Bituminous Coal Resources of Texas

By W. J. MAPEL

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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A review of the occurrence of bituminous and cannel coal in Texas and a new estimate of the original coal resources

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BITUMINOUS COAL RESOURCES OF TEXAS

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ABSTRACT

Occurrences of coal reported in sample logs of wells drilled for oil and gas are plotted for eight beds or intervals in Pennsylvanian rocks and for three in Lower Permian rocks. This information is combined with published thickness measurements of coal at outcrops to give a new estimate of 5,400 million short tons of bituminous coal inferred to be present in Paleozoic rocks of north-central Texas in beds more than 14 inches thick and under less than 3,000 feet of overburden. Of this total, 3,400 million short tons is inferred to lie under less than 1,000 feet of overburden.

An additional 525 million short tons of bituminous coal of Cretaceous age is inferred to underlie the Eagle Pass district in Maverick County; 115 million short tons of cannel coal is inferred to underlie the Santo Tomas district, Webb County; 25 million short tons of bituminous coal is inferred to underlie the San Carlos district, Presidio County; and 65 million short tons of coal is estimated as a potential resource in areas, largely unexplored for coal, underlain by the Aguja Formation (Upper Cretaceous) in Brewster and Presidio Counties.

The combined total of these estimates is about 6,100 million short tons of bituminous and cannel coal in Texas in beds more than 14 inches thick and under less than 3,000 feet of overburden.

INTRODUCTION

LOCATION

Bituminous coal occurs locally in rocks of Pennsylvanian and Early Permian age in north-central Texas in an area of several thousand square miles bounded approximately on the east and west by longs 97° E. and 100° E., respectively, and extending from the northern side of the Llano region at about lat 31° N. north to the Oklahoma border at about lat 34° N. About 90 percent of the accessible bituminous coal known in the State is within this area. Other deposits are of Cretaceous age and occur in southern Texas adjacent to the Rio Grande, principally at Eagle Pass in Maverick County, but also at scattered places in Hudspeth, Presidio, and Brewster Counties (Andrews and Huddle, 1948, p. 6) as shown in figure 1.

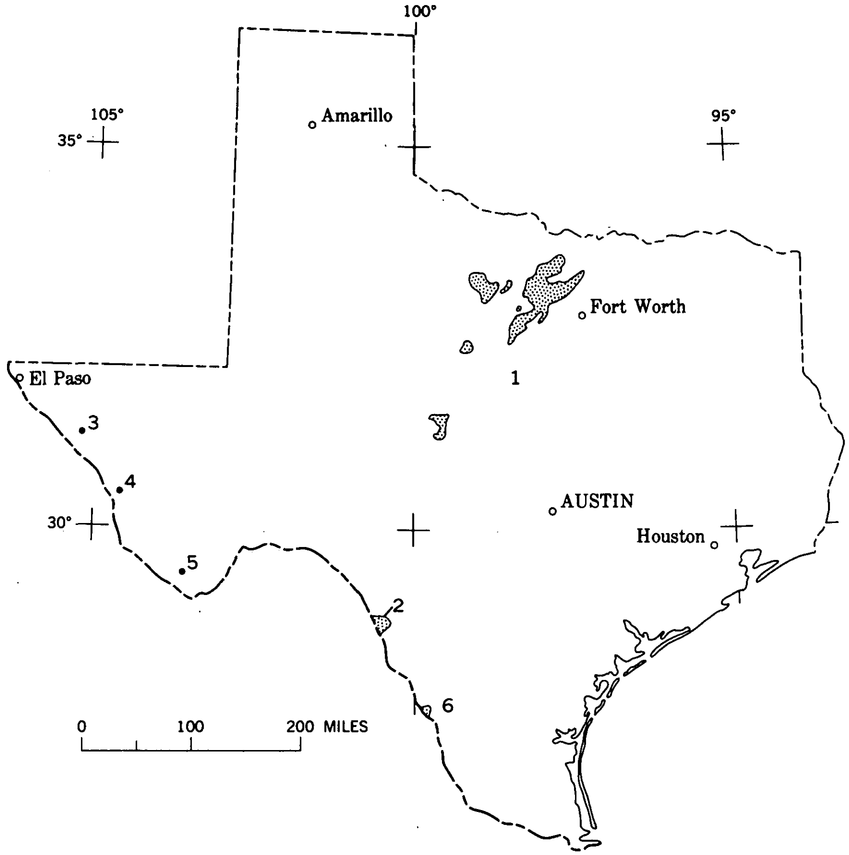

FIGURE 1.—Bituminous and cannel coal districts in Texas. 1, North-central Texas; 2, Eagle Pass district, Maverick County; 3, Eagle Spring area, Hudspeth County; 4, San Carlos district, Presidio County; 5, Terlingua district, Brewster County; 6, Santo Tomas district, Webb County (cannel coal). Known coal-bearing areas for which resources are estimated are shown stippled.

Cannel coal is found in rocks of early Tertiary age in the Santo Tomas district, Webb County. These deposits have been regarded as part of the bituminous coal resources in most previous reports on Texas coal, and they are included in the present report.

PURPOSE OF REPORT

The resource estimate of 8,000 million short tons of bituminous coal usually quoted for Texas was made prior to 1910 by Campbell and Parker (1909, p. 24), and was based on very generalized information on the areal and stratigraphic distribution of the coal. Campbell and Parker (1909, p. 24), and Campbell (1913, 1917, 1929) in later reports, did not specify the average thickness of coal assumed in their calculations, nor did they itemize resources for individual beds or areas. Some writers, including Andrews and Huddle (1948, p. 7) and Averitt (1961, p. 78), suggested that the Campbell estimate is probably too large. Until recently, however, information for making any better assessment of the resources was lacking.

From 1963 to 1965, several hundred commercial sample logs of wells drilled for oil and gas were examined by the author as part of an investigation of the regional stratigraphic relations of the Pennsylvanian System in north-central Texas. Information on the occurrence of coal as reported in the logs was plotted for eight beds or intervals in Pennsylvanian rocks and for three in Permian rocks. The resulting maps outline the distribution of Paleozoic coal beds more precisely than have any previous reports. This information is combined with published thickness measurements to give a new estimate for bituminous coal resources in north-central Texas.

A total coal-resource estimate is made for bituminous and cannel coal in Cretaceous and lower Tertiary rocks to complete the survey of the bituminous coal deposits of the State.

In conformity with the standard practice of the U.S. Geological Survey (Averitt, 1961, p. 18, 20–21), the estimates do not include bituminous coal in beds thinner than 14 inches or beneath more than 3,000 feet of cover. Perkins and Lonsdale (1955) and Fisher (1963) discussed the lignite resources of Texas; coal of this rank is excluded from resource estimates in this report.

SOURCES OF INFORMATION

Most of the sample logs used in outlining coal bearing areas in north-central Texas were made by the Abilene Sample Log Service, Abilene, Tex., and the North Texas Sample Log Service, Wichita Falls, Tex. Selected logs made by the following Texas companies were also examined: Permian Basin Sample Laboratory, Midland; Texas Panhandle Sample Log Service, Amarillo; and West-Central Texas Sample Log Service, Abilene. Wells logged by these three companies are generally marginal to the main coal-bearing areas. The location of the wells for which logs were examined is shown in figure 2. All sample logs were drawn at a scale of 1 inch = 100 feet.

The distance between wells for which logs were examined averages about 10 miles. This spacing is dense enough to outline broadly the major coal deposits, but it is not sufficient to show details of coal distribution within the coal-bearing region.

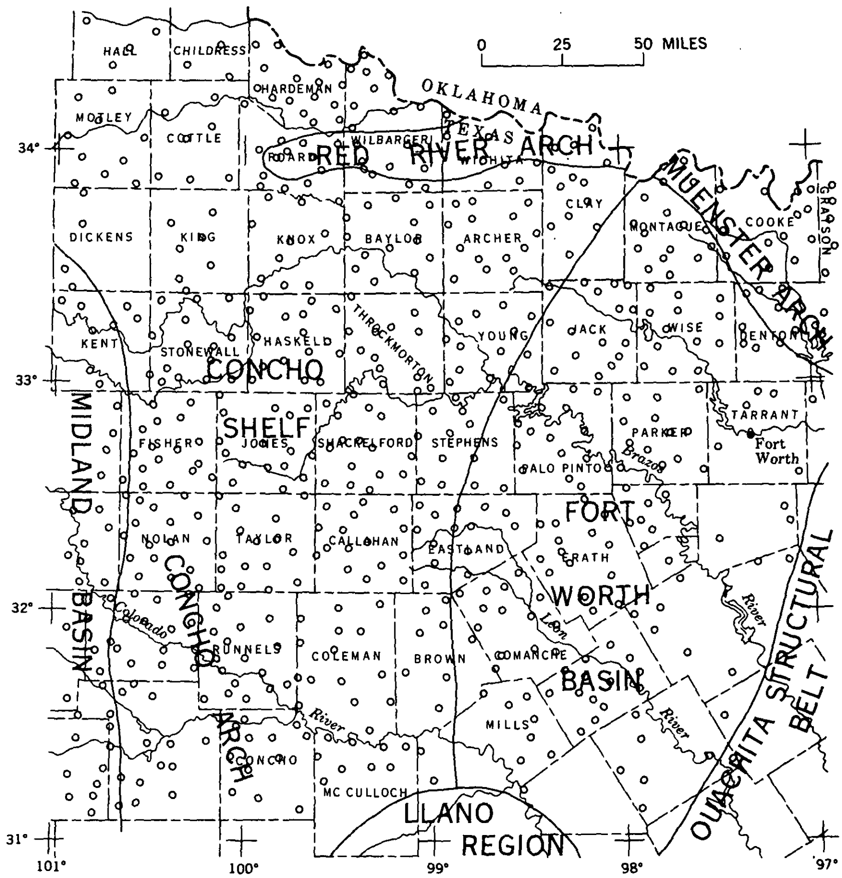

FIGURE 2.—Structural elements, and location of wells for which sample logs were examined for coal, north-central Texas.

