CERN/ET/Internal Note 96-08

Status of Lead Sample Analysis

March 26, 1996

A. Asghar, M. Embid, C. Gelès, J.P. Revol and F. Schussler

We have analysed the data obtained by various laboratories in the determination of the impurities present in the raw Lead delivered to the Calder company for the manufacturing of our Lead blocks. An analysis of the final Lead block composition will only be possible after the final manufacturing phase at CERN. One can hope that there will not be any significant difference between the results of the present analysis and the true composition of the Lead blocks installed in the t7 beam line.

The data are separated in two parts: (1) measured values for 11 elements (Ag, Al, Cd, Te, Sb, Bi, Na, Mg, Cu, Tl and Au) and (2) a set of upper limits with unknown (at this point) confidence level for 49 other elements. The error analysis will be improved later on when we obtain a clear understanding of the uncertainty of each measurement.

I. Study of Lead Purity for the construction of lead blocks for the TARC experiment

1) The 99.99 % Lead received from the Britannia company is coming from 4 different smelting batches:

Batch name	Quantity (ton)	Fraction of total (%)
5G30	185.4	47.473
5G34	184.44	47.227
5H28	5.0	1.28
5J28	15.7	4.02
Total	390.54	100.

2) Impurity analysis

Samples of each smelting batch were sent to several laboratories (US, German, British [GDMS] and French [neutron activation in Grenoble]). This means that we have up to five independent analyses of the same sample, given that we can also use the analysis certificate from Britannia. The typical error bars on the various measurements are the following:

Laboratory	Error bar
Charles Evans & Associates	20 %
Britannia	0.5 ppm for Ag; 1ppm for the others
Griffith	1 ppm for Ag & Tl; 1.5 ppm for Bi
Grenoble	See enclosure
Karlsruhe	See enclosure

II. Analysis of all the elements whose composition was detected to some level

1) Straight averages

Tables 1, 2, 3 & 4 below contain, for each batch and for each sample within the batch, the list of all the elements for which at least one measured value was obtained. When upper limits also exist they are ignored in the determination of the impurity content.

The summary columns for each batch contain (1) a *straight average* of all the measured values, with an error which was obtained by combining quadratically individual errors and (2) a *preferred value* where the apparently "abnormal" measurements were taken out of the average.

Table 1: Batch 5G30: sample 5G30/1

	5G30 Britannia (ppm)	5G30/1 Evans #7 (ppm)	5G30/1 Griffith #21 (ppm)	5G30/1 Karlsruhe#11 (ppm)	5G30/1 Grenoble# 15 (ppm)
Na	--	< 0.0079	--	--	--
Mg	--	0.0029	--	--	--
Al	--	< 0.00024	--	--	--
Cu	< 1.0	0.015	--	--	--
Ag	2.9	2.9	5.0	3.6	4.4
Cd	< 1.0	0.041	--	--	< 0.189
Te	< 5.0	0.30	--	< 2.0	--
Sb	< 1.0	1.1	--	< 2.5	0.29
Tl	--	5.0	7.0	4.5	--
Bi	14.0	< 29	9.0	14.0	--
Au	--	< 0.0028	--	--	2.24E-4

Table 1: Batch 5G30 (continued): sample 5G30/10

	5G30/10 Evans #8 (ppm)	5G30/10 Griffith #22 (ppm)	5G30/10 Grenoble# 16 (ppm)
Na	< 0.0019	--	--
Mg	0.020	--	--
Al	0.11	--	--
Cu	< 0.0015	--	--
Ag	2.7	4.0	5.62
Cd	0.051	--	< 0.189
Te	0.30	--	--
Sb	0.79	--	0.0896
Tl	5.5	8.0	--
Bi	< 38	9.0	--
Au	< 0.0024	--	5.36E-4

Table 1: Batch 5G30 (continued): sample 5G30/2

	5G30/2 Evans #14 (ppm)	5G30/2 Griffith #23 (ppm)	5G30/2 Grenoble# 17 (ppm)	Average * (ppm)	Preferred value** (ppm)
Na	0.0040	--	--	0.0040 ± 8E-4	0.0040 ± 8E-4
Mg	< 0.00058	--	--	0.0114±4E-3	0.0114±4E-3
Al	0.0095	--	--	0.0597±2E-2	0.0597±2E-2
Cu	0.016	--	--	0.0155±4E-3	0.0155±4E-3
Ag	2.4	5.0	5.4	3.9927±2.2	3.9927±2.2
Cd	0.042	--	< 0.189	0.0447±2E-2	0.0447±2E-2
Te	0.23	--	--	0.2767±0.096	0.2767±0.096
Sb	0.72	--	0.212	0.5336±0.31	0.5336±0.31
Tl	4.5	8.0	--	6.0714±2.92	6.0714±2.92
Bi	< 24	10.0	--	11.2±3.25	11.2±3.25
Au	< 0.0054	--	4.1E-4	3.9E-4±4.4E-4	3.9E-4±4.4E-4

Table 2: Batch 5G34: sample 5G34/2

	5G34 Britannia (ppm)	5G34/2 Evans #13 (ppm)	5G34/2 Griffith #24 (ppm)	5G34/2 Grenoble# 20 (ppm)
Na	--	0.055	--	--
Mg	--	< 0.00035	--	--
Al	--	0.0031	--	--
Cu	< 1.0	0.12	--	--
Ag	3.5	2.5	5.0	4.72
Cd	< 1.0	0.21	--	< 0.189
Te	<5.0	0.37	--	--
Sb	< 1.0	0.97	--	0.274
Tl	--	4.5	6.0	--
Bi	14.0	< 28	9.0	--
Au	--	< 0.0014	--	4.4E-4

Table 2: Batch 5G34 (continued): sample 5G34/3

	5G34/3 Evans #9 (ppm)	5G34/3 Griffith #25 (ppm)	5G34/3 Karlsruhe#12 (ppm)	5G34/3 Grenoble# 18 (ppm)
Na	0.041	--	--	--
Mg	< 0.00082	--	--	--
Al	0.020	--	--	--
Cu	0.14	--	--	--
Ag	3.0	4.0	3.8	11.82
Cd	0.083	--	--	< 0.189
Te	0.32	--	< 2.0	--
Sb	0.85	--	3.5	0.588
Tl	4.1	7.0	3.5	--
Bi	< 25	10.0	13.5	--
Au	< 0.0076	--	--	4.95E-4

Table 2: Batch 5G34 (continued): sample 5G34/4

	5G34/4 Evans #10 (ppm)	5G34/4 Griffith #26 (ppm)	5G34/4 Grenoble# 19 (ppm)	Average * (ppm)	Preferred value** (ppm)
Na	0.046	--	--	0.0473±1.6E-2	0.0473±1.6E-2
Mg	< 0.00077	--	--	--	--
Al	0.66	--	--	0.2277±1.3E-1	0.2277±1.3E-1
Cu	0.15	--	--	0.1367±5E-2	0.1367±5E-2
Ag	2.9	4.0	4.44	4.5164±2.2	3.7860±2.1
Cd	0.082	--	< 0.189	0.125±4.8E-2	0.125±4.8E-2
Te	0.37	--	--	0.3533±0.12	0.3533±0.12
Sb	0.91	--	0.186	1.0397±2.59	0.6297±0.31
Tl	4.7	6.0	--	5.1143±2.45	5.1143±2.45
Bi	< 30	10.0	--	11.3000±3.2	11.3000±3.2
Au	< 0.013	--	7.33E-4	5.6E-4±4.6E-4	5.6E-4±4.6E-4

Table 3: Batch 5H28: sample 5G34/4

	5H28 Britannia (ppm)	5H28 Evans #29 (ppm)	Average * (ppm)	Preferred value ** (ppm)
Na	--	< 0.00074	--	--
Mg	--	< 0.00015	--	--
Al	--	0.0089	0.0089±1.8E-3	0.0089±1.8E-3
Cu	< 1.0	< 0.0006	--	--
Ag	3.0	3.2	3.1±0.8	3.1±0.8
Cd	< 1.0	0.056	0.056±1.1E-2	0.056±1.1E-2
Te	< 5.0	0.019	0.019±3.8E-3	
Sb	< 1.0	0.012	0.012±2.4E-3	0.012±2.4E-3
Tl	--	4.7	4.7 ± 0.96	-4.7 ± 0.96
Bi	16.0	< 20	16±1.0	16±1.0
Au	--	< 0.0017		

Table 4: Batch 5J28

	5J28 Britannia (ppm)	5J28/1 Evans #30 (ppm)	5J28/10 Evans # 31 (ppm)	Average * (ppm)	Preferred value** (ppm)
Na	--	0.019	< 0.0017	0.019±3.8E-3	0.019±3.8E-3
Mg	--	< 0.00068	< 0.00065	--	--
Al	--	< 0.0048	0.026	0.026±5.2E-3	0.026±5.2E-3
Cu	< 1.0	< 0.0050	0.0093	9.3E-3±1.9E-3	9.3E-3±1.9E-3
Ag	3.0	4.1	4.7	3.9333±1.3	3.9333±1.3
Cd	< 1.0	0.18	0.31	0.245±7.1E-2	0.245±7.1E-2
Te	< 5.0	0.15	0.16	0.155E±4E-2	0.155E±4E-2
Sb	< 1.0	0.12	0.083	0.1015±2.9E-2	0.1015±2.9E-2
Tl	--	5.2	5.2	5.2±1.47	5.2±1.47
Bi	11.0	< 27	< 19	11±1.0	11±1.0
Au	--	< 0.0061	< 0.0074		

* The upper limits have been ignored for the calculation of the averages.

** For the preferred values, a number of obviously wrong data points, given in the following list, have been ignored:

Te: Evans #29

Sb: Karlsruhe #12

Ag: Grenoble #18

2) Weighted averages

Using the error bars, as we know them today, we have also determined a weighted average of all the measurements for each smelting batch. Even though this is in principle the correct method for determining the average value, we doubt that the errors quoted by the various laboratories are correct. In particular, if we consider the spread of measurements (figures 1 to 11), we can assume that in most cases the errors are underestimated. The formulae used are the standard ones:

$$\langle C \rangle = \frac{\sum_{i=1}^{N} \frac{C_i}{\sigma_i^2}}{\sum_{i=1}^{N} \frac{1}{\sigma_i^2}} \qquad \& \qquad \sigma^2 = \frac{\sum_{i=1}^{N} \frac{(C_i - \langle C \rangle)^2}{\sigma_i^2}}{(N-1)\sum_{i=1}^{N} \frac{1}{\sigma_i^2}}$$

The following table contains the weighted averages obtained for each smelting batch. They show in some cases significant differences from the straight averages shown above.

