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EARLY CRETACEOUS MUDDY SANDSTONE DELTA OF WESTERN WIND RIVER BASIN, WYOMING

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INTRODUCTION

The Muddy sandstones in the western Wind River Basin were deposited in a thin, but well-developed delta system during Early Cretaceous Albian time. Open marine Skull Creek shales grade upward into the lower marine Muddy sandstones (Fig. 1). The depositional surface was raised to sea level by deposition of 65 feet of prodelta sediments and delta-front sandstones at the northwest seaward edge of the delta. Progradation of delta plain deposits then covered these delta-front sandstones. Rapid subsidence allowed preservation of most Muddy sedimentary rocks in the northwest part of the study area, but a lesser rate of subsidence or slight uplift to the southeast allowed progressively deeper erosion, resulting in two intraformational unconformities. The lower marine deposits were eroded deeply by rivers of the delta plain and most of these lower marine sedimentary rocks southeast of Lander were removed (D of Fig. 2). The delta plain was successively covered by two main facies: 1) fluvial channel sandstones and 2) flood plain deposits. The Fluvial sandstones, deposited in a northwest-flowing river system, terminate to the northwest (C of Fig. 2). The overlying flood plain deposits are truncated southeastward (upstream) (F of Fig. 2) by erosion at the base of the overlying transgressive beach deposits. Progressive onlapping by beach and nearshore deposits of the middle marine Muddy sequence subsequently buried the older delta system (Fig. 1). The unconformity at the base of the beach deposits cuts progressively deeper into underlying delta plain deposits to the southeast, where reworked beach sandstones were deposited directly on the fluvial sandstones of the delta plain. A second, or upper, marine sandstone and shale sequence buried the delta to the southeast. Northwest of line H (Fig. 2) the sandstones grade seaward into marine shales.

This complex depositional history resulted in preservation of only 50 to 75 feet of Muddy sandstones which lack widespread internal correlation markers. Reconstruction of the depositional history over a sizable area is difficult and not without controversy. Fortunately, the subject area affords a unique combination of data including: abundant well control allowing gross correlations; outcrops for interpretation of depositional environments; and a recognizable sequence of preserved depositional environments. This unusual combination of evidence allows for interpretation of the depositional history for the Muddy sandstones in the western Wind River Basin. Throughout much of Wyoming, however, critical evidence of the depositional history is missing. For example, in most outcrops of central, southern, and eastern Wyoming the lower-marine rocks are absent; the fluvial sandstones are only locally present in the lower parts of the paleotopography; and the flood plain deposits of the delta plain are absent. In these areas, the bulk of the preserved Muddy section is composed of the middle and upper transgressive marine sandstones over a basal unconformity. In these areas the delta concept is of little value.

NOTE: Exhibits 1, 2, 3, 4 are enclosed in the back pocket.

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ACKNOWLEDGEMENT

The outcrops described in this paper were initially studied by the author during the summers of 1957 and 1958, as part of a doctoral thesis study at Princeton University (Curry, 1960, 216 p.). Fossils collected in the field study were identified and analyzed to determine their paleo-environmental significance. The results of this aspect of the field work have been previously published (Curry, 1962, pp. 118-123). The most useful conclusion of that paper, regarding Muddy depositional environments, was:

> "As in the Fall River member, the most abundant fossils of the Muddy member are the evidences of tracks, trails, and burrows (spoor). The spoor is consistently associated with other marine fossils, and is absent in the non-marine facies."

The above conclusion is the key to interpretation of marine versus non-marine depositional environments for outcrops and cores in the Lower Cretaceous of Wyoming.

In May, 1969, the author re-examined the Muddy outcrops between wells I & P (Fig. 3), and postulated a deposi-

