SOUTH DAKOTA

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E. P. Rothrock, State Geologist

REPORT OF INVESTIGATIONS

No. 12

S L A C K I N G P R O P E R T I E S

O F

S O U T H D A K O T A C O A L S

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SLACKING PROPERTIES OF SOUTH DAKOTA COALS

INTRODUCTION

Slacking, as the term is used in coal studies, refers to the breakdown of coal through drying and through alternate wetting and drying. Since slacking is due chiefly to expansion and contraction, or to swelling and shrinkage on addition and subtraction of water, it is largely mechanical. It differs from slaking in which a mixing with water occurs and a chemical combination takes place. The result of slacking is reduction in size of the pieces of coal as mined with but little chemical alteration.

Coal, when mined wet, loses water to the atmosphere by evaporation. Since loss by evaporation is greatest at the surface the amount of water at and near the surface of a coal lump is less than that within the lump as drying proceeds. Shrinkage of the lump due to volume loss occurs and is greatest at and near the surface of the lump. Wetting following partial or complete air drying reverses the process and differential expansion occurs because of migration of water from the surface to the interior of the lump. Thus drying after mining may produce slacking and subsequent alternate wetting and drying contributes greatly to a more or less complete breakdown of some coals.

The amount of water contained in the coal as mined, or bed moisture would seem to be important. Studies by the United States Bureau of Mines[1] indicate a general relation between slacking tendencies and bed moisture but suggest a lack of correlation between minor variations in bed moisture and the tendency of a coal to slack. Relative brittleness or toughness of coal is probably concerned with amount and rate of slacking. The rapidity of drying or soaking with water are doubtless of importance also.

1. Fieldner, A. C., Selvig, W. A., and Frederic, W. H., U. S. Bureau of Mines, R. I. 3055, 1930.

The tendency of low rank coals to slack is of great importance in handling and shipping subsequent to mining. South Dakota coals are all of low rank and contain a high percentage of bed moisture and therefore slack appreciably.

Acknowledgments

The tests of the slacking property of South Dakota coals were made possible by the cooperation of owners, operators and other residents of the coal area who gladly furnished samples for testing. The electric ovens used were kindly loaned by the South Dakota State Chemical Laboratory and by the Department of Chemistry of the University of South Dakota. The College of Engineering, University of South Dakota, loaned other apparatus.

Sampling

Samples of South Dakota coals were collected for slacking tests in October, 1931. At this time of year most of the mines in the state are open and in operation. Wherever possible, face samples were collected from the mines, but inclement weather at the time of collection necessitated the taking of several freshly mined mine run samples.

In collecting of face samples a clean, freshly uncovered face was selected. A cut was made from topto bottom of the bed and pieces were taken from all parts of the coal bed. Pieces less than 1 1/4 inches in diameter were avoided as were those greater than approximately 1 3/4 inches. Each sample was placed in two or more glass topped mason fruit jars and fine coal was sifted in about the pieces. The sample was then sealed and labelled. In most mines only one sample was collected but in one several were taken.

Mine run samples were taken from freshly mined coal, care being taken to pick the sample from various parts of the load or pile. Most pieces were broken from larger ones to insure fresh materials.

The Accelerated Laboratory Test

An accelerated laboratory test of the slacking characteristics of coal has been developed by the United States Bureau of Mines.[1] The test consists of the drying of the sample at a temperature safely above room temperature, under a flow of air for 24 hours. Following drying the sample is soaked in water for one hour and drying repeated for 24 hours. The percentage of the sample which will pass through standard .263 mm. screen, shaken one minute, indicates the amount of slacking. The percentage is called the first cycle slacking index. The test on the oversize remaining after the first cycle may be subsequently repeated for the second cycle index, the third, etc.

In the laboratory procedure cited it was found desirable to eliminate from the first cycle indices the percentage of the sample which passes through the sieves, because of friability and brittleness of the coal. This is done by shaking the sample one minute over a 0.263 mm. sieve. The percentage which is broken sufficiently fine to pass through the sieve may then be deducted from the uncorrected first cycle index giving a corrected index due entirely to slacking.

