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## Late Pleistocene and Recent Missouri River Terraces in the Big Bend Reservoir, South Dakota

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# Late Pleistocene and Recent Missouri River Terraces in the Big Bend Reservoir, South Dakota<sup>1</sup>

By ALAN H. COOGAN and WILLIAM N. IRVING

*Abstract.* Three cut-and-fill terraces of the Missouri River are present in the Big Bend Reservoir. The upper terrace (Mt-2), tentatively correlated with the Cary moraine, consists of outwash sands and gravels. It stands at heights of 80-100 feet above the river. Its surface is capped by a deposit of as much as 30 feet of aeolian sand and silt. The intermediate terrace (Mt-1) consists of gravel, sand, and silt, and stands at heights of 35-45 feet above the river. It, too, is capped with aeolian sand and silt. This terrace is tentatively dated as Mankato, but may be younger. The lower terrace (Mt-0) stands 10-15 feet above the average river level and is the flood plain of the present Missouri River. The upper part of the terrace fill consists of sand and silt of Recent age. The lower part of the fill is gravel, sand, and silt and is probably post-Altithermal but may be late Pleistocene in age. Several humic horizons are present in the silt covering both Mt-1 and Mt-2, and a well-defined paleosol is buried in the silt on Mt-2. Study of these horizons indicates the possibilities of correlating them with geological events and of finding a stratigraphic separation of archeological remains dating from Pleistocene to late prehistoric times.

This is a preliminary report based on three months of field work carried out during the summer of 1958 as part of the chronology program of the Smithsonian Institution, Missouri Basin Project. The purpose of the study was to establish a sequence of geological events which might be useful to the archeologist in the correlation of prehistoric sites.

The area under investigation was centered around the site of the proposed Big Bend Dam on the Missouri River near Fort Thompson in central South Dakota. Detailed mapping was done in parts of Buffalo, Brule, Hand, Hughes, Hyde, and Lyman counties, an area comprising approximately 250 square miles.

The terraces of the Missouri River were mapped along the river proper and up adjacent creeks and former glacial spillways leading to the moraines defined by Flint (1955), Petsch and Curtis (1950), and Curtis and Wadell (1951). Although stratigraphic correlations are tentative, they are based on the study of 61 measured sections of terrace fill and overlying aeolian deposited sandy silt. In addition, the Corps of Army Engineers, Oahe Dam, South Dakota, kindly made available the records of 73 drill cores which confirm and add

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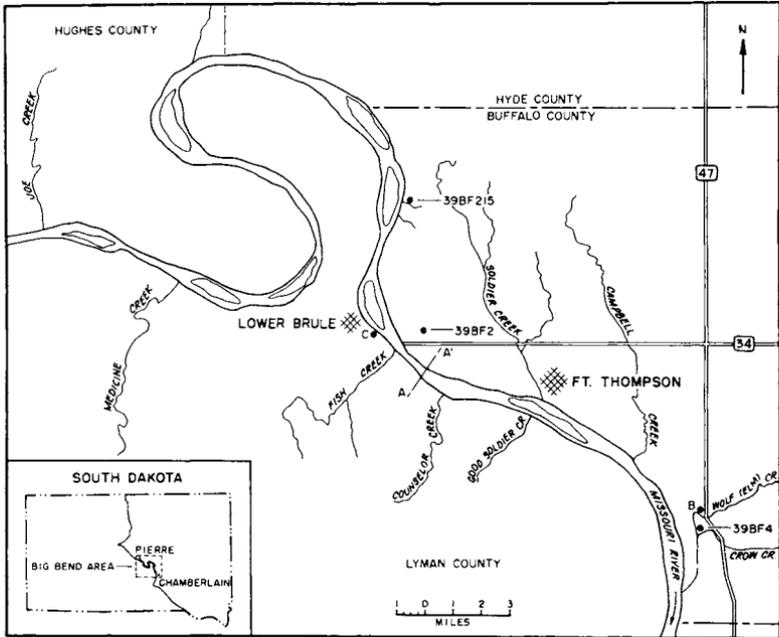


Figure 1. Map of the Big Bend Area. "B" and "C" are the locations of the sections pictured in Figures 2 and 3, respectively.

to the stratigraphic picture based on outcrop studies. No attempt is made here to rationalize the glacial sequences of Flint (1955) and the present writers with revisions of the late Wisconsin substages now being attempted in the Middle West.

