RA NO. 63

RECLASSIFICATION AUTHORIZATION

In accordance with the authority delegated to me by memorandum from the General Manager, dated December 6, 1948, subject, "Security Procedures and Policies relating to the Domestic Raw Materials Program" and based on criteria for determining classification, as outlined in Appendix A attached thereto, the documents listed below are reclassified as indicated.

Document and Title Description	Present Classification	Revised Classification
(1) USGS - TEI Report No. 34 "Trace Elements Reconnaissance in Indiana, Illinois, Missouri, Arkansas, and Kentucky" Preliminary Report by John M. Nelson and Edward V. Stratton, dated May 1949	SECRET	UNCLASSIFIED
(2) USGS - TEI Report No. 32 "Placer Deposits of Monazite in North Carolina" Preliminary Report by K. G. Brill, Jr., and G. V. Carroll, dated September 1946	SECRET	UNCLASSIFIED
(3) USGS - TEI Report No. 20 "Trace Elements Reconnaissance in South Dakota and Wyoming" Preliminary Report by A. L. Slaughter and John M. Nelson, dated March 1946	SECRET	OFFICIAL USE ONLY
(4) USGS - TEI Report No. 43 "Radioactivity of Asphaltites, Coals, and Shales in Tennessee, Kentucky, West Virginia, and Pennsylvania" Preliminary Report by J. M. Nelson and K. G. Brill, Jr., dated October 1948	SECRET	UNCLASSIFIED

Feb. 21, 1951 — Jesse C. Johnson

Date

Jesse C. Johnson
Manager
Raw Materials Operations

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

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AEC-63/9

Mr. P. L. Merritt, Assistant Director,
Raw Materials Division,
U. S. Atomic Energy Commission,
P. O. Box 30, Ansonia Station,
New York 23, New York.

Dear Mr. Merritt:

Transmitted herewith are copies 1 through 5 of:

Preliminary Report on Radioactivity of Asphaltites, Coals, and Shales in Tennessee, Kentucky, West Virginia, and Pennsylvania.

Sincerely yours,

Homer B. Hulse
Assistant Director.

Enclosures

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RMOO-143

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RADIOACTIVITY OF ASPHALTITES, COALS, AND SHALES IN TENNESSEE, KENTUCKY, WEST VIRGINIA, AND PENNSYLVANIA

by

J. M. Nelson and E. G. Brill, Jr.

October 1948

Trace Elements Investigations - Report 43

RMOO-143

Classification cancelled
By authority of J.C.J.
RA No. 63, Feb. 21 19
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CONTENTS

ILLUSTRATIONS

(Illustrations at back of report)

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RADIOACTIVITY OF ASPHALTITES, COALS, AND SHALES IN TENNESSEE, KENTUCKY, WEST VIRGINIA, AND PENNSYLVANIA

J. M. Nelson and K. G. Brill

ABSTRACT

The radioactivity of asphaltites, coals, and shales of Pennsylvanian and Permian age was measured at 101 localities in Tennessee, Kentucky, West Virginia, and Pennsylvania. The radioactivity of the asphaltites and coals ranged from 0.000 to 0.004 percent equivalent uranium, and that of shales ranged from 0.001 to 0.011 percent equivalent uranium. The most radioactive shales were immediately above coals in western Kentucky. None of the materials examined in this investigation are of interest in comparison with other known large reserves of low-grade uranium-bearing rock.

INTRODUCTION

The radioactivity of asphaltites, coals, and shales of Paleozoic age was investigated in the spring of 1945 in Tennessee, Kentucky, West Virginia, and Pennsylvania by Kenneth G. Brill, Jr. and John M. Nelson.

A few shales associated with coals and black shales are known to be more highly radioactive than most sedimentary rocks /. Also,

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/ Beers, R. F., Radioactivity and organic content of some Paleozoic shales: Am. Assoc. of Petroleum Geologists Bull., Vol. 29, pp. 1-22, 1945.
Brill, K. G., Nelson, J. M., and Prouty, C. E., Preliminary

~~SECRET~~

report, Trace Elements Investigations, Hickman and adjacent counties, Tennessee; U. S. Geol. Survey Trace Elements Investigations Rept. 8, unpublished, 1945.

Russell, W. L., The total gamma-ray activity of sedimentary rocks as indicated by Geiger counter determinations: Geophysics, Vol. 9, pp. 187-192, 1944.

Slaughter, A. L. and Nelson, J. M., Trace elements reconnaissance in South Dakota and Wyoming, preliminary report: U. S. Geol. Survey Trace Elements Investigations Rept. 20, pp. 13-17, 1946.

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because of similarities in the organic content of some black shales and asphaltites, it was thought that asphaltites might also be radioactive. The purpose of the investigation was to determine whether any of these rocks within the area discussed in this report were unusually radioactive. Mr. Brill planned and supervised the field work. Upon his departure from full-time duties with the Geological Survey, the report was written by Mr. Nelson.

MEASUREMENTS OF RADIOACTIVITY

All radioactivity measurements given in this report were made by placing the Geiger-Mueller tube of the portable field counter against a portion of the outcrop for a period of three minutes. These outcrop tests indicate the number of gamma rays per unit time, which pass through the sensitive portion of the counter tube. The relation of the number of gamma rays, per unit time, recorded at the outcrop to the equivalent uranium content of the rock was obtained by correlating the radioactivities of a large number of outcrops with the equivalent uranium contents of samples collected from the outcrops. The correlation is described by the writers in Trace Elements Investigations Report No. 22.

The accuracy of the outcrop measurements of radioactivity is limited by several variables. The most important of these are described

below.

The number of gamma rays passing through the counter tube per unit time are functions of the solid angle and shielding matter between the counter tube and the source of the gamma rays. Thus, more gamma rays are recorded per unit time if the radioactive part of the outcrop is large and fewer if the radioactive part of the outcrop is small. Likewise, more gamma rays are recorded if the tube is located in a reentrant in the outcrop than if the tube is located on a protuberance. Also, a fragment of radioactive mineral immediately adjacent to the counter tube might indicate a high degree of radioactivity for the outcrop, whereas a channel sample, not including this fragment of radioactive mineral, would show little or no radioactivity. Conversely, the tube might be placed on a barren spot on the outcrop and indicate a lower radioactivity than the sample from the same outcrop which, by chance, contains one or more fragments of a radioactive mineral. These chance errors in gamma-ray tests may be reduced by increasing the number of observations.

