TABLE 1.—Chemical analyses (as received basis) of selected coal samples from Castleman Coal Field

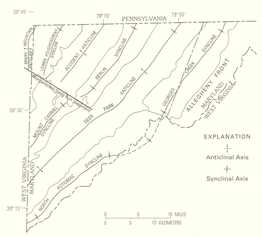
Coal Bed	NCRDS[1] Locality No.	Laboratory No.	Proximate (percent)				Ultimate (percent)					Fusibility of ash			Specific gravity	Agglutinating index[*]	Core received (inches)	Core analyzed (inches)
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calorific value (B.t.u.)	Initial deformation temperature (°F)	Softening temperature (°F)	Fluid temperature (°F)				
Barton	31-CB	D-7124	0.9	22.5	58.4	18.2	3.6	4.3	69.6	1.4	2.9	12,410	2,150	2,230	2,490	1.45	9.4	13	13
Federal Hill	2-CB	C-76253	.8	23.3	59.1	16.8	3.7	4.3	71.0	1.3	2.9	12,710	2,080	2,150	2,410	1.44	10.0	19	14.75
Harlem	17-CB	C-91451	.9	22.4	62.9	13.8	3.1	4.5	74.2	1.3	3.1	13,260	2,080	2,170	2,340	1.39	9.7	20.5	19.5
Upper Bakerstown	2-CB	C-76720	.9	20.6	56.7	21.8	3.9	3.9	65.9	1.2	3.3	11,790	2,160	2,220	2,360	1.51	8.8	29.5	11
Lower Bakerstown	27-CB	D-1486	1.3	18.9	67.2	12.6	3.9	4.3	75.1	1.3	2.8	13,290	2,050	2,150	2,310	1.42	6.6	27	27
Brush Creek	37-CB	D-14554	.9	21.2	65.0	12.9	3.0	4.3	75.3	1.2	3.3	13,300	1,970	2,050	2,260	1.40	9.3	13	13
Upper Freeport	31-CB	D-8016	1.5	18.9	70.4	9.2	1.7	4.6	79.5	1.3	3.7	13,940	2,570	2,650	2,800	1.36	10.0	22	20.5
Upper Kittanning	32-CB	D-8812	1.0	21.7	61.3	16.0	3.7	4.3	72.5	1.1	2.4	12,900	2,050	2,250	2,460	1.43	8.8	21	20
Middle Kittanning	12-CB	C-87624	.9	19.4	61.8	17.9	3.0	4.0	71.2	0.9	3.0	12,480	2,080	2,490	2,570	1.47	6.5	15	15
Lower Kittanning	4-CB	C-81488	.6	25.3	54.6	19.5	3.5	4.3	67.9	1.0	3.8	12,140	2,700	2,780	2,910+	1.49	8.0	12	12
Upper Mt. Savage	1-CB	C-77529	.8	19.9	58.8	20.5	6.8	3.8	66.0	1.0	1.9	11,880	2,000	2,380	2,470	1.55	6.5	23	23
Upper Mercer	7-CB	C-83694	.9	21.3	62.8	15.0	1.3	4.2	73.8	.9	4.8	12,910	2,910+	—	—	1.43	4.9	42	29.5

Data from Toenges and others, 1952.

[1]National Coal Resources Data System

[*]"Approximate measure of the quantity and quality of fusible material in coal that becomes plastic on heating in the absence of air, which property is necessary for coals used in coke manufacture". Toenges and others, 1952, p. 18.