### MISSOURI RIVER TERRACE SEQUENCE

The three major terraces recognized in the Big Bend area have been correlated with those mapped by Warren and Crandell (1952) at Chamberlain and by Crandell (1953) at Pierre. All three are present within the Missouri River trench, but owing to lateral erosion by the river, only one or two are present at any given locality. Furthermore, well exposed cuts in the terrace fill are rarely seen and by their very nature are transitory, so that it is necessary to trace the terrace up and down stream in order to establish its relative position. The criteria for correlating and mapping a terrace are the continuity and height of the terrace, the relative amount of area graded to the particular terrace level, the lithology of the terrace fill, the stratigraphic relationship of the terrace fill to the other fills and to bedrock, and the presence of zones of weathering and old soil horizons.

The three terraces are numbered in this report from lowest to highest starting with zero. For example, Mt-0 (Missouri terrace zero) is the flood plain terrace. No correlation with similarly num-

bered terraces in Nebraska is implied.

#### Upper Terrace (Mt-2)

Mt-2 is an extensive terrace on the left bank of the Missouri River at Fort Thompson. It stands at heights of 80-100 feet above the present Missouri River level, and at elevations of about 1440-1460 feet in the Big Bend area. Elsewhere along the Missouri River it occurs on the right bank. It is the terrace mapped as Cary (?) outwash by Warren and Crandell (1952) at Chamberlain; as Tazewell (?) outwash by Crandell (1953) at Pierre; and as the Fort Thompson terrace, the Joe Creek terrace, the Soldier Creek terrace, the Fort Sully terrace, the Polo Grounds terrace, the Fort George terrace, the Crow Creek terrace, and the Fort Hale terrace by Rockroth (1944).

The outwash fill of Mt-2 consists of cobble gravel, sand, and silt of varied lithology. The cobbles and pebbles consist of up to 30-40 percent granitoid rock supplied by the glacier. The rest, for the most part, consists of fragments of the underlying Cretaceous Pierre shale. The amount of granitoid rock varies greatly, probably as a function of the nearness of the outcrop to the former glacial source. The thickness of Mt-2 outwash also varies. It may be no thicker than 20 feet and is as much as 60 feet thick. The outwash overlies a strath terrace cut at heights between 1,383 and 1,419 feet, or at a mean elevation of 1,414 feet at Fort Thompson.

Overlying the outwash sand and gravel is a deposit of aeolian sand and silt as much as 30 feet thick and as little as a foot or so thick. The source for the aeolian deposit is judged to be the sand deposits on the present and past flood plains of the Missouri River, and to a less extent, the larger tributaries of the river. Humic horizons and a well-developed paleosol buried in the aeolian deposit indicate former levels of surface stabilization. It is expected that these horizons will prove to be important stratigraphic markers and that they may be useful in locating and correlating archeological sites in the Missouri River valley.

The surface of Mt-2 has been the location of extensive prehistoric Indian villages and camps. Archeological excavations in the silt cap on Mt-2 carried out by the Smithsonian Institution include the Medicine Crow site (39 BF 2), the Crow Creek site (39 BF 4), site 39 BF 224, and the Sully site (39 SL 4). The sites are numbered according to the Smithsonian Institution's numbering system.

Wolf (Elm) Creek Section. The most complete and best exposed section of Mt-2 in the Big Bend area is located near the mouth of a creek shown on maps of the area either as Wolf Creek, Elm Creek, or Little Elm Creek. The exposure is located just west of Highway

47 in a bluff on the south side of Wolf (Elm) Creek and one hundred yards east of the entrance of the creek into the Fort Randall Reservoir of the Missouri River (N.E.¼ Sec. 15, T. 106 N., R. 71 W.) Buffalo County, South Dakota.

Description of the Wolf (Elm) Creek Section. Elevation at the top of Mt-2, 1440-1445 feet.

