Depositional environments of a coal-bearing section in the Upper Cretaceous Mesaverde Group, Routt County, Colorado

By

Thresa M. Gaffke

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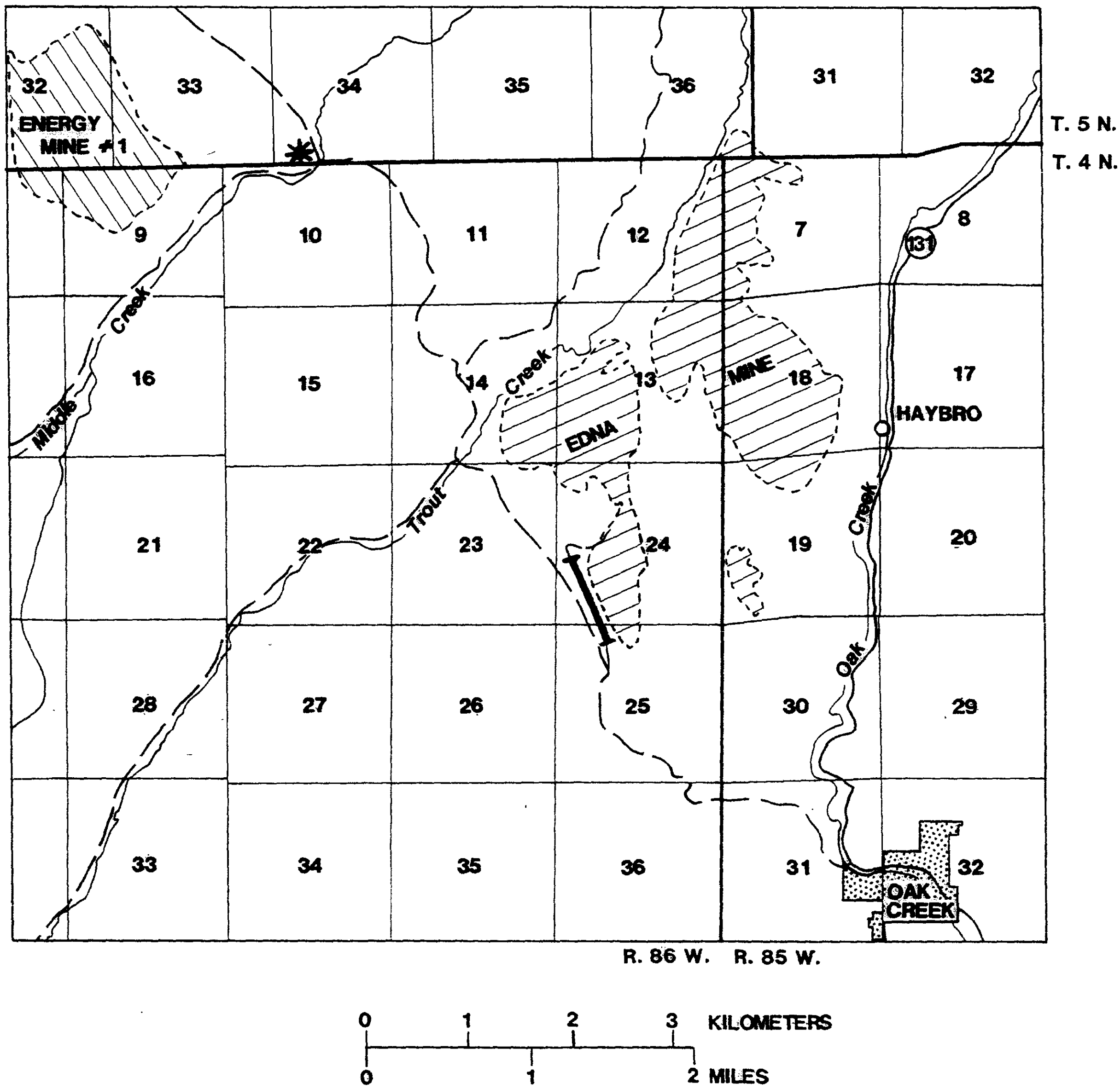
ABSTRACT

A 107-m (350 ft) section of coal-bearing rocks of the Upper Cretaceous Mesaverde Group that is exposed along an access road to the Edna Mine in Routt County, Colorado, records deposition of sediment during a regressive phase of the epicontinental sea. Each of the coal beds in the section occurs at the top of a bayfill sequence that records infilling of a bay sufficient to provide swamp conditions and allow formation of peat.

