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# RADIOACTIVE COAL AND SHALE OF PENNSYLVANIAN AND PERMIAN AGE IN NORTHERN WEST VIRGINIA

By
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This report is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

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CONTENTS



ILLUSTRATION



TABLES

# RADIOACTIVE COAL AND SHALE OF PENNSYLVANIAN AND PERMIAN AGE IN NORTHERN WEST VIRGINIA

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## ABSTRACT

The commercially important coal beds in the Monongahela series of Pennsylvanian age and coal and shale of the Dunkard series of Permian age were examined and sampled in eight counties in northern West Virginia. Most coal examined was non-radioactive, but a few carbonaceous shales and coaly beds in the Dunkard series were weakly radioactive, yielding 0.002 to 0.004 percent equivalent uranium. The principal beds sampled are the Pittsburgh and Redstone coal beds of the Monongahela series.

## INTRODUCTION

The area investigated for radioactive coal and carbonaceous shale lies in Wetzel, Doddridge, Marion, Harrison, Taylor, Barbour, Upshur, and Lewis counties, in northern West Virginia. Clarksburg is near the center of the area studied (fig. 1).

The investigation was made by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission as part of a systematic investigation of the radioactivity and uranium in coal and associated carbonaceous shale in the eastern United States. The area was examined and samples were collected during August 1953, by E. D. Patterson and J. L. Snider.

### Previous investigations

Geology and coal resources of Marshall, Wetzel, Tyler, Monongalia, Marion, and Taylor counties are described by Hennen (1909, 1913) and