The number of cosmic rays actuating the counter increases with altitude and, for the differences in elevation in the area investigated, the maximum error arising from this source will be less than 0.0005 percent equivalent uranium.

The theoretical and observed statistical errors in outcrop tests were computed by the methods outlined by Heber _/. For a three-minute

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_/ Strong, John, et. al., Procedures in experimental physics, p. 300, New York, Prentice-Hall, 1944.

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observation of rocks having an equivalent uranium content of 0.002 percent, the probable error is about 0.00026 percent equivalent uranium; for rocks of 0.005 percent equivalent uranium content, the probable error is about 0.00035 percent equivalent uranium; for rocks having 0.011 percent equivalent uranium content, the probable error is about 0.0005 percent equivalent uranium. The relation of actual errors to probable error is very roughly: 50 percent of the actual errors will be less than the probable error; 82 percent of the errors will be less than twice the probable error; 96 percent of the errors will be less than thrice the probable error; 99.4 percent of the errors will be less than four times the probable error. The probable errors refer only to the probable differences in radioactivity noted on repeated measurements at the outcrop without moving the counter tube. The probable errors do not include errors arising from the infinite number of geometric relations of counter tube to outcrop.

RADIOACTIVITY OF THE ROCKS

Asphaltites

Asphaltites of Pennsylvanian age were tested at four localities in central Kentucky (see appendix and pl. 1). Their radioactivities range from 0.000 to 0.002 percent equivalent uranium. This is about normal for non-asphaltic sandstones. The asphalt, therefore, is

essentially non-radioactive. The oil in the sandstones has migrated from other source rocks and it is possible that the source rocks might be more radioactive.

Coals

Field measurements of radioactivity were made on coal seams in western and eastern Kentucky, Tennessee, West Virginia, and Pennsylvania (pls. 1 and 2). Cannel, bituminous, and anthracite coals were measured (figs. 1 and 2). Locality, lithology, and radioactivity of the individual coals are tabulated and described in the appendix.

The radioactivity of the coals ranges from 0.000 to 0.004 percent equivalent uranium and the average of 75 outcrop radioactivity measurements is 0.0013 percent equivalent uranium. No correlation was found between the type of coal, or geographic position of the coal, and radioactivity. The average radioactivity of the coals was less than the average radioactivity of other rocks.

Shales

The radioactivity of Paleozoic shales in Tennessee, Kentucky, West Virginia, and Pennsylvania was determined by 159 outcrop tests, (see pls. 1 and 2 and appendix). The content of equivalent uranium in the shales ranged from 0.001 to 0.011 percent equivalent uranium and averaged 0.0026 percent (figs 1 and 2). No positive correlation was found between radioactivity of the shales and color, contained nodules and fossils, or age. However, two positive correlations are suggested; 1) position with respect to the coal seam, and 2) geographical location.

The following data suggests that the shales above the coals are relatively higher in radioactivity at more localities than the shales below coals. The 75 shales tested above coals range from 0.001 to 0.011 percent equivalent uranium and six of these shales have a radioactivity of more than 0.005 percent equivalent uranium. The 47 shales tested below coals have a lesser range, 0.001 to 0.005 percent equivalent uranium.

The shales appear to be more radioactive in western Kentucky than in eastern Kentucky, West Virginia, Tennessee, and Pennsylvania. In the former area the outcrop tests range from 0.001 to 0.011 percent equivalent uranium and average 0.0036 percent equivalent uranium. Five of the six most radioactive shales were found in this area. The highest is at locality 166. In the areas other than western Kentucky the 135 outcrop tests indicate from 0.001 to 0.0065 percent equivalent uranium and the average is 0.0027. Farther to the west in Oklahoma, Russell _/ finds the average radioactivity of the shales to be about

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_/ Russell, W. L., op. cit., p. 180, 1944.

0.0045 percent equivalent uranium. It seems possible that the apparent increase in radioactivity toward the west reflects the decrease in grain size of the sediments away from their source.

CONCLUSIONS

None of the rocks examined in this investigation are of interest in comparison with other known large reserves of low-grade uranium-bearing rocks. The greater radioactivity of some shales associated with

scale in western Kentucky may be of some significance in relation to regional variations in radioactivity of black shales. Any such significance, however, cannot be appraised on the basis of data now available.

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
Bn-139—	Grundy Co., Tenn. Southeast of Coalmont on dumps from Mine A.			
	Pennsylvanian rocks			
	Dumps composed of coal and shales			
	Dump at end of truck	1		0.001
	Burned dump	2		0.002
Bn-149—	Van Buren Co., Tenn. About 0.8 miles east of Spencer at Jack Hit coal mine on north side of Tenn. Highway 30.			
	Pennsylvanian rocks			
	Ben Air coal 2 feet thick	1	2.0	0.002
Bn-151—	White Co., Tenn. About 4 miles east of Sparta on east side of U. S. Highway 70 S.			
	Pennsylvanian rocks			
	Whitwell shale. Dark gray shale with lenses of quartzite and siltstone.	1	15.0	0.002
Bn-153—	White Co., Tenn.			
	Dumps from Ravenscroft mine.			
	Ravenscroft coal and shale dumps 16 tests averaging			0.002
	Burned dump, average of 6 tests			0.004
Bn-152A—	White Co., Tenn. About 4.5 miles southeast of DeRossett on Clifty road.			
	Pennsylvanian rocks			
	Clifty coal			
	Roof shale, dark-gray	2	3.0	0.003
	Clifty coal	1	2.5	0.003
Bn-162—	Christian Co., Ky. At Empire strip coal mine about 2.5 miles west of U. S. Highway 41.			
	Pottsville rocks			
	Fossiliferous limestone			
	Dark-gray silty overcoal	2	6.0	0.001
	Coal No. 4	1	3.0	0.001

