

STRATIGRAPHY, FACIES, AND DEPOSITIONAL HISTORY OF THE FERRON SANDSTONE IN THE CANYON OF MUDDY CREEK, EAST-CENTRAL UTAH

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The Ferron Sandstone Member of the Mancos Shale is an eastward-thinning clastic wedge deposited during Turonian-Coniacian (Upper Cretaceous) time. Seven parasequence-level transgressive-regressive cycles are recognized in the Ferron. The delta-front sandstone bodies that define the cycles are characterized by an initial forward-stepping arrangement, followed by vertical-stacking and then back-stepping arrangements. This architecture indicates an initial strong supply of sediment relative to the creation of space within which sediment could accumulate, followed by near-balance and then a relative decrease in sediment supply. The upper part of the Ferron is well exposed along the length of the canyon of Muddy Creek, where facies relationships between delta-front, delta-plain, and alluvial-plain facies will be examined.

INTRODUCTION

Friday afternoon will be spent examining the stratigraphy of the Ferron Sandstone Member of the Mancos Shale in the canyon of Muddy Creek. The focus will be on the upper part of the Ferron Sandstone Member, which undergoes dramatic facies changes in this area. Predominantly shallow-marine facies interfinger southward with predominantly delta-plain and alluvial-plain facies. These changes are magnificently displayed on the canyon walls. There are few places where the complexities of these kinds of facies changes can be more clearly seen and better appreciated.

SYNOPSIS OF FERRON STRATIGRAPHY

The Ferron Sandstone Member of the Mancos Shale and equivalent portions of the Frontier Formation in northern Utah and Wyoming record a pronounced and widespread regression of the Western Interior Cretaceous seaway during middle Turonian through early Coniacian time (Figures 1 and 2). The relatively straight, north-trending western shoreline of the seaway had reached as far west as the Wasatch Range, the Gunnison Plateau, and the western side of the Markagunt Plateau during middle Turonian time (Williams and Stelck, 1975). As the shoreline prograded eastward during middle Turonian time, the shoreline configuration changed. Because of geographical variations in the subsidence rates and the volumes of sediment arriving from the Sevier Orogenic Belt, rates of progradation varied during the Ferron regression, being more rapid in northern and southern Utah, less rapid in central Utah.

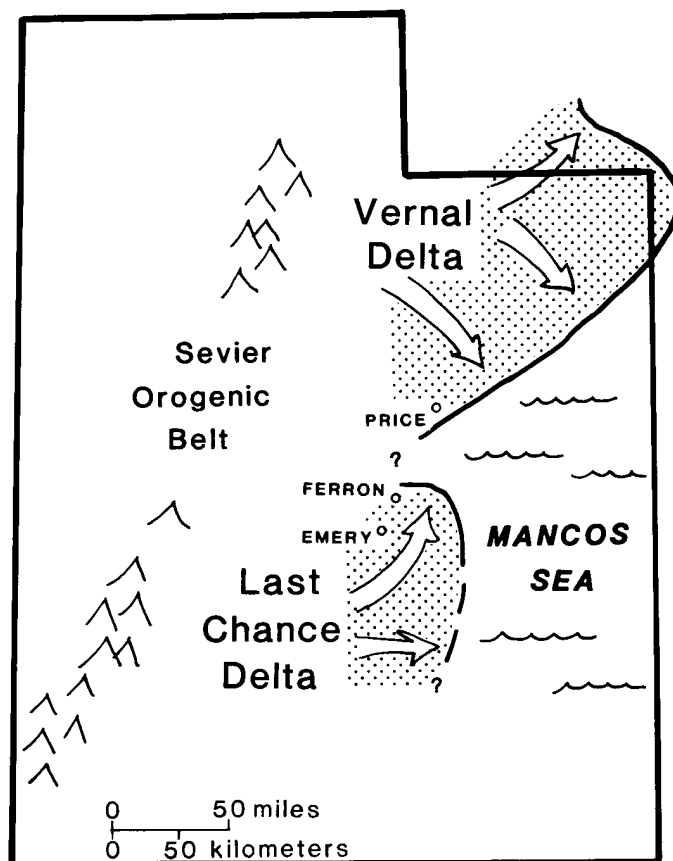
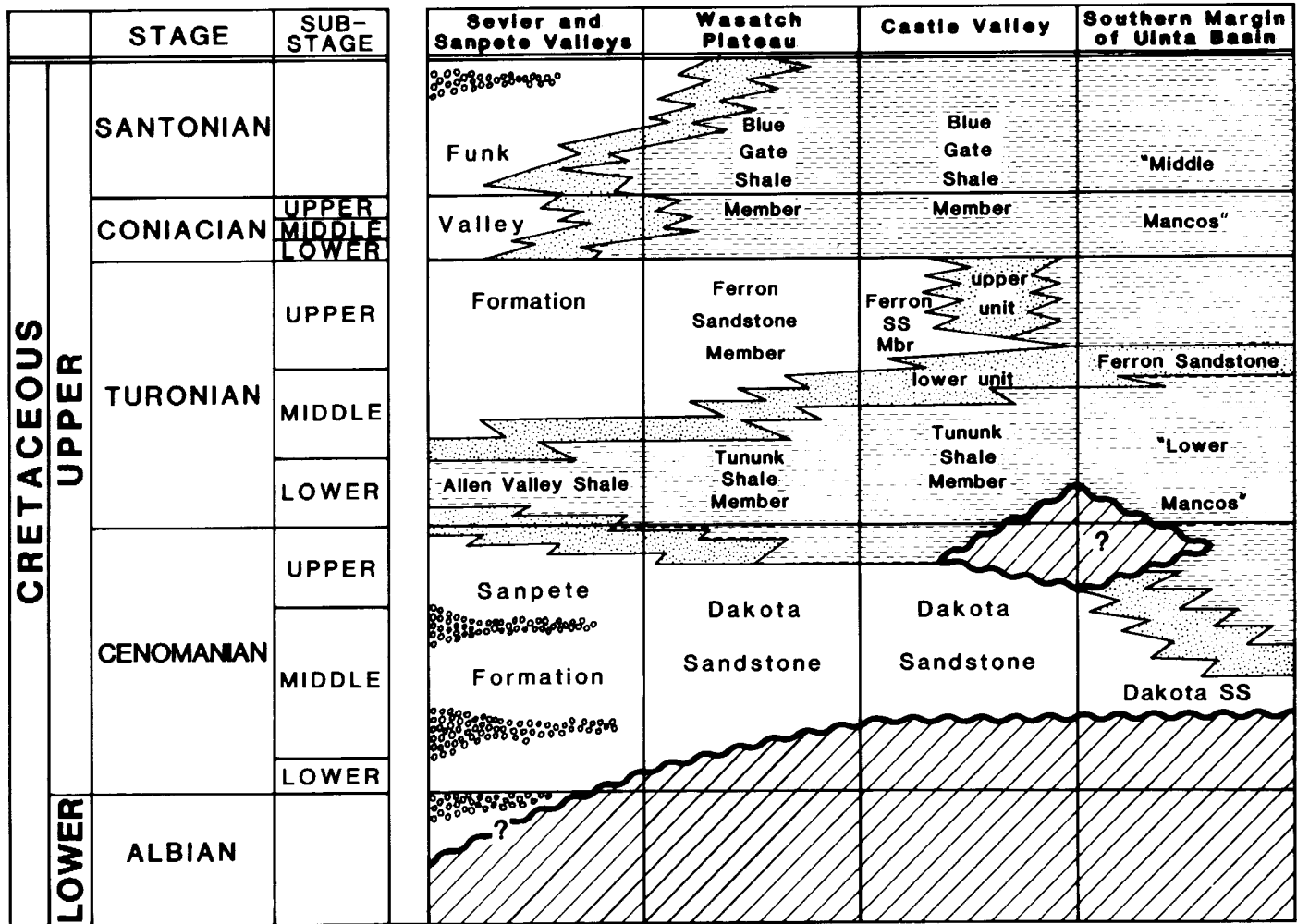


