DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1271-E
PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE CHEAT MOUNTAIN ROADLESS AREA, RANDOLPH COUNTY, WEST VIRGINIA

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1983

Studies Related To Wilderness

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Cheat Mountain Roadless Area, Monongahela National Forest, Randolph County, West Virginia. The area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The Cheat Mountain Roadless Area contains approximately 7,720 acres in the Monongahela National Forest, Randolph County, W. Va. All the surface rights are owned by the U.S. Government, but mineral rights of 65 percent of the area remain in private ownership. The area is in the Allegheny Mountain section of the Appalachian Plateaus physiographic province and is situated at the eastern edge of the Appalachian coal region.

Sandstone and shale of Late Devonian age and limestone, sandstone, and shale of Mississippian age are exposed on the west slope of Cheat Mountain. Rocks of Late Mississippian age also crop out locally along Shavers Fork at the east edge of the area. Coal-bearing rocks of Pennsylvanian age underlie a broad plateau formed by the North Potomac syncline.

Coal is the most important mineral resource in the Cheat Mountain Roadless Area. The coal is tentatively ranked as medium- to high-volatile A bituminous and, like coal of this rank in nearby mining areas, is primarily of coking quality; most of the raw coal is suitable for use as low-sulfur steam coal. Coal resources are estimated to total 44.5 million short tons, of which 11.5 million short tons are included in the reserve base. Actual reserves recoverable by underground methods could not be determined due to insufficient data concerning the possible percent recovery. However, if a 50 percent recovery factor is used, 5.74 million short tons may be recovered and, at 60 percent, 6.88 million short tons may be recovered.

The Cheat Mountain Roadless Area has low potential for mineral resources including limestone, shale, clay and sandstone. The limestone is suitable for road metal, railroad ballast, construction aggregate, and high-calcium limestone uses. Clay and shale in beds that were tested could be used for building brick, clay tile, and other structural-clay products. Some sandstone may be suitable for concrete aggregate, road-base aggregate, rough building stone, and various special-purpose sands. Available information suggests a low potential for oil and gas resources in the Cheat Mountain Roadless Area. No evidence of a potential for the occurrence of metallic mineral resources potential was found in the area.

INTRODUCTION

The Cheat Mountain Roadless Area is in the Greenbrier Ranger District of the Monogahela National Forest, east-central West Virginia. It is located in Randolph County, about 10 mi southeast of Elkins, W. Va., and is accessible from there via U.S. 219-250 to Beverly, W. Va., and then southeastward along an improved country road (fig. 1). From the east, the area can be reached via U.S. 33 and by a paved country road that extends from Alpena, W. Va., to the village of Bemis at the northeastern corner. Unimproved Forest Service roads, abandoned logging railroad grades, and primitive trails provide access by foot or horseback into the interior of the study area.

Physiographically, the Cheat Mountain Roadless Area is in the Allegheny Mountain section of the Appalachian Plateaus province and is situated at the

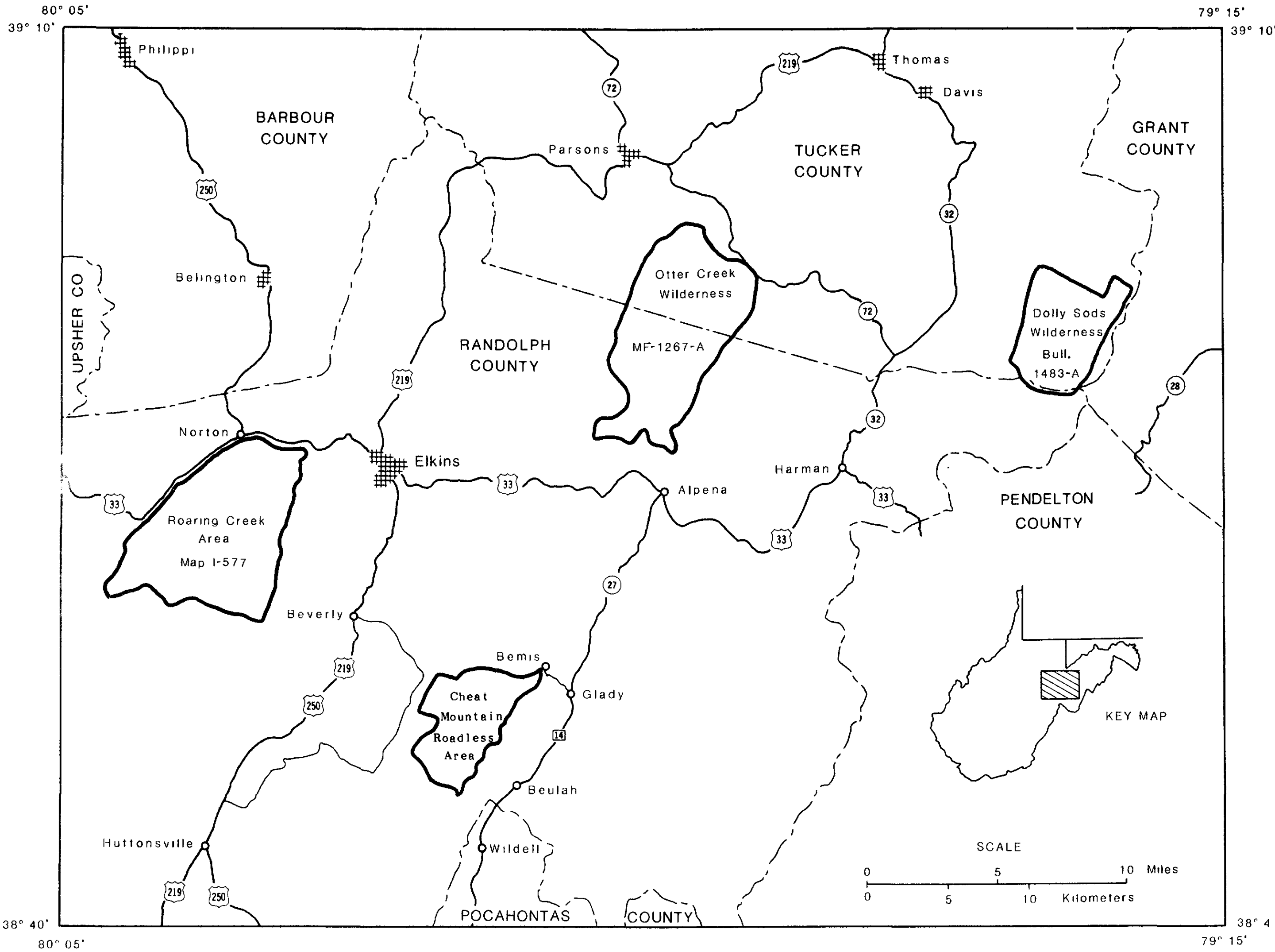

Figure 1.—Index map showing location of Cheat Mountain Roadless Area.