Element	Average (ppm) Batch 5G30	Average (ppm) Batch 5G34	Average (ppm) Batch 5H28	Average (ppm) Batch 5J28
Na	0.004±0.0008	4.6001E-2±5.4E-3	--	1.9000E-2±3.8E-3
Mg	3.2521E-3±4.9E-4	--	--	--
Al	1.0244E-2±1.2E-2	3.5106E-3±5.0E-4	0.0089±1.8E-3	0.026±0.0052
Cu	1.5468E-2±4.8E-4	1.3427E-1±1.1E-2	--	0.0093±0.00186
Ag	3.6640±0.12	3.829±5.8E-2	3.0758±0.08	3.5378±0.51
Cd	4.3853E-2±2.2E-3	9.1628E-2±3.9E-2	0.056±0.0112	2.1278E-1±4E-2
Te	2.6782E-1±2E-2	3.4997E-1±1.3E-2	--	1.5468E-1±4.8E-3
Sb	1.8694E-1±3.2E-2	2.5447E-1±3.3E-2	0.012±0.0024	9.4973E-2±2E-2
Tl	6.1748±4.6E-1	4.9273±1.8E-1	4.7 ± 0.96	5.2±0
Bi	1.1685E+1±1.58	1.1818E+1±1.47	16.0±1	11.0±1
Au	3.1754E-4±8.9E-5	5.7767E-4±1.1E-4	--	--

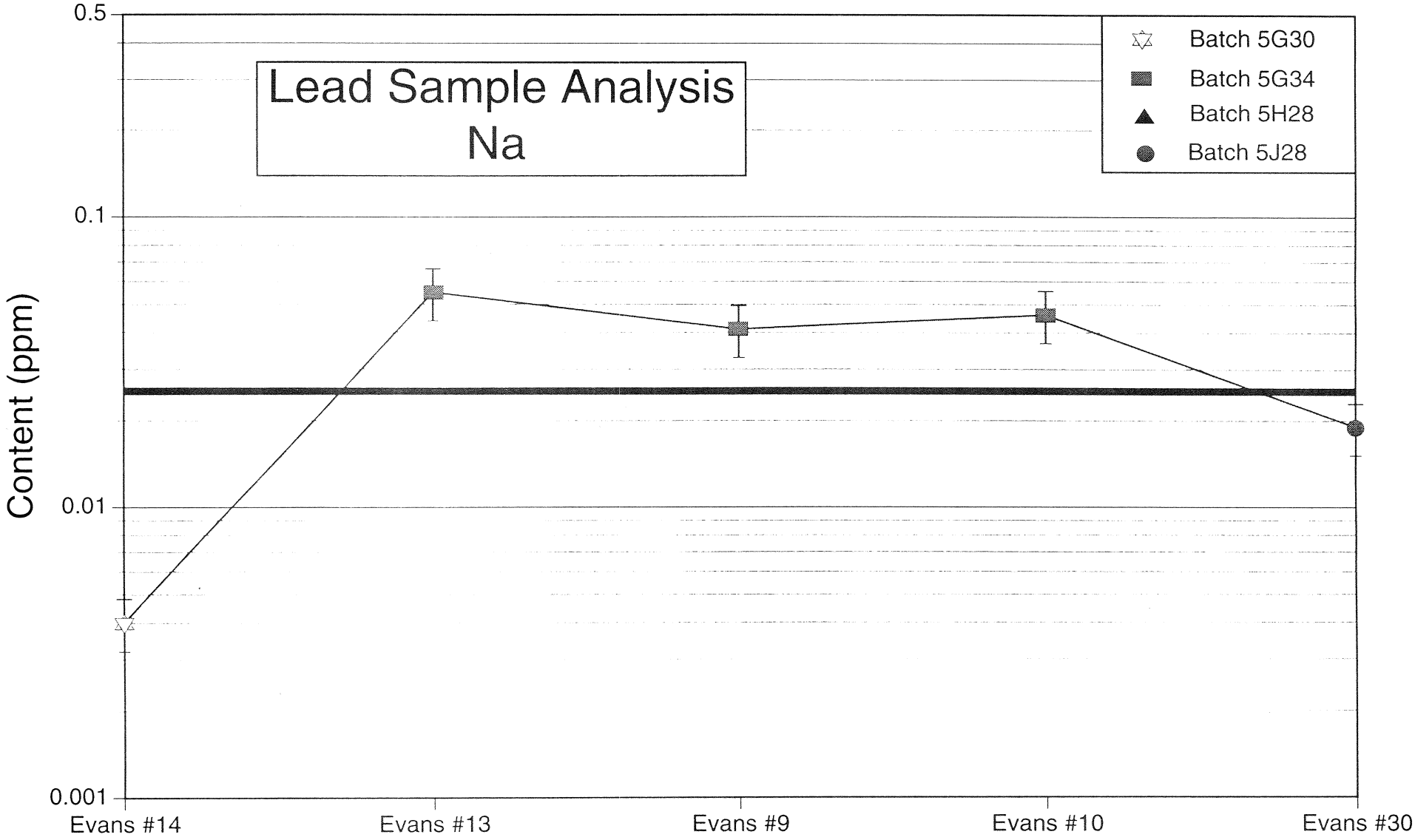

Lead Sample Analysis
Na
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
0.5
0.1
0.01
0.001
Content (ppm)
Evans #14
Evans #13
Evans #9
Evans #10
Evans #30
Company, sample number

Figure 1

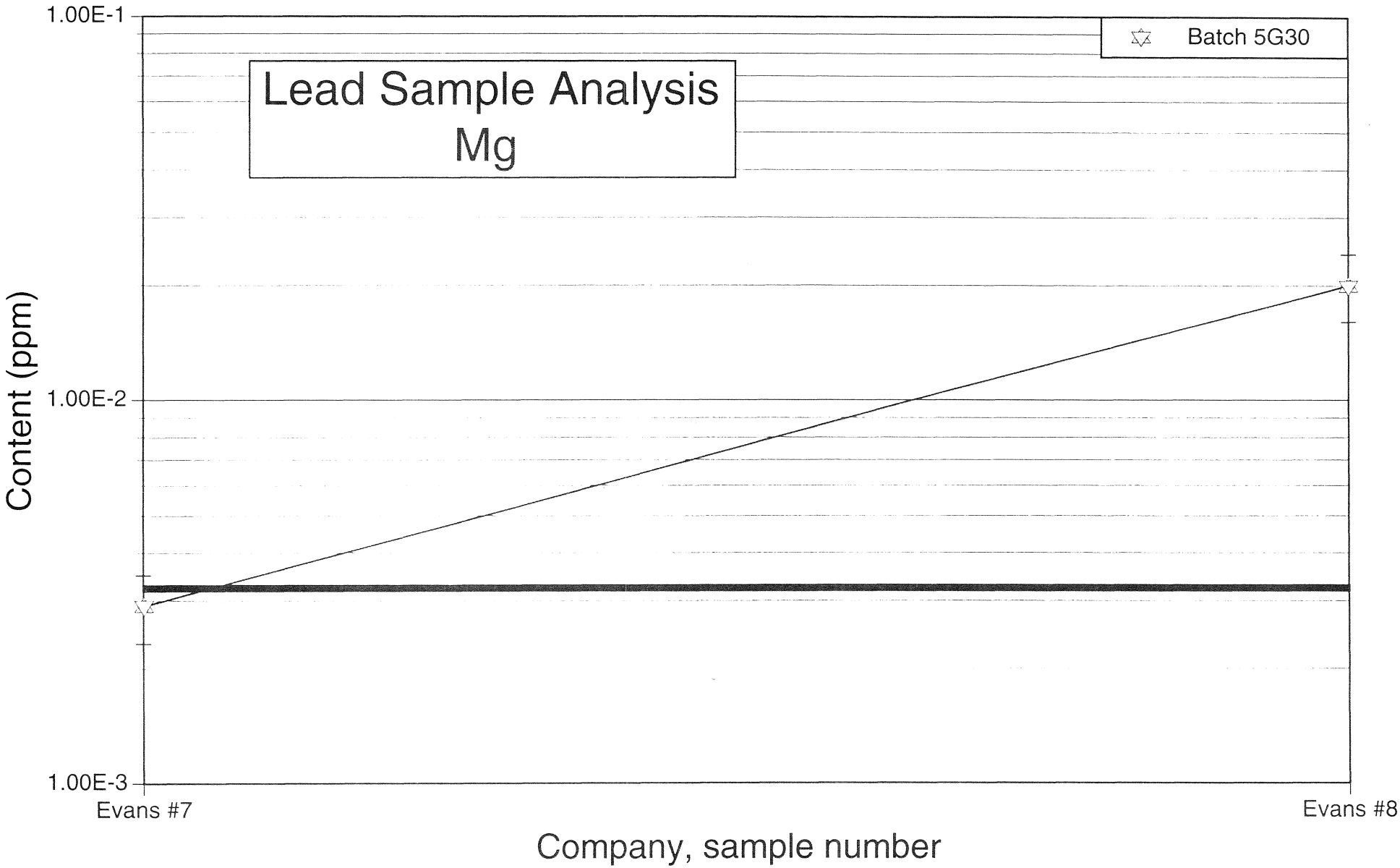

Lead Sample Analysis
Mg
Batch 5G30
1.00E-1
1.00E-2
1.00E-3
Content (ppm)
Evans #7
Evans #8
Company, sample number

Figure 2

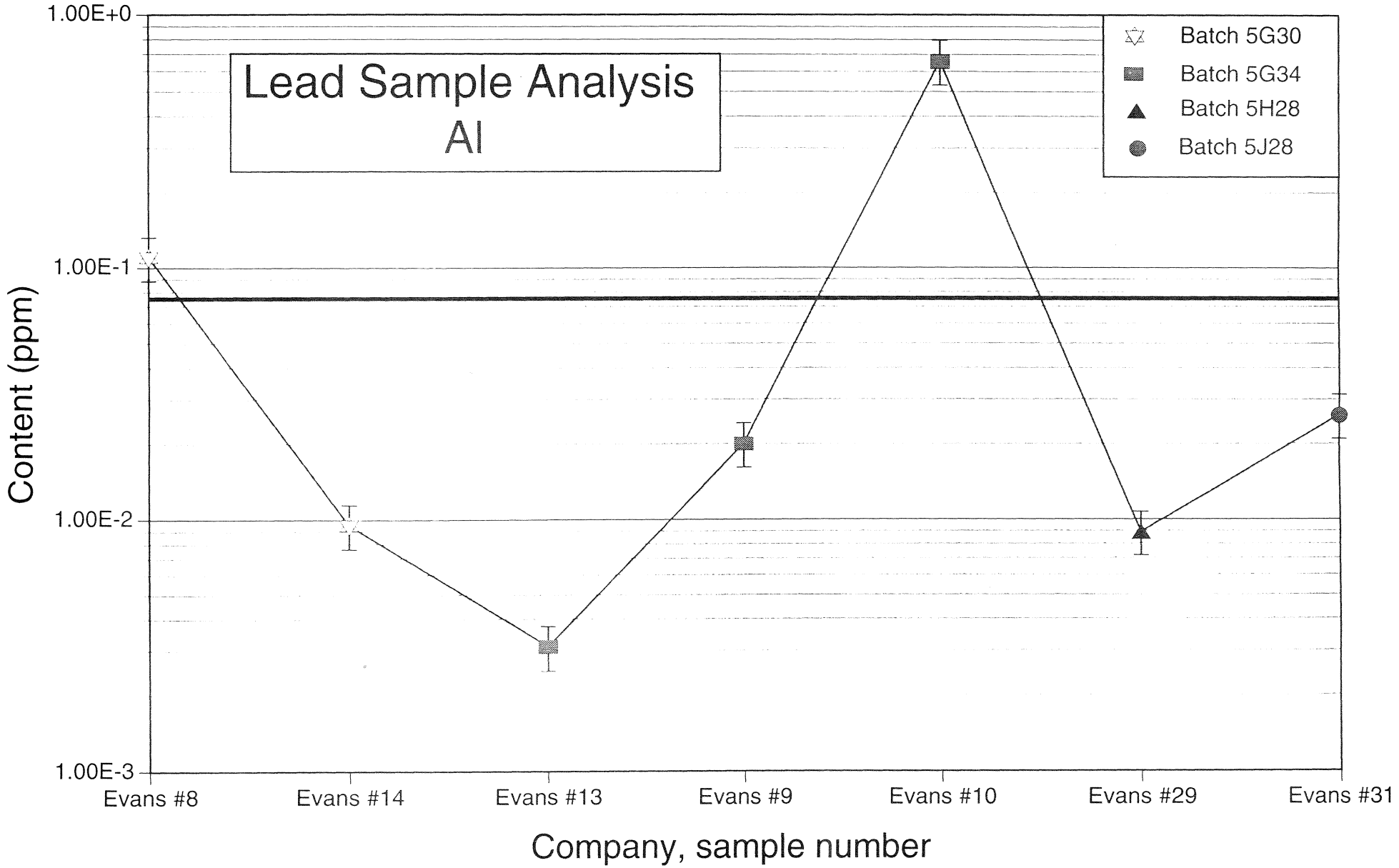

Lead Sample Analysis
Al
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
1.00E+0
1.00E-1
1.00E-2
1.00E-3
Content (ppm)
Evans #8
Evans #14
Evans #13
Evans #9
Evans #10
Evans #29
Evans #31
Company, sample number

