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Anthracite in the Narragansett Basin of Rhode Island and Massachusetts

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONTENTS

ILLUSTRATIONS

TABLES

ANTHRACITE IN THE NARRAGANSETT BASIN OF RHODE ISLAND AND MASSACHUSETTS

by

William R. Barton,[1] James W. Skehan,[2] Albert W. Deurbrouck,[3] and Daniel P. Murray[4]

ABSTRACT

Anthracite has been mined from the Narragansett Basin of Rhode Island and Massachusetts sporadically, and with limited success, for more than 170 years. Beginning in 1974, interest in the coal of the Basin was renewed because of increasing prices and supply uncertainties involving petroleum products. During 1974-77 the Bureau of Mines analyzed 28 samples of Basin coals and conducted washing tests on 20 of them. Results, reported herein, indicate that the coals are low-sulfur, moderate- to high-ash anthracites and semianthracites, suitable for physical preparation to a product generally containing less than 10 percent ash. Additional exploration, sampling and testing will be required to permit appraisal of the potential value of the Narragansett Basin coal resources.

INTRODUCTION

The fuel requirements of New England are supplied almost entirely by petroleum and natural gas; coal, once a primary regional energy source, has almost faded from the scene (fig. 1). The drop in coal use, combined with New England's location at the far end of the domestic "fuel pipeline," has resulted in heavy dependence upon foreign oil supplies. Since the 1973-74 embargo by the Organization of Petroleum Exporting Countries (OPEC), the region has been looking for means to relieve its dependence on foreign fuel. One means would be greater use of potential energy resources indigenous to the region. Such alternatives might include Georges Bank petroleum, wood, wind, water, sun, and the Narragansett Basin coals. The Bureau of Mines report presents the results of recent analytical and float-sink tests on these coals.

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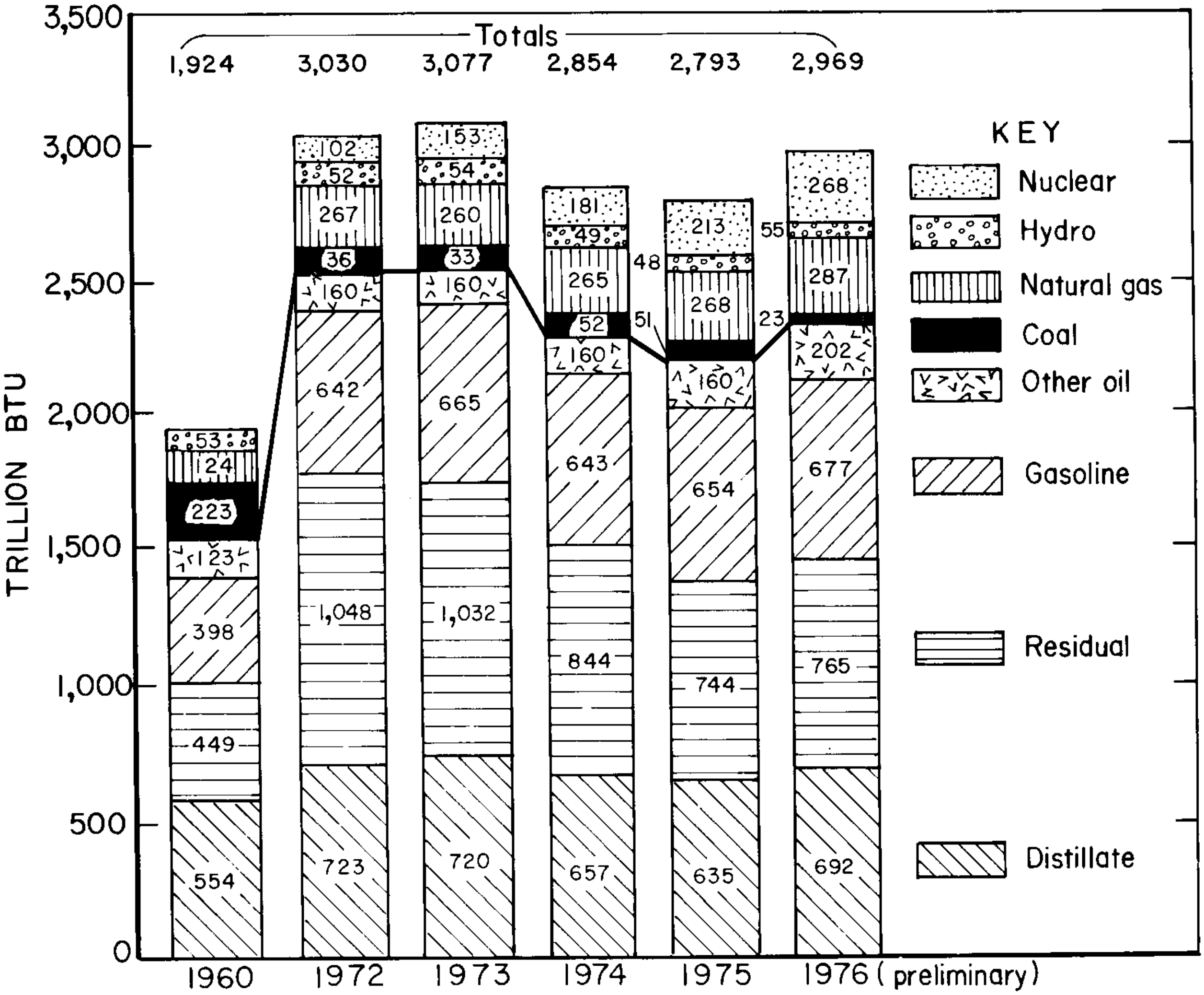

FIGURE 1. - New England sources of energy.

