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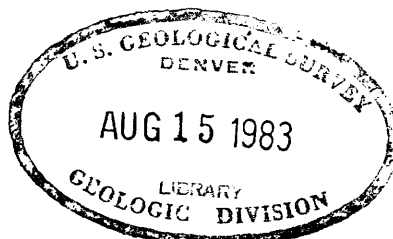
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for W. H. Bradley
Chief Geologist



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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RADIOACTIVITY OF COAL AND ASSOCIATED ROCK
IN THE COAL FIELDS OF EASTERN KENTUCKY*

By

Stewart W. Welch

June 1953

Trace Elements Investigation Report 347

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*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

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RADIOACTIVITY OF COAL AND ASSOCIATED ROCK IN THE COAL FIELDS OF EASTERN KENTUCKY

By Stewart W. Welch

ABSTRACT

A reconnaissance study was made of radioactivity of coal and associated rock in the coal fields of eastern Kentucky and Logan and Mingo counties, W. Va. Sixty-one localities were visited and 98 samples, 90 of coal and two each of carbonaceous shale, marine shale, flint clay, and dike rock, were collected. Radioactivity of the samples was measured with portable assay equipment prior to being shipped to the Trace Elements laboratory in Washington, D. C. for final determinations of radioactivity. The results showed the coal to have little or no radioactivity - 0.000 to 0.001 percent equivalent uranium, and other rock sampled to have slight radioactivity - about 0.002 percent equivalent uranium.

INTRODUCTION

A reconnaissance for radioactivity in coals of the eastern United States has been undertaken by the U. S. Geological Survey for the Division of Raw Materials of the Atomic Energy Commission. As a part of this investigation, samples, mainly of minable coals, have been collected from the coal fields of eastern Kentucky and tested for radioactivity. Field work was carried on during parts of September, October, and November 1952 by S. W. Welch, J. L. Snider, J. W. Huddle, and W. E. T. Brown.

The area included in this investigation is underlain by the coal-bearing rocks of eastern Kentucky and Logan and Mingo counties, W. Va. Topographic quadrangle maps at scales of 1:62,500 or 1:125,000 are available

for all of the region, and $7\frac{1}{2}$ -minute sheets at a scale of 1:24,000 are available for part of the area.

Both the Kentucky Geological Survey and the West Virginia Geological Survey (Hennen and Reger, 1914) have published county and regional reports that furnish limited geologic data for most of the area. McFarlan (1943) presents a good summary of the coal fields of eastern Kentucky. The U. S. Geological Survey has published a report on the coals of Pike County, Ky., and is at the present engaged in geologic mapping in the Hazard Field in eastern Kentucky. Wanless (1939, 1946) presents data collected in a regional study of the area. His correlations of the coals are used in this report with only slight modification. (See table 1.)

Nelson and Brill (1948) visited 22 localities in the area covered by this report. Most of the exposures at these localities included coal and associated rock. These rocks when tested for radioactivity with a portable Geiger counter contained 0.001 or less percent equivalent uranium for coals of minable thickness and 0.001 to 0.003 for associated shales and sandstones.

Kronstadt (1951) gives equivalent uranium contents of ashed samples of coal from 8 localities in the area under present investigation. These results indicated the radioactivity of each of the original coal samples to be less than 0.001 percent equivalent uranium.

Most of the localities visited during the present investigation were operating coal mines; a few were road cuts and natural outcrops. Field work consisted of collecting channel samples of minable beds of coal and a few samples of rocks associated with coal, such as partings in coal and roof shale; at one locality an igneous dike intruded into coal-bearing strata was sampled. The samples were then crushed and their radioactivity measured with portable assay equipment. Later they were shipped

to the Trace Elements laboratory in Washington, D. C. for measurements of radioactivity with more sensitive instruments. The samples showed no significantly high radioactivity in either the field or the laboratory tests.

GEOLOGY

Stratigraphy

The coal-bearing strata in eastern Kentucky and southern West Virginia are of Pennsylvanian age and are generally divided into two formations: the Lee formation, at the base of the Pennsylvanian, and the Breathitt formation. Younger rocks outcropping in the northeastern part of the area have been correlated with the Conemaugh formation of southwestern Pennsylvania.

The Lee formation overlies the Pennington formation of Mississippian age, and is composed of thick units of massive, conglomeratic sandstone separated by relatively thin units of carbonaceous shale and coal. With few exceptions, outcrops of the Lee formation are restricted to narrow belts along Pine Mountain and Cumberland Mountain in the extreme southeastern part of Kentucky, and a broader belt trending northeast and forming the western margin of the area of outcrop of Pennsylvanian rocks. The coals of the Lee formation are generally thin but locally some of them are relatively thick, minable beds, especially in the southwestern part of the area studied. The Lee formation has a maximum thickness of about 1,400 feet in southern Kentucky and becomes thinner toward the north to less than 100 feet in Greerup County.

The Breathitt formation overlies the Lee formation and is generally considered to include the youngest Pennsylvanian strata in Breathitt County, Ky., for which it has been named. The Breathitt consists of carbonaceous shale, channel sandstone, coal, marine shale, and thin beds of limestone. Some of the marine shale and limestone have been useful in correlation.

This formation contains nearly all of the commercially important beds of coal of the area studied. Names and correlations of these coals are given in table 1. The Breathitt formation, like the Lee, thins from south to north. It has a thickness of about 2,000 feet in Bell County and thins to about 500 feet in Greenup County.

In northeastern Kentucky, parts of Boyd, Carter, and Lawrence counties are underlain by rocks considered to be younger than those of the Breathitt formation. These rocks have been correlated with the Conemaugh formation and are believed to be the youngest strata in eastern Kentucky. They are composed mainly of massive sandstone and carbonaceous shale, but include thin beds of coal and limestone.