INTRODUCTION

Most of the coal mines in northwestern Colorado obtain their coal from the Upper Cretaceous Mesaverde Group (Dawson and Murray, 1978). Near one of these mines a 107 m (350 ft) exposure of a coal-bearing section in the Mesaverde Group was measured by T. A. Ryer in 1978 (written commun., 1978). This section was examined to determine the environments of deposition of the contained rock units.

The section is located along an access road to Pittsburg and Midway's Edna strip mine, about 5 km (3 mi) northwest of the town of Oak Creek, in secs. 24 and 25, T. 4 N., R. 86 W., Routt County, Colorado (fig. 1). The geology of the area surrounding the Edna Mine section has been mapped by Bass, Eby and Campbell (1955) and Ryer (1977). Previous depositional studies in the region were made by Masters (1966), who examined a broad area between Craig and Oak Creek (fig. 2), and by Collins (1976), who studied the Upper Cretaceous strata in the Grand Hogback between Meeker and Marble (fig. 2).



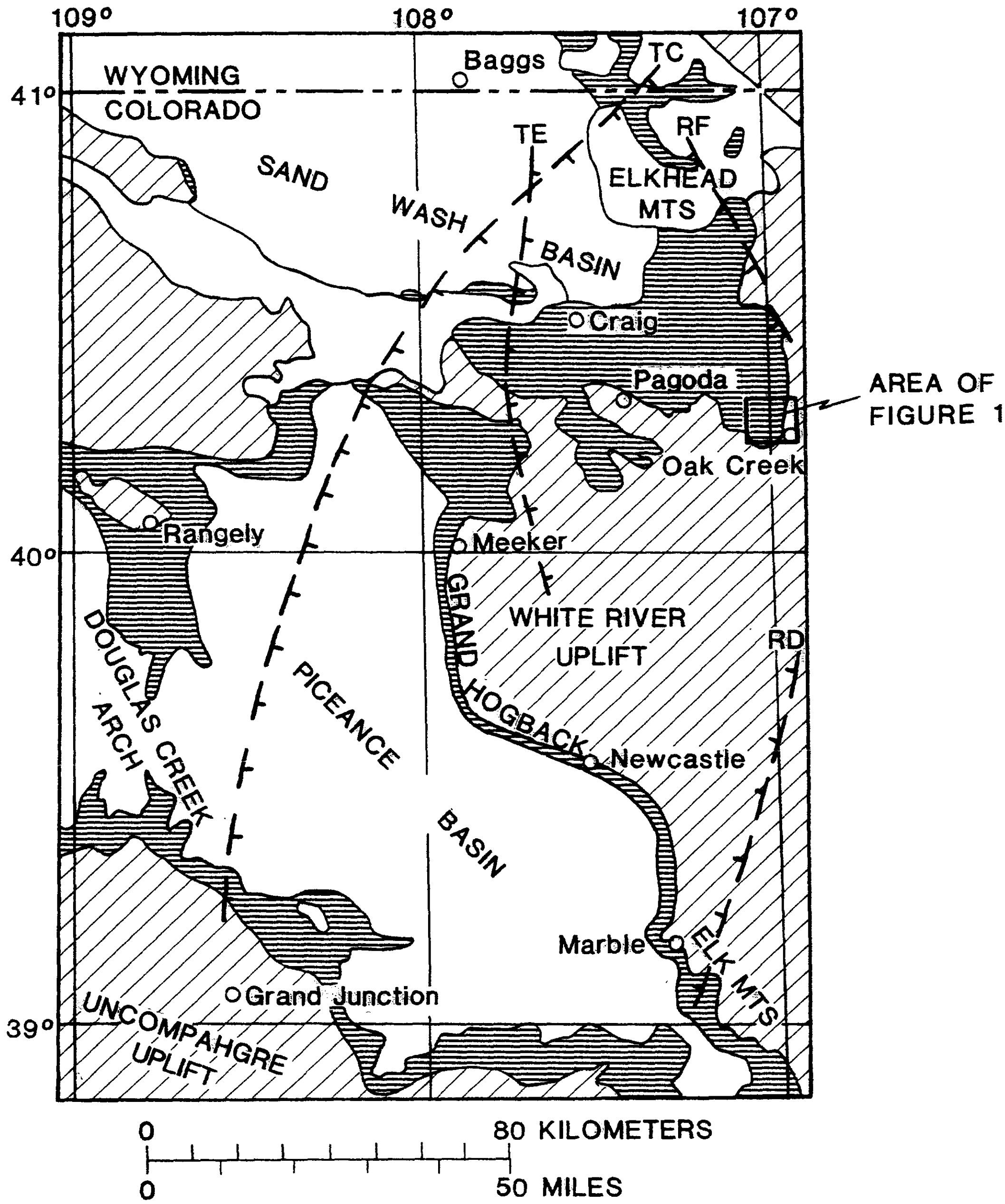
Edna Mine section

Middle Creek roadcut

State route

Light-duty road, hard or improved surface

FIGURE 1.--MAP SHOWING LOCATION OF THE EDNA MINE SECTION, ROUTT COUNTY, COLORADO.



(blank box)	Rocks younger than Upper Cretaceous rocks
(horizontal-ruled box)	Mesaverde Group and younger Upper Cretaceous rocks
(diagonal-hatched box)	Rocks older than Mesaverde Group
⊥T	Approximate landward limit of deposition of tongues of marine rocks. Hatchures point in seaward direction.

RF	Upper Williams Fork regression
TE	Middle Williams Fork transgression
RD	Lower Williams Fork–lower Bowie regression
TC	Upper Iles–lower Mount Garfield transgression
⊥R	Approximate seaward limit of deposition of tongues of nonmarine rocks. Hatchures point in landward direction.