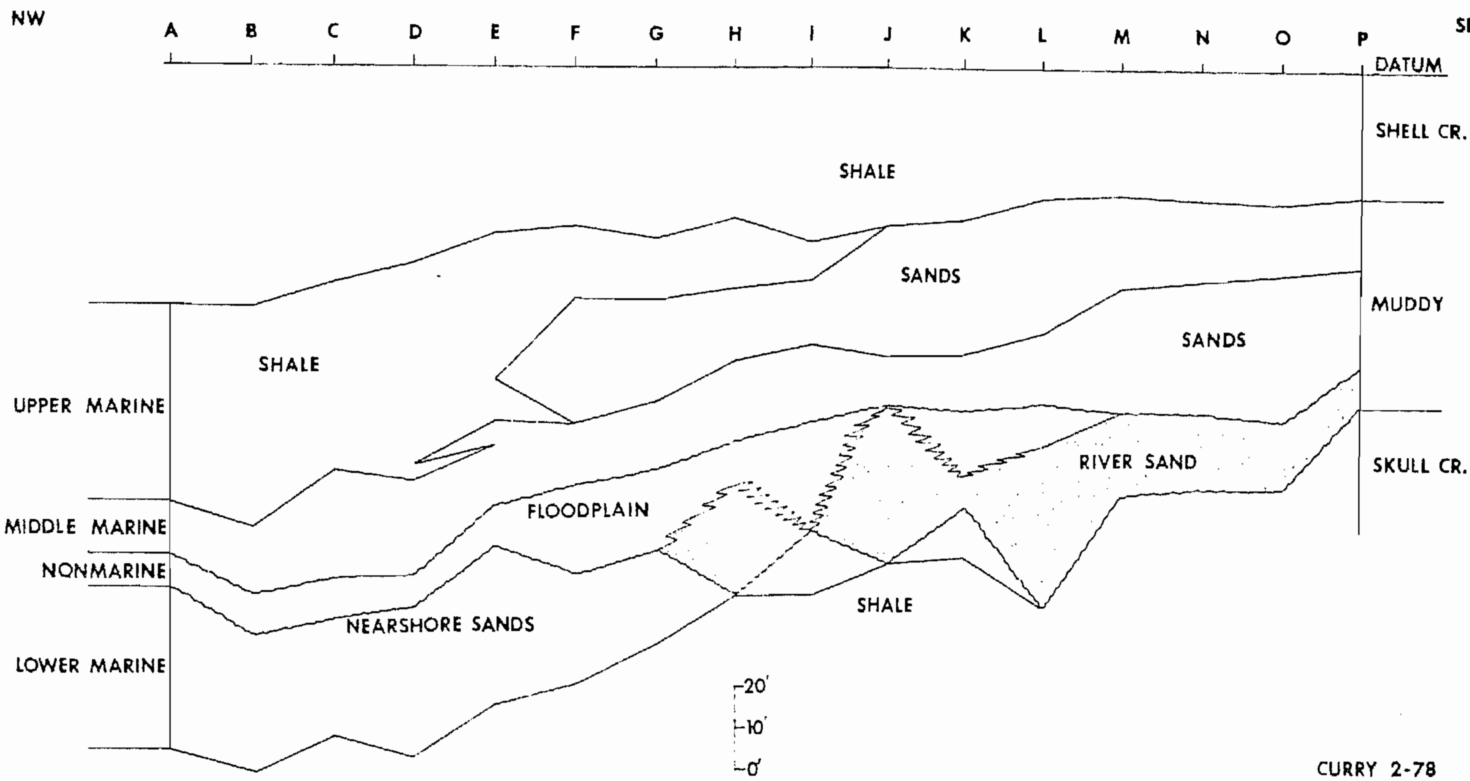


Figure 1. Controlled Diagramatic cross-section A-P of Muddy Delta, showing the vertical and horizontal limits of different depositional units which characterize the ancient delta.

tional sequence. An experienced group of geologists viewed the outcrop evidence, considered the author's interpretation, and largely accepted the suggested sequence.

In 1974, the author participated in the WGA Muddy Sandstone Field Conference in the Wind River Basin, led by Hugh W. Dresser, and found good agreement on many interpretations of specific depositional environments (except for Dresser's lagoonal facies).

Following this field trip, Dresser published 142 measured sections in the Wind River Basin. These sections were not correlated; however, Dresser recorded the presence and type of burrows in great detail. Using this author's previous conclusion that burrows are typical of marine (including brackish) Lower Cretaceous sedimentary rocks, Dresser's published sections were used to classify the rocks as marine (burrows present), non-marine (burrows absent), and one mixed facies, where root zones and burrowing co-existed. It is suggested that the absence of marine burrows and presence of root zones and paleosoil horizons as described by Dresser's sections, characterizes the non-marine delta plain deposits which divide the Muddy into the upper and lower marine sequences. This analysis conforms with the author's outcrop studies between wells I and P (Fig. 3) and has been expanded northwestward on the basis of Dresser's outcrop descriptions. The author acknowledges the use of Dresser's excellent published sections, but accepts full responsibility for the correlations and interpretations presented here. Exhibits 1 and 2 are generalized outcrop cross-sections based on Dresser's published measured sections.

LOG CROSS-SECTION

Well logs allow the correlation of the upper and lower boundaries of the Muddy Formation and adjacent sedimentary rocks (Exhibit 3). The location of the cross-section in Exhibit 4 is shown on Figure 3 and the location of all wells used in this paper are listed in Appendix A. No horizontal scale was employed in this cross-section. The cross-section is hung on a datum bentonite in the Shell Creek shales above the Muddy.

The upper contact of the Muddy is clearly defined in logs L through P (Exhibit 3). Northwest of log G (Fig. 3), the upper Muddy is present as a shale facies, making placement of the Muddy top difficult.