Table 1.--Correlation of important coals in eastern Kentucky*

Logan-Williamson Field	Big Sandy-Elkhorn Field	Hazard Field	Harlan Field	Southern Appalachian Field
No. 5 Block	Richardson	Helton	High Splint	Red Springs
Broas or Stockton	Torehligh	Hindman		Upper Hignite
Lewiston or Belmont	Lewiston or Belmont	Fugate or Francis		Lower Hignite
Coalburg	Peach Orchard	Hazard No. 7	Cornett	Peewee
		Hazard No. 6 or Leatherwood		Red Ash
Buffalo Creek	Lower Peach Orchard	Haddix		
Fossil limestone	Fossil limestone	Magoffin limestone	Fossil limestone	Fossil limestone
** Winifrede	Winifrede	Hamlin	Limestone coal	Sterling
Chilton or Taylor	Flatwoods	Fire Clay	Wallins Creek	Dean
Hernshaw	Whitesburg	Whitesburg	Low Splint	Mills
Dingess limestone	Kendrick shale	Kendrick shale	Kendrick shale	Kendrick shale
** Williamson	Williamson	Amburgy	Crech	Mason
			Darby or "D"	
Upper Thacker, or Island Creek, or Upper Cedar Grove	Elkhorn No. 3	Elkhorn No. 3	Kelliocka or "C"	
Lower Thacker or Lower Cedar Grove	Elkhorn No. 2	Elkhorn No. 2	"B"	Moss
Alma	Elkhorn No. 1	Elkhorn No. 1	Harlan	Jellico
Pond Creek or Eagle	Lower Elkhorn		Imboden	Blue Gem or Rich Mtn.
Powellton				
Matewan	Bingham			Lily, River Gem, or Horse Creek
Lower War Eagle				Barren Fork
				Stearns No. 2
				Stearns No. 1 $\frac{1}{2}$
				Stearns No. 1

- * Coals of the Princess Field are not included here because of the uncertainty as to their correlation with coals of the other fields.
- ** Dashed lines underscore marine zones which have been used as key horizons for correlation between coal fields.

Breathitt Formation

Lee Formation

Structure

The area covered by this report occupies a part of a large basin known as the Appalachian Basin. Its axis trends in a northeasterly direction crossing Knox, Breathitt, and Lawrence counties. This part of the basin is bounded on the west by the Cincinnati Arch, and the massive, cliff-forming sandstones of the Lee formation outline the basin boundary in the form of an escarpment. The strata dip gently toward the axis of the basin with many small, random-trending undulations, but dips may be steep where associated with faulting.

One of the more striking structural features of the area is the Cumberland overthrust. The overthrust block is about 125 miles long and 25 miles wide in southeastern Kentucky and adjacent parts of Tennessee and Virginia. It has been thrust in a northwesterly direction a distance of about seven miles (Butts, 1927), and is bounded on both ends by tear faults. The thrust crops out along Pine Mountain, where a narrow belt of Devonian and Mississippian rocks overlie the Breathitt formation. Southeast of Pine Mountain, directly behind the trace of the thrust, is a broad syncline called the Middlesboro syncline which occupies most of Harlan County and parts of Letcher and Bell counties, and extends into adjacent states. The forces responsible for the movement of the Cumberland overthrust block are considered to be the same as those which produced the intense folding and thrusting of the Folded Appalachians.

The Kentucky River fault zone is another prominent structural feature of the area. This zone extends from the Blue Grass region of central Kentucky into Wolfe, Morgan, Magoffin, Johnson, and Elliott counties. The fault zone in these counties has an easterly trend. The individual faults in this zone are characteristically normal, and the south sides are down-

thrown. The strata dip steeply toward the faults on the downthrown sides and dip gently away from the faults on the upthrown sides. Two of the best known of these faults are the Irvine-Paint Creek fault and the Johnson Creek fault.

The only igneous rock known to occur in the area is in Elliott County, Ky. It is a peridotite dike containing numerous phenocrysts of olivine and angular inclusions of the enclosing rock. It is not known whether this dike is in any way related to the faulting of this area.

RADIOACTIVITY MEASUREMENTS

Measurements of the equivalent uranium content of crushed samples were obtained with portable assay equipment, and from determinations made by the Trace Elements laboratory in Washington, D. C. Neither the field nor laboratory measurements showed abnormal radioactivity of any of the samples. The results showed that most of the coal samples contain less than 0.001 percent equivalent uranium, and a few contain 0.001 percent. Samples of carbonaceous shale, flint clay, calcareous shale, and dike rock contain about 0.002 percent equivalent uranium.

The following table gives descriptions of the samples tested, measurements of radioactivity, and the percent uranium in the ash of some of the samples.

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples.

Loc. No.	Location	Thickness		Lithology	eU ²³⁸ /percent		U in Ash ²³⁸ /U in Sample percent	
		Ft.	In.		percent		percent	
1	Greenup Co., Ky. I. L. Griffith's truck mine in unnamed coal 4 miles south of Riverton on State Highway 1 and 0.7 mile east on dirt road. Greenup quadrangle: 7,700' N. 38°30'21" 6,600' E. 82°50'	3		Sandstone, fine-grained, massive				
		1	3	Shale, grayish-black, thin-bedded				
			11	Coal, lower 2" dull	a			
		1	2	Underclay and bone coal				
		1		Coal, bright	a			
			1	Underclay, root imprints				
2	Boyd Co., Ky. Ferguson's truck mine in Coalton coal 1 mile northeast of Coalton on U. S. Highway 60 and 0.6 mile northwest on dirt road. Kenova quad: 20,000' N. 38°20' 21,000' E. 82°50'	1	6	Shale, light-gray, poorly bedded				
			11	Coal, bright, fusain stringers	a			
			2	Shale, brownish-gray				
		2		Coal, lower 1" dull	a			
			1	Underclay, brownish-gray				

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1/ Analysts were Benjamin A. McCall and Julius H. Goode, U. S. Geological Survey.