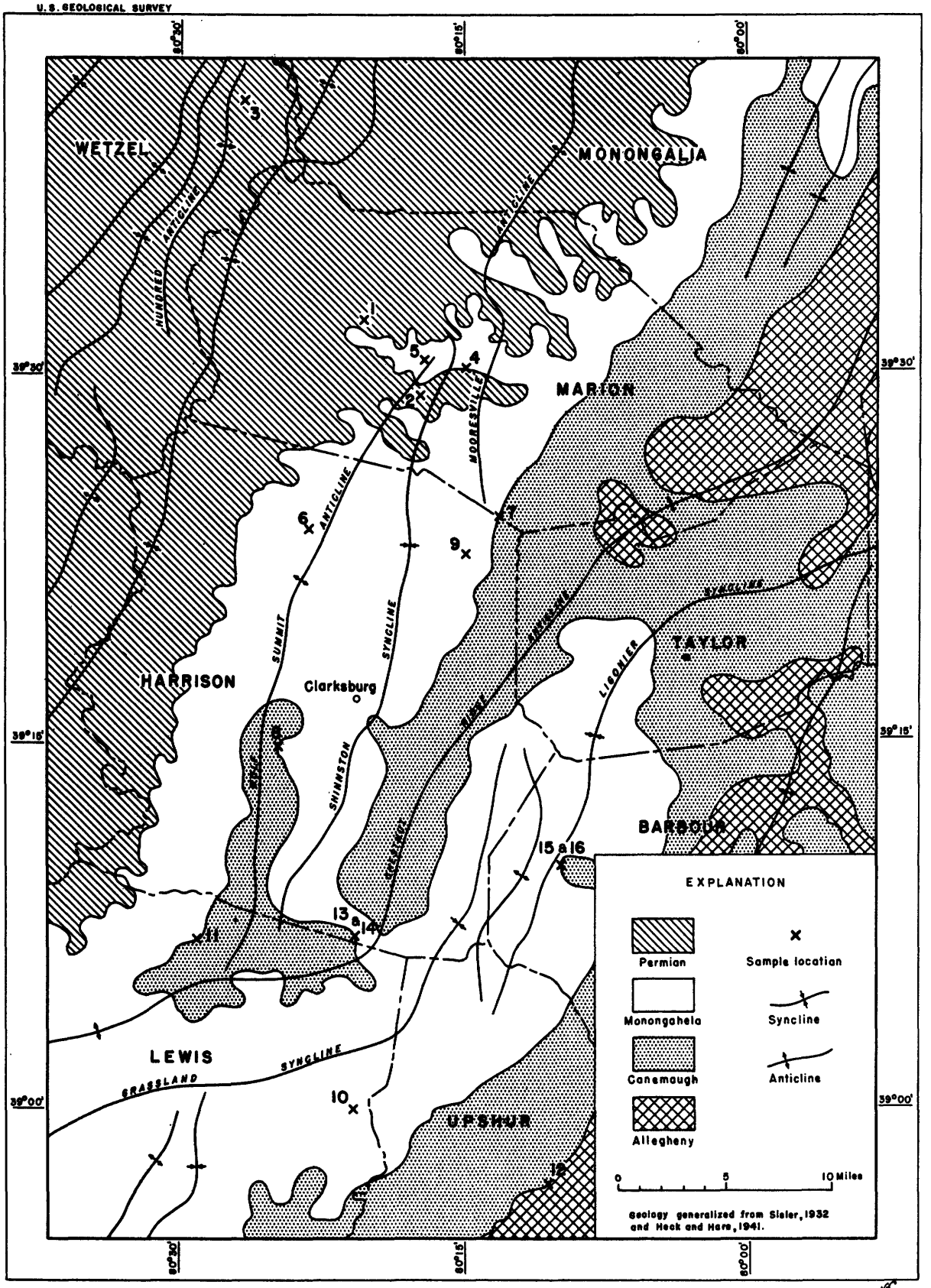


FIGURE 1. — SAMPLE LOCALITIES IN NORTHERN WEST VIRGINIA

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similar reports by Reger (1916, 1918) describe the geology and coal resources of Lewis, Gilmer, Barbour, and Upshur counties.

Nelson and Brill (1949) made an investigation in eastern United States for outcrops of radioactive rocks using both carborne and portable Geiger counters. They examined 23 localities in the counties under consideration and reported weakly radioactive shale (over 0.001 percent eU) at several localities and radioactive Pittsburgh coal at one locality.

The West Virginia Geological Survey is engaged in a study of the occurrence of trace elements in West Virginia coal ash, but no appreciable quantities of uranium have been reported (Price, personal communication).

Kronstadt (1951) lists equivalent uranium content of ash from coal from the area discussed in this report. None of the four coal samples tested contained more than 0.005 percent eU.

## Method of present investigation

An attempt was made to obtain fresh coal samples, from each coal bed, in localities spaced about five miles apart. Most of the samples of coal were collected in strip mines. Some of the localities of Nelson and Brill (1949) were resampled, but others of their localities could not be relocated with certainty.

At each sample locality, fresh coal or shale from each foot of the bed was sampled individually. Shale partings in commercial coals were not included, and the underclay or roof shale was not sampled unless the portable scintillation meter read higher than the background count (0.005 mr/hr). A total of 88 samples was collected from 16 localities. The samples were crushed to minus one-fourth inch by a jaw crusher, then tested with a portable radioactivity scaler, and shipped to the U. S. Geological Survey laboratory in Washington, D. C., for further radioactivity tests.

# GEOLOGY

The area investigated is in the Appalachian Plateau, a highly dissected plateau ranging from 1,350 to 1,600 feet above sea level. Erosion has cut the plateau into a series of deep valleys, high ridges, and knobs.

The Pennsylvanian and Permian rocks which underlie the Appalachian Plateau in the area studied are gently folded into broad, northeast trending anticlines and synclines, some of which are shown on figure 1. The eastward boundaries of the formations are ragged due to the deep dissection of the plateau by streams, but this does not show in figure 1 because the map is greatly generalized.

## Stratigraphy

The following summary of stratigraphy is derived largely from Price and others (1938, p. 272-282).

