GEOMORPHOLOGY OF THE BEAVER CREEK ARCHAEOLOGY SITE, NORTH DAKOTA

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ABSTRACT

The Beaver Creek Site (32EM49) in Emmons County, North Dakota occurs on a terrace of outwash from the late Wisconsin glacier which stagnated 40 or 48 km to the east. The habitation environment can be inferred from the geomorphology. The creek gradually developed a lower lying floodplain when the load of outwash sediment decreased and downcutting commenced. The terrace was slightly higher than the floodplain when the site was first inhabited about 1190 BC. Further stream downcutting created an escarpment at the floodplain-terrace boundary. Winds eroded the escarpment and deposited the sediment in a cliff dune on the terrace above the escarpment. The cliff dune has three layers: the lowest layer was blown from the outwash sediment, the middle layer was blown from the outwash sediment and Pierre shale, and the upper layer was blown mainly from fluvial sediments after the shale fragments weathered and were stabilized by vegetation. The climate was more arid than today's climate when the cliff dune was deposited and probably more humid before and after this time.

INTRODUCTION

The Beaver Creek Site (32EM49) is located near Linton in Emmons County, North Dakota, about 48 km from the South Dakota border. Published geologic data and soil physical, morphological, and chemical properties were used to determine the kinds of soil parent materials and the conditions necessary for them to be deposited. The objective was to estimate the conditions for habitation from the data.

METHODS

A one square meter grid system was used to locate excavation units across the study area (Fig. 1). Each square meter excavation unit was studied by excavating successively deeper decimeter layers and by screening the soil for artifacts. After the artifacts such as scrapers, knives, and projectile points were collected, boundaries between culturally sterile and artifact-bearing layers were more accurately located on the vertical faces of the pits by placing

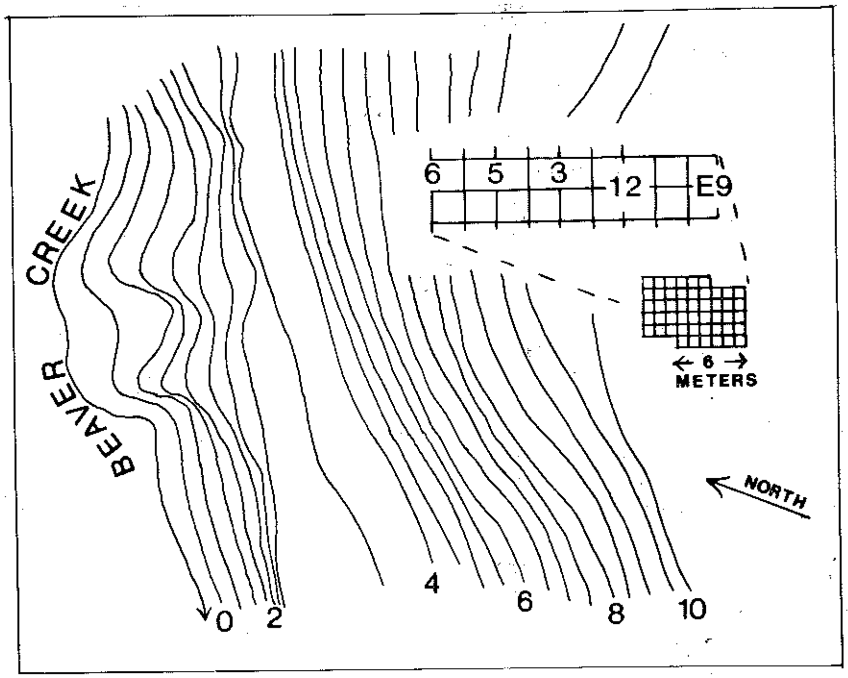

Figure 1. Elevation contours (0.5 m interval), location of the archaeological 1-m-grid study area, and location of the soils that were sampled at 6, 5, 3, 12, and E9.

strings at the irregular contacts between the layers.