Published reports of the Texas Bureau of Economic Geology, the U.S. Geological Survey, and the U.S. Bureau of Mines provided information on the thickness and the chemical and physical characteristics of the coal at outcrops, in mines, and in a few drill holes. Fairly complete tabulations of analyses are given by Baker (1934) and by Cooper, Snyder, Abernethy, and Tarpley (1948).

Information on Cretaceous and younger coal in the Eagle Pass, Santo Tomas, and other districts comes mainly from Vaughan (1900), Ashley (1918), Baker (1934, p. 316–329), and Lonsdale and Day (1937).

PALEOZOIC COAL DEPOSITS

GEOLOGIC SETTING

Outcropping Pennsylvanian and lowermost Permian coal-bearing rocks form a discontinuous irregular band as much as 70 miles wide that extends from the north edge of the Llano region northeastward to within about 20 miles of the Oklahoma border (fig. 3). To the west, these rocks dip at low angles beneath younger Permian rocks; to the east, they are overlain unconformably by eastward-dipping rocks of Cretaceous age.

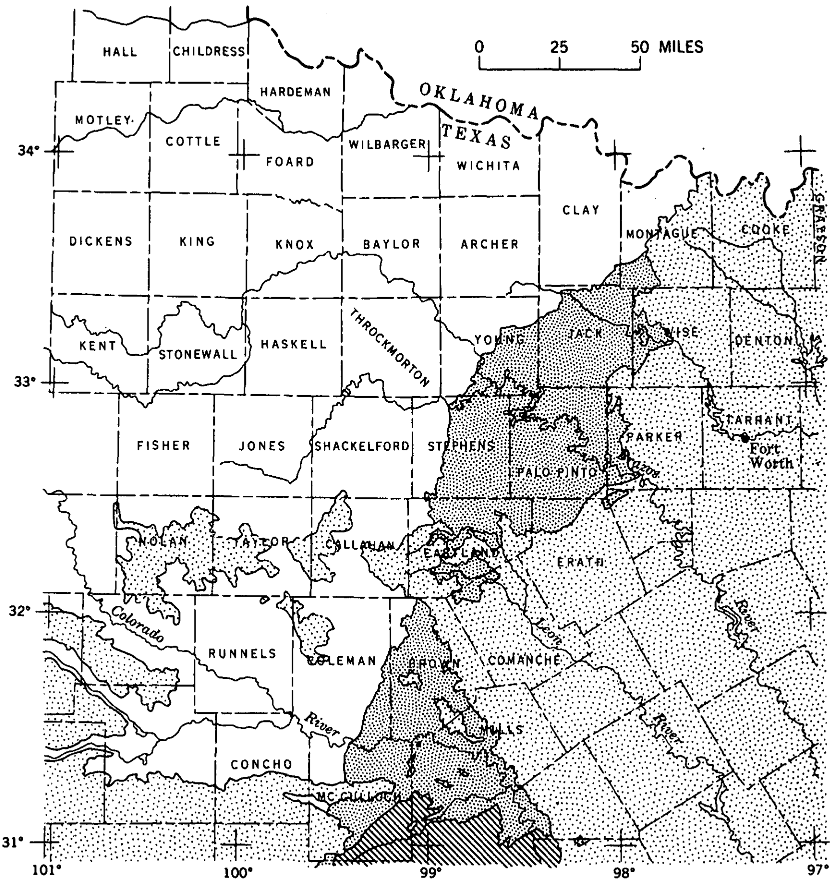

FIGURE 3.—Generalized geologic map, north-central Texas. Cretaceous rocks, light stipple; Triassic and Permian rocks, no pattern; Pennsylvanian rocks, heavy stipple; pre-Pennsylvanian rocks, diagonal rule.

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Structural elements that governed distribution of the coal deposition early in Pennsylvanian time in north-central Texas were, principally, the Fort Worth basin and the positive elements that bordered it. These elements were the Ouachita structural belt on the east, the Muenster and Red River arches on the north, and the Concho shelf on the west. (See fig. 2.) Coal was deposited during Early Pennsylvanian time in the northern part of the Fort Worth basin and in a belt along the north side of the Red River arch. Beginning in about Middle Pennsylvanian time, the area of the Fort Worth basin was mostly emergent, and coal formed locally and intermittently on the Concho shelf. This coal region was bordered on the west by a sea in the sinking Midland basin, and on the north by highlands that rose first in north Texas and later in Oklahoma.

Turner (1957) and Adams (1962) discussed in more detail the regional stratigraphic relations of the Pennsylvanian rocks in north-central Texas.

OCCURRENCES OF COAL

Pennsylvanian coal is found in rocks of Atoka age, and in the Strawn, Canyon, and Cisco Groups. These rocks correspond closely to the Atoka, Des Moines, Missouri, and Virgil Series, respectively, of the standard Mid-continent terminology. Coal-bearing Permian rocks occur in the basal part of the Wichita Group of the Wolfcamp Series.

Coal is much more widespread in the Brazos River drainage basin than elsewhere in north-central Texas. Within the Brazos River region, however, the locus of coal deposition shifted gradually westward from the northeastern part of the Fort Worth basin during Atoka time to the north-central part of the Concho shelf in Early Permian time. Figure 4 shows the stratigraphic positions of the main coal beds.

ROCKS OF ATOKA AGE

Rocks of Atoka age consist of limestone and sandy limestone, shale, sandstone, conglomerate, and minor amounts of coal. They range in thickness from zero along a somewhat indefinite line on the west side of the Concho shelf to about 6,000 feet in the Fort Worth basin in eastern Tarrant County, and they attain a thickness of as much as 665 feet north of the Red River arch in Hardeman County.

The main coal-bearing areas lie in the northern part of the Fort Worth basin, mostly in Wise and Denton Counties, and locally in Jack, northern Parker, and southern Clay Counties. Some coal is present, also, in a west-trending belt north of the Red River arch in Wilbarger, Hardeman, Cottle, Motley, and nearby Counties (fig. 5).

AGE	GROUP	FORMATION	MEMBER	COAL BED
Early Permian (part)	Wichita (part)	Pueblo (part)	Saddle Creek Limestone	
			Waldrip Shale	Saddle Creek
				Newcastle
				Bull Creek in Colorado River area
Late Pennsylvanian	Cisco	Pueblo (part) / Thrifty	Crystal Falls Limestone (Chaffin Limestone in Colorado River area)	Chaffin in Colorado River area
		Thrifty	Breckenridge Limestone	
		Thrifty / Graham	Blach Ranch Limestone (Speck Mountain Limestone in Colorado River area)	
		Graham	Ivan Limestone	
			Avis Sandstone	
			Wayland Shale	
			Gunsight Limestone	
			Bunger Limestone	
			Gonzales Limestone	
	Canyon	Caddo Creek	Home Creek Limestone	
			Colony Creek Shale	
		Brad	Ranger Limestone	
			Placid Shale	
		Graford	Merriman Limestone (Winchell Limestone in Colorado River area)	
				Dalton
			Adams Branch Limestone	
		Palo Pinto Limestone		Bridgeport
			Wiles Limestone	
Middle Pennsylvanian (part)	Strawn (part)	Mineral Wells	Turkey Creek Sandstone	
			East Mountain Shale	
		Garner	Brazos River Conglomerate	Abbott
			Mingus Shale	Thurber
		Millsap Lake	Grindstone Creek of Plummer and Hornberger (1935)	Sunday Creek

FIGURE 4.—Some stratigraphic units in the Brazos River area.