Rocks of Pennsylvanian and Permian age are extensively exposed in the area sampled (table 1). The older Pennsylvanian rocks are divided into four series, named in ascending order; the Pottsville, Allegheny, Conemaugh, and Monongahela. Permian rocks of the area are assigned to the Dunkard series.

### The Pottsville series

Rocks of the Pottsville series not shown on the accompanying map (fig. 1) are exposed along the Chestnut Ridge anticline in eastern Marion County and as small inliers surrounded by younger Allegheny rocks at other places in the map area. The Pottsville series is reported (Price and others, 1938, p.278) to range in thickness from a minimum of 240 feet in

Harrison County to a maximum of 1,053 feet in Upshur County.

Table 1.--Pennsylvanian and Permian series and coal beds examined in northern West Virginia. (Names and correlations of coals after Hennen, 1909, 1913, and Regen, 1916, 1918).

| | Coal bed | Sample locality |
|---|---|---|
| Permian system | | |
| Dunkard series | 300'± above the Washington coal | 3 |
| | Washington coal | 4 |
| | Uncorrelated | 1, 2 |
| Pennsylvanian system | | |
| Monongahela series | Waynesburg | 5 |
| | Uniontown | None |
| | Sewickley | None |
| | Redstone | 10, 14, 16 |
| | Pittsburgh | 6, 7, 8, 9, 11, 13, 15 |
| Conemaugh series | No coal beds sampled | |
| Allegheny series | Upper Freeport | 12 |
| | No other coal sampled | |
| Pottsville series | No coals sampled | |

## The Allegheny series

The Allegheny series ranges in thickness from 180 feet in Taylor County to 310 feet in Wetzel County. It is composed mainly of gray sandstone and sandy shale with a few thin limestones and several coals and flint clays. It contains six minable coal beds: the Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport. Of these, only the uppermost coal of the Upper Freeport was examined and sampled and this at only one locality (12).

## The Conemaugh series

The Conemaugh series ranges in thickness from 470 to 650 feet, and averages about 600 feet in the counties being discussed. It consists of gray and brown sandstone, sandy shale, red shale, thin impure limestone, coal, and a few fire clays. It contains eight minable coal beds including the Mahoning, Brush Creek, Bakerstown, Upper Bakerstown, Harlan, Elk Lick, Little Clarksburg, and Little Pittsburgh.

## The Monongahela series

The Monongahela series ranges in thickness from 295 feet in Wetzel County to 485 feet in Harrison County and averages about 400 feet in the counties sampled. It consists mainly of gray and brown sandstone, sandy shale, red shale, limestone, and coal. Five of the coals are minable, including the world famous Pittsburgh at the base, and the Redstone, Sewickley, Uniontown, and Waynesburg coal in stratigraphic order above.

The Pittsburgh coal is extensively mined in Harrison County where it outcrops in the major valleys along Wolf Summit and Chestnut Ridge anticlines. It is also mined in Barbour County where it ranges in thickness from 5 to 10 feet. The Pittsburgh coal has an average thickness of 8 feet in Harrison, Marion, and Taylor counties. (Headlee and Nolting, 1940, p. 16-17).

The Redstone coal bed, which lies 20 to 40 feet above the Pittsburgh coal, ranges in thickness from 2 to 6 feet and has an average thickness of about 5 feet in the minable areas in Lewis, Upshur, Harrison, and Barbour counties.

The Waynesburg coal is of minable thickness in Wetzel County (Headlee and Nolting, 1940, p. 7). It ranges in thickness from 3 to 12 feet and

is divided into two benches at most localities by a parting of shale 1 to 36 inches thick.

### The Dunkard series

The Dunkard series is 1,180 feet thick in Wetzel County. The surface rocks in Wetzel County and western parts of Marion, Harrison, and Lewis counties belong to the Dunkard series and consist mainly of gray, green, and red sandstone, shale, thin limestone, and thin impure coal beds. The Washington coal is the only bed of minable thickness and quality in the Dunkard series. It is composed of two or more benches separated by shale or bony partings and ranges from 3 to 6 feet in thickness in Marion County, but elsewhere the coal is thinner. (Headlee and Nolting, 1940, p. 4-5).

