

CHAPTER 2

The San Pedro and Santo Tomas Coal Beds (Claiborne Group, Eocene) of Webb County, Texas

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INTRODUCTION

The San Pedro and Santo Tomas coal zones of Webb County, Texas, are unique within the realm of Gulf Coast coal geology. Coal beds within these zones are distinguished by calorific yields and vitrinite-reflectance values that indicate a rank as high as high-volatile bituminous C, which is considerably greater than other Tertiary coals within the Gulf Coastal Province. In the past, the San Pedro and Santo Tomas were identified as cannel coal because of their blocky, nonbanded character, and conchoidal fracture (Vaughan, 1900; Ashley, 1919; Lonsdale and Day, 1937). Unlike true cannel coal known from the Upper Carboniferous of the Appalachians and Europe, the Webb County deposits are not particularly rich in spores or cuticular material and are not restricted to local channel fills. Rather, the San Pedro and Santo Tomas coals contain abundant green-algae fructifications and occur as multiple tabular coal beds within zones that extend for tens of miles along strike (Warwick and Hook, 1995).

Recent work has addressed the depositional origin, petrography, and geochemistry of the San Pedro and Santo Tomas coal beds, but several basic questions remain. The full extent of these deposits has

not been determined. In adjacent parts of Mexico, numerous cannel-like beds occur within the Claiborne Group (SPP, 1989), but no comparable deposits are known elsewhere in Texas outside of Webb County. The question of rank also cannot be resolved at this time. Previously, we attributed the high rank of the San Pedro and Santo Tomas to geothermal influences (Warwick and Hook, 1995). Although the suggestion of geothermal influence is consistent with data that indicate an elevated rank of Wilcox coal deposits in adjacent counties, additional study is required to confirm the origin and delineate the extent of such alteration. Likewise, the significance of abundant green-algae fructifications in these coals, identified only from petrographic study of polished blocks, cannot be judged fully at this time because comparable polished block petrographic data do not exist for the great majority of other Tertiary coals.

GEOLOGIC SETTING AND STRATIGRAPHY

The Farco mine complex of Webb County lies within the outcrop of the southwestern flank of the Rio Grande Embayment, which extends southwesterly through Coahuila, Nuevo León, and