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-162A	About ½ mile north of Empire on east side of U. S. Highway 41. OK			
	Pottsville rocks			
	Dark-gray silty overcoal			0.003
	Coal No. 4			0.001
BR-163	Hopkins Co., Ky. About ½ mile south of Mannington on east side of U. S. Highway 41. OK			
	Lower Pennsylvanian rocks			
	Gray shale	1	13.0	0.003
	Gray shale	2	5.0	0.002
	Gray shale	3	1.5	0.009
	Gray shale	4	1.0	0.006
	No. 6 coal	5	1.0	0.003
	Gray shale	6	4.0	0.003
	Gray-brown shale, with calcareous nodules	7	4.0	0.002
	Dark-gray coaly siltstone	8	6.0	0.004
BR-164	Hopkins Co., Ky. About ½ mile north of St. Charles At Miller Clarkson Const. Co. strip mine. OK			
	Pennsylvanian rocks.			
	Yellow-brown shale, base of	1	5.0	0.003
	Gray shale		1.0	
	Black fissile gypsiferous shale	2	1.5	0.006
	" " " "	3	1.5	0.006
	Coal No. 9	4	4.0	0.000
	Clay, top of	5		0.002
BR-165	Hopkins Co., Ky. About 5 miles southwest of St. Charles in strip mine of White Consolidated Coal Co. OK			
	Pennsylvanian rocks.			
	Gray shale	3	1.0	0.002
	" "	2	1.0	0.002
	No. 6 coal, top of	1		0.000
BR-166	Hopkins Co., Ky. About 3 miles north of Ilsley in cut on west side of portal to Norton Coal Co. Adit OK			
	Pennsylvanian rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Dark-gray clay	6		0.002
	" " "	5		0.004
	Coal No. 12			
	Gray shale and brown sandstone	4	6.0	0.001
	Providence limestone	3	6.0	0.001
	Dark-gray clay	2	0.5	0.011
	Coal No. 11	1	4.0	0.000
BP-167	Hopkins Co., Ky. About 3 miles west of Madisonville at Century Coal Co. strip mine.			
	Middle Pennsylvanian rocks.			
	Light-gray shale	5	1.0	0.002
	" " "	4	0.6	0.003
	Coal		0.5	
	Light-gray shale	3	0.4	0.003
	Gray clay with coal seams	2	0.7	0.003
	Coal No. 14	1	4.0	0.000
BP-168	Hopkins Co., Ky. About 3 miles north of Nebo at abandoned Nashville Coal Co. strip mine.			
	Pennsylvanian rocks			
	Light-gray shale		15+	
	Dark-gray shale	1	0.5	0.002
	" " " with Myalina		0.2	
	Coal No. 15		3.0	
BP-169	Breckinridge Co., Ky. About 1 mile south of U. S. Highway 60 on south side of abandoned Victoria-Cloverport coal railroad.			
	Small oil seep in lower Pennsylvanian (Pottsville) sandstone. Tested on oily sandstone at water-level of spring.	1		0.002
BP-170	Breckenridge Co., Ky. About ½ mile southwest of Garfield on U. S. Highway 60.			
	Natural asphaltic sand dump alongside R.R. and hauled from quarry in Pottsville sandstone about 3 miles to the south.	1		0.002
BP-173	Edmonson Co., Ky. Town of Asphalt about 500 feet south of Post Office in quarry on east side of Kentucky Highway 67.			
	Pennsylvanian (Pottsville)			
	Sandstone impregnated with natural asphalt	1		0.001

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-174	Edmonson Co., Ky. About 1 mile east of Lindseyville in quarry operated by Kyrock Asphalt Co. SEGAL			
	Pennsylvanian (Pottsville)			
	Sandstone impregnated with natural asphalt	1		0.000
BR-180	Laurel Co., Ky. About 2 miles south of London on east side of U. S. Highway 25 E.			
	Pennsylvanian (Pottsville) rocks. GK			
	Dark-gray silty shale	1		0.002
	Robinson Creek Coal (Lily coal)	2	6.0	0.000
	Dark-gray silty shale	3		0.002
BR-181	Bell Co., Ky. On left fork of Straight Creek in road cut across the tracks from the Crockett Fuel Co. Mine Office. 3MI NW OF LAYMAN			
	Pennsylvanian (Pottsville) rocks.			
	Light-gray shale 1 foot above #4 coal	4	20	0.002
	Top of #4 coal	3		0.000
	Center of gray shale below #4 coal and 2 feet above 10-inch coal	2		0.002
	Shale 1.5 feet below 10-inch coal	1		0.002
BR-182	Bell Co., Ky. Cut on east side of road on the Left Fork, Straight Creek about 50 feet stratigraphically above Straight Creek coal and just upstream from the first tipple that crosses the road. 3MI NW OF MOLUS			
	Dark-gray shale containing many concretions.	1		0.002
BR-183	Bell Co., Ky. Road cut on Left Fork of Straight Creek downstream from first tipple that crosses the road. 3MI NW OF MOLUS			
	Pennsylvanian (Pottsville)			
	Straight Creek or Jellico Coal	1	4.0	0.000

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BH-184—	Bell Co., Ky. Road cut on Left Fork, Straight Creek about 1.5 miles upstream from U. S. Highway 119.			
	Pennsylvanian (Pottsville).			
	Dark-gray thin-bedded shale	1	10.0	0.003
	Unnamed coal about 60 feet below Straight Creek Coal		0.8	
BH-185—	Bell Co., Ky. East side of U. S. Highway 25 E about 3/4 mile south of junction with U. S. Highway 119 on east side of Pine Mountain fault. AT HARBELL?			
	Pennsylvanian (Pottsville).			
	Dark-gray shale with a few concretions.	1	20.0	0.002
BH-186—	Bell Co., Ky. North side of U. S. Highway 119 about 1 mile northeast of junction with Highway 25 E. AT PGH 24 ★			
	Pennsylvanian (Pottsville).			
	Black fissile silty shale with numerous pelecypods.	1	6.0	0.003
BH-187—	Harlan Co., Ky. About ¼ mile south of Cornett Coal Co., on west side of Kentucky Highway 38, near Closplint. OK			
	Pennsylvanian (Pottsville).			
	Dark-gray thin-bedded shale	1	3.0	0.002
	" " " " "	2	3.0	0.003
	Darby coal seam	3	2.0	0.001
BH-188—	Harlan Co., Ky. At north edge of High Splint on west side of Kentucky Highway 38. OK			
	Pennsylvanian (Pottsville).			
	Gray hackly shale	1	1.8	0.004
	Harlan coal seam		1.0	