The approximate depths of the layers delineated by the strings on the vertical pit walls were 0-5, 5-22, 22-42, 42-50, 50-75, 75-90, and 90-110 cm. Soils were sampled along a NNW-SSE direction across the excavation area at locations 6, 5, 3, 12, and E9 (Fig. 1). Within each archaeological layer at each sample location, three equal-sized samples were collected from a vertical pit face and composited for the final sample. Rodent-mixed material was avoided in this sampling. Layers 1 and 2 contained artifacts which subsequently were identified as being an Extended Middle Missouri occupation (about 1230-1280 AD); Layer 3 was culturally sterile, Layer 4 and 5 contained Late Archaic cultural material (1192 BC, the mean of four C14 dates of charred sediment), and Layers 6 and 7 were culturally sterile.

Cross-sections of the Beaver Creek valley were prepared from 7.5 minute quadrangle topographic maps, usually located where

the Emmons County Soil Survey (Wroblewski and Lunde, 1980) reported the soils were likely developed from or underlain by fluvial sands and gravels in what appeared to be a terrace position. Elevations of the terraces, or elevations found by extrapolating the two valley side slopes across the stream until they intersected, were used to estimate the elevation of the terrace relative to the stream elevation. These elevations were plotted to construct the long profile of the stream today and of the stream when the terrace level was the floodplain. The terrace system was subsequently examined in the field and found to be located as accurately as could be portrayed in a publishable figure.

Soil samples were crushed to pass through a 2-mm-opening stainless steel screen, dried, and stored in the plastic bags used to collect the samples in the field. Particle-size analyses were with the pipette method (Day, 1965) on organic-matter-free, hexametaphosphate-dispersed samples. Methods described by Jackson (1958) were used for Walkley-Black organic matter, Kjeldahl total N, and perchloric-acid-soil digestion for the ascorbic-acid-determined total PO_4-P (Watanabe and Olsen, 1965). DTPA extractable (Lindsay and Norvell, 1978) and total Cu, Zn, Mn, and Fe were determined by atomic adsorption spectrometry.

Description of the Site Area

The Beaver Creek Site (Fig. 2-A) is located 32 km east of the Missouri River and 48 km north of the North and South Dakota border (SW¼, sec. 29, T.132N., R.75W., Emmons County). The area was glaciated in an earlier glaciation (Clayton and Freers, 1967) than the late Wisconsin glacier which stagnated 40 to 48 km to the east (Clayton, 1967, p. 36) and furnished meltwater to Beaver Creek from about 12,500 to 9,000 years ago (Clayton, 1967). Ice, buried under supraglacial debris that accumulated during melting, furnished meltwater to Beaver Creek into the Holocene.

The Beaver Creek site is located on a 10-m-high terrace that is underlain by Pierre shale (Fisher, 1952). The glaciated landscape adjacent to the site has some knolls with mesa-like surfaces formed from consolidated Foxhills sandstone which have protected the area from erosion. Slopes leading from these sandstone-capped knolls have had a long time to be graded to the terrace level between the time the area was glaciated and the glacial outwash terrace sediment was deposited. The late Wisconsinan glacier which advanced to the upper reaches of Beaver Creek and was the source of the outwash sediment, had little if any effect on the upland landscape.

Precipitation is about 430 mm annually, and average January and July temperatures are about −13C and 22C, respectively. Prai-