HISTORY

The existence of coal deposits has been known in the Narragansett Basin (fig. 2) of Rhode Island and southeastern Massachusetts since colonial times. Coal was mined intermittently at various locations with limited success; the last mine, at Cranston, R.I., closed in 1959. The coal's reported uses were as industrial fuel for copper smelting and heating greenhouses, as a carbon raiser in steel batches, and as an oxygen scavenger in foundries. The coal generally has been called metaanthracite (1, 18)[6] or was characterized as graphitic (11) in nature. William Cullen Bryant used "anthracite" in an 1826 poem (7):

> Dark anthracite! that reddenest on my hearth,
> Thou in those island mines didst slumber long;
> But now thou art come forth to move the earth...

[6]Underlined numbers in parentheses refer to items in the list of references at the end of this report.

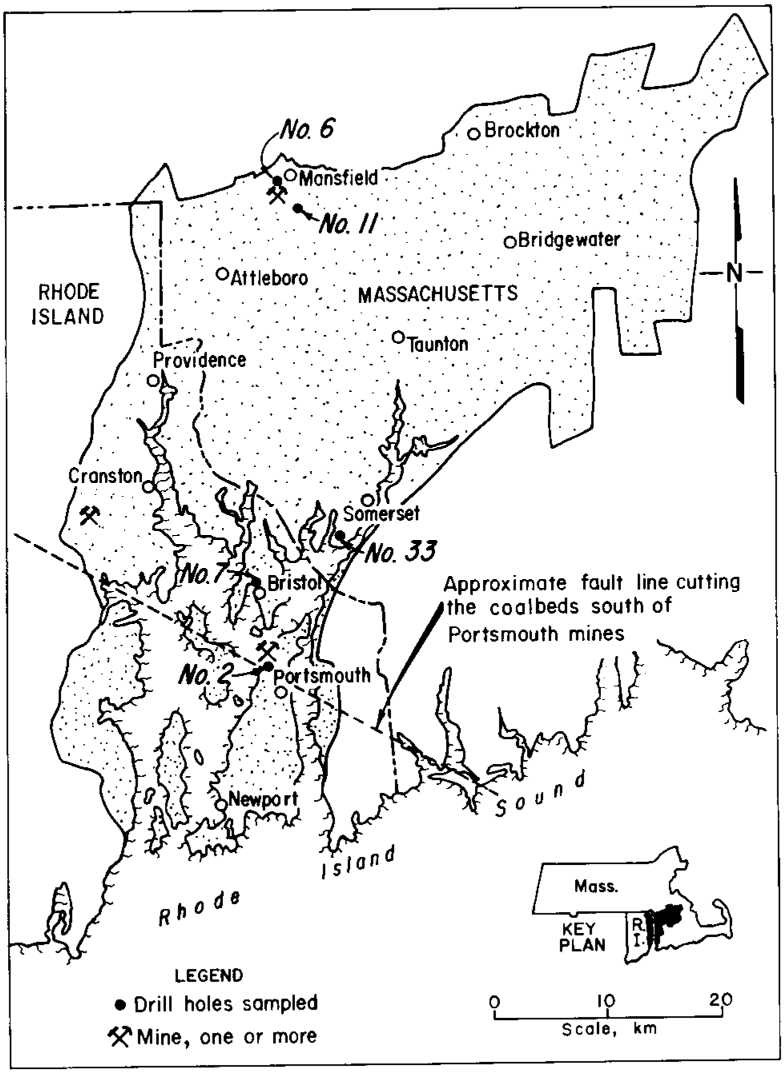

FIGURE 2. - Geography of the Narragansett Basin.

Commercial mining attempts began as early as 1808 near Portsmouth, R.I., about 1835 at Mansfield, Mass., and in 1866 near Cranston, R.I. The most successful operations were at Portsmouth, where the anthracite was used for fuel in a copper smelter from 1860 to 1883 (4-5). The last operating mine was at Cranston, where the material was mined for its high carbon content and sold to foundries until 1959. The mine was closed due to unsafe working conditions and is now the site of Garden City shopping center.

After World War II the Bureau of Mines conducted some limited investigations in the Basin (18), and in cooperation with the University of Rhode Island produced gas and rock wool from material mined at Cranston (10). An appraisal in the 1950's suggested minable coal might exist in the Basin but concluded that further study at that time was not justified because it was "unlikely that any coal found could compete with fuels on the market" (2).