INDEX MAP TO 7.5′ QUADRANGLES COVERING CASTLEMAN COAL FIELD



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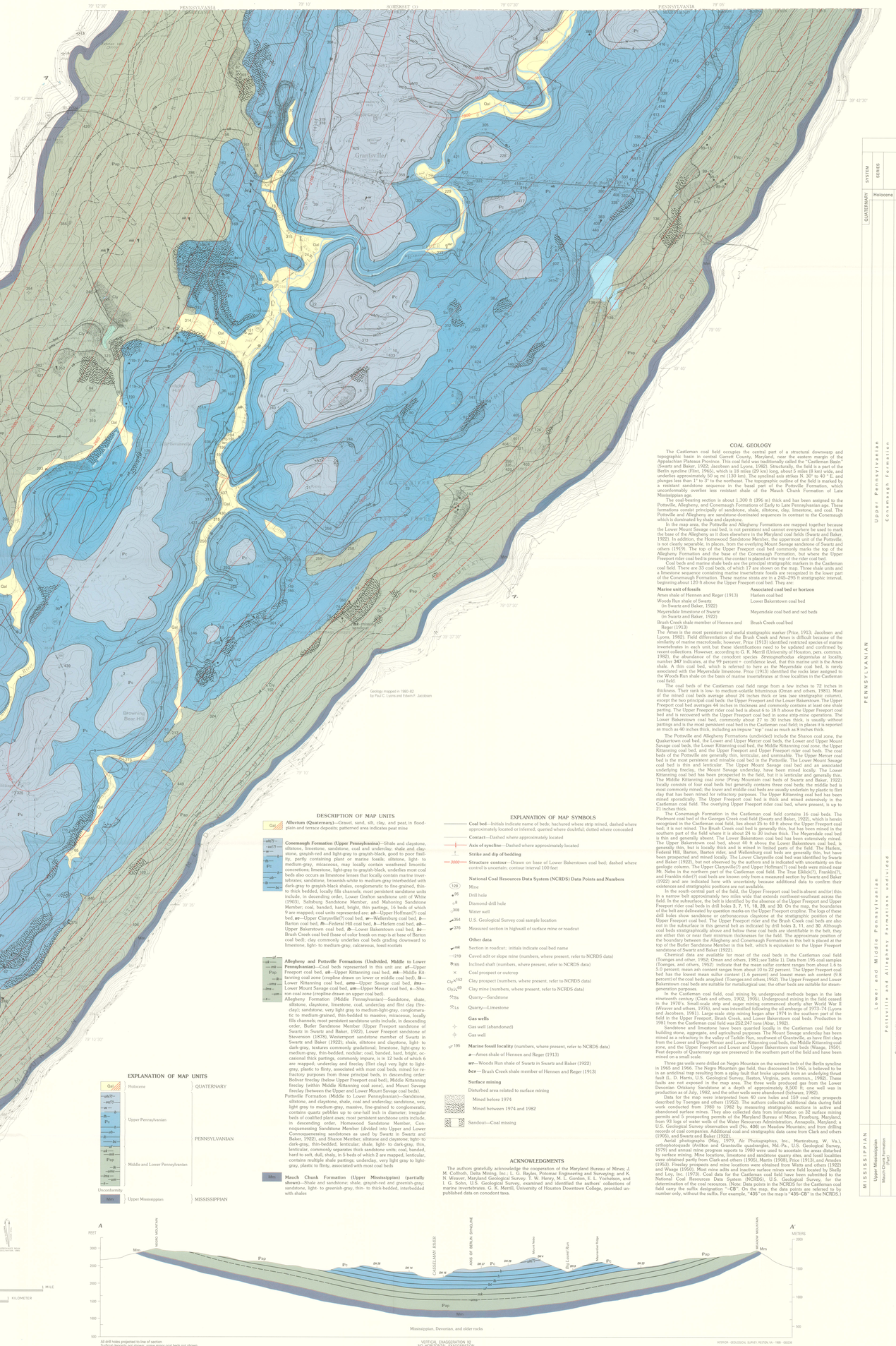

DESCRIPTION OF MAP UNITS

Qal — **Alluvium (Quaternary)**—Gravel, sand, silt, clay, and peat, in flood-plain and terrace deposits; patterned area indicates peat mine