Figure 1--Map of Utah showing the general configuration of the shoreline during deposition of the Ferron Sandstone Member of the Mancos Shale and, in northern Utah, equivalent parts of the Frontier Formation.

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The result was a bend in the shoreline centering on the Castle Valley area. Hale (1972), and later Cotter (1975) interpreted the bulges of the shoreline as representing deltas, the Vernal delta to the north and the Last Chance delta to the south (Figure 1). Ryer and Lovekin (1986) argued that the embayment in central Utah was caused primarily by very rapid subsidence, i.e. that for a given volume of sediment, the shoreline was able to prograde farther in the more slowly subsiding areas that lay to the north and south, less far in rapidly-subsiding central Utah. The question of just what constitutes an ancient delta aside, all previous investigators have agreed that the Ferron in Castle Valley accumulated on a deltaic shoreline in a rapidly subsiding portion of the Cretaceous foreland basin.

Ryer (1981) recognized that the Ferron consisted of a series of stacked, small-scale transgressive-regressive cycles that can be defined in outcrop on the basis of cliff-forming delta-front sandstone bodies. Five major delta-front sandstones, numbered 1 through 5 in ascending order, plus two less widespread delta-front sandstones that are here

Figure 2--Correlation chart showing stratigraphy and ages of mid-Cretaceous strata in central and eastern Utah.

referred to as 6 and 7, were mapped. Each was found to have an associated coal bed. The coals carry letter designations originally assigned to them by Lupton (1916). Figure 3 shows the basic stratigraphy and facies architecture of the Ferron. Recent studies by Gardner (in preparation) document Ferron facies and stratigraphy in considerable detail.

An important aspect of Ferron facies architecture is that the configuration of the delta-front sandstone bodies changed through time. The oldest sandstone bodies, 1 and 2, are widespread and display little "stratigraphic climbing" in a seaward direction, i.e. they prograded during periods of slowly rising relative sea level. The intermediate units, 3 through 5, are less widespread and display larger amounts of stratigraphic climbing. Relative sea level rose more rapidly during their deposition. In fact, sea level appears to have risen at an increasingly rapid rate throughout the