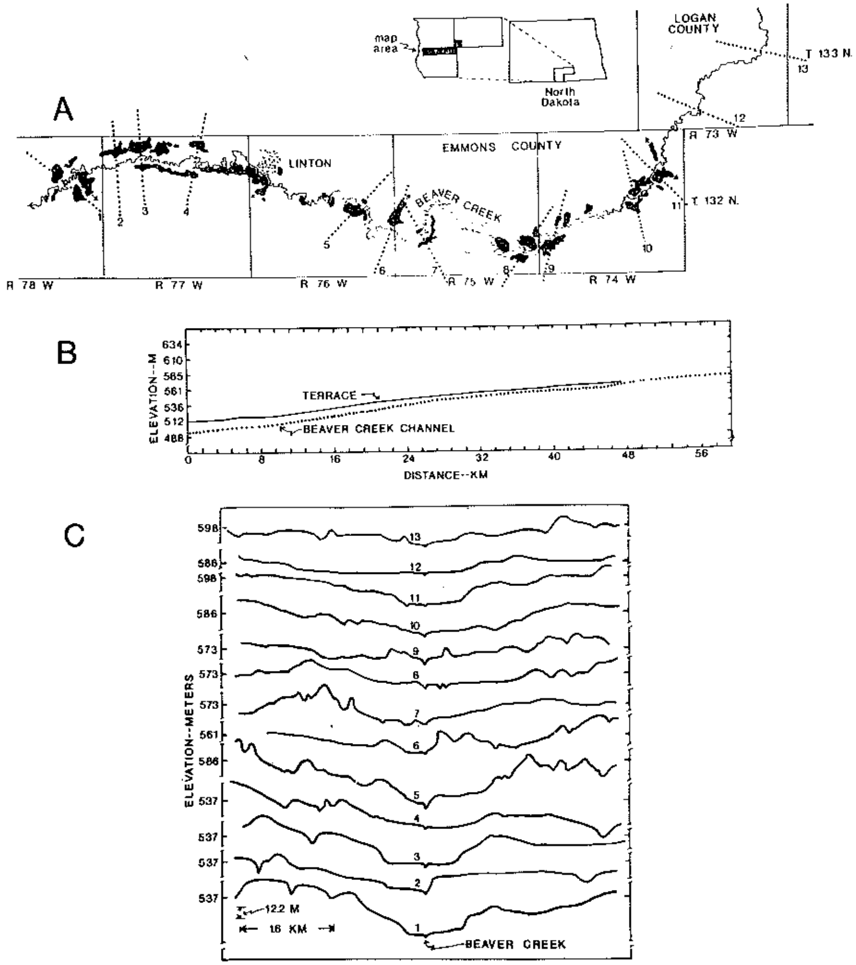

Figure 2-A. Locations of Beaver Creek, late Pleistocene-age terraces (shaded), and the transects along which cross-sections of the valley were prepared. The archaeological site is located at Transect 7. Arrows from shaded areas indicate soil map unit extended up small drainageway.

B. Cross-sections (6.4 km long) of the Beaver Creek valley from the Missouri River (Profile 1) upstream into Logan County (Profile 13).

C. Elevation of Beaver Creek and the terrace from the Missouri River.

rie is the dominant vegetation but patches of deciduous trees and shrubs occur along stream and in mesic upland locations. Prairie became dominant about 9,000 to 10,000 years B.P. (McAndrews et al., 1967, Table H-3), so prairie was dominant when the site was inhabited.

RESULTS AND DISCUSSION

A buried soil, that has most of the cultural material in the former surface layer (Layer 4), occurs at a depth of about 40 cm. It has a very dark grayish-brown color, is underlain by a dark grayish-brown layer, and overlain by a 15-20 cm-thick lighter-colored sediment that was deposited so rapidly that organic matter did not accumulate. This upper layer darkens upward to a very dark grayish-brown color in the present surface soil. Quartz grains in the buried soil have coatings of clay and organic matter that bridge the grains. This bridging is less evident in the upper soil, partly because the buried soil may have formed over a longer period of time and partly because its clay content is larger (White, 1967).

Landscapes portrayed in cross sections of the Beaver Creek valley from the confluence with the Missouri River to the late-Wisconsinan glaciated area (Fig. 2-B), have progressively less relief. The creek has downcut more below the outwash terrace in the lower than in the upper part of the valley (Fig. 2-C). This downcutting probably started as the glacial meltwater flow waned, as is the normal case in the formation of terraces in outwash (Flint 1971, p. 189-190). If the terrace at the archaeology site was formed after the meltwater ceased to flow, the volume of water would have been insufficient to cause the sorting and grading of material from coarser to finer textured upward from layer 7 to layer 4 (Fig. 3). Instead, thinner coarse-textured strata and fine-textured strata would have accumulated.