Conemaugh Formation (Upper Pennsylvanian)—Shale and claystone, siltstone, limestone, sandstone, coal and underclay; shale and claystone, grayish-red and light-gray to grayish-black, good to poor fissility, partly containing plant or marine fossils; siltstone, light- to medium-gray, micaceous, may locally contain weathered limonitic concretions; limestone, light-gray to grayish-black, underlies most coal beds also occurs as limestone lenses that locally contain marine invertebrates; sandstone, brownish-white to medium-gray interbedded with dark-gray to grayish-black shales, conglomeratic to fine-grained, thin- to thick bedded, locally fills channels; most persistent sandstone units include, in decending order, Lower Grafton sandstone unit of White (1903), Saltsburg Sandstone Member, and Mahoning Sandstone Member; coal, banded, hard, bright, thin partings, 16 beds of which 9 are mapped; coal units reported are, **uf**—Upper Hoffman(?) coal bed, **uc**—Upper Clarysville(?) coal bed, **w**—Wellersburg coal bed, **b**—Barton coal bed, **fh**—Federal Hill coal bed, **h**—Harlem coal bed, **ub**—Upper Bakerstown coal bed, **lb**—Lower Bakerstown coal bed, **bc**—Brush Creek coal bed (base of coal break on map is at base of Barton coal bed); clay commonly underlies coal beds grading downward to limestone, light- to medium-gray, calcareous, fossil rooted

Allegheny and Pottsville Formations (Undivided, Middle to Lower Pennsylvanian)—Coal beds represented in this unit are: **uf**—Upper Freeport coal bed, **uk**—Upper Kittanning coal bed, **mk**—Middle Kittanning coal zone (cropline drawn on lower or middle coal bed), **lk**—Lower Kittanning coal bed, **ums**—Upper Savage coal bed, **lms**—Lower Mount Savage coal bed, **um**—Upper Mercer coal bed, **s**—Sharon coal zone (cropline drawn on upper coal bed);

Allegheny Formation (Middle Pennsylvanian)—Sandstone, shale, siltstone, claystone, limestone, coal, underclay and flint clay (fireclay); sandstone, very light gray to medium-light-gray, conglomeratic to medium-grained, thin-bedded to massive; micaceous, locally fills channels; most persistent sandstone units include, in descending order, Butler Sandstone Member (Upper Freeport sandstone of Swartz in Swartz and Baker, 1922), Lower Freeport sandstone of Stevenson (1878), Westernport sandstone member of Swartz in Swartz and Baker (1922); shale, siltstone and claystone, light- to dark-gray, textures commonly gradational; limestone, light-gray to medium-gray, thin-bedded, nodular; coal, banded, hard, bright, occasional thick partings, commonly impure, is in 12 beds of which 6 are mapped; underclay and fireclay (flint clay) very light to light-gray, plastic to flinty, associated with most coal beds, mined for refractory purposes from three principal beds, in descending order: Bolivar fireclay (below Upper Freeport coal bed), Middle Kittanning fireclay (within Middle Kittanning coal zone), and Mount Savage fireclay (between the Upper and Lower Mount Savage coal beds).

Pottsville Formation (Middle to Lower Pennsylvanian)—Sandstone, siltstone, and claystone, shale, coal and underclay; sandstone, very light gray to medium-gray, massive, fine-grained to conglomeratic, contains quartz pebbles up to one-half inch in diameter, irregular beds of coalified plant axes; most persistent sandstone units include, in descending order, Homewood Sandstone Member, Connoquenessing Sandstone Member (divided into Upper and Lower Connoquenessing sandstones as used by Swartz in Swartz and Baker, 1922), and Sharon Member; siltstone and claystone; light- to dark-gray, thin-bedded, lenticular; shale, light- to dark-gray, thin, lenticular, commonly separates thick sandstone units; coal, banded, hard to soft, dull, shaly, in 5 beds of which 2 are mapped, lenticular, contains multiple shale partings; underclay, very light gray to light-gray, plastic to flinty, associated with most coal beds

Mm — **Mauch Chunk Formation (Upper Mississippian) (partially shown)**—Shale and sandstone; shale, grayish-red and greenish-gray; sandstone, light- to greenish-gray, thin- to thick-bedded, interbedded with shales

EXPLANATION OF MAP UNITS

Qal	Holocene	QUATERNARY
uk(?) — ms(?)	Upper Pennsylvanian	PENNSYLVANIAN
uf — mk — lk — ums — lms — um — s	Middle and Lower Pennsylvanian	
Pzp	Unconformity	
Mm	Upper Mississippian	MISSISSIPPIAN