Figure 3

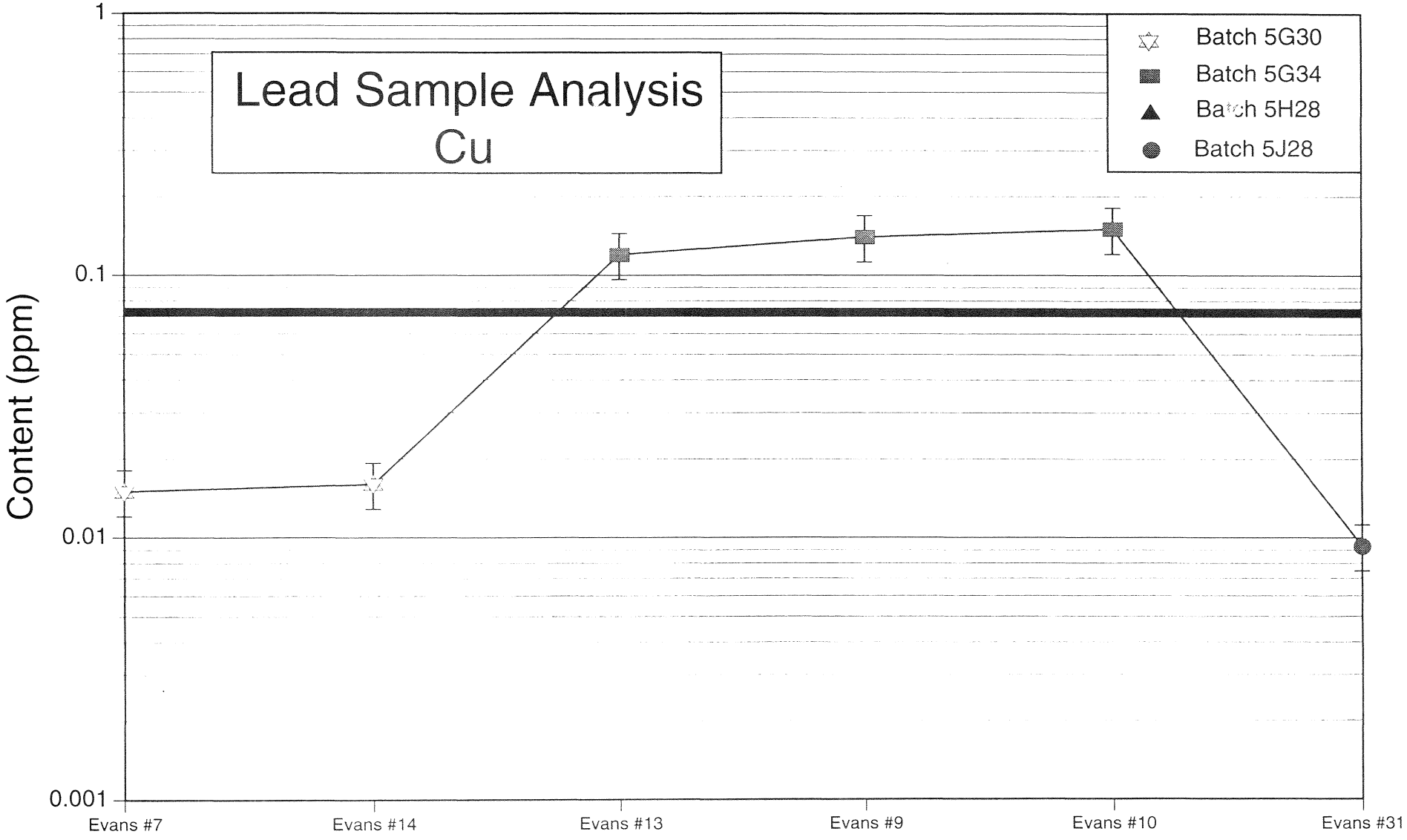

Lead Sample Analysis
Cu
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Content (ppm)
1
0.1
0.01
0.001
Evans #7
Evans #14
Evans #13
Evans #9
Evans #10
Evans #31
Company, sample number

Figure 4

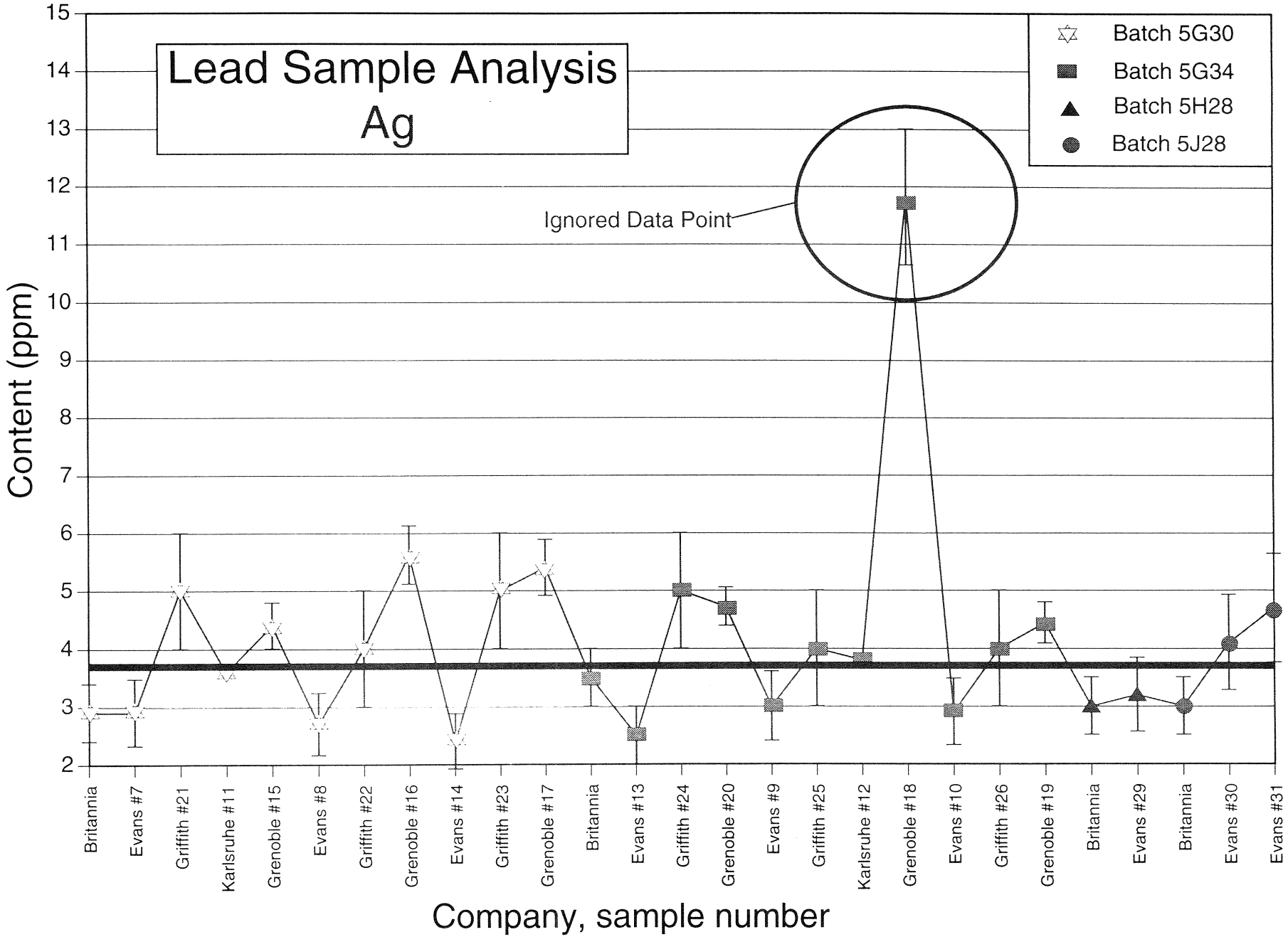

Lead Sample Analysis
Ag
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Ignored Data Point
Content (ppm)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
Britannia
Evans #7
Griffith #21
Karlsruhe #11
Grenoble #15
Evans #8
Griffith #22
Grenoble #16
Evans #14
Griffith #23
Grenoble #17
Britannia
Evans #13
Griffith #24
Grenoble #20
Evans #9
Griffith #25
Karlsruhe #12
Grenoble #18
Evans #10
Griffith #26
Grenoble #19
Britannia
Evans #29
Britannia
Evans #30
Evans #31
Company, sample number

Figure 5

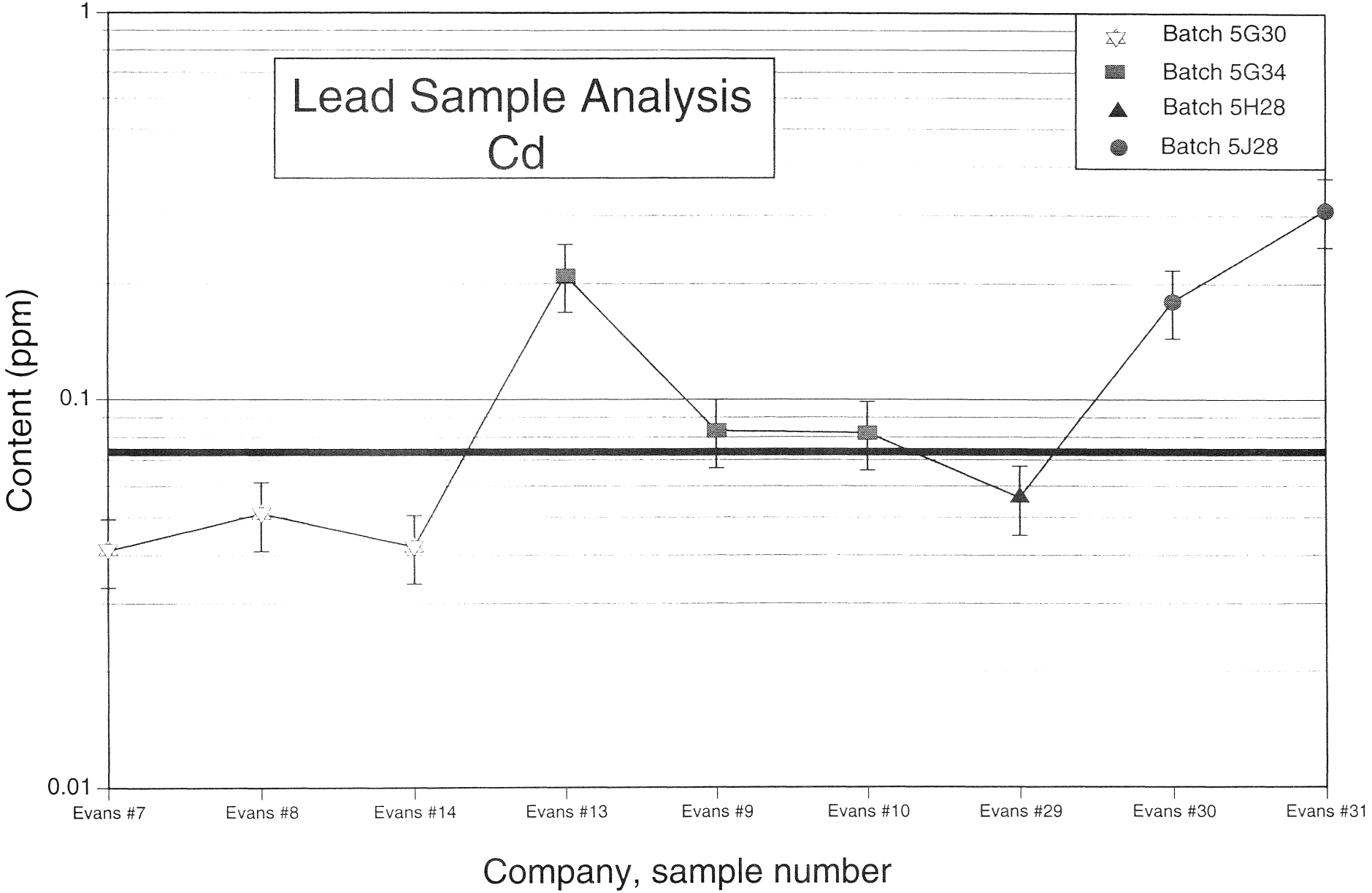

Lead Sample Analysis
Cd
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Content (ppm)
1
0.1
0.01
Evans #7
Evans #8
Evans #14
Evans #13
Evans #9
Evans #10
Evans #29
Evans #30
Evans #31
Company, sample number

