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

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

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

shipped directly to the laboratory, where they were transferred at once to one-quart jars of the "Lightning" or Putnam type, the coal being sufficient to practically fill the jars. This transfer was made with as much as possible of the original moisture retained in the coal. The "Lightning" jars were chosen because from extended experience with sodium peroxide, this jar was found to be the only container having a perfect seal. Twenty-one other samples were collected and sealed in the ordinary Mason jars.

After standing in the laboratory for about ten months, twenty-six of the "Lightning" jars, upon opening, showed a slight pressure of gas which ignited with a strong blue flame, burning from one-half to six inches in height above the top of the jar. Upon covering and retesting, these jars would reignite for two or three successive times. None of the samples sealed in the Mason jars would so ignite.

Two points are to be noted here, namely, that the coal content very nearly filled the jar and that the enclosure in the Putnam jar is practically that of a continuous glass seal, while the Mason jar is quite different as to the security with which the gasket is held and, in addition, has a large metallic surface exposed to the transmission of gases.

Another test pertains to the enclosing of the air-dried samples of the same coal in Putnam jars for more than eighteen months with the dry coal occupying about one-quarter of the jar. Upon opening, all of these jars showed a very positive evidence of the absorption of oxygen as indicated by the extinguishing of a lighted match. Analysis showed the presence of less than 1.5 per cent. oxygen and less than 2 per cent. of carbon dioxide.

TABLE NO. 1.—LOSS IN CALORIFIC VALUE DURING TRANSIT.

Test. No.	Locality.	Size of coal.	When sampled.	B.T.U. of ash, water and sulphur-free coal.	B.T.U. Lost.
1	Westville	1¼ inch screenings	same day as mined	14684	
	"	" "	7 days after mining	14627	57
2	Springfield	" "	same day as mined	14478	
	"	" "	4 days after mining	14351	127
3	Herrin	1¾ inch screenings	same day as mined	14658	
	"	" "	6 days after mining	14553	105
4	Westville	3 inch nut	same day as mined	14768	
	"	3 " "	7 days after mining	14586	182
5	Springfield	3 " "	same day as mined	14655	
	"	3 " "	4 days after mining	14461	194
6	Herrin	3 " "	same day as mined	14751	
	"	3 " "	6 days after mining	14682	69

Another series of results related to the calorimetric determination of freshly mined coal and similar determinations made upon the coal after shipment in the cars in the ordinary manner. Six cars of coal were sampled at the mine while in the process of loading and calorimetric determinations made on the samples so collected. After arrival at the University, the cars were sampled from the wagons as the cars were unloaded.

In the table above, the results are tabulated and attention is called to the fact that in each case there is a uniform drop in fuel values as between the freshly mined coal and that which had been subjected to transportation conditions.

Another series of results is given in Table No. 2, which is a comparison of values obtained at the St. Louis Coal Testing Plant of the United States Geological Survey, and samples from the same or near-by Illinois mines as determined in this laboratory. All conditions of operation were duplicated as nearly as possible, including the type of calorimeter, which was of the Mahler-Atwater design. Still, the results here, when reduced to the "ash, water and sulphur-free basis," were uniformly lower than those obtained at St. Louis. The only explanation seemed to lie in the fact that the samples here were held in laboratory storage longer than was the case with the St. Louis samples, our heat values being determined on the average after about 10 months of such storage. The extremes of difference lie between 1.6 per cent. and 3 per cent., but it is quite sufficient in amount to be a disturbing factor in basing conclusions on the behavior of coals of this type.

TABLE NO. 2.—COMPARISON OF U. S. G. S. WITH ILL. GEOL. SURV. VALUES.

U. S. G. S. No.	Ill. G. S. Lab. No.	Locality.	B.T.U. per lb. ash, water and sulphur-free coal.	Difference in B.T.U.	Per cent. of difference in B.T.U.
Ill. 1		O'Fallon	14567		
	95,96,97	" (a)	14214[1]	353	—2.4
Ill. 3		Marion	14561		
	330	" (a)	14335	226	—1.6
Ill. 9		Staunton	14615		
	91,92,93,94(a)	" (a)	13933[1]	682	—4.7
Ill. 10		West Frankfort	14647		
	364	" (b)	14332	315	—2.2
Ill. 14		E. of Springfield	14464		
	81,82	" (a)	14020[1]	444	—3.1
Ill. 15		Centralia	14587		
	167,168,169	" (b)	14257[1]	330	—2.3
Ill. 16		Herrin	14558		
	323,325	" (a)	14267[1]	291	—2.0
Ill. 18		La Salle	14722		
	393	" (b)	14440	282	—1.9

(*a*) Samples not from same mine, but from adjacent mines.
(*b*) Samples from the same mine.

In further testing this matter of age, fresh samples were collected by us for comparison with our own samples of 10 months' standing, and

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[1] Average of several samples from neighboring mines.

calorimetric determinations made as before. Table No. 3 gives the results of this comparison, which showed that these new values are uniformly higher upon the fresh samples than upon the old. The variations lie between 1.3 per cent. and 3.4 per cent.