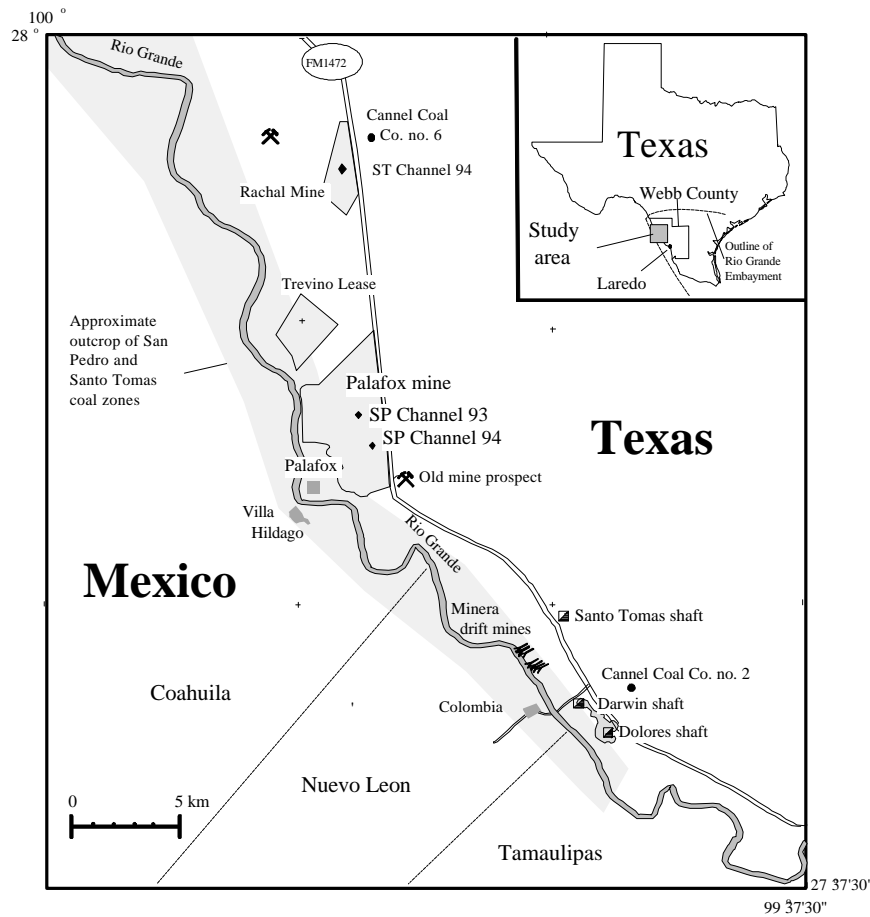


Figure 1. Location of study area, underground mine entries and prospects, Cannel Coal Company coreholes 2 and 6, surface mines, and sample sites. Inset shows location of study area, Webb County, and Rio Grande Embayment in South Texas. From Warwick and Hook (1995).

Tamaulipas in Mexico (fig. 1). Within the Rio Grande Embayment, the lower to middle part of the Claiborne Group consists of marine mudstones (Reklaw Formation) in the east and northeast, and sandstones and mudstones (Bigford Formation) in the south and southwest (fig. 2). The marine mudstones coarsen upward into the fluvialdeltaic Queen City Sand, which prograded gulfward across eastern and central Texas. To the west and southwest, the interval overlying the Bigford Formation becomes less sandy and claystones of the El Pico Clay Formation predominate.

The San Pedro and Santo Tomas coal zones occur within the fining-upward transition from sandstone-dominated rocks to mudstone-rich deposits. The coal beds dip approximately 2° to the northeast, toward the synclinal axis of the embayment.

The San Pedro coal zone ranges up to 10 m (33 ft) in thickness and contains as many as five organic-rich beds that vary from carbonaceous mudstone to nonbanded coal in composition. The thinner Santo Tomas coal zone occurs approximately 25 to 35 m (82 to