The base of the Muddy is uniform and conformable with the underlying Skull Creek on all logs in this area. This consistent relationship is in contrast to the unconformity recognized between the Muddy and Skull Creek over much of Wyoming. Explanation and interpretation of the uniform lower contact of the Muddy is not possible from

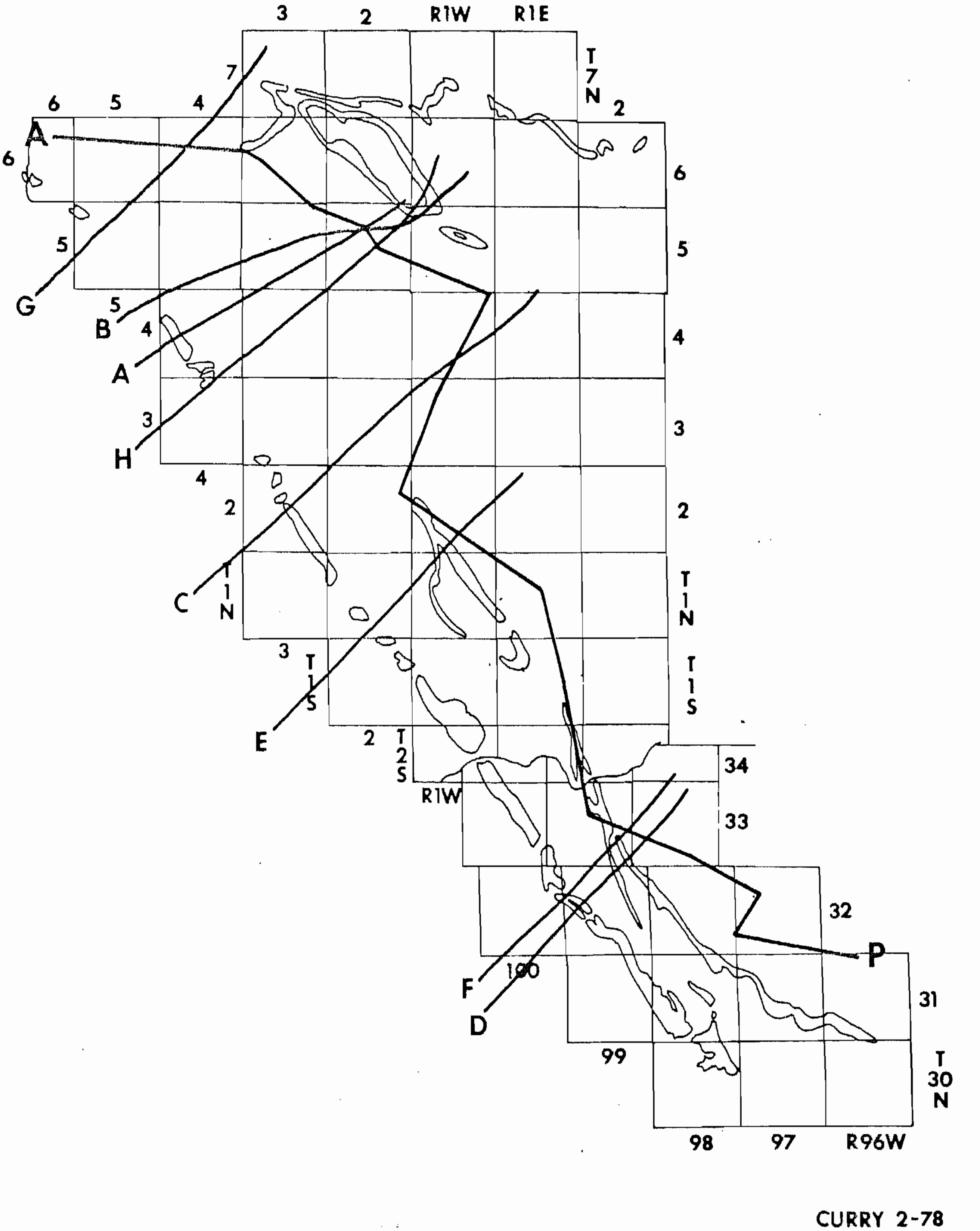
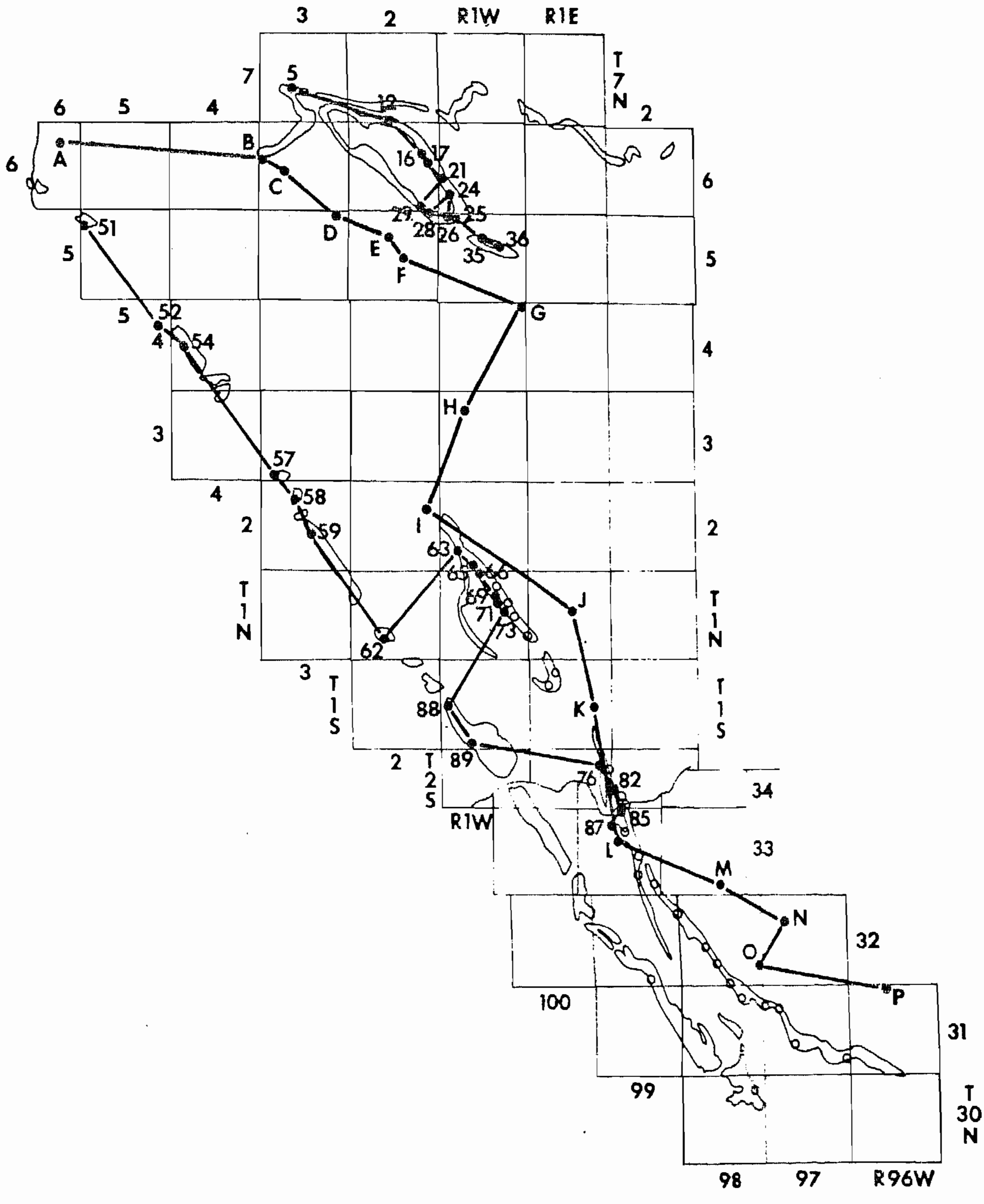