EXPLANATION OF MAP SYMBOLS

Coal bed—Initials indicate name of bed; hachured where strip mined, dashed where approximately located or inferred; queried where doubtful; dotted where concealed

Contact—Dashed where approximately located

Axis of syncline—Dashed where approximately located

Strike and dip of bedding

3000 — **Structure contour**—Drawn on base of Lower Bakerstown coal bed; dashed where control is uncertain; contour interval 100 feet

National Coal Resources Data System (NCRDS) Data Points and Numbers

128 — Mine

$_{d}^{16}$ — Drill hole

$_{d}^{8}$ — Diamond-drill hole

308 — Water well

$_{s}^{354}$ — U.S. Geological Survey coal sample location

$_{m}^{276}$ — Measured section in highwall of surface mine or roadcut

Other data

$_{s}^{m4}$ — Section in roadcut; initials indicate coal bed name

$_{c}^{219}$ — Caved adit or slope mine (numbers, where present, refer to NCRDS data)

^{h}165 — Inclined shaft (numbers, where present, refer to NCRDS data)

× — Coal prospect or outcrop

Clx^{152} — Clay prospect (numbers, where present, refer to NCRDS data)

$Clyx^{69}$ — Clay mine (numbers, where present, refer to NCRDS data)

^{Ss}6a — Quarry—Sandstone

^{Ls}1a — Quarry—Limestone

Gas wells

Gas well (abandoned)

Gas well

^{p}196 — **Marine fossil locality** (numbers, where present, refer to NCRDS data)

a—Ames shale of Hennen and Reger (1913)

wr—Woods Run shale of Swartz in Swartz and Baker (1922)

bcs—Brush Creek shale member of Hennen and Reger (1913)

Surface mining

Disturbed area related to surface mining

Mined before 1974

Mined between 1974 and 1982

Sandout—Coal mining

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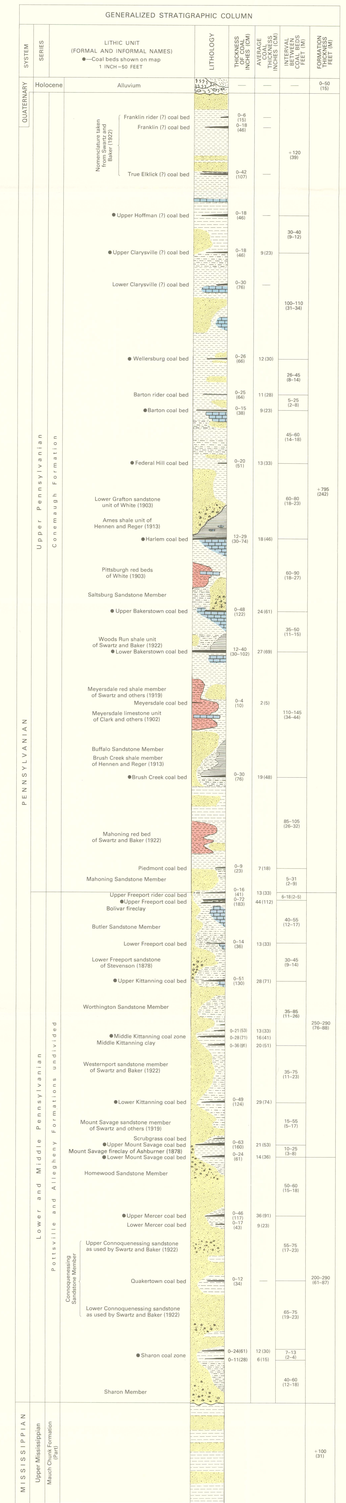
The authors gratefully acknowledge the cooperation of the Maryland Bureau of Mines; J. M. Coffroth, Delta Mining, Inc.; L. G. Bayles, Potomac Engineering and Surveying; and K. N. Weaver, Maryland Geological Survey. T. W. Henry, M. L. Gordon, E. L. Yochelson, and I. G. Sohn, U.S. Geological Survey, examined and identified the authors' collections of marine invertebrates. G. K. Merrill, University of Houston Downtown College, provided unpublished data on conodont taxa.