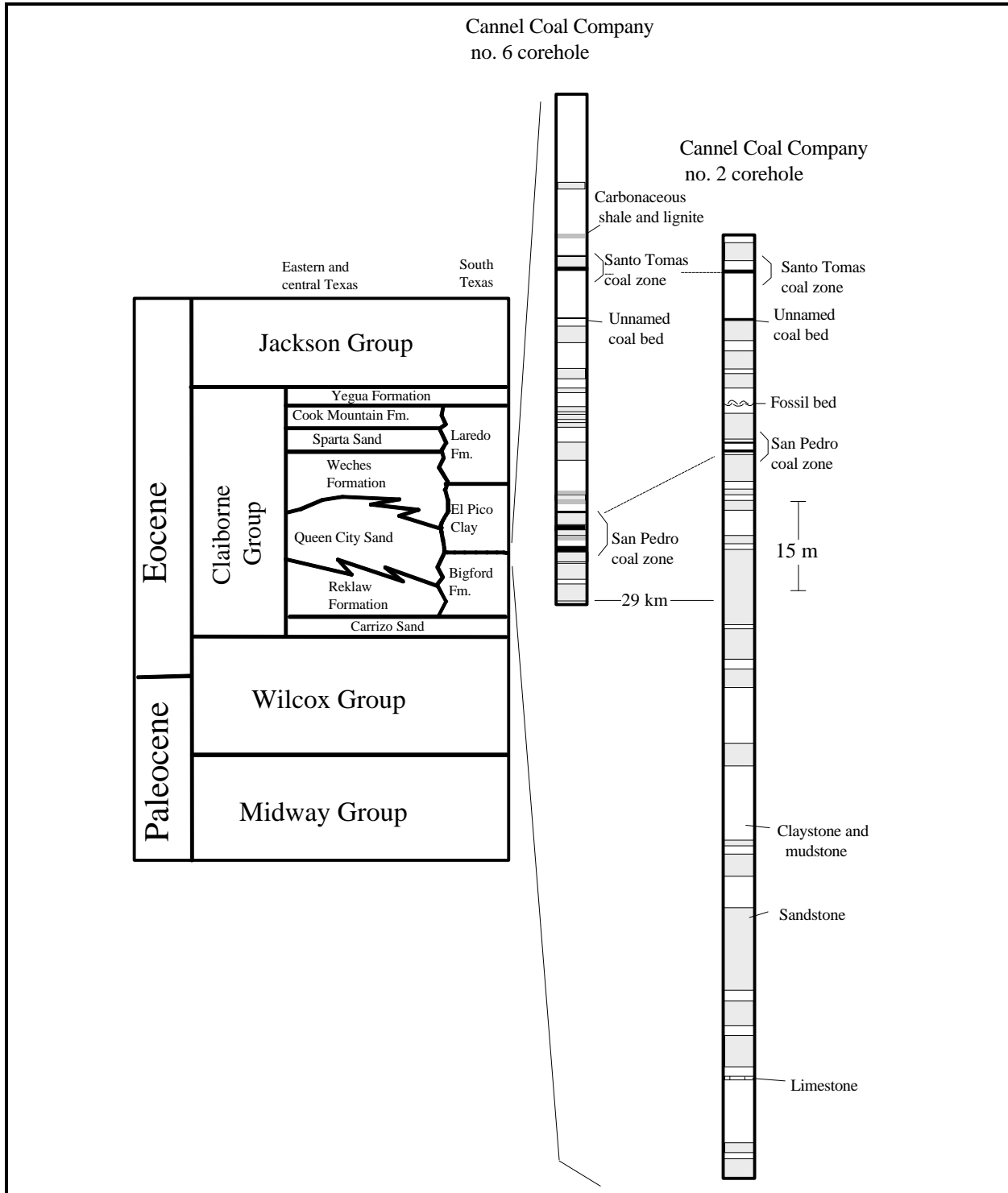


Figure 2. Representative corehole records from Vaughan (1900) that include both coal zones. Approximate locations shown on figure 1. Regional stratigraphy after Eargle (1968) and Guevara and Garcia (1972). From Warwick and Hook (1995).