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-190	Knott Co., Ky. About 1.2 miles east of Sassafras on south side of Kentucky Highway 15.			
	Pennsylvanian (Pottsville) rocks.			
	Gray shale with small sandy concretions and plant fragments	2	2.5	0.002
	Coal (No. 4 coal?)		0.2	
	Gray clay	1	1.2	0.003
	Coal		0.2	
BR-191	Perry Co., Ky. About 4 miles east of Hazard on south side of Kentucky Highway 15.			
	Pennsylvanian (Pottsville) rocks.			
	Black fissile silty shale	1	4.0	0.003
	Four coal beds interbedded with gray shale.		6.0	
BR-192	Breathitt Co., Ky. About 1 mile southeast of Van Cleve on north side of Kentucky Highway 15.			
	Pennsylvanian (Pottsville) rocks.			
	Dark-gray fissile silty shale	1	1.5	0.002
	" " " " "	2	1.5	0.002
	Coal seam		2.0	
BR-198	Morgan Co., Ky. About 6 miles east of West Liberty at coal mine on Bush Fork.			
	Pennsylvanian (Pottsville) rocks.			
	Yellow sandstone		10.0	
	Interbedded coal and shale	1	1.0	0.001
	Cannel coal No. 2	2	4.0	0.001
BR-199	Morgan Co., Ky. Just north of Cannel City on west side of Kentucky Highway 191 at portals of Richardson's Cannel Coal mines.			
	Pennsylvanian (Pottsville) rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Yellow sandstone		10.0	
	Soft gray shale		1.0	
	Bituminous coal		0.6	
	Soft gray shale	2	0.3	0.002
	Cannel coal No. 2	1	1.5	0.000
HH-200	Johnson Co., Ky. About 1 mile northeast of Paintsville on east side of road at North East Coal Co. Mine. OK			
	Pennsylvanian (Pottsville) rocks.			
	Massive sandstone	1	10.0	0.001
	Bituminous coal	2	4.0	0.000
	Gray siltstone	3	1.0	0.002
HH-201	Johnson Co., Ky. About 2 miles east of Paintsville on south side of Kentucky Highway 40. OK			
	Pennsylvanian (Pottsville) rocks.			
	Thin-bedded micaceous gray shale	1	4+	0.002
	Bituminous and cannel coal	2	0.5	0.002
HH-202	Mingo Co., W. Virginia, near Red Jacket at Mine No. 5 on Mitchell Branch. 1 MI NE OF K2 OK			
	Pennsylvanian rocks. Kanawha			
	Yellow-brown sandstone		6.0	
	Lower Thacker or Lower Cedar Grove coal.	1	4.0	0.000
	Gray clay	2	1.0	0.001
HH-203	Mingo Co., W. Va. Red Jacket mine No. 32 on Mitchell Branch. AT OK			
	Pennsylvanian (Kanawha) rocks.			
	Gray overclay	1	6+	0.001
	Red Jacket or Upper Cedar Grove coal	2	4.0	0.000
	Gray underclay	3	3.0	0.002
HH-204	Mingo Co., W. Va. Between Matewan and Red Jacket at Mine No. 6. 1 MI SW OF K2			
	Pennsylvanian (Kanawha) rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Overclay	1	2.0	0.002
	Alma coal		3.0	
	Light-gray underclay	2	2.0	0.001
BR-205	Mingo Co., W. Va. About 2 miles northwest of Matewan on east side of West Virginia Highway 49. GK			
	Pennsylvanian (Kanawha) rocks.			
	Gray-brown sandstone containing calamites		6.0	
	Interbedded coal and shale	1	1.5	0.003
	Gray shale	2	3.0	0.002
BR-206	Logan Co., W. Va. Wilbur coal mine at Rita on the north side of the tracks. GK			
	Pennsylvanian (Kanawha) rocks.			
	Thin-bedded sandstone			
	Eagle coal seam	1	4.0	0.001
	Light-gray underclay	2	1+	0.003
BR-207	Logan Co., W. Va. George's Creek Coal Co. at No. 3 portal at Hetzel. GK			
	Pennsylvanian (Kanawha) rocks.			
	Medium-gray shale		6.0	
	Coal		0.1	
	Medium-gray shale	1	2.5	0.002
	Chilton coal		4.0	
BR-208	Boone Co., W. Va. About 1 mile south of Peytona at entrance to old mine on Mr. Babe McCormick's property. GK			
	Thin-bedded brownish-gray shale	1	1.0	0.002
	Factory cannel coal	2	2.8+	0.001
	Water covers base of coal			
BR-209	Boone Co., W. Va. About 1.2 miles north of Racine on west side of U. S. Highway 119. GK			
	Pennsylvanian (Kanawha) rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Medium-gray shale	1	3.0	0.002
	No. 2 Gas coal		3.0	
	Gray shale	2	2.0	0.002
BR-210	Boone Co., W. Va. About 1.95 miles north of Racine on east side of U. S. Highway 119. OK			
	Pennsylvanian (Kanawha) rocks.			
	Brownish-gray sandy shale	1	5.0	0.001
	Coal and shale		2.0	
	Light and dark-gray shale	2	3.0	0.002
	Coal	3	0.4	0.002
	Light-gray shale	4	2.0	0.002
BR-211	Boone Co., W. Va. About 2 miles north of Racine on east side of U. S. Highway 119. OK			
	Pennsylvanian (Kanawha) rocks.			
	Bluish-gray micaceous shale.	1		0.001
	Coal		0.7	
	Shale and coal, calcareous	2	3.0	0.002
	Coal	3	1.8	0.001
	Bluish-gray shale	4	3.0	0.003
BR-212	Boone Co., W. Va. About 2.4 miles north of Racine on east side of U. S. Highway 119. OK			
	Pennsylvanian (Kanawha) rocks.			
	Buff micaceous shale	1	2.0	0.003
	Bituminous coal	2	1.1	0.003
	Light-gray shale		5.0	
BR-213	Kanawha Co., W. Va. About 0.7 miles west of Handley on southwest side of W. Va. Highway 61 in bluff above Kanawha River. OK			
	Pennsylvanian rocks.			
	Dark-gray thin-bedded shale	1	0.2	0.001
	Bituminous and cannel coal		2.0	
	Dark shale and coal	2	3.0	0.002