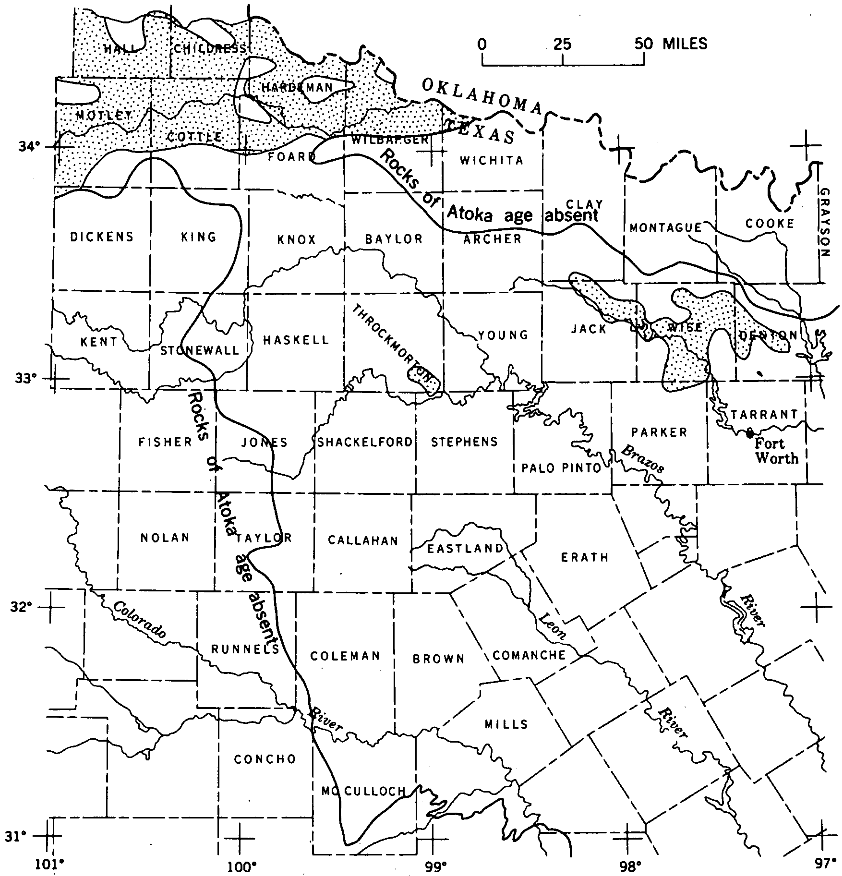

FIGURE 5.—Distribution of coal (stippled) in rocks of Atoka age.

Well logs examined by G. H. Dixon (written commun., 1965) show coal irregularly but widely distributed in rocks of Atoka age in the Panhandle of Texas immediately northwest of the area shown in figure 5. Coal appears to be randomly distributed stratigraphically in all the areas in which it occurs; no single persistent coal horizon was identified. The coal everywhere is 4,000 to more than 7,000 feet below the surface; hence, it is too deeply buried to be mined, and resources have not been calculated.

STRAWN GROUP

The Strawn Group is mostly sandstone and shale, but includes a few limestone beds, some conglomerate, and a few coal deposits, some of which have been mined. Some stratigraphic units in outcrops near the Brazos River are listed in figure 4. The nomenclature is largely that of Sellards (1932); some workers have amended this classification, one of the principal changes being that the top of the East Mountain Shale Member of the Mineral Wells Formation as used by Sellards (1932) is taken as the boundary between the Canyon and Strawn Groups (Canyon and Strawn Series of some writers), and is the boundary between Middle and Late Pennsylvanian rocks (Cheney, 1940, 1945, 1947; Abilene Geol. Soc., 1949; Fort Worth Geol. Soc., 1957; Shelton, 1958).

Where the Strawn is coal bearing, it ranges in thickness from about 2,500 feet, as in southern Palo Pinto County, to 4,500 feet, as in the subsurface in eastern Denton County in the central part of the Fort Worth basin. The Strawn thins abruptly along the trend of the Red River and Muenster arches and is locally absent in the subsurface in northern Wichita and Clay Counties on the crest of the Red River arch.

Coal in the Strawn is most widespread in the northern part of the Fort Worth basin, in an area extending from Grayson County westward to Young County and from northern Clay County southward to Palo Pinto County; minor amounts exist in Callahan and Coleman Counties to the southwest. Near the Red River arch, in and near Wilbarger, Hardeman, Foard, Cottle, and Motley Counties, some coal is reported in well logs at or near the base of the Strawn, but this coal lies more than 3,000 feet underground and is not considered part of the coal resources.

THURBER COAL BED

The Thurber is the most extensive coal bed in outcrops of the Strawn. It was mined for many years in southern Palo Pinto County and in adjoining parts of Erath County, and in these places it occurs at or near the base of the Mingus Shale Member of the Garner Formation, about 600 feet below the top of the Strawn (Plummer and Hornberger, 1935, p. 195–203). A coal bed, which was mined locally, crops out near the middle of the Mingus Shale Member along Rock Creek in western Parker County. Plummer and Hornberger (1935, p. 195) correlated the coal at Rock Creek with the Thurber coal; Hendricks (1957, p. 20), however, considered the coal at Rock Creek to be slightly higher stratigraphically than the Thurber coal and probably not continuous with it. A coal bed that may be equivalent to the Thurber lies 1,400–1,500 feet below the top of the Strawn in the subsurface in Wise and Jack Counties (Scott and Armstrong, 1932, p. 17, pl. 2). The extent of the Thurber coal and approximately equivalent coal beds in the Mingus Shale Member as determined during the present work is shown in figure 6.

The Thurber coal is 26–36 inches thick where mined in northern Erath and southern Palo Pinto Counties (Plummer and Hornberger,

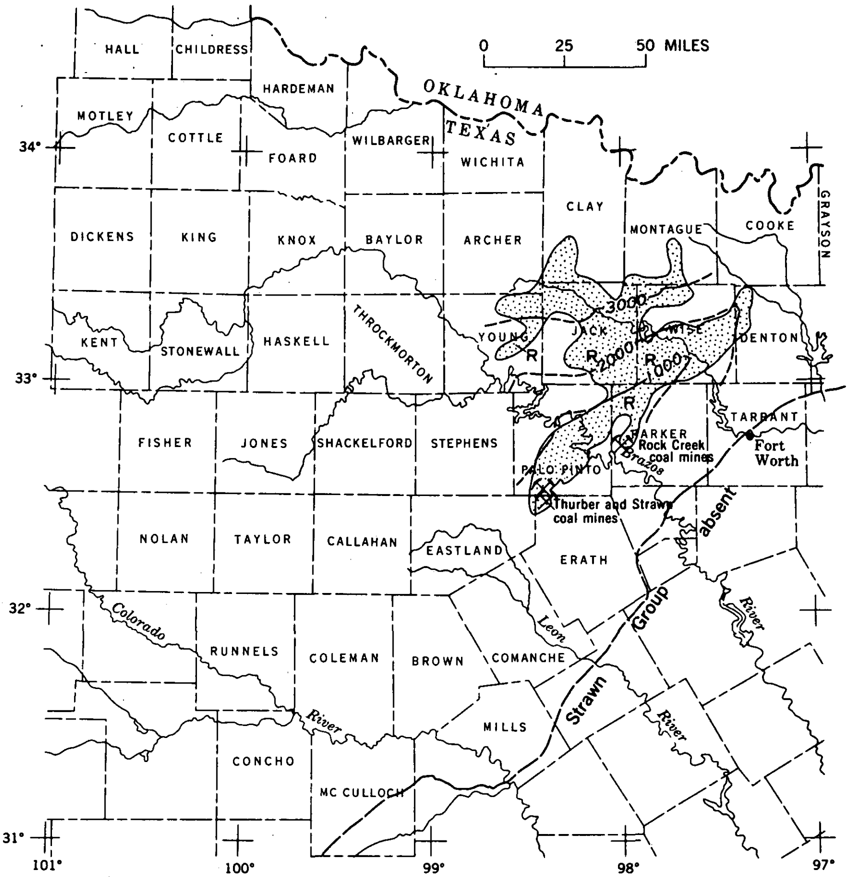

FIGURE 6.—Distribution of the Thurber and approximately equivalent coal beds (stippled). Isopachs show thickness of overburden, in feet. R, areas for which resources are estimated (table 2).

1935, p. 198–199); it is 18–26 inches thick along Rock Creek in Parker County (Cummins, 1891, p. 519). No thickness figures are available for the coal in the subsurface in Jack and Wise Counties.

OTHER COAL BEDS

The Abbott coal bed (fig. 7), named and described by Plummer and Hornberger (1935, p. 194), is a discontinuous bed locally as much as 26 inches thick that crops out in east-central Palo Pinto County; it is in the upper part of the Brazos River Conglomerate Member of the Garner Formation, about 200 feet stratigraphically above the Thurber coal bed (fig. 4). A bed at this position is also present locally in the subsurface in Jack and Wise Counties (Scott and Armstrong, 1932, pl. 2).

