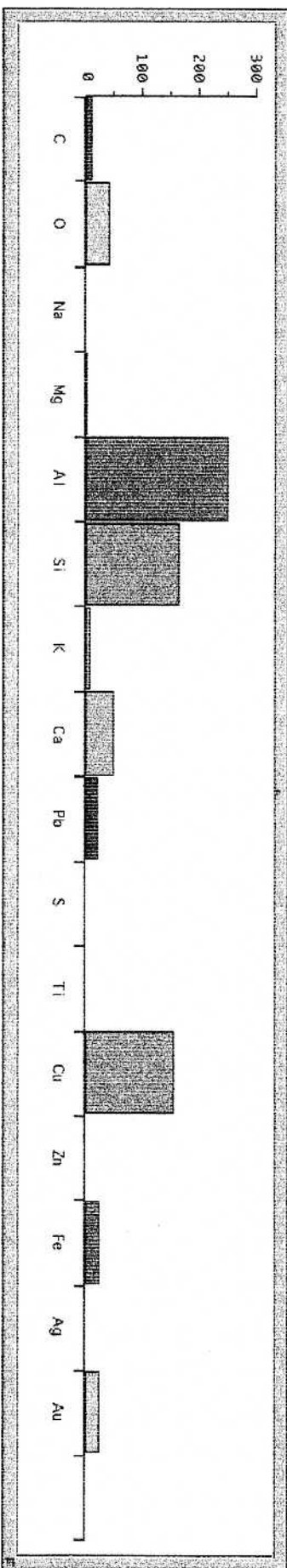
12277	42135	26394	11313	76686	248985	33027	95019	76637	0	2572	36812	14181	31636	0	2405	0
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Work Sheet - Averaged Intensity (Counts)/Element
 6043.2. Inclusions: Cl-3-45 (MIT-5136)
 25 kV, 120 Secs. Working Distance = 39 mm 30,000 - 70,000X

Probe	C	O	Na	Mg	Al	Si	K	Ca	Pb	S	Ti	Cu	Zn	Fe	Ag	Au
2a	4138	14377	-	-	21152	50841	2605	9204	2997	-	-	67189	-	7981	1202	16185
2b	3845	14343	-	1867	210587	56447	3046	17097	17454	-	678	44512	-	9211	-	1375
2c	3576	12631	-	2225	18368	55802	1379	23534	1282	-	-	43270	-	8279	-	6502

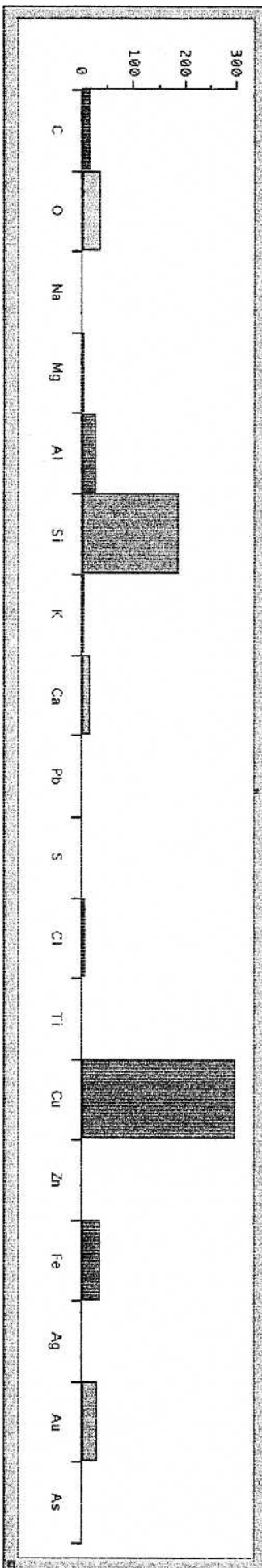
11559	41351	0	4092	250107	163090	7030	49835	21733	0	678	154971	0	25471	1202	24062	0
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Work Sheet - Averaged Intensity (Counts)/Element
 6043.3, Inclusions: Cl-3-45 (MIT-5136)
 25 kV, 120 Secs. Working Distance = 39 mm 30,000 - 70,000X