## SUMMARY AND CONCLUSIONS

Coal and associated shale at 16 localities in northern West Virginia were sampled and tested radiometrically. Most of the rocks examined were nonradioactive. Table 2 shows the sample localities, a description of the coal and associated rocks at each locality, and the amount of radioactivity expressed as equivalent uranium determined by the U. S. Geological Survey laboratory.

The samples of coal and shale from the Monongahela series have radioactivities of 0.001 percent eU or less for coal and 0.004 percent eU or less for shale. The coal of the Dunkard series is weakly radioactive at each sample locality, some layers containing 0.002 or 0.003 percent eU. Coal beds of the Dunkard series are difficult to sample, however, because they are not mined commercially and are not exposed at many localities. Additional study of these coal beds might be worthwhile. If the uranium now found in the Monongahela and Dunkard coals was originally disseminated

throughout the series and was later concentrated by adsorption on the coals and adjacent carbonaceous shale from circulating water, the few thin coals of the Permian Dunkard series might concentrate more uranium than the numerous thick coals of the Monongahela series of Pennsylvanian age, merely because they are fewer and thinner. Migrating solutions containing uranium would move through much of the Dunkard beds before coming in contact with sufficient organic matter to precipitate the uranium. Thus the uranium, possibly leached from a considerably thicker section of rocks, would be more apt to be concentrated in a Dunkard coal than it would in a coal in the Monongahela series.

Table 2.--Location, lithology, and radioactivity of samples.

| Loc. No. | Location 1/ | Thickness (feet) | Lithology | Equivalent uranium (percent) 2/ |
|---|---|---|---|---|
| 1 | Uncorrelated Dunkard coal, probably below Washington coal. Road cut on east side of U. S. Highway 250, northern city limits of Mannington, Mannington quadrangle, Marion County. 15,200' N. 39°30' 20,700' E. 80°25' Same locality as Br. 237 of Nelson and Brill. | 0.5 | Coal, weathered | 0.002 |
| | | .4 | Clay | .002 |
| | | .7 | Siltstone, dark gray | .002 |
| | | 3 | Shale, black, carbonaceous | .001 |
| | | 1 | Siltstone | ---- 3/ |
| | | 2.8 | Sandstone | ---- |
| | | 6 | Siltstone | a 4/ |
| | | 0.6 | Coal, weathered | a |
| | | 2 | Clay, gray | .003 |
| | | 1 | Sandstone | ---- |
| 2 | Uncorrelated Dunkard coal below Washington coal. One mile north of Festus, in a road cut, Clarksburg quadrangle, Marion County. 25,600' N. 39°25' 12,300' E. 80°20' Near locality Br. 235 of Nelson and Brill. | 1 | Clay | .003 |
| | | 1 | Coal, weathered | a |
| | | 0.6 | Shale, dark gray | .002 |
| | | .6 | Siltstone, gray | ---- |
| | | 6 | Sandstone, medium-grained, massive, gray | ---- |

1/ Locations are shown by coordinates measured from longitude and latitude lines on U. S. Geological Survey topographic quadrangle maps.

2/ Analyses by U. S. Geological Survey.

3/ No sample taken, bed nonradioactive according to field test.

4/ Less than 0.001 percent eU, according to laboratory test.