FIGURE 2.—GENERALIZED GEOLOGIC MAP OF NORTHWESTERN COLORADO SHOWING GENERAL LOCATION AND TREND OF CERTAIN REGRESSIVE AND TRANSGRESSIVE STRAND LINES DURING LATE CRETACEOUS TIME (MODIFIED FROM ZAPP AND COBBAN, 1960).

REGIONAL DEPOSITIONAL SETTING

The Mesaverde Group in northwestern Colorado was deposited during Late Cretaceous time and is characterized by numerous minor westward transgressions and eastward regressions of the Interior Cretaceous epicontinental sea (Weimer, 1960; Zapp and Cobban, 1960). Sediment was supplied by the still-active Sevier orogenic belt. Variations in the rates of sediment supply and basin subsidence resulted in the cyclic deposition of marine and nonmarine facies (Gill and Cobban, 1966, p. A45; McGookey, 1972, p. 223).

The approximate seaward limits of deposition of nonmarine facies and landward limits of deposition of marine facies within the Mesaverde Group, as determined by Zapp and Cobban (1960), are shown in figure 2 and in cross section in figure 3. The Edna Mine section includes the uppermost Iles Formation and lowermost Williams Fork Formation of the Mesaverde Group (fig. 3) and was deposited during the lower Williams Fork-lower Bowie regression of Zapp and Cobban (1960). It is evident from figures 2 and 3 that the nonmarine strata deposited during this regression are near their seaward limit of deposition at the Edna Mine section.

ANALYSIS OF DEPOSITIONAL ENVIRONMENTS IN THE EDNA MINE SECTION

The basal part of the Edna Mine section consists of the Trout Creek Sandstone Member of the Iles Formation (fig. 4). It is conformably overlain by the lower coal-bearing member of the Williams Fork Formation. A model of the depositional environments interpreted from the rock units of the section is shown in figure 5. The schematic model depicts an interdeltaic depositional setting. The lateral extent of the environments, such as the bay, are not known; a distributary channel and its associated delta are shown although they were not recognized in the area.