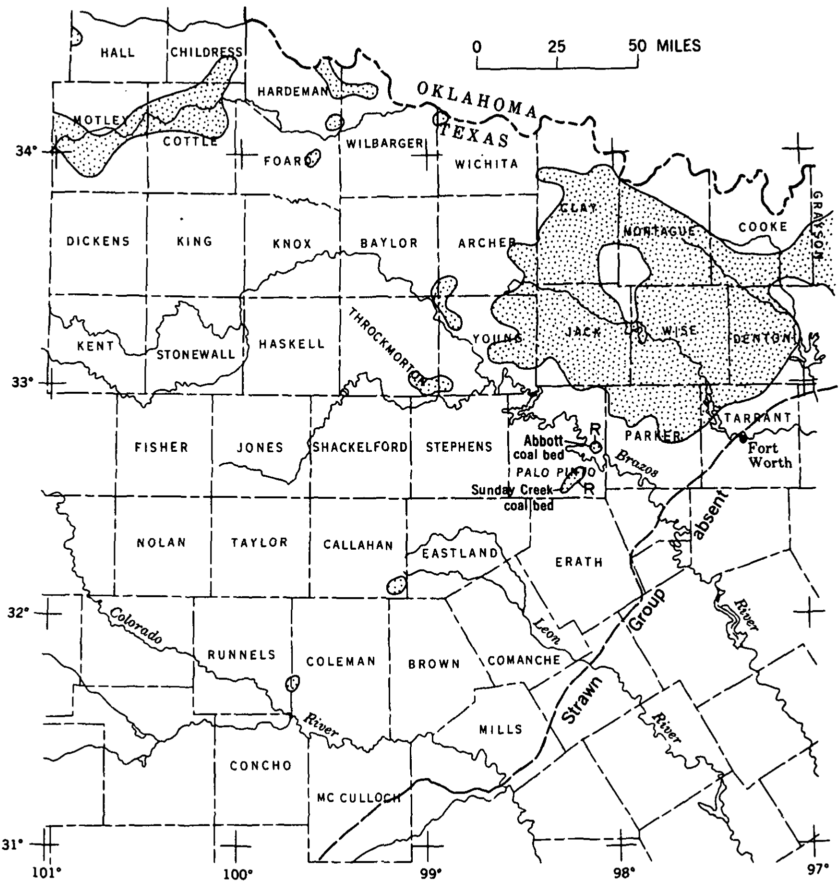

Figure 7.—Distribution of coal (stippled) in the Strawn Group, other than the Thurber coal bed. R, areas for which resources are estimated (table 2).

The Sunday Creek coal bed in southeastern Palo Pinto County, also named and described by Plummer and Hornberger (1935, p. 203), is in the lower part of their Grindstone Creek Member of the Millsap Lake Formation, about 220 feet stratigraphically below the Thurber coal. This bed is apparently in the same shale interval, but it is somewhat higher stratigraphically than a thin coal Scott and Armstrong (1932, pl. 2) reported in Jack and Wise Counties within the Millsap Lake Formation. The Sunday Creek coal bed is 18–22 inches thick at its outcrop in Palo Pinto County (Plummer and Hornberger, 1935, p. 203).

Discontinuous coal stringers are found at a few other levels in the Strawn in Jack, Wise, and adjoining Counties. One well in east-central Jack County contains 10 thin coal beds in a sequence of rocks 2,300 feet thick beginning about 1,500 feet below the top of the Strawn.

In Grayson County, east of the area shown in figure 7, coal occurs fairly commonly in the Strawn Group, but at depths of several thousand feet. Thicknesses of these coal lenses are unknown, and none of the lenses has been considered in calculating the coal resources.

CANYON GROUP

The Canyon Group consists of ridge-forming beds of limestone separated by shale, sandstone, and, locally, some coal. The group attains a maximum thickness of about 1,300 feet in Clay and Montague Counties and thins gradually and somewhat irregularly from this area southwestward across north-central Texas at about 10–15 feet per mile. Stratigraphic divisions of the Canyon Group at outcrops along the Brazos River are given in figure 4.

Several coal beds occur in the Canyon Group, the most persistent being the Bridgeport coal and approximately equivalent beds in the northern part of the Fort Worth basin and on adjoining parts of the Red River arch.

BRIDGEPORT COAL BED

The Bridgeport coal crops out near the town of Bridgeport in western Wise County. It is in the upper part of the Palo Pinto Limestone about 1,300 feet below the top of the Canyon Group (Scott and Armstrong, 1932, p. 26). The same bed, or perhaps separate lenses of coal at about the same stratigraphic position, was identified in sample logs of wells in two irregularly shaped areas in parts of Wise, Montague, Jack, Young, and southern Clay and Archer Counties (fig. 8). Separate smaller areas in northern Clay and eastern Wichita Counties also contain some coal at about the top of the Palo Pinto, which there is 1,000–1,100 feet below the top of the Canyon. The coal was once mined near Bridgeport, where it consists of a single bed 18–22 inches thick (Scott and Armstrong, 1932, p. 72). Other measurements of the coal have not been reported.

DALTON COAL BED

The Dalton coal was named by Plummer and Hornberger (1935, p. 192–193). It is a bed in their Wolf Mountain Shale Member of the Graford Formation, a name they gave to that part of the Graford Formation below the Merriman Limestone Member. The coal is 150–160 feet below the top of the Merriman Limestone Member and about 500 feet below the top of the Canyon Group in northwestern Palo Pinto County (fig. 9). Plummer and Hornberger (1935, p. 193) traced the bed along its outcrop for about 4 miles, and at one locality measured a thickness of 9 feet 8 inches of coal in the bed. Coal was not identified at this horizon in the logs examined during the present work; therefore, despite its unusual thickness, the bed is probably confined to the immediate vicinity of its outcrop.

OTHER COAL BEDS

Well logs show that coal occurs fairly commonly in the Canyon Group in the northern part of the Fort Worth basin and on the adjoining east side of the Concho shelf (fig. 9). None of the beds appear to be very persistent, and the sample descriptions on the well logs examined in this investigation suggest that the coal is thin everywhere. The coal beds occur in the upper part of the Placid Shale Member of the Brad Formation and in the upper part of the Colony Creek Shale Member of the Caddo Creek Formation. Coal in these beds was not considered in the resource calculations.

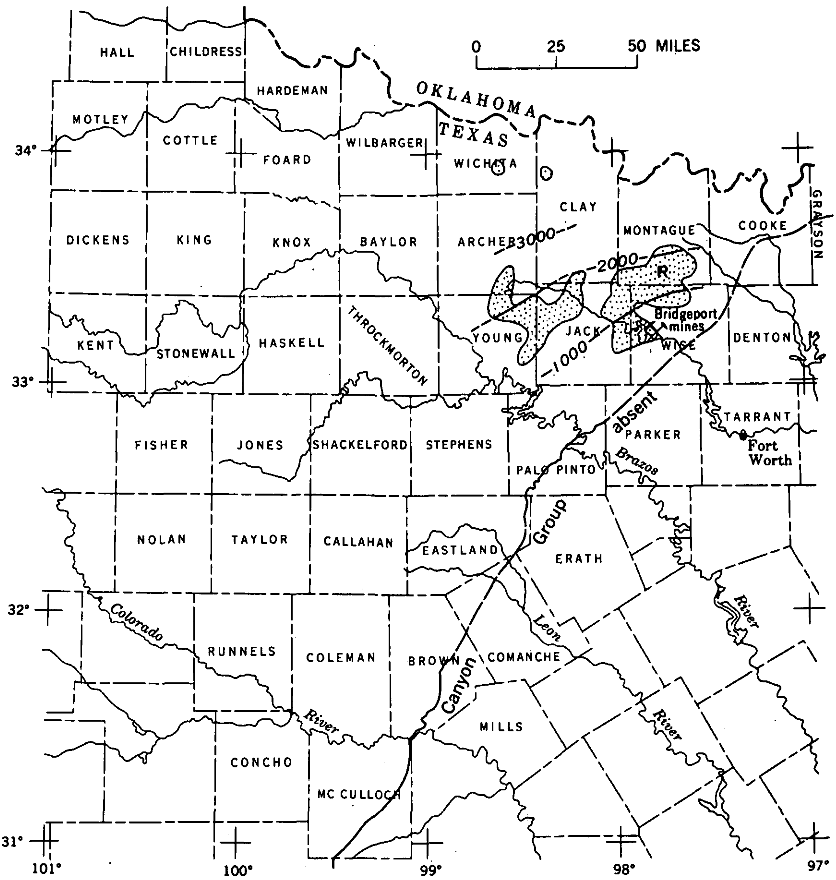

FIGURE 8.—Distribution of the Bridgeport and approximately equivalent coal beds (stippled). Isopachs show thickness of overburden, in feet. R, area for which resources are estimated (table 2).