eastern edge of the Appalachian coal region. Cheat Mountain, a northeast-trending linear ridge, is bordered on the west by the Right Fork of Files Creek and on the east by Shavers Fork and its tributaries. Most of the area occupies an elevated plateau capped by resistant sandstone and conglomerate. Altitudes range from about 2,320 ft on Lime Kiln Run to more than 3,900 ft on Cheat Mountain. The topography ranges from relatively flat in the uplands to very steep in the canyons along tributaries of Shavers Fork. The area is heavily forested with vegetation varying from mixed hardwoods on the western slope of Cheat Mountain to thickets of conifers in the uplands. Hemlocks are sparsely interspersed and red spruce, the dominant tree at higher elevations prior to logging in the mid 1920's, is again reforesting upland areas. Rhododendron and laurel flourish in moist, protected areas along drainage courses and in coves.

Previous Investigations

The first major geologic investigation of the coal resources in the Cheat Mountain coal field was made by Reger (1928). The study was followed by a comprehensive county report of the West Virginia Geological Survey that described the distribution, quantity, and quality of coal resources in Randolph County (Reger, 1931). These reports show the outcrops of major coal beds and the locations of numerous mines, prospects, and exploratory drill holes on 1:62,500-scale maps.

Brief accounts of prospecting in and near the area appear in a short report by Maxwell (1931) and an unpublished U.S. Forest Service report (1975). Englund (1969) and Englund and other (1980) have described the geology and mineral resources of the Roaring Creek area and the Dolly Sods Wilderness in two nearby coal basins (fig. 1). The geology and mineral resources of the Otter Creek Wilderness, located along the North Potomac syncline about 9 mi to the north, were described by Warlow and others (1981), and Behum and Mory (1981).

Present Investigations

U.S. Bureau of Mines (USBM) field reconnaissance was conducted by P. T. Behum and R. W. Hammack in the spring of 1979. Forty-nine channel, chip, and grab samples of rock and coal were collected from within or near the area, and all were analyzed spectrographically for 40 elements by the USBM Reno Research Center, Reno, Nev. In addition, atomic absorption, radiometric, and chemical analyses, as well as petrographic studies, were performed on selected samples. Clay and shale samples were evaluated for ceramic properties and lightweight-aggregate potential by the USBM Tuscaloosa Metallurgy Research Center, Tuscaloosa, Ala. Coal samples were analyzed by the U.S. Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Analysis Laboratory, Pittsburgh, Pa. During the field investigation, all known mines, prospects, and exposures in and near the study area were examined and sampled, where possible.

Field investigations by the U.S. Geological Survey (USGS) consisted of reconnaissance geologic mapping and data collecting by K. J. Englund and W. R. Sigleo during early November 1979 and late March 1980. This study included the measurement of stratigraphic sections and coal beds using altimetry to determine altitudes of stratigraphic units, mines, prospects, and exploratory drill holes, and tracing mappable units in and adjacent to the area. A. E. Grosz, assisted by J. O. Olson, J. S. West, and N. A. Wrights, conducted a geochemical survey in May 1980. A total of 65 bulk samples of stream sediments and 34 samples of bedrock were collected. These samples were analyzed semi-quantitatively for 31 elements, including elements having the greatest economic importance, in USGS Laboratories, Denver, Colorado (Grosz and Cooley, 1981).

Acknowledgments

The authors gratefully acknowledge the cooperation of landowners and local residents who supplied coal information and permitted access to their properties for the examination of coal mines and prospects. Appreciation is also extended to Forest Service personnel in the Area Supervisor's office, Elkins, W. Va. and to personnel of the Mower Lumber Company who provided information concerning exploratory drill holes and other coal prospects. A. H. Randall, III, P. L. Foose, and N. K. Teaford, USGS, and L. E. Harris, USBM, assisted in report preparation.

SURFACE- AND MINERAL-RIGHTS OWNERSHIP

Cheat Mountain Roadless Area comprises portions of seven large surface land tracts acquired in 1936 under the authority of the Weeks Act of 1911. The two largest tracts were purchased from West Virginia Pulp and Paper Company; one 3,181-acre tract lies almost entirely within the proposed boundary along the eastern edge, part of the second tract is near the southern boundary (fig. 2). In 1936, two large tracts of 992 and 3,068 acres were purchased from Davis Coal Land Company. A fifth tract, the 908-acre D. E. Lutz tract, encompasses most of the study area on the west slope of Cheat Mountain. Two smaller tracts of about 292 acres and 480 acres of land were acquired from the L. W. McQuain and Flora A. Rose estates.

Mineral rights were retained by the Davis Coal Land Company on the 992-acre tract in the southeastern portion of the area, but the 3,068-acre Davis Coal Land Company tract was acquired "fee simple," thereby passing these mineral rights into U.S. Government ownership in 1936. In the two West Virginia Pulp and Paper Company tracts, the mineral rights were retained until August 16, 1975. However, prior to this expiration data, a 5-year moratorium on mining in the Shavers Fork drainage was enacted beginning September 2, 1973. When this moratorium expired September 2, 1978, Mower Lumber Company, purchaser of West Virginia Pulp and Paper Company's mineral rights on these two tracts, had two years to propose and open mines. The D.E. Lutz tract has mineral rights outstanding in perpetuity to third parties for all minerals on 98 acres and for a 3/4 interest in all minerals on 110 acres. The remainder of the minerals in the study area are owned by the U.S. Government (fig. 2).

Oil and gas leases are retained on Mower Lumber Company tracts by Union Drilling and Columbia Gas (fig. 2).