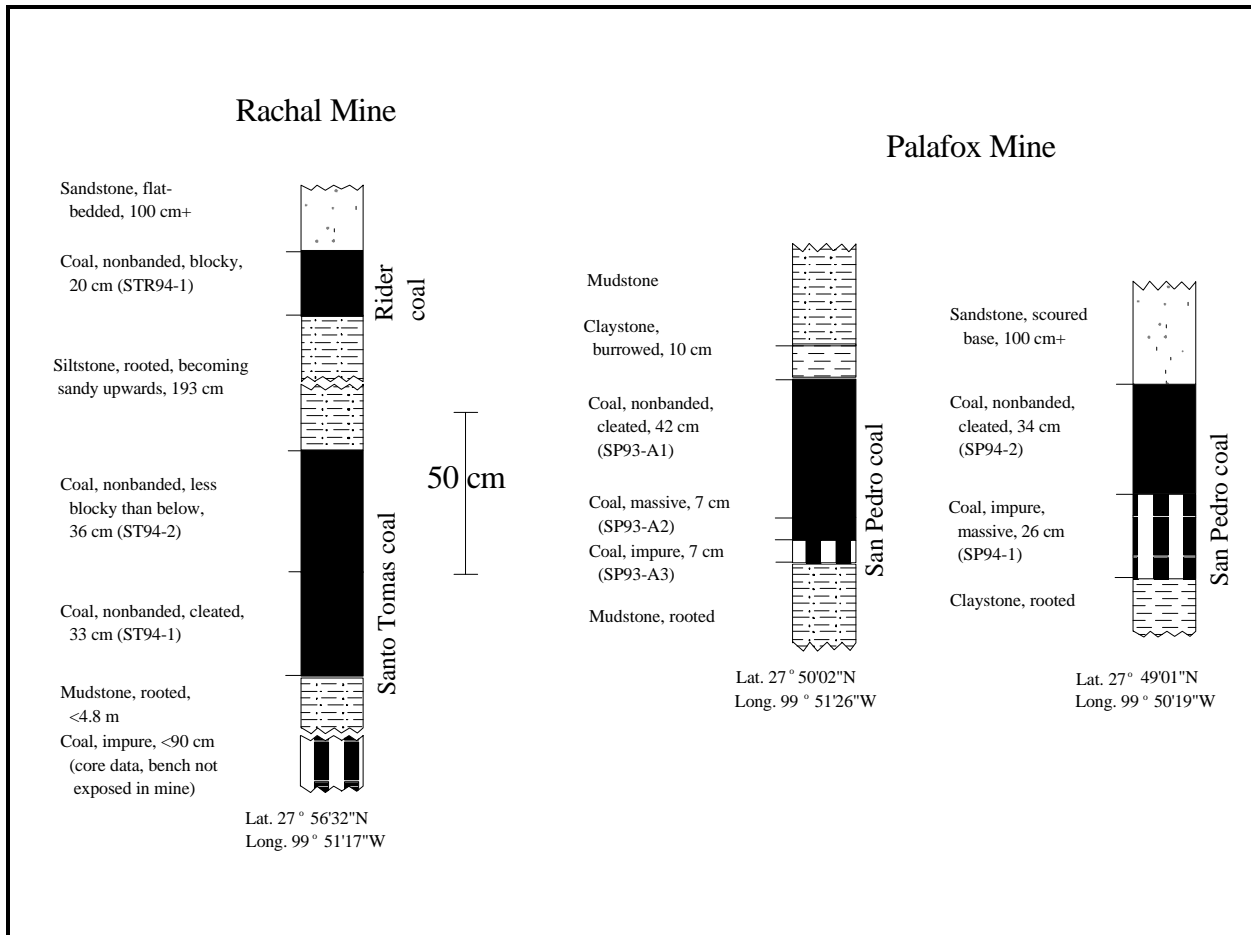


Figure 3. Bed sections and sample intervals of the San Pedro, Santo Tomas, and Santo Tomas rider coal beds. Sample numbers are in parentheses. Approximate locations are shown in Figure 1. From Warwick and Hook (1995).

115 ft) above the San Pedro zone, averages approximately 2.4 m (7.9 ft) in thickness, and consists of a lower main bed and an overlying rider, both of which may occur as nonbanded coal, impure coal, or carbonaceous mudstone (fig. 3). Within the Farco property and leases, coal beds of the San Pedro zone are mined at the Palafox and Trevino mines, and the Santo Tomas zone is developed at the Rachal mine (fig. 1).

MINING HISTORY

The Santo Tomas coal zone of Webb County was first mined commercially by the Rio Grande Coal and Irrigation Company between 1881 and 1914 in modest drift openings in the vicinity of Minera (fig. 1). By 1895, the Cannel Coal Company had completed a shaft and had driven mains in both the Santo Tomas and San Pedro zones at Darwin (fig. 1). The company, which employed several hundred miners, was directed by David Darwin Davis, a mining

engineer from Wales (Hopson, 1975). A second shaft of the Cannel Coal Company at Dolores also mined both coal zones. The Santo Tomas Coal Company opened a shaft to the Santo Tomas coal bed between 1910 and 1912 near the village of Santo Tomas. This operation ceased in 1918 after a mine fire. The Darwin mines were abandoned in 1921, and the Dolores mines closed in 1939.