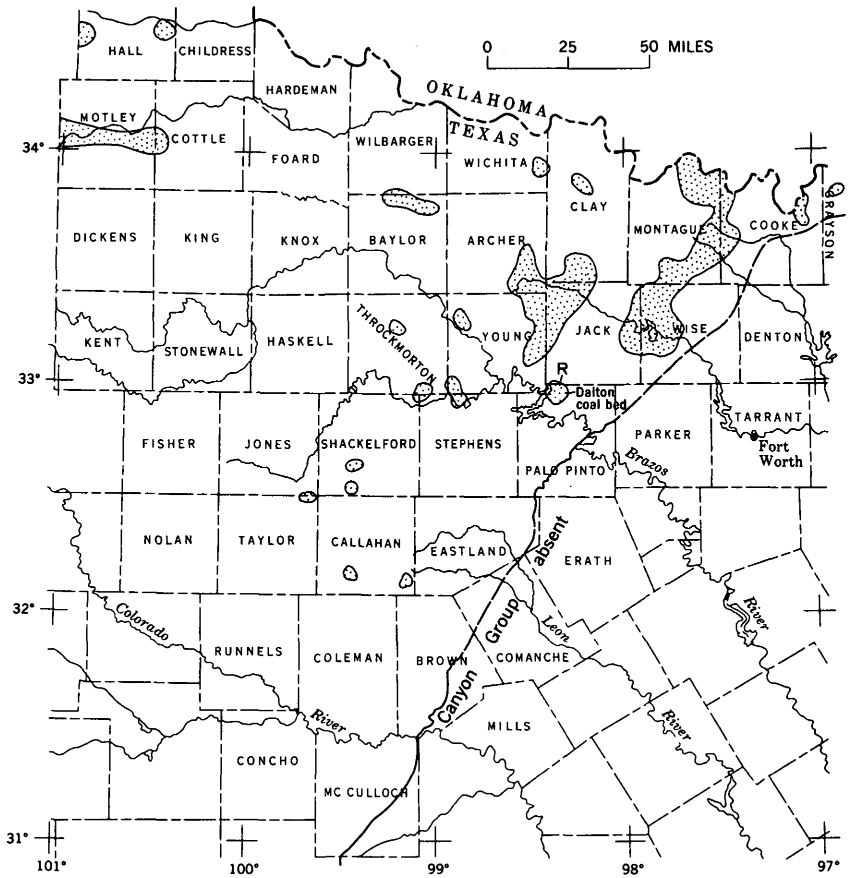

FIGURE 9.—Distribution of coal (stippled) in the Canyon Group, other than the Bridgeport coal bed. R, area for which resources are estimated (table 2).

CISCO GROUP

The Cisco Group consists of shale, lenticular sandstone, many thin beds of limestone, and minor amounts of coal. In the area studied the group ranges in thickness from a maximum of about 1,200 feet, in the subsurface in northern Wichita and Wilbarger Counties, to about 350 feet, in outcrops along the west side of the Llano region in Brown and Coleman Counties. Stratigraphic divisions of the group in outcrops in the Brazos River region are shown in figure 4. The coal is found at several horizons in the Cisco Group, but mostly in the part that lies above the Gunsight Limestone Member of the Graham Formation. Coal is more common in the subsurface than along the outcrop, where only a few thin stringers of coal have been reported.

GRAHAM FORMATION

The Graham Formation, at the base of the Cisco Group, is about 260 feet thick along its outcrop in Coleman County (Eargle, 1960, pl. 26), about 675 feet thick in outcrops near the Stephens-Young County boundary (Lee, 1938, pl. 4), and about 900 feet thick in the subsurface in Baylor County. Coal in irregular discontinuous lenses is fairly common in the formation (fig. 10). Coal is most common at the base of the formation, just above the Home Creek Limestone Member of the Caddo Creek Formation; within a few feet of the top of the unit that underlies the Gunsight Limestone Member (Necessity Shale Member of Sellards, 1932); and at the top of the formation, just below the Speck Mountain or Blach Ranch Limestone Member of the Thrifty Formation. A lens of coal at the top of the formation in outcrops in northwestern Brown County is 3½–6 inches thick (Eargle, 1960, p. 71; Stafford, 1960, p. 46). Lee (1938, p. 59) reported 6 inches of coal at this horizon along the Brazos River in southern Young County. No other thickness measurements of coal in the formation are available; and coal in the Graham Formation, therefore, is nowhere known to be thick enough to be considered in the coal resources.

THRIFTY FORMATION

The Thrifty Formation is about 60 feet thick in outcrops in Coleman County (Eargle, 1960, pl. 26); equivalent rocks are about 105 feet thick in outcrops in northern Stephens County (Brown, 1960, pl. 3), and about 200 feet thick in the subsurface in Baylor and adjoining Counties. Coal is more common in the Thrifty than in the underlying Graham Formation. The principal coal horizon in outcrops and in the subsurface is within or just below the Crystal Falls or Chaffin Limestone Member of the Thrifty, although coal is also present locally in other parts of the formation.

The Chaffin coal bed, which was named by Drake (1917, p. 62) for its occurrence at the Chaffin mine 2 miles east of Waldrip in McCulloch County (fig. 11), lies immediately below the Chaffin Limestone Member of the Thrifty Formation. The bed is 20 inches thick at the mine (Drake, 1917, p. 64); however, it has not been found in outcrops nearby (Drake, 1917, p. 63; Eargle, 1960, pl. 3), and it is apparently a small lens.

In northern Stephens County at two localities about 3½ miles apart, as much as half a foot of coal was reported by Brown (1960, p. 33, 34) in a bed just below the Crystal Falls Limestone Member of the Thrifty Formation, within the top 5 feet of the Quinn Clay of Plummer, Bradley, and Pence (1949). This coal is at the stratigraphic position of the Chaffin coal bed. Coal is fairly widespread at this

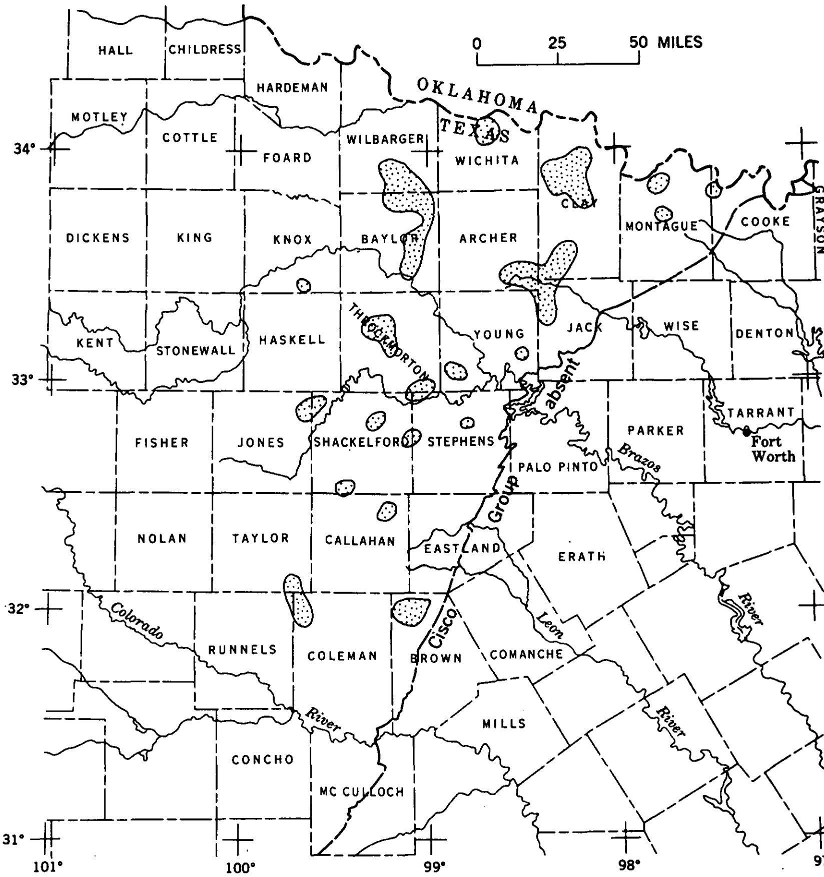

Figure 10.—Distribution of coal (stippled) in the Graham Formation.

horizon in the subsurface on the northern part of the Concho shelf in Throckmorton, Baylor, Wilbarger, and some adjoining Counties, but the thickness of the coal in the subsurface is not known.