The OPEC Embargo and petroleum price increases changed the context in which the Narragansett Basin should be viewed. As a result in 1974 the Bureau of Mines, in conjunction with the Massachusetts State Geologist Joseph A. Sinnott sampled the mine dumps at Mansfield, Mass., and with Joseph Pecoraro of FEA subsequently sampled the dumps at Portsmouth, R.I. When the results of those efforts were made public, great interest in the area was generated. The Federal Energy Administration, the Massachusetts Science and Technology Foundation (14), and others urged restudy of the Basin. Professor James W. Skehan, S.J., Director of Boston College's Weston Observatory, applied for and on February 1, 1976, received a National Science Foundation (NSF) grant to study Basin geology. He also received funds from the New England Regional Commission, some New England utilities and industrial firms, and the Southeastern Massachusetts Regional Planning Council to support diamond drilling of the coal strata at the same time. This report does not go into detail on the Narragansett Basin project but is limited to Bureau of Mines work on samples provided by project members and on samples obtained directly by the Bureau of Mines.

GEOLOGY

There have been many geologic studies of the Narragansett Basin (6, 8, 12, 15). In general it may be summarized as a complex structural depression containing intricately folded and faulted rocks of Pennsylvanian age. The major fold axes generally trend northerly in Rhode Island, curving to northeasterly in the Massachusetts portion of the Basin.

Due to an ubiquitous cover of glacial drift, good outcrops occur only along the shore of Narragansett Bay or where coarser clastic rocks have been more resistant to erosion. The shales, coals, and other finer sedimentary sequences are more poorly exposed. In addition to folding, the strata are cut by faults and fault zones trending in several directions. Because of poor exposures it is difficult or impossible to accurately determine the direction and amount of slip along most of the faults. One such fault zone, or lineament, just south of the old Portsmouth mines was discovered during this study (9) that appears to transect the entire Basin (and State of Rhode Island); it may represent the practical southern limit of potentially economic coal deposits.

The coalbeds are best known near the Basin margins, where they are tilted up to the surface; they remain essentially unexplored in the center of the Basin. The best coal identified to date appears in one or more beds 5 to 30 feet thick near the southeastern edge of the Basin. Such beds have been intersected by drilling at Portsmouth and Bristol, R.I., and Somerset, Mass., but their extent, structural complexity, continuity, and average thickness are unknown at this time.

ANALYTICAL RESULTS

Key data from analyses of 28 samples of Narragansett Basin coal are summarized in table 1. Ten samples from Portsmouth, R.I., represented six drill core sections, three 100-pound samples from the Portsmouth South mine dump, and a chip sample from a Portsmouth South mine pillar. The six Bristol and four Somerset (Brayton Point) analyses were all performed on core sections; the Mansfield-West Mansfield analyses represent five core sections and three samples comprising small coal fragments gleaned from three Mansfield mine dumps.

The data, while undoubtedly not completely representative of the total coal resource in each area, indicate that the bulk of Narragansett Basin coal ranges in rank from anthracite to low-volatile bituminous coal and on the average is true anthracite or semianthracite. None of the samples analyzed were found to be metaanthracite by ASTM D338 classification.

TABLE 1. - Analyses of raw coal core samples collected from the Narragansett Basin

	Mansfield, Mass., hole 6 samples				West Mansfield, Mass., hole 11 sample	Somerset, Mass., hole 33 samples			
	1	2	3	4		1	2	3	4
Chemical analysis, percent:									
Moisture, as received	1.0	0.7	0.9	1.6	1.0	0.5	2.7	6.3	3.0
Ash, moisture free	42.8	65.1	38.0	48.2	17.4	29.9	16.2	22.4	17.0
Sulfur, moisture free	0.5	0.9	0.3	0.6	1.4	0.1	0.2	0.1	0.02
Volatile matter, moisture free	4.5	5.8	4.2	5.7	5.6	3.0	5.5	3.7	4.3
Fixed carbon, moisture free	52.7	29.1	57.8	46.1	77.0	67.1	78.3	73.9	78.7
British thermal units, moisture free	7,921	4,335	8,765	6,988	11,667	9,639	12,348	12,103	11,158
Fusibility of ash, ° F:									
Initial deformation temperature	2,280	2,190	2,280	2,240	2,030	2,420	2,530	2,300	2,210
Softening temperature	2,400	2,250	2,400	2,300	2,080	2,520	2,660	2,410	2,300
Fluid temperature	2,910	2,440	2,710	2,450	2,200	2,740	2,910	2,720	2,410