Table 2.--Location, lithology, and radioactivity of samples--Continued.

| Loc. No. | Location 1/ | Thickness (feet) | Lithology | Equivalent uranium (percent) 2/ |
|---|---|---|---|---|
| 3 | Dunkard coal 300± feet above Washington coal. Road cut on West Virginia Highway 70, 0.3 mile east of Hundred. Mannington quadrangle, Wetzel County. 7,000' N. 39°40' 13,900' E. 80°30' | 2 | Coal bloom | ---- |
| | | 4 | Sandstone, massive | ---- |
| | | 4.5 | Shale, black | 0.002 |
| | | 0.4 | Siltstone, black | a |
| | | .4 | Coal, weathered | .001 |
| | | 2 | Clay, gray | .002 |
| 4 | Washington coal (Fennen, 1913). Road cut 0.5 mile south of Farmington, Mannington quadrangle, Marion County. Near locality Br. 236 of Nelson and Brill. 1,200' N. 39°30' 20,600' E. 80°20' | 1 | Shale, black | ---- |
| | | 0.8 | Coal, weathered | a |
| | | .9 | Clay, gray | ---- |
| | | 2 | Shale, black, fissile | ---- |
| | | 1.8 | Coal, weathered | a |
| | | 1 | Shale, carneloid | .002 |
| | | 2 | Coal, weathered | a |
| | | 2 + | Clay | .003 |
| 5 | Waynesburg coal (Hennen, 1913). Road cut on U. S. Highway 250, 1.5 miles east of Farmington, Mannington quadrangle, Marion County. 3,200' N. 39°30' 12,200' E. 80°20' | 20 | Sandstone, crossbedded | ---- |
| | | 1 | Coal, weathered, bony | a |
| | | 0.5 | Shale, black, fissile | ---- |
| | | 1.2 | Coal, weathered | a |
| | | 0.5 | Clay, gray | ---- |
| | | .3 | Shale, black, fissile | ---- |
| | | 2 | Coal, weathered | a |
| | | 3 | Clay, dark, silty | .004 |
| 6 | Pittsburgh coal. Strip mine at Nolan's Run, 2.5 miles north of Lumberport. Clarksburg quadrangle, Harrison County. 27,100' N. 39°20' 9,400' E. 80°25' | 1 + | Shale, silty | ---- |
| | | 6 | Coal, abundant vitrain bands | a |
| | | 0.5 | Clay, gray, base concealed | ---- |

Table 2.--Location, lithology, and radioactivity of samples--Continued.

| Loc. No. | Location 1/ | Thickness (feet) | Lithology | Equivalent uranium (percent) 2/ |
|---|---|---|---|---|
| 7 | Pittsburgh coal. Paul Farold's strip mine, Swiger Farm tract, owned by Francis Mine Company, Fairmont quadrangle, Harrison County. 23,600' N. 39°20' 7,900' E. 80°15' | 3 + | Siltstone, light-gray | |
| | | 1 | Siltstone, dark-gray | |
| | | 2.6 | Coal; sparse, thick vitrain bands | a |
| | | 0.1 | Coal, bony | a |
| | | 3.5 | Coal, bright; moderate, medium vitrain | a |
| | | 0.5 | Clay, gray | a |
| 8 | Pittsburgh coal. Keely Construction Company, strip mine 1.4 miles west of U. S. Highway 19 on Coburn Creek road, 3.4 miles north of West Milford. Weston quadrangle, Harrison County. 28,600' N. 39°10' 22,200' E. 80°30' | 1 | Coal, weathered | ---- |
| | | 1 | Clay | ---- |
| | | 5 | Limestone | ---- |
| | | 9 | Claystone | ---- |
| | | 0.1 | Shale, carbonaceous | ---- |
| | | .3 | Coal | 0.002 |
| | | 6 | Coal | a |
| | | 0.1 | Siltstone, gray, base concealed | ---- |
| 9 | Pittsburgh coal. A & H Coal Co. strip mine, 1 mile west of Saltwell. Clarksburg quadrangle, Harrison County. 13,500' N. 39°20' 21,700' E. 80°20' | 8 | Sandstone, very fine, light-gray, flaggy, iron stained | ---- |
| | | 12 | Siltstone, dark-gray, massive, carbonaceous | ---- |
| | | 8.8 | Coal | a |
| | | 0.1 | Siltstone, gray | ---- |
| 10 | Redstone coal (Reger, 1916). Road cut 1 mile west of Lorentz on U. S. Highway 11a-33. Weston quadrangle, Lewis County. (Locality Br. 233 of Nelson and Prill). 4,500' N. 39°00' 3,200' E. 80°20' | 10 | Shale, gray | ---- |
| | | 3 | Shale, gray and carbonaceous | ---- |
| | | 4 | Coal, weathered | a |
| | | 0.4 | Clay, dark-gray | |
| | | 10 | Sandstone, light-gray, massive | ---- |