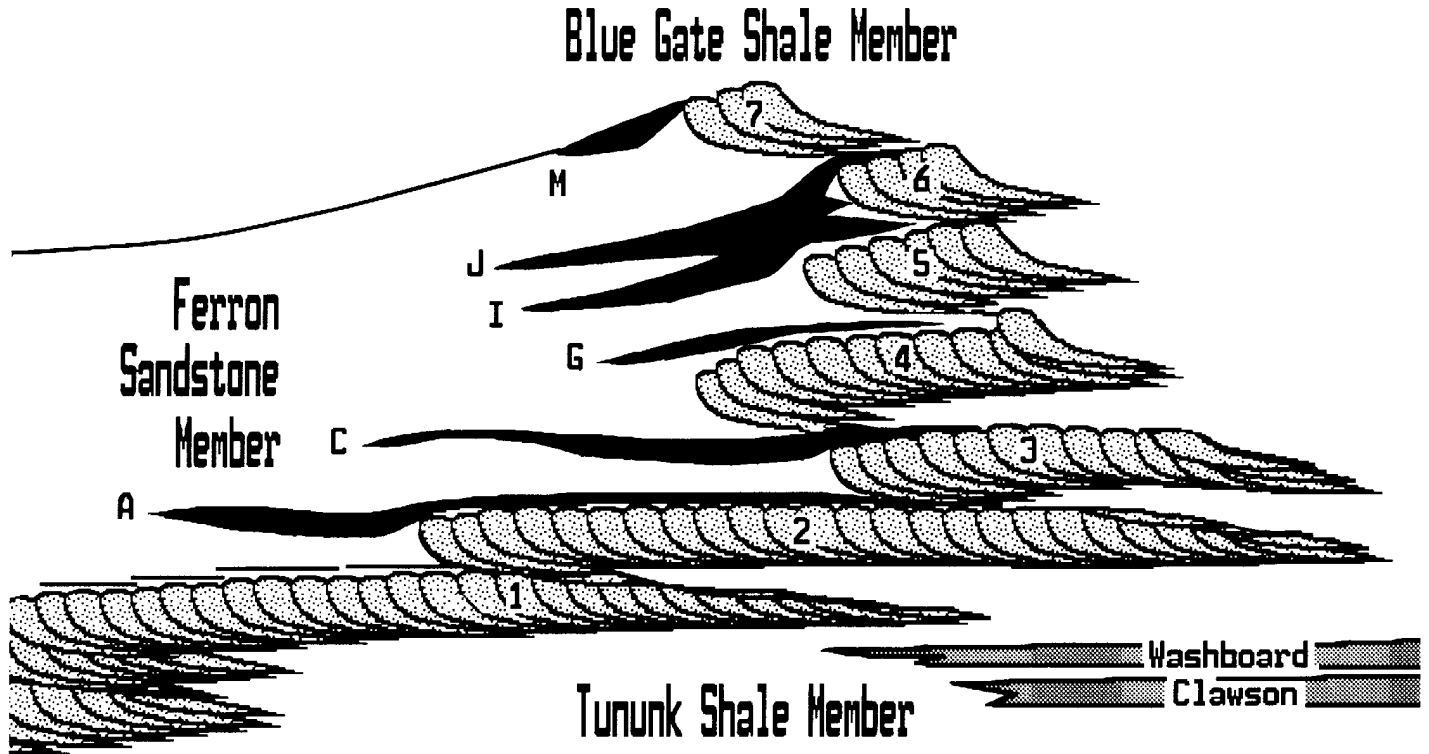


Figure 3 (above)--Diagram showing the basic stratigraphic architecture of the Ferron. Delta-front sandstone bodies (designated with numbers) and their associated coal beds (designated with letters) provide a means for recognizing and correlating transgressive-regressive cycles of deposition. The field trip will focus on the stratigraphy of delta-front sandstone bodies 5, 6, and 7 and correlative strata.

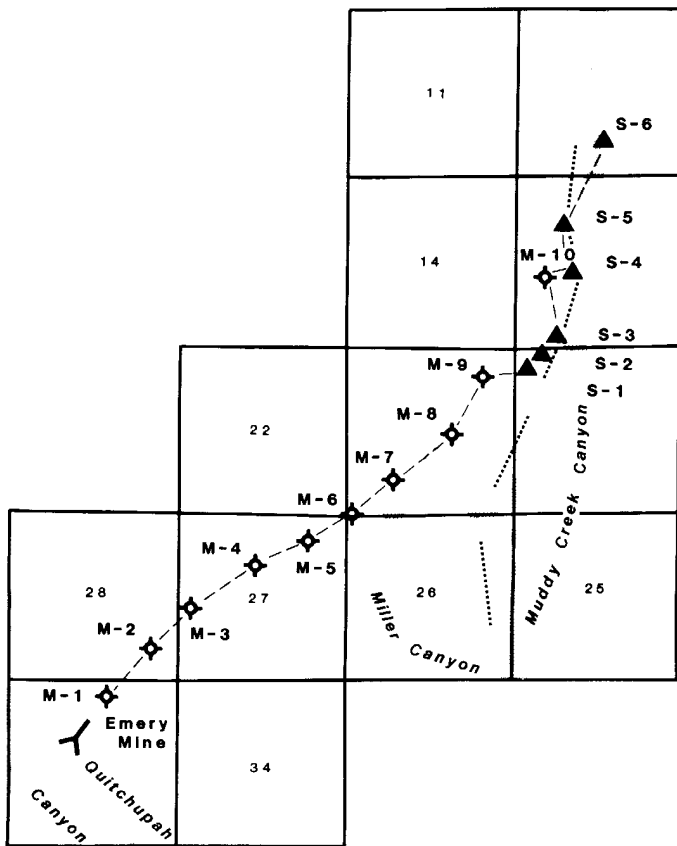


Figure 4 (left)--Map showing the locations of the principal canyons, locations and orientations of the cross sections presented in Figures 5 (cross-section location indicated by shorter dash pattern) and 6 (longer dash pattern), and the locations of outcrop sections and bore holes utilized in Figure 6.

time span represented by deposition of sandstone bodies 3 through 7, resulting in vertical-stacking and back-stepping arrangements. Sandstone bodies 6 and 7 display extreme "stratigraphic climbing" and prograded only short distances. Seven is displaced considerably landward from 6. The rate of rise of relative sea level during deposition of these units was so rapid that the sediment supply was just barely sufficient to result in progradation.