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-214	--Fayette Co., W. Va. South of Mt. Hope on west side of U. S. Highway 21. OK			
	Pennsylvanian rocks.			
	Thin-bedded buff shale	3	6.0	0.001
	Coal (Sewell seam) Sewell fm + coal is in Pottsville G.P		3.0	
	Black fissile shale, top of	2	3.0	0.002
	" " " , base of	1		0.002
BR-215	--Fayette Co., W. Va. Beelick Knob behind Alaska Coal Mining Co. machine shop. OK			
	Purplish-gray to black shale	1	3.0	low
	Coal (Pocahontas No. 6) Pocahontas fm in Pottsville G.P		4.0	
	Light-gray shale	2	1.0	160
BR-216	--Greenbrier Co., W. Va. About ½ mile east of company store in Leslie at strip mine of New River and Pocahontas Coal Co. OK			
	Pennsylvanian rocks.			
	Dark-gray fissile shale / Pottsville	1	8.0	0.002
	Sewell coal		5.0	
BR-217	--Nicholas Co., W. Va. On west side of U. S. Highway 19 between Summersville and Sutton and 1 mile south of Muddlety, Nicholas County. 2 MI S OF TIOGA			
	Pennsylvanian (Kanawha) rocks.			
	Dark-gray thin-bedded shale containing Lingula	1	3.0	0.002
	Coal (Coalburg "A")		0.3	
	Light-gray clay	2	1.0	0.004
BR-218	--Nicholas Co., W. Va. About 4.9 miles north of Muddlety on west side of U. S. Highway 19. 2 MI E OF BIRCH RIVER			
	Pennsylvanian (Allegheny) rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Black coal and clay	1	1.0	0.002
	Bituminous coal	2	3.0	0.001
	Soft gray shale	3	1.0	0.003
	Light-brown sandy shale		30.0	
	Coal	4	0.3	0.002
	Gray shale		2.0	
BX-219	Braxton Co., W. Va. About 1.4 miles south of Little Birch on west side of U. S. Highway 19. OK			
	Pennsylvanian (Allegheny) rocks.			
	Brown shale			
	Coal	1	1.5	0.001
	Soft light-gray shale	2	1.0	0.004
	Interbedded sandstone and shale		14.0	
	Dark-gray shale	3	4.0	0.001
	Coal		0.5	
	Dark-gray shale		1.0	
	Coal lens	4	0.5	0.001
	Gray sandstone			
BX-220	Braxton Co., W. Va. About 1 mile south of Tesla at abandoned mine entry east of U. S. Highway 19. OK			
	Pennsylvanian rocks.			
	Dark-gray shale	1	1.5	0.003
	Coal		2.0	
	Dark-gray shale	2	1.0	0.003
BX-221	Braxton Co., W. Va. About 1.9 miles upstream from Bulltown on west side of U. S. Highway 19. GK			
	Pennsylvanian rocks			
	Dark-gray fissile shale	1	0.3	0.001
	Coal, shaly	2	3.0	0.002
	Dark-gray shale	3	1.0	0.002

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Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-222--	Braxton Co., W. Va. About 3.5 miles north of Bulltown on west side of U. S. Highway 19. OK			
	Pennsylvanian (Conemaugh) rocks.			
	Light-gray sandstone		20.0	
	Coal		1.0	
	Gray shale and brown sandstone	1	3.0	0.003
	Black to gray shale	2	15.0	0.003
	Coal and shale	3	2.0	0.001
BR-223--	Lewis Co., W. Va. About 1 mile west of Lorentz on north side of U. S. Highway 33. ok			
	Pennsylvanian (Monongahela) rocks.			
	Dark-gray fissile shale	1	15.0	0.002
	Coal		2.5	
	Gray shale	2	1.0	0.004
	Coal		0.3	
	Gray, shale			
BR-224--	Upshur Co., W. Va. About 5.8 miles west of Ellamore on north side of U. S. Highway 33. OK			
	Pennsylvanian rocks.			
	Thin-bedded black shale	1	2.0	0.001
	Coal		2.0	
	Shale and covered interval		4.0	
	Brown thin-bedded sandstone		4.0	
	Dark-gray clayey shale	2	3.0	0.001
	Coal		2.0	
BR-225--	Upshur Co., W. Va. About 15.3 miles west of Ellamore on north side of U. S. Highway 33 in front yard of farmhouse. OK			
	Pennsylvanian (Allegheny) rocks.			
	Light-gray thin-bedded shale	1	3.0	0.006
	Bituminous coal		1.5	
	Light-gray clay		2.0	

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Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-226--	Upshur Co., W. Va. About 2.5 miles west of Ellamore on north side of U. S. Highway 33. OK			
	Pennsylvanian (New River?) rocks.			
	Light purplish tan shale.	1	4.4	0.003
	Black shaly coal		0.8	
	Light-gray clay			
BR-227--	Upshur Co., W. Va. About 1.5 miles west of Midvale at abandoned mine on north side of dirt road. OK			
	Pennsylvanian (New River) rocks			
	Dark-gray to black shale	1	1.2	0.004
	Cannel coal	2	0.3	0.002
	Bituminous coal		2.7	
BR-228--	Randolph Co., W. Va. Abandoned portal of Antili Coal Co. just north of tipple, Harding, Randolph Co. OK			
	Pennsylvanian (Allegheny) rocks.			
	Dark-gray thin bedded shale	1	3+	0.004
	Bituminous coal	2	2.0	0.002
	Black shale and coal	3	2.0	0.002
	Coal, base covered	4	2.0	0.002
BR-229--	Barbour Co., W. Va. About 6 miles west of Philippi and 3/4 miles north of W. Va. Highway 57. OK			
	Pennsylvanian (Monongahela) rocks			
	Dark-gray silty shale	1	10+	0.004
	Coal (Redstone)		4.0	
	Light-gray nodular shale	2	13.0	0.003
	Coal (Pittsburgh)	3	2.5	0.003
	Gray nodular shale	4	2.0	0.004
	Coal (Pittsburgh)		3.0+	
BR-230--	Harrison Co., W. Va. About 3.5 miles south of Nutter Fort on east side of W. Va. Highway 20 about 2.5 miles north of junction with W. Va. Highway 57. OK			