Samples of South Dakota coal were tested by the accelerated laboratory test. The process as outlined by the United States Bureau of Mines[2] was followed closely as possible throughout. Small thermostatically controlled electric ovens were used and a gentle flow of air through the ovens was induced by an electric fan. Temperatures during drying were maintained at about 32° C.

Before the first drying blank sievings were made to determine as closely as possible the breakage due to brittleness and friability of each specimen. In most cases the test was carried through the first cycle only but in a few the test was carried through the third cycle. Results, however, are stated for first cycles only.

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1. Fieldner, A. C., Selvig, W. A., and Frederic, W. H., Accelerated Laboratory Test for Detrmination of Slacking Characteristics of Coal, U. S. Bureau of Mines, R. I. No. 3055, 1930.
2. Fieldner, A. C., et al, Ibid., pp. 3-4.

RESULTS OF SLACKING TESTS

General Statement

Slacking tests indicate that, as a rule, the tendency of South Dakota coal to slack is rather pronounced. The tests indicate that slacking characters are similar in different parts of the same bed, but that differences in the tendency to slack occur from bed to bed. In the pages which follow the results of the tests are described by formations or members in order of their stratigraphic position. For those interested in the relation of slacking characters to geographic position, the tests are also described by counties. For the convenience of the reader results are given in graphic form. The average first cycle slacking indices corrected for blank sieving of the coals are stated according to stratigraphic position. These first cycle indices are as follows: Fox Hills 60; Hell Creek 23; Ludlow 51; Fort Union 66. The figure for the Fox Hills (?) is the result of a test on a sample from one mine only, not an average. The Fort Union average is of one sample from South Dakota, and two from North Dakota. The coal bed or beds at or near the base of the Ludlow member of the Lance show a high first cycle slacking index of 75, whereas tests on the remaining beds of the Ludlow average 32. An average of the slacking indices obtained by averaging together the several averages of coal bearing formations and members gives the average first cycle slacking index for South Dakota coal as 50 or 51 (Figures 1 and 6).

The suggestion has been made[1] that coals be divided into six groups according to results of the accelerated laboratory test as follows:

Class	First Cycle Slacking Index (Less Blank Sieving)
1. Non-slacking	0--1
2. Very slight slacking	1--5
3. Slight slacking	5--15
4. Moderate slacking	15--35
5. Strong slacking	35--90
6. Very strong slacking	90--100

1. Ibid., p. 8.

Classified on this basis the tests suggest that the average South Dakota coal is a strong slacking coal. The Hell Creek coal and those above the basal beds of Ludlow in the Ludlow member of the Lance are mostly moderate slacking coals. None of the samples tested from South Dakota were of the very strong slacking class.

Results by Formations

Fox Hills (?)

The test was made on a single mine run sample of coal from a bed presumably of Fox Hills age which occurs in the vicinity of Stoneville in northern Meade County. The first cycle slacking index of the sample corrected for blank sieving is 60. The slacking index of this sample thus lies between the average index of Ludlow and Fort Union coals. (Figure 2)

Hell Creek

Nine samples of coal from the Hell Creek member of the Lance have been tested. (Figure 3) Variations in the first cycle slacking index, corrected for blank sieving, range between 7 and 37. In two samples the corrected index is less than 15; in six between 15 and 35. In the only sample above 35 the index is only 37. The average index is 24. The tests suggest that the tendency of Lower Hell Creek coal to slack is less strongly developed than in the other coals of the South Dakota coal fields.

Ludlow

Seven samples of coal from various beds of Ludlow age have been tested in this investigation. (Figure 4) Striking variations in the slacking property are observed. The range in first cycle slacking index corrected for blank sieving is from 21 up to 79. The average corrected first cycle index is 51. The variations are believed to be due to variation in the slacking property in different beds. Thus the three highest, which range between 70 and 77 with an average of 75, are from the same bed at the base of the Ludlow member of the Lance. The remaining four range between 21 and 40 with an average corrected index of 32. These samples are taken from three or more beds of the Ludlow.