Figure 2. Geographic limits of the depositional units of the Muddy Delta based on outcrop and well log data. A marks the trend of maximum lower marine sandstone development; B is the seaward (northwest) edge of the lower flood plain deposits; C is the seaward edge of thick fluvial sandstones; D is the landward (southeast) edge of the lower marine deposits; E is the landward edge of the thin marine tongue in the middle of the flood plain deposits; G is the seaward edge of the upper marine sandstones. Diagramatic cross-section A-P (Fig. 1) and the Muddy outcrops are also shown.



CURRY 2-78

Figure 3. Shows outcrop and well control used (location in Appendix A, B, C) in this study and the locations of the four cross-sections presented (Exhibits 1, 2, 3, 4,).

logs alone.

Since the vertical scale of the logs shown on Exhibit 3 is small, the same logs and correlations are blown up in vertical scale in the diagramatic cross-section (Fig. 1). All vertical scales and correlation lines of Figure 1 are accurately taken from Exhibit 3 (no horizontal scale).

OUTCROP CROSS-SECTION

Although logs are useful in defining the upper and lower boundaries of the Muddy, as well as the upper facies change, they don't afford diagnostic information fundamental to the interpretation of the depositional history of the rocks. Accordingly, Dresser's published measured sections have been incorporated into a cross-section of Muddy outcrops (Exhibit 1). Logs indicate the base of the Muddy to be uniform, so this lower contact is used as a datum on the southeast part of this outcrop cross-section. Since the thin, marine tongue between outcrops 52 and 65 is interpreted to have been deposited near sea level, its base has been used as a second datum for the northwest part of the cross-section. The base of the Muddy is exposed in most sections, but the upper contact is rarely exposed. The location of Dresser's published measured sections used in this paper are shown on Figure 3 and listed in Appendix B. The outcrops studied by the author are listed in Appendix C and shown on Figure 3 as open circles.

PRODELTA AND DELTA FRONT SANDSTONES

Outcrops display a uniform lower Muddy contact, grading upward from open marine Skull Creek shales into prodelta marine sedimentary rocks. These lower Muddy rocks are characterized by ripple lamination, thin sandstone lenses, minor scouring, thin laminations, fine grain size, interbedded gray shales, and rare low angle cross-laminated sandstones. The marine brachiopod *Lingula* is found in these rocks, associated with U-shaped burrows (outcrop "x"), vertical sand filled tubes (outcrops "m" & "r"), and abundant horizontal burrows along bedding in most outcrops. This lower marine member appears to have been completely eroded at outcrop "a". The thin prodelta deposits are generally inconspicuous below the thicker more resistant delta plain sandstones. On the northwestern marine side of the delta, however, thicker delta front sandstones are present, as at outcrops 24, 25, 26, 28, 29, 52 and 54. Dresser's detailed measured sections in the northern part of the study area give the best description of these prodelta and delta front facies. At outcrop 29, Dresser (1974, p. 12) interprets the main lower marine Muddy sandstone as a "shoreline sandstone" and observes that this sandstone pinches out to the northwest. Outcrop cross-section 5-36 (Exhibit 2) shows the stratigraphic changes within the lower marine Muddy. Well log cross-section B-G (Exhibit 4) shows the subsurface log expression of the same. The thicker sandstones on outcrop correlate with the thicker sandstones of log E (Exhibit 4) and a northeast-southwest trend of thicker delta front sandstone is shown as trend A on Figure 2. This same relationship was noted by Dresser (1974, p. 14) and outlined as a belt of "shoreline sandstone." The author agrees with Dresser's previously published interpretation of the lower marine Muddy in this area.

DELTA PLAIN DEPOSITS

At outcrops 25 and 29 of Exhibit 2, Dresser (1974, p. 12) interprets the rocks above the lower shoreline sandstone to be lagoonal deposits capped by a shoreline sandstone. This author subdivides Dresser's lagoonal and shoreline sandstone sequence and presents a somewhat different interpretation of the depositional environments.

The sedimentary rocks deposited above the lower marine prodelta and delta-front deposits are interpreted to represent non-marine delta plain sediments. The delta plain deposits have three main elements: 1) a basal unconformity overlain by; 2) fluvial channel sandstones in turn overlain by; 3) flood plain and overbank deposits. Each of these elements will be discussed individually.

1) Basal Unconformity: The unconformity at the base of the delta plain is recognized at the base of fluvial channel sandstones in exposures in the southeastern part of the study area, but may not be significant in the northwestern (seaward) part of the area. This unconformity, as noted earlier, is prsent throughout most of Wyoming, marking the base of the Muddy. Southeastward through the study area, the unconformity cuts progressively deeper into the underlying lower marine Muddy. Southeast of line D (Fig. 2), essentially all of the lower marine Muddy is absent. East of the study area, the unconformity lies on Skull Creek shales.

2) Lower Fluvial Channel Sandstones: The dominant Muddy sandstones south of line C (Fig. 2) are fluvial sandstones at the base of the overlying delta plain sequence These sandstones lack marine burrows and are considered to be of non-marine origin. Dresser (1974, p. 10) classified these as "channel sands" and his outcrop descriptions note the absence of burrows except at outcrop 87 (Fig. 3) where an apparent upper marine sandstone is present overlying the fluvial channel sandstones. Similar transgressive beach sandstones bearing burrows are present on the top of the fluvial sandstones on outcrops southeast of outcrop 87 (Fig. 3).

The fluvial sandstones are characterized by high angle cross-bedding, often displaying trough-shaped geometries in cross section. Although paleocurrent directions inferred from cross-bedding are highly variable, the weight of evidence supports a northwestward flow direction. These high energy deposits contain surprisingly coarse grained material in places, as at outcrop "a," where a 3-foot chert-pebble conglomerate containing pebbles 3/8 inches in diameter occurs at the base of the sandstone.

The fluvial sandstones often exhibit a high degree of sorting and excellent porosity. Internal erosion surfaces are evidenced by high-angle, abrupt scour structures. Chert granules, intraformational conglomerates, irregularly bedded sandstones, and fragments of woody material are commonly present on the internal erosional surfaces.