	Bristol, R.I., hole 7 samples						Portsmouth, R.I., hole 2 samples					
	1	2	3	4	5	[1]6	1	2	3	4	5	6
Chemical analysis, percent:												
Moisture, as received	0.2	0.2	0.2	0.1	0.2	0.2	16.1	14.0	11.0	13.8	15.3	10.7
Ash, moisture free	22.9	16.3	12.0	13.4	11.3	52.0	24.2	21.2	32.1	24.8	26.2	39.6
Sulfur, moisture free	0.0	0.01	0.0	0.0	0.0	0.4	0.3	0.3	0.1	0.3	0.2	0.5
Volatile matter, moisture free	5.2	7.8	6.3	6.0	6.1	4.4	9.3	13.9	7.2	9.6	13.1	6.1
Fixed carbon, moisture free	71.9	75.9	81.7	80.6	82.6	43.6	66.5	64.9	60.7	65.6	60.7	54.3
British thermal units, moisture free	10,408	11,076	11,956	11,664	12,061	6,408	11,040	10,720	8,910	10,010	9,970	7,800
Fusibility of ash, ° F:												
Initial deformation temperature	2,250	2,350	2,130	2,150	2,140	2,230	2,110	2,120	2,140	2,680	2,730	2,200
Softening temperature	2,350	2,400	2,180	2,200	2,190	2,340	2,160	2,170	2,190	2,720	2,780	2,250
Fluid temperature	2,550	2,460	2,310	2,350	2,330	2,450	2,360	2,370	2,390	2,760	2,880	2,450

	Mansfield, Mass., mine dump samples			Portsmouth, R.I., South mine dump samples			Portsmouth, R.I., South mine sample from pillar
	1	2	3	1	2	3	
Chemical analysis, percent:							
Moisture, as received	2.8	3.1	2.7	13.3	12.6	13.8	4.9
Ash, moisture free	13.4	13.9	18.8	13.6	7.2	4.7	19.6
Sulfur, moisture free	0.3	0.5	0.3	0.4	0.1	0.4	0.2
Volatile matter, moisture free	5.0	4.7	3.6	7.2	4.7	4.4	5.3
Fixed carbon, moisture free	81.6	81.4	77.6	79.2	88.1	90.9	75.1
British thermal units, moisture free	12,380	12,320	11,360	12,000	12,860	13,250	11,000
Fusibility of ash, ° F:							
Initial deformation temperature	2,140	2,150	2,240	-	-	-	2,200
Softening temperature	2,240	2,240	2,340	-	-	-	2,250
Fluid temperature	2,600	2,460	2,600	-	-	-	2,300

[1]No separation at 2.00 specific gravity.

Results also refute a previous hypothesis that the rank of coal decreases regionally in the Basin from southwest to northeast (13). In fact, the lowest average rank coal was found at Portsmouth, R.I., with increasing average rank to the north and northeast at Bristol, Mansfield-West Mansfield, and Somerset (Brayton Point). Rank appears more closely related to localized phenomena such as faulting, intensity of folding, and internal mechanical deformation of coalbeds due to specific tectonic forces at each location. Coal rank of samples is summarized and presented graphically in figure 3.

The rank data, as presented, suggest another reason why the most successful Basin coal mining was at Portsmouth.

The coal is typically low in sulfur content (table 1), that from Bristol being extremely so. Ash content is relatively high and acts as the principal moderator of Btu's in samples as received. Ash relative to contained Btu on a weight-percent basis is presented graphically in figure 4. Much of the ash consists of free quartz and is amenable to separation by standard float-sink methods to achieve a product that could readily meet Pennsylvania Anthracite Committee specifications for finer sizes (table 2). The free-swelling index for all samples analyzed was zero.

TABLE 2. - Standard anthracite specifications approved and adopted by the Pennsylvania Anthracite Committee, effective July 28, 1947

Size	Round test mesh, inches	Percent					
		Oversize, maximum	Undersize		Maximum impurities[1]		
			Maximum	Minimum	Slate	Bone	Ash[2]
Broken.........	Through 4-3/8.....	-	-	-	1-1/2	2	11
	Over 3 1/4 to 3...	-	15	7-1/2	-	-	-
Egg...........	Through 3-1/4 to 3	5	-	-	1-1/2	2	11
	Over 2-7/16.......	-	15	7-1/2	-	-	-
Stove..........	Through 2-7/16....	7-1/2	-	-	2	3	11
	Over 1-5/8........	-	15	7-1/2	-	-	-
Chestnut.......	Through 1-5/8.....	7-1/2	-	-	3	4	11
	Over 13/16........	-	15	7-1/2	-	-	-
Pea............	Through 13/16.....	10	-	-	4	5	12
	Over 9/16.........	-	15	7-1/2	-	-	-
Buckwheat No. 1	Through 9/16......	10	-	-	-	-	13
	Over 5/16.........	-	15	7/1/2	-	-	-
Buckwheat No. 2	Through 5/16......	10	-	-	-	-	13
(Rice).	Over 3/16.........	-	17	7/1/2	-	-	-
Buckwheat No. 3	Through 3/16......	10	-	-	-	-	15
(Barley).	Over 3/32.........	-	20	10	-	-	-
Buckwheat No. 4	Through 3/32......	20	-	-	-	-	15
	Over 3/64.........	-	30	10	-	-	-
Buckwheat No. 5	Through 3/64......	30	([3])	([3])	-	-	16

[1]When slate content in the sizes from Broken to Chestnut, inclusive, is less than above standards, bone content may be increased by 1-1/2 times the decrease in the slate content under the allowable limits, but slate content specified above shall not be exceeded in any event. A tolerance of 1 percent is allowed on the maximum percentage of undersize and the maximum percentage of ash content. The maximum percentage of undersize is applicable only to anthracite as it is produced at the preparation plant. Slate is defined as any material that has less than 40 percent fixed carbon. Bone is defined as any material that has 40 percent or more, but less than 75 percent, fixed carbon.