Unit No.	Description	Thickness
1	Gray bedded to laminated shale and yellow to light gray chalky shale. Cretaceous Pierre shale. — erosional unconformity —	not measured
2 a	Orange stained gravel and sand.	2'
b	Buff, coarse sand and gravel.	1'
c	Partly covered, slightly laminated, calcareous sand.	17'
d	Buff, slightly silty, very fine sand.	1'
e	Tan, laminated, sandy, silty clay.	2'
f	Buff, calcareous, clean, very fine sand.	6'
Thickness of Unit 2		29'
3 a	Yellowish, calcareous, clayey, very fine sand. "B" horizon.	1' 6"
b	Dark brown to black, leached, very fine sand. "A" horizon.	1'
Thickness of Unit 3		2' 6"
4 a	Dark brown to black humic clayey sand.	1' 6"
Thickness of Unit 4		1' 6"
5 a	Partly covered, very fine sand.	4' 6"
b	Buff, very fine clayey sand.	5'
c	Buff, very fine sand, 80% silt, 20%.	1'
d	Buff, very fine sand, 60% silt, 40%; unlaminated, calcareous.	7' 4"
e	Buff, very fine sandy silt and clayey silt.	4"
f	Tan to brown, calcareous, humic horizon developed in very fine sandy silt.	6"
g	Buff, calcareous, very fine sandy, clayey silt.	1'
h	Obscure, calcareous, humic horizon developed in very fine sandy silt.	1'
i	Buff, calcareous, clayey, sandy silt.	1' 2"
j	Dark, calcareous, humic horizon developed in sandy silt. Traces of bone.	10"
k	Tan or buff, very fine sand, 50% silt, 50%. "A" soil horizon 4 inches thick, leached to depth of 5 inches.	2'
Thickness of Unit 5		24' 8"
Total thickness		57' 8"

Interpretation: Unit 1 is the bedrock Pierre shale. Unit 2 is a fine grained facies of the fluvial deposited outwash sand and gravel which constitutes the bulk of Mt-2, but which is only 29 feet thick at this locality. Unit 3 is a two and one-half foot thick well-defined paleosol developed on stream deposited sand. Unit 4 is one and one-half foot thick clayey humic layer of very limited lateral extent which probably was washed in over the underlying paleosol. Unit 5



Figure 2. Wolf (Elm) Creek Section, Mt-2. Unit 1—Cretaceous Pierre shale. Unit 2—fluvial sand and silt. Units 3 and 4—paleosol and colluvial layer. Unit 5—aeolian silt.

is an aeolian deposited silty sand 27 feet thick which contains humic horizons representing former surface levels.

The Wolf (Elm) Creek section is chosen as a reference section for Mt-2 because the record of events subsequent to the deposition of fluvial deposited fill is well preserved at this locality. The reference section is not typical of Mt-2 however. Elsewhere in the Big Bend area units 3 and 4 are not present, and unit 5 is only three to six feet thick. Moreover, unit 2 usually consists of predominantly coarse sand and gravel outwash such as is present on the north side of Wolf (Elm) Creek rather than of the sands of unit 2 found in the reference section.

**Age of Mt-2.** The exact age of the outwash fill of Mt-2 is not known. A study of aerial photographs and reconnaissance mapping along the former glacial spillway, now occupied by Crow Creek and

the tributary of Crow Creek called Elm Creek, indicates that Mt-2 can be traced from the Missouri River up the creeks to the gravel outwash deposits which are contiguous with the end moraine mapped as Cary by Flint (1955). The correlation of Mt-2 with the Cary moraine is in agreement with the tentative age assigned by Warren and Crandell (1952) to the same terrace fill at Chamberlain.

The aeolian sand and silt (unit 5) is post-Cary to Recent in age and is being deposited at present. The well-defined paleosol (unit 3) at the top of the Cary outwash is believed to have been developed during a period of erosion and down cutting following the deposition of Cary outwash and may have continued to develop during Mankato time.

The next datable horizon occurs in the silt cap in the dark humic layer (unit 5 j) near the top of the section. Kivett (letter, 1959), who excavated the Crow Creek site (39 BF 4) in the silt cap on Mt-2 about a hundred yards from the reference section, says that the sherds collected from the humic horizon appear to be Middle to Late Woodland in age. He feels that this particular variety of Woodland falls between A.D. 371 and A.D. 851 and that the Woodland occupation of the site probably did not occur later than A.D. 1000. The dating is based on a correlation of pottery and artifacts from 39 BF 4 with radiocarbon dated materials from Kansas (see Wedel and Kivett, 1956).