WICHITA GROUP

Coal occurs in the Wichita Group in the Waldrip Shale Member of the Pueblo Formation. According to the classification by Eargle (1960, pl. 27), the Waldrip overlies the Chaffin or the Crystal Falls Limestone Member of the Thrifty Formation and is overlain by the Saddle Creek Limestone Member of the Pueblo Formation. Some other writers place the Waldrip and equivalent beds in the upper part of the Harpersville Formation (Plummer and Moore, 1921; Lee, 1938; Nickell, 1938; Brown, 1960). The name Harpersville is not used in Eargle's (1960) nomenclature.

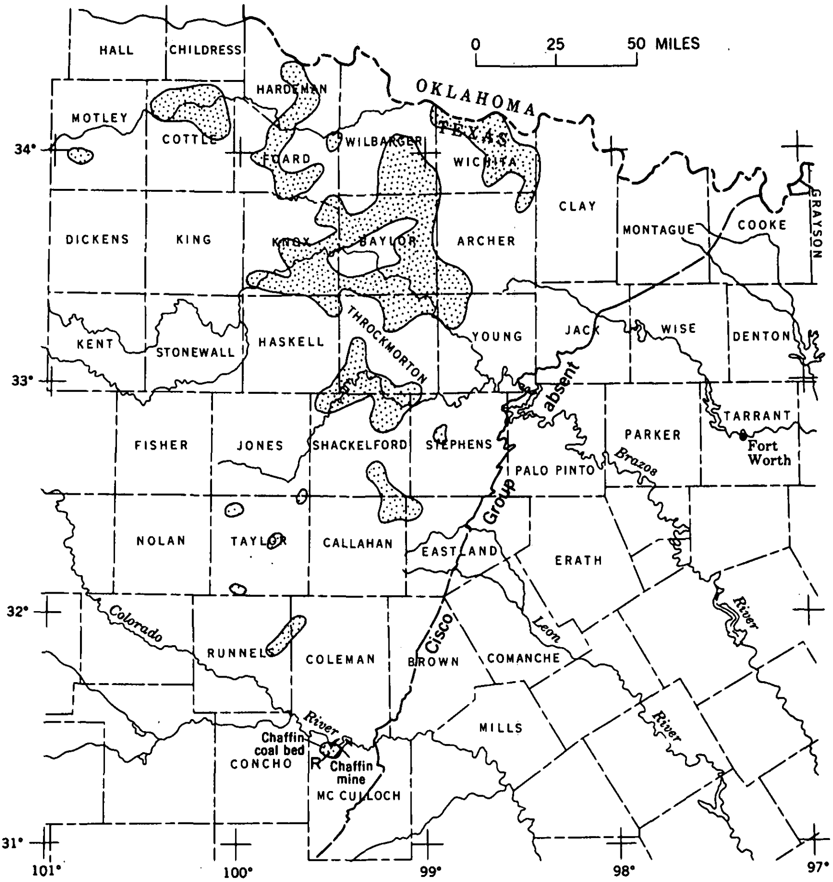

Figure 11.—Distribution of coal (stippled) in the Thrifty Formation. R, **area for which resources are estimated (table 2).**

The Waldrip Shale Member of the Pueblo Formation is predominantly shale, most of which is gray but some of which is red; it also contains lenticular beds of sandstone, and generally one or more thin beds of limestone. The member is 100 to about 200 feet thick in Brown and Coleman Counties (Eargle, 1960, pl. 26) and approximately the same thickness in outcrops in the Brazos River drainage area farther north (Myers, 1965; Lee, 1938, pl. 10); the member thickens to as much as 275 feet in the subsurface in Baylor and nearby Counties.

Three coal-bearing zones can be recognized in the Waldrip Shale Member of the Pueblo Formation; all three are fairly widespread in the subsurface, as shown in figures 12–14.

BULL CREEK COAL AND APPROXIMATELY EQUIVALENT BEDS

The Bull Creek coal bed and other coal lenses at about the same stratigraphic position crop out in the lower part of the Waldrip Shale Member 24–50 feet above the Chaffin Limestone Member of the Thrifty Formation in southern Coleman County (Drake, 1917, p. 49). According to Drake (1917, p. 49), the coal bed ranges in thickness from 12 to 30 inches. The coal was formerly mined at Bull Creek, a mile or two north of the Colorado River (fig. 12), where Nickell (1938, p. 130) reported the thickness as "about 1 foot, and nowhere more than 15 inches."

Lee (1938, p. 65–66) reported nearly 6 feet of impure coal in thin layers alternating with carbonaceous shale in the lower part of the

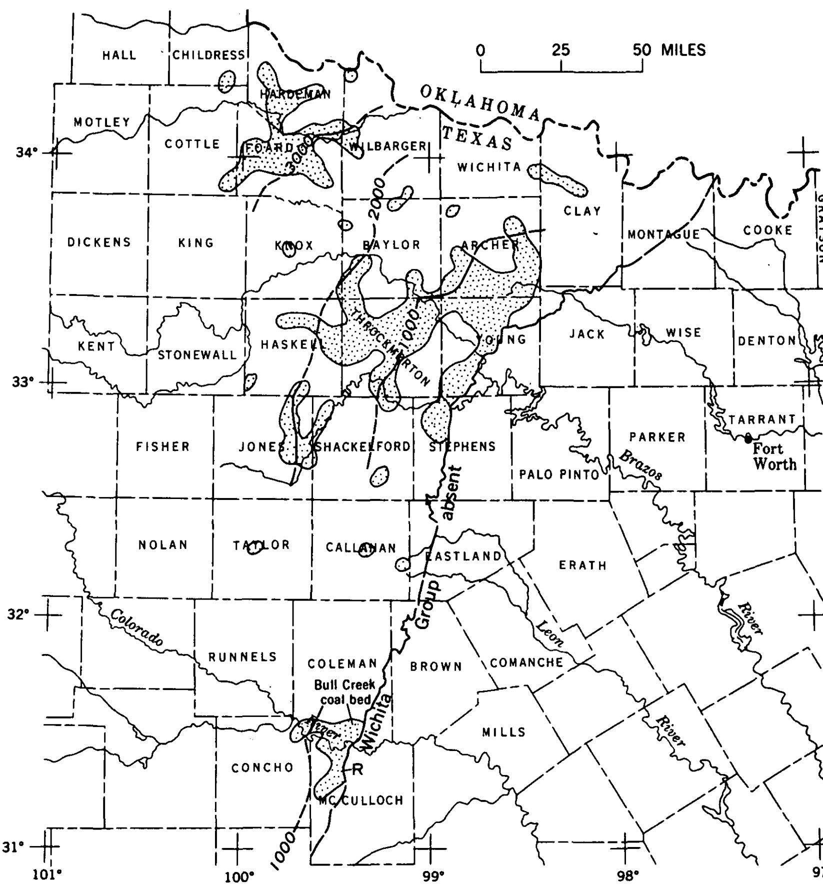

FIGURE 12.—Distribution of Bull Creek and approximately equivalent coal beds (stippled). Isopachs show thickness of overburden, in feet. R, area for which resources are estimated (table 2).

Waldrip (the Curry Clay of Plummer and others, 1949) near Crystal Falls in northwestern Stephens County, and 4 feet of coal and shale about 10 miles to the northeast in southern Young County. Brown (1960, fig. 6) described the principal coal layer at the Crystal Falls locality as being 1½ feet thick, and the remainder of the bed as mostly carbonaceous shale. This coal is 15–20 feet above the Crystal Falls Limestone Member of the Thrifty Formation, which is approximately the stratigraphic position of the Bull Creek coal bed of Coleman County with which it is correlated. The extent of coal at the horizon of the Bull Creek coal bed is shown in figure 12.

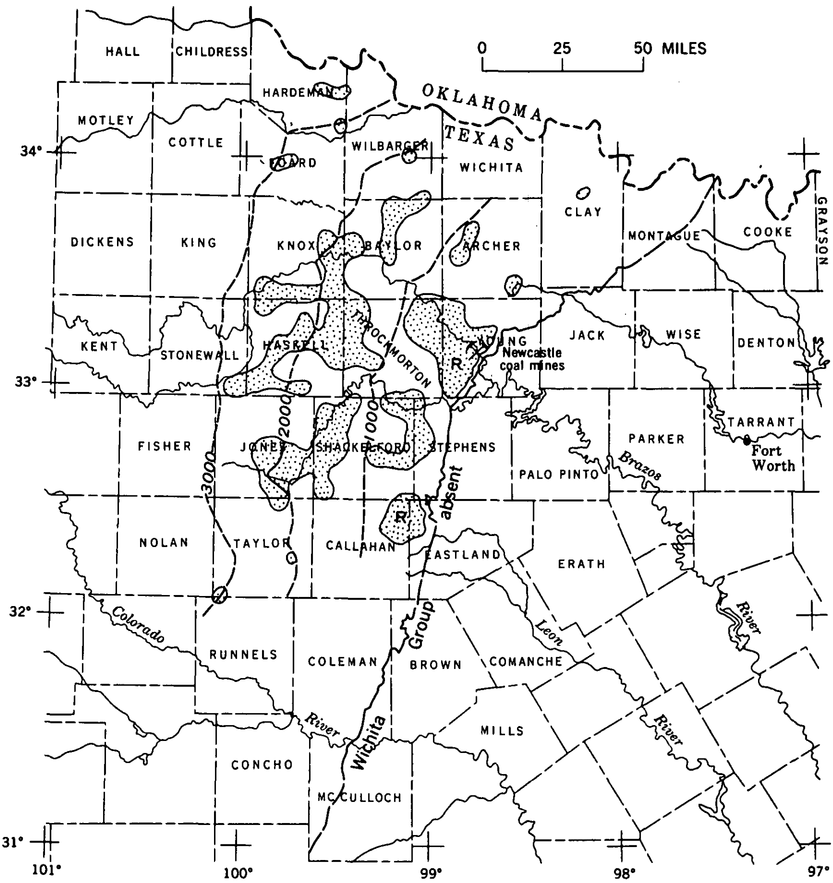

FIGURE 13.—Distribution of the Newcastle and approximately equivalent coal beds (stippled). Isopachs show thickness of overburden, in feet. R, areas for which resources are estimated (table 2).