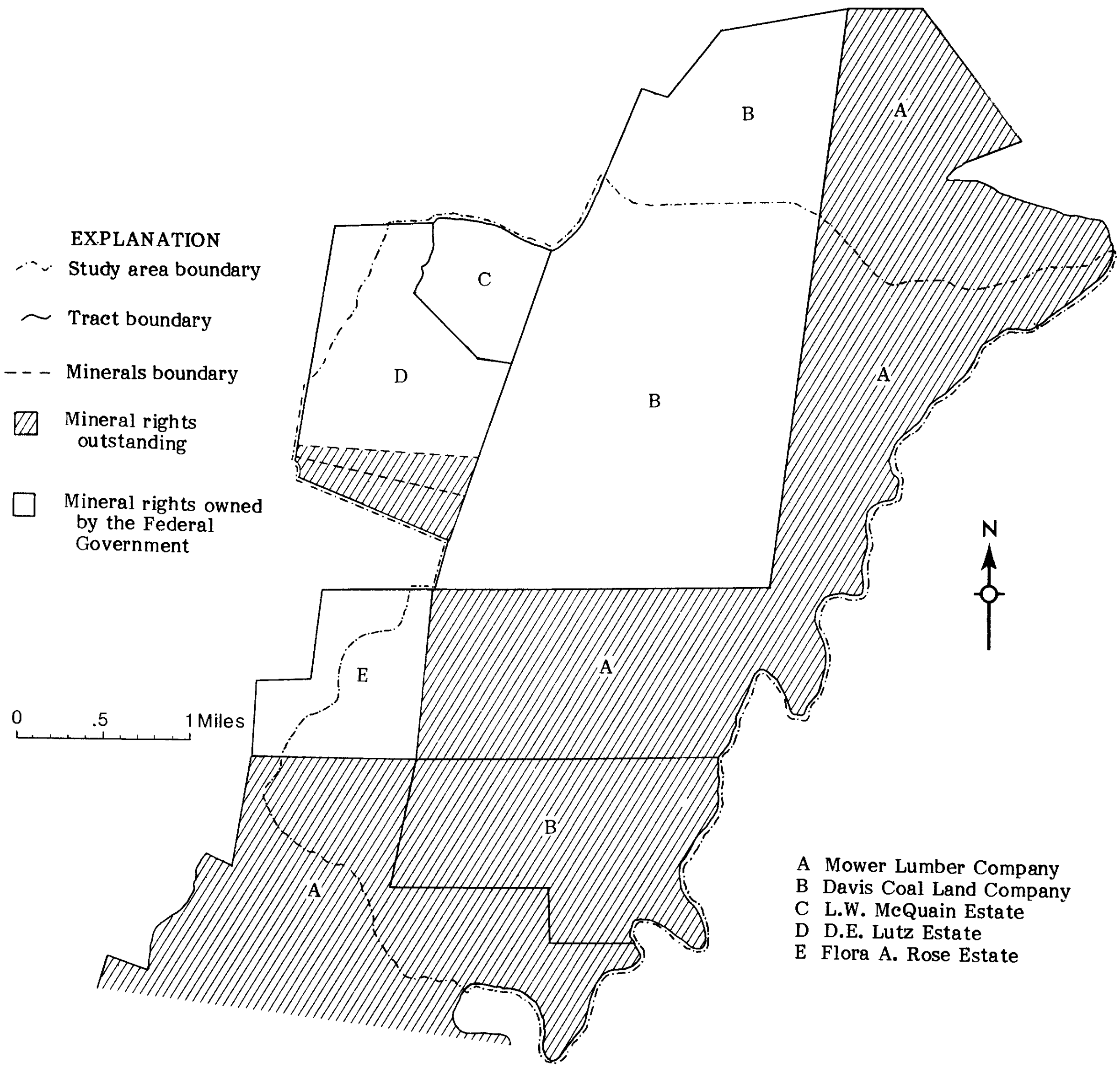

Figure 2.--Surface- and mineral-rights ownership in the Cheat Mountain Roadless Area.

GEOLOGY

About 2,600 ft of sedimentary rocks of Late Devonian to Middle Pennsylvanian age crop out in the study area (Englund and others, 1981), and as much as 30,000 ft of older Paleozoic sediments may be in the subsurface. The basal part of the exposed section consists of continental and marine rocks assigned to the Hampshire, Pocono, Greenbrier, and Mauch Chunk Formations of Late Devonian to Late Mississippian age.

The lower 600 ft of the exposed section is assigned to the Hampshire Formation of Late Devonian age. It consists of thin- to thick-bedded sandstone, siltstone, and shale that were deposited in a coastal deltaic environment. The overlying Pocono Formation of Early Mississippian age consists of up to 60 ft of very fine- to fine-grained sandstone and interbedded greenish-gray shale that were deposited in a prodeltaic environment. Marine invertebrate fossils are found locally. Use of the name Pocono for this stratigraphic unit follows the usage of previous geologic maps of the area (Reger, 1931; Cardwell and others, 1968).

The Greenbrier Limestone of Late Mississippian age is about 250 to 300 ft thick and consists of thick-bedded, light-olive-gray to medium-gray limestone and one or two beds of grayish-red shale as much as 10 ft thick. It disconformably overlies the Pocono Formation (?) and locally includes lenses of quartz-pebble conglomerate in the basal bed. Deposition occurred in subtidal to supratidal marine environments. Marine invertebrate fossils are common throughout the formation. The Upper Mississippian Mauch Chunk Formation is characterized by interbedded grayish-red shale, siltstone, and sandstone that attain a maximum thickness of about 500 ft in the study area. These rocks were deposited largely as tidal-flat and delta-front sediments. Outcrops of Devonian and Mississippian formations are principally on the northwestern slope of Cheat Mountain, but a few exposures of the upper part of the Mauch Chunk Formation are also along Shavers Fork near the eastern edge of the study area.

Overlying rocks of the New River and Kanawha Formations (Early to Middle Pennsylvania age) are mostly continental and coal bearing, but the sequence also contains a few deposits of marine origin. The New River Formation of Early Pennsylvanian age disconformably overlies the Mauch Chunk Formation and consists of as much as 575 ft of conglomeratic cliff- or ledge-forming sandstone and interbedded non-resistant sandstone, siltstone, shale, coal, and underclay. Deposition of the New River and Kanawha Formations was in coastal or near-coastal environments, dominated by barrier-bar, lagoonal, and deltaic processes.

The Kanawha Formation of Middle Pennsylvania age conformably overlies the New River Formation and is lithologically similar. As much as 490 ft of these beds crop out at the crest of Cheat Mountain. The most prominent unit in the formation is the Roaring Creek Sandstone Member of White (1903), which, together with the underlying unnamed sandstone member, underlies broad upland areas near the crest of Cheat Mountain.

Quaternary deposits consist mostly of sandstone and conglomeratic sandstone debris that occurs as colluvium in unmapped slope deposits, or as alluvium in locally mapped deposits on the valley floor.

The Cheat Mountain Roadless Area occupies part of the much larger North Potomac syncline, the major structural feature in central Randolph County, W. Va. The trough of the syncline in the eastern part of the area strikes generally N 25°E and plunges gently in that direction. Structure-contour lines drawn on the base of the Sewell (?) coal bed indicate that the rocks have a low to moderate dip ranging from about 3° near the trough of the syncline to as much as 17° on the limbs which parallel with the eastern and western boundaries. No evidence of faulting was observed in the area.