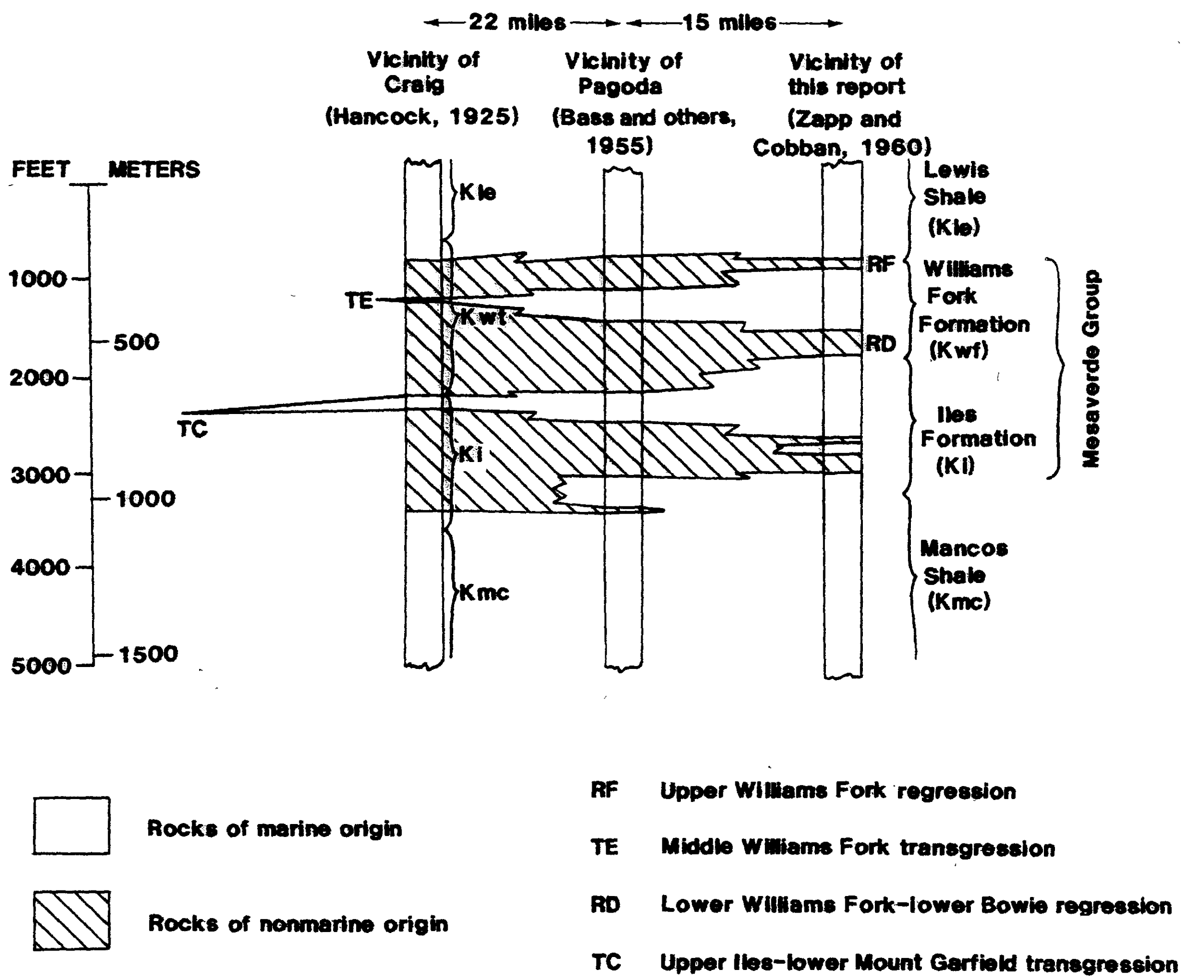


FIGURE 3.--GENERALIZED COLUMNAR SECTIONS SHOWING THE STRATIGRAPHIC POSITION OF UPPER CRETACEOUS MARINE AND NONMARINE FACIES IN NORTHWESTERN COLORADO (MODIFIED FROM ZAPP AND COBBAN, 1960).