Fort Union

Three samples of Fort Union coal, presumably all from the Lodgepole-Haynes bed were tested. (Figure 5) Only one of these was collected in South Dakota, the other two being from North Dakota. These samples show relatively slight variation in the first cycle slacking index, corrected for blank sieving. The range is between 61 and 72 with an average of 66.

Results by Counties

Dewey, Ziebach, and Corson Counties

Seven samples of Dewey County coal, all from the Isabel-Firesteel bed of the Hell Creek member of the Lance, were tested for slacking tendencies. The results show variations between a corrected first cycle index of 6 to 37. The average corrected first cycle index of these samples is 25. One sample has an index less than 15, five between 15 and 35, and one is over 37. One sample is slight slacking, five moderate slacking, and one strong slacking. The latter is but two points over the upper limit of moderate slacking coal. (Figure 7)

A sample from the Isabel-Firesteel bed collected in northwestern Ziebach County is somewhat lower than the average of those of Dewey County (Figure 10). The first cycle slacking index corrected for blank sieving is 14. It is thus near the upper limit for slight slacking coal.

One sample was collected near Gopher in Corson County. (Figure 8) The bed is lower Hell Creek in age and is possibly equivalent with the Isabel-Firesteel bed. It agrees well with that coal in its slacking index which is 29 when corrected for blank sieving. It is thus a moderate slacking coal.

Harding County

Samples from Harding County were collected from two or more beds of Ludlow age. Of the three samples tested, the lowest was 21, the highest 36, and the average 29, all first cycle, corrected for blank sieving. (Figure 11)

Meade County

A single sample of coal from near Stoneville was tested for slacking character. (Figure 9) The corrected first cycle index for this sample is 60. It is thus a strong slacking coal. Additional slacking tests of coal from the locality are desirable for more adequate information on this coal which appears to be stratigraphically lower than other coals mined in South Dakota.

Perkins County

Of five samples of Perkins County coal, three are from a bed lying at the base of the Ludlow member of the Lance, one from a bed within the Ludlow, and one from a bed within the Ludlow, and one from the Lodgepole-Haynes bed of the Fort Union. (Figure 12) Variations of the slacking property of the samples from the base of the Ludlow and from the Fort Union is slight, the range being between 70 and 77 in the first cycle index, correction for blank sieving being made. The sample within the Ludlow has a corrected first cycle index of 40. All coal tested from Perkins County is strong slacking, although the Ludlow bed northwest of Strool is only five points above moderate slacking coal.

SIGNIFICANCE OF RESULTS OF THE ACCELERATED SLACKING TEST ON SOUTH DAKOTA COAL

The results of the slacking test on South Dakota coal are believed to be indicative of the tendency of these coals to slack. Further, it appears that these tests are of value in comparing the slacking characteristics of one coal with another. The slacking indices, however, do not appear to be directly related to rank or quality of the coals tested, at least so far as investigated, except with regard to the tendency of the coal to slack. Thus, the lignitic coals within the Ludlow member of the Lance do not, in these tests, show so great a tendency to slack as the coal at the base of the Ludlow and the Lodgepole-Haynes bed of the Fort Union. Both of these latter coals are less lignitic than most of the Ludlow coals. Again, the coals of Fort Union age and Lower Hell Creek, which are very similar in other physical and chemical characters differ considerably from each other in their slacking characters. The results are thus corroborative of those made by the United States Bureau of Mines[1] which did not "indicate a close relation between slacking indices and rank as measured by proximate analyses".