MINERAL RESOURCE POTENTIAL

Coal of medium- to high-volatile A bituminous rank is the principal mineral resource in the Cheat Mountain Roadless Area. It is in at least 22 beds, 10 of which are of sufficient thickness, extent, and quality to contain identified coal resources. Exploitation of the coal resources has been limited to several small underground and surface mines located beyond the southern and northeastern edges of the area. Nonmetallic resources include limestone, sandstone, shale, and clay. Metallic deposits have not been identified in the area, and because major chemical anomalies were not detected in a geochemical survey, a very low potential exists for the occurrence of such deposits (Grosz and Cooley, 1981).

Coal

Coal resources have been estimated for the Fire Creek (?), Little Raleigh (?), Sewell (?), Sewell A (?), Sewell B (?), and Hughes Ferry (?) coal beds in the New River Formation and for four unnamed coal beds in the overylying Kanawha Formation. Usage of these coal bed names generally follows that of previous geologic investigations (Reger, 1928, 1931; Englund, 1969). However, because of the local nature of the Cheat Mountain Roadless Area study, queries were added to the bed names to indicate that correlations with the type areas were not confirmed. The four unnamed coal beds that contain resources in the Kanawha Formation have not been correlated with beds beyond the study area.

Several additional thin or discontinuous coal beds were noted in the study area. One to two thin beds occur locally in the basal conglomeratic sandstone of the New River Formation and another bed is immediately above this sandstone. The latter coal bed is 40 to 75 ft below the Sewell (?) coal bed and is reported to be about 18 in. thick in two prospects on the west slope of Cheat Mountain, where it was identified as the Welch coal by Reger (1928, 1931); (Behum and Hammack, in press). A small block or area of potentially minable coal is present in this bed south of the study area. Drill records indicate that as much as 18 in. of coal also occurs locally in an unnamed bed in the Nuttall Sandstone Member of the New River Formation. In addition to the coal beds with identifiable resources, the lower part of the Kanawha Formation also contains several beds that are usually less than 12 in. thick. A coal bed in the upper part of the formation locally is as much as 36 in. thick, but its thickness and distribution are highly irregular because of erosion before the deposition of the overlying Roaring Creek Sandstone Member.

Fire Creek (?) coal bed—The Fire Creek (?) coal bed lies approximately 10 to 15 ft above the Mississippian-Pennsylvanian boundary and stratigraphically is the lowest coal bed with estimated resources in the New River Formation. It crops out along the lower valley slopes near the eastern edge of the study area and contains a resource block as much as 28 in. thick adjacent to the outcrop. The bed splits into two thin benches northward, and is thin or absent to the south and west where it was eroded before the deposition of overlying sandstone. Estimated coal resources in the Fire Creek (?) coal bed, 1,598,000 short tons, are in the 14- to 28-inch thickness category and include 73,000 short tons of restricted (surface mineable) reserves.

Sewell (?) coal bed—The Sewell (?) coal bed is the most important resource unit in the study area. It has been mined north of the area at the David Coal Land Company mines (Behum and Hammack, in press, fig. 2), along Shaver's Fork east of the area on Shavers Mountain, and, most recently, at the Linan Mine 7 mi south of the area. The bed extends throughout the study area in a thick dark-gray shale that also includes one to four thin coal beds. Cores from drill holes SF-11 and SF-17 indicate that coal bed is largely canneloid in the southernmost reserve block. In the northeastern part of the area the bed includes at its base carbonaceous shale and impure coal that commonly was extracted to gain additional mining height. The Sewell (?) coal bed ranges from 0 to 58 in. in thickness and reserves occur in four distinct northeast-trending blocks. Estimated coal in the Sewell (?) coal bed totals as follows:

Resources.........	22,814,000 short tons
Reserve base......	7,960,000 short tons
Reserves..........	3,980,000 short tons*

(*assuming a 50 percent recovery factor)
Additional coal may be recoverable by surface mining.

Sewell A (?) coal bed—The Sewell A (?) coal bed is 50 ft or more above the Sewell (?) coal bed and ranges from 0 to 31 in. in thickness. The bed has a limited distribution and attains its maximum thickness in the south-central part of the area. Analyses of a drill-core sample (Behum and Hammack, in press, fig. 2, SF-17) show ash and sulfur contents of 4.5 and 0.5 percent, respectively, on an as-received basis. Estimated resources in the Sewell A (?) coal bed total 1,207,000 tons. Coal thick enough for underground mining was not identified within the study area during this investigation.

Sewell B (?) coal bed—The Sewell B (?) coal bed lies at the base of a conglomeratic sandstone near the middle of the New River Formation about 90 ft above the Sewell (?) coal bed. It is as much as 30 in. thick in the southwestern corner of the area, but it is thin or absent elsewhere because of erosion that preceded the deposition of the overlying sandstone. The quantity of coal estimated in the Sewell B (?) is:

Resources.........	4,423,000 short tons
Reserve base......	334,000 short tons
Reserves..........	167,000 short tons*

*(assuming a 50 percent recovery factor)

Hughes Ferry (?) coal bed—The Hughes Ferry (?) coal bed is near the base of the Nuttall Sandstone Member of the New River Formation and as much as 200 ft above the Sewell (?) coal bed. It ranges in thickness from 0 to about 50 in. and contains resources in three separate blocks within the study area. Estimated resources in the Hughes Ferry (?) coal bed are:

Reserves..........	4,993,000 short tons
Reserve base......	641,000 short tons
Reserves..........	321,000 short tons*

*(assuming a 50 percent recovery factor)

C coal bed—A thick sequence of shale with thin interbeds of siltstone and sandstone in the lower part of the Kanawha Formation contains 1 to 8 thin coal beds. Of these, two are locally of sufficient thickness to permit the estimation of resources. The lower unnamed bed, designated C, occurs 440 to 540 ft above the Sewell (?) coal bed. It attains a maximum thickness of 46 in. in a block of estimated resources in the south-central part of the area. Reger (1931, p. 545) reported that a small coal mine operated at the position of the C coal bed about 1 mi north of the study area during early railroad construction. At this locality, an upper 28-inch bench and a lower 13-inch bed are separated by 45 in. of carbonaceous shale (Behum and Hammack, in press, fig. 2, loc. 8) Resources in the C coal bed are estimated to total:

Reserves..........	4,858,000 short tons
Reserve base......	2,320,000 short tons
Reserves..........	1,160,000 short ton*

*(assuming a 50 percent recovery factor)

C-1 coal bed—The C-1 coal bed is about 40 ft above the C coal bed and is separated from it by a sequence of shale, siltstone, and sandstone that locally includes a thin coal bed and associated underclay. Resources in the C-1 coal bed are in the southern part of the area where the bed is as much as 42 in. thick. Estimated resources in the C-1 coal bed are:

Resources.........	2,351,000 short tons
Reserve base......	216,000 short tons
Reserves..........	108,000 short tons*

*(assuming a 50 percent recovery factor)
Additional coal may be recovered by surface mining.