Sand contents decrease with distance from the NW side of the study area (Figure 3) for layers 1, 2, and 3. This decrease in sand content SE across the area is characteristic of eolian sediments in which the mean particle size decreases with distance from the source (Smith, 1942). Escarpments in arid to subhumid climatic zones commonly are the source area for eolian material that is deposited above the escarpment as a cliff dune (Sharp, 1949; White, 1960). If the escarpment is from Pierre Shale, sand-size shale fragments are eroded from the escarpment and are deposited as sand in the cliff dune (White 1973, 1983). Weathering subsequently destroys the shale fragment, and the clay content of the cliff dune near the escarpment is higher than it is farther away. The decrease in the clay content of layer 2 with distance from the escarpment (Fig. 3) probably is because sand-sized Pierre

Shale fragments were blown from an escarpment in the shale for layer 2 but for layers 1 and 3 the shale was either not exposed or the sand-size fragments were destroyed by weathering so that individual silt and clay particles were eroded from the weathered shale. The sand and part of the silt in layers 1 and 3 were derived by wind from the fluvial sediment exposed in the cliff and possibly from the stream floodplain. Many cliff dunes are not associated with a stream floodplain so that source probably is unimportant, particularly because Beaver Creek is small. Clay contents (Fig. 3) of layers 1 and 3 tend to increase with distance from the cliff source which is the typical sorting pattern for eolian deposits.

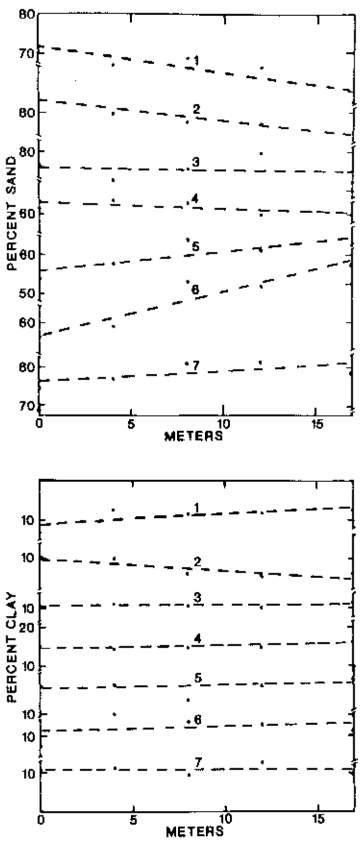

Figure 3. Sand and clay contents of the archaeological layers (1 through 7) across the area from soil 6 southeast to soil E9 as shown in Figure 2.

The PO_4-P, N, and organic matter contents are smaller for layer 3 than for layer 4 which had characteristics of a buried soil surface layer (Table 1). The cultural layer 4 has more total PO_4-P than the overlying layer. Phosphorus contents in cultural layers are frequently enriched by the inhabitants but, because surface layers can also be enriched by plants, the higher phosphorus content is not indicative of habitation. Phosphorus is extracted by plant roots from deeper soil layers, moved upward in the plant, and deposited in organic matter in the soil surface. This accumulation is evident in the present soil surface as well as the buried soil surface.

Extractable Fe is largest in layers with the largest organic matter content (Table 1). Fe released from minerals apparently is chelated by the organic matter and held in the surface layer. Thus, preferential leaching of Fe from the soil seems unlikely, but if it leaches, the buried soil should have had a lower Fe content in the upper part. The distribution of extractable Mn, Cu, and Zn also is related to the organic matter content. Total amounts of Mn, Cu, and Zn probably are the trace amounts that are present in the minerals, and they are not distributed unequally in the eolian and fluvial sediments. No evidence was found that the inhabitants influenced the distribution of these trace elements in the different layers.

The lower total iron content of the eolian sediment (Layers 1, 2, and 3, Table 1) in comparison to the underlying fluvial sediment, is additional evidence that the upper layers are eolian. Eolian sediments are sorted according to sizes if the densities of the clastic grains are similar. If densities are different, the more dense grains tend to remain behind. Iron oxides (hematite and magnetite) have densities that range from 5.5 to 6.5, and quartz has a density of 2.65. Iron oxide concretions are found in fluvial sediments derived from the Foxhills, Hell Creek, and Pierre formations. The high-density grains would tend to fall from an escarpment rather than be blown upward to form a cliff dune.