1. Fieldner, A. C., et al, Ibid., p. 8.

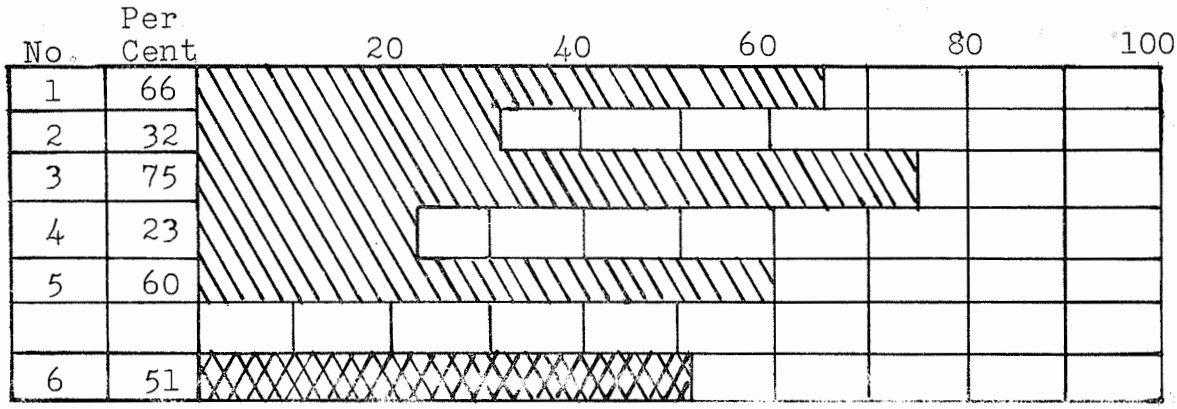

Figure 1. Averages of First Cycle Slacking Indices According to Stratigraphic Position
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Figure 2. Fox Hills (?) Slacking Test (Corrected for Blank Sieving) on Sample Taken from Stainbrook Mine in NW ¼, NW ¼, S 10, T 9 N, R 12 E.
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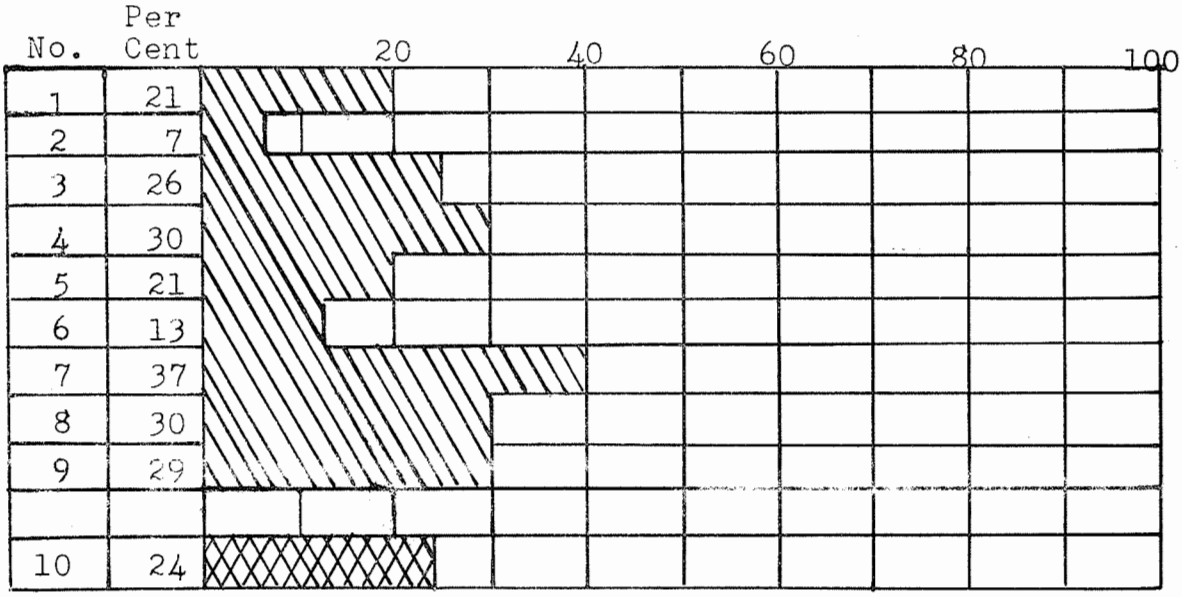