In 1979, Farco Mining Company of Texas, Inc., initiated surface mining at Palafox (fig. 1). The Rachal and Trevino mines began production in 1983 and 1996, respectively. Cumulative production from 1979 through 1997 totaled approximately 6 million short tons. The coal is washed and sized at a cleaning plant at Palafox. A significant amount of the coal is exported to the Republic of Ireland as lump coal for domestic use, and other production is consumed by local cement plants. Kelmac, Inc., a subsidiary of Chevron Corporation, recently acquired the Webb County mines of Farco Mining Company of Texas and operates currently under the name Farco Mining, Inc.

DEPOSITIONAL SETTING

The coal-bearing portion of the lower to middle Claiborne Group of Webb County is a fining-upward sequence situated above a thick, sandstone-dominated section that contains poorly preserved marine invertebrates, and below a mudstone-rich section that yields mainly nonmarine fossils. Corehole records and natural exposures show that the San Pedro coal zone overlies a barren interval dominated by thick (7.6-10.7 m or 25-35 ft), predominantly flat-bedded, sandstone deposits.

At Palafox, the San Pedro coal zone consists of a thick (\leq 0.85 m or 2.9 ft),

nonbanded upper bed and a thin, impure bed approximately 3 m (9.8 ft) below; additional thin coal beds and carbonaceous mudstones occur in the lower part of the coal zone but are not mined (fig. 3). The upper coal bed is underlain by a dark gray, root-penetrated, silty claystone, and the uppermost portion of this coal bed contains mud-filled invertebrate burrows and trails. As seen in-mine, the contact between this coal and overlying mudstone or sandstone generally is sharp.

The interval immediately above the San Pedro coal zone consists mainly of sandstone, a slightly smaller proportion of mudstone, a minor intraformational conglomerate, local fine-grained limestone nodules or bands, and thin ($<$ 0.45 m or 1.5 ft), discontinuous coal beds that range from nonbanded coal to clay or silt-rich impure coal. The sandstones are calcareous and are composed chiefly of fine to very fine, subangular to rounded quartz grains; individual beds are massive, cross bedded, streaked or interbedded with mudstone, rippled, or rooted or otherwise biotributed. An en echelon pattern characterizes sandstone bodies above the San Pedro coal zone in the Palafox Mine. These sandstone bodies are flat bottomed, flat to ripple bedded, and exhibit characteristics of mouth-bar to crevasse-splay sands deposited in shallow water. Between the main coal bed and these sandstone deposits, coarsening-upward, rhythmically interbedded mudstones and sandstones contain flaser bedding suggestive of tidal influences. A few zones of poorly preserved marine invertebrate fossils (pelecypods, gastropods) occur above the San Pedro coal zone (Lonsdale and Day, 1937).

At the Rachal Mine (fig. 1), the Santo Tomas coal zone consists of a thick (0.69 m) nonbanded main seam, a clastic interval that ranges from 0.91 to 1.98 m (3 to 6.5 ft) in

thickness, and a thin (0.20 m or 0.6 ft) rider coal bed (fig. 3). Both beds are underlain by paleosols, and the top of the main bed contains invertebrate burrows and trails. The interval between these coal beds consists of flat-bedded siltstone and fine to very fine grained, noncalcareous sandstone that fine laterally into coarsening-upward mudstone deposits. These mudstones lack the flaser-bedded sandstone interbeds that occur above the San Pedro coal bed at Palafox. Channel-form deposits within this interval are small (0.25 m or 0.8 ft thick, 1 m or 3.3 ft wide), few in number and limited to the top of thick sandstone deposits. Overall, the interval between the main Santo Tomas coal bed and rider bed records the drowning of an initial mire, infilling of the resulting floodbasin by minor crevasse splays, and re-establishment of mire conditions.