Probe	C	O	Na	Mg	Al	Si	K	Ca	Pb	S	Cl	Ti	Cu	Zn	Fe	Ag	Au	As
3a	4578	14261	-	-	11089	76295	1416	3078	-	-	-	-	77233	-	12378	773	14898	1074
3b	4279	10309	-	1026	7348	47984	1124	8285	1363	-	5335	-	118451	-	11387	-	7232	-
3c	5848	10992	-	939	8690	61140	1097	3207	-	-	-	-	101075	-	11013	-	7134	-

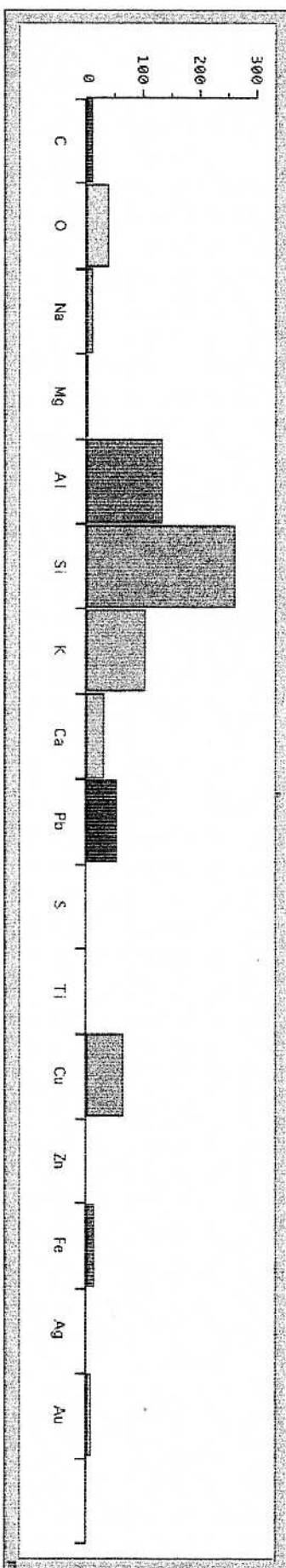
14705	35562	0	1965	27127	185419	3637	14570	1363	0	5335	0	296759	0	34778	773	29264	1074
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Work Sheet - Averaged Intensity (Counts)/Element
 8043.4, Inclusions: Cl-3--45 (MIT-5136)
 25 kV, 120 Secs. Working Distance = 39 mm 30,000 - 70,000X

Probe	C	O	Na	Mg	Al	Si	K	Ca	Pb	S	Ti	Cu	Zn	Fe	Ag	Au
4a	3597	14769	11261	-	61813	90173	22799	14336	12152	-	-	14680	-	2487	-	5350
4b	4104	12931	-	1714	31865	90309	35337	11774	31100	-	689	19013	-	8156	-	1375
4c	4183	10720	0	0	38502	80629	43412	5555	8599	-	428	28821	-	2373	-	710

11884	38420	11261	1714	132180	261111	101548	31665	51851	0	1117	62514	0	13016	0	7435	0
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Work Sheet - Averaged Intensity (Counts)/Element
 6043.5, Inclusions: Cl-3-45 (MIT-5136)
 25 kV, 120 Secs. Working Distance = 39 mm 30,000 - 70,000X

Probe	C	O	Na	Mg	Al	Si	K	Ca	Pb	S	Ti	Cu	Zn	Fe	Ag	Au
5a	3533	9083	-	2968	15563	34478	-	12517	7511	-	-	98860	-	8148	631	19866
5b	4015	10171	-	874	19001	29173	-	4529	9364	-	-	102477	-	8669	701	18986
5c	809	2298	-	704	3793	8761	-	3104	-	-	183	25683	-	1638	-	3732

8357	21552	0	4546	38357	72412	0	20150	16875	0	163	227020	0	18455	1332	42584	0
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