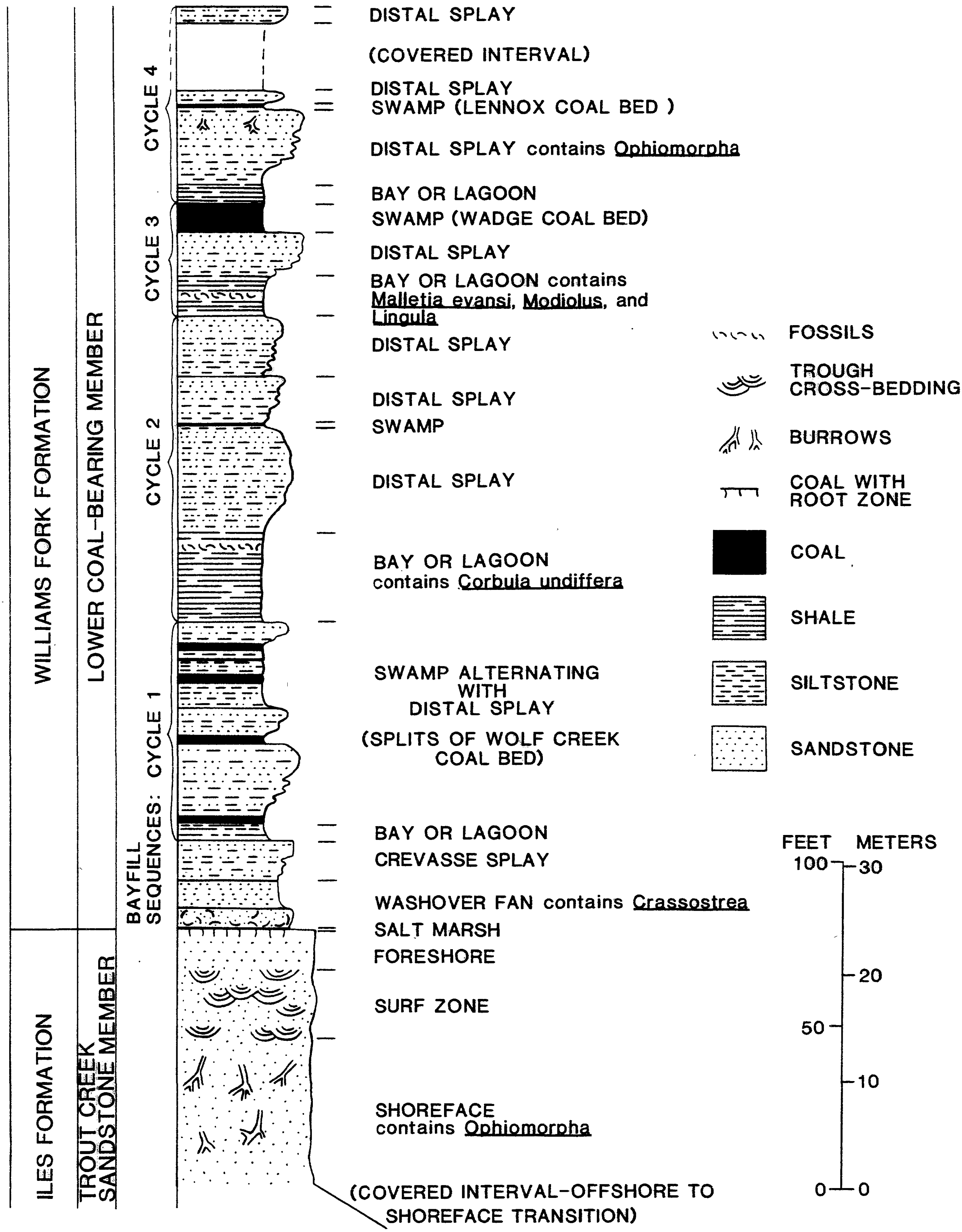


FIGURE 4.--DEPOSITIONAL ENVIRONMENTS INTERPRETED FOR THE MEASURED SECTION ALONG THE EDNA MINE ACCESS ROAD, ROUTT COUNTY, COLORADO.

