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Effect of arsenic on assay for gold and silver

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Department: Mining and Nuclear Engineering

THESIS

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EFFECT OF ARSENIC

ON

ASSAY FOR GOLD AND SILVER.

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Rolla, Missouri,
June 1908.

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THESIS

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EFFECT OF ARSENIC ON AN ASSAY FOR GOLD AND SILVER

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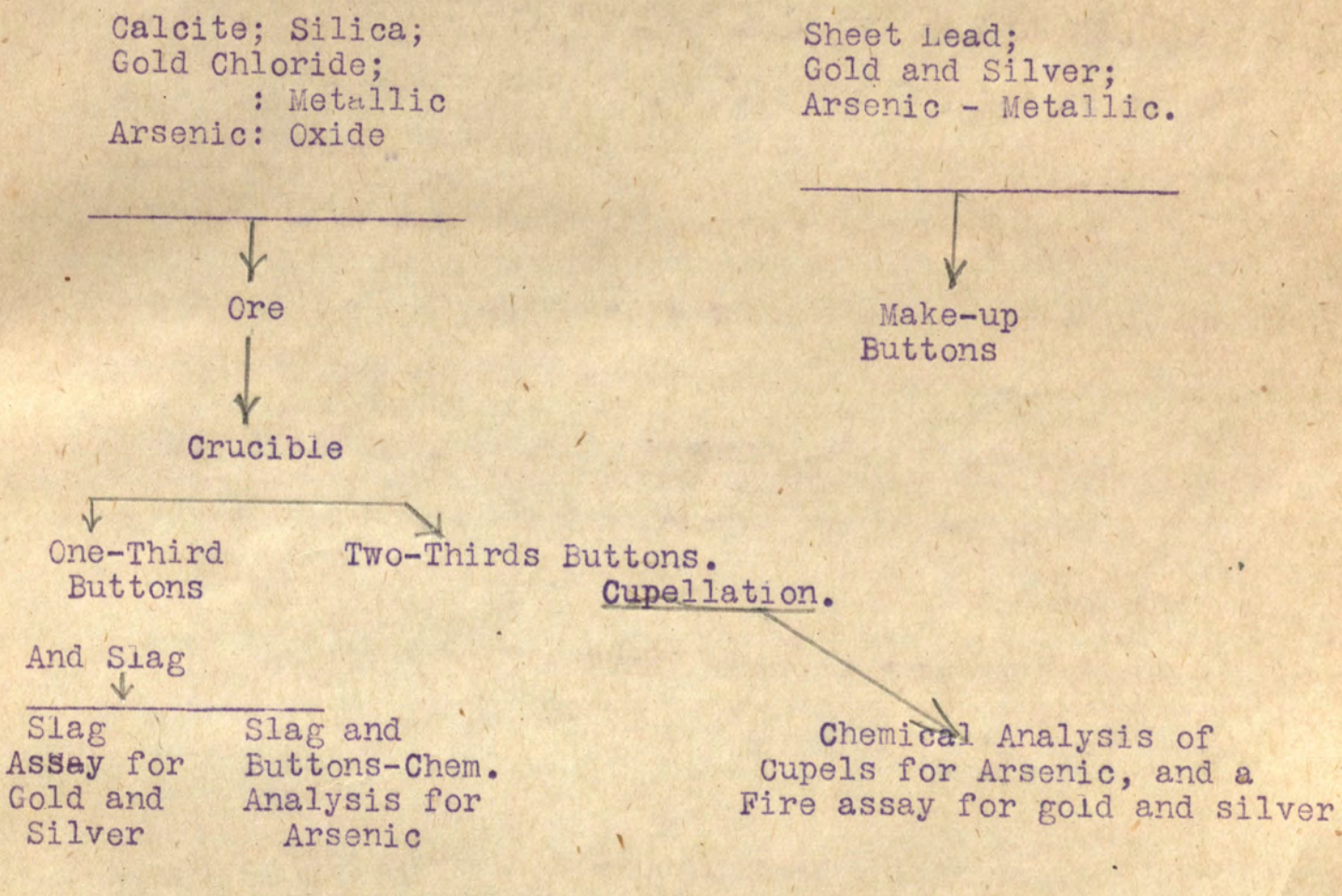
In presenting the within thesis, it is not claimed by the authors that the experiments have been, by any means, exhaustive of the subject. Neither is any claim made to original research work other than a series of simple experiments with a view to determining, if possible, some of the more important effects of Arsenic upon a fire assay for gold and silver as met with in the ordinary assay laboratory. To make a work complete and exhaustive on such a subject will require much more time and more complete apparatus than was available in the experiments covered by this thesis.

The experiments have been intended to cover both fusion by crucible, and cupellation, as well as the wet

assay of slags, cupels and lead buttons.

Briefly stated, the problem presented in this paper is to locate the sources of loss in a fire assay for gold and silver, due to the impurity, Arsenic, and its compounds, and to ascertain, if possible, the remedy for those losses. The solution of the problem is proposed by means of the scheme outlined in the following flow sheet:-

FLOW SHEET SHOWING WORK COMPREHENDED BY THIS PAPER.



Results of above tabulated and curves drawn showing comparisons.

The objective point in all the experiments carried out was the determination of the gold and silver loss due to any particular step in the process of assay, and also to locate as definitely as possible those sources, their cause, and, if possible, their remedy. The success of this paper depends, of course, upon the success of establishing those sources.

Throughout the experiments, the plan has been to select a series of experiments which conform as nearly as possible to the conditions met with in practice. Therefore, percentages, weights, amounts, etc., have been chosen accordingly. In the general run of assay work, variations will of course be met with, but for the purpose of the experiments herein comprehanded, only those have been selected as will cover ordinary cases met with in assay work.

The apparatus used comprised a soft coal, double muffle assay furnace of the Denver Fire Clay Co. type, and the single muffle Case gasoline furnace, although the latter was used almost exclusively, especially where temperature was to be measured.