Figure 6

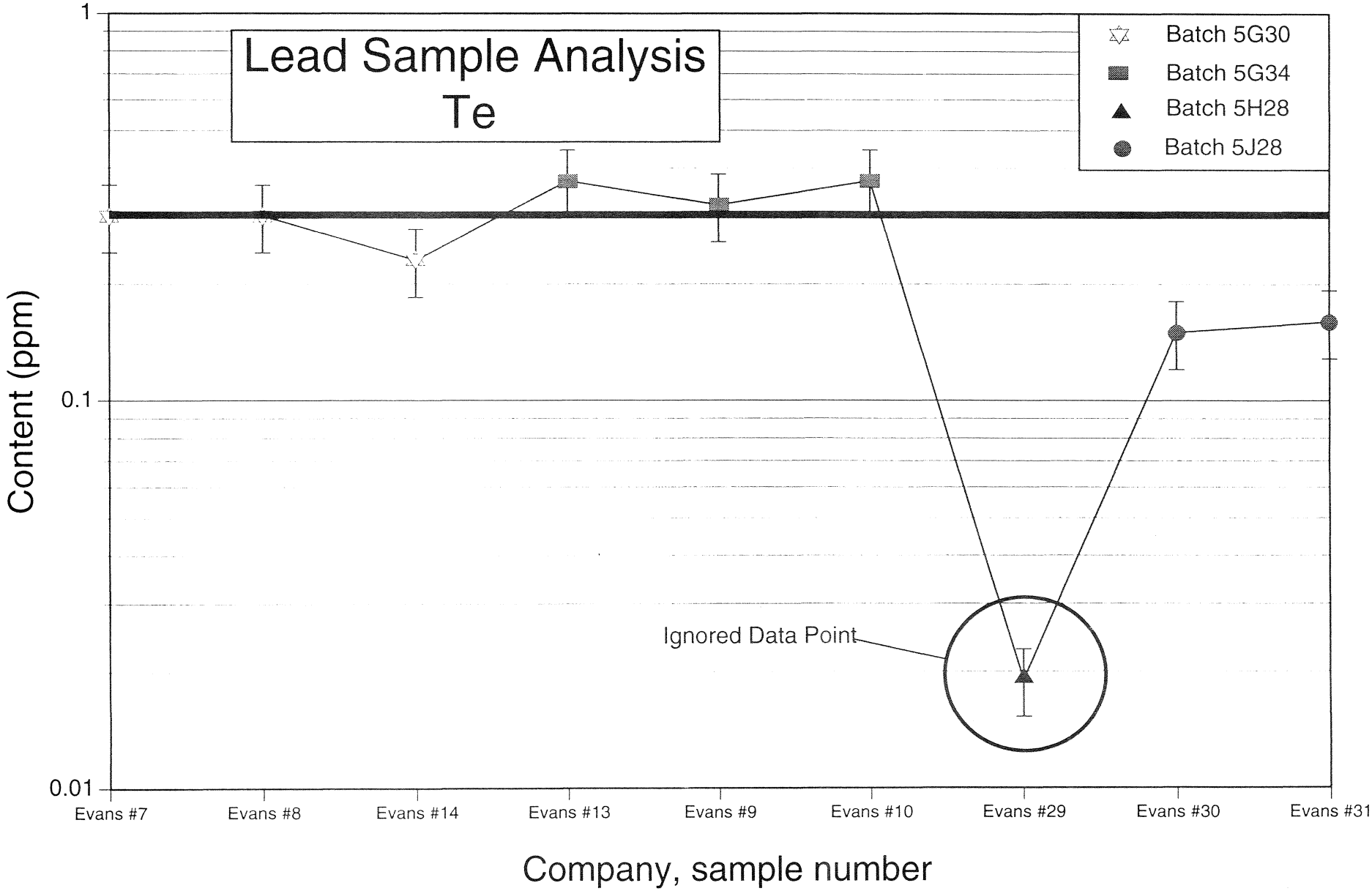

Lead Sample Analysis
Te
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Content (ppm)
1
0.1
0.01
Ignored Data Point
Evans #7
Evans #8
Evans #14
Evans #13
Evans #9
Evans #10
Evans #29
Evans #30
Evans #31
Company, sample number

Figure 7

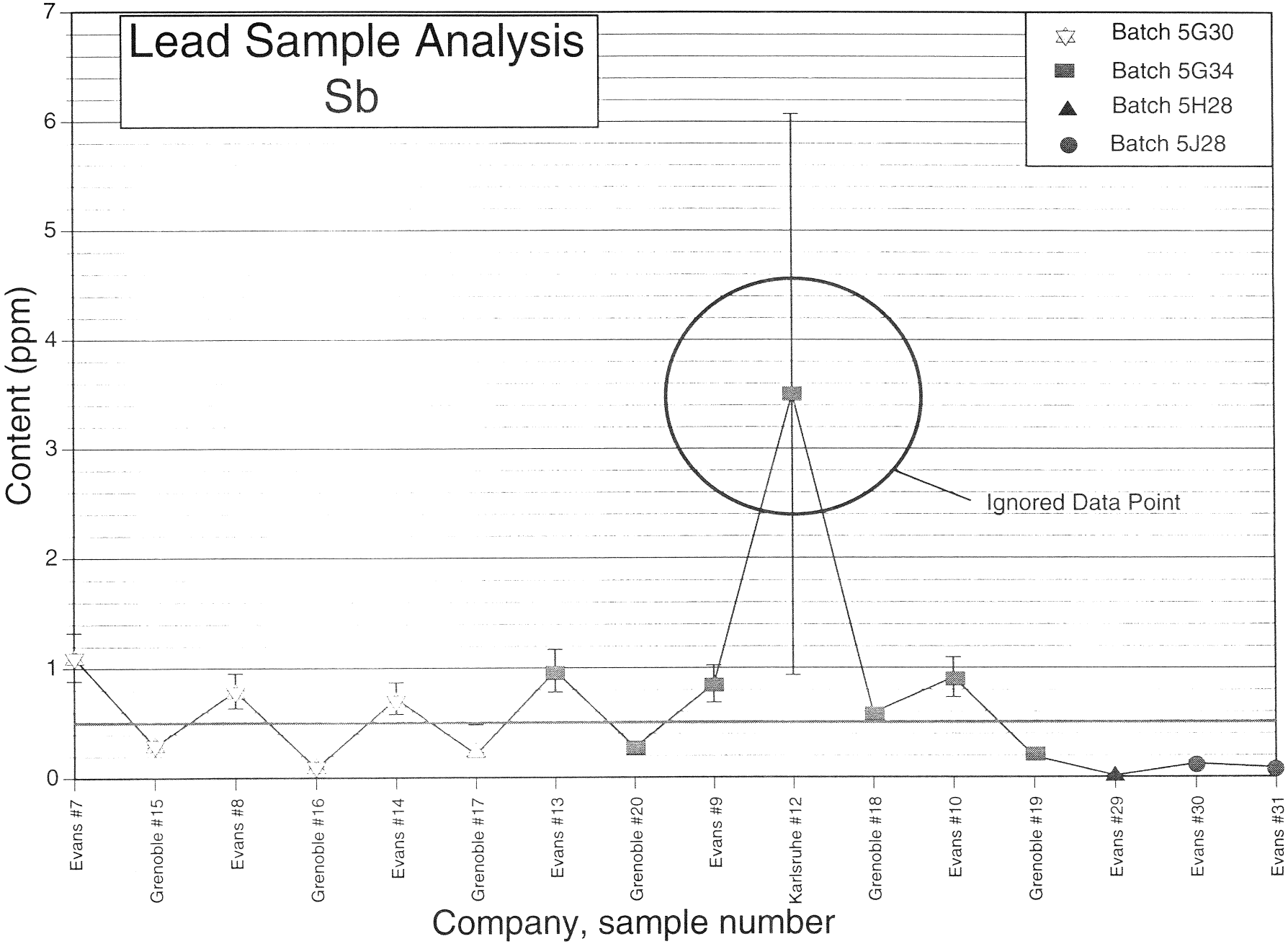

Lead Sample Analysis
Sb
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Content (ppm)
0
1
2
3
4
5
6
7
Ignored Data Point
Evans #7
Grenoble #15
Evans #8
Grenoble #16
Evans #14
Grenoble #17
Evans #13
Grenoble #20
Evans #9
Karlsruhe #12
Grenoble #18
Evans #10
Grenoble #19
Evans #29
Evans #30
Evans #31
Company, sample number

Figure 8

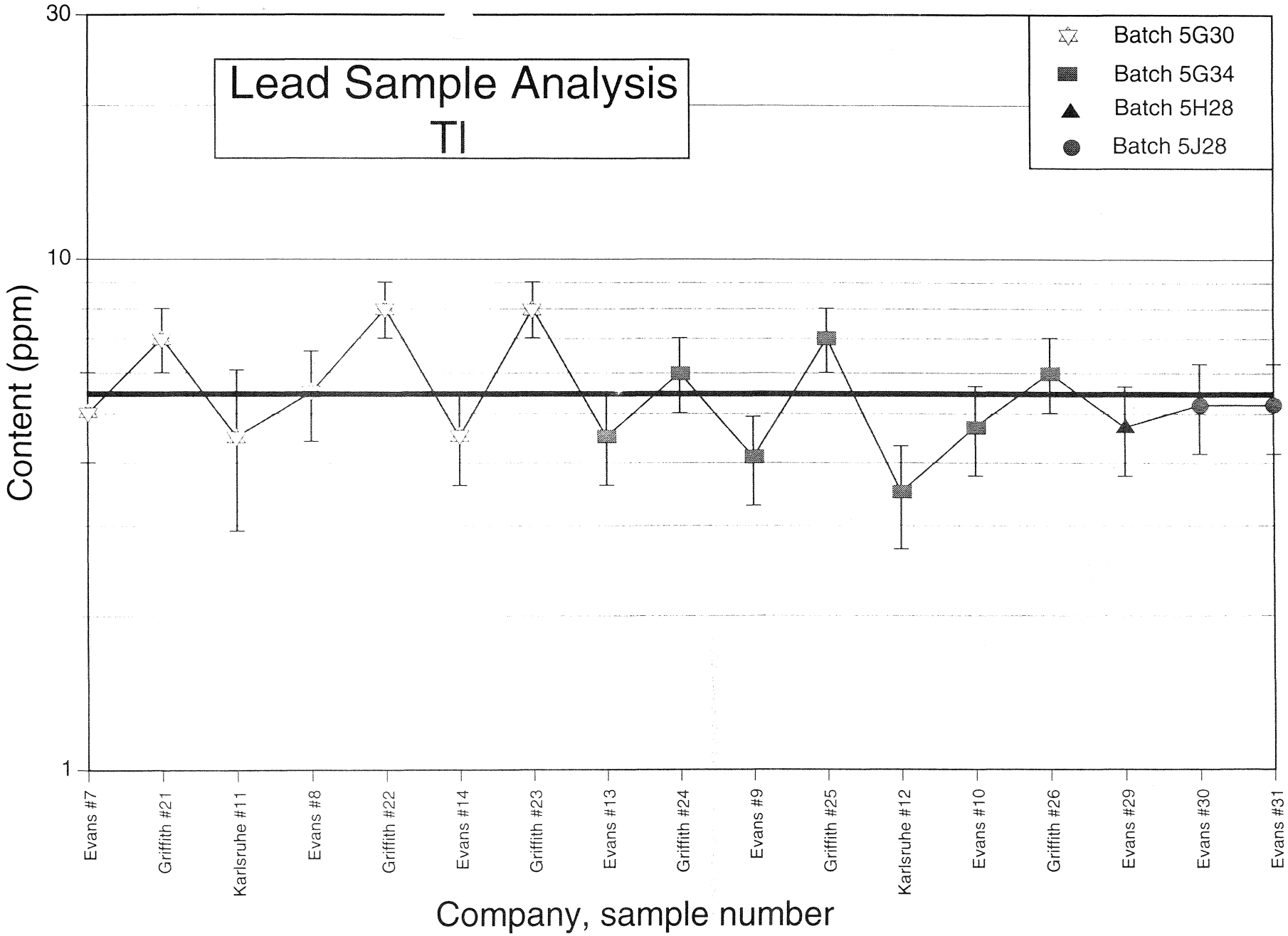

Lead Sample Analysis
Tl
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
30
10
1
Content (ppm)
Evans #7
Griffith #21
Karlsruhe #11
Evans #8
Griffith #22
Evans #14
Griffith #23
Evans #13
Griffith #24
Evans #9
Griffith #25
Karlsruhe #12
Evans #10
Griffith #26
Evans #29
Evans #30
Evans #31
Company, sample number