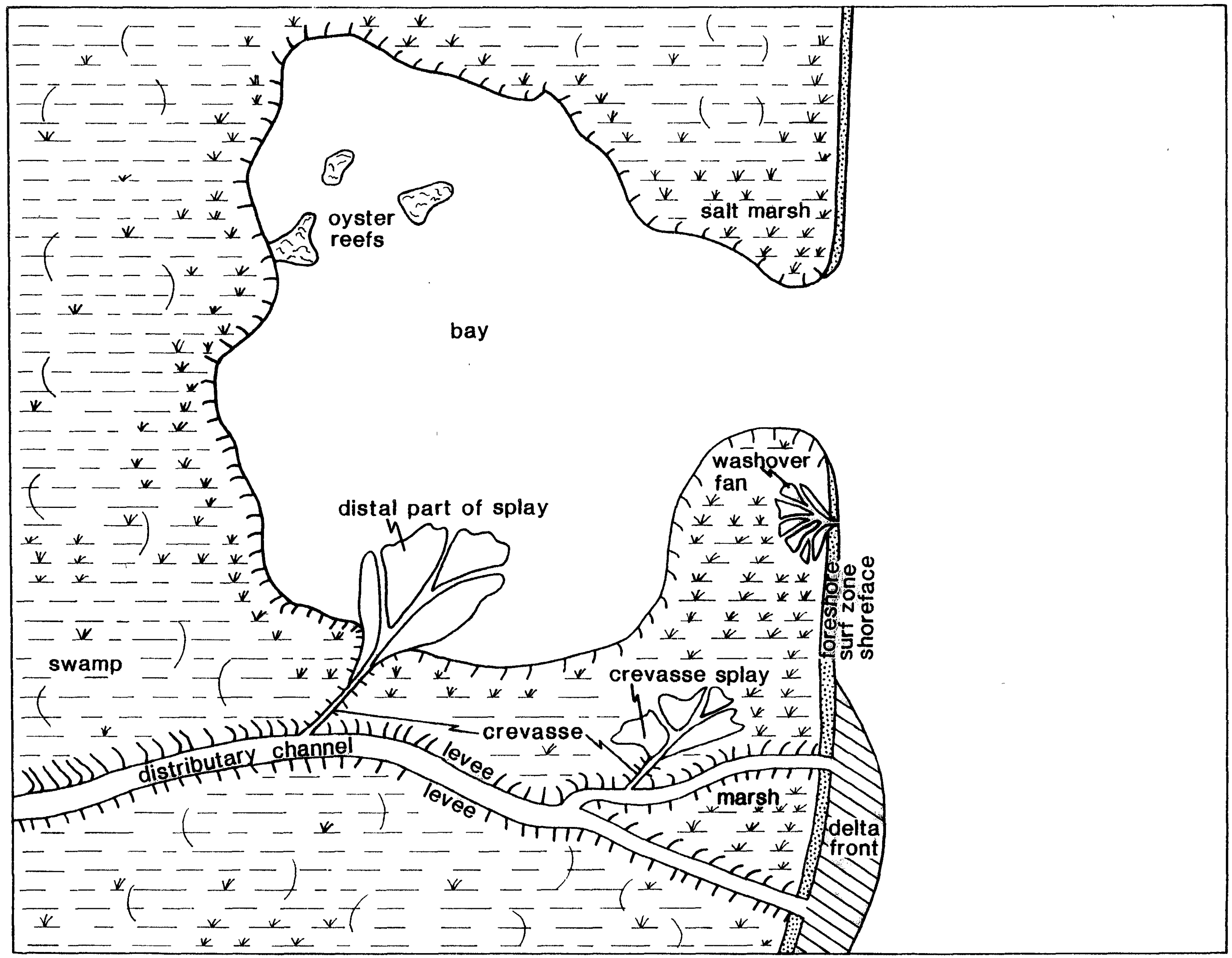


FIGURE 5.--DEPOSITIONAL MODEL FOR THE ENVIRONMENTS INTERPRETED IN THE MEASURED SECTION ALONG THE EDNA MINE ACCESS ROAD, ROUTT COUNTY COLORADO. THE LATERAL EXTENTS OF THE ENVIRONMENTS ARE NOT KNOWN; THE DISTRIBUTARY CHANNEL AND DELTA ARE NOT RECOGNIZED IN THIS AREA.

Trout Creek Sandstone Member, Iles Formation

The lowermost part of the Trout Creek Sandstone, interpreted as a lower shoreface deposit, is characterized by fine-grained, glauconitic, planar-laminated sandstone with carbonaceous shale stringers less than 2.5 cm (1 in) thick. Ophiomorpha are common in its upper part. The planar laminated sandstone grades upward into trough cross bedded, fine-grained sandstone, which represents the surf zone. This facies grades upward into fine-grained, planar laminated sandstone that is interpreted as representing the deposit of the foreshore. The topmost 0.3 m (1 ft) of this facies is carbonaceous due to extensive rooting.

Lower coal-bearing member, Williams Fork Formation

At the base of the lower coal-bearing member of the Williams Fork Formation is a shaly coal less than 0.15 m (1/2 ft) thick that is interpreted as the deposit of a salt marsh. Salt marshes are typically characterized by unevenly laminated, fine-grained sediments that are extensively rooted (Reineck and Singh, 1975, p. 359). The elevation of the marsh approximates high-tide level. Modern salt marshes contain salt-tolerant plants in a band seaward of the fresh-water or brackish marsh (Coleman and Gagliano, 1965, p. 146).

Above the salt-marsh deposit lies a layer of abundant broken oyster shells (Crassostrea) in sandy mudstone that grades upward into fine-grained, planar laminated sandstone. This represents the deposit of a washover fan and is similar to the wedge-shaped washover fans described by Andrews (1970, p. 45) on St. Joseph Island on the central Texas coast. Washover fans are formed by storms eroding sediment from the strandline and transporting it inland.