Figure 3. Slacking Tests on Hell Creek Coal
(Corrected for Blank Sieving)
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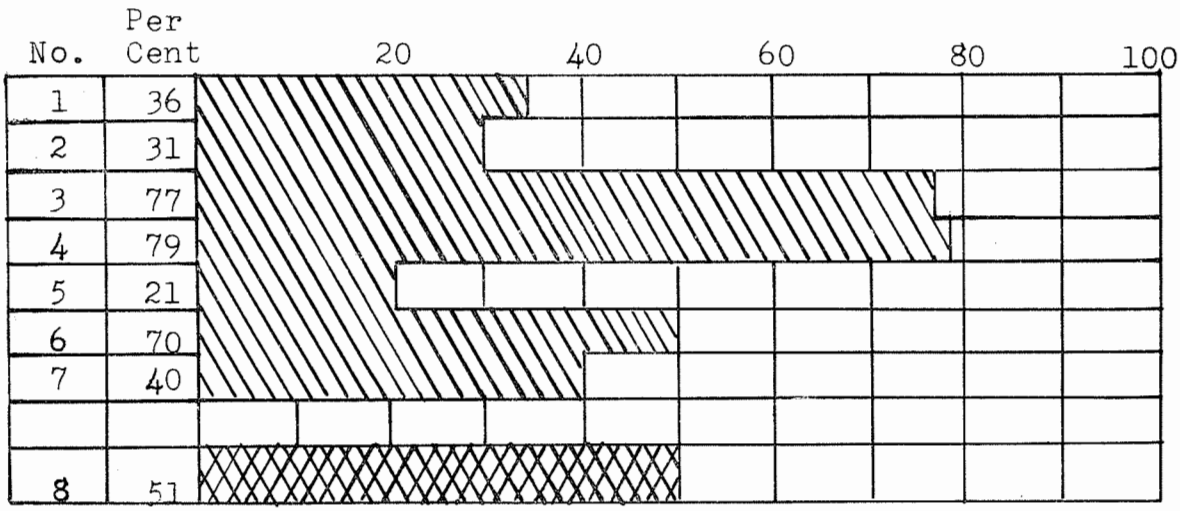

Figure 4. Slacking Tests on Ludlow Coals
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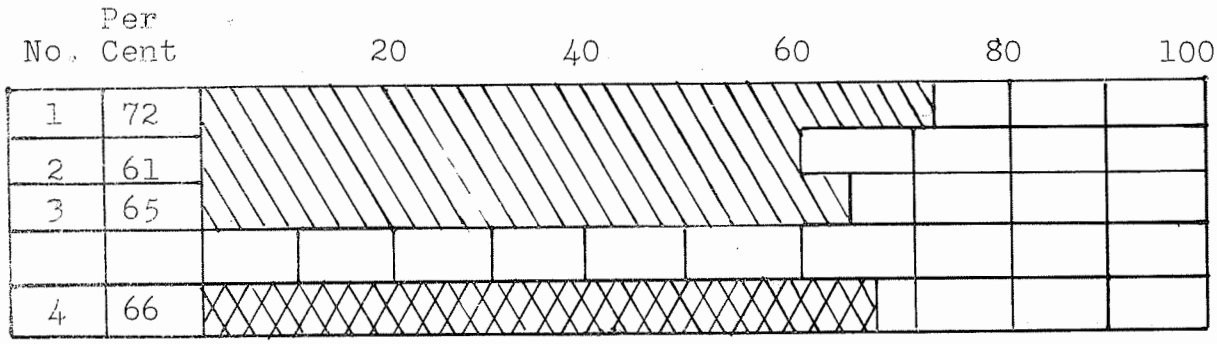

Figure 5. Slacking Tests on Fort Union Coals
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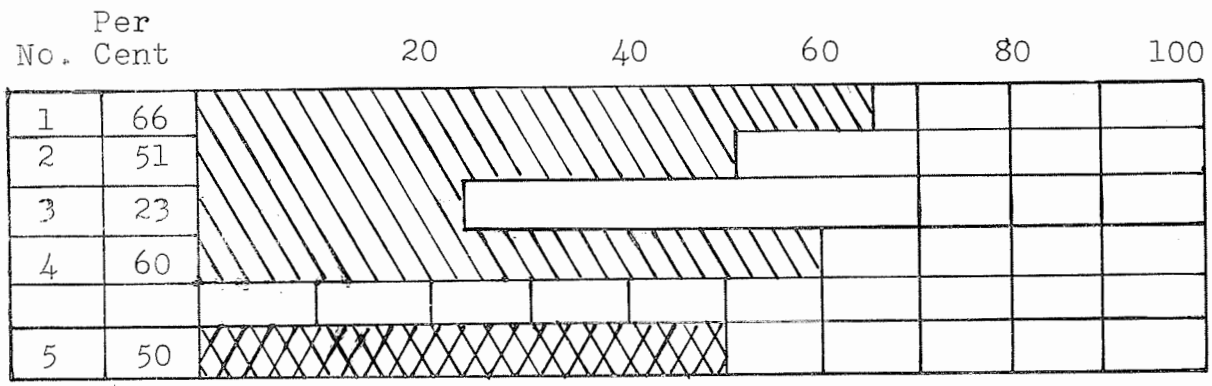