Figure 9

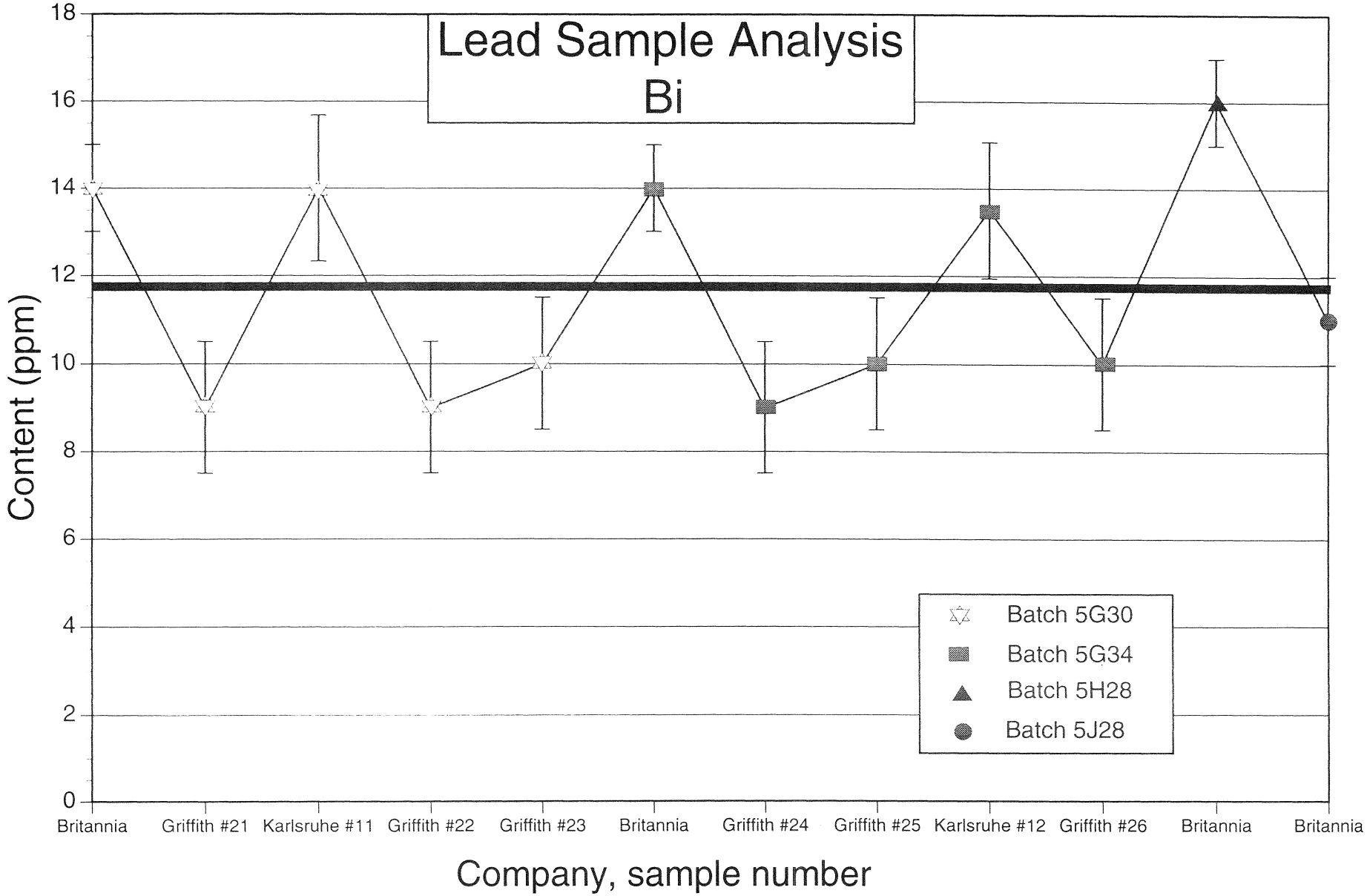

Lead Sample Analysis
Bi
Content (ppm)
18
16
14
12
10
8
6
4
2
0
Britannia
Griffith #21
Karlsruhe #11
Griffith #22
Griffith #23
Britannia
Griffith #24
Griffith #25
Karlsruhe #12
Griffith #26
Britannia
Britannia
Batch 5G30
Batch 5G34
Batch 5H28
Batch 5J28
Company, sample number

Figure 10

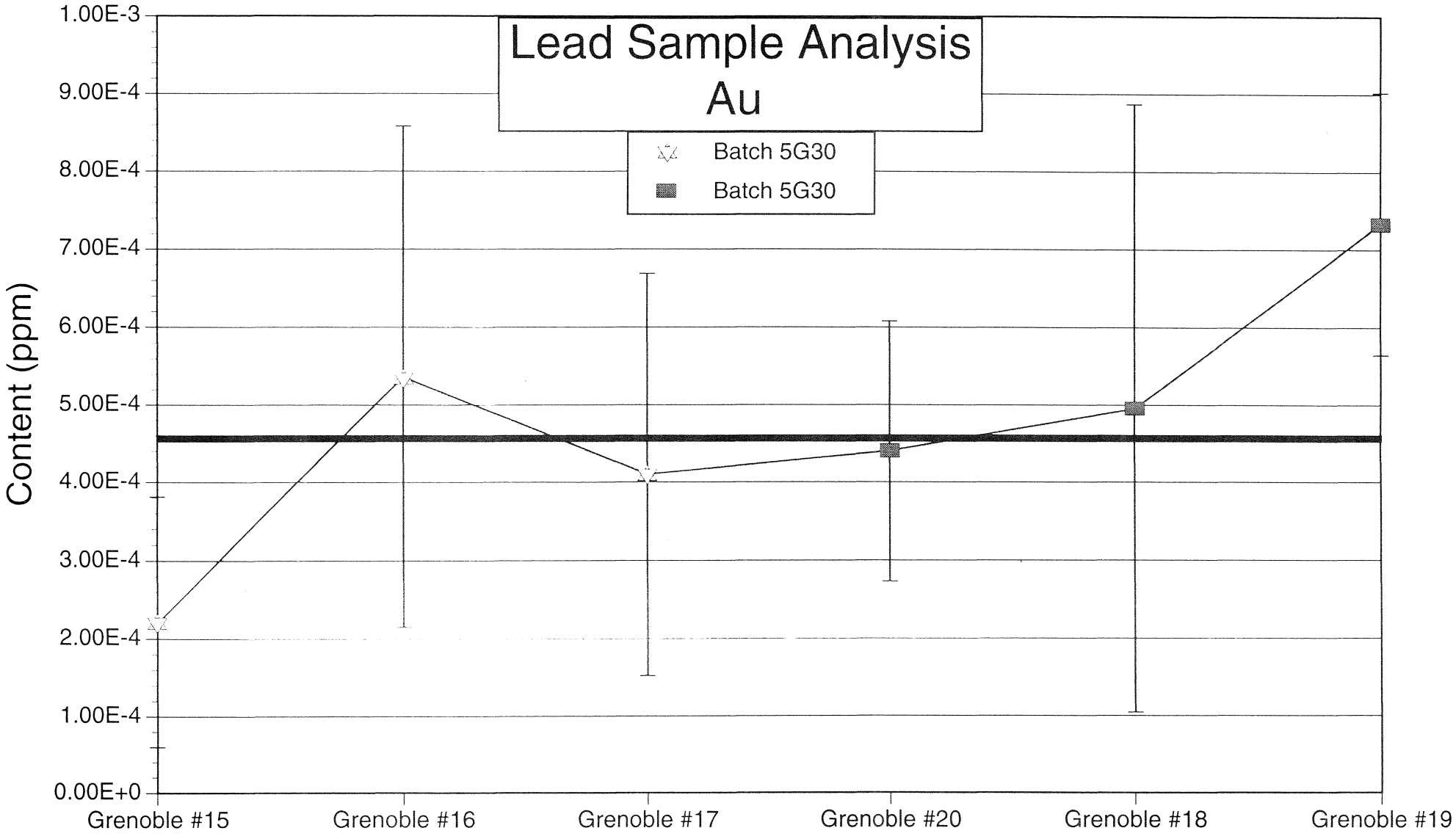

Lead Sample Analysis
Au
Batch 5G30
Batch 5G30
1.00E-3
9.00E-4
8.00E-4
7.00E-4
6.00E-4
5.00E-4
4.00E-4
3.00E-4
2.00E-4
1.00E-4
0.00E+0
Content (ppm)
Grenoble #15
Grenoble #16
Grenoble #17
Grenoble #20
Grenoble #18
Grenoble #19
Company, sample number

Figure 11

III. Smelting batch mixing

In order to obtain a Lead assembly with homogeneous impurity content, we have asked the Calder company to mix the ingots from the various smelting batches in an amount proportional to the total quantity of ingots for each batch. In practice they used the following mixing procedure:

Batch	Number of Ingots
5G30	36
5G34	36
5H28	1
5J28	3

According to the above mixture we have determined the following impurity composition of our raw Lead:

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Na	5G30	0.0040±8E-4		0.004±8E-4	
	5G34	0.0473±1.6E-2		4.6001E-2±5.4E-3	
	5H28	--		--	
	5J28	0.019±3.8E-3		1.9000E-2±3.8E-3	
			0.0253±7.6E-3		**0.0247±3E-3**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Mg	5G30	0.0114±0.004		3.2521E-3±4.9E-4	
	5G34	--		--	
	5H28	--		--	
	5J28	--		--	
			0.0114±0.004		**3.2521E-3±4.9E-4**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Al	5G30	0.0597±2E-2		1.0244E-2±1.2E-2	
	5G34	0.2277±1.3E-1		3.5106E-3±5E-4	
	5H28	0.0089±1.8E-3		0.0089±1.8E-3	
	5J28	0.0260±5.2E-3		0.026±0.0052	
			0.1373±6E-2		**0.0077±6E-3**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Cu	5G30	0.0155±4E-3		1.5468E-2±4.8E-4	
	5G34	0.1367±5E-2		1.3427E-1±1.1E-2	
	5H28	--		--	
	5J28	9.3E-3±1.9E-3		0.0093±1.9E-3	
			0.0732±2.3E-2		**0.072±0.005**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Ag	5G30	3.9927±2.2		3.6640±0.12	
	5G34	3.7860±2.1		3.829±5.8E-2	
	5H28	3.1±0.8		3.0758±0.08	
	5J28	3.9333±1.3		3.5378±0.51	
			3.8807±1.4		**3.7294±6.6E-2**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Cd	5G30	0.0447±2E-2		4.3853E-2±2.2E-3	
	5G34	0.125±4.8E-2		9.1628E-2±3.9E-2	
	5H28	0.056±1.1E-2		0.056±0.0112	
	5J28	0.245±7.1E-2		2.1278E-1±4E-2	
			0.0908±0.02		**0.0733±0.02**

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Te	5G30	0.2767±0.096		2.6782E-1±2E-2	
	5G34	0.3533±0.12		3.4997E-1±1.3E-2	
	5H28	--		--	
	5J28	0.155±0.04		1.5468E-1±4.8E-3	
			0.3080±0.07		0.3021±0.011

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Sb	5G30	0.5336±0.31		1.8694E-1±3.2E-2	
	5G34	0.6297±0.31		2.5447E-1±3.3E-2	
	5H28	0.012±2.4E-3		0.012±2.4E-3	
	5J28	0.102±2.9E-2		9.4973E-2±2E-2	
			0.5552±0.2		0.2130±0.02

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Tl	5G30	6.0714±2.92		6.1748±4.6E-1	
	5G34	5.1143±2.45		4.9273±1.8E-1	
	5H28	4.7 ± 0.96		4.7 ± 0.96	
	5J28	5.2±1.47		5.2±0	
			5.566±1.81		5.530±0.23

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Bi	5G30	11.2000±3.25		1.1685E+1±1.58	
	5G34	11.3000±3.2		1.1818E+1±1.47	
	5H28	16.0000±1.0		16.0±1	
	5J28	11.0000±1.0		11.0±1	
			11.3026±2.25		11.7778±1.0

Element	Batch Number	Average (ppm)	Average Content (ppm)	Weighted Average (ppm)	Weighted Average Content (ppm)
Au	5G30	3.9E-4±4.4E-4		3.1754E-4±8.9E-5	
	5G34	5.6E-4±4.6E-4		5.7767E-4±1.1E-4	
	5H28	<0.0017		--	
	5J28	<6.75E-3		--	
			7.4E-4±3E-4		**4.48E-4±7.E-5**

Note that for Na, Cu, Te and Tl the average for batch 5H28 is the average of the other batches, since no value was available, but the Lead quality is supposed to be similar. In the case of Au only batches 5G30 and 5G34 have been measured so far. The analysis of other batches will be performed in Grenoble at the beginning of April.