The first division of the work was that of cupellation. The cupels were made of bone ash, the material being passed through a sixty-mesh sieve, after moistening with water. As little water as possible was used. The cupels were made several weeks in advance of the time of use in order that they might be well dried.

Pure sheet lead was used for the make-up buttons, twenty grams being the amount cupelled in every case. Pure test gold and silver were obtained by carefully parting bullion, and metallic Arsenic completed the list of working materials for cupelh tion.

The scheme outlined in the work was to have one variable in any one serires, all other amounts being constant.

In all those experiments where temperatures were recorded, the LeChatlier pyrometer was used. During the first experiments on cupellation, the Platinum-Rhodium junction was used. In the later experiments the Copper-Nickel junction was used.

Considerable trouble was experienced with the Copper-Nickel junction due to oxidation of the wires and brittleness of the Nickel wireZ A few experiments were tried with this junction and the results were so successful that they are deemed worthy of record.

To overcome the difficulty of oxidation, the junction was covered with a stiff mixture of bone ash and molases. This mixture was made up so as to be easily moulded with the hand, and a small lump was placed on the junction so as to cover it well. The junction was then held in the muffle until the cover was baked.

The trouble due to the brittleness of the Nickel wire was overcome by allowing the junction to remain in the muffle throughout the heat and taking care not to jar or disturb the connections.

With this arrangement, very good results were obtained with the Copper-Nickel Junction. Of course, readings above 1000° were not attempted.

For the crucible work, an ore was made up by using calcite crushed through 100 mesh and the purest Pacific sand obtainable, crushed through 80 mesh, in the proportions to form a bisilicate slag in a fusion. The value in gold was introduced by saturating the above mixture with chloride of gold in solution. While the ore was made up so as to assay a certain value, an actual assay was made in order to avoid any error, and all calculations were based on the actual assay.

Four divisions of the ore were then made, and to three of these additions were made of Arsenic, either as metallic Arsenic or as arsenious oxide, in the proportions to make three ores of different percentages of Arsenic. These three percentages were ten, twenty-five and forty-six, the latter being approximately the same as pure Arsenopyrite.

In making up the three ores with the different percentages of Arsenic, the gold content was changed with the addition or Arsenic or arsenious oxide, and this fact was taken into consideration when the losses were determined in cupellation.

Two series were assayed by crucible in order to test the difference in heat treatment, one series being given the ordinary run, with the temperature approximately the same throughout. The second series was first subjected to low temperature which was gradually raised, and ending with a high heat, No temperature readings were taken on the crucible work but the final heat on this series of crucibles was probably 1200 degrees C.

Three methods were made use of in the crucible assay in order to determine if possible the best method to use with arsenic ores. The three methods were, High Soda, - Low Litharge: High Litharge- Low soda, and the nails method. These three charges, which will be referred to as A. B. and C. respectively, were made up according to the following table:-

		Na_2CO_3	PbO	Argols	Borax	Nails
High Soda Low Litharge	A.	25	40	3	10	0
High Litharge Low Soda	B.	15	100	3	10	0
Nails	C.	25	25	0	10	4

As noted above, two series were run, each consisting of twenty-seven assays, three crucibles of each percentage, and the three percentages by the three methods.

The two series were duplicates and the numbers run from 1 to 54. Good buttons were obtained from methods A. and B., but as was expected in method C., a large amount of speiss was formed, even with the ten per cent ore, and while cupellation was attempted with these buttons from the nail assay, the results were altogether unsatisfactory, although a bead was obtained in some instances.

Of the buttons obtained from the crucible assay, two from each set of three were cupelled, and one bu ton was analyzed for arsenic, except in the case of those from the nails assay. In the la ter case, the assay was thought unnecessary as the greater part of the button was speiss, and an attempt to separate the button from the slag met with great difficulty.

The results of the cupellations and analyses of the above buttons are shown in subsequent tables.

An analysis was made of the cupels in the cupellation series to determine the percentage of Arsenic present, and an assay was also made to determine the gold and silver loss through this source.

Analysis was also made of the slags of the crucible series, as well as an assay of the same for gold and results for the wet analysis for Arsenic are shown in the following table:-

TABLE SHOWING RESULTS OF ANALYSIS OF CUPELS FOR ARSENIC

Cupellation series.

No.	% As. in Original charge	Gold or Silver Used	% Loss due to Cupel-lation.	Amt. assay-ed	% AS. in Cupel	Total Weight of Absorb. Cupel	% of total As. Used
A-1	.0015	100.00	1.56	2.007	- - - -	40.88	---
A-3	.0025	100.22	1.74	lost	----	37.85	---
A-5	.0050	100.42	2.28	1.210	lost	43.07	- -
A-7	.0250	100.28	2.71	1.013	.034	43.64	59.3
A-12	.1000	100.10	2.93	1.009	.0776	41.06	31.8
A-16	Blank	100.28	?	- -	---	42.55	- -
B-2	.0015	20.53	1.02	2.050	lost	39.76	--
B-4	.0025	20.15	1.24	2.040	.0338	41.03	--
B-6	.0050	20.19	1.73	1.047	.0475	42.95	--
B-10	.0500	20.56	1.94	1.030	.0930	42.10	78.3
B-12	.1000	20.58	1.94	1.022	.0730	40.70	29.7
B-15	Blank	20.74	0.69	---	.--	33.37	--

TABLE SHOWING RESULTS OF ANALYSIS OF SLAGS AND BUTTONS

FOR ARSENIC - - - CRUCIBLE SERIES.

SLAGS.