Figure 6. Averages by Formations of First
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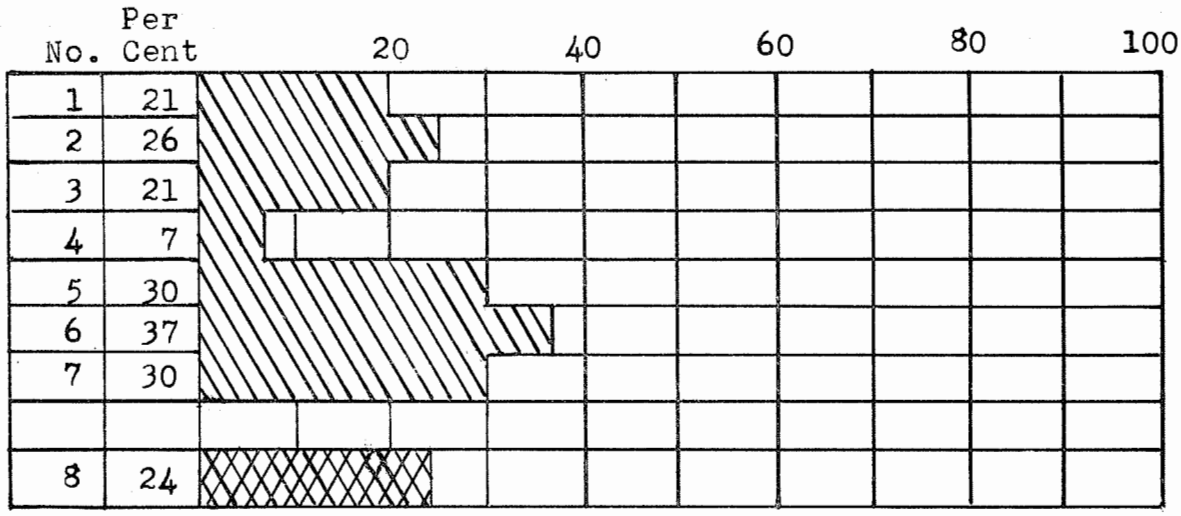

Figure 7. Slacking Tests on Dewey County Coal
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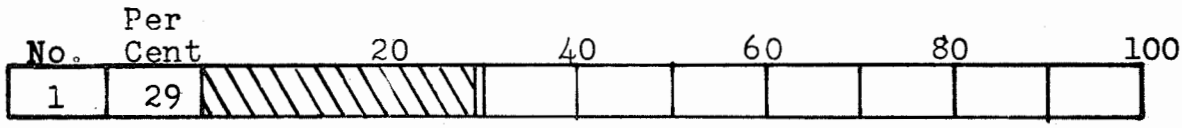

Figure 8. Slacking Test on Corson County Coal from Anderson Mine 1½ miles west of Gopher.
(Corrected for Blank Sieving)
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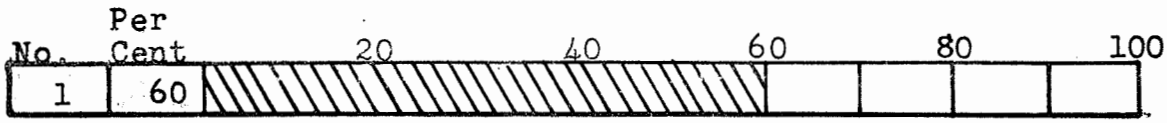