The deposit of the washover fan is unconformably overlain by rippled, wavy-laminated, sandy siltstone interbedded with very fine grained sandstone. The unit becomes sandier at the top and is interpreted as a crevasse splay. A crevasse splay forms where a natural levee of a distributary (fig. 5) is breached during a flood. Sediment transport through the crevasse typically increases through subsequent floods, though the crevasse will eventually heal (Coleman, 1976, p. 37).

The remaining part of the exposed section can be divided into four lithologic sequences. Each sequence consists of a variation from a generalizd sequence of shale, thin beds of rippled, wavy-laminated siltstone and sandstone becoming sandier at the top, and coal. These are interpreted as bayfill sequences (fig. 5.) in which the shale represents a bay deposit, the thin beds of wavy-laminated siltstone and sandstone represent the distal deposits of a crevasse splay, and the coal represents a swamp deposit. The initial deposit of the bay was mud; then distal deposits of splays from a nearby distributary sufficiently filled the bay with silt and sand to allow a swamp to become established and form peat. Subsequent local subsidence or decrease in sediment supply then resulted in a localized, minor transgression of the sea and reestablishment of the bay.

The coal beds in the bayfill sequences, except in the case of the Wadge coal bed, are overlain by distal splays. These distal splays have a remarkably sharp, even contact with the underlying coal beds (fig. 6). The even contact may be attributed to the following factors: (1) the deposition of peat in low, flat-lying areas so that the influx of sediment as distal splays occurs as a low-energy process and results in little erosion, (2) the toughness of peat deposits, which makes them difficult to erode, and (3) the compaction of peat by a factor of more than 5 to 1 as it forms coal (Weller, 1959, p. 302), which minimizes the irregularities of an erosional contact.

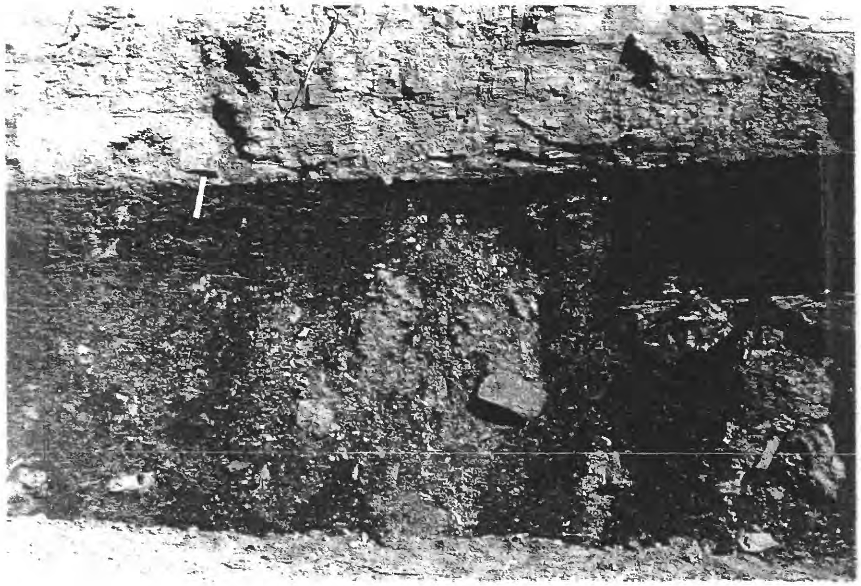


FIGURE 6.--DISTAL SPLAY ABOVE TOPMOST SPLIT OF WOLF CREEK COAL BED, EDNA MINE SECTION, SHOWING SHARP CONTACT.

At the start of the bayfill sequence of Cycle 1 (fig. 4), mud was deposited in a shallow bay. A swamp formed directly upon the bay mud, resulting in a deposit of peat. The peat was covered by siltstone and sandstone delivered as a distal splay from a nearby distributary and then the swamp reestablished itself and formed more peat on the distal splay. Distal splay deposits then alternate several times with swamp deposits. The coal which formed from the peat of the swamps in this cycle correlates with the Wolf Creek coal bed (Bass and others, 1955).

The bayfill sequence of Cycle 2 is similar to that of Cycle 1 except that there was less peat development in Cycle 2 than in Cycle 1 and the bay shales are thicker, representing a long period of quiet deposition. The shale contains Corbula undiffera, a brackish-water pelecypod. This bay was filled by the thick deposits of sandstone and siltstone of a distal splay, then a swamp formed and produced a thin layer of peat. The peat was covered by two successive distal splays.

