INFLUENCE OF VOLUME OF SOLVENT.

(Solvent: 1% Citric Acid Solution.)

	Phosphoric acid (P_2O_5). Per cent.	Potash (K_2O). Per cent.	Lime (CaO). Per cent.
100 grams soil in 1000 cc. 7 days.....	0.02287	0.03818	0.5320
100 grams soil in 500 cc. 7 days.....	0.01999	0.03355	0.2718
100 grams soil in 1000 cc. 5 hours.....	0.01807	0.03958	0.5210
100 grams soil in 500 cc. 5 hours.....	0.01599	0.03089	0.2285

In this table are given the same data as in the preceding, but they are arranged to more readily show the influence of the volume of solvent. No detailed discussion of these data is necessary; a glance at the figures is sufficient to make apparent the only conclusion that can be reached, *viz.*, that reducing the volume of solvent used, materially decreases the percentages of phosphoric acid and potash obtained. In the case of lime, the smaller volume extracted but one-half that taken out by the larger volume. Clearly the influence of volume of solvent is decidedly greater than that of the period of extraction.

No doubt soils of a different character would not yield results that would fall exactly into line with those here recorded, that is, as to the effect of varying the period of extraction and the volume of the solvent on the amount of mineral matter dissolved, but the general trend would, we believe, be the same. It seems highly desirable that further data on this important question of available plant food should be obtained from widely different points and correlated with the field results. These analytical data should be, as far as is practicable, strictly comparable, and to this end it is evidently necessary that the details of the process as regards period of extraction and volume of solvent, should be carried out alike by all workers. There seems to be every reason for adherence, in these respects, to the time and volume as given by Dr. Dyer in his original account of the process.

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SOME OBSERVATIONS ON THE ASSAY OF TELLURIDE ORES.

BY GEORGE BORROWMAN.

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Much has been written concerning the assaying of telluride gold and silver ores, yet the literature affords striking contradictions as well as statements unsupported by experimental data. However, there seems to be agreement in the opinion that tellurium is the cause of serious irregularities. Mr. A. L. Davis, in *Tech. Quart., Vol. XII*, sums up the situation as follows: "As to the percentage of loss sustained in work, whether by scorification or crucible method, many experiments carried out upon the foregoing lines indicate to me that nothing definite can be

laid down in regard to it. Every ore, every slag, every scorification, every cupel, let alone the temperature at which the assay is carried on, has some effect upon the loss and these make too many unknown quantities to arrive at any conclusion."

It was the purpose of the writer in the work here recorded to ascertain a few facts concerning the effect of tellurium in the crucible assay for gold. The points investigated were: loss in the slag; loss in cupellation; the effect of variation in temperature of fusion.

The ore selected for the experiments was a high-grade telluride gathered from various parts of Colorado, rich in silver, gold and tellurium. With the sulphuric acid test it gave a very strong indication of the latter element and analysis showed the presence of 10.5 per cent. chiefly as hessite and sylvanite. The gangue was silicious, consisting of quartz, feldspar and a little calcite. The ore had a reducing power of about 1.5.

The material was ground very fine, first through 120 mesh sieve, then in agate till all passed through bolting-cloth. In all the work 1/10 A. T. was taken for each assay, the samples being weighed out on a quantitative balance instead of on the usual pulp scales. All fusions were made in a muffle at about 1200° excepting in Series No. 4; all the fluxes were passed through a 40-mesh sieve mixed with the ore till thoroughly homogeneous. In short, the greatest care was taken to eliminate all variations except the one studied.

Experiments were first conducted to learn the influence of tellurium in carrying gold into the slag. Mr. C. H. Fulton, in THIS JOURNAL, **20**, 586, records data to show that slag losses in telluride fusions are much greater than in ordinary gold ore crucible work. Messrs. Hillebrand and Allen, *Bulletin No.* **253**, *U. S. Geological Survey*, find losses insignificant, and commenting on the work of Mr. Fulton suggest that his losses might have been due to the use of iron nails in the fusions.

In the investigation of this point a series of assays was first made on the raw ore, using the following charge:

Ore 1/10 A. T.	
Litharge	90 g.
Silica	10 g.
Argols	2½g.
Sodium bicarbonate	30 g.
Salt cover.	

Another series was then made on ore from which the tellurium had been removed. In removing it use was made of the fact that nitric acid dissolves tellurium and silver in a telluride and leaves the gold in the residue. Each sample was boiled with nitric acid (1.27) till no further action was apparent; the residue was washed and dried and fluxed under the same conditions as maintained in the first series. Enough silver

was added to the de-tellurized series to replace what had been removed by the acid. The slags from each series were then carefully ground and assayed, using the following charge:

Slag
Litharge..... 30 g.
Argols..... 2 g.
Salt cover

The buttons from both the ores and slags were cupelled. The results are set down in the following tables:

SERIES NO. 1.

No.	Ore. Mg. gold found.	Ore. Oz. gold per ton.	Slag. Gold found.
1	16.14	161.4	None
2	16.18	161.8	"
3	16.18	161.8	"
4	16.23	162.3	"
Av.....	16.18	161.8	

SERIES NO. 2.

No.	Ore. Mg. gold found.	Ore. Oz. gold per ton.	Slag. Gold found.
1	16.10	161.00	Trace
2	16.16	161.60	None
3	16.20	162.0	Trace
4	16.11	161.10	None
Av.....	16.14	161.4	

From the above data it is obvious that the influence of tellurium in carrying gold into the slag is very slight, if there is any; the amount recovered was in no case weighable.