2/ Analysts were Audrey Pietsch and Joan Smith, U. S. Geological Survey.

3/ Distances from coordinates on published topographic maps are given to permit relocation in case land marks are destroyed.

a Less than 0.001 percent.

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	eU percent	U in	
						ash percent	sample percent
3	Elliott Co., Ky. Stream outcrop of dike rock intruded into Pennsylvanian strata 1 mile west of Stephens on gravel road and in small drain south of road. Kenova quad: 11,600' S. 38°10' 7,700' E. 83°00'			Dike rock, soft, numerous inclusions of sandstone, limestone, and carbonaceous material. Dike rock, hard, few inclusions, scattered phenocrysts	.002 .001		
4	Morgan Co., Ky. Truck mine in Hazard No. 6 (?) coal 1.5 miles southwest of West Liberty on U. S. Highway 460 on south side of gap. Salyersville quadrangle: 25,200' N. 37°50' 18,400' E. 83°20'	2 1	4 1 2 7 8	Coal, medium-banded Flint fire clay Coal, dull Shale, light-gray, not sampled Coal, blocky Underclay, light-gray	a a		
5	Breathitt Co., Ky. Spurlock Coal Co. truck mine in uncorrelated coal 2.5 miles north of Frozen Creek P.O. on State Highway 15 and on hill east of highway. Salyersville quadrangle: 13,200' S. 37°40' 20,500' W. 83°20'	8 2 1	3 4 5 1	Shale, dark-gray, carbonaceous Coal, bright, has $\frac{1}{4}$ " shale parting Shale, light-gray, not sampled Coal, bright, has $\frac{1}{4}$ " shale parting Shale, dark-gray, carbonaceous			a

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	U in	
					percent	sample percent
6	Breathitt Co., Ky. Robert	4		Shale, medium-gray, thin-bedded		
	Hounsshell's truck mine	2		Coal, medium-bright, fusain stringers		
	in Elkhorn No. 2 (?) coal		1	Shale, black, not sampled		
	3 miles north of Elkatawa		2	Coal, moderately bright		
	on gravel road and O.4		3	Shale, carbonaceous, not sampled	a	
	mile west of road.		2	Coal, moderately bright		
	Salversville quad:		1	Shale, carbonaceous, not sampled		
	30,000' N. 37°30'		8	Coal, moderately bright		
7	23,000' W. 83°20'		2	Underclay, root imprints		
	Breathitt Co., Ky.	1		Sandstone, very fine-grained		
	Gramble Little's truck		6	Coal, few pyrite fusain stringers		
	mine in Elkhorn No. 2 (?)		2	Coal, dull		
	coal 1.6 miles west of	1	4	Coal, bright, few fusain stringers	a	
	Jackson on State Highway		6	Coal, bright, thin shale partings		
	30 on north side of highway.	1		Underclay, root imprints		
	Salversville quad:					
	16,200' N. 37°30'					
	21,600' W. 83°20'					
8	Breathitt Co., Ky. Aban-	2		Shale, dark-gray, contains marine fossils		
	doned truck mine in Fire		11	Coal, bright, few fusain and bone partings	a	
	Clay Rider (?) coal 9 miles	1		Shale, carbonaceous		
	east of Booneville on State		4	Coal, thin shale and pyrite partings		
	Highway 30 just east of		2			
	Owsley-Breathitt County	1		Underclay, medium-gray	.001	
	line. Manchester quad:					
	12,400' S. 37°30'					
	13,400' W. 83°30'					

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	eU percent	U in	
						Ash percent	Sample percent
9	Breathitt Co., Ky. M. M.	3		Shale, light-gray			
	Redwine's truck mine in	2	4	Coal, moderately dull			
	Hazard No. 6 coal 6.5	1	1	Shale, carbonaceous, not sampled	a		
	miles north of Jackson	1	2	Coal, bright			
	on State Highway 15 and		1	Shale, silty			
	about 5 miles east on						
	gravel road to left head						
	of Cope Fork.						
	Salversville quad:						
	12,700' S. 37°40'						
	11,400' E. 83°20'						
10	Breathitt Co., Ky. Road cut	1	8	Siltstone, calcareous, has			
	in Magoffin beds 1 mile			marine fossils			
	southeast of Rousseau on	10		Shale, dark-gray, marine fossils	.002		
	State Highway 30.	1	4	Limestone, dense, marine fossils			
	Salversville quad:	1	4	Shale, dark-gray, abundant fossils			
	28,100' S. 47°40'		4	Limestone, fragmental fossils			
	15,500' W. 83°10'		4	Coal, has several thin partings			
		2		Underclay, olive-gray			
11	Magoffin Co., Ky. Truck	5		Shale, light-gray, silty			
	mine in Hazard No. 6 coal	1		Coal, dull			
	10 miles northeast of		1	Shale, carbonaceous, not sampled			
	Rousseau on State Highway	1	11	Coal, mainly dull	a		
	30 and 0.2 mile north up		2	Shale, very carbonaceous, not			
	small drain.			sampled			
	Salversville quad:		1	Coal, bright			
	8,200' S. 37°40'		6	Underclay, light-gray			
	0' 83°10'						