The oldest artifacts found on top of the gravel outwash of Mt-2 were located at the Medicine Crow site (39 BF 2) four miles west of Fort Thompson on Highway 34 (Irving, 1958). The artifacts came from the base of a 4- to 6-foot thick aeolian deposit (unit 5) and lay in part on gravel. A comparison with artifacts from the Allen site (25 FT 50; Holder and Wike, 1949) in Nebraska suggests that those from the lowest occupation zone at 39 BF 2 are between seven and ten thousand years old (Arnold and Libby, 1951). The basal portion of a small, fluted point of unknown type which was found at Medicine Crow just above the outwash gravel suggests an age of more than nine thousand years for the deposition of the outwash. These dates do not conflict with the assignment of a Cary age to the outwash fill of Mt-2.

In the middle levels of the silt cap at 39 BF 2, artifacts were found which are attributable to the period between 2500 and 1500 B.C. owing to their resemblance to Duncan points and others from radiocarbon dated sites in western South Dakota and Wyoming (Wheeler, personal communication).

#### Intermediate Terrace (Mt-1)

Mt-1 forms a prominent flat on the right bank of the Missouri River near the community of Lower Brule at elevations of about 1390-1400 feet or about 35-45 feet above the present Missouri River

level. On the left bank it is represented by only a narrow remnant in the Fort Thompson area but may be seen east of Joe Creek in the bend of the Missouri in Hughes County and at Brule Bottom north of Chamberlain in Brule County. At Chamberlain the correlative of Mt-1 has been dated as Mankato (?) by Warren and Crandell (1952); and at Pierre, Crandell (1953) called it Cary and Mankato (?) outwash. The Farm Station terrace and at least part of the Big Bend terrace mapped by Rockroth (1944) are equivalent to Mt-1.

The fill of Mt-1 consists of gravel and sand deposited by the Missouri River. The cobbles and pebbles are mostly granitoid rock or Pierre shale fragments. The fill is as much as 40 feet thick and overlies strath terraces in the Pierre shale at heights between 1,300 and 1,390 feet or at a mean elevation of 1,350 feet near Lower Brule (see Figure 4).

Capping the fill of Mt-1 is a deposit of very fine aeolian sand and silt as much as 13 feet thick. Buried in the silt are at least one, and in places, several, dark humic horizons.

The surface of Mt-1 has also been the site of widespread habitation and camps of prehistoric Indians. Archeological excavations in the aeolian deposit on Mt-1 have been made at sites 39 BF 215, 39 LM 218, 39 LM 4, 39 LM 225, 39 ST 55, 39 ST 12, and 39 SL 40.

Lower Brule Section. There is a well-exposed section of the fill of Mt-1 in the bluffs along the Missouri River southeast of the community of Lower Brule and northwest of Fish Creek (N. E.  $\frac{1}{4}$  Sec. 14, T. 107 N., R. 73 W.) Lyman County, South Dakota. It is considered a reference section for this unit in the Big Bend area. The elevation of the top of Mt-1 here is 1,395 feet.

#### Description of the Lower Brule Section.

Unit No.	Description	Thickness
1	Gray, thin-bedded, Cretaceous Pierre shale. — erosional unconformity —	not measured
2 a	Coarse sandy cobble, pebble gravel.	7'
b	Orange stained sandy gravel.	3'
c	Coarse sandy, cobble, pebble gravel.	7'
d	Coarse to medium sand and gravelly, pebbly sand.	10'
e	Tan, medium to coarse sand, 90%; pebbles, 10%.	3'
Thickness of Unit 2		30'
3 a	Buff, very fine sand and silt with scattered pebbles and coarse sand. Bone present at a depth of four feet.	4'
b	Brown, calcareous, humic horizon developed in silty, very fine sand.	1'
c	Buff, very fine sand and silt. "A" soil horizon five inches deep.	2'
Thickness of Unit 3		7'
Total thickness		37'