No.	% As in Ore	Wt. of Slag	Amt. assayed	% Arsenic in slag	Arsenic in slag	Arsenic in charge	% of original arsenic in chg.
1	10	32.0	2.0	.0239	.7648	1.5	50.9
4	10	62.4	2.0	. - -	--	1.5	--
7	10	38.5	2.0	---	---	1.5	--
10	25	30.4	2.0	.0230	.6992	3.75	18.64
13	25	66.6	2.0	.0257	1.7116	3.75	45.5
16	25	40.7	2.0	--	--	3.75	--
19	46	38.8	2.0	.0737	2.107	6.9	30.5
22	46	74.7	2.0	..0531	3.970	6.9	57.7
26	46	36.4	2.0	.0263	0.967	6.9	14.0

BUTTONS

3	10	27.0	5.010	trace	---	---	---
6	10	27.5	5.005	"	--	--	--
9	10	24.5	No assay	--	--	--	--
12	25	45.0	5.006	.012	.54	--	14.5
15	25	32.5	5.002	.008	.26		6.9
18	25	30.6	No Assay	---	---		---
20	46	30.0	5.007	.0332	.996		14.4
24	46	51.5	5003	.0376	1.91		27.8
25	46	20.0	No Assay	---	---		---

As will be noted from the above tables, the s assays having charges of high soda and high litharge give a slag very high in arsenic, the high soda carrying greater amounts than the litharge, if there is any difference. Correspondingly it is noted that the analysis of the buttons for these two methods show but a small amount of arsenic. No analysis is shown of the speiss and button from the nail assay, but it can be stated with confidence that an assay of these buttons would show a much greater percentage of arsenic present.

TABLE I. TEMPERATURE LOSS OF SILVER.

CUPELLATION.

Amt. Ag.	Ag. Bead	% of Loss	Temperature.
100.28	98.10	2.17	780
100.04	97.62	2.41	830
100.26	97.77	2.47	830
100.31	97.49	2.81	960
100.41	97.30	3.11	1010
50.39	49.00	2.75	950
5076	49.00	3.46	1060
50.05	----	Froze	550
50.19	----	Froze	550
50.19	----	Froze	530
50.04	----	Froze	610

The cupellations shown by Table I were made for the purpose of determining the loss of silver due to temperature alone, no arsenic being present. Variable amounts of silver were also used in order to ascertain if there was an appreciable difference in loss due to this factor. It is apparent that there is no difference in the losses.

Two pyrometers were used on the above cupellations, one a Platinum-Rhodium which proved unreliable, and the other a Copper-Nickel. The latter

gave very good satisfaction on the cupellations in Table I and those of Table II and III.

It may be mentioned in passing, however, that the Platinum-Rhodium pyrometer failed in this case because of fact that the two junctions were too close together.

It was found impossible to maintain a constant temperature in the muffle on more than two rows of cupels at a time. The large Case Gasoline Furnace was used, and a difference of 300° was found between the back of the muffle and the point of lowest temperature in the front where cupelling could be done. There was also a difference of 50 ° to 100° between the sides and the middle of the muffle, the middle being the hotter.

The following diagram shows the curve from which the temperature losses shown in Table I were derived. For Table II the losses were determined by cupellations made alongside of those containing Arsenic. This was considered to be more accurate as in this manner, the temperature would be practically the same in both cases.

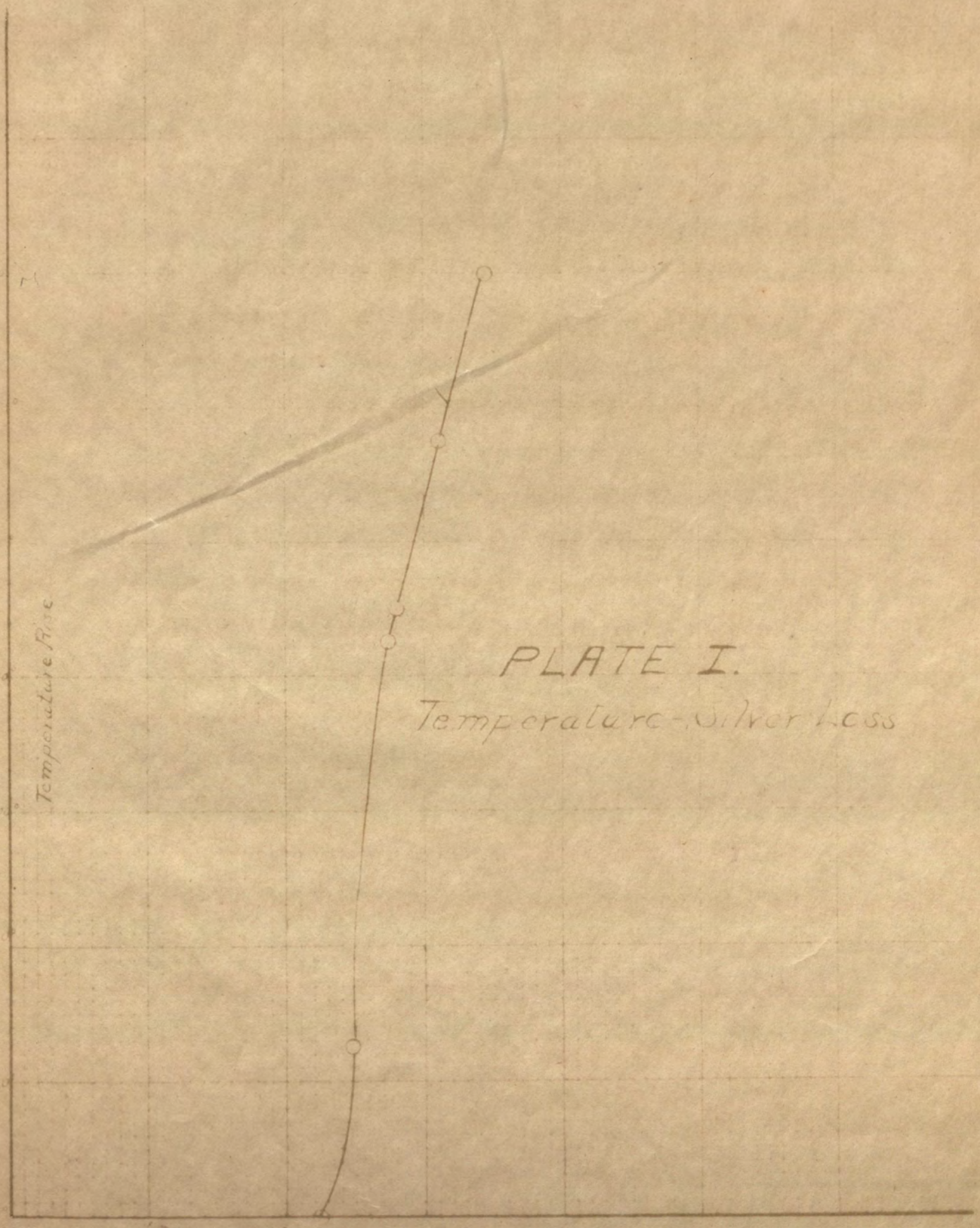


PLATE I.