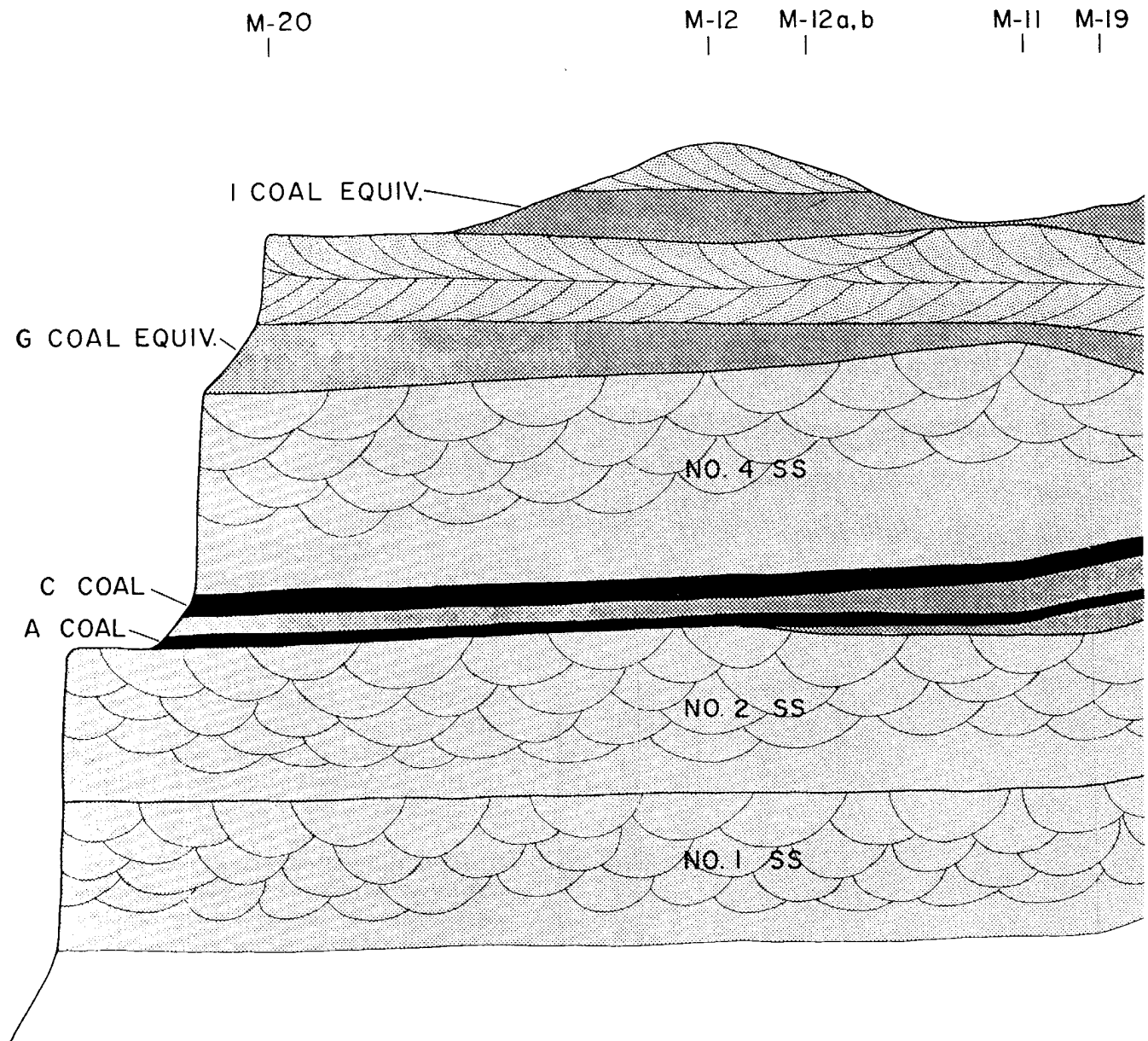
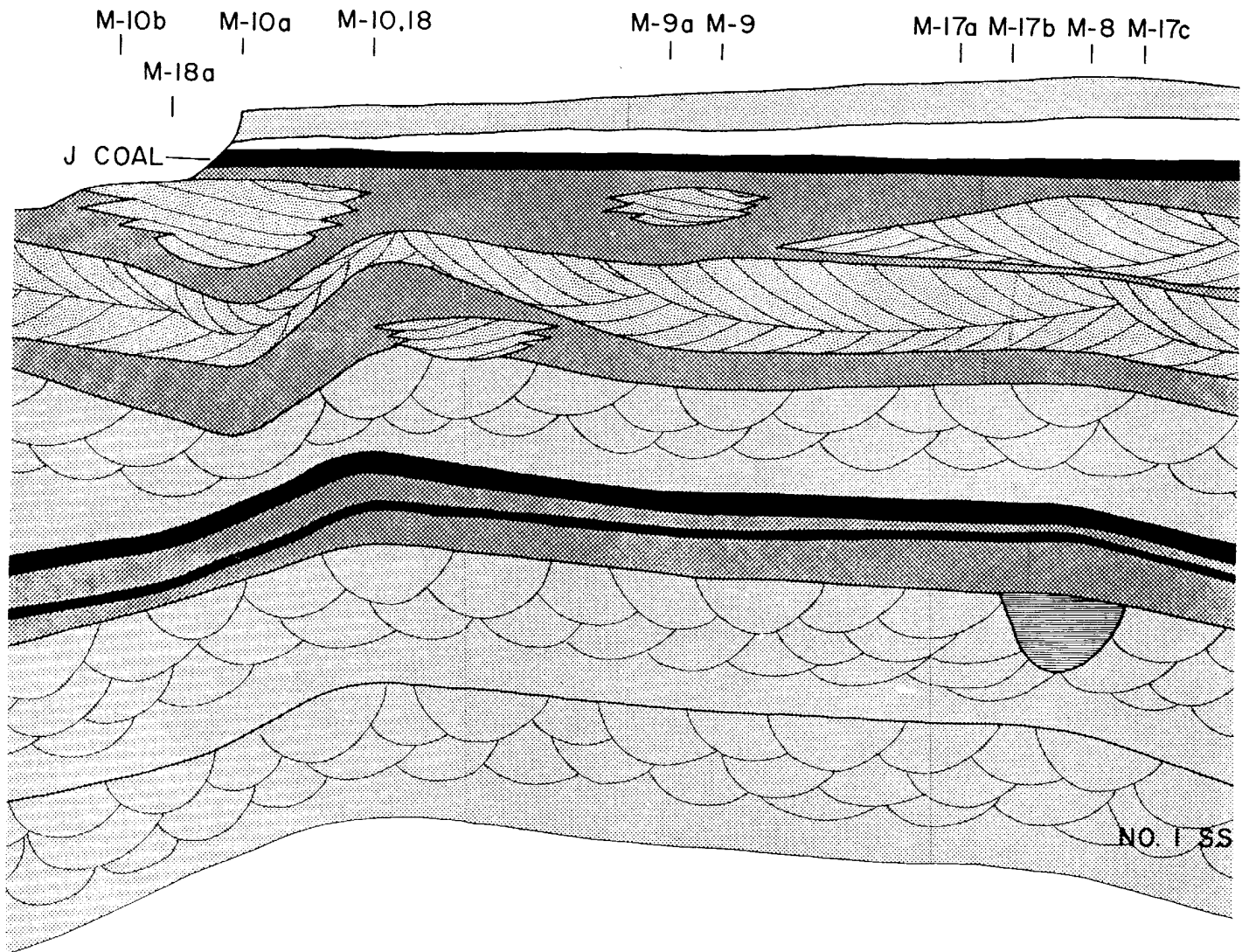