Figure 9. Slacking Test on Meade County Coal from Stainbrook Mine in NW ¼, NW ¼, S 10, T 9 N, R 12 E.
(Corrected for Blank Sieving)
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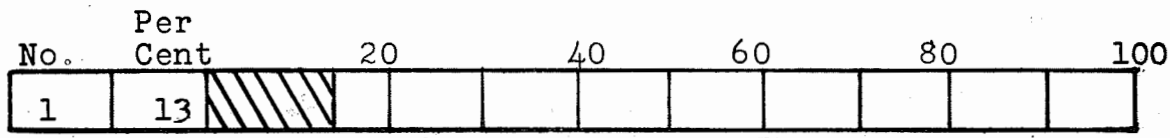

Figure 10. Slacking Test on Ziebach County Coal from Isabel Coal Co. Mine in SE ¼, S 12, T 16 N, R 21 E.
(Corrected for Blank Sieving)
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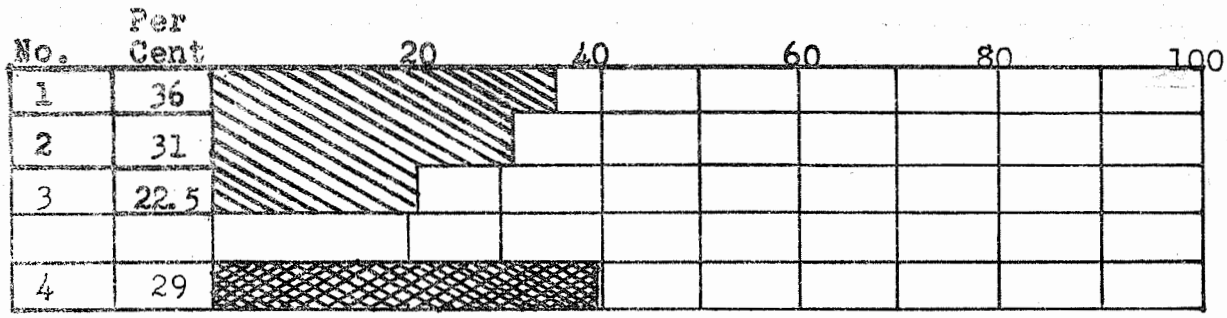

Figure 11. Slacking Tests on Harding County Coal
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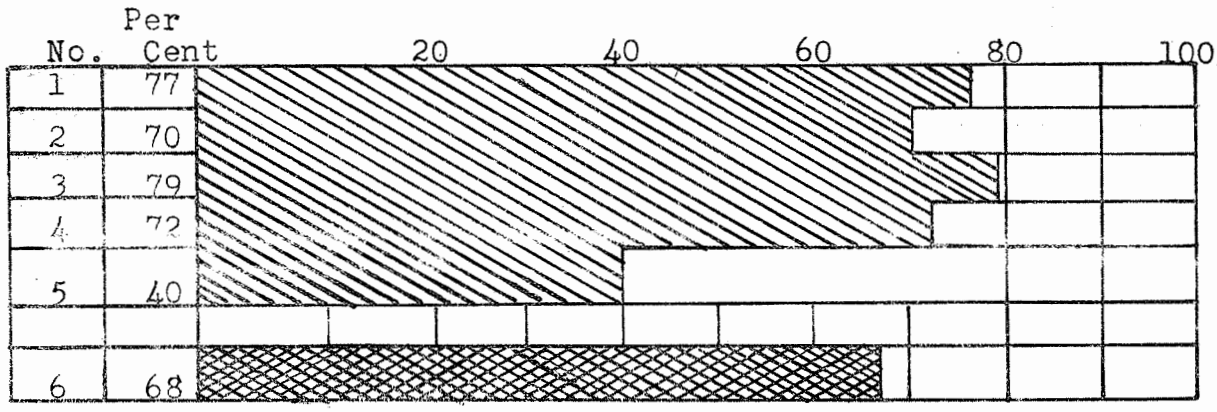

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1 Sample taken from Anderson Mine, 1½ miles west of Gopher

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