The basal part of the bayfill sequence of Cycle 3 consists of a thick shale that contains the marine pelecypods Malletia evansi and Modiolus. It also contains Lingula, a shallow marine to brackish-water brachiopod. The bay was filled by a distal splay and covered by a swamp, which formed an exceptionally thick deposit of peat. The peat is preserved as the 2.4 m (8 ft) thick Wadge coal bed.

The Wadge coal bed is overlain by the bay shale of Cycle 4 rather than a distal splay like the other coal beds in the section. This indicates that the rate of local subsidence eventually exceeded the rate of peat accumulation. There were no outbreaks of sediment from the distributary and the bay was reestablished. The bayfill sequence of Cycle 4 contains evidence of a bay, a distal splay with Ophiomorpha, a swamp, and at least one more splay. The coal in this sequence is thin, but it may correlate with the Lennox bed of Bass and others (1955).

BEDDING PLANE EXPOSURE OF INTERTIDAL DEPOSIT AT MIDDLE CREEK ROADCUT

An excellent exposure of ripple marks in interbedded siltstone and sandstone at the horizon of the Lennox coal bed occurs about 5 km (3 mi) northwest of the Edna Mine section at the Middle Creek roadcut (fig. 1 and fig. 7-9). The roadcut exposure is nearly on a dip slope and displays several bedding planes, in contrast to the cross section view at the Edna Mine section. Several features of the ripple marks in the interbedded siltstone and sandstone indicate that the beds were deposited in an intertidal environment, and may represent a distal splay. First, the ripples are symmetrical, indicating formation by oscillatory flow induced by small waves of shallow water. Second, the ripple marks are flat-topped, indicating that they were planed by wavelets in shallower water that was about 5 cm (2 in) or less deep (Tanner, 1958, p. 96). This variation of water level is best explained as tidal. Third, associated with the ripple marks is <u>Arenicolites</u>, a marine to brackish-water trace fossil that is common along sandy shorelines (Crimes, 1975, p. 117). Fourth, a variety of ripple directions are preserved in the rocks including instances of two directions of ripple marks preserved in the same plane. The ripple marks exposed at the Middle Creek roadcut would appear as wavy laminations in a cross-sectional view, as in the Edna Mine section.

ACKNOWLEDGEMENTS

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FIGURE 7.--PANORAMA OF EXPOSURE AT MIDDLE CREEK. THICK CLIFF-FORMING SANDSTONE AT LEFT IS TROUT CREEK SANDSTONE MEMBER OF ILES FORMATION. ROADCUT EXPOSURE IS NEARLY A DIP SLOPE.

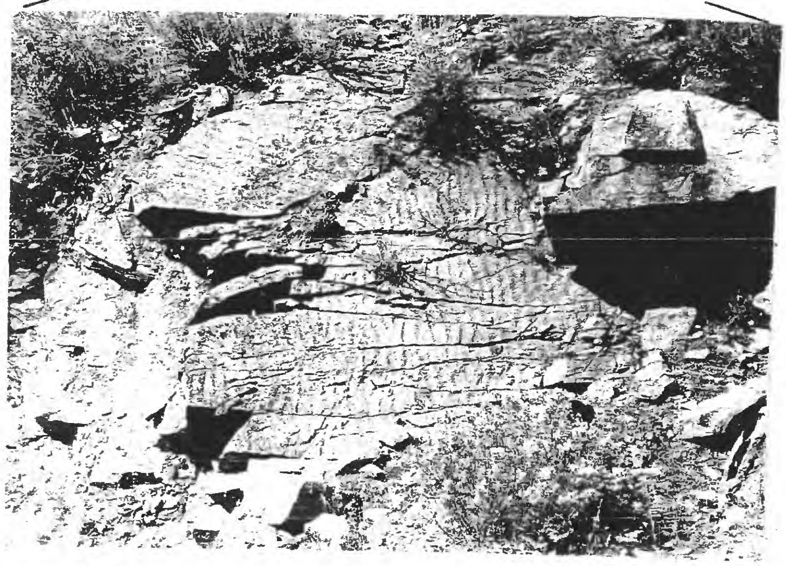

FIGURE 8.--AN EXAMPLE OF THE EXPOSED RIPPLE MARKS.

FIGURE 9.--CLOSEUP OF FLAT-TOPPED RIPPLE MARKS. BURROWS ARE CONCENTRATED IN TROUGHS.

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