Figure 5--Cross section showing Ferron stratigraphy along the west wall of Muddy Creek canyon. It was compiled from a series of photomosaics augmented by measured sections, whose locations are indicated by the numbers along the top of the cross section.

Progradation of sandstone body 7 was terminated by an abrupt and continuous transgression of the Blue Gate sea, bringing Ferron deposition to a close. The transgression ultimately pushed the shoreline westward to the eastern side of the Wasatch Range, the western side of the Wasatch Plateau, and the eastern side of the Kaiparowits Plateau in Coniacian time.

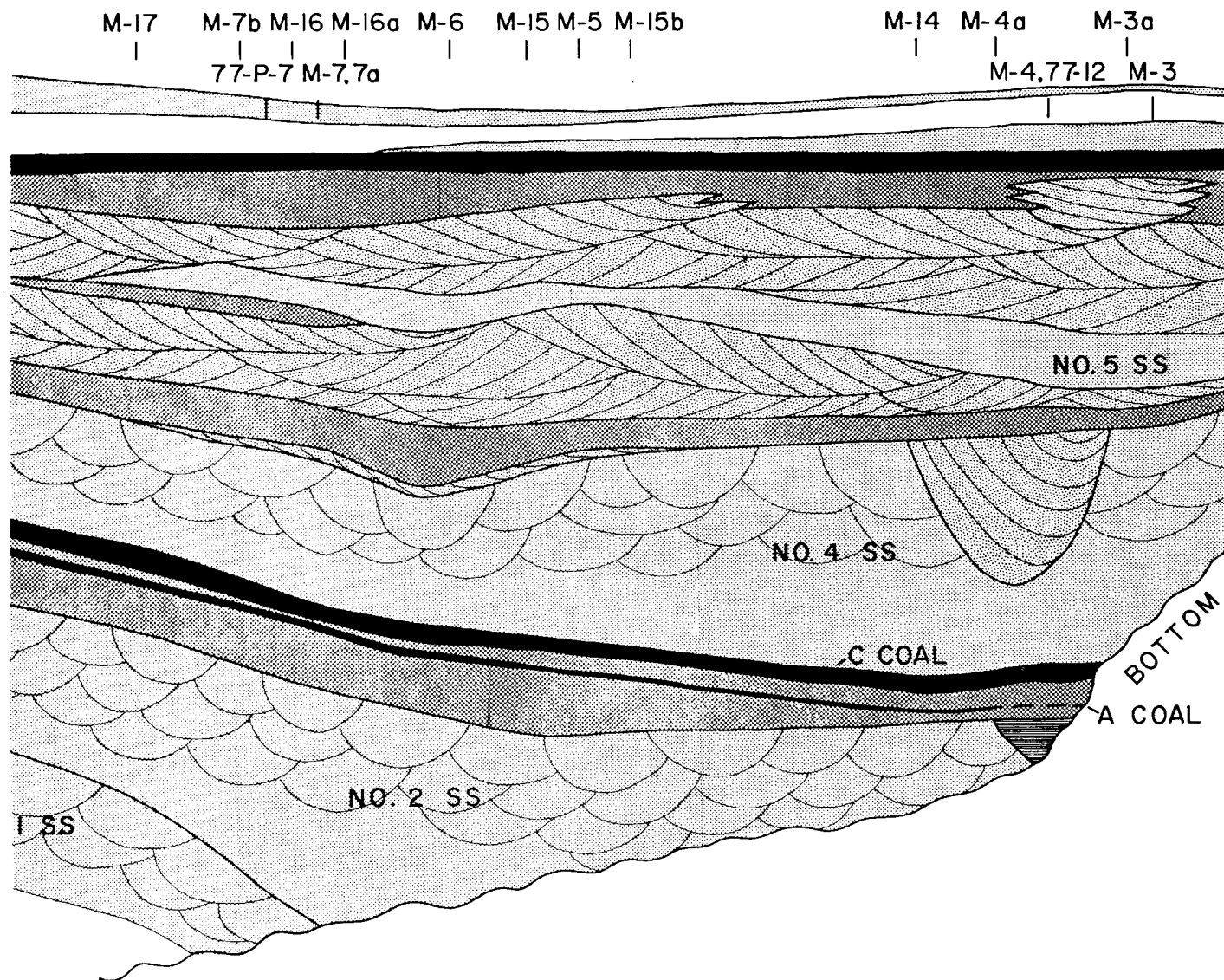
CANYON OF MUDDY CREEK

The field party will enter the canyon where Muddy Creek crosses the Blue Gate Shale/Ferron Sandstone contact and first cuts the top of the Ferron. At the point where the group will leave the canyon, the entire Ferron section as well as the upper part of the Tununk Shale are exposed in its walls. Figures 4, 5 and 6 present the details of Ferron stratigraphy in the area of interest. There are many things to see along the walls of the canyon of Muddy Creek and a running commentary will be offered during the hike. The group will pause for extended discussions at the following stops:



Stop 1--Williams mine. Coal of the J seam was removed at three small mines in this vicinity. At the northernmost of these, the Williams mine, the J coal overlies a well-sorted, white-weathering sandstone. The lower part of the sandstone unit is planar laminated and was deposited in a middle shoreface paleoenvironment; the upper part is multi-directionally cross-stratified and records upper shoreface deposition. The top of the shoreface sequence is rooted and is overlain by bioturbated, carbonaceous sandstone followed by coal of the J seam. The coal bed is, in turn, overlain by a thin transgressive lag at the base of the Blue Gate Shale.