Summary of recommended impurity contents for the raw Lead

Element	Content
Na	0.0247 ± 0.003
Mg	0.0032 ± 0.0004
Al	0.0077 ± 0.006
Cu	0.072 ± 0.005
Ag	3.73 ± 0.066
Cd	0.0733 ± 0.02
Te	0.302 ± 0.011
Sb	0.213 ± 0.02
Tl	5.53 ± 0.23
Bi	11.78 ± 1.0
Au	4.48E-4 ± 7.E-5

IV. Analysis of upper limits

The previous analysis is repeated for all the elements which have been searched for, and for which only upper limits are available. Our first approach is to simply take a straight average of all available upper limits.

There are 65 elements which have been searched for using a Glow Discharge Mass Spectrometre (GDMS). Eleven of them were detected at some level, for the other 55 only an upper limit was given. Among them the upper limits for C, N, O, F and Cl are not significant because they are produced by the background present in the GDMS itself, and are therefore ignored here. If it turned out that for any reason the concentration of C, N, O, F, Cl and any other impurity not yet detected is needed with a better sensitivity, a specialised chemical analysis will have to be performed. Whenever upper limits were also available from other laboratories they were also used.

Consequently we present in the following table the resulting upper limits obtained for 49 elements.

Element	Average 5G30 (ppm)	Average 5G34 (ppm)	Average 5H28 (ppm)	Average 5J28 (ppm)
Li	2.7333E-4	1.600E-4	5.10E-5	4.2500E-4
Be	5.0333E-4	5.1333E-4	9.30E-5	7.8500E-4
B	4.3667E-4	3.3667E-4	0.00011	5.2000E-4
Si	7.0500E-4	3.5567E-3	0.0034	0.0023
P	6.0000E-4	6.4000E-4	0.00011	1.2900E-3
S	2.9500E-3	0.008	--	2.7500E-3
K	3.1667E-3	5.2333E-3	0.0092	7.5500E-3
Ca	8.4000E-3	3.4500E-3	--	3.6500E-3
Sc	6.9300E-5	8.5000E-5	--	8.90E-5
Ti	9.0000E-4	2.1100E-3	--	2.1500E-4
V	1.0000E-4	1.4100E-4	4.500E-5	1.9500E-4
Cr	0.0336	0.0297	0.0504	0.05048
Mn	0.0258	0.0337	0.0504	0.0337
Fe	6.7400E-3	3.7567E-3	--	--
Co	0.0252	0.02521	5.0000E-2	3.3570E-2
Ni	0.1	0.1	0.1	1.0000E-1
Zn	1.7433E-3	2.4000E-3	0.00053	2.4000E-3
Ge	2.6667E-3	2.7333E-3	0.00034	3.5000E-3
Ga	1.3700E-3	2.3333E-3	0.00032	1.7000E-3
As	3.9000E-3	0.0013	0.00014	1.5500E-3
Br	5.8667E-3	6.4667E-3	0.0034	8.5000E-3
Se	1.5733E-2	1.1367E-2	0.0017	1.4000E-2
Rb	2.4600E-3	3.7167E-3	0.00034	1.3000E-3
Sr	9.2000E-5	9.17E-5	1.70E-5	1.3000E-4
Y	3.8433E-4	1.3400E-4	1.40E-5	1.1500E-4
Zr	2.5667E-4	8.3333E-4	0.0001	4.2000E-4
Nb	1.4500E-4	6.5E-4	2.70E-5	2.2500E-4
Mo	1.4833E-3	1.3833E-3	--	1.7000E-3

Element	Average 5G30 (ppm)	Average 5G34 (ppm)	Average 5H28 (ppm)	Average 5J28 (ppm)
Ru	1.3667E-3	1.0767E-3	0.0012	1.7000E-3
Rh	3.6667E-3	2.3667E-3	0.0029	4.2000E-3
Pd	2.7000E-3	1.72E-3	--	3.6500E-3
In	1.0800E-3	1.3067E-3	0.0002	1.7500E-3
Sn	2.5500E-3	1.0	--	3.6500E-3
I	6.1000E-4	6.1333E-4	0.00021	9.0500E-4
Cs	5.4667E-4	6.9E-4	0.0002	7.7500E-4
Ba	1.0433E-3	4.8000E-4	8.80E-5	6.7000E-4
La	8.1333E-5	1.07E-4	7.10E-6	1.3500E-4
Ce	4.0967E-4	8.73E-5	6.40E-6	1.2000E-4
Nd	3.0667E-4	3.8667E-4	0.00023	4.4500E-4
Hf	2.6000E-4	2.6333E-4	9.60E-5	3.7000E-4
Ta	6.3667E-1	0.036	0.09	4.9000E-1
W	3.0600E-3	3.5633E-3	0.00041	1.1050E-3
Re	4.3000E-4	4.6000E-4	0.00017	1.3600E-3
Os	5.3667E-4	5.4333E-4	0.00065	7.6500E-4
Ir	3.8000E-4	3.7000E-4	0.00016	5.2000E-4
Pt	8.1333E-4	1.09E-3	0.0002	1.1850E-3
Hg	2.6333E-2	1.9667E-2	0.083	3.0550E-2
Th	1.1400E-3	6.7000E-4	--	5.4500E-4
U	1.3167E-4	2.4000E-4	1.70E-5	1.0950E-4

Recommended set of upper limits for the raw Lead:
(with unknown confidence level)

Element	Upper Limit (ppm)
Li	2.2271E-4
Be	5.1379E-4
B	3.8829E-4
Si	2.1542E-3
P	6.3974E-4
S	5.3555E-3
K	4.3980E-3
Ca	5.8252E-3
Sc	7.7670E-5
Ti	1.4484E-3
V	1.2245E-4
Cr	3.264E-2
Mn	3.0178E-2
Fe	5.2483E-3
Co	2.5861E-2
Ni	0.1
Zn	2.0627E-3
Ge	2.7005E-3
Ga	1.8254E-3
As	2.5262E-3
Br	6.2222E-3
Se	1.3412E-2
Rb	2.9816E-3
Sr	9.2371E-5

Element	Upper Limit (ppm)
Y	2.5025E-4
Zr	5.3421E-4
Nb	3.8582E-4
Mo	1.4445E-3
Ru	1.2403E-3
Rh	3.0619E-3
Pd	2.2732E-3
In	1.2022E-3
Sn	0.4794
I	6.1780E-4
Cs	6.1901E-4
Ba	7.4917E-4
La	9.4633E-5
Ce	2.4023E-4
Nd	3.4429E-4
Hf	2.6375E-4
Ta	0.3391
W	3.1864E-3
Re	4.7745E-4
Os	5.5033E-4
Ir	3.7789E-4
Pt	9.5097E-4
Hg	2.4087E-2
Th	8.8921E-4
U	1.8060E-4

Appendix

We include in this appendix all the raw data from the various laboratories, so that they can be available to everyone if needed.

The values obtained from Britannia require some clarification. Their certificate of analysis is only meant to show that the Lead they provide is within the specifications. In particular they are not trying to be precise on the content of elements which they detect (error of ± 1 ppm) except for Ag where they made a special analysis with an error bar of 0.5 ppm. For the upper limits all of them are very loose. After talking to their chief chemist, we obtained typical upper limits for some of the elements of interest, and it is those upper limits which we used:

Co, Cr, Ni < 0.1 ppm; Mn « 0.1 ppm; Te < 1 ppm.

For Ca and Ta they did not have data. What they can say is that it is virtually impossible to dissolve Ta in Lead. The only way to get Ta on a Lead sample is by surface pollution. Therefore we should only expect an upper limit for Ta, if any measurement is made. The spread of upper limits from Charles Evans & Associates is very large. It goes from 16 ppm for the largest to 0.036 ppm for the smallest. For this report we have chosen to ignore the two largest upper limits. Clearly, if needed, we will have to send samples to a chemist which could determine the Ta content to 0.01 ppm or better. For Ca we have also chosen to ignore the Britannia upper limit, and have only used the values from the other laboratories.

We propose that, after having run the simulation with all available upper limits we can identify which elements are sensitive enough that they require a more precise determination. We will then arrange to have these elements studied with more accuracy.

Appendix content:

1) Analysis certificates from Britannia.

2) Analysis results from the Charles Evans & Associates Laboratory for samples 7, 8, 9, 10, 13, 14, 29, 30 and 31.

3) Grenoble analysis performed by F. Schussler and A. Asghar for samples 15, 16, 17, 18, 19 and 20.

4) Analysis results from Inspectorate Griffith Ltd for samples 21, 22, 23, 24, 25 and 26. & their list of estimated errors.

5) Analysis results from the Forschungszentrum Karlsruhe for samples 11 and 12 & their list of estimated errors.

F A C S I M I L E:

BRITANNIA REFINED METALS LIMITED

Botany Road, Northfleet,
Gravesend, Kent DA11 9BG

Telephone: 01474 538200
Fax: 01474 538203
Telex: 965207 BRIT G

TOTAL NO OF PAGES:

TO: MR REVOL
(CERNE GENEVA)
00-41-22-7677555

FROM: DON LEACH
(BRM LTD ENGLAND)

DATE:

Dear Mr Revol

The actual assay results for mouldings:-

5G30	:	2.9p.p.m.
5G34	:	3.5p.p.m.

The names and addresses of International Independent Analysts are:-

Inspectorate Griffith Ltd UK : 2 PERRY ROAD
WITHAM
ESSEX
CM8 3TU

TEL: (01376) 515081

inspectorate Griffith Ltd Suisse : P.O BOX 227
PLACE CHAUDERON 4
1000 LAUSANNE 9

TEL: 41-41-201111

A H Knight UK : Eccleston Grange
Prescot Road
St Helens
Merseyside
WA10 3BQ

TEL: (01744) 733757

Regards

Don Leach

DON LEACH
CHIEF CHEMIST

BRITANNIA REFINED METALS LTD, NORTHFLEET, KENT.
CERTIFICATE OF WEIGHT & ANALYSIS

Customer

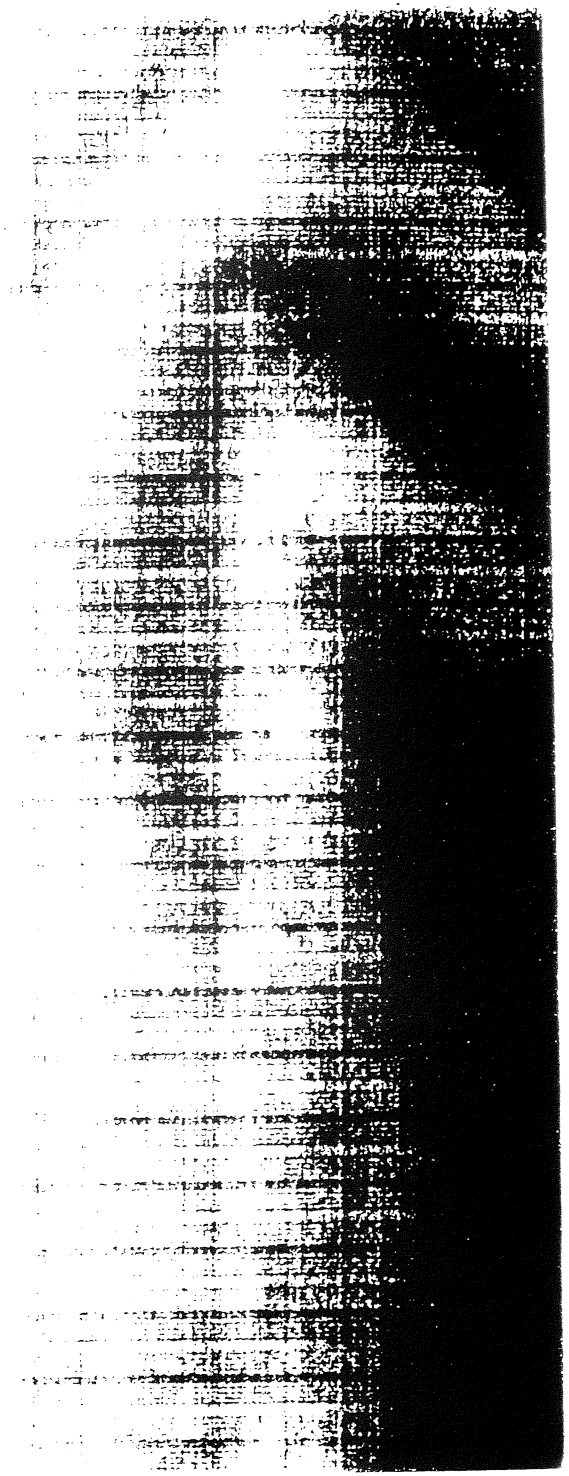
Date 10/01/96
Contract

Product Refined Lead - 99.99pct Purity
Lot No. 5630

Element Percentage	Element	PPM	Element	PPM	Element	PPM
	Ag	3.0	S <	1.0		
	As <	1.0	Sb <	1.0		
	Bi	14.0	Sn <	1.0		
	Ca <	10.0	Te <	5.0		
	Cd <	1.0	Zn <	1.0		
	Co <	10.0				
	Cr <	10.0				
	Cu <	1.0				
	Fe <	1.0				
	Mn <	3.0				
*	Ni <	3.0	*			