The absence of marine burrows and the presence of diagnostic sedimentary structures in these sandstones suggests that they were deposited in a major northwest-flowing river system. This system was cut into the beaches of the lower marine Muddy, resulting in erosion of the lower prodelta and delta-front sandstones except in the northern part of the study area.

The location of the basal unconformity and lower fluvial sandstones on the well log cross-section (Exhibit 3) is based on correlations between outcrops and adjacent well logs, using the thickness of the section above the base of the Muddy as a guide. Since no Muddy outcrops occur in the central portion of the study area, log cross-section (Exhibit 3) correlations in this part of the area are probably less accurate than those where outcrops closely tie the subsurface data.

3) Flood Plain Deposits: Northwest of line F (Fig. 2), a carbonaceous, non-fissile mudstone generally overlies the fluvial sandstones. The maximum seaward limit of the lower flood plain deposits is shown by line B (Fig. 2). The mudstone is generally brownish in color and contains abundant carbonaceous material. Marine burrows are absent and Dresser often recognized this unit by its root zones and "soil horizons." By description, Dresser infers that it was above sea level and this author further interprets the evidence to indicate deposition on a river flood plain above sea level.

In the central part of the study area, younger stream channels of the flood plain cut into the lower fluvial sandstones. An excellent example is seen at outcrop "v," where the younger stream channels contain intraformational conglomerate at the base, point bar sandstone at the edge, and fine-grained, low-energy flood plain deposits of carbonaceous mudstone and irregularly ripple laminated sandstone at the top. These younger stream-channel sandstones are relatively rare in the flood plain facies.

In outcrops of the northwestern part of the study area, Dresser describes a thin, but persistent, marine tongue (Exhibit 1 and 2) that represents a minor marine onlap of the delta plain at its seaward margin. This apparent marine tongue extends to line E (Fig. 2).

It is interesting to note on Exhibit 2, the lateral relationships between outcrops 28 and 26. It would appear that the lower marine beach sandstones may have formed a "barrier," and that the lower delta plain deposits formed behind this shoreline barrier. The thin marine tongue may represent a marine transgression over the shoreline barrier onto the lower delta plain deposits.

Only 45 to 50 feet of prodelta and delta-front sediments exist near outcrop 28. If the unconformity at the base of the delta plain sequence has not eroded much section, the open marine muds of the Skull Creek were deposited on an ocean floor that was only 45 to 50 feet deep.

An interesting facies of the Muddy is described by Dresser (in published measured sections) at the top of the flood plain deposits between outcrops 54 and 63 (Exhibit 1). Southeast of outcrop 63 (Exhibit 1), the upper delta plain deposits contain root zones and soil horizons. Marine burrows are absent. From outcrop 62 to 57 (Exhibit 1) Dresser describes a mixture of root zones and marine burrows in the lateral delta plain facies equivalent. It would appear that this depositional environment was at sea level, allowing development of root zones. Shallow brackish marine waters were also probably present. Seaward of this mixed facies, from outcrop 54 to 51 (Exhibit 1), marine shales represent the seaward equivalent facies of the upper delta plain. The mixed facies of root zones and marine burrows suggests a transitional environment between marine and non-marine environments. According to Dresser's measured sections, the seaward limit of the delta plain deposits is near line G (Fig. 2).

TRANSGRESSIVE BEACH AND SHALLOW MARINE

Aside from a 16-foot interval of mixed root zones and marine burrows above the delta plain section in outcrop 66 (Exhibit 1), sedimentary rocks above the delta plain display marine burrows and are considered to represent beach and shallow marine deposits.

On the seaward, northwestern, side of the delta, transgressive erosion may have been minor. From outcrop 82 (Exhibit 1) southeastward, however, progressive erosion of the upper delta plain deposits was significant. From line F of Figure 2 southeastward, the carbonaceous mudstones of the delta plain are absent, probably by erosion, at the base of the transgressive beach zone.

In general, the transgressive beaches and shallow marine rocks are fine-grained and probably represent shallow marine reworked deposits of the carbonaceous upper delta plain mudstones. Only southeast of the line F (Fig. 2), where all of the carbonaceous mudstone of the flood plain was eroded, is there a significant amount of beach sandstone. In the area southwest of line F, a thin beach sandstone, reworked from the sandstones of the underlying fluvial channel sandstones, is present. For example, along the southeastern part of the outcrop area, a thin bedded, fine grained, calcite-cemented sandstone is present at the top of the fluvial sandstone. High iron content is indicated by the brown weathering and occasional spherolites of siderite which are present locally. This sandstone is usually only two to five feet thick; however, at outcrop "i" it is over 10 feet thick. The thicker sandstone at outcrop "i" contains marine *Skolithus* burrows, is parallel bedded, and has excellent porosity, representing the best development of the reworked beach sandstones noted in the southeastern part of the study area.