[2]Ash determinations are on a dry basis.

[3]No limit.

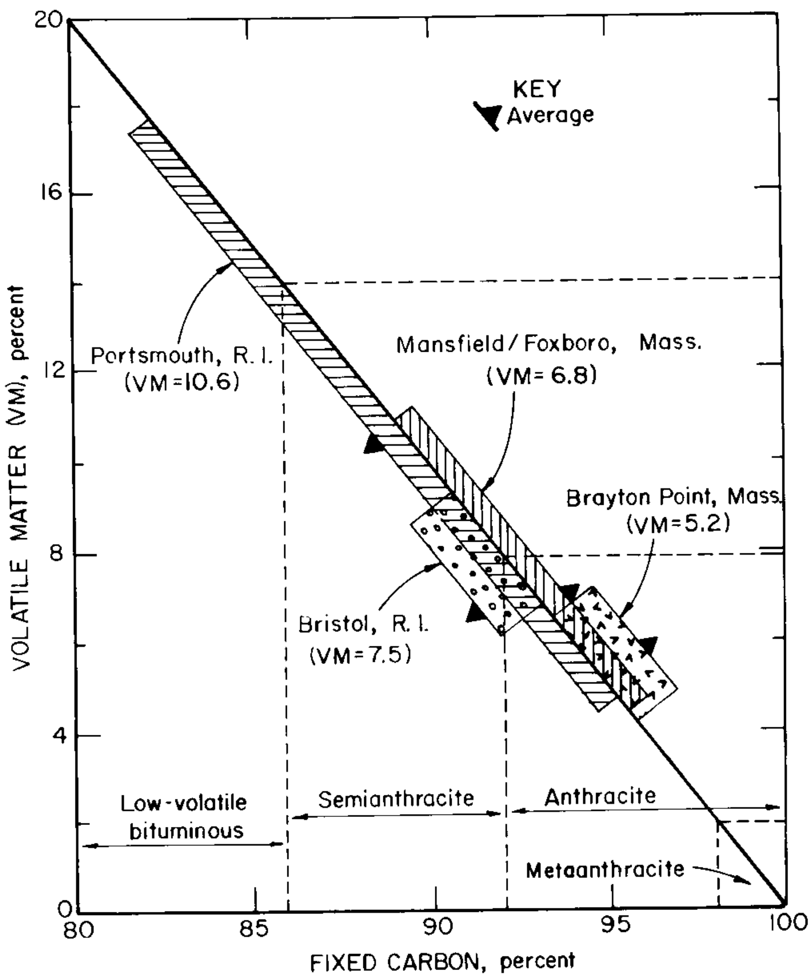

FIGURE 3. - Rank of Narragansett Basin coal sample.

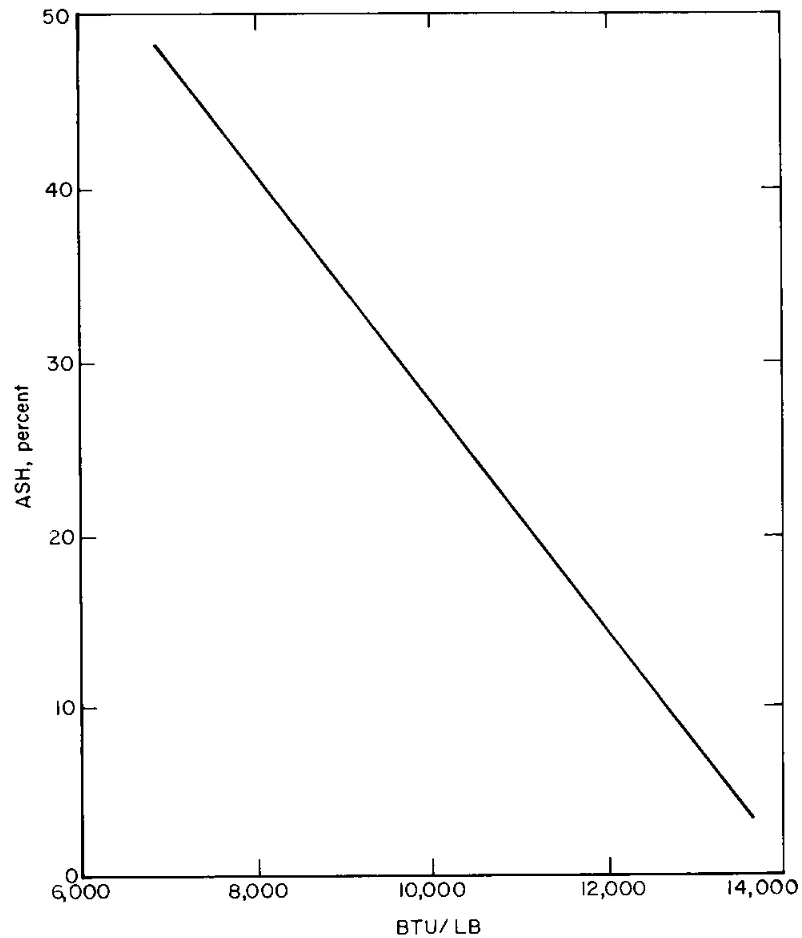

FIGURE 4. - Relation of ash to Btu content.