C-2 coal bed—The C-2 coal bed is a thin, persistent bed that lies about 40 ft above the C-1 coal bed. Intervening strata consist mostly of medium-gray shale. As much as 16 in. of coal were penetrated in the bed by core drilling in the northern and southern parts of the area. Resources are estimated to total 1,317,000 short tons, of which 66,000 short tons may be recovered by contour strip mining in conjunction with the stripping of the C-1 coal bed.

C-4 coal bed—The C-4 coal bed, at approximately 55 ft above the C-1 coal bed, is the uppermost of several unnamed coal beds in the lower part of the Kanawha Formation. It is relatively persistent in the southern part of the area where it includes a small tract of resources as much as 18 in. thick. Estimated resources total 359,000 short tons, of which 35,000 tons may be recovered by surface mining techniques.

Resource Summary

Approximately 44.5 million tons of coal are contained in the 10 major coal beds underlying the Cheat Mountain Roadless Area (table 1). Of the estimated original resources, 74 percent of the coal is 14-28 in. thick and 22 percent is 28-42 in. thick. The Sewell (?) coal, the thickest and most persistent bed, contains an estimated 23 million tons of coal, or 52 percent of the total coal resources estimated for the study area. The coal resources for the principal coal beds are mostly located in the southwestern part of the area and in a north-trending belt parallel to the axis of the North Potomac syncline (fig. 3).

Chemical analyses (Behum and Hammack, in press, sheet 2, table 2) of coal from different beds at several localities in the study area indicate that the rank of the coal ranges from medium- to high-volatile A bituminous. Accurate rank determinations of each coal bed could not be made because of the lack of sufficient samples from the area and the weathered or oxidized condition of coal near the outcrop. Available samples indicate that the rank of the Sewell (?) is medium-volatile bituminous, on an as-received basis and that the bed has a low to medium sulfur content, ranging from 0.4 to 1.1 percent. The ash content of the Sewell (?) coal, an important criterion affecting the quality of coal, ranges from about 6.4 to 34.4 percent, on an as-received basis (table 2). The high-ash content (34.4 percent) of the Sewell (?) coal in sample SF-11-3 is related to the occurrence of cannel coal at this locality. The total estimated reserve base is about 8.1 million short tons (fig. 4). Current mining activity in the vicinity of the Cheat Mountain Roadless Area is insufficient to determine accurately a recovery factor for calculating reserves. However, if a 50 percent recovery factor is used, the study area would contain about 5.74 million tons of deep-mineable reserves (table 2).

Additional reserve base was estimated for surface minable coal in the Fire Creek(?), Sewell(?), C, C-1, C-2, and C-4 coal beds (table 2). This reserve base is classified as restricted because of the prohibition of surface mining in eastern National Forests. The restricted reserve base is 1.69 million short tons, of which 863,000 short tons are minable by strip and 236,000 short tons are minable by auger mining. A composite restricted reserve-base area for all of the above-mentioned coal beds is shown in figure 5.

Limestone

The Greenbrier Limestone has been quarried extensively near the Cheat Mountain Roadless Area. North of the area, near Bowden, W. Va., quarries have supplied limestone for agricultural use, concrete aggregate, road metal, and railroad ballast. The former Faulkner quarry of the Monongahela Construction Company was the largest operation, having an underground mine off the main quarry and a crushing and loading facility on a railroad siding at Bowden. Currently, two active quarries near Bowden furnish stone primarily for road metal. South of the area, the West Virginia Medium Security Prison operated a quarry along U.S. Route 250 which produced stone for road metal and some agricultural use.

Within the study area, the Greenbrier Limestone crops out in a narrow belt along the western slope of Cheat Mountain (Englund and others, 1981). Approximately 120 acres of limestone are exposed and, based on chemical analyses, this limestone may be suitable for use in the manufacture of portland cement. Certain high-calcium units of the Greenbrier Limestone can be used for agricultural lime and steel flux (Reger, 1931). The limestone is also suitable for road metal and railroad ballast.

The Greenbrier Limestone in the Cheat Mountain Roadless Area has moderate resource potential because some units meet established criteria for some high-calcium limestone uses. However, deposits and existing quarries closer to both good transportation systems and markets could adequately supply road metal and railroad ballast in the foreseeable future.

Clay and Shale

Clay and shale from Mississippian and Pennsylvanian formations in the Cheat Mountain Roadless Area have not been mined locally. However, shale of the Brallier Formation of Late Devonian age was quarried near Elkins, W. Va. to supply raw material for a local brick plant. Underclay beds in the Allegheny Formation of Middle Pennsylvanian age are mined for refractory products in western Maryland and have been mined in the past in Mineral County (Waage, 1950). Englund and Goett (1968) reported refractory-clay beds in the lower part of the Allegheny Formation 10 mi west of Beverly. Rocks of this formation were not identified in the area.

Underclay and shale from the New River and Kanawha Formations and shale from the Hampshire and Mauch Chunk Formations were sampled to evaluate their chemical composition. Chemical analyses from this investigation show high-alumina concentrations (greater than 25 percent) for four shale samples (sheet 2, fig.14); two of these samples were collected from the New River Formation (WVCM-6 and 23, Behum and Hammack, in press), and one each from the Kanawha (locality WVCM-15) and Hampshire Formations (locality WVCM-43). These analyses are comparable to those previously reported (Reger, 1931; Lessing and Thomson, 1973).

Preliminary bloating and ceramic tests indicate that most samples are suitable for structural-clay products. Most samples from the Hampshire and Mauch Chunk Formations appear suitable for building brick, but have low melting temperatures which restrict their use for other ceramic products. Two samples from the Mauch Chunk Formation (localities WVCM-3 and 42, Behum and Hammack, in press, fig. 3) have detrimental lime content for structural-clay products. The addition of ball clays to improve plasticity may be required for units with short-working properties. All bloating tests were negative, indicating that these units are not suitable for use in lightweight-aggregate products.