NEWCASTLE COAL AND APPROXIMATELY EQUIVALENT BEDS

The Newcastle coal bed, which was mined for several years at Newcastle in central Young County (fig. 13), is about 60 feet below the top of the Waldrip Shale Member of the Pueblo Formation. In the terminology used by some writers (Criswell, 1942; Brown, 1960), the bed is in the lower part of the sequence between the so-called Upper Crystal Falls Limestone and the Belknap Limestone Member of Plummer and Moore (1921) of the Harpersville Formation. The Newcastle coal bed is 18–48 inches thick in outcrops near the mines and in wells drilled in western Young County several miles from the mines (Criswell, 1942, p. 2).

In the northwestern part of Eastland County, two coal beds, 3 feet and 2½ feet thick, occur in the middle part of the Waldrip Shale

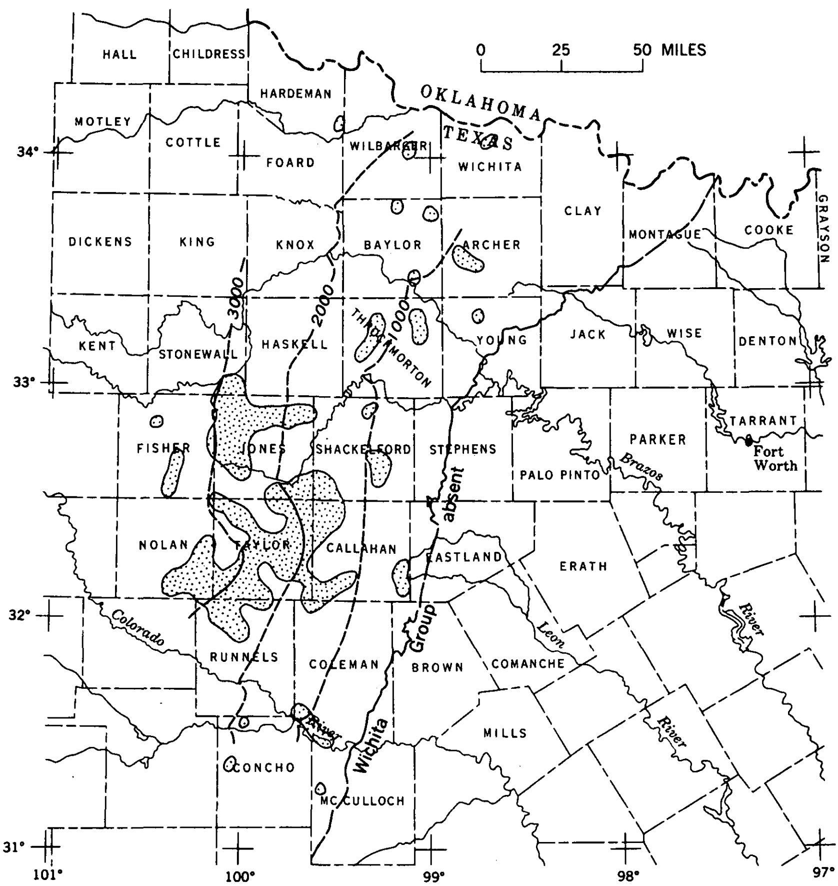

FIGURE 14—Distribution of the Saddle Creek and approximately equivalent coal beds (stippled). Isopachs show thickness of overburden, in feet.

Member, 45 and about 70 feet, respectively, below the top of the member (C. A. Hamill, in Plummer and Moore, 1921, p. 164). The upper bed is 26 inches thick about 1 mile northwest of Cisco and is probably the Newcastle coal, according to Plummer, Bradley, and Pence (1949, p. 21, fig. 16). Figure 13 shows the distribution of the Newcastle coal and approximately equivalent coal beds in the middle part of the Waldrip Shale Member.

SADDLE CREEK COAL AND APPROXIMATELY EQUIVALENT BEDS

A coal bed that locally occurs within the top few feet of the Waldrip Shale Member of the Pueblo Formation, immediately below the Saddle Creek Limestone Member, is referred to here as the Saddle Creek coal bed. In outcrops, the Saddle Creek coal bed is reported only in the southeast corner of Young County, where it consists of a few thin coal streaks (Lee, 1938, p. 72). In the subsurface, the bed is widespread (fig. 14). Shenkel (1960, p. 179) found coal, or a bed of carbonaceous shale, at this interval to be 1–2 feet thick in much of Taylor and Callahan Counties. His thickness measurements were computed from the lateral resistivity curves of electric logs of wells; no other thickness measurements of the coal are available. Resources were not calculated for this bed.

CRETACEOUS AND YOUNGER COAL DEPOSITS

EAGLE PASS DISTRICT

Bituminous coal crops out in the Eagle Pass district, Maverick County (fig. 1), in the Olmos Formation of Late Cretaceous age. The Olmos Formation, where coal bearing, ranges in thickness from 400 to 600 feet. Coal occurs in a bed a little below the middle of the formation. The coal, excluding shale and bone partings, is 4½–7 feet thick and averages 6 feet in thickness at seven localities along and near Elm Creek, 3–8 miles northeast of Eagle Pass; it is 6–7 feet thick in a water well about 2 miles south of Eagle Pass (Vaughan, 1900, p. 57–59). Where it was mined in the district the bed has an average thickness of about 4 feet, including partings (Baker, 1934, p. 318). The coal splits into several bony benches, thins out to the east and is known to be minable in a belt extending no more than 15 miles east of Eagle Pass (Andrews and Huddle, 1948, p. 5).

SANTO TOMAS DISTRICT

The Santo Tomas field, Webb County (fig. 1), has been included in the bituminous coal districts of Texas by Campbell and Parker (1909), by Baker (1934), and by Andrews and Huddle (1948). This field contains minable deposits of cannel coal in the Mount Selman Formation of Eocene age. These coals have chemical and physical properties unlike those of the bituminous coals elsewhere in Texas, and although included with the bituminous coals for the purposes of resource estimates, they probably should be classified separately. Descriptions of the deposits and their stratigraphic relations were given by Vaughan (1900), Ashley (1918), and Lonsdale and Day (1937).

The thickest coal in the district is the Santos Tomas coal bed, which commonly is 24–36 inches thick and which averages about 24 inches in thickness for a distance of 6–8 miles along its outcrop in bluffs along the Rio Grande between Dolores and Palafox (Ashley, 1918, p. 265–266). These thickness figures exclude 2–14 inches of bony coal commonly found at the bottom of the bed. In the northern part of its outcrop, the Santo Tomas coal bed separates into four or five thinner coal beds that are lignite at some places and cannel coal at others (Lonsdale and Day, 1937, p. 34); the bed is not exposed north of Palafox.

Other deposits of cannel coal in the district are in the San Pedro coal bed, which is about 90 feet below the Santo Tomas coal bed in mines near Dolores. Ashley (1918, fig. 41) noted that in the mine workings and in a drill hole near the mines, the San Pedro contains about 2 feet of coal in an upper bench and as much as 19 inches of coal in a lower bench, the two benches being separated by about 2 feet of shale. The San Pedro coal bed is absent in exposures of the Mount Selman Formation near the mines. However, coal correlated with the San Pedro crops out at Palafox, 11 miles northwest of Dolores (Ashley, 1918, p. 267; Lonsdale and Day, 1937, p. 74); and a bed of cannel coal, or, locally, several thin beds of lignite, occupy the general zone of the San Pedro coal bed discontinuously from Palafox northward for about 15 miles (Lonsdale and Day, 1937, pl. 1, p. 21).