Some of the misclassification and misunderstandings that have developed concerning the Narragansett Basin coal are related to its appearance--it does not look like Pennsylvania anthracite. The Narragansett Basin coal is dull gray to black with a different luster, and owing to the presence of two sets of close-spaced cleavage is more easily drilled than Pennsylvania anthracite. If one measures reflectance on the cleavage planes, the result may be abnormally high reflective indices due to the glossy surface of the planes or, in some cases, the presence of secondary minerals along the planes.

Minor amounts of graphite in Narragansett Basin coal tend to be concentrated along fractures and shear planes, but graphite is not important volumetrically except for that found in local zones of intense shearing. It is probable that incorrect interpretation of analyses representing such graphite-bearing anthracite are what gave rise to the classification of all of the basin coal as metaanthracite.

FLOAT-SINK TESTS

Tables 3-7 summarize the results of preliminary float-sink tests performed on four core samples from Mansfield, Mass., one sample from West Mansfield, Mass., four samples from Somerset (Brayton Point), Mass., five samples from Bristol, R.I., and six samples from Portsmouth, R.I. The results were promising and indicate that there is a reasonable basis to predict that an anthracite product similar in quality to typical Pennsylvania grade could be produced using standard physical coal preparation techniques.

TABLE 3. - Washing characteristics of core samples from the "A" seam, Mansfield, Mass., hole 6[1]

Specific gravity fractions	Elementary data				Cumulative data			
	Percent			Btu	Percent			Btu
	Weight	Ash	Sulfur		Weight	Ash	Sulfur	
SAMPLE 1								
Float-1.80	14.4	7.6	0.50	13,387	14.4	7.6	0.50	13,387
1.80 -2.00	32.6	28.8	.46	10,077	47.0	22.3	.47	11,091
2.00 -Sink	53.0	60.9	.55	5,109	100.0	42.8	.51	7,921
SAMPLE 2								
Float-1.80	5.4	6.8	0.55	13,429	5.4	6.8	0.55	13,429
1.80 -2.00	7.1	25.2	.53	10,662	12.5	17.2	.54	11,859
2.00 -Sink	87.5	72.9	.95	3,260	100.0	66.1	.90	4,335
SAMPLE 3								
Float-1.80	16.5	7.7	0.43	13,344	16.5	7.7	0.43	13,344
1.80 -2.00	34.0	28.7	.33	10,120	50.5	21.8	.36	11,173
2.00 -Sink	49.5	53.5	.25	6,308	100.0	37.5	.31	8,765
SAMPLE 4								
Float-1.80	9.3	7.5	0.53	13,336	9.3	7.5	0.53	13,336
1.80 -2.00	22.3	28.8	.47	10,062	31.6	22.5	.49	11,026
2.00 -Sink	68.4	59.6	.62	5,122	100.0	47.9	.58	6,988

[1]Analyses on moisture-free basis.

TABLE 4. - Washing characteristics of core sample from West Mansfield, Mass., hole 11[1]

Specific gravity fractions	Elementary data				Cumulative data			
	Percent			Btu	Percent			Btu
	Weight	Ash	Sulfur		Weight	Ash	Sulfur	
Float-1.80	69.2	5.4	0.93	13,573	69.2	5.4	0.93	13,573
1.80 -2.00	15.0	23.7	2.52	10,820	84.2	8.7	1.21	13,083
2.00 -Sink	15.8	63.8	2.23	4,124	100.0	17.4	1.37	11,667

[1]Analyses on moisture-free basis.

TABLE 5. - Washing characteristics of core samples from the "A" seam, Somerset, Mass., hole 33[1]

Specific gravity fractions	Elementary data				Cumulative data			
	Percent			Btu	Percent			Btu
	Weight	Ash	Sulfur		Weight	Ash	Sulfur	
				SAMPLE 1				
Float-2.00	12.2	6.6	0.16	12,754	12.2	6.6	0.16	12,754
2.00 -2.40	68.1	15.0	.00	11,383	80.3	13.7	.02	11,591
2.40 -Sink	19.7	85.4	.50	1,683	100.0	16.8	.12	9,639
				SAMPLE 2				
Float-1.80	30.8	3.6	0.16	13,292	30.8	3.6	0.16	13,292
1.80 -2.00	49.9	7.5	.15	12,224	80.7	6.0	.15	12,632
2.00 -2.40	17.9	10.9	.12	11,785	98.6	6.9	.15	12,478
2.40 -Sink	1.4	71.0	.10	3,219	100.0	7.8	.15	12,348
				SAMPLE 3				
Float-1.80	9.8	2.9	0.15	13,478	9.8	2.9	0.15	13,478
1.80 -2.00	51.1	4.3	.15	13,030	60.9	4.1	.15	13,102
2.00 -2.40	34.4	12.1	.08	11,674	95.3	7.0	.12	12,587
2.40 -Sink	4.7	78.4	.06	2,290	100.0	10.3	.12	12,103
				SAMPLE 4				
Float-2.00	20.8	6.2	0.11	12,277	20.8	6.2	0.11	12,277
2.00 -2.40	67.2	8.3	.00	12,386	88.0	7.8	.03	12,360
2.40 -Sink	12.0	75.8	.00	2,349	100.0	16.0	.02	11,158

[1]Analyses on moisture-free basis.