Sandstone

The Roaring Creek Sandstone Member of the Kanawha Formation has been quarried west of Elkins, W.Va. in conjunction with railroad construction (Reger, 1931). These quarries supplied building stone for bridge piers, abutments, tunnel linings, and local

Table 1.--*Estimated original coal resources. In thousands of short tons, covered by less than 1,000 ft of overburden, as of December 31, 1980*

Formation	Coal bed	Original resources															
		Measured				Indicated				Inferred				Total			
		In beds 14-28 in thick	In beds 28-42 in thick	In beds more than 42 in thick	Total	In beds 14-28 in thick	In beds 28-42 in thick	In beds more than 42 in thick	Total	In beds 14-28 in thick	In beds 28-42 in thick	In beds more than 42 in thick	Total	In beds 14-28 in thick	In beds 28-42 in thick	In beds more than 42 in thick	Total
Kanawha	C-4	257			257	102			102					359			359
	C-2	644			644	654			654	19			19	1,317			1,317
	C-1	1,142	553		1,695	533	123		656					1,675	676		2,351
	C	1,670	1,498	56	3,224	1,570	64		1,634					3,240	1,562	56	4,858
New River	Hughes Ferry (?)	1.932	284		2,216	2,412	307		2,719	58			58	4,402	591		4,993
	Sewell B (?)	1,896	279		2,175	2,191	19		2,210	38			38	4,125	298		4,423
	Sewell A (?)	949	87		1,036	171			171					1,120	87		1,207
	Sewell (?)	2,925	3,387	1,382	7,694	10,837	3,124	389	14,350	770			770	14,532	6,511	1,771	22,814
	Little Raleigh (?)	248	66		314	78			78					326	66		392
	Fire Creek (?)	512			512	1,076			1,076	10			10	1,598			1,598
		12,175	6,154	1,438	19,767	19,624	3,637	389	23,650	895			895	32,694	9,791	1,827	44,312

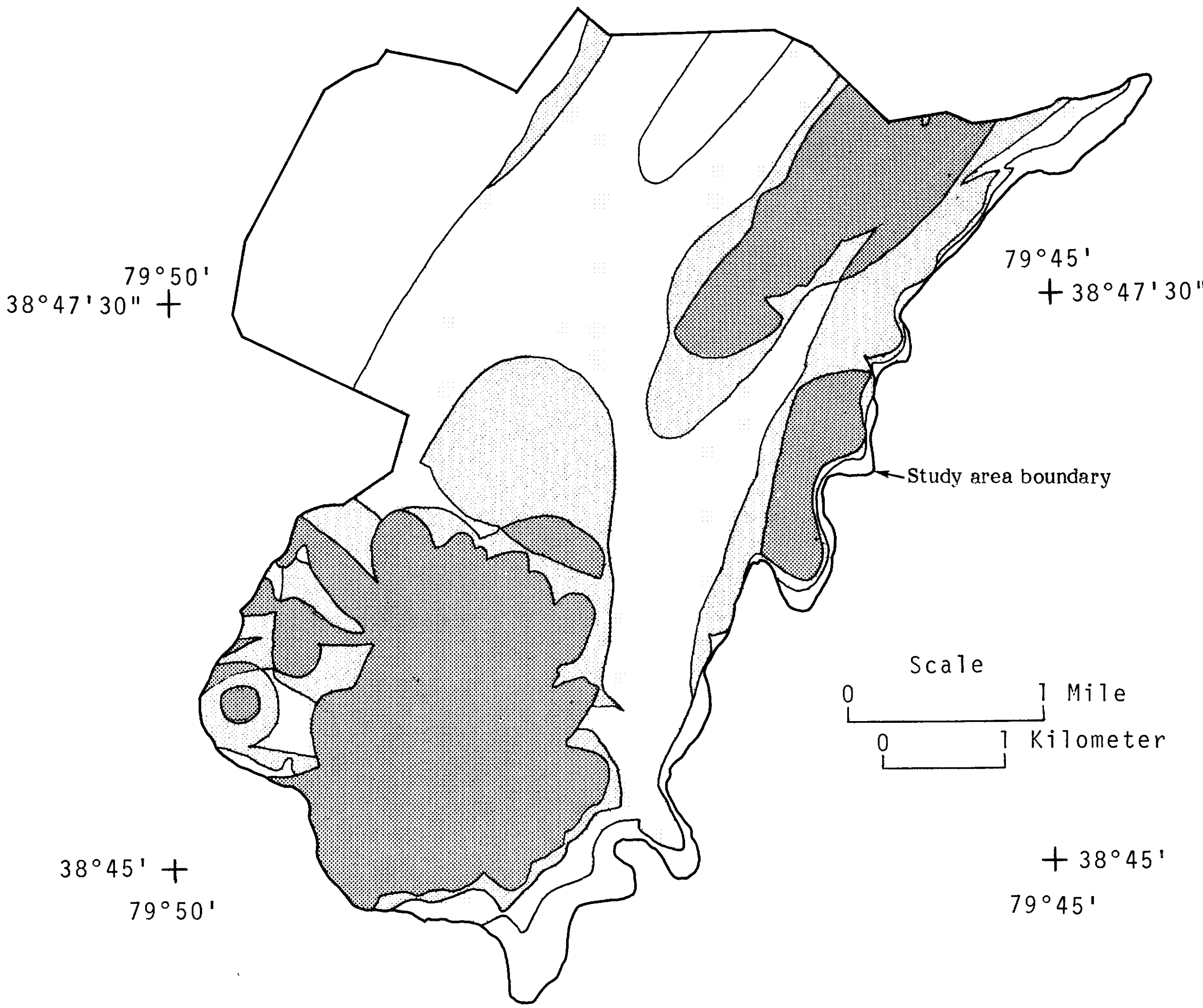

Figure 3.—Known cumulative coal-resource distribution of all beds.