Table 2.--Location, lithology, and radioactivity of samples--Continued.

| Loc. No. | Location 1/ | Thickness (feet) | Lithology | Equivalent uranium (percent) 2/ |
|---|---|---|---|---|
| 11 | Pittsburgh coal. Fitner Fuel Company | 3 | Clay, gray, massive | ---- |
| | strip mine 1 mile north of Valley Chapel | 0.9 | Coal, bony | a |
| | on Millstone Run Road. Weston quadrangle, | 4.1 | Coal | a |
| | Lewis County. | 0.5 ± | Siltstone, massive, light-gray | ---- |
| | 12,900' N. 39°05' | | | |
| | 2,800' E. 80°30' | | | |
| 12 | Upper Freeport coal (Reger, 1918). | 20 ± | Mudstone, medium dark-gray, massive | ---- |
| | Casello Coal Company strip mine, 1 mile | | | |
| | north of Ivy. Sago quadrangle, | 4.6 | Coal, contains pyrite lenses | a |
| | Upshur County. | 0.5 ± | Siltstone, medium dark-gray | |
| | 13,700' N. 38°55' | | | |
| | 19,300' E. 80°15' | | | |
| 13 | Pittsburgh coal. Scott Coal Company | 2 ± | Siltstone, soft, gray, massive | ---- |
| | strip mine 1.5 miles east of McWhorter. | 0.4 | Siltstone, hard, gray, massive | ---- |
| | Weston quadrangle, Harrison County. | .3 | Coal, bony | ---- |
| | 14,300' N. 39°05' | 2.5 | Coal | a |
| | 19,700' E. 80°25' | 1 | Coal | 0.003 |
| | | 0.1 | Mudstone, medium dark-gray | |
| 14 | Redstone coal. Scott Coal Company | 5 ± | Sandstone, massive | |
| | strip mine 1.5 miles east of McWhorter. | 10 ± | Mudstone, medium dark-gray | ---- |
| | Weston quadrangle, Harrison County. | 2.9 | Coal | a |
| | 15,400' N. 39°05' | 0.3 | Bone, light-gray, silty | a |
| | 18,500' E. 80°25' | 2.2 | Coal | a |

Table 2.--Location, lithology, and radioactivity of samples--Continued.

| Loc. No. | Location 1/ | Thickness (feet) | Lithology | Equivalent uranium (percent) 2/ |
|---|---|---|---|---|
| 15 | Pittsburgh coal. Compass Coal Company strip mine 2 miles east of Overfield on West Virginia Highway 57. Phillipi quadrangle, Barbour County. Near locality Br. 229 of Nelson and Brill (1949). 30,100' N. 39°05' 23,500' E. 80°15' | 0.5 ± | Sandstone | ---- |
| | | 4 | Shale, dark-gray, massive | ---- |
| | | 0.3 | Coal, bony | ---- |
| | | 2.2 | Coal | a |
| | | 0.2 | Coal | a |
| | | 4.9 | Coal | a |
| | | 1 ± | Mudstone, dark-gray | ---- |
| 16 | Redstone coal. Compass Coal Company strip mine 2 miles east of Overfield on West Virginia Highway 57. Phillipi quadrangle, Barbour County. 30,200' N. 39°05' 22,500' E. 80°15' | 1 ± | Clay, light-gray, massive | ---- |
| | | 5.3 | Coal | a |
| | | 0.5 ± | Siltstone, gray | ---- |

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