TABLE 6. - Washing characteristics of core samples from the "A" seam, Bristol, R.I., hole 7[1]

Specific gravity fractions	Elementary data				Cumulative data			
	Percent			Btu	Percent			Btu
	Weight	Ash	Sulfur		Weight	Ash	Sulfur	
SAMPLE 1								
Float-2.00	5.3	2.0	0.00	12,924	5.3	2.0	0.00	12,924
2.00 -2.40	75.6	8.0	.00	12,395	80.9	7.6	.00	12,430
2.40 -Sink	19.1	83.0	.00	1,847	100.0	22.0	.00	10,408
SAMPLE 2								
Float-2.00	19.6	1.7	0.01	12,803	19.6	1.7	0.01	12,803
2.00 -2.40	67.8	5.2	.01	12,377	87.4	4.4	.01	12,473
2.40 -Sink	12.6	83.7	.00	1,391	100.0	14.4	.01	11,076
SAMPLE 3								
Float-2.00	11.2	1.0	0.03	13,355	11.2	1.0	0.03	13,355
2.00 -2.40	80.5	4.7	.00	12,834	91.7	4.2	.00	12,898
2.40 -Sink	8.3	78.1	.00	1,558	100.0	10.4	.00	11,956
SAMPLE 4								
Float-2.00	6.7	0.9	0.01	13,292	6.7	0.9	0.01	13,292
2.00 -2.40	84.4	4.5	.00	12,646	91.1	4.2	.00	12,694
2.40 -Sink	8.9	83.0	.00	1,125	100.0	11.2	.00	11,664
SAMPLE 5								
Float-2.00	5.4	0.9	0.01	13,363	5.4	0.9	0.01	13,363
2.00 -2.40	86.3	3.6	.00	12,988	91.7	3.4	.00	13,010
2.40 -Sink	8.3	79.4	.00	1,575	100.0	9.8	.00	12,061

[1]Analyses on moisture-free basis.

TABLE 7. - Washing characteristics of core samples from the "C" seam, Portsmouth, R.I., hole 2[1]

Specific gravity fractions	Elementary data				Cumulative data			
	Percent			Btu	Percent			Btu
	Weight	Ash	Sulfur		Weight	Ash	Sulfur	
SAMPLE 1								
Float-1.80	10.6	6.6	0.16	13,160	10.6	6.6	0.16	13,160
1.80 -2.00	73.0	15.1	.29	12,622	83.6	13.7	.27	12,690
Sink -2.00	16.4	75.9	.45	2,650	100.0	24.2	.30	11,040
SAMPLE 2								
Float-1.80	7.0	4.0	0.17	13,480	7.0	4.0	0.17	13,480
1.80 -2.00	75.8	12.8	.27	11,995	82.8	12.1	.26	12,120
Sink -2.00	17.2	65.1	.29	3,970	100.0	21.2	.27	10,720
SAMPLE 3								
Float-1.80	11.6	4.6	0.18	13,580	11.6	4.6	0.18	13,580
1.80 -2.00	43.0	15.0	.17	11,550	54.6	12.8	.17	11,980
Sink -2.00	45.4	55.4	.10	5,210	100.0	32.1	.14	8,910
SAMPLE 4								
Float-1.80	20.8	4.4	0.20	13,550	20.8	4.4	0.20	13,550
1.80 -2.00	50.3	11.2	.29	11,887	71.1	9.2	.26	12,370
Sink -2.00	28.9	63.3	.33	4,180	100.0	24.8	.28	10,010
SAMPLE 5								
Float-1.80	52.6	7.0	0.30	12,610	52.6	7.0	0.30	12,610
1.80 -2.00	24.5	18.3	.22	11,387	77.1	10.6	.27	12,220
Sink -2.00	22.9	78.7	.16	2,390	100.0	26.2	.25	9,970
SAMPLE 6								
Float-1.80	17.6	3.4	0.16	13,630	17.6	3.4	0.16	13,630
1.80 -2.00	31.3	7.5	.19	11,018	48.9	6.0	.18	11,960
Sink -2.00	51.1	66.0	.82	3,810	100.0	36.6	.51	7,800

[1]Analyses on moisture-free basis.

Separating at a specific gravity of 2.00 resulted in a product typically containing about 9 to 12 percent ash and 12,000 to 13,000 Btu/lb, representing 70 to 85 percent of the original sample. With a 1.80 specific gravity separation, ash was typically lowered to 4 to 7 percent at 13,000 to 13,500 Btu/lb, but this higher quality product was only about 22 percent of the original sample. Separation at a specific gravity of 2.00 thus appears to be the logical course a prospective producer would follow to obtain a marketable product without unreasonable loss. The sulfur determinations made on the Mansfield material indicated that the sulfur content of the cumulative 2.00 specific gravity float fractions was not appreciably different from the sulfur content of the original core sample.