* Lead by difference

Chief Chemist - Don Leach



BRITANNIA REFINED METALS LTD, NORTHFLEET, KENT.
CERTIFICATE OF WEIGHT & ANALYSIS

Customer

Date 10/01/96

Contract

Product Refined Lead - 99.99pct Purity

Lot No. 5634

Element Percentage	Element		PPM	Element		PPM	Element	PPM
	Ag		4.0	S	<	1.0		
	As	<	1.0	Sb	<	1.0		
	Bi		14.0	Sn	<	1.0		
	Ca	<	10.0	Te	<	5.0		
	Cd	<	1.0	Zn	<	1.0		
	Co	<	10.0					
	Cr	<	10.0					
	Cu	<	1.0					
	Fe	<	1.0					
	Mn	<	5.0					
	Ni	<	5.0					

* Lead by difference

Chief Chemist - Don Leach

Certificate No. FM 21791

BRITANNIA REFINED METALS LTD., NORTHFLEET, KENT.

CERTIFICATE OF CONFORMITY & ANALYSIS

Customer
CERN

Date 24/01/96
Contract 4786
Heller R & B CONTRACTS

Product Refined Lead - 99.97pct
Conforms to N
Ref. CD 1000395 D-N CERN
No. SH28 Weight 5.0000 Nominal No of Pigs 180

Element	Percentage	Element	PPM	Element	PPM	Element	PPM
		Ag	7.0	S	1.0		
		As	< 1.0	Sb	< 1.0		
		Bi	18.0	Sn	< 1.0		
		Cd	< 10.0	Te	< 5.0		
		Co	< 1.0	Zn	< 1.0		
		Cr	< 10.0				
		Cu	< 1.0				
		Fe	< 1.0				
		Mn	< 5.0				
		Ni	< 5.0				

* Lead by difference Total Chemical - Our Lead

Original Samples

SH 28

5,000ngs

@♥2

BRITANNIA REFINED METALS LTD, NORTHFLEET, KENT.

CERTIFICATE OF WEIGHT & ANALYSIS

Customer

Date 28/02/96

Contract

Product Refined Lead - 99.99pct Purity

Lot No. 5J28

Element	Percentage	Element	PPM	Element	PPM	Element	PPM
		Ag	3.0	S	1.0		
		As	1.0	Sb	1.0		
		Bi	11.0	Sn	1.0		
		Ca	10.0	Te	5.0		
		Cd	1.0	Zn	1.0		
		Co	10.0				
		Cr	10.0				
		Cu	1.0				
		Fe	1.0				
		Mn	5.0				
		Ni	5.0				

* Lead by difference

Chief Chemist - Don Leach

Table 1. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 7
CE&A No. 61751 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00041	Y	<	0.00011
Be	<	0.00076	Zr	<	0.00036
B	<	0.00044	Nb	<	0.00022
C	<	0.29	Mo	<	0.0028
N	<	0.17	Ru	<	0.0011
O	<	4.7	Rh	<	0.0048
F	<	0.0034	Pd	<	0.0022
Na	<	0.0079	Ag		2.9
Mg		0.0029	Cd		0.041
Al	<	0.00024	In	<	0.0016
Si	<	0.00061	Sn	<	0.0038
P	<	0.00091	Sb		1.1
S		0.0036	Te		0.30
Cl	<	0.015	I	<	0.00096
K	<	0.0027	Cs	<	0.00082
Ca		0.010	Ba	<	0.00055
Sc	<	8.20E-05	La	<	0.00010
Ti		0.044	Ce	<	0.0011
V	<	0.00013	Nd	<	0.00045
Cr		0.012	Hf	<	0.00039
Mn	<	0.00041	Ta	<	0.040
Fe	<	0.0079	W	<	0.00098
Co	<	0.00037	Re	<	0.00061
Ni		0.011	Os	<	0.00081
Cu		0.015	Ir	<	0.00060
Zn	<	0.0025	Pt	<	0.0012
Ge	<	0.0039	Au	<	0.0028
Ga	<	0.0023	Hg	<	0.023
As	<	0.0012	Tl		5.0
Br	<	0.0077	Pb		100 %
Se	<	0.0082	Bi	<	29
Rb	<	0.0014	Th	<	0.0019
Sr	<	0.00014	U	<	0.00011

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 4. GDMS Analysis Results of Pb Sample
CERN Sample No. 8
CE&A No. 61751 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00016	Y	<	4.30E-05
Be	<	0.00029	Zr	<	0.00016
B	<	0.00019	Nb	<	8.50E-05
C	<	0.59	Mo	<	0.00069
N	<	0.11	Ru	<	0.0014
O	<	1.4	Rh	<	0.0021
F	<	0.0012	Pd	<	0.0012
Na	<	0.0019	Ag		2.7
Mg		0.020	Cd		0.051
Al		0.11	In	<	0.00064
Si		0.027	Sn	<	0.0013
P	<	0.00035	Sb		0.79
S	<	0.0017	I	<	0.00034
Cl	<	0.0055	Te		0.30
K	<	0.0047	Cs	<	0.00032
Ca	<	0.0063	Ba	<	0.00028
Sc	<	7.60E-05	La	<	5.60E-05
Ti	<	0.00060	Ce	<	5.00E-05
V	<	7.00E-05	Nd	<	0.00018
Cr	<	0.00034	Hf	<	0.00015
Mn	<	0.00019	Ta	<	0.070
Fe	<	0.00032	W	<	0.0011
Co	<	0.00015	Re	<	0.00026
Ni		0.0090	Os	<	0.00031
Cu	<	0.0015	Ir	<	0.00021
Zn	<	0.00083	Pt	<	0.00048
Ge	<	0.0016	Au	<	0.0024
Ga	<	0.00071	Hg	<	0.018
As	<	0.0040	Tl		5.5
Br	<	0.0048	Pb		100 %
Se	<	0.018	Bi	<	38
Rb	<	0.0050	Th	<	0.00022
Sr	<	5.30E-05	U	<	0.00021

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 3. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 9
CE&A No. 61751 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00013	Y	<	0.00021
Be	<	0.00024	Zr	<	0.0018
B	<	0.00015	Nb		0.013
C	<	1.7	Mo	<	0.00055
N	<	0.59	Ru	<	0.0010
O	<	3.6	Rh	<	0.0015
F	<	0.0031	Pd		0.0017
Na		0.041	Ag		3.0
Mg	<	0.00082	Cd		0.083
Al		0.020	In	<	0.00052
Si	<	0.00051	Sn		0.039
P	<	0.00029	Sb		0.85
S	<	0.0080	I	<	0.00033
Cl	<	0.036	Te		0.32
K	<	0.0097	Cs		0.0013
Ca		0.018	Ba	<	0.00022
Sc	<	2.80E-05	La	<	7.30E-05
Ti	<	0.00044	Ce	<	4.10E-05
V	<	0.00011	Nd	<	0.00035
Cr	<	0.0016	Hf	<	0.00012
Mn	<	0.00060	Ta	<	16
Fe	<	0.0043	W	<	0.0050
Co	<	0.00019	Re	<	0.00020
Ni		0.012	Os	<	0.00025
Cu		0.14	Ir	<	0.00017
Zn	<	0.0019	Pt		0.0056
Ge	<	0.0011	Au	<	0.0076
Ga	<	0.00095	Hg	<	0.022
As	<	0.0013	Tl		4.1
Se	<	0.0096	Pb		100 %
Br	<	0.0036	Bi	<	25
Rb	<	0.00035	Th	<	0.0012
Sr	<	4.20E-05	U	<	0.00035

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 2. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 10
CE&A No. 61751 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li		0.037	Y	<	0.00014
Be	<	0.00095	Zr	<	0.00051
B	<	0.00063	Nb	<	0.0012
C	<	0.67	Mo	<	0.0022
N	<	0.22	Ru	<	0.0017
O	<	5.4	Rh	<	0.0039
F	<	0.0027	Pd	<	0.0028
Na		0.046	Ag		2.9
Mg	<	0.00077	Cd		0.082
Al		0.66	In	<	0.0021
Si	<	0.0094	Sn		0.016
P	<	0.0012	Sb		0.91
S		0.0054	I	<	0.0011
Cl	<	0.019	Te		0.37
K	<	0.0042	Cs	<	0.0010
Ca	<	0.0051	Ba	<	0.00089
Sc	<	0.00017	La	<	0.00018
Ti	<	0.0058	Ce	<	0.00016
V	<	0.00023	Nd	<	0.00059
Cr	<	0.017	Hf	<	0.00049
Mn	<	0.00061	Ta	<	6.3
Fe	<	0.0068	W	<	0.0049
Co	<	0.00047	Re	<	0.00086
Ni		0.016	Os	<	0.0010
Cu		0.15	Ir	<	0.00069
Zn	<	0.0043	Pt	<	0.0016
Ge	<	0.0052	Au	<	0.013
Ga	<	0.0052	Hg	<	0.023
As	<	0.0014	Tl		4.7
Se	<	0.016	Pb		100 %
Br	<	0.012	Bi	<	30
Rb	<	0.0028	Th	<	0.00014
Sr	<	0.00017	U	<	0.00014

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 2. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 13
CE&A No. 61765 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00019	Y	<	5.20E-05
Be	<	0.00035	Zr	<	0.00019
B	<	0.00023	Nb	<	0.00010
C	<	1.1	Mo	<	0.0014
N	<	0.26	Ru	<	0.00053
O	<	2.4	Rh	<	0.0017
F	<	0.00061	Pd	<	0.00064
Na		0.055	Ag		2.5
Mg	<	0.00035	Cd		0.21
Al		0.0031	In	<	0.0013
Si	<	0.00076	Sn		0.026
P	<	0.00043	Sb		0.97
S		0.0061	I	<	0.00041
Cl	<	0.0010	Te		0.37
K	<	0.0018	Cs	<	0.00038
Ca	<	0.0018	Ba	<	0.00033
Sc	<	5.70E-05	La	<	6.70E-05
Ti	<	8.80E-05	Ce	<	6.10E-05
V	<	8.40E-05	Nd	<	0.00022
Cr	<	0.00041	Hf	<	0.00018
Mn		0.0015	Ta	<	0.036
Fe	<	0.00017	W	<	0.00079
Co	<	0.00017	Re	<	0.00032
Ni		0.013	Os	<	0.00038
Cu		0.12	Ir	<	0.00025
Zn	<	0.0010	Pt	<	0.00058
Ge	<	0.0019	Au	<	0.0014
Ga	<	0.00085	Hg	<	0.014
As		0.0039	Tl		4.5
Br	<	0.0038	Pb		100 %
Se	<	0.0085	Bi	<	28
Rb	<	0.0080	Th	<	0.00067
Sr	<	6.30E-05	U	<	0.00023