Temperature - Silver Loss

TABLE II.

SHOWING LOSSES IN CUPELLATION DUE TO ARSENIC.

No.	Ag. Used	As. Used	% of As to Pb	Temp-Ag. Bead	Total Loss %	Temp Loss %	Arsenic Loss %
1	49.92	5.00	.025	875	49.40	1.04	2.25	-1.51
2	50.12	10.00	.0500	915	49.47	1.33	2.60	-1.23
3	50.oo	10.00	..0500	915	48.82	2.36	2.60	- .36
4	50.65	30.00	.1500	900	14.06	--	---	~~---~~
5	50.48	30.00	.1500	875	49.63	1.67	2.55	-. .88
6	50.47	50.00	.2500	915	Froze	-	-	-
7	50.53	50.00	.2500	915	"	-	-	-
8	80.34	80?00	.4000	875	80.18	1.99	2.25	- .56
9	100.40	100.00	.5000	915	98.14	2.25	2.60	- .35
10	100.00	100.00	.5000	915	98.02	1.98	2.60	- .62
11	50.10	400.00	2.00	900	48.52	3.18	2.60	+ .42
12	50.34	400.00	2.00	900	48.58	3.49	2.60	.89
13	50.46	600.00	3.00	900	49.00	2.80	2.60	.20
14	50.36	600.00	3.00	900	49.00	2.70	2.60	.10
15	50.28	800.00	4.00	900	48.50	3.54	2.60	.94
16	50.18	800.00	4.00	900	48.46	3.42	2.60	.82
17	50.40	2000.00	10.00	1050	48.34	4.08	3.35	.73
18	50.00	2000.00	10.00	890	48.36	3.28	3.60	.68
19	50.36	4000.00	20.00	890	46.70	7.26	2.60	4.66

The Platinum-Rhodium pyrometer was used on cupellations in Table II and the temperatures are somewhat uncertain. The temperature loss was obtained from Curve I, no blanks being run with this series. Plate II, A and B, are drawn from this table. There is little uniformity in the losses and consequently the curves are not as satisfactory as they would otherwise be. Nevertheless, the curves, as drawn serve as a check on those made from Table II. As will be seen by comparison, the scale used in constructing the curves on Plate II, A and B, is much smaller , and the range of Arsenic greater than that used on Plate I. If plotted from the total silver losses, and the actual figures given in Table II, the curve derived would not be as regular as the curveshown on Plate II. Plate II, B, seems to indicate that Arsenic up to 1 % has a favorable effect upon cupellation, the loss of silver being lower than the loss due to temperature alone. However, this is no doubt due to the fact that the bead contained Arsenic thus giving the impression that there was a reduction in the losses due to Arsenic. This apparent gain in percentage is obscured in those cases where the greater amounts of silver are cupelled so that a small amount of Arsenic present ~~are~~ 15 not noticeable.