The presence of several thin coal and carbonaceous shale beds a short distance above the Santo Tomas rider bed indicates that clastic-rich mires persisted locally. Overlying coarsening-upward sequences represent the terminal flooding and clastic infilling of the floodbasin. Lonsdale and Day (1937) reported thin sandstone beds in the area of Darwin that contained poorly preserved nonmarine molluscs and abundant green algae fructifications. Although they interpreted these fossil occurrences as a unique bed of considerable persistence, Gardner (1945), who measured and collected many of the fossiliferous sections reported by Trowbridge (1923, 1932) and Lonsdale and Day (1937), stated clearly that several such beds occur. The presence of these locally rich beds of nonmarine aquatic fossils above the Santo Tomas coal zone indicates that lacustrine settings may have been common within the floodbasin.

COAL CHARACTERISTICS

The nonbanded coals that are mined in Webb County are extremely hard, fracture conchoidally, and have cleats developed at a scale similar to that of bituminous nonbanded coals. The lower part of the San Pedro coal bed at Palafox is very massive and breaks into blocks that average 0.5 m (1.6 ft) in width; to a lesser extent, the main Santo Tomas coal bed becomes more massive and less fractured downward.

Physical and geochemical analyses (fig. 4) reported by us previously (Warwick and Hook, 1995) are comparable to earlier analyses of these coal beds (Evans, 1974; Mukhopadhyay, 1989). All the San Pedro and Santo Tomas samples have relatively high ash yields (9.5-18% dry basis) at their base. Total sulfur content (0.8-2.0%, dry basis) generally increases upward, and organic sulfur is predominant. Calorific values increase upward within each coal bed, with a maximum of 7,434 kcal/kg (13,371 Btu, dry basis) found in the top part of the main San Pedro bed at Palafox. Hydrogen content follows calorific values, ranging from 5.4 to 6% (dry basis). Additional physical and geochemical data, including trace-element analyses, are reported in Warwick and Hook (1995).

Petrographic study of particle pellets and unetched polished blocks from San Pedro and Santo Tomas coal samples (Warwick and Hook, 1995) indicate that a highly degraded groundmass composed of eugelite is the main organic component (approximately 71%, mineral-matter-free basis). An enriched liptinite fraction (approximately 23%) accounts for a portion of the high calorific