COAL GEOLOGY OF THE CASTLEMAN COAL FIELD, GARRETT COUNTY, MARYLAND

By
Paul C. Lyons, Edwin F. Jacobsen, and Bryan K. Scott

1985

COAL GEOLOGY

The Castleman coal field occupies the central part of a structural downwarp and topographic basin in central Garrett County, Maryland, near the eastern margin of the Appalachian Plateau Province. This coal field was traditionally called the "Castleman Basin" (Swartz and Baker, 1922; Jacobsen and Lyons, 1982). Structurally, the field is a part of the Berlin syncline (Flint, 1965), which is 18 miles (29 km) long, about 5 miles (8 km) wide, and underlies approximately 50 sq mi (130 km). The synclinal axis strikes N. 30° to 40 ° E. and plunges less than 1° to 3° to the northeast. The topographic outline of the field is marked by a resistant sandstone sequence in the basal part of the Pottsville Formation, which unconformably overlies less resistant shale of the Mauch Chunk Formation of Late Mississippian age.

The coal-bearing section is about 1,300 ft (396 m) thick and has been assigned to the Pottsville, Allegheny, and Conemaugh Formations of Early to Late Pennsylvanian age. These formations consist principally of sandstone, shale, siltstone, clay, limestone, and coal. The Pottsville and Allegheny are sandstone-dominated sequences in contrast to the Conemaugh which is dominated by shale and claystone.

In the map area, the Pottsville and Allegheny Formations are mapped together because the Lower Mount Savage coal bed, is not persistent and cannot everywhere be used to mark the base of the Allegheny as it does elsewhere in the Maryland coal fields (Swartz and Baker, 1922). In addition, the Homewood Sandstone Member, the uppermost unit of the Pottsville, is not clearly separable, in places, from the overlying Mount Savage sandstone of Swartz and others (1919). The top of the Upper Freeport coal bed commonly marks the top of the Allegheny Formation and the base of the Conemaugh Formation, but where the Upper Freeport rider coal bed is present, the contact is placed at the top of the rider coal bed.

Coal beds and marine shale beds are the principal stratigraphic markers in the Castleman coal field. There are 33 coal beds, of which 17 are shown on the map. Three shale units and a limestone sequence containing marine invertebrate fossils are recognized in the lower part of the Conemaugh Formation. These marine strata are in a 245–295 ft stratigraphic interval, beginning about 120 ft above the Upper Freeport coal bed. They are:

Marine unit of fossils	Associated coal bed or horizon
Ames shale of Hennen and Reger (1913)	Harlem coal bed
Woods Run shale of Swartz (in Swartz and Baker, 1922)	Lower Bakerstown coal bed
Meyersdale limestone of Swartz (in Swartz and Baker, 1922)	Meyersdale coal bed and red beds
Brush Creek shale member of Hennen and Reger (1913)	Brush Creek coal bed

The Ames is the most persistent and useful stratigraphic marker (Price, 1913; Jacobsen and Lyons, 1982). Field differentiation of the Brush Creek and Ames is difficult because of the similarity of marine macrofossils; however, Price (1913) identified restricted species of marine invertebrates in each unit, but these identifications need to be updated and confirmed by recent collections. However, according to G. K. Merrill (University of Houston, pers. commun. 1982), the abundance of the conodont species *Streptognathodus elegantulus* at locality number **347** indicates, at the 99 percent + confidence level, that this marine unit is the Ames shale. A thin coal bed, which is referred to here as the Meyersdale coal bed, is rarely associated with the Meyersdale limestone. Price (1913) identified the rocks later assigned to the Woods Run shale on the basis of marine invertebrates at three localities in the Castleman coal field.