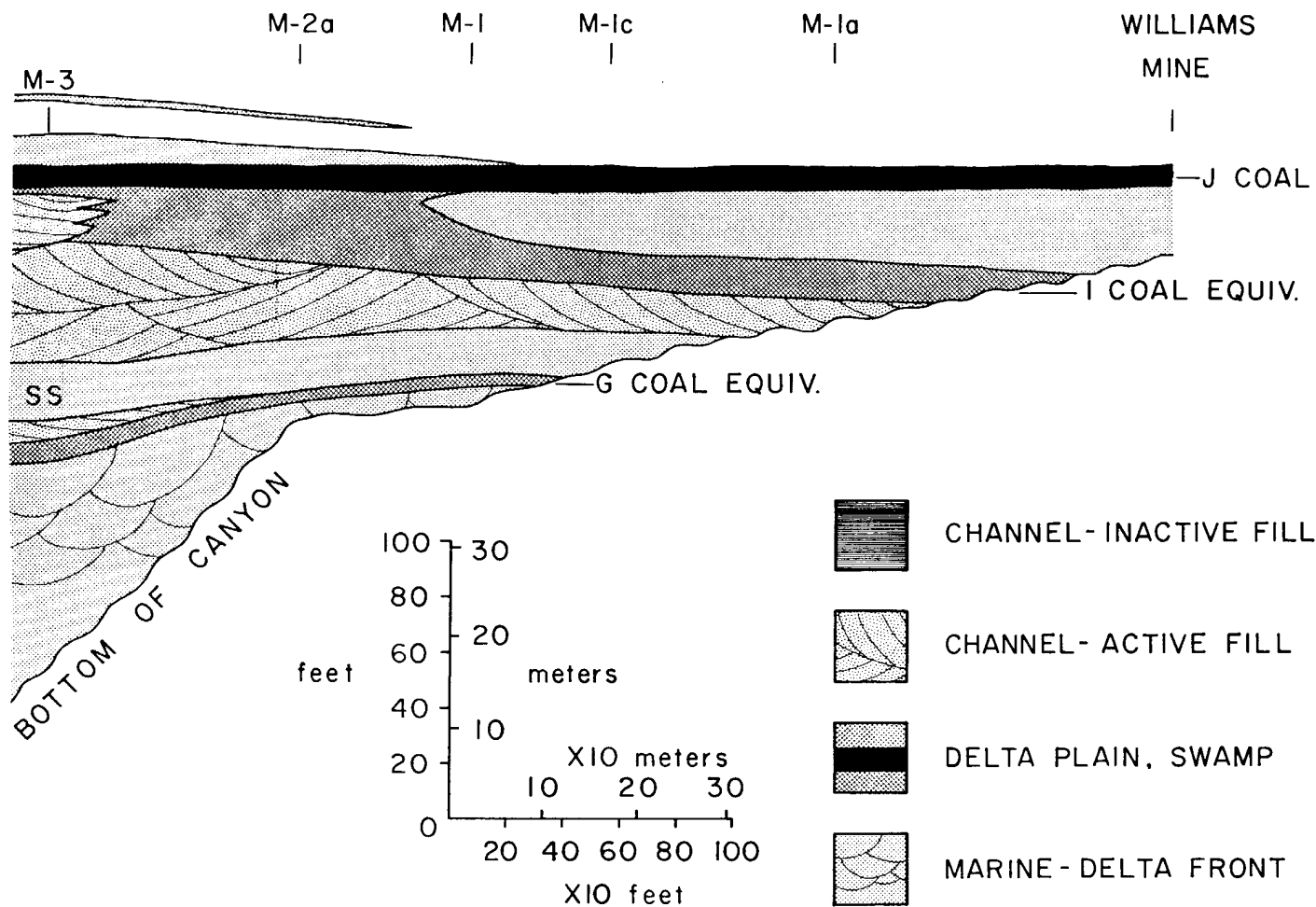
Stop 2--Pinchout of No. 6 sandstone. The landward pinchout of the shoreface sandstone beneath the J coal seam is superbly exposed on both sides of the canyon and on the walls of a tributary canyon to the east. The shoreline trended approximately northwestward. The transgression forced the shoreface landward across coastal swamps and forests. Some of the larger trees remained standing in the surf zone and were buried in sand when the shoreline prograded. These trees can be observed standing vertically in the immediate vicinity of the pinchout.



Two sandstone units, neither of which were present at the Williams mine, occur above the J coal bed here. The lower of the two directly overlies the coal with an abrupt contact. It is medium-grained, trough cross-stratified, and moderately bioturbated; it reaches a maximum thickness of about 10 ft (3 m). The sandwaves that produced the cross-stratification migrated toward the southeast. This sandstone body probably represents the downdrift edge of a spit or possibly a shelf sand "plume" derived by erosion of the shoreline somewhere toward the northwest during the transgression that flooded the J peat swamp. The sandstone is very localized in the depositional dip direction, thinning and disappearing about a mile south of here.

The upper of the two sandstone units lies enclosed in marine mudstone about 10 ft (3 m) higher in the section. It consists of planar laminated and hummocky cross-stratified, very fine to fine-grained sandstone and represents the seaward featheredge of the No. 7 sandstone. It is contorted into ball-and-pillow structures locally.

Stop 3--Unnamed coal mine. The No. 4 delta-front sandstone has been eroded and replaced by a sandy meanderbelt. Differences in sorting and clay content of the two sandstone types result in considerably different styles of jointing, which, together with color differences, facilitates distinguishing the two sandstone types. Considerable



erosional relief can be recognized at the base of the meanderbelt.