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	eU percent	U in	
						Ash percent	Sample percent
12	Magoffin Co., Ky. Dickson	1		Shale, very carbonaceous			
	Pink's truck mine in		6	Coal, bright			
	Whitesburg coal 0.5 mile		2	Shale, dark-gray, not sampled	a		
	southwest of Ivyton.	2		Coal, moderately dull, few bone partings			
	Prestonsburg quad:						
	14,400' N. 37°40'	1		Underclay, root imprints			
	6,350' E. 83°00'						
13	Magoffin Co., Ky. Domestic	3		Sandstone and shale interbedded			
	opening in Hazard No. 7		4	Cannel coal, moderately bright)			
	coal about 4 miles south	2	5	Coal, few bone partings	a		
	of Swampton on Came Branch		3	Underclay, medium light-gray			
	Salversville quad:						
	22,300' S. 37°40'						
	5,100' W. 83°00'						

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

<u>Loc. No.</u>	<u>Location</u>	<u>Thickness</u> <u>Ft.</u> <u>In.</u>	<u>Lithology</u>	<u>eU</u> <u>percent</u>	<u>U in Ash</u> <u>percent</u>	<u>U in</u> <u>Sample</u> <u>percent</u>
14	Breathitt Co., Ky.	2	Shale, very carbonaceous)		
	United Electric Coal Co.	5	Bone coal, not sampled)		
	strip mine in Helton (?)	5	Coal, moderately bright)		
	coal on ridge 1.5 miles	1	Shale, black, not sampled)		
	northwest of Evanston.	8	Coal, bright)		
	Salversville quad:	2	Shale, grayish-black, not)		
	24,000' N. 37°30'		sampled)		
	13,900' W. 83°00'	2	Coal, moderately dull)		
		4	Shale, black, not sampled)		
		1	Coal, bright)		
		6	Shale and bone, not sampled)		
		9	Coal, moderately bright)		
		2	Bone coal, not sampled)		
		4	Coal, moderately bright)		
		2	Bone coal, not sampled)		
		4	Coal, moderately bright)		
		1	Shale, light-gray, not sampled)		
		4	Coal, moderately bright)		
		4	Shale and bone, not sampled)		
		10	Coal, bright, few pyrite stringers)		
		3	Bone coal)		
		2	Coal, bright)		
		7	Shale, dark-gray, not sampled)		
		1	Coal, bright)		
		2	Shale, very thin-bedded)		
		2	carbonaceous)		

a

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples-Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample percent
		Ft.	In.			percent	percent	
15	Breathitt Co., Ky. United Electric Coal Co. strip mine in Helton (?) coal on ridge 2.5 miles northwest of Evanston. Salversville quad: 23,700' N. 37°30' 21,500' W. 83°00'	40		Sandstone, massive Coal, bright Shale, dark-gray, thin-bedded Coal, moderately bright Cannel coal, dull Coal, bright Bone coal, not sampled Coal, bright Bone coal, not sampled Coal, bright, fusain stringers Bone coal, not sampled Bone coal, moderately dull Shale carbonaceous Coal, mainly bright, fusain stringers Shale, greenish-gray, plant imprints Coal, very bright Bone coal and shale Coal, bright, thin pyrite and fusain stringers, thin shale partings near base Bone coal, not sampled Coal, bright Bone coal, not sampled Coal, bright, fusain stringers Underclay, root imprints				
		2	2					
		7	2					
		2	11					
		2	2					
		5	2					
		4	2					
		1	2					
		2	2					
		1	1					
		3	3					
		1	3					
		3	3					
		3	3					
		4	2					
		2						
		3						
		4						
		7						
		2						
		4						

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample	
		Ft.	In.			percent	percent	percent	percent
16	Knott Co., Ky. Domestic opening in Fugate coal 0.4 mile northeast of Decoy P. O. Salyersville quad: 4,800' N. 37°30' 24,100' W. 83°00'		6	Shale, medium-gray, thin-bedded					
			11	Coal, bright, fusain stringers					
			3	Shale, dark-gray, not sampled					
			9	Coal, bright, fusain stringers					
			4	Shale, dark-gray, not sampled					
			10	Coal, moderately bright					a
		1		Coal, dark-gray, not sampled					
		1	2	Coal, bright					
			1	Underclay, root imprints					
		1		Shale, medium dark-gray					
17	Breathitt Co., Ky. Pond Creek Pocahontas slope mine in Elkhorn No. 3 coal 4 miles southeast of Evans-ton on gravel road. Prestonsburg quad: 3,300' N. 37°30' 1,350' E. 83°00'		6	Bone coal					
			3	Coal, bright					
			2	Bone coal, not sampled					a
		2	5	Coal, bright					
			1	Underclay, root imprints					
				Shale, medium dark-gray					
				Bone coal					
				Coal, bright					
				Bone coal, not sampled					
				Coal, bright					
18	Floyd Co., Ky. Edgemont Fuel Co. rail mine in Elkhorn No. 3, Elkhorn No. 2, and Elkhorn No. 1 coals 0.5 mile south of McDowell on State Highway 122. Pikeville quad: 11,900' N. 37°25' 4,000' E. 82°45'	5		Sandstone, very fine-grained					
		2	4	Coal, bright, few thin shale partings					a
			1	Underclay, light-gray					
		?		Concealed interval					
		5		Sandstone, fine-grained					
		3	9	Coal, mainly bright, few pyrite and fusain stringers					a
			3	Underclay, root imprints					
		?		Concealed interval					
			9	Shale, carbonaceous					
		3	2	Coal, mainly bright, few fusain stringers					a
			1	Shale, light-gray					