The coal beds of the Castleman coal field range from a few inches to 72 inches in thickness. Their rank is low- to medium-volatile bituminous (Oman and others, 1981). Most of the mined coal beds contain about 24 inches thick or less (see stratigraphic column), except the two principal coal beds: the Upper Freeport and the Lower Bakerstown. The Upper Freeport coal bed averages 64 inches in thickness and commonly contains at least one shale parting. The Upper Freeport rider coal bed is about 6 to 18 ft above the Upper Freeport coal bed and is recovered with the Upper Freeport coal bed in some strip-mine operations. The Lower Bakerstown coal bed, commonly about 27 to 30 inches thick, is usually without partings and is the most persistent coal bed in the Castleman coal field; in places it is reported as much as 40 inches thick, including an impure "top" coal as much as 8 inches thick.

The Pottsville and Allegheny Formations (undivided) include the Sharon coal zone, the Quakertown coal bed, the Lower and Upper Mercer coal beds, the Lower and Upper Mount Savage coal beds, the Lower Kittanning coal bed, the Middle Kittanning coal zone, the Upper Kittanning coal bed, and the Upper Freeport and Upper Freeport rider coal beds. The coal beds of the Pottsville are generally thin, lenticular, and unmirable. The Upper Mercer coal bed is the most persistent and minable coal bed in the Pottsville. The Lower Mount Savage coal bed is thin and lenticular. The Upper Mount Savage coal bed and an associated underlying fireclay, the Mount Savage underclay, have been mined locally. The Lower Kittanning coal bed has been prospected in the field, but it is lenticular and generally thin. The Middle Kittanning coal zone (Piney Mountain coal beds of Swartz and Baker, 1922) locally consists of four coal beds but generally contains three coal beds; the middle bed is most commonly mined; the lower and middle coal beds are usually underlain by plastic to flint clay that has been mined for refractory purposes. The Upper Kittanning coal bed has been mined sporadically. The Upper Freeport coal bed is thick and mined extensively in the Castleman coal field. The overlying Upper Freeport rider coal bed, where present, is up to 21 inches thick.

The Conemaugh Formation in the Castleman coal field contains 16 coal beds. The Piedmont coal bed of the Georges Creek coal field (Swartz and Baker, 1922), which is herein recognized in the Castleman coal field, lies about 25 to 40 ft above the Upper Freeport coal bed; it is not mined. The Brush Creek coal bed is generally thin, but has been mined in the southern part of the field and where it is about 24 to 30 inches thick. The Meyersdale coal bed is thin and generally absent. The Lower Bakerstown coal bed has been extensively mined. The Upper Bakerstown coal bed, about 40 ft above the Lower Bakerstown coal bed, is generally thin, but is locally thick and is mined in limited parts of the field. The Harlem, Federal Hill, Barton, Barton rider, and Wellersburg coal beds are generally thin, but have been prospected and mined locally. The Lower Clarysville coal bed was identified by Swartz and Baker (1922), but not observed by the authors and is indicated with uncertainty on the geologic column. The Upper Clarysville(?) and Upper Hoffman(?) coal beds were mined near Mt. Nebo in the northern part of the Castleman coal field. The True Eliklick(?), Franklin(?), and Franklin rider(?) coal beds are known only from a measured section by Swartz and Baker (1922) and are indicated here with uncertainty because additional data to confirm their existences and stratigraphic positions are not available.

In the south-central part of the field, the Upper Freeport coal bed is absent and (or) thin in a narrow belt approximately two miles wide that extends northwest-southeast across the field. In the subsurface, the belt is identified by the absence of both the Upper Freeport and Upper Freeport rider coal beds in drill holes 3, 7, 11, 18, 28, and 30. On the map, the boundaries of the belt are delineated by question marks on the Upper Freeport cropline. The logs of these drill holes show sandstone or carbonaceous claystone at the stratigraphic position of the Upper Freeport coal bed. The Upper Freeport rider and the Brush Creek coal beds are also not in the subsurface in this general belt as indicated by drill holes 3, 11, and 30. Although coal beds stratigraphically above and below these coal beds are identifiable in the belt, they are either thin or near their minimum thicknesses for the field. The approximate position of the boundary between the Allegheny and Conemaugh Formations in this belt is placed at the top of the Butler Sandstone Member in this belt, which is equivalent to the Upper Freeport sandstone of Swartz and Baker (1922).