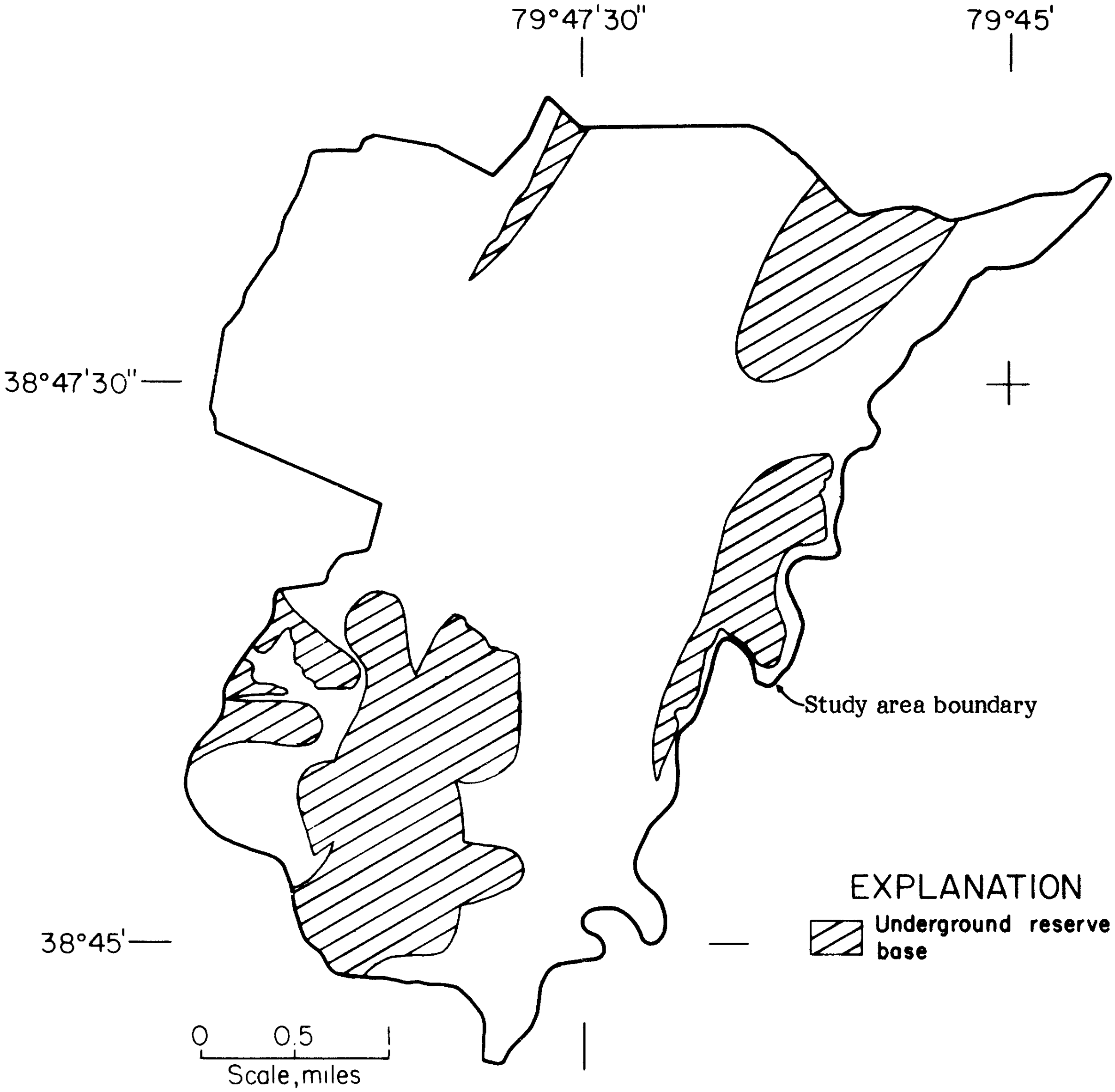

Figure 4.—Composite underground reserve base for all coal beds.

Table 2.--*Summary of estimated demonstrated coal reserve base and reserves.*
[Compiled by P.T. Behum and R.W. Hammack, April 14, 1982 .]

Coalbed / Mining technique	Acres of coal	Reserve base (short tons)			Reserves (short tons)
		Measured	Indicated	Demonstrated 1	
C-4					
Strip2	17	34,000	8,000	42,000	35,0003
C-2					
Strip2	34	54,000	23,000	78,000	66,0003
C-1					
Underground	46	45,000	171,000	216,000	108,000-129,0004
Strip2	104	237,000	91,000	328,000	279,0003
Auger2	52	161,000	41,000	203,000	71,0005
Surface total2	155	398,000	132,000	530,000	349,000
C					
Underground	485	1,710,000	613,000	2,320,000	1,160,000-1,390,0004
Strip2	127	327,000	142,000	469,000	401,0003
Auger2	76	184,000	95,000	280,000	98,0005
Surface total2	203	511,000	237,000	749,000	499,000
Hughes Ferry(?)					
Underground	133	324,000	317,000	641,000	321,000-385,0004
Sewell B(?)					
Underground	77	315,000	19,000	334,000	167,000-200,0004
Sewell(?)					
Underground	1,519	4,530,000	3,430,000	7,960,000	3,980,000-4,780,0004
Strip2	9	32,000	19,000	51,000	43,0003
Auger2	15	56,000	45,000	101,000	35,0005
Surface total2	23	89,000	64,000	152,000	79,000
Fire Creek(?)					
Strip 2	13	45,000	3,000	48,000	41,0003
Auger 2	25	84,000	6,000	90,000	32,0005
Surface total2	38	130,000	8,000	138,000	73,000
Total					
Underground		6,930,000	4,560,000	11,500,000	5,740,000-6,880,0004
Strip2		730,000	286,000	1,020,000	863,0003
Auger2		486,000	188,000	673,000	236,0005
Surface total2		1,220,000	473,000	1,690,000	1,100,000

1 Demonstrated is the total of the measured and indicated reserve base; tonnage may not total due to independent rounding.
2 Classified as restricted.
3 At an 85 percent recovery factor.
4 At a 50 to 60 percent recovery factor, respectively.
5 At a 35 percent recovery factor.
6 Total surface acres may not total due to independent rounding.