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Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Pennsylvanian (Conemaugh) rocks.			
	Brown and black shale		7.0	
	Black thin-bedded shale with pyritized gastropods, productids	1	4.0	0.003
	Coal.	2	2.0	0.002
BR-231	-- Harrison Co., W. Va. About 2.5 miles west of Clarksburg post office at abandoned mine on south side of U. S. Highway 50. OK			
	Pennsylvanian rocks			
	Brownish-gray thin-bedded shale	1	3+	0.002
	Coal (Pittsburgh)	2	5+	0.001
BR-232	-- Harrison Co., W. Va. About 10 miles west of post office in Clarksburg and 2.6 miles east of Salem on south side of U. S. Highway 50. OK			
	Pennsylvanian (Monongahela) rocks.			
	Greenish-gray sandstone			
	Brownish-gray shale	1	1.5	0.003
	Black carbonaceous shale	2	0.3	0.001
	Coal		1.0	
BR-233	-- Harrison Co., W. Va. Railroad cut on south side of Hepzibah and on east side of U. S. Highway 19. OK			
	Medium-gray thin-bedded shale	1	1+	0.001
	Coal (Pittsburgh)	2	7.5	0.001
	Light gray massive shale	3	2+	0.004
BR-234	-- Marion Co., W. Va. About 0.6 mile west of Worthington on north side of road to Farmington. OK			
	Pennsylvanian (Monongahela) rocks.			
	Light-gray soft shale	1	1.0	0.002
	Dark-gray blocky shale	2	1.0	0.002
	Coal (Waynesburgh)		4.0	
	Dark-gray shale	3	0.6	0.004

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-235--	Marion Co., W. Va. About 2.2 miles northwest of Worthington on north side of road to Farmington. OK			
	Permian (Dunkard) rocks.			
	Dark-gray shale	1	0.7	0.001
	Light-gray shale	2	1.5	0.001
	Dark-gray shale	3	0.5	0.003
	Coal (Washington)		0.8	
	Buff coaly clay	4	2.0	0.004
BR-236--	Marion Co., W. Va. About 3/4 miles south of Farmington on road to Worthington. OK			
	Permian (Dunkard) rocks.			
	Black shale	1	24	0.003
	Coal (Washington)		2.0	
	Black fissile shale	2	0.4	0.002
	Coal		1.5	
	Light-gray clay	3	2.0	0.004
BR-237--	Marion Co. W. Va. At city limits on west side of Mannington on east side of U. S. Highway 250. OK			
	Permian (Dunkard) rocks.			
	Light-gray, thin-bedded shale	1	14	0.002
	Coal		1.0	
	Dark-gray shale	2	1.0	0.005
	Interbedded sandstone and shale		15.0	
	Brown sandstone and shale	3	2.0	0.003
	Coal		1.0	
	Medium-gray micaceous shale	4	3.0	0.003
	Gray micaceous sandstone		3.0	
BR-238--	Marion Co., W. Va. About 5.3 miles north of Mannington on northeast side of U. S. Highway 250. OK			
	Permian (Dunkard) rocks.			
	Calcareous nodules and clay		0.5	
	Medium-gray shale	1	3.0	0.002
	Shaly coal	2	1.0	0.002
	Light gray shale	3	14	0.002

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-239--	Monongalia Co., W. Va. North side of W. Va. Highway 7 about ½ mile east of junction with U. S. Highway 250. AT STEIGUD			
	Permian (Dunkard) rocks.			
	Soft light gray shale	1	3.0	0.005
	Coal	2	0.8	0.003
	Medium-gray thin-bedded shale	3	3+	0.003
BR-240--	Monongalia Co., W. Va. About 3.4 miles east of Pentress on north side of W. Va. Highway 7. OK			
	Permian (Dunkard) rocks.			
	Brown shale	1	2.0	0.002
	Black thin-bedded shale	2	1.0	0.002
	Shaly coal		0.5	
	Dark-brown shale	3	1.0+	0.002
BR-241--	Monongalia Co., W. Va. About 2 miles east of Core on west side of W. Va. Highway 7. OK			
	Burned dump from Sewickley coal seam mined at Cassville ½ mile to the east.	1		0.000
BR-242--	Monongalia Co., W. Va. Pursglove tipple on north side of W. Va. Highway 7. OK			
	Pennsylvanian (Monongahela) rocks.			
	Brown limestone		15.0	
	Light-gray shale	1	8.0	0.003
	Coal (Sewickley seam)	2	4.0	0.001
	Medium-gray shale	3	1+	0.003
BR-243--	Monongalia Co., W. Va. About 1 mile west of Granville on north side of W. Va. Highway 7. OK			
	Pennsylvanian (Monongahela) rocks.			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Gray shale and sandstone	1	10.0	0.003
	Coal (Pittsburgh)		1.0	
	Medium-gray shale with interbedded gray limestone	2	5.0	0.002
BR-244	-- Monongalia Co., W. Va. About 2 miles east of Easton on north side of W. Va. Highway 73. OK			
	Pennsylvanian (Monongahela) rocks.			
	Dark-gray blocky shale			
	Coal	1	0.5	0.000
	Black fissile shale	2	1.0	0.002
	Coal		5.0	
BR-245	-- Monongalia Co., W. Va. About 6 miles east of Easton on north side of W. Va. Highway 73. OK			
	Pennsylvanian rocks.			
	Light-gray shale	1	2+	0.002
	Coal	2	1.5	0.001
	Buff clay	3	2+	0.002
BR-246	-- Preston Co., W. Va. About 0.3 miles west of Bruceton Mills on north side of W. Va. Highway 73. OK for Allegheny			
	Pennsylvanian rocks.			
	Gray-brown shale and sandstone	1	3.0	0.002
	Coal (Lower Kittanning)	2	5.0	0.001
	Dark-gray shale	3	1.5	0.002
	Light-gray shale	4	2+	0.003
BR-247	-- Fayette Co., Pa. About 1 mile northeast of W. Va. state line on north side of Pa. Highway 281. 1 MI W OF MARKLEYSBURG			
	Pennsylvanian (Allegheny) rocks.			
	Blue-gray shale	1	6.0	0.001
	Coal	2	3.0	0.000
	Medium-gray clay	3	3.0	0.003