Chemical data are available for most of the coal beds in the Castleman coal field (Toenges and others, 1952; Oman and others, 1981; see Table 1). Data from 195 coal samples (Toenges, and others, 1952) indicate that the mean sulfur content ranges from about 1.6 to 3.9 percent; mean ash content ranges from about 10 to 22 percent. The Upper Freeport coal bed has the lowest mean sulfur content (1.6 percent) and lowest mean ash content (9.8 percent) of the coal beds analyzed (Toenges and others, 1952). The Upper Freeport and Lower Bakerstown coal beds are suitable for metallurgical use; the other beds are suitable for steam-generation purposes.

In the Castleman coal field, coal mining by underground methods began in the late nineteenth century (Clark and others, 1902, 1905). Underground mining in the field ceased in the 1970's. Small-scale strip and auger mining commenced shortly after World War II (Weaver and others, 1976), and was intensified following the oil embargo of 1973–74 (Lyons and Jacobsen, 1981). Large-scale strip mining began after 1974 in the southern part of the field in the Upper Freeport; Brush Creek, and Lower Bakerstown coal beds. Production in 1981 from the Castleman coal field was 252,247 tons (Abar, 1982).

Sandstone and limestone have been quarried locally in the Castleman coal field for building stone, aggregate, and agricultural purposes. The Mount Savage underclay has been mined as a refractory in the valley of Tarklin Run, southwest of Grantsville, as have flint clays from the Lower and Upper Mercer and Lower Kittanning coal beds, the Middle Kittanning coal zone, and the Upper Freeport and Lower and Upper Bakerstown coal beds (Waage, 1950). Peat deposits of Quaternary age are preserved in the southern part of the field and have been mined on a small scale.

Three gas wells were drilled on Negro Mountain on the western limb of the Berlin syncline in 1965 and 1966. The Negro Mountain gas field, thus discovered in 1965, is believed to be in an anticlinal trap resulting from a splay fault that broke upwards from an underlying thrust fault (L. D. Harris, U.S. Geological Survey, written commun., 1982; Schwarz, 1982). These faults are not exposed in the map area. The three wells produced gas from the Lower Devonian Oriskany Sandstone at a depth of approximately 8,500 ft; one well was in production as of July, 1982, and the other wells were abandoned (Schwarz, 1982).

Data for the map were interpreted from 40 core holes and 159 coal mine prospects described by Toenges and others (1952). The authors collected additional data during field work conducted from 1980 to 1982 by measuring stratigraphic sections in active and abandoned surface mines. They also collected data from information on 32 surface mining permits and 5 prospecting permits of the Maryland Bureau of Mines, Frostburg, Maryland; from 93 logs of water wells of the Water Resources Administration, Annapolis, Maryland; a U.S. Geological Survey observation well (No. **406**) on Meadow Mountain; and from drilling records of coal companies. Additional coal and stratigraphic data came from Clark and others (1905), and Swartz and Baker (1922).

Aerial photographs (May, 1979, Air Photographics, Inc., Martinsburg, W. Va.), orthophotoquads (Avilton and Grantsville quadrangles, Md.-Pa., U.S. Geological Survey, 1979) and annual mine progress reports to 1980 were used to ascertain the areas disturbed by surface mining. Mine locations, limestone and sandstone quarry sites, and fossil localities were obtained partly from Clark and others (1905), Martin (1908), Price (1913), and Amsden (1953). Fireclay prospects and mine locations were obtained from Watts and others (1922) and Waage (1950). Most mine adits and inactive surface mines were field located by Skelly and Loy, Inc. (1973). Coal data for the Castleman coal field have been submitted to the National Coal Resources Data System (NCRDS), U.S. Geological Survey, for the determination of the coal resources. (Note: Data points in the NCRDS for the Castleman coal field carry the suffix designation "–CB". On the map, the data points are referred to by number only, without the suffix. For example, "435" on the map is "435–CB" in the NCRDS.)

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