In the upper part of the middle marine member, most of the sedimentary rocks are composed of silty claystones and thin bedded burrowed siltstones. Vertical, sand-filled tubes, horizontal bedding burrows, and intensely reworked sediments are common. Occasionally, as at outcrop "u," a thin, porous, bar-like sandstone containing cross-bedding indicates the presence of migrating marine sand waves.

Abundant calcareous cement has reduced the porosity of the sandstones deposited in this shallow marine setting.

UPPER MARINE DEPOSITS

The final stage in deposition of the Muddy sandstones in this area was burial of the delta and beach deposits by gray marine shales and sandstones. Except where the uppermost sandstone of the Muddy is well developed, exposures of the upper section are generally poor.

Log correlation (Exhibit 3) of the upper Muddy equivalent on the northwest side of the study area indicates that the upper half of the Muddy interval is composed of shale. Log correlations (Exhibit 3) also show a thin low resistivity shale interval between the upper and middle marine sandstones. Over most of the area, log correlations show the division of the upper and middle marine sandstone more clearly than do outcrop correlations.

The upper marine sequence is clearly shown in outcrop "m," where black fissile shales at the base grade upward into alternating thin beds of fissile shale, one-to-two inch thick ripple-laminated sandstones, and tight, very fine-grained burrowed sandstones. The top of the upper marine sandstone is capped by a fine-grained, parallel-laminated sandstone which coarsens and increases in bedding thickness upwards. Depositional current velocities increased upwards in this sequence which is interpreted to represent the edge of an offshore bar sandstone.

Near the center of this upper marine bar facies (e.g., at outcrop "q"), the sandstone has good porosity and exhibits low angle cross-bedding.

Farther from the center of the bar sandstone (outcrop "k"), the uppermost unit is thin-bedded, irregularly bedded, and contains *Skolithus* burrows.

Shown in the northwestern part of the study area (cross-section: Exhibit 3), are shales between the middle and upper marine sandstones. The outcrop cross-section (Exhibit 3) also shows the northwestward thinning of the upper marine sandstone. This thinning is also seen in well logs of Exhibit 4. The seaward limit of this upper marine sandstone is indicated by line H (Exhibit 4).

By way of comparison, at outcrops 25 and 29, Dresser (1974, p. 12) interprets everything between the lower marine sandstones and the upper sandstone as lagoonal and the upper sandstone to be a shoreline sandstone. At outcrop 84, Dresser, in considering this uppermost Muddy shandstone, states that:

> "It probably represents some sort of shoreline facies developed at the margin of the advancing Shell Creek sea, but its characteristics do not fit modern models with which the author is familiar." (Dresser, 1974, p. 13).

In contrast, this author subdivides Dresser's lagoonal deposits into a lower non-marine delta plain facies; a middle shoreline and shallow marine faices; and Dresser's upper shoreline sandstone, a shallow marine bar facies.

Muddy sandstone deposition was terminated by burial under transgressive, open-marine shales of the overlying Shell Creek.

ERODED OIL ACCUMULATION

Known oil fields are not common in Muddy sandstones in the western Wind River Basin. Most of the larger anticlines that have been tested in this area are breached through the Muddy sandstones. At outcrop "s" on the southeast plunge of the Sage Creek Anticline, for example, lower fluvial sandstones are oil saturated at an elevation of 5790 feet. At an elevation of 5620 feet, however, outcrop "t" lacks oil saturation. This observation might suggest that the Muddy oil-water contact in this anticline was between 5620 feet and 5780 feet. There is little doubt that the thick, porous, Muddy fluvial sandstones contained a significant oil and gas accumulation prior to erosion on this large anticline.

CONCLUSION

Outcrop and subsurface analysis in the western Wind River Basin provide basic information necessary to define the depositional history of the Muddy sandstones. Preservation of a more complete depositional sequence in this area allows a more thorough understanding of the Muddy than in most areas of Wyoming, where key facies are absent. Similar evidence of depositional environments may be present in the Big Horn Basin, and a similar stratigraphy should persist southwest of the Wind River Mountains where much needed outcrops and well control are lacking. A better understanding of the depositional history in this area may help with the interpretation of the Muddy in other parts of Wyoming where the preserved record is incomplete.

It is suggested that the Muddy sandstones of the western Wind River Basin were deposited in prodelta, delta-front, and delta plain environments. This ancient delta system was onlapped by two phases of beach and nearshore, marine bar sandstone deposition.

The interested reader is encouraged to examine the more detailed stratigraphic evidence cited by Hugh Dresser in this published measured sections or, better yet, examine the outcrop evidence. Outcrops "a," "f," "i," "m," "q," "r," "u," "v," and 29 show a representative cross-section of the ancient Muddy delta.