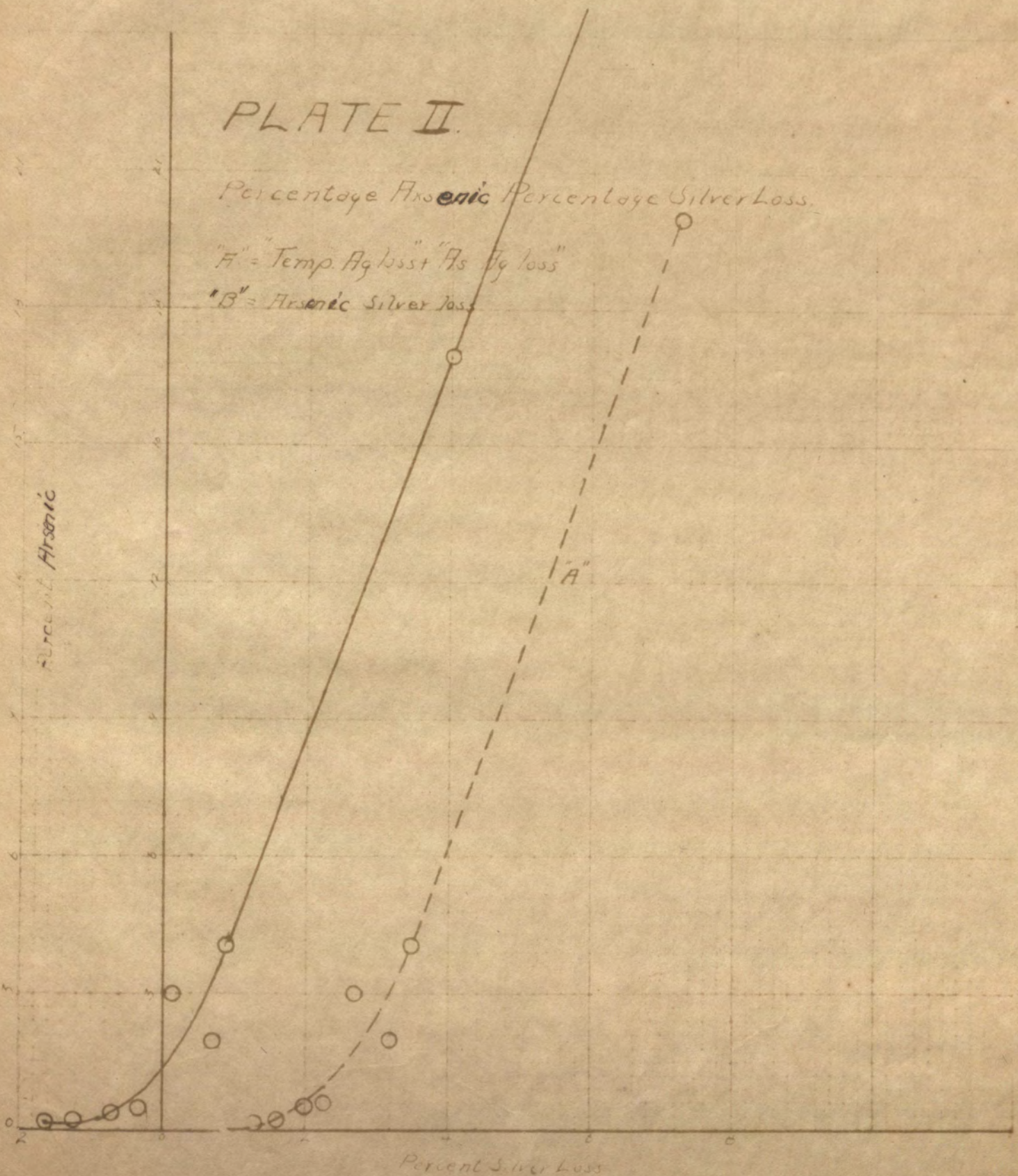


PLATE II.
Percentage Arsenic Percentage Silver Loss.
"A" = Temp. Ag loss "As Ag loss"
"B" = Arsenic Silver loss
Percent Arsenic
"A"
Percent Silver Loss

In cupelling, it was observed that the cupels containing Arsenic opened up very quickly after closing the door, those having high percentages of Arsenic requiring less than one minute in which to start driving. The Arsenic began to oxidize immediately, as attested by the blue flame over the cupel, and copious white fumes coming from the muffle. Cupels having as much as 2.5 % Arsenic (percentage in cupellation is based on the amount of lead used) immediately after opening began to deposit a ring or crust of the oxide around the edge of the cupel.

Apparently the presence of Arsenic had no effect on the time of cupellation. The "Blanks" carrying silver only, finished in practically the same time as those having different amounts of Arsenic. However, the cupels bearing Arsenic opened up much more readi;y than the blanks, owing to the oxidation of the Arsenic. It was frequently the case that the Arsenic cupels would be opened and driving long before the "Blanks" which required opening by burning wood over them. At the same time, it is to be noted that the Arsenic cupels required more than the ordinary temperature to keep them driving after the bulk of the Arsenic had been oxidized. After the greater part of the Arsenic had been eliminated from the driving

cupel, cupellation proceeded as in the ordinary case. The appearance of the bath when Arsenic is present is characteristic, as it has a dead, clouded surface, giving the impression that the cupel is about to freeze.

During cupellation, the temperature was run as near freezing as possible, in fact, many cupels froze. From this it was learned that a higher temperature was needed to prevent the Arsenic cupels from freezing than the "Blanks".

A few experiments were made with cupels containing twenty to forty per cent Arsenic. These boiled and spit profusely while opening and the oxidation of Arsenic took place with brilliant display, The loss in cupels having 20 % Arsenic was 7.26 %.

TABLE III.

SHOWING SILVER LOSSES IN CUPELLATION - DUE TO ARSENIC.

No.	Ag.	As.	As. %	Temp.	Ag. Bead	Total Loss %	Temp. Loss	As. loss
1	100.00	30	.15	830	98.44	1.56	2.43	-.87
2	100.28	30	.15	830	98.26	2.01	2.41	-.40
3	100.22	50	.25	830	98.47	1.74	2.43	-.69
4	100.26	50	.25	830	98.77	1.48	2.43	-.95
5	100.24	100	.50	830	98.13	2.28	2.43	-.13
6	100.32	100	.50	830	98.28	2.03	2.43	-.40
7	100.00	500	2.50	830	97.56	2.71	2.43	+.28
8	100.38	500	2.5	830	97.70	2.67	2.43	+.24
9	100.18	1000	5.00	830	97.47	2.70	2.43	+.26
10	100.14	1000	5.00	780	97.47	2.56	2.17	+.39
11	100.20	2000	10.00	780	97.76	2.43	2.17	+.26
12	100.10	2000	10.00	780	97.16	2.93	2.17	+.76

PLATE III.

Percentage Arsenic, Percentage Silver Loss.

A = Temp. Silver Loss + Arsenic Silver Loss

B = Arsenic Silver Loss.