Stop 4--Horseshoe bend. Cutting ever deeper into the Ferron Sandstone down-canyon, Muddy Creek has here exposed the No. 1 and No. 2 sandstone units. No. 2 is distinguished by its very flat top and local development of a "white-cap."

No. 3 is absent here, the transgression that preceded its deposition never having reached this point. (It pinches out in the same fashion as does the No. 6, but the pinchout occurs to the northeast and cannot be seen here.)

No. 4 is represented by river mouth-bar facies characterized by lensey sandstone bodies with erosional bases and, locally, inclined bedding representing the sloping front and flanks of the mouth bars themselves.

No. 5 has been completely removed here by the meanderbelt deposit we examined in detail at the last stop. Data from nearby outcrops and wellbores indicates that we are very near the position at which No. 5 pinched out landward.

The unit of sandstone and siltstone that separates the I and J coal zones was deposited in a bay or lagoon situated landward of the No. 6 shoreline at peak transgression,

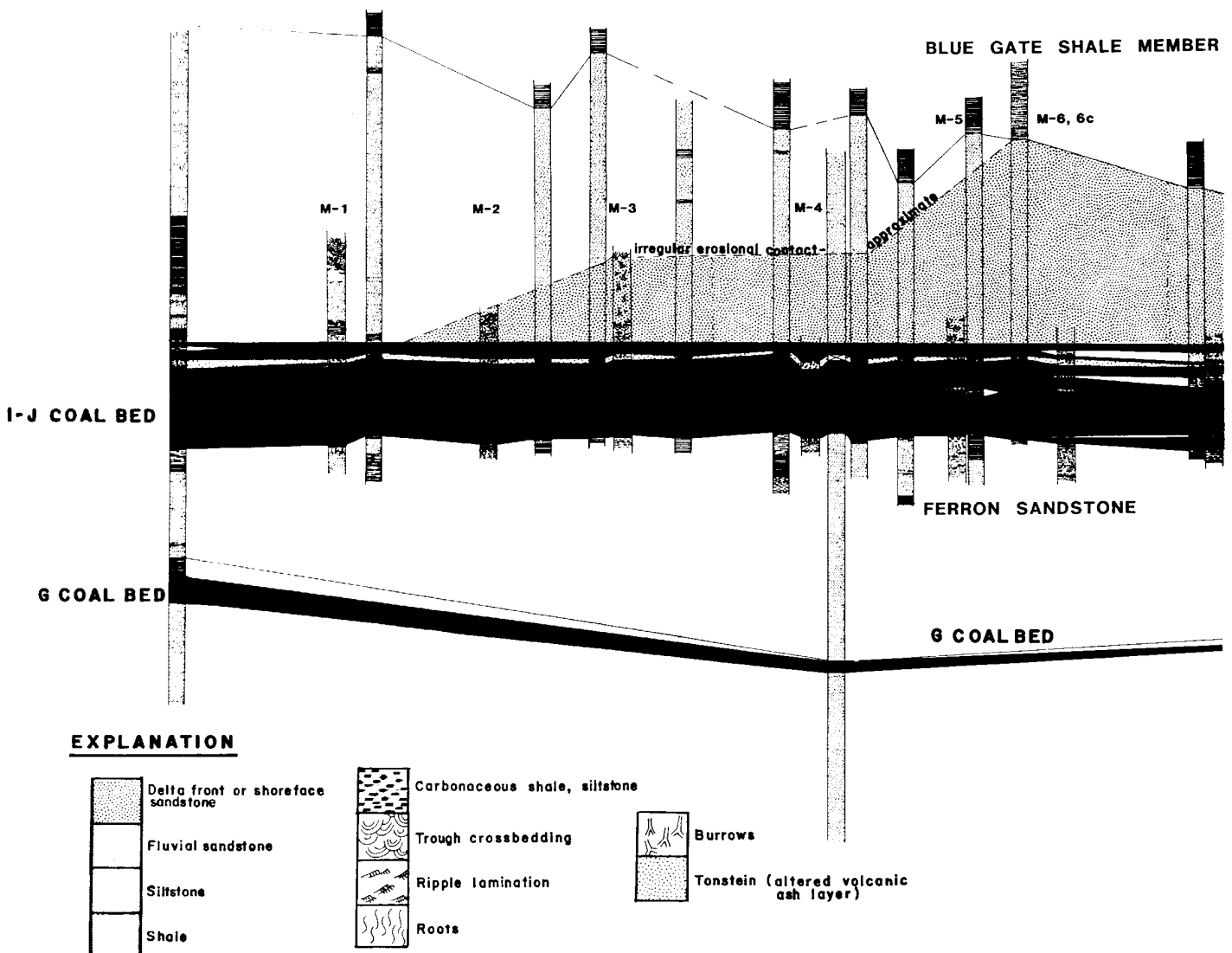


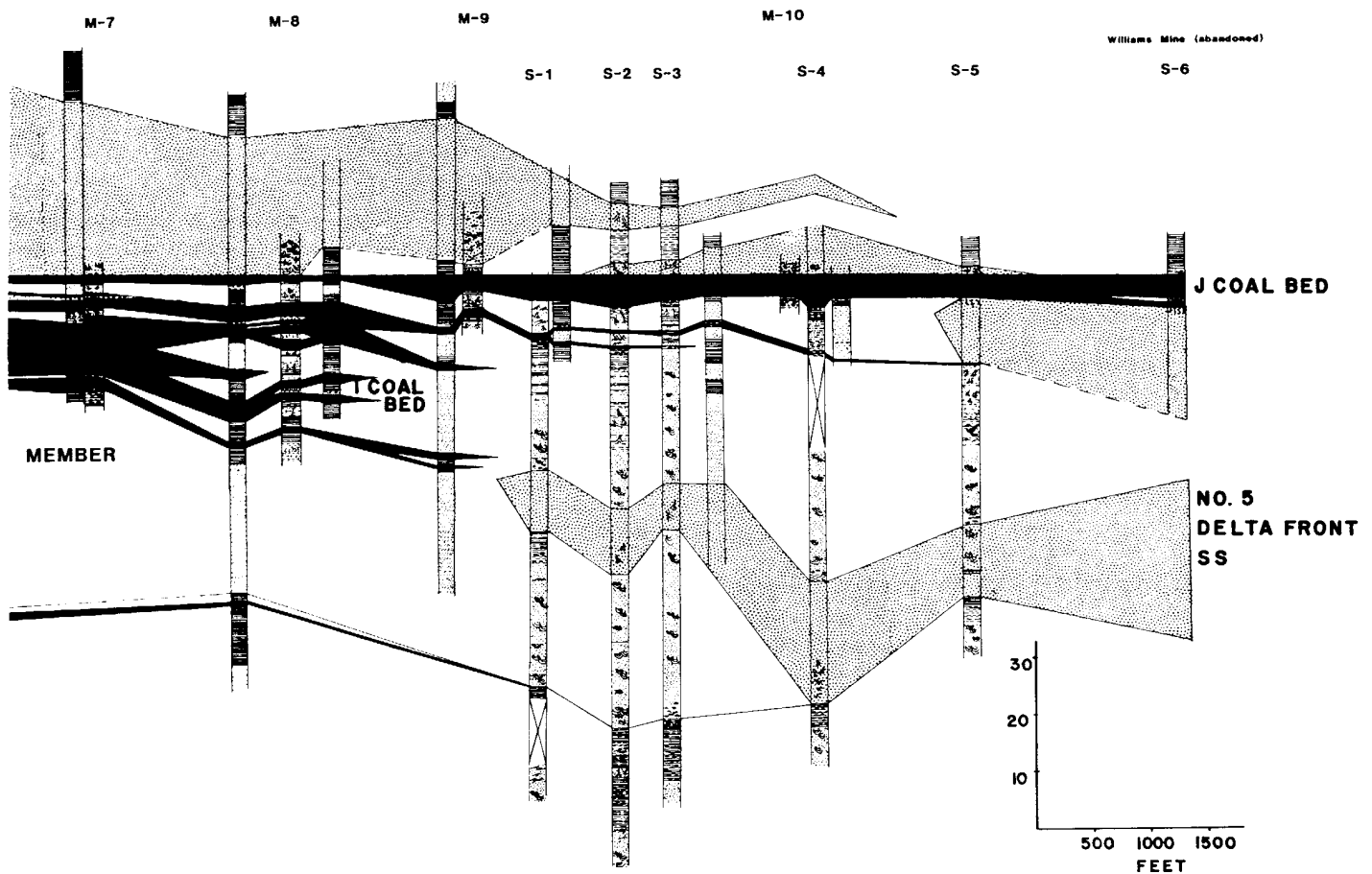
Figure 6--Cross section showing detailed stratigraphy of the uppermost part of the Ferron from the upstream part of Muddy Creek canyon and in the subsurface along the base of the Ferron dip slope southwestward to the Emery mine. Subsurface sections labelled M- and Q- represent cores cut in holes drilled by the U.S. Geological Survey. Unlabelled sections are based on data from bore holes drilled by Consolidation Coal Company; their locations, not shown on Figure 4, are projected into the line of section.

probably at about the time the trees seen earlier were being buried. The J peat swamp was established directly on top of the bay- or lagoon-filling sequence and subsequently extended northward onto the top of the No. 6

sandstone as the facies tract prograded.

Hummocky cross-stratification is well displayed by the No. 7 sandstone, which has grown thicker southward. Note that the medium-grained sandstone that directly overlies the coal to the north is absent here.

Stop 5--Sandstone pillows. These soft-sediment deformation features formed as the No. 6 sandstone foundered into mudstone of the underlying tongue of the Blue Gate Shale. The J coal bed is undisturbed. Sandstone pillows occur elsewhere in the Ferron, but they are nowhere so common as here. Why this should be so is not at all clear; there is