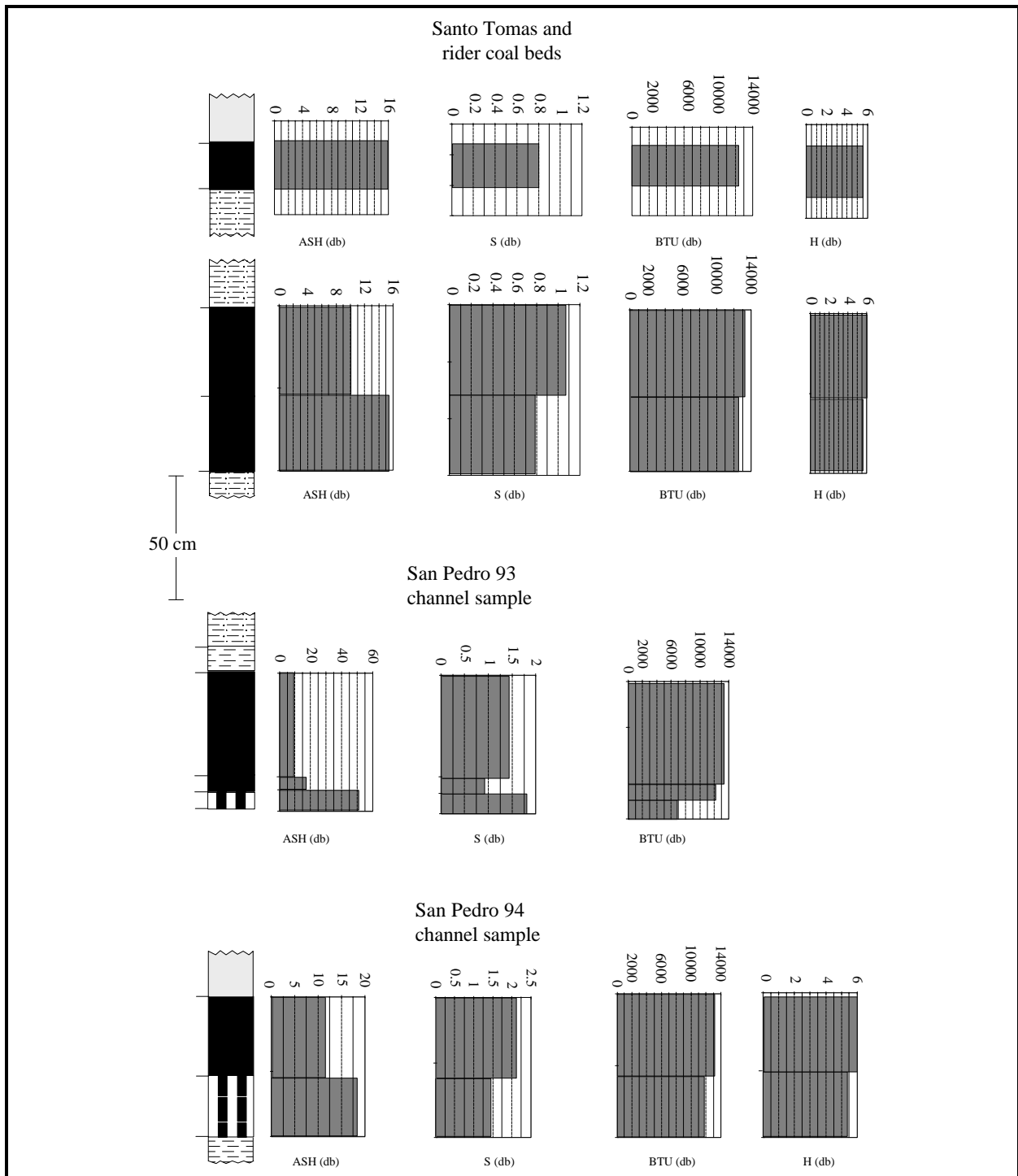


Figure 4. Selected proximate and ultimate data. Sample descriptions and symbols are the same as those used in figure 3. All values as percentages except Btu. Sample locations are shown in Figure 1. Complete sample data are given in Warwick and Hook, 1995. From Warwick and Hook (1995).

values that distinguish these coals. Most of this enrichment represents fusiform green-algae fructifications, which because of their size (up to 2 mm or 0.1 in. in length), cannot be identified or quantified readily by conventional coal petrography techniques or palynologic preparations that involve acidification. There is a negligible proportion of inertinite macerals in these coals.

Average maximum vitrinite reflectance ($R_{o_{max}}$) values for San Pedro and Santo Tomas coal samples reported previously by us was 0.53. This was comparable to the $R_{o_{max}}$

reported by Mukhopadhyay (1989) for one San Pedro sample. Compared to standard rank parameters, the San Pedro and San Tomas coal deposits fall within the range of subbituminous A to high-volatile bituminous C coal.

SUMMARY

The unusual coals of the San Pedro and Santo Tomas coal zones of the Claiborne Group in Webb County, Texas, are distinguished by physical, petrographic, and