TABLE NO. 3.—COMPARISON OF VALUES FOR FRESH AND OLD SAMPLES BY ILLINOIS GEOLOGICAL SURVEY.

Ill. G. S. Lab. No.	Locality.	B.T.U. per lb. ash, water and sulphur-free coal.	Difference in B.T.U.	Per cent. of difference in B.T.U.
421	DuQuoin, fresh	14386		
307,308,309	" old(*a*)	14009[1]	377	—2.6
460 and 1088	Herrin, fresh	14647		
323,325	" old(*a*)	14285[1]	362	—2.5
460	Clifford, fresh	14615		
325	" old(*b*)	14213	402	—2.7
462	Marion, fresh	14781		
330	" old(*b*)	14335	446	—3.0
540,740,741	Springfield, fresh	14468[1]		
81,82	" old(*a*)	14020[1]	448	—3.1
557	Westville, fresh	14550		
332	" old(*b*)	14054	496	—3.4
558	Hinrod, fresh	14564		
333	" old(*b*)	14087	477	—3.3
1111	Eldorado, fresh	14857		
317	" old(*b*)	14597	278	—1.9
358	" old(*a*)	14662	195	—1.3
1114	Harrisburg, fresh	14931		
315	" old(*b*)	14622	309	—2.1
1110	3 miles E. of Eldorado, fresh	15131		
359	" " old(*b*)	14939	192	—1.3
1119	Maryville, fresh	14450		
418	" old(*b*)	14134	316	—2.2
1121	Norris City, fresh	14658		
316	" old(*b*)	14322	336	—2.3

(*a*) Samples not from same mine, but from adjacent mines.
(*b*) Samples from the same mine.

A third comparison was also made as between freshly collected and determined samples here and those made by the St. Louis Fuel Testing Plant; the results are given in Table No. 4. Here the differences are equally distributed between those of a plus and minus character. To determine, if possible, what effect the time element might have on these variations, the two extremes were selected and by correspondence, with the chemist of the Geological Survey at St. Louis, it was found that

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[1] Average of several samples from neighboring mines.

Illinois No. 7, with an extreme variation of +1.7 per cent., showed its calorimetric value to have been determined upon the sample twenty days after collection at the face of the vein. Our own sample, which, as nearly as we could determine, was analyzed ten days after collection, showed a higher value as indicated. The other extreme, Illinois No. 9, with a drop in our results of —2.4 per cent., was found by the records of the Fuel Testing Plant, to have been but six days old. The exact age of our own sample is not definitely known, but it was not less than from ten to fifteen days old. The other variations are small and might be accounted for on other grounds than that of age of the sample.

TABLE NO. 4.—COMPARISON OF NEW U. S. G. S. SAMPLES WITN NEW SAMPLES OF THE ILL. STATE GEOL. SURV.

U. S. G. S. No.	Ill. S. G. S. Lab. No.	Locality.	B.T.U. per lb. ash, water and sulphur-free coal.	Difference in B.T.U.	Per cent. of difference in B.T.U.
Ill 3		Marion	14561		
	462	" (*b*)	14781	+220	+1.5
Ill. 4		Troy	14439		
	1118	" (*b*)	14168	—271	—1.9
Ill. 7		Collinsville	14373		
	723,724,725	" (*a*)	14621[1]	+248	+1.7
Ill. 9		Staunton	14615		
	735,736,737	" (*a*)	14260[1]	—355	—2.4
Ill. 14		E. of Springfield	14464		
	540,740,741	" (*a*)	14468[1]	+ 4	+0.03
Ill. 16		Herrin	14558		
	459,460,1088	" (*a*)	14647[1]	+ 89	+0.6
Ill. 19		Zeigler	14601		
	419,420	" (*b*)	14463	—138	—0.9

(*a*) Samples not from same mine, but from adjacent mines.
(*b*) Samples from the same mine.

In Table No. 5, the average differences as between old and fresh samples by the two laboratories is assembled, and does not need explanation.

TABLE NO. 5.—AVERAGES OF TABLES NOS. 2, 3 AND 4.

17 Illinois Geological Survey samples compared with 8 United States Geological Survey samples Illinois Geological Survey samples analyzed 6 months to 1 year after collection; United States Geological Survey analyses made soon after collection.	Average 365 B. T. U. or 2.5 per cent. lower.
17 Illinois Geological Survey samples analyzed 6 months to 1 year after collection, compared with 16 similar samples analyzed within two weeks after collection.	Average 356 B. T. U. or 2.4 per cent. lower.
16 Illinois Geological Survey samples analyzed within 2 weeks after collection, compared with 7 United States Geological Survey samples analyzed soon after collection.	Average 29 B. T. U. or 0.2 per cent. lower,

[1] Average of several samples from neighboring mines,

It seems evident from these results that the drop in values occurs within the first two or three weeks after the coal is broken out of the seam, but the rapidity and extent as to any given length of time, is not easily determined and can be inferred only from such data as are found in the tables. Presumably, it is due in the main part to exudation of combustible gases consequent upon the releasing of the coal from conditions of pressure and sealing in the vein.