Dumble (1892, p. 188–189) and Ashley (1918, p. 268) suggested that coal of the Santo Tomas district extends underground across most of Webb County and into the eastern parts of Dimmit and Zavala Counties to the north. Lonsdale and Day (1937, pl. 1) indicated, however, that in outcrops the cannel coal is not persistent for any great distance. They reported that drilling in the northwestern part of Webb County gives no evidence of cannel coal there. Moreover, some of the coal beds in Zavala County that Dumble considered to be correlative with the Santo Tomas and San Pedro coal beds are lignite beds now known to be older (Fisher, 1963, p. 78–79).

Resources of cannel coal calculated for the present report are for an area extending not more than 10 miles into Texas from a point on the Rio Grande midway between Dolores and Palafox.

OTHER AREAS

Coal occurs in Cretaceous rocks in Brewster, Presidio, and Hudspeth Counties (fig. 1), but it cannot be traced beyond local areas. All this coal is characterized by a high ash content (Andrews and Huddle, 1948, p. 6).

The Brewster County deposits, which are near Terlingua in the southern part of the county, consist of coaly zones at the base of and in the upper part of the Aguja Formation of Late Cretaceous age (Yates and Thompson, 1959, p. 14–15). Baker (1934, p. 322) reported coal as much as 18 inches thick at three closely spaced localities about 15 miles east of Terlingua and at one locality about 10 miles south of Terlingua. According to Baker (1934, p. 321), the coal is altered to anthracite at a few places where it is cut by igneous rocks.

In the San Carlos district (northwestern Presidio County) two coal beds, each about 2 feet thick and separated by as much as 8 feet of claystone and sandstone, were traced for at least 2 miles during early prospecting and mining (Vaughan, 1900, p. 77–79, pl. 6). The coal-bearing rocks in this area were assigned to the Aguja Formation by Baker (1934, p. 321).

In Hudspeth County the principal coal occurrence is at Eagle Spring on the north side of the Eagle Mountains, and is in the Upper Cretaceous Eagle Ford Formation (Gillerman, 1953, p. 32). A coal bed as much as 3 feet thick has been exposed by mining at this locality (Baker, 1927, p. 67). No information is available on the extent of the coal; but as coal has not been reported in the Eagle Ford elsewhere in the region, the area in which coal is more than a few inches thick is assumed to be small.

COAL PRODUCTION

Bituminous coal produced in Texas from 1895 to 1943 totaled slightly more than 24 million short tons (table 1). Cannel coal mined in Webb County is called bituminous coal in the statistical reports and is included in this production figure. For the 11-year period preceding 1895, the total amount of coal mined in Texas was 1,943,500 tons, including both bituminous coal and lignite (Phillips and Worrell, 1913, p. 11–12). Separate records were not kept for these two ranks of coal prior to 1895; however, production trends for the 5 years following 1895 suggest that about two-thirds of the pre-1895 tonnage, or about 1,300,000 short tons, was bituminous coal, and the remainder was lignite.

The peak year for production of bituminous coal in Texas was 1913, when 1,247,988 short tons was mined. Yearly production dropped below 100,000 tons in 1930, and the mining of bituminous coal virtually ceased by 1944.

TABLE 1.—*Bituminous coal production in Texas, 1895–1943*

[Data summarized from U.S. Geol. Survey (1895–1923) and from U.S. Bur. Mines (1924–43)]

Years	*Production (thousands of short tons)*	*Years*	*Production (thousands of short tons)*
1895–99	2,337	1925–29	738
1900–04	3,650	1930–34	222
1905–09	4,749	1935–39	169
1910–14	5,759	1940–43	52
1915–19	5,290		
1920–24	1,360	Total	24,326

COAL RESOURCES TABULATED BY AREAS AND BEDS

Original resources of bituminous and cannel coal in Texas are estimated to total 6,100 million short tons in beds more than 14 inches thick and under less than 3,000 feet of overburden. Of this amount, 5,400 million short tons, or about 88 percent, is coal of Pennsylvanian and Permian age in north-central Texas; 665 million short tons, or about 11 percent, is coal of Cretaceous or early Tertiary age in the Eagle Pass, Santo Tomas and San Carlos districts; and 65 million short tons, or about 1 percent, is coal of Cretaceous age that may exist in parts of Brewster and Presidio Counties where the extent of the coal beds is poorly known.

About 3,400 million short tons, or about 65 percent, of the Pennsylvanian and Permian coal is under less than 1,000 feet of overburden. Information on the depth to coal in Cretaceous and lower Tertiary rocks is less detailed than for Pennsylvanian and Permian rocks, but at least half of the Cretaceous and Tertiary coal for which resources are calculated is less than 1,000 feet underground.

Tables 2 and 3 itemize the resources of each coal bed for which reliable thickness measurements of coal are available. The areas in north-central Texas for which the resources are estimated are shown in figures 6–9 and 11–13. All the resources are classified as inferred according to definitions discussed by Averitt (1961, p. 21–22) and used by the U.S. Geological Survey for resource estimates for other States.

Density of drilling in most of Texas seems sufficient to identify and outline coal deposits in Paleozoic rocks. It is unlikely that any undiscovered coal-bearing areas would be large enough to add appreciably to the total bituminous-coal resources.

Cretaceous rocks are less adequately explored for coal. The nonmarine Aguja Formation is present either at the surface or under fairly

TABLE 2.—*Inferred original resources of bituminous coal (Paleozoic) in north-central Texas*

[In beds >14 in. thick and under <3,000 ft of overburden; 1,150,000 short tons of coal per square mile-foot]

Group	Coal bed	Overburden (feet)	Thickness (feet)	Area (square miles, rounded)	Resources (millions of short tons, rounded)
Wichita	Newcastle	0–1,000	2.5	450	1,300
			1.5	150	260
		1,000–2,000	----	----	----
		2,000–3,000	----	----	----
	Bull Creek	0–1,000	1.2	180	250
		1,000–2,000	1.2	30	41
		2,000–3,000	----	----	----
Cisco	Chaffin	0–1,000	1.5	1	2
		1,000–2,000	----	----	----
		2,000–3,000	----	----	----
Canyon	Dalton	0–1,000	3.0	5	17
		1,000–2,000	----	----	----
		2,000–3,000	----	----	----
	Bridgeport	0–1,000	1.5	145	250
		1,000–2,000	1.2	295	410
		2,000–3,000	1.2	30	41
Strawn	Abbott	0–1,000	1.7	3	6
		1,000–2,000	----	----	----
		2,000–3,000	----	----	----
	Thurber	0–1,000	2.0	550	1,260
		1,000–2,000	1.5	510	880
		2,000–3,000	1.5	370	640
	Sunday Creek	0–1,000	1.7	7	14
		1,000–2,000	----	----	----
		2,000–3,000	----	----	----
Totals (rounded)		0–1,000	----	----	3,400
		1,000–2,000	----	----	1,300
		2,000–3,000	----	----	680
Grand total (rounded)		----	----	----	5,400

TABLE 3.—*Inferred original resources of bituminous and cannel coal (Cretaceous and younger), in Maverick and Webb Counties and part of Presidio County, Tex.*

[In beds >14 in. thick and under <3,000 ft of overburden; 1,150,000 short tons of coal per square mile-foot]

District	County	Coal bed	Thickness (feet)	Area (square miles)	Resources (millions of short tons, rounded)
Eagle Pass	Maverick	Unnamed	6.0	18	125
		do	2.0	140	400
Total	----	----	----	----	525
Santo Tomas	Webb	Santo Tomas	2.0	40	90
		San Pedro:			
		upper bench	1.5	10	17
		lower bench	1.2	5	7
Total (rounded)	----	----	----	----	115
San Carlos	Presidio	Unnamed:			
		upper bench	2.0	5	12
		lower bench	2.0	5	12
Total (rounded)	----	----	----	----	25
Grand total (rounded)	----	----	----	----	665

shallow overburden in about 900 square miles of southern Brewster County, and in at least 50 square miles of northwestern Presidio County. If 5 percent of these areas is estimated to contain at least one bituminous coal bed 14 inches thick under less than 3,000 feet of overburden, a potential resource of about 62 million short tons of bituminous coal would be added to the State resources for Brewster County, and 3 million short tons, for Presidio County.

The total original bituminous and cannel coal resources of Texas are summarized in table 4.

TABLE 4.—*Summary of original bituminous and cannel coal resources in Texas*

[In beds >14 inches thick and under <3,000 feet of overburden; in millions of short tons, rounded]

Area	Resources determined by mapping and exploration	Possible additional resources in unexplored areas	Total resources
North-central Texas	5, 400	None	5, 400
Eagle Pass district	525	do	525
Santo Tomas district	115	do	115
San Carlos district	25	do	25
Brewster County	None	62	62
Presidio County [1]	do	3	3
Total (rounded)	6, 070	65	6, 100

[1] Excluding the San Carlos district.

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