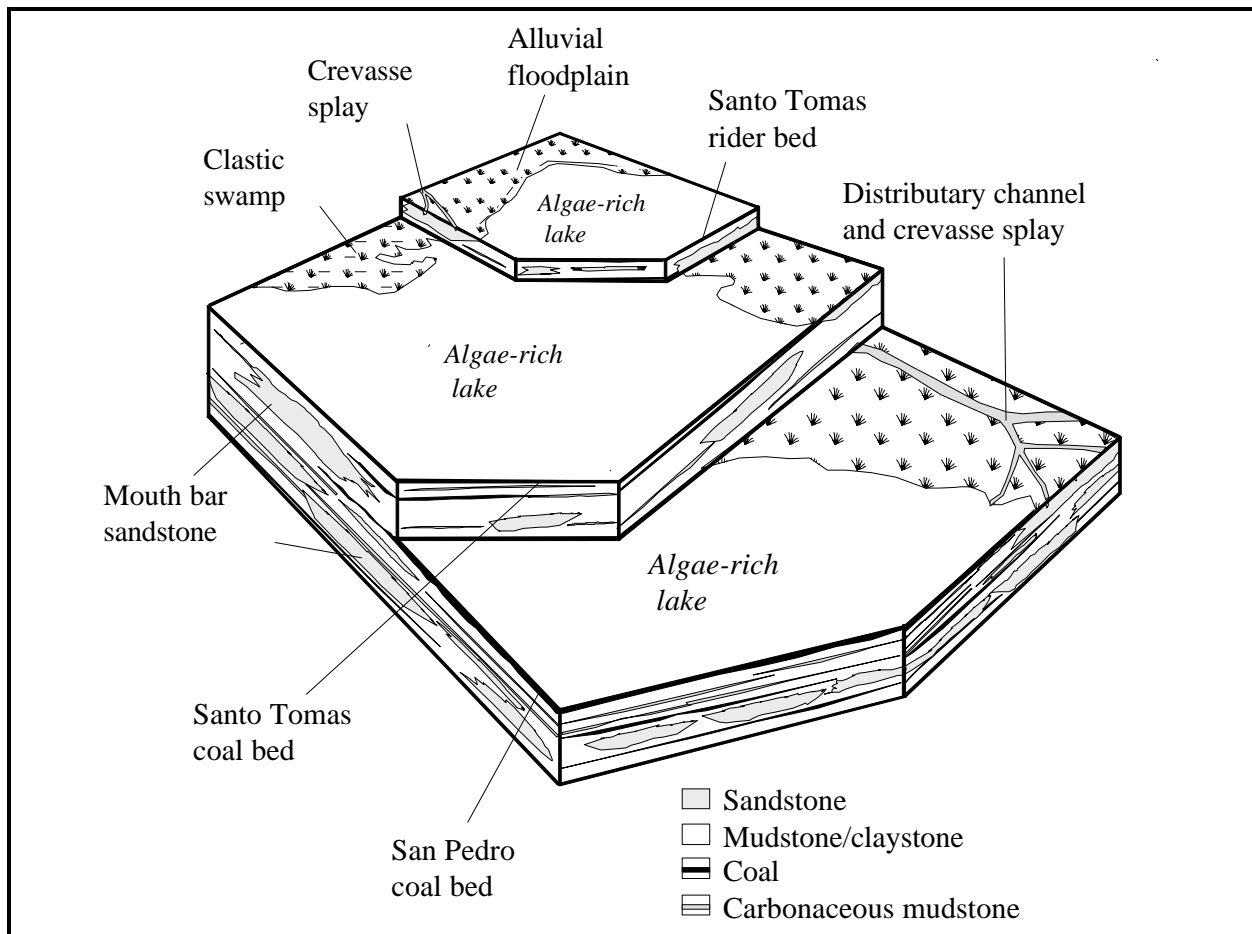


Figure 5. Schematic block diagram of depositional environments for the San Pedro and Santo Tomas coal zones in the middle part of the Claiborne Group. No scale implied. The geometric distribution of lithologies on the panels is inferred from borehole and mine highwall data. From Warwick and Hook (1995).

geochemical characteristics unlike those of other Gulf Coast Tertiary coal deposits. Whereas the San Pedro deposits accumulated in marine-influenced lower delta plain settings, the overlying Santo Tomas interval represents a nonmarine, mudstone-dominated sequence (fig. 5). Mineable coal beds within both coal zones contain an abundance of green algae fructifications, which account in part for the anomalously high calorific value. Data from Mexico (SPP, 1989), however, record Quaternary igneous intrusive rocks less than 100 km (62 mi) west of the Rio Grande area, and coal-quality data from coal beds in the underlying Wilcox Group of Texas counties bordering Webb County indicate increased rank. Additional work is required to determine the postdepositional history of the coal deposits of South Texas.

ACKNOWLEDGMENTS

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