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-248--	Somerset Co., Pa. About 1 mile northeast of Ursina on north side of Pa. Highway 53.			
	Pennsylvanian rocks.			
	Coal	1	2.5	0.000
	Dark-gray to black shale		0.8	
	Light-gray shale	2	1.0	0.002
BR-249--	Somerset Co., Pa. About ½ mile north of Allenvale in R. R. cut.			
	Pennsylvanian rocks			
	Dark-gray calcareous shale (Ames limestone)	1	5.0	0.003
	Coal (Harlem?)	2	1.0	0.002
	Light-gray shale	3	1+	0.003
BR-250--	Somerset Co., Pa. About 1 mile west of Jennerstown on south side of U.S. Highway 30.			
	Pennsylvanian (Allegheny) rocks.			
	Dark-gray shale	1	2.0	0.003
	Coal (Lower Kittanning)	2	4.0	0.002
	Light-gray clay	3	2+	0.002
BR-251--	Westmoreland Co., Pa. About 2 miles northwest of Ligonier at abandoned coal mine.			
	Pennsylvanian rocks.			
	Dark-gray shale	1	2+	0.003
	Coal (Pittsburgh)	2	8+	0.000
BR-252--	Cambria Co., Pa. About 1 mile north of Carrolltown at abandoned mine on south side of U. S. Highway 219.			
	Pennsylvanian (Allegheny) rocks.			
	Gray shale	1	15.0	0.003
	Coal (Upper Freeport)	2	2+	0.000

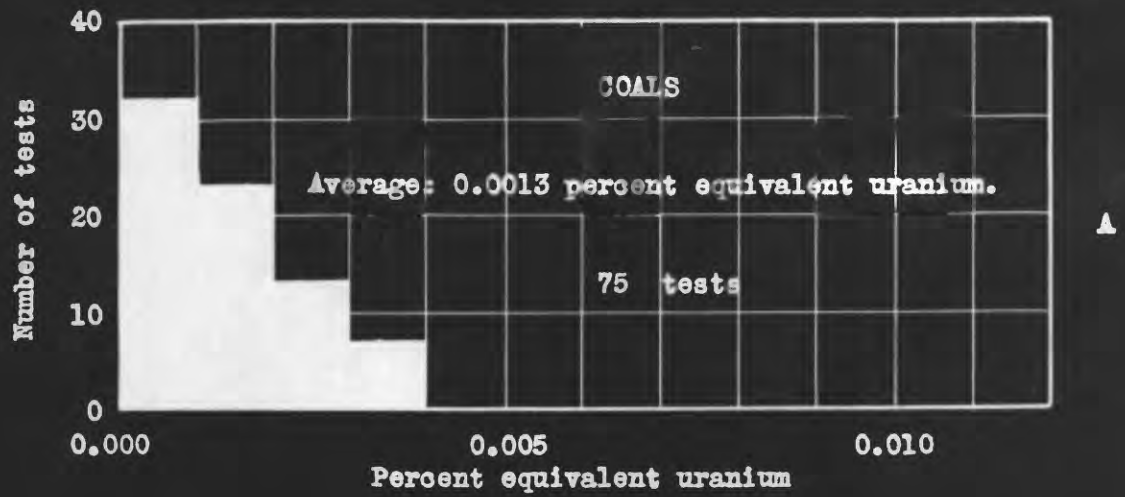
Locality No. Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-253-- Cambria Co., Pa. About 1 mile east of Spangler on south side of U. S. Highway 219. OK			
Pennsylvanian (Alleghany) rocks.			
Brown sandy shale	1	15	0.002
Coal (Lower Freeport?)	2	4+	0.000
BR-254-- Cambria Co., Pa. About 0.3 mile west of St. Bonifacius on north side of Pa. Highway 36. OK			
Pennsylvanian (Alleghany?) rocks.			
Medium-gray shale	1	10+	0.001
Coal (Manning?)	2	4+	0.001
BR-255-- Blair Co., Pa. About 2 miles south of Tyrone on U. S. Highway 220. OK			
Devonian (Portage or Genesee) rocks			
Black fissile shale	1	20+	0.003
BR-256-- Clearfield Co., Pa. About 2 miles north of Houtzdale on east side of Pa. Highway 53. OK			
Pennsylvania (Alleghany?) rocks.			
Dark-gray shale	1	10	0.002
Coal ("E" seam; L. Freeport?)	2	2.8	0.000
Brown shale	3	1+	0.002
BR-257-- Clearfield Co., Pa. About 9 miles (2 MI S OF BARRETT) west of Philipsburg on south side of U. S. Highway 322 about 0.2 miles from junction with Pa. Highway 153.			
Pennsylvanian (Alleghany?) rocks.			
Dark-gray shale, fissile	1	10	0.004
Coal (Clarion?)	2	1.3	0.003
Light-gray shale	3	8	0.001

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
BR-258	Clearfield Co., Pa. About 3 miles north of Woodland on north side of road. OK			
	Pennsylvanian (Allegheny?) rocks.			
	Dark-gray shale	1	15	0.002
	Coal (Freeport?)	2	1.0	0.000
	Light-gray shale	3	6.0	0.004
	Coal	4	1.8	0.001
	Dark-gray shale	5	14	0.003
BR-259	Clearfield Co., Pa. About 3 miles north of Woodland and at southeast side of Bish Town on Landsberry Cannel Coal mine. OK			
	Pennsylvanian (Allegheny?) rocks.			
	Dark-gray shale	1	10	0.004
	Coal (Cannel "C" seam)	2	4	0.002
	Dark-gray shale	3	2	0.003
BR-260	Clearfield Co., Pa. About 4 miles southwest of Clearfield on southeast side of U. S. Highway 322. OK			
	Dark-gray to blackshale with Lingula	1	7+	0.002
	Coal		2.5	
	Gray and yellow shale	2	2.0	0.003
	Coal		1.0	
	Light-gray shale	3	3.0	0.003
BR-261	Jefferson Co., Pa. About 3 miles south of Brookville on northwest side of Pa. Highway 28. OK			
	Pennsylvanian (Allegheny?) rocks.			
	Bituminous coal	1	1.0	0.003
	Gray shale	2	2.0	0.002
	Bituminous and cannel coal		1.3	
	Gray nodular shale	3	15.0	0.004
BR-262	Jefferson Co., Pa. About 1 mile south of Summerville on south side of Pa. Highway 28. OK			