The effect of tellurium in cupellation was next investigated, and incidentally the functions of litharge in the fusion. On the assumption that the tellurium in a crucible charge is oxidized by the litharge and carried into the slag, a series of charges was made up varying this constitutent from 90 to 180 grams. Theoretically the amount of tellurium carried into the button as a lead alloy should be in inverse ratio to the amount of litharge in the fusion. A series of four samples was made in duplicate. The buttons of one series were dissolved in nitric acid and the tellurium determined by precipitating it in hydrochloric acid solution with sulphur dioxide. The other series was cupelled for gold. The two duplicates are considered as one series, *i. e.*, No. 3.

SERIES NO. 3.

No.	Grams. PbO in charge.	Mg. Te in button.	Mg. gold found.	Oz. gold per ton.
1	90	lost	16.10	161.00
2	120	287.5	16.24	162.24
3	150	298.9	16.18	161.80
4	180	176.8	16.15	161.50
Average.....			16.17	161.70

All of the beads of the above series were frosted, showing the presence of tellurium, notwithstanding the great excess of litharge in the fusion. It would then seem that litharge in reasonable amount is inadequate to slag off all the tellurium in this ore. The loss of gold, however, was inconsiderable, the average of the series varying but 0.01 mg. from the average of Series No. 1 in which the tellurium had been removed previous to fusion. These results are at variance with published statements regarding tellurium in cupellation. Messrs. T. J. Eager and W. W. Welch, however, found that no loss occurred in the presence of the element up to, 10 per cent. The amounts in the above experiment are many times that. A bead from an assay, duplicate of No. 1 in the above series which was also the same as those of Series No. 2, was tested quantitatively for tellurium and 6.9 mg. were found; so that it may be present even in the bead in considerable amount without there being more than a negligible loss of gold.

The work was concluded with some experiments to learn the effect of variation of temperature of fusion on gold recovered and the amount of tellurium carried into the button. Some assayers recommend an extremely high temperature. Mr. R. W. Lodge, however, in his "Notes on Assaying," states that he believes high temperatures break up some tellurium compounds in the slag with a consequent alloying of the element with the lead.

A series of four was run in duplicate consisting of charges made up exactly as those of Series No. 2. The temperature was varied between 800° and 1600°. As in the previous experiment the buttons from one set were cupelled for gold, the other dissolved in nitric acid and assayed for tellurium.

SERIES NO. 4.

No.	Temperature.	Wt. of buttons.	Gold found. Mg.	Gold per ton. Oz.	Tellurium found. Mg.
1	800° C.	30.5	16.10	161.00	258.2
2	1000° C.	32.5	16.16	161.60	150.0
3	1250° C.	32.8	16.20	162.00	195.6
4	1600° C.	32.8	16.16	161.60	215.9
	Average.....		16.16	161.60	

The irregularities in the amounts of tellurium could not be accounted for, yet it seems improbable that the amount varies directly with the temperature. As to the gold the yield is greatest at about 1200°, though the average of the series is but slightly below that of Series No. 1.

Summary.

The foregoing data seem to warrant the conclusion that tellurium as the cause of irregularities in crucible work has been overestimated. Slag losses are no greater than in ordinary gold ores; the element may be present in the lead button in relatively large amounts with no consider-

able percentage of loss. The presence of tellurium in the bead does not necessarily imply a loss of gold in the cupellation though, of course, a frosted bead would not be permissible when silver is to be determined. In high-grade tellurides when silver is to be estimated, the writer suggests a preliminary treatment with nitric acid, with subsequent precipitation of the silver as chloride which may be dried and added with the residue from the acid treatment to the fluxes in the crucible. Variation in temperature of fusion does not seem to be of great moment though the data above are most favorable to a temperature of about 1200°.

The average obtained from Series No. 1 is higher than that obtained in the others showing a loss due to tellurium in fusion and cupellation, yet the variation is small, the average of No. 1 being not more than 0.24 per cent. higher than the lowest average, that of Series No. 2. The members of the various series differ among themselves in some cases considerably, but perhaps not more than would be expected in any high-grade ore, owing to lack of homogeneity of sample. In the opinion of the writer, irregularities in high-grade tellurides are due more to this lack of homogeneity than to tellurium. It is conceivable that in some ores the ratio of gold to tellurium might be much less and hence the percentage of loss greater. In such cases a preliminary treatment with nitric acid to remove the tellurium would obviate the difficulty.

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THE DETERIORATION OF COAL.

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In coöperation with the State Geological Survey and the Engineering Experiment Station of The University of Illinois, certain facts have developed which bear directly upon the behavior of coal. They are of considerable moment and should be taken into account in any study of this material. The first pertains to a deterioration which cannot be ascribed to weathering processes, but rather to the simple fact of the release of the material from the conditions which have surrounded it in the seam. This has been recognized in a rather indefinite way from time to time, but without data to substantiate the fact.[1]

The following items are given in support of this theory of loss. In the summer of 1900 twenty-nine samples of coal were collected at the face of the vein, quartered in the usual manner, placed in galvanized iron cans with screw cap and tire-tape seal, exactly as described by the Coal Testing Plant of the United States Geological Survey.[2] They were

[1] THIS JOURNAL, **28**, 650 (1906).

[2] *Bulletin No.* **261**, *of the Coal Testing Plant, U. S. G. S.*