References

Curry, W. H. III, 1960, Stratigraphy and Paleogeography of Upper Jurassic and Lower Cretaceous Rocks of Central Wyoming: PhD Thesis, Princeton University, 216 p.

________, 1962, Depositional Environments in Central Wyoming During the Early Cretaceous, Seventeenth Annual Field Conference Guidebook, Wyo., Geol. Assoc. pp. 118-123.

Dresser, H. W., 1974, "Muddy Sandstone — Wind River Basin," Wyoming Geological Association Earth Science Bulletin, vol. 7, No. 1, pp. 4 - 70.

APPENDIX A
Location of well logs

A 6N-6W, Sec. 11 SE NE
B 6N-3W, Sec. 18, C SW NW
C 6N-3W, Sec. 20, SW NE
D 5N-3W, Sec. 1, NE NW
E 5N-2W, Sec. 9, SE SE
F 5N-2W, Sed. 22, NE NE
G 4N-1W, Sec. 1, NW NE
H 3N-1W, Sec. 8, SE NE NE
I 2N-2W, Sec. 12, SE SW
J 1N-1E, Sec. 15, NW SW
K 1S-1E, Sec. 23, NW NE
L T33N R99W, Sec. 15, NE SE NW
M T33N R98W, Sec. 35, C NW
N T32N R97W, Sec. 8, SE SE
O T32N R98W, Sec. 25, SE SE
P T31N R96W, Sec. 4, SE NE

APPENDIX B
LOCATION OF PUBLISHED SECTIONS MEASURED
By Hugh Dresser

5. 7N-3W, Sec. 21 E½SW¼
12. 7N-2W, Sec. 33, SE SE
16. 6N-2W, Sec. 14, 150 FEL, 1200 FNL
17. 6N-2W, Sec. 13, 1200 FWL, 2600 FSL
21. 6N-1W, Sec. 19, SW SW
24. 6N-1W, Sec. 30, 200 FEL, 1400 FSL
25. 5N-1W, Sec. 5, NE NW
26. 5N-1W, Sec. 6, C NE
28. 5N-2W, Sec. 1, NE NW
29. 6N-2W, Sec. 36, 50 FWL, 300 FSL
35. 5N-1W, Sec. 10, S½SW¼
36. 5N-1W, Sec. 14, NE NW
51. 5N-5W, Sec. 7, W½NW¼
52. 4N-5W, Sec. 12, NE SW
54. 4N-4W, Sec. 19, SE NE
57. 3N-3W, Sec. 31, C S½
58. 2N-3W, Sec. 9, NW NW
59. 2N-3W, Sec. 22, SE SW
62. 1N-2W, Sec. 28, NE SW
63. 2N-1W, Sec. 29, S½SW¼
65. 2N-1W, Sec. 33, C SW¼
66. 1N-1W, Sec. 4, SW NE
69. 1N-1W, Sec. 10, NW SE
71. 1N-1W, Sec. 15, SE NE
73. 1N-1W, Sec. 14, SE SW
76. 2S-1E, Sec. 12, SE NW
82. 2S-2E, Sec. 18, NW SW
85. T33N R99W, Sec. 3, SE SW
86. T33N R99W, Sec. 3, SE SW
87. T33N R99W, Sec. 9, SE NE
88. 1S-1W, Sec. 19, E½NW¼
89. 1S-1W, Sec. 33, NW SW

APPENDIX C
LOCATION OF OUTCROPS STUDIED BY AUTHOR

a. T31N R97W, Sec. 36, SW NE
b. T31N R97W, Sec. 28, NW¼
c. T31N R97W, Sec. 8, SW SW
d. T31N R97W, Sec. 7, NE SW
e. T31N R98W, Sec. 11, NW¼
f. T31N R98W, Sec. 3, N½NW¼
g. T32N R98W, Sec. 28, SE SW
h. T32N R98W, Sec. 20, E½
i. T32N R99W, Sec. 12, SE SE
j. T32N R99W, Sec. 12, NW SE
k. T33N R99W, Sec. 36, S½NW¼
l. T33N R99W, Sec. 26, NE SE
m. T33N R99W, Sec. 23, SW NE
n. T33N R99W, Sec. 26, NW SW
o. T33N R99W, Sec. 10, NE SW
p. T33N R99W, Sec. 3, E½NW¼
q. T2S R2E, Sec. 19, E½NW¼
r. T2S R1E, Sec. 12, NW SE
s. T1S R1E, Sec. 8, NE SW
t. T1S R1E, Sec. 5, SW SE
u. T1N R1W, Sec. 25, NE SE
v. T1N R1W, Sec. 23, SE NE
w. T1N R1W, Sec. 15, NE SE
x. T1N R1W, Sec. 10, NE SW