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent uranium
	Pennsylvanian (Allegheny) rocks.			
	Dark-gray fissile shale	1	10	0.003
	Coal			
	Brownish-gray shale	2	2.5	0.004
	Gray limestone		2.0	
BR-263	-- Armstrong Co., Pa. south of New Bethlehem and 0.7 miles east of bridge over Mahoning River on east side of Pa. Highway 26.			
	Dark-gray fissile sandy shale	1	5.0	0.003
	Coal		2.0	
	Gray and black banded shale	2	14	0.002
BR-264	-- Westmoreland Co., Pa. About 0.2 miles east of Irwin on south side of Pa. Turnpike.			
	Pennsylvanian (Monongahela) rocks			
	Dark-gray shale	1	24	0.004
	Coal	2	1	0.002
	Light-gray shale	3	0.7	0.003
	Coal	4	1.5	0.004
	Gray thin-bedded shale	5	3.0	0.002
	Coal		0.3	
BR-265	-- Franklin Co., Pa. Pa. Turnpike at east portal of Blue Mountain tunnel.			
	Ordovician rocks			
	Martinsburg slate			
	Dark-gray slate	1	100+	0.002
BR-266	-- Dauphin Co., Pa. About 1 mile north of Williamstown.			
	Buck Mountain seam	1	2.5	0.003
	Big Seam coal	2	4.0	0.001
	White Seam coal	3	3.0	0.001
	Little Seam coal	4	2+	0.002
	Zero Seam coal	5	4+	0.000

Locality No.	Location and description of rocks	Test No.	Thickness	Outcrop equivalent Uranium
BR-267--	Schuylkill Co., Pa. on northeast side of Pa. Highway 125 between Sacramento and Goodspring. 2 MI SE OF SHERMANTO			
	Coal (Tracy)	11	3.0	0.000
	Dark-gray shale	10	10.0	0.003
	Mammoth coal	9	12.0	0.000
	" "	8		0.000
	" "	7		0.000
	" "	6		0.004
	" "	5		0.002
	" "	4		0.001
	Shale (Partly covered)		20.0	
	Shale and sandstone		100+	
	Skidmore coal	3	8.0	0.001
	" "	2		0.003
	Sandstone and conglomerate		100+	
	No. 2 coal	1	4.0	0.001
BR-268--	Luzerne Co., Pa. About 3 miles west of Hazelton at Cox Coal Co. OK			
	Primrose anthracite	4	10.0	0.001
	Sandstone and conglomerate		35.0	
	Mammoth coal	3	8.0	0.000
	Sandstone and conglomerate		10.0	
	Wharton coal	2	6.0	0.001
	Sandstone and conglomerate		50.0	
	Gamma coal	1	5.0	01000
BR-269--	Schuylkill Co., Pa. About ½ mile south of Delano on south side of Pa. Highway 395. OK			
	Pennsylvanian rocks.			
	Anthracite coal	1		0.000

Fig. 2 Average radioactivities of rocks tested.



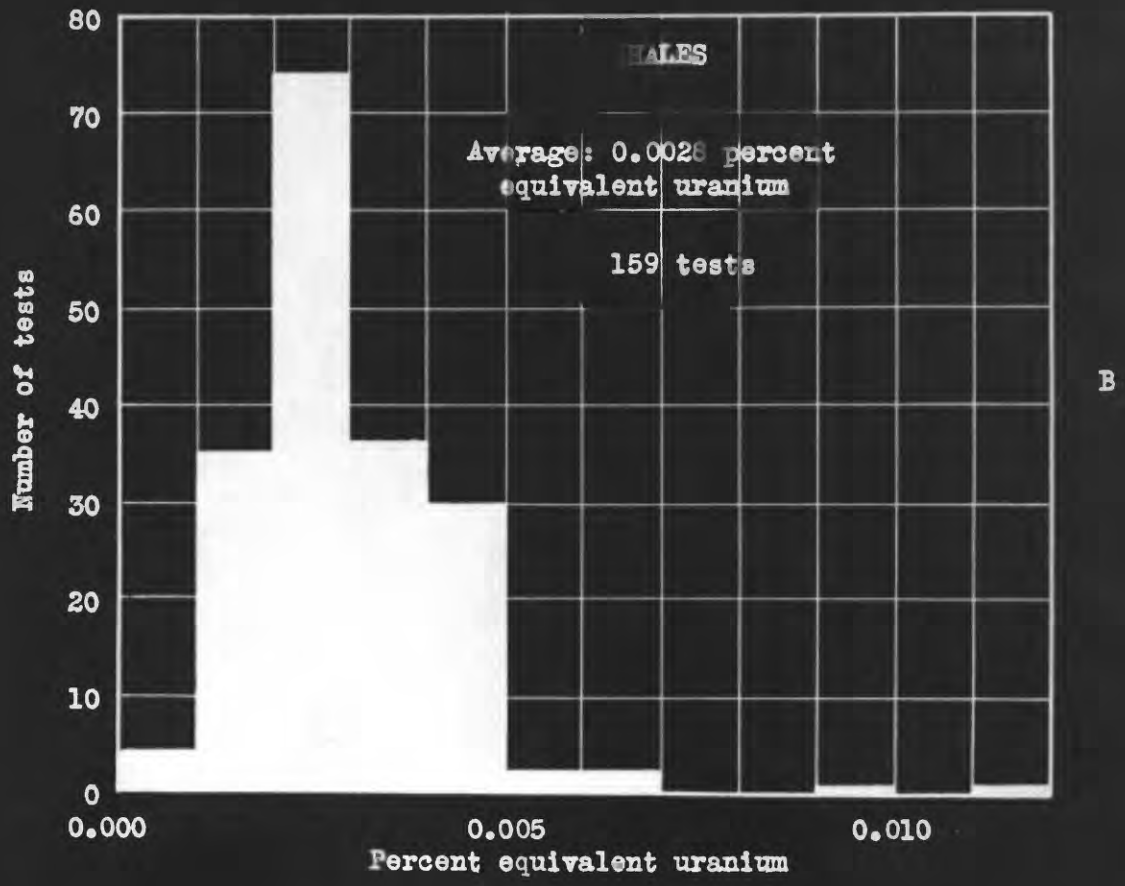


Fig. 1 Frequency distribution of coal and shale radioactivities.