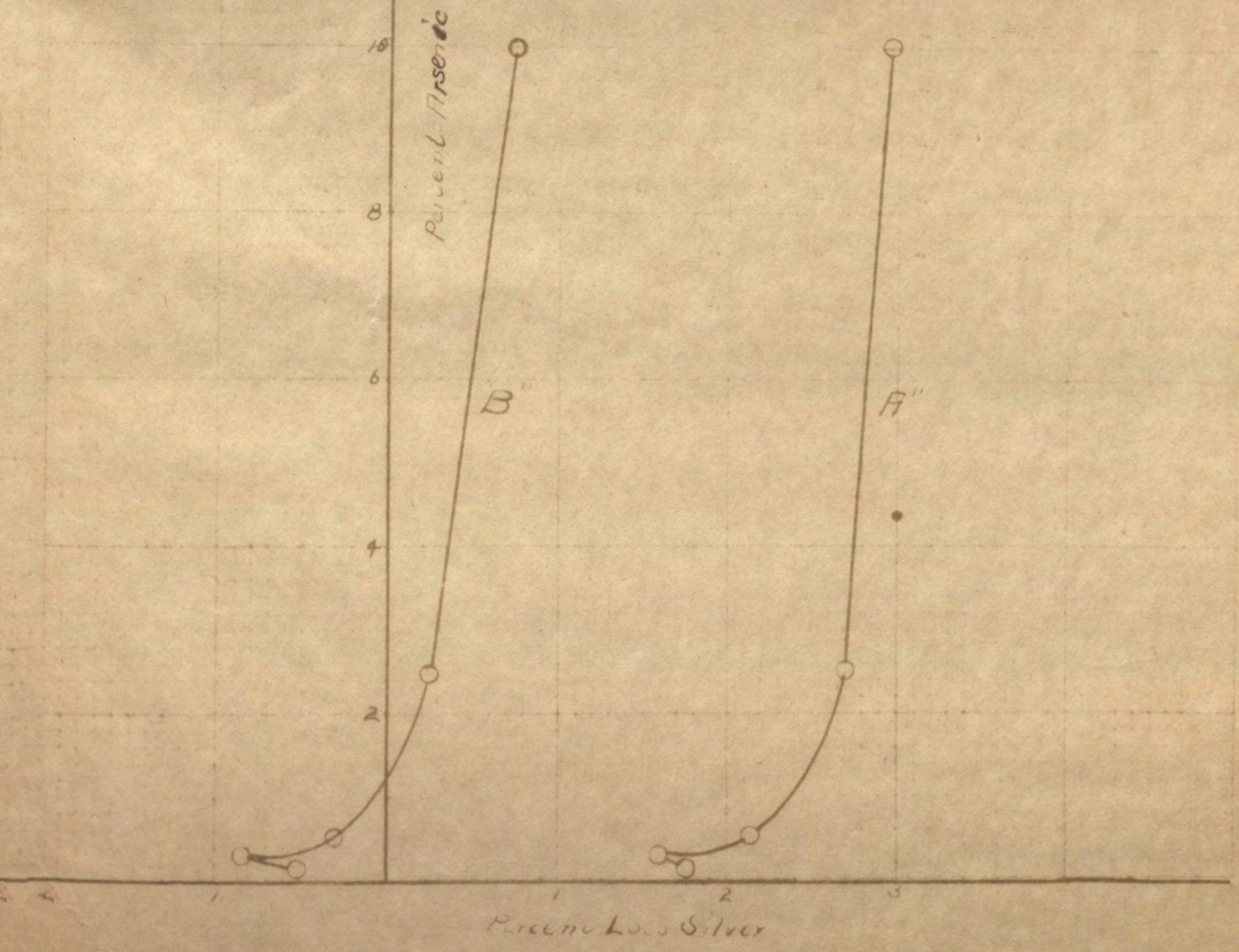


TABLE IV.

SHOWING GOLD LOSSES IN CUPELLATION DUE TO ARSENIC.

No.	Gold	As.	% As	Temp.	Gold Bead	Total Loss %	Temp loss	As. loss	Au&Ag. from cupel	Au. in Cupel	% of loss in Cupel	As in Cupel
1	20.28	30	.15	780	19.88	1.97	.89	1.08				
2	20.53	30	.15	780	20.22	1.02	.89	.13				
3	20.32	50	.25	780	20.03	1.42	.89	.53				
4	20.15	50	.25	780	19.86	1.24	.89	.35	.39	.08	27.6	
5	20.11	100	5.00	780	19.71	1.98	.89	1.09				
6	20.19	100	5.00	780	19.84	1.73	.98	.84	.46	.12	34.2	
7	20.15	500	2.50	780	19.94	.59	.67	.22				
8	20.22	500	2.50	780	19.96	1.25	.67	.58				
9	20.48	1000	5.00	7800	20.06	2.05	.67	1.38				
10	20.56	1000	5.00	780	20.16	1.94	.54	1.40	.39	.09	18.0	78.3
12	20.58	2000	10.00	780	20.18	1.94	.54	1.40	.43	.09	22.5	29.7
13	20.04			780	19.86	.89						

The Copper Nickel Junction was used.

"Blanks" Nos. 13, 14, 15 and 16 were run with the Arsenic cupels. Four cupellations only were made at a time and a constant temperature was secured throughout the run, this being the most successful run in the whole number of experiments. Good feathers were obtained on all cupels.

Owing to the fact that different parts of the furnace gave different temperatures at the same instant,

readings were taken and from these readings corrections were made for temperature losses, as shown by the column in Table IV. marked "Temperatur e Loss".

For the first six cupels, there is a temperatur e loss of .89 milligrams; for Nos. 7, 8 and 9, the loss is .67 Milligrams and for 10, 11 and 12, the loss is .54 milligrams, these different losses corresponding to the position which these cupels occupied in the muffle. Curve A, Plate IV. made from this Table shows an increasing loss up to .5% Arsenic, and thereafter, the loss is approximately the same for any amount up to 10 %. This curve indicates loss due to both temperature and Arsenic.

Curve B. Plate IV. shows the loss due to Arsenic alone. From this diagram it is noted that after passing .5% the loss increases gradually up to about 3% from which point the loss is approximately constant for values of Arsenic up to 10 %.

There is a lack of uniformity in loss in this series and those values were selected which were representative and which would produce the most unifrom curve.