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample	
		Ft.	In.			percent	percent	percent	percent
19	Pike Co., Ky. Domestic opening in Elkhorn No. 1 coal about 4 miles south-east of Gulnare on State Highway 304 and 1 mile south on Miller Creek. Harold quad: 100' S. 37°35' 6,600' W. 82°30'	3	6 5 1	Shale, medium-gray Coal, mainly bright, few fusain and thin bone partings Underclay, light-gray, hard	a				
20	Martin Co., Ky. Winco Block Coal Co. rail mine in Coalburg coal 0.5 mile southeast of Naugatuck, W. Va. Naugatuck quad: 11,250' N. 37°45' 2,850' W. 82°20'		1 7 1 4 5 10 4 9 2 6 1	Sandstone, fine-grained Coal, bright Shale, dark-gray, not sampled Coal, bright Shale, medium-gray, not sampled Coal, moderately bright Bone coal Coal, moderately bright Shale, medium-gray, not sampled Coal, moderately bright Underclay, light-gray	a				
21	Logan Co., W. Va. Winisle Coal Co. rail mine in Alma coal 0.5 mile north of Phico on State Highway 10 and 1.5 miles west on gravel road to just north of Godby Branch--Kanawha Branch Gap. Logan quad: 12,900' S. 38°00' 1,300' E. 82°00'		1 6 2 5 7 3	Shale, medium-gray, thin-bedded Coal, bright Coal, dull Coal, moderately bright Coal, moderately dull to dull)	a				

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample percent
		Ft.	In.			percent	percent	
22	Logan Co., W. Va. Superior Eagle Coal Co. truck mine in Chilton coal about 4 miles northeast of Pecks Mill on gravel road. Logan quad: 12,050' N. 37°55' 3,800' W. 81°55'	1	10	Sandstone, very fine-grained				
				Coal, bright, few fusain stringers)				
		2	6	Flint fire clay, dark, not sampled)	a			
				Coal, moderately dull)				
			10	Coal, moderately bright)				
23	Logan Co., W. Va. Switzer Domestic Coal Co. truck mines in Williamson and Island Creek coals 0.6 mile south of Rossmore on U. S. Highway 119. Logan quad: 12,600' S. 37°50' 4,900' E. 82°00'		6	Shale, light bluish-gray				
			11	Coal, bright)				
			1	Bone coal, not sampled)	a			
		2	3	Coal, mainly bright)				
			2	Shale, medium-gray, silty				
		?		Concealed interval				
			1	Shale, medium-gray				
		1	1	Coal, bright, fusain and				
				pyrite stringers)				
		1	4	Coal, moderately dull				
			4	Shale, poorly-bedded, not sampled)	a			
24	Logan Co., W. Va. Utility Coal Co. rail mine in Eagle coal 0.4 mile north of Kistler, Logan quad: 4,550' N. 37°45' 8,150' W. 81°50'	3	6	Coal, moderately bright, several thin bone partings and fusain stringers				
				Shale, carbonaceous	a			
		2	8	Coal, moderately bright				
			1	Shale, medium-gray	a			

Table 2.--Description of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU percent	U in Ash percent	U in Sample percent
25	Logan Co., W. Va. Powell- ton Coal Co. rail mines in Powellton and Eagle (?) coals at Christian. Gilbert quad: 9,300' N. 37°40' 5,500' W. 81°50'	2 1 ? 3 2	Sandstone, fine-grained Coal, medium bright, fusain stringers Underclay, silty, root imprints Concealed interval Shale, irregularly-bedded Coal, bright, several thin shale partings Shale, light-gray	a		
26	Logan Co., W. Va. Domestic opening in Lower War Eagle coal 0.4 mile south of Christian on State High- way 80. Gilbert quad: 7,250' N. 37°40' 5,800' W. 81°50'	6 2 7 3 1	Shale, dark-gray, carbonaceous Bone coal Coal, moderately bright, few dull streaks and fusain stringers Shale, carbonaceous, thin-bedded	a		
27	Logan Co., W. Va. Crystal Block Coal and Coke Co. Mine No. 6 in Upper Cedar Grove and Lower Cedar Grove coals 1 mile south of Sarah Ann on U. S. Highway 119. Gilbert quad: 11,500' N. 37°40' 2,000' E. 82°00'	4 9 3 1 2 ? 6 11 8 1	Shale, thin-bedded, plant imprints Coal, moderately bright, fusain stringers Bone coal Coal, moderately dull Concealed interval Shale, medium-gray, carbonaceous Coal, moderately dull, thin shale parting at base Coal, moderately bright Underclay, root imprints	a		a

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU		U in Ash		U in Sample	
				percent		percent		percent	
28	Mingo Co., W. Va. Dayton	1	Shale, medium light-gray						
	Coal Co. mine in Upper	1	Coal, bright						
	Thacker coal 1.2 miles	2	Coal, dull						
	southeast of Lobata on	8	Coal, bright						
	State Highway 49 and 1.2	2	Coal, dull		a				
	miles east to head of	2	Coal, bright						
	Ferrell Branch.	2	Coal, dull						
	Matewan quad:	11	Coal, bright, thin pyrite lenses)						
	7,100' S. 37°40'		and shale partings near base						
	4,000' E. 82°10'	1	Shale, medium dark-gray						
29	Mingo Co., W. Va. Standard	1	Shale, carbonaceous						
	Alma Coal Co. rail mine in	6	Coal, moderately bright)						
	Alma coal 2 miles south-	1	Bone coal						
	east of Lobata on State	1	Coal, bright		a				
	Highway 49. Matewan quad:	1	Coal, dull						
	11,050' S. 37°40'	2	Coal, bright						
	350' W. 82°10'	1	Coal, dull						
	Mingo Co., W. Va. Crystal	2	Shale, thin-bedded, plant imprints						
	Block Coal Co. rail mine	6	Coal, medium bright						
	in Pond Creek coal 1.5	7	Coal, dull						
30	miles northwest of Merri-	2	Coal, bright, few fusain stringers)		a				
	mac on State Highway 49.	5	Coal, medium bright to dull						
	Matewan quad:	2	Bone coal						
	6,400' S. 37°40'	5	Coal, bright						
	8,650' E. 82°15'	1	Underclay, medium-gray						