nothing unique about the stratigraphy or arrangement of facies in the area affected. It is tempting to propose some rare event--perhaps an earthquake associated with movement on one of the faults of the Sevier Orogenic belt to the west triggered the deformation.

Stop 6--Overview of Ferron section. The entire section can be seen in this segment of the canyon, and a summary of the Ferron stratigraphy will be presented before heading for the vehicles. Of particular interest here are curved, sloping, convex-up surfaces in a sandstone that locally underlies the No. 1 delta-front sandstone. The sandstone occurs in blocks that are interpreted to have slumped

seaward from the front of the No. 1 deltaic shoreline; the curved, landward-dipping surfaces represent originally horizontal beds deformed as the slump blocks rotated on their glide surfaces (small-scale listric faults.)

Stop 7--Near the head of Miller Canyon. A 70-foot-thick meanderbelt sandstone unit can be observed toward the south, on the divide between Miller Creek and Muddy Creek canyons. Lateral to it, at the small corral and extending southwestward to the Emery mine, there is 20 ft (6 m) or more of coal in the I coal zone. It appears that the peat swamp did a very effective job of holding the river in its course for a considerable period of time in this immedi-

ate area. While the I coal lies lateral to the meanderbelt, the J coal overlies it, demonstrating that this meanderbelt fed the No. 6 delta front.

Stop 8 (optional)--Emery mine Directly overlying the combined I and J coal beds at the Consolidation Coal Company's Emery mine is a thick meanderbelt deposit in which at least three vertically stacked pointbar sequences can be recognized. The stratigraphic position of this meanderbelt, above the J coal and beneath the Blue Gate Shale, indicates that it fed the No. 7 sandstone. Just a few hundred yards to the north, remnants of the No. 7 sandstone can be found separating the fluvial sandstone from the coal, indicating that the shoreline had transgressed across this area prior to progradation of the No. 7 deltaic complex. Note the *Ophiomorpha* burrows in the top of the fluvial sandstone beneath the contact with Blue Gate Shale.

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