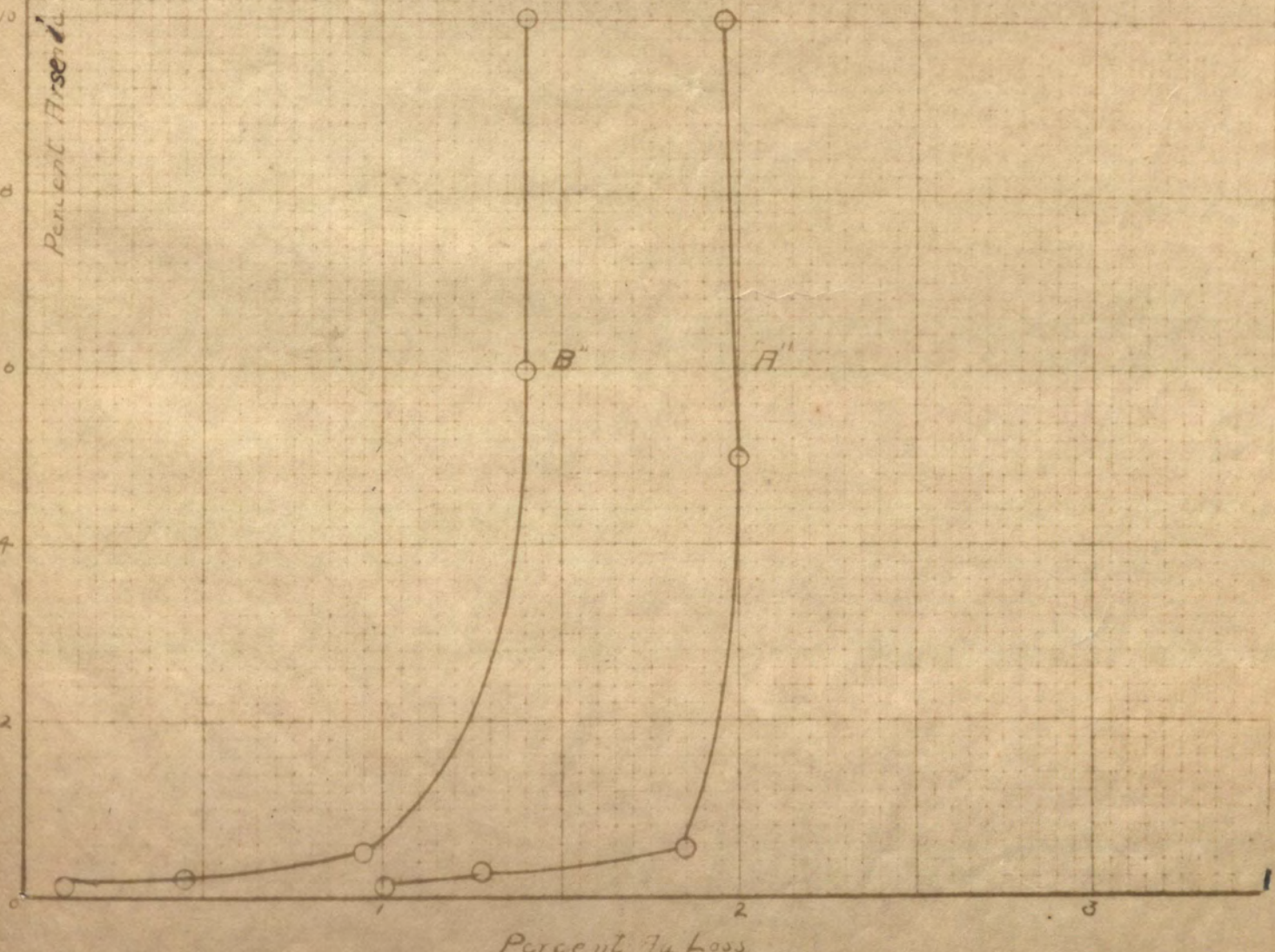
The loss due to the presence of 2.5 % Arsenic is .87% of the loss due to temperature, or the percentage of loss is increased by the presence of 2.5% Arsenic in the button. When cupelling is carried on

PLATE 4.

Percentage Gold Loss - Percentage Arsenic

A' = Temp Gold Loss + Arsenic Gold Loss.

B'' = Arsnec Gold Loss



very carefully, at a low temperature the loss is appreciable, but under ordinary conditions of assaying, it is probable that with Arsenic present in the button in amounts less than 2.5%, the loss due to the Arsenic will not be material. No experiments were in cupellation at variable temperatures, but, judging from the experiments on cupelling silver alone, a small increase in temperature is the cause of a greater loss than that due to Arsenic in amounts less than 2.5%

It was found that with from 3 to 10% Arsenic, there was no change in the gold loss. The greatest increase in loss in cupellation occurs with Arsenic present in amounts from .15 to .5 % so that in order to entirely eliminate Arsenic losses, the impurity must be gotten rid of as far as possible during the crucible process. The problem thus presented is to provide a flux that will permit the volatilization and secure the removal of the Arsenic through the slag with as little loss as possible of the gold and silver values through these two avenues.

Table V is prepared from data taken on a crucible assay of the ore perpared as referred to in this paper. The object in view was to determine the best charge and ascertain the percentage of Arsenic volatilized, slagged and going into the button.

TABLE V.

SHOWING TWO SERIES OF CRUCIBLE ASSAYS, CHARGES FOR SAME, THE PERCENTAGE OF ARSENIC IN THE ORE, RESULTS OF ASSAYS? LOSSES, SOURCES OF LOSS, ETC.

No.	Na.	PbO	Borax	Argols	Nails	% As in Ore	Gold Au. Bead	Gold Au.	Gold Ag.	Value of Ore	Loss %	Au & Ag in Slag	Au in Slag
1	25	40	10	3	0	10	- -	---	---	6.67	--	.30	Trace
2	25	40	10	3	0	10	6.84	6.72	.12	6.67			
3	25	40	10	3	0	10				6.67			
4	15	100	10	3	0	10	6.96	6.64	.32	6.67	.45	.32	Trace
5	15	100	10	3	0	10	6.93	6.61	.32	6.67	.90		
7	25	25	10	0	4	10				6.67		.30	Trace
8	25	25	10	0	4	10	5.92	5.85	.07	6.67	12.30		
9	25	25	10	0	4	10				6.67		.26	Trace
11	25	40	10	3	0	25	5.66	5.53	.13	5.66	2.3		
13	15	100	10	3	0	25	5.74	5.44	.30	5.66	3.90	.30	Trace
14	15	100	10	3	0	25	5.78	5.43	.35	5.66	4.0		
17	25	25	10	0	4	25	6.02	5.29	.73	5.66	6.7		
19	25	40	10	3	0	46	3.44	3.19	.25	4.00	20.2		
21	25	40	10	3	0	46	3.53	3.23	.30	4.00	19.25		
22	15	100	10	3	0	46	3.56	3.20	.30	4.00	20.0		
23	15	100	10	3	0	46	3.54	3.12	.42	4.00	22.0		
							- - - - - - - -						
28	25	40	10	3	0	10	6.90	6.88	.02	6.67	---		
29	25	40	10	3	0	10	6.82	6.30	.52	6.67	5.5		
30	25	40	10	3	0	10	6.84	6.30	.54	6.67	5.5		