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU percent	U in Ash percent	U in Sample percent
34	Letcher Co., Ky. Elkhorn-Jellico Coal Co. abandoned tunnel in Elkhorn No. 3 (?) coal 1.8 miles northwest of Whitesburg on State Highway 15 and 0.3 mile west on small drain. Whitesburg quad: 11,500' S. 37°10' 100' W. 82°50'	1 2 3 1 1 1	Shale, dark-gray, carbonaceous Coal, bright, few pyrite and fusain stringers Underclay, light-gray, plastic Coal, bright Shale, carbonaceous, not sampled Coal	a a a a a	a a a a a	a a a a a
35	Letcher Co., Ky. Ed Sexton's truck mine in Fire Clay coal and Lawrence Maggard's truck mine in Whitesburg coal 5.7 miles north of Whitesburg on State Highway 15 and 0.2 mile west. Whitesburg quad: 4,600' N. 37°10' 700' E. 82°50'	2 2 1 ? 2	Sandstone, fine-grained Coal, bright Flint fire clay, brownish-gray Coal, dull Coal, bright Bone coal Concealed interval Siltstone, light-gray Coal, dull Coal, bright Shale, carbonaceous	a a a a a a a a a	.003 .001 .002 .002 .001 .001 .001 .001 .001	a a a a a a a a a

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample percent
		Ft.	In.			percent	percent	
36	Knott Co., Ky. Abandoned strip mine in Hindman coal 2 miles west of Hindman on State Highway 80 and 2.5 miles northeast to head of Ogden Branch. Hindman quad: 11,500' N. 37°20' 3,450' E. 83°00'	6	4	Shale, light bluish-gray, disc shaped limestone concretions near center, contains marine fossils	.002			
		4	5	Concealed interval				
		4	2	Coal, bright, few pyrite stringers				
			2	Shale, very carbonaceous	a			
			1	Coal, bright)				
			3	Bone coal)				
			5	Coal, bright)	a			
			1	Bone coal)				
37	Knott Co., Ky. Abandoned mines in Hazard No. 7 and Haddix coals 0.5 mile west of Emmalena on State Highway 80 and 0.5 mile north on dirt road. Troublesome quad: 3,100' N. 37°20' 1,400' E. 83°05'	3		Sandstone, fine-grained, massive				
		1	8	Coal, bright, 1/2" shale parting near top)				
			2	Bone coal)	a			
		2	2	Coal, moderately bright)				
			1	Underclay, medium light-gray				
		75		Mostly sandstone, fine-grained				
		1	3	Coal, bright)				
		1	1	Coal, bright, several thin shale partings)	a			
			3	Underclay, medium light-gray				
		1	10	Coal, mainly bright)				
			5	Coal, moderately dull, bony)	a			
			1	Underclay				

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

<u>Loc. No.</u>	<u>Location</u>	<u>Thickness</u> <u>Ft.</u> <u>In.</u>	<u>Lithology</u>	<u>eU</u> <u>percent</u>	<u>U in Ash</u> <u>percent</u>	<u>U in</u> <u>Sample</u> <u>percent</u>
38	Perry Co., Ky. Domestic opening in Fugate coal	4	Shale, weathered olive-gray			
	0.5 mile northwest of Stacy on right fork of Noble Branch.	1 3	Coal, bright)			
		2	Shale, carbonaceous)			
		5	Coal)	a		
		1	Shale, carbonaceous)			
		10	Coal)			
	Troublesome quad:	2	Shale, carbonaceous			
	2,600' S. 37°25'	1 5	Coal, moderately dull	a		
	10,600' E. 83°15'	1	Shale, carbonaceous, poorly-bedded	.002		
		1	Coal, moderately dull	a		
		2	Shale, carbonaceous, thin-bedded			

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU percent	U in	
					Ash percent	Sample percent
39	Perry Co., Ky. Road cuts or abandoned openings in Hindman, Hazard No. 7, and Hazard No. 6 coals about 1 mile west of Hazard along gravel road up Messer Branch. Cornettsville quad: 2,300' S. 37°15' 11,000' E. 83°15'	4	Shale, medium dark-gray			
		1	Coal)			
		3	Bone coal)			
		3	Coal, blocky)	a		
		3	Underclay, plastic			
		112	Concealed interval			
		13	Interbedded sandstone and siltstone			
		20	Sandstone, medium-grained, massive			
		1	Siltstone, carbonaceous, ironstones			
		4	Coal, bright, blocky	a		
		2	Shale, black, hard			
		1	Underclay, medium dark-gray			
		8	Siltstone, medium dark-gray			
		4	Concealed interval			
		21	Sandstone, very fine-grained			
		1	Laminated coal and shale			
		12	Sandstone, very fine-grained			
40	Perry Co., Ky. Road cut in Francis coal about 3 miles southeast of Hazard on State Highway 15 and 2.5 miles south-west on gravel road to head of Buffalo Creek. Cornettsville quad: 13,500' N. 37°10' 8,200' W. 83°10'	1	Laminated coal and shale			
		2	Underclay, not sampled			
		3	Coal			
		3	Underclay, not sampled			
		2	Coal			
		6	Underclay, not sampled			
		3	Coal			
		3	Siltstone, medium-gray			
		3	Coal			
		3	Siltstone, carbonaceous	a		
		10	Shale, dark-gray, unevenly bedded			
		10	Sandstone, very fine-grained			
		8	Coal, bright			
		2	Shale, carbonaceous, not sampled			
		2	Coal			
		8	Underclay, not sampled			
		3	Coal			
		3	Laminated coal and shale			
		2	Underclay, not sampled			
		6	Coal			
		5	Underclay, silty			