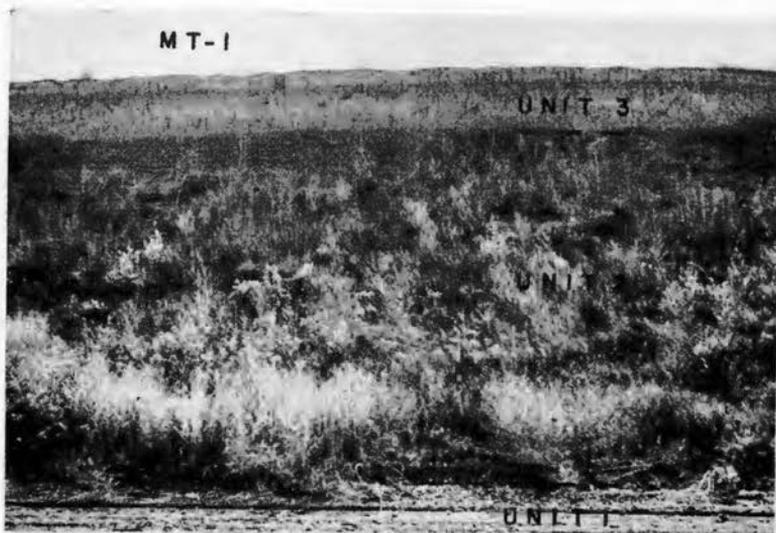


Figure 3. Lower Brule Section, Mt-1. Unit 1—Cretaceous Pierre shale. Unit 2—fluvial sand and gravel. Unit 3—aeolian silt.

Interpretation: Unit 1 is the Cretaceous Pierre shale bedrock. Unit 2 is fluvial deposited sand and gravel 30 feet thick. Unit 3 is aeolian deposited sandy silt seven feet thick.

Although unit 2 is composed of gravels and sands in some parts of the Big Bend area, at Brule Bottom the fill is much finer grained and predominantly composed of Pierre shale fragments. It is possible that the gravel and coarse sand fill of the reference section at Lower Brule is not a primary deposit of outwash from a nearby glacial source, but results from the erosion and redeposition of the fill of Mt-2.

Age of Mt-1. The age of the outwash fill of Mt-1 is even less certainly fixed than that of Mt-2. An attempt to trace the terrace to the end moraines mapped by Flint (1955) as Mankato was not successful. The distance from Flint's Mankato moraine, even as relocated by White (1957), to the Missouri River is close to 30 miles in a straight line.

At 39 BF 215, which is located at the mouth of a small creek, a series of cultural horizons was found buried in the dark colored occupation zones in the silt cap on Mt-1. Potsherds characterized by "simple stamp" surface treatment came from an occupation horizon at a depth of two feet, and cord marked body sherds came from a lower dark colored occupation at a depth of about four feet. The latter are tentatively correlated with the Over focus and are dated at about A.D. 1000 to 1300. Below the lower occupation horizon is eight feet of aeolian silt or a total of 12-13 feet of silt

overlying a deposit of creek and river laid clay, sand, and gravel. Cracked bones and cultural remains were located below part of the fluvial deposited section at a depth of about 17 feet. Below this, gravel, sand, and silt are exposed to the bottom of the creek about 35-40 feet below the top of Mt-1.

The best estimate of the age of the alluvial fill (unit 2) of Mt-1 that can be given at the present time is post-Cary to some time before A.D. 1000, although a relatively early date, perhaps Mankato, seems most reasonable. This appears likely in view of the resemblance of Mt-1 to a terrace in the upper reaches of Crow Creek which seems to consist of Mankato outwash.

#### Flood Plain Terrace (Mt-0)

Mt-0 is the flood plain of the Missouri River. Exceptionally high water may cover all of this surface, but normally this flat bottom land stands at about 10-15 feet above the river. The islands in the river are considered as part of the terrace. At the present time the river is eroding and depositing parts of the flood plain. The islands are shifting position and lateral erosion is removing older parts of Mt-0 and older terraces. Older parts of the flood plain marked by meander scars can be recognized, but no attempt to separate older and younger surfaces will be made here.