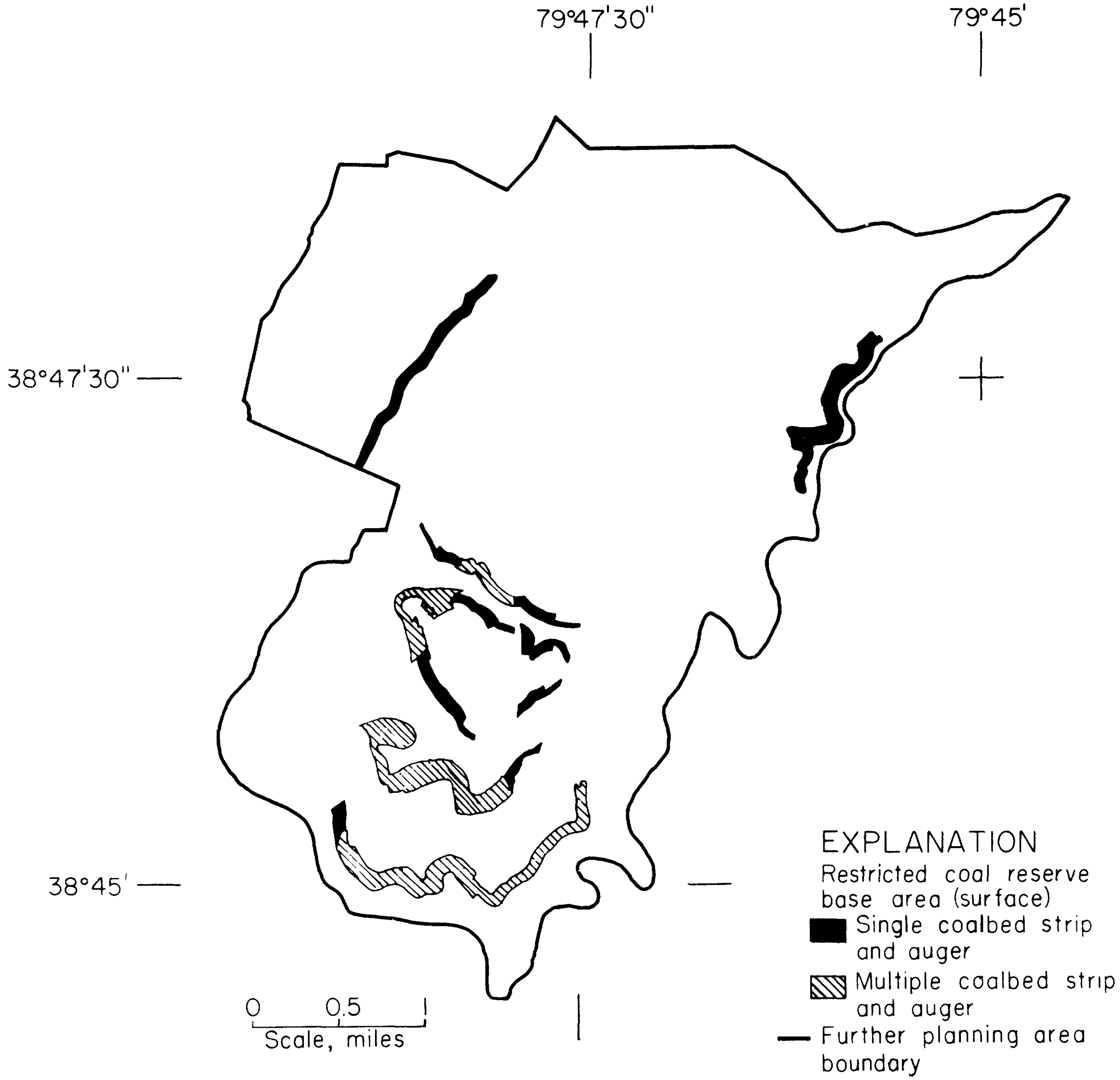

Figure 5.—Composite restricted (surface minable) reserve base for all coal beds.

buildings and coarse aggregate for use as railroad ballast. Glass and other special-purpose sands, in particular, were excavated from the Roaring Creek Sandstone Member for several years near Silica, 23 mi southwest of the study area (Grimsley, 1909; Reger, 1918, and 1931). In Tucker County, north of the Cheat Mountain Roadless Area, the Roaring Creek Sandstone Member has been excavated for use as structural sand and aggregate (Arkle and Hunter, 1957). Near Glady, a lower sandstone member of the Mauch Chunk Formation was quarried to supply rough building stone to line the nearby Western Maryland Railroad tunnel through Shavers Mountain.

Nonporous sandstone from most formations within the study area is suitable for use as rough building stone and as architectural stone where even-textured and nonconglomeratic. Friable sandstone can be used as engine and structural sand and for the manufacture of sand-lime brick and some abrasives.

Chemical analyses of samples from the Roaring Creek Sandstone Member and an upper unnamed sandstone of the Mauch Chunk Formation indicate that these deposits may be suitable as special-purpose sands. Where subsequent leaching has reduced the iron content, the sandstone may be suitable for use as foundry, furnace, and low-grade glass sand and for the manufacture of silica brick, silicon carbide, and roofing materials. More exploration would be necessary to delineate individual deposits.

The market for sandstone products in the region is not large. However, a casting plant located in Elkins could serve as a consumer for foundry and furnace sands. Sandstone resources are available throughout the region, but past production has been limited to areas proximal to points of consumption and transportation routes.

Oil and Gas

Hydrocarbon production in the vicinity of the Cheat Mountain Roadless Area has been limited to natural gas. There is a low potential for oil resources because of the high thermal maturity of the rocks. Closest hydrocarbon production was from the Glady field, now used for storage, on the Blackwater anticline 2 mi east of the study area. The Cassidy field on the Hiram anticline is 15 mi west of the area. Natural gas pipelines are located along the northern boundary of the study area.

In all but the Cassidy field, gas is produced from calcareous sandstone units of the Lower Devonian Oriskany Group, with additional productions from the cherty limestone beds which overlie the Oriskany (Reeves and Price, 1950; Price and others, 1957; Patchen, 1968). These stratigraphic units are known as the Oriskany sand and Huntersville chert to local drillers. Production in the Cassidy field is from sandstone units of the Upper Devonian Hampshire Formation (West Virginia Geological Survey, 1962), locally and informally known to drillers as the fifth and Bayard (sixth) sands.

Upper Devonian sandstone is well exposed to the west of the study area, allowing any gas accumulated in these rocks to escape. The Oriskany sand and the Huntersville chert probably underlie the area at a depth of about 9,000 ft and may be involved in small-scale splay faulting. Older formations are largely untested in the region. Structure features as possible targets, such as those in the Lower Silurian Tuscarora Sandstone and Cambrian and Ordovician carbonates, are probably complex due to thin-skinned faulting.

Weed (1981) reported that the Cheat Mountain Roadless Area shows no potential for oil production and a relatively low potential for gas production. Tectonic analysis of local structural features suggests the presence of splay and fracture zones with favorble fracture porosity. Recent exploratory drilling in similar structural settings in Pennsylvania has proven successful. However, two recent exploration wells in a neighboring syncline were dry. Source and reservoir rocks appear to be present but maturation levels are high. Adequate subsurface data are not available within Cheat Mountain Roadless Area and data from nearby wells are insufficient to determine if structural traps exist at depth or if gas is present. Seismic data are needed to determine the existence of structural traps for hydrocarbon accumulation.

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