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

<u>Loc. No.</u>	<u>Location</u>	<u>Thickness</u> <u>Ft.</u> <u>In.</u>	<u>Lithology</u>	<u>eU</u> <u>percent</u>	<u>U in Ash</u> <u>percent</u>	<u>U in</u> <u>Sample</u> <u>percent</u>
41	Leslie Co., Ky. Phipple Bros. abandoned truck mine in Amburgy coal 2.4 miles north of Hyden on State Highway 257 and 0.1 mile west on Asher Branch. Hyden quad: 6,500' N. 37°10' 9,300' E. 83°25'	5 2	Shale, light-gray, silty Coal, bright Shale, medium light-gray Coal, moderately dull Shale, very carbonaceous	a a		
42	Leslie Co., Ky. Shamrock Coal Co. truck mine in Fire Clay coal 2.1 miles north of Hyden on State Highway 257 and 0.2 mile southwest on right of small drain. Hyden quad: 4,200' N. 37°10' 9,700' E. 83°25'	5 3 1	Shale, plant imprints on bedding Coal, dull Shale, carbonaceous Coal, bright Bone coal Coal, bright, few pyrite and fusain stringers Flint fire clay, brownish-gray Coal, bright Underclay, light brownish-gray	 a .002		
43	Perry Co., Ky. Road cut in Leatherwood coal 3.4 miles south of Slemp on State Highway 448 and 3 miles west on gravel road up Clover Fork. Cornettsville quad: 14,500' N. 37°00' 1,400' W. 83°10'	7 2 1 7 10 10 1 4 1 2 9	Shale, medium dark-gray Coal, bright Coal, dull, fusain stringers Coal, bright Coal, moderately dull Coal, dull and fusain Coal, bright Coal, dull Coal, bright Shale, poorly-bedded, scattered ironstones	 a		

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample percent
		Ft.	In.			percent	percent	
44	Harlan Co., Ky. Inter-national Harvester Mines in "D", "C", and "B" coals 0.8 mile east of Benham on State Highway 160 and 0.2 mile north. Big Stone Gap quad: 11,300' S. 37°00' 5,300' W. 82°55'	1	6	Shale, carbonaceous				
			1	Coal, bright				
			5	Coal, moderately dull	a	.002		a
		1	5	Coal, moderately bright				
			7	Underclay, root imprints				
			9	Laminated coal and shale				
			9	Coal, bright				
			1	Bone coal				
		?		Concealed interval				
		1		Clay, medium-gray carbonaceous				
		4	8	Coal, bright, thin bone partings	.001 (?)	.002		a
			1	Underclay, medium-gray				
		?		Concealed interval				
		2		Sandstone, fine-grained				
		2	4	Coal, moderately bright				
			3	Coal, moderately dull				
			5	Coal, bright	a	.001		a
			6	Coal, dull				
		2		Underclay, silty				
45	Harlan Co., Ky. Mary Helen Coal Corp. rail mine in Low Splint coal about 6.5 miles south-east of Harlan on U. S. Highway 421 and 3 miles northeast to head of Turtle Creek. Nolansburg quad: 4,500' S. 36°50' 8,150' E. 83°15'		6	Shale, medium-gray, plant imprints				
			9	Coal, bright				
			1	Shale, medium-gray	a	a		a
		3	6	Coal, medium bright				
			6	Shale, medium-gray				

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	eU percent	U in Ash percent	U in Sample percent
46	Harlan Co., Ky. Blue Diamond Coal Co. rail mines in Creech and Harlan coals about 5.5 miles southeast of Harlan on U. S. Highway 421 and 1 mile north on Enoch Branch. Harlan quad: 2,500' S. 36°50' 5,500' W. 83°15'	1	3	Shale, thin uneven-bedded Coal, very bright			
			8	Shale, thin-bedded, carbonaceous			
			10	Coal, very bright	.001(?)	.002	a
			2	Shale, very carbonaceous			
			3	Coal, bright)			
			1	Fusain and shale)			
			2	Coal, bright)			
			3	Coal, dull)			
			3	Coal, bright)			
			4	Coal, dull)			
			11	Coal, bright)			
			1	Shale, medium light-gray			
		450		Concealed interval			
			5	Shale, carbonaceous			
			2	Coal, moderately bright)			
			2	Coal, dull)			
			1	Coal, moderately bright)			
			1	Bone coal)			
		3	10	Coal, medium bright)			
					a	.001	a
47	Bell Co., Ky. Better Coal Co. truck mine in Mason (?) coal about 5 miles west of Middle- boro on State Highway 74. Cumberland Gap quad: 16,900' S. 36°40' 15,500' E. 83°50'	1	3	Shale, carbonaceous Coal, moderately bright Bone coal Coal, very bright Shale, very carbonaceous Coal, bright, fusain stringers Shale, medium-gray, poorly-bedded Coal, bright, fusain stringers Sandstone, very fine-grained			
			2	Coal, moderately bright)			
			2	Bone coal)			
			4	Coal, very bright)			
			2	Shale, very carbonaceous)			
			8	Coal, bright, fusain stringers)			
			8	Shale, medium-gray, poorly-bedded)			
		3	1	Coal, bright, fusain stringers)			
		1	1	Coal, bright, fusain stringers)			
		1	1	Sandstone, very fine-grained)			
					a	.001	a