The fill of Mt-0 consists of silt, sand, and gravel. Corps of Engineers drill logs show that bedrock has been excavated to a depth of 73 feet below the river at a point near Fort Thompson or an elevation of 1,279 feet. The mean elevation of bedrock under Mt-0 in 13 holes is 1,287 feet. There is, in addition, a bedrock strath terrace buried by Mt-0 at about 1,321 feet and another at 1,347 feet.

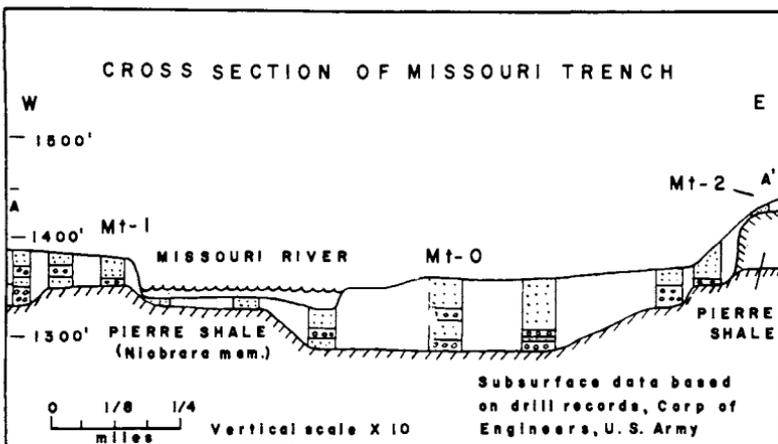


Figure 4. Cross section A-A' (Figure 1) of the Missouri trench showing the cut-and-fill terraces Mt-0, Mt-1 and Mt-2.

There is no uniform or widespread cap of aeolian sand and silt on the flood plain terrace. Where the river is locally choked with sand, however, stabilized and active dunes are present on the down-wind side of the prevailing westerly winds.

Age of Mt-0. The upper part of the valley consists of sand and silt and of clayey material derived from the Pierre shale. It contains the remains of *Bison* and other mammals of Recent age. The oldest archeological remains from Mt-0 are sherds from the Pretty Bull site (39 BF 12), identified as "Middle Woodland" by Robert W. Neuman (1957). The lower portions of the fill are locally gravelly and may be much older than the superficial deposits.

Corps of Engineers logs show that the bedrock floor of the Missouri trench, with one exception, has been excavated to a much greater depth under Mt-0 than it has under Mt-1 or Mt-2. The exception is found where the channels of pre-Missouri River streams which flowed east toward the James River have been buried by later Missouri terrace fills. One such channel is buried under Mt-2 east of Fort Thompson, and another may be present west of the river under Mt-1 (see Figure 4). The deep cut under Mt-1 is recorded in only one drill log so there is not sufficient evidence to justify an interpretation. If the cut is an old river channel, then the excavation of the deep trench under Mt-0 probably took place after the formation of Mt-1 and during Altithermal time. The assignment of the deep cutting of the Missouri trench to the Altithermal is especially attractive if the fill of Mt-1 can be correlated with the latest Wisconsin glaciation. The age of the Mt-0 fill would be no older, then, than four to five thousand years.

If the deep cut under Mt-1 is not an old channel, and only more drilling can determine whether it is or not, the sequence must be reinterpreted.

#### PROBLEMS AND SIGNIFICANCE

Although a relative terrace sequence has been established, there remains a serious gap in the chronological sequence. There is a period of about eight thousand years during which the exact history of the Missouri River is unknown. During this period the river built Mt-1, and it may have excavated the deep valley trench and refilled it with sediment to about its present level.

A further point of uncertainty is the correlation of the paleosol in the Wolf (Elm) Creek section and the various humic horizons with periods of deposition and erosion by the Missouri River in post-Cary time.

Notwithstanding these uncertainties, the stratigraphic sequence of terrace deposits should be of aid to the archeologist who wants to

choose early stratified sites for excavation from among the many untested sites along the Missouri River. Probably the most favorable location for the preservation of undisturbed, stratified cultural remains is in a sequence of thick aeolian deposited silt in which humic horizons are conspicuously developed. In general, such sites should be found at the mouths of creeks which empty into the Missouri River and at points favorable for the accumulation of silt which is being blown off the river bottom by the prevailing westerlies. Older sites should be found in the silt caps on Mt-1 and Mt-2 but not on Mt-0.

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