A second series of facts relates to a secondary process which undoubtedly begins after the breaking out of the coal from the seam, namely, the oxidation of compounds in the coal. This is, perhaps, more properly designated under the name of weathering. Advantage has been taken of the fact that in a number of mines, old pillars have been standing, and samples have been procured from these, after properly cleaning the surface, and comparing the results with samples obtained at the freshly worked faces of the mine. In Table No. 6 the results are given for such samples from pillars twenty-two and twenty-seven years old. The pillar coal shows a loss in comparison with the fresh coal of approximately 2.5 per cent. In the same table are given also the results for samples from another mine which have been subjected to various conditions, including submerging for one year, and the analysis of coal which has been exposed to the weather for one year. The difference is inappreciable as between the outer surface of the pile and that of the interior.

TABLE NO. 6.

Test No.	Material.	B.T.U. per lb. referred to ash, water and sulphur-free.	Drop in heat units compared with initial values.
	Belleville, Illinois		
1	Fresh face sample	14785	
2	Pillar coal, 22 years exposure	14372	413
	Equality, Illinois		
3	Fresh face sample	15188	
4	Pillar coal, 27 years exposure	14754	434
	Westville, Illinois		
5	1¼ inch screenings 1 week from mine	14627	
6	3 inch nut, 1 week from mine	14586	
7	1¾ inch screenings, submerged 1 week after mining, for 1 year	14588	
8	From surface of 15 ton pile, 1 year exposure	14241	347
9	From throughout 15 ton pile, 1 year exposure	14264	324
10	Four weeks after mining	14410	178

Six other weathering tests have been conducted on smaller samples by Mr. N. D. Hamilton. Each sample was subjected to different conditions, namely, submerged; exposed to the weather; exposed to a dry atmosphere, at a rather elevated temperature; and a duplicate of the latter with frequent drenchings with water. A charting of the results, which is more or less characteristic of all the tests, is given in Fig. 1,

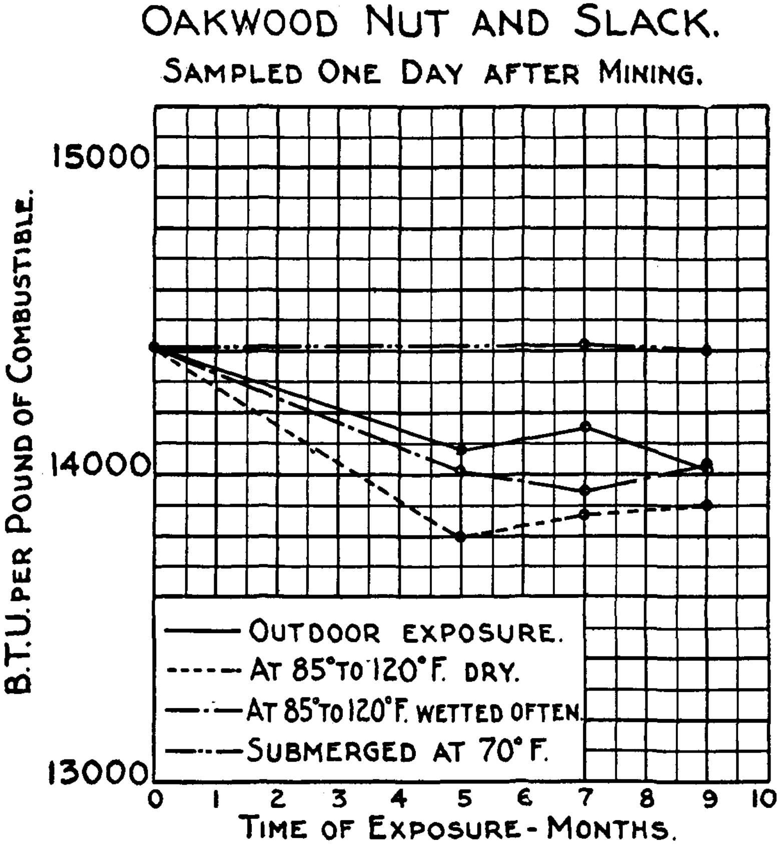

FIG. 1.

which is sufficiently clear to be self-explanatory. While the results of this series of tests are not conclusive, they point to the fact that submerged coal is without loss so far as oxidation processes are concerned; that exposure to a dry atmosphere is quite as conducive to the loss of heat values as exposure to weather and that, in general, these calorific losses are largely overestimated and probably, on an average, do not exceed 3 or 4 per cent. in amount.

A continuation of these tests upon carload lots is now being made under conditions of outdoor exposure, housing in bins, and in the submerged conditions, with some accompanying experiments intended to develop, if possible, the conditions which result in spontaneous combustion.

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