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft.	In.	Lithology	eU percent	U in Ash percent	U in Sample percent
48	Bell Co., Ky. Garmeade Coal Co. rail mine in Red Springs coal about 10 miles west of Middleboro on State Highway 74 and north 1.5 miles to gravel road to head of Stoney Fork. Cumberland Gap quad: 9,300' S. 36°40' 3,000' W. 83°50'	2	6	Shale, medium dark-gray Coal, bright) Underclay, dark-gray) Coal, bright) Coal, dull) Coal, bright) Shale) Coal, bright) Bone coal) Underclay, medium light-gray	.001	.002	.001
49	Bell Co., Ky. Pruden Coal Co. rail mine in Hignite coal about 2.5 miles north of Fondy on State Highway 74 and gravel road to near head of Sowder Creek. Cumberland Gap quad: 16,500' S. 36°40' 13,800' W. 83°50'	1	4	Sandstone, ironstones in base Coal and thin shale partings) Coal, bright, few fusain stringers and pyrite nodules) Underclay, light-gray, plastic	a	.001	a
50	Claiborne Co., Tenn. Pruden Coal Co. rail mine in Rich Mountain coal about 1 mile northeast of Pruden on State Highway 90. Cumberland Gap quad: 26,300' N. 36°30' 19,000' W. 83°50'	3	2	Shale, thin-bedded, plant imprints Coal, bright, thin shale parting) Shale, dark-gray, carbonaceous) Coal, bright, few fusain stringers) Shale, dark-gray, carbonaceous) Coal, bright) Underclay, light-gray, plastic	a	.002	a

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples

Loc. No.	Location	Thickness		Lithology	eU percent	U in Ash		U in Sample	
		Ft.	In.			percent	percent	percent	percent
51	Claiborne Co., Tenn. Pruden Coal Co. strip mine in Mason coal about 2 miles northwest of Pruden on dirt road. Cumberland Gap quad: 30,000' N. 37°30' 18,400' E. 84°00'	2		Shale, light-gray, plant imprints					
		1	5	Coal, moderately bright)					
			1	Clay, light-gray)	a	.001		a	
			4	Coal, moderately bright)					
			3	Shale, very carbonaceous					
		2		Coal, medium bright	a	.002		a	
			1	Underclay, light-gray, plastic					
52	Whitley Co., Ky. Packard Coal Co. truck mine in Jellico coal 4 miles southwest of Williamsburg on State Highway 92 and 1 mile south to left head of Briar Creek. Williamsburg quad: 10,900' N. 36°40' 7,800' W. 84°10'	3		Sandstone, fine-grained					
		2		Coal, bright, few fusain stringers)					
			1	Shale, carbonaceous)	a	.003		a	
			4	Coal, very bright)					
			1	Underclay, medium-gray					
53	Whitley Co., Ky. Bobo and Denham Coal Co. strip mine in River Gem coal 4 miles east of Holly Hill on State Highway 92 and 2 miles north on gravel road. Williamsburg quad: 12,400' N. 36°40' 19,000' E. 84°20'	8		Clay, medium-gray, massive					
			5	Bone coal, pyrite stringers)					
		1	8	Coal, bright)					
			1	Underclay, medium-gray, silty	a	.001		a	

Table 2.--Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples--Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU percent	U in Ash percent	U in Sample percent
54	McCreary Co., Ky. B. R. Campbell & Son Coal Co. truck mine in Blue Gem coal 2.4 miles west on State Highway 92 and 2 miles south on gravel road. Williamsburg quad: 16,500' S. 36°40' 9,800' W. 84°20'	3 7 4 9 2	Shale, dark-gray, ironstone nodules Coal, moderately bright Coal, moderately dull Coal, moderately bright Underclay, root imprints	.002(?) a	a	a
55	McCreary Co., Ky. Stearns Coal & Lumber Co. rail mine in Stearns No. 2 coal 1.5 miles southwest of Barthell on west side of Cumberland River. Barthell quad: 5,200' N. 36°40' 14,600' W. 84°30'	2 3 3 2 5	Shale, dark-gray, thin-bedded Coal, moderately bright Ironstone layer, disseminated pyrite Bone coal and shale	a a .003	a	a
56	McCreary Co. Ky. Stearns Coal & Lumber Co. rail mine in Stearns No. 1½ coal at Worley. Barthell quad: 11,800' N. 36°40' 9,100' W. 84°30'	4 1 2 10 1	Shale, thin-bedded, plant imprints Coal, medium bright Bone coal Coal, moderately bright Shale, medium-gray	a a .001	a	a

Table 2.—Descriptions of rocks tested, measurements of radioactivity, and percent uranium contained in ashed samples—Continued.

Loc. No.	Location	Thickness Ft. In.	Lithology	eU percent	U in Ash percent	U in Sample percent
57	McCreary Co., Ky. Stearns Coal & Lumber Co. rail mine in Stearns No. 1 coal at Oz Station. Barthell quad: 14,900' S. 36°45' 2,300' E. 84°35'	2 2 2 1 1	Sandstone, very fine-grained Coal, bright) Coal, dull) Coal, medium bright) Siltstone, light-gray	a	.002	a
58	Whitley Co., Ky. Osbourne Mining Co. strip mine in Lilly coal 3 miles south of Woodbine on State High- way 26 and 0.5 mile west. Williamsburg quad: 7,600' N. 37°50' 3,400' E. 84°10'	3 7 2 8 6	Shale, plant imprints Coal, bright, pyrite in top) Bone coal) Coal, bright, fusain stringers) Underclay, root imprints	a		
59	Laurel Co., Ky. Pine Creek Coal Co. truck mine in Barren Fork (?) coal about 4 miles south- west of Bernstadt on gravel road. London quad: 10,600' S. 37°10' 19,800' W. 84°10'	4 2 8 1	Shale, silty, thin-bedded Cannel coal) Coal, moderately bright, pyrite) stringers) Cannel coal)	a		

CONCLUSIONS

Coals in the coal fields of eastern Kentucky and Mingo and Logan counties, W. Va. examined during this investigation contain 0.001 percent or less equivalent uranium. Some of the rock associated with the coals contain as much as 0.002 percent equivalent uranium.

No correlation between radioactivity and stratigraphic position nor between radioactivity and structural relationship was detected.

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