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 1. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 14
CE&A No. 61766 PO No.
January 21, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00025	Y	<	0.0010
Be	<	0.00046	Zr	<	0.00025
B	<	0.00068	Nb	<	0.00013
C	<	0.29	Mo	<	0.00096
N	<	0.050	Ru	<	0.0016
O	<	6.1	Rh	<	0.0041
F	<	0.0022	Pd	<	0.0047
Na		0.0040	Ag		2.4
Mg	<	0.00058	Cd		0.042
Al		0.0095	In	<	0.0010
Si	<	0.00080	Sn		0.032
P	<	0.00054	Sb		0.72
S	<	0.0042	Te		0.23
Cl	<	0.023	I	<	0.00053
K	<	0.0021	Cs	<	0.00050
Ca	<	0.0021	Ba	<	0.0023
Sc	<	5.00E-05	La	<	8.80E-05
Ti	<	0.0012	Ce	<	7.90E-05
V		0.00092	Nd	<	0.00029
Cr	<	0.00052	Hf	<	0.00024
Mn	<	0.0025	Ta	<	1.8
Fe	<	0.012	W	<	0.0071
Co	<	0.00037	Re	<	0.00042
Ni		0.010	Os	<	0.00049
Cu		0.016	Ir	<	0.00033
Zn	<	0.0019	Pt	<	0.00076
Ge	<	0.0025	Au	<	0.0054
Ga	<	0.0011	Hg	<	0.038
As	<	0.0065	Tl		4.5
Br	<	0.0051	Pb		100 %
Se	<	0.021	Bi	<	24
Rb	<	0.00098	Th	<	0.0013
Sr	<	8.30E-05	U	<	7.50E-05

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 1. GDMS analysis of 1 Pb sample
CERN Sample ID # 29 02/07/96
CEA No. 62145 P.O.No.
Analysed by Meg Amano

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	5.10E-05	Zr	<	0.00010
Be	<	9.30E-05	Nb	<	2.70E-05
B	<	0.00011	Mo		0.0075
C	<	0.75	Ru	<	0.0012
N	<	2.9	Rh	<	0.0029
O	<	4.2	Pd		0.0018
F	<	0.0016	Ag		3.2
Na	<	0.00074	Cd		0.056
Mg	<	0.00015	In	<	0.00020
Al		0.0089	Sn		0.013
Si	<	0.0034	Sb		0.012
P	<	0.00011	I	<	0.00021
S		0.0006	Te		0.019
Cl	<	0.016	Cs	<	0.00020
K	<	0.00092	Ba	<	8.80E-05
Ca		0.0067	La	<	7.10E-06
Sc		0.00028	Ce	<	6.40E-06
Ti		0.00018	Pr	<	3.60E-05
V	<	4.50E-05	Nd	<	0.00023
Cr	<	0.00081	Hf	<	9.60E-05
Mn	<	0.00023	Ta	<	0.090
Fe		0.046	W	<	0.00041
Co	<	9.30E-05	Re	<	0.00017
Ni		0.0068	Os	<	0.00065
Cu	<	0.0006	Ir	<	0.00016
Zn	<	0.00053	Pt	<	0.00020
Ga	<	0.00032	Au	<	0.0017
Ge	<	0.00034	Hg	<	0.083
As	<	0.00014	Tl	<	0.085
Se	<	0.0017	Pb		100 %
Br	<	0.0034	Bi	<	20
Rb	<	0.00034	Th		0.00037
Sr	<	1.70E-05	U	<	1.70E-05
Y	<	1.40E-05			

Notes: C,N,P,F,Cl - Common source / instrument background
Ta - Sample holder and source material
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 2. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 30
CE&A No. 62722 PO No.
March 07, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00046	Y	<	0.00012
Be	<	0.00084	Zr	<	0.00045
B	<	0.00056	Nb	<	0.00024
C	<	2.5	Mo	<	0.0020
N	<	0.60	Ru	<	0.0014
O	<	3.8	Rh	<	0.0038
F	<	0.0032	Pd	<	0.0041
Na		0.019	Ag		4.1
Mg	<	0.00068	Cd		0.18
Al	<	0.0048	In	<	0.0018
Si	<	0.0023	Sn	<	0.0041
P	<	0.0016	Sb		0.12
S	<	0.0020	I	<	0.00097
Cl	<	0.0091	Te		0.15
K	<	0.0094	Cs	<	0.00091
Ca		0.0053	Ba	<	0.00079
Sc	<	9.10E-05	La	<	0.00016
Ti	<	0.00023	Ce	<	0.00014
V	<	0.00020	Nd	<	0.00052
Cr	<	0.00097	Hf	<	0.00043
Mn	<	0.00054	Ta	<	0.40
Fe		0.0039	W	<	0.0013
Co	<	0.00042	Re	<	0.00072
Ni		0.024	Os	<	0.00090
Cu	<	0.0050	Ir	<	0.00061
Zn	<	0.0024	Pt	<	0.0014
Ge	<	0.0046	Au	<	0.0061
Ga	<	0.0020	Hg	<	0.056
As	<	0.0013	Tl		5.2
Se	<	0.010	Pb		100 %
Br	<	0.0060	Bi	<	27
Rb	<	0.0015	Th	<	0.00014
Sr	<	0.00015	U	<	0.00015

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Table 1. GDMS Analysis Results of 1 Pb Sample
CERN Sample No. 31
CE&A No. 62722 PO No.
March 07, 1996 Chris Lazik

Element		Concentration (ppm except as noted)	Element		Concentration (ppm except as noted)
Li	<	0.00039	Y	<	0.00011
Be	<	0.00073	Zr	<	0.00039
B	<	0.00048	Nb	<	0.00021
C	<	0.81	Mo	<	0.0014
N	<	0.18	Ru	<	0.0020
O	<	3.2	Rh	<	0.0046
F	<	0.0036	Pd	<	0.0032
Na	<	0.0017	Ag		4.7
Mg	<	0.00065	Cd		0.31
Al		0.026	In	<	0.0017
Si		0.029	Sn	<	0.0032
P	<	0.00098	Sb		0.083
S	<	0.0035	I	<	0.00084
Cl	<	0.0091	Te		0.16
K	<	0.0057	Cs	<	0.00064
Ca	<	0.0073	Ba	<	0.00055
Sc	<	8.70E-05	La	<	0.00011
Ti	<	0.00020	Ce	<	0.00010
V	<	0.00019	Nd	<	0.00037
Cr		0.017	Hf	<	0.00031
Mn	<	0.00052	Ta	<	0.58
Fe		0.0090	W	<	0.00091
Co	<	0.00029	Re	<	0.0020
Ni		0.025	Os	<	0.00063
Cu		0.0093	Ir	<	0.00043
Zn		0.0015	Pt	<	0.00097
Ge	<	0.0024	Au	<	0.0074
Ga	<	0.0014	Hg	<	0.051
As	<	0.0018	Tl		5.2
Br	<	0.011	Pb		100 %
Se	<	0.018	Bi	<	19
Rb	<	0.0011	Th	<	0.00095
Sr	<	0.00011	U	<	6.90E-05

Notes: C,N,O,F,Cl - Common source/instrument background
Rh - Pb2+ background interference
Bi - PbH+ interference

Analysis of Pb-samples thr. γ-activation

Element detected	Mass (gm) / gm of Pb, of	Sample No. 15	16	17	18	19	20
^{109}Ag [250d]	Ag	4.40×10^{-6} (±9%)	5.62×10^{-6} (±9%)	5.40×10^{-6} (±9%)	11.82×10^{-6} (±10%)	4.44×10^{-6} (±8%)	4.72×10^{-6} (±7%)
^{121}Sb [2.7d]	Sb	2.90×10^{-7} (± 5%)	8.96×10^{-8} (±12%)	2.12×10^{-7} (±7%)	5.88×10^{-7} (±5%)	1.86×10^{-7} ±6%	2.74×10^{-7} (±5%)
^{197}Au [2.7d, 2.3d]	Au	2.24×10^{-10} (±73%)	5.36×10^{-10} (±60%)	4.1×10^{-10} (±63%)	4.95×10^{-10} (±79%)	7.33×10^{-10} ±23%	4.40×10^{-10} (±38%)
^{114}Cd [46.8d]	Cd	Upper limit (2σ) for all the Pb-samples together ⇒ 1.89×10^{-7}					
^{152}Sm [46.7h]	Sm	Averaged over all the Pb-samples = 6.0×10^{-9}					

FS 28261

INSPECTORATE

NAMAS
TESTING
No. 1364

Inspectorate Griffith Ltd
2 Perry Road, Witham, Essex, CM8 3TU, England
Tel: +44 1376 515081 Telex: 995281 DCG UKG Fax: +44 1376 520819

CERTIFICATE OF PARTY ANALYSIS DATE: 28. 2.96

OUR REF. : PA - 9345 - CERN. 1
CLIENT : CERN
CLIENT ADDRESS : CERN CEDEX, SWITZERLAND
CLIENT REF. : LOTS 21-26
COMMODITY : LEAD SAMPLES

THIS IS TO CERTIFY THAT WE HAVE ANALYSED THE SAMPLES OF THE ABOVE CONSIGNMENT AND REPORT THE FOLLOWING TO BE THE RESULT:-

LOT REF	WEIGHT	ANALYSIS		
21		THALLIUM	7	PPM
		BISMUTH	9	PPM
		SILVER	5	PPM
22		THALLIUM	8	PPM
		BISMUTH	9	PPM
		SILVER	4	PPM
23		THALLIUM	8	PPM
		BISMUTH	10	PPM
		SILVER	5	PPM
24		THALLIUM	6	PPM
		BISMUTH	9	PPM
		SILVER	5	PPM
25		THALLIUM	7	PPM
		BISMUTH	10	PPM
		SILVER	4	PPM
26		THALLIUM	6	PPM
		BISMUTH	10	PPM
		SILVER	4	PPM

ANALYSIS RELATES TO SAMPLE AS RECEIVED

SAMPLES SEALED : NO SEALS

METHODS USED : I32

INSPECTORATE GRIFFITH LTD. WITHAM, ESSEX, ENGLAND

J.P.YENERALSKI

AUTHORISED SIGNATORY

INSPECTORATE

Inspectorate Griffith Ltd
2 Perry Road, Witham, Essex, CM8 3TU, England
Tel: +44 1376 515081 Telex: 995281 DCG UKG Fax: +44 1376 520819

20th March, 1996

FAX NO:0041227677555: PA.CERN

To : CERN - Jean-Pierre Revol

From : Inspectorate UK - Paul Alston

No. of Pages : One

Our Ref. 9345

Your Ref. P.O CA 1090696

Lots. 21-26

Ref our tlcon of yesterday herewith information as requested.

Silver	+/- 1	PPM
Thallium	+/- 1	PPM
Bismuth	+/- 1.5	PPM

Best Regards

Paul Alston

NJS/SKE

Forschungszentrum Karlsruhe
Bereich Stillegung nuklearer Anlagen

Analytical results

Sample: lead 11 and 12

Customer: European Organization for Nuclear Research (CERN)

Date: 02/02/1996

Element	Concentration [mg/kg]	
	lead 11	lead 12
Sb	≤ 2.5	3.5
Te	≤ 2.0	≤ 2.0
B	≤ 2.0	≤ 2.0
Tl	4.5	3.5
Ag	3.6	3.8
Bi	14.0	13.5

Forschungszentrum Karlsruhe
Bereich Stillegung nuklearer Anlagen

Hauptabteilung Dekontaminationsbetriebe

kommissarischer Leiter: W. Stegmaier

Telefax

An/To: Hr. Ruel
European Organization
for Nuclear Research

Telefax-Nr.: 41-22-7678345

Von/From: Fr. Dr. Rittmeyer

Telefax-Nr: 07247/82-4442
Telefon/Phone: 07247/82-2230

Datum/Date: 20.03.96

Anzahl der Seiten (inkl. Deckblatt)/ No. of pages (incl. transm. form): 2

Dear Mr. Ruel,

referring to your request, we submit you the standard deviations of the analytical results. The confidence level can not be given within the short time. For we normally deal with the standard deviation only, it will take us some time to calculate the confidence level. If you really need this values, please contact Mr. Bumiller.

Sincerely yours

Forschungszentrum Karlsruhe
Bereich Stillegung nuklearer Anlagen

Analytical results

Sample: lead 11 and 12

Customer: European Organization for Nuclear Research (CERN)

Date: 02/02/1996

Element	Concentration [mg/kg]	
	lead 11	lead 12
Sb	≤ 2.5 RSD = 63,6%	3.5 RSD = 73,4
Te	≤ 2.0 79,0%	≤ 2.0 106,0%
B	≤ 2.0 4,3%	≤ 2.0 10,3%
Tl	4.5 35%	3.5 23%
Ag	3.6 2,4%	3.8 2,7%
Bi	14.0 12,0	13.5 11,6

RSD - relative Standard Abweichung