In all cases where more than one sample was reported for a given seam, sample 1 was taken from the top of the seam and all other samples were numbered sequentially. An interesting characteristic of this anthracite is its low ash content at exceptionally high specific gravities. For some samples float-sink tests were conducted at 2.40 specific gravity; the resulting float coal products were of low ash content, down to 3.6 percent ash from a Bristol, R.I., sample.

The washing of coal at specific gravities as high as 2.40 does not present a formidable problem even though this is beyond the range of normal specific gravity separation for coal. With magnetite, medium cyclone separations have been made at 2.20 specific gravity on Pennsylvania anthracite. Therefore, by substituting a heavier density material, such as ferrosilicon, for magnetite, the higher separating density can be easily attained (17). Ferrosilicon has been used successfully in Europe for the washing of coal.

Data on the samples are summarized in the following paragraphs, with dump samples grouped at the end of the discussion.

Mansfield, Mass.--Hole 6, located in the Wrentham quadrangle, latitude 42° 02' 24" N, longitude 71° 16' 25" W.

Four samples were collected from the "A" seam, a 9-foot-thick bed of coal located 182 feet below the surface. The average recovery at 2.00 specific gravity was 35.4 percent of 21.0-percent-ash coal, again of low sulfur content; this was therefore not a particularly promising deposit. Table 3 summarizes the float-sink analyses of these samples. Head sample analyses are presented in table 1.

West Mansfield, Mass.--Hole 11, located in the Mansfield quadrange, latitude 42° 01' 07" N, longitude 71° 12' 33" W.

One sample was collected from a seam of coal 15-1/2 inches thick located at a depth of 975 feet. Table 4 summarizes the float-sink analyses on this sample. A complete head sample analysis is presented in table 1.

Somerset, Mass.--Hole 33, located in the Fall River quadrangle, latitude 41° 42' 47" N, longitude 71° 11' 34" W.

Four samples were collected from the "A" seam, a 9.2-foot-thick bed of coal located 721 feet below the surface. A low-ash product could be obtained at a reasonable recovery from the total seam. Table 5 summarizes the float-sink analyses on these samples. Head sample analyses are presented in table 1.

Bristol, R.I.--Hole 7, located in the Bristol quadrangle, latitude 41° 43' 28" N, longitude 71° 15' 49" W.

Six samples were collected from the "A" seam, a 24.2-foot-thick bed of coal located 229 feet below the surface. The low-ash material in this coal floats at 2.40 specific gravity, providing an average recovery of 88.6 percent of a 4.8-percent-ash product. Table 6 summarizes the float-sink analyses on five of these samples. A sixth sample all sank at 2.00 specific gravity. Head sample analyses are presented in table 1.

Portsmouth, R.I.--Hole 2, located in the Prudence Island quadrangle, latitude 41° 36' 30" N, longitude 71° 16' 15" W.

Six samples were collected from the "C" seam, a 5-foot-thick bed of coal located 259 feet below the surface. The average recovery at 2.00 specific gravity would be 69.9 percent of 10.7-percent ash coal of low sulfur content, assuming the samples collected represented equal intervals. Table 7 summarizes the float-sink analyses on these samples.

Head sample analyses are presented in table 1. The high moisture contents shown for these samples are atypical and are caused by a hydrous silica mineral occurring dispersed throughout these samples.

Mansfield, Mass.--Mansfield dump samples, located in the Wrentham quadrangle, latitude 42° 00' 35" N, longitude 71° 15' 10" W.

Three samples were collected from old mine dumps in 1974. The material analyzed consisted of small, weathered chips of coal gleaned from the dumps, the only material from Mansfield that could be obtained for analysis at that time. The results of analyses on these first samples obtained generated the subsequent interest in Narragansett Basin coal exploration. No washing tests were performed on these samples.

Portsmouth, R.I.--Portsmouth South mine dump and mine pillar samples, located in the Prudence Island quadrangle, latitude 41° 37' 00" N, longitude 71° 16' 16" W.

These samples consisted of three large blocks of coal collected from old mine dumps in early 1975, plus one sample provided by Chief John T. Pierce of the Portsmouth Police Department. The latter sample was obtained from a mine pillar about 50 feet underground while foundations were being excavated for an aluminum fabrication plant; when the excavators broke into the old workings Chief Pierce entered them and obtained several large chunks of coal from old mine pillars. No washing tests were performed on these samples.

CONCLUSIONS

Narragansett Basin coal is predominantly of anthracite and semianthracite rank. It is a low-sulfur, high-ash coal that appears suitable for physical preparation of a product containing less than 10 percent ash. Continued exploration and sampling and an assessment of the environmental effects of recovering the coal would be required to permit a quantitative and economic appraisal of the potential value of the Narragansett Basin anthracite resources.

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