TABLE V (CONT'D)

33	15	100	10	3	0	10	7.76	---	---	6.67	----
34	25	25	10	0	4	10	7.27	5.85	1.43	6.67	12.3
36	25	25	10	0	4	10	6.32	5.94	.38	6.67	10.0
39	25	40	10	3	0	25	5.72	5.05	.67	5.66	10.8
40	15	100	10	3	0	25	6.62	5.10	1.52	5.66	10.0
46	25	40	10	3	0	46	7.37	6.7	.67	4.00	---
47	25	40	10	3	0	46	7.20	6.52	.68	4.00	---
48	25	40	10	3	0	46	4.00	3.30	.62	4.00	15.0
49	15	100	10	3	0	46	4.81	3.21	1.80	4.00	19.7
50	15	100	10	3	0	46	4.76	320	1.56	4.00	20.0
53	25	25	10	0	4	46	3.71	3.26	.45	4.00	18.2
54	25	25	10	0	4	46	3.60	3.11	.49	4.00	22.2
B-1	15	80	10	3	0	0	7.64	7.42	.22	7.42	--
B-2	15	80	10	3	0	0	7.61	7.39	.22	7.39	--

No Arsenic ores were available, and as referred to above, one was made up as follows:

Pure Calcite, 100 parts by weight

" White sand 60 " " "

This mixture was moistened with a solution of gold chloride in the proportion of one gram of the chloride to one kilogram of ore. From this, three lots were made up containing ten, twenty-five and forty-six per cent of Arsenic.

; No. 1 to 9 - 10 % Ore

Series No. 1-: No. 10 to 18 -25 % "

: No. 19 to 27 -46 % "

Beginning with No. 28, and running up to 54 the series is repeated. As may be observed from Table V the first three in each set of nine were run with charges of high soda, the second three with high litharge, and the third with Nails. The first series of twenty-seven was run at an average crucible heat in the Case muffle furnace. The second series, Nos. 28 to 54 was run at a low temperatur e for the first 25 minutes and at a high temperature for the lst twenty minutes. From this combinati on it was expected that a charge could be found giving the desired results.

The blank ore containing no Arsenic was run giving 7.41 Mg. gold. This was reduced by 10 % in the case of the 10% Arsenic, by 25 in the case of the 25 % Arsenic, and 46 in the case of the 46 % Ore, giving 6.67 Mg. , 5.66 Mg and 4.00 Mg. respectively as the gold value of the pure ore without Arsenic.

The cupellation on all work was done at about 800° C giving a constant temperature, and thus error was eliminated from this source. Thus the beads obtainéd from the crucible work in the Arsenic ores, by difference from their calculated weight, gives the loss due to Arsenic direct without correction for losses during the assay.

Had sufficient time been available for running all slags for gold, more definite statements could have been made as to accurate results of the assay.

On all the slags run for gold, only a trace was found, showing that in this respect, charges A and and B are satisfactory. However, owing to lack of time no slags were run on the second series of twenty-seven crucibles so that an absolutely definite comparison can not be made.

Comparing No. 8, nails, on first series, run at ordinary temperatures, and containing 10 % Arsenic with No. 34, 10 % Arsenic, run at low temperature 25 Mins. and high temperature 20 Mins. there is found a loss on both of 12.5 of gold. This is entirely too large and the nails assay can be eliminated as being unsuitable. On all the nails assay, a large speiss was formed which in cupelling remained on top of the supel as a black iron scoriae sometimes entirely covering the top of the cupel. This cupellation required a much higher heat and from 10 to 15 minutes more time to complete the operation than with cupels from either of the other charges. It was sometimes impossible to tell when the bead had blicked without disturbing it, and unless this crucible charge be accompanied by rescorification, it is impractical.

On the 46 per cent Arsenic ore, the gold losses on High Soda, High Litharge, and Nails, at different temperatures are about the same, namely, about 20 %. This is entirely too high, and an ore having this amount of Arsenic present must be well fluxed with soda or litharge, and the lead button rescorified one or more times before cupellation is attempted. In fact, on all ores carrying 10% or more Arsenic, rescorification is advised.

Further, no assays were made on the slags from the assays of the 46 % Ore, and no statements can be made as to the source of loss, but the analysis for Arsenic in the lead button indicates that there is comparatively little Arsenic present, so that there should be a very small loss in the cupel, not over 1.5 % at most. This low percentage of loss does not agree with the action of these buttons while cupelling. In this operation, the result was very similar to that of the high Arsenic cupellation of Table IV except that the action was not as violent. This result may be expected when it is considered that the Arsenic in Table IV was e metallic and very easily oxidized, while that of the cupels in Table V probably consists of an alloy of Arsenic and lead.

To reach any definite conclusions as to the assay of a 46 % Arsenic ore, from these figures, assays on the slags and cupels must be made and more definite analyses obtained on the Arsenic contained in the lead buttons.

Figures on the 10 % ore would indicate a greater loss by the variable temperature than by the constant temperature but the absence of sufficient data on this point precludes any definite conclusions. The assay of the slags from this ore showing a trace of gold indicates that the loss is probably due to volatilization.

On the 25 % Ore, the constant temperature has much the preference over the variable, as indicated by the table. In the assay of the slag, the trace of gold indicates that the loss of from 2.3 to 4 % from the original is due to volatilization.

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