Inferred Development and Environment of the Site

The Beaver Creek Site is on a terrace that was the floodplain when the creek carried glacial meltwater in the late Wisconsinan or early Holocene (Fig. 4-A). Subsequently the floodplain was dissected to form a low terrace above flood level that became the first habitation surface (Fig. 4-B). The soil in the fluvial terrace sediments formed under grass and was leached of carbonates. In addition, the overlying eolian sediment was leached of carbonates. In order for this amount of leaching to occur in the time before and after the first habitation, the first habitation must have oc-

Table 1. Means of the sand, clay, pH, PO_4-P, Kjeldahl N, Organic Matter, and DTPA extractable and total Cu, Zn, Mn, and Fe for the seven archaeological layers in the five soils.

Layer	Sand	Clay	pH	P	N	Org. Mat.	Extractable Cu	Extractable Zn	Extractable Mn	Extractable Fe	Total Cu	Total Zn	Total Mn	Total Fe
	%	%		ppm	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppt
1	66.1	11.1	6.4	568	1.01	4.01	.66	2.75	16.9	31.3	10.2	32.1	293	7.2
2	78.9	7.4	6.5	464	.48	1.69	.47	.57	10.4	17.8	11.0	24.2	276	6.9
3	75.5	10.7	6.8	428	.35	1.25	.41	.16	11.7	9.7	8.1	23.6	266	7.6
4	61.7	15.3	7.0	470	.42	1.54	.51	.16	9.7	7.9	9.6	28.1	281	8.6
5	60.6	17.2	7.2	450	.45	1.25	.56	.22	7.9	5.3	9.9	30.0	304	9.7
6	66.2	11.9	7.6	408	.31	.99	.53	.23	4.9	5.2	10.1	27.7	305	10.4
7	78.6	10.7	7.8	410	.21	.53	.57	.18	10.8	7.5	9.0	22.4	321	9.0
F†	90.5	1.3	0.5	202.8	35.3	41.6	31.3	0.1	9.1	32.9	6.0	3.59	0.22	0.03

† Orthogonal comparisons of layer 3 with layers 2 and 4 are significantly different at F value of 4.26 for p = 0.05 and 7.82 for p = 0.01.

curred in the last 4,000 years as a minimum. The stream meandered and undercut the terrace near the site to expose fluvial sediment in an escarpment (Fig. 4-C) so that it could become the source of the cliff dune sediment in the culturally sterile layer 3. Additional deepening exposed Pierre Shale which was another source for sediment in layer 2. Either because the shale weathered or was protected by vegetation, sand-size shale fragments were not deposited as a significant part of the sediment in layer 1. Possibly, the stream channel moved away from the site when layer 1 was deposited so the terrace edge was not an escarpment (Fig. 4-D).

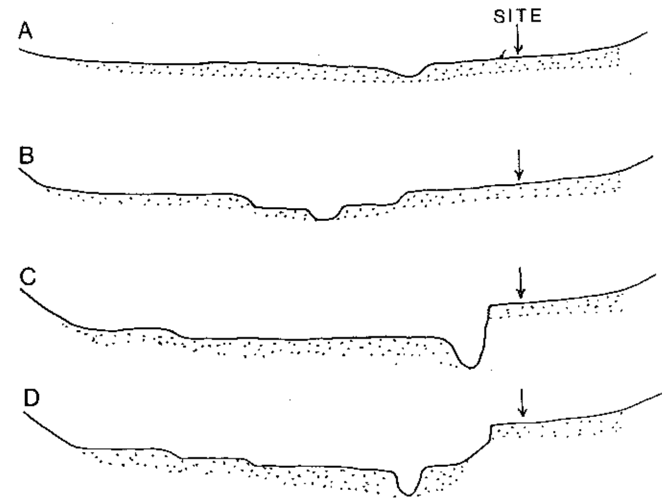

Figure 4. Idealized cross-sections of the Beaver Creek valley at the archaeological site (Transect 7, Figure 2). A. in early Holocene, B. during the archaic habitation, C. when eolian sediment buried the cultural layers, and D. today. The stippled pattern is alluvium.

Vegetation was prairie when the site was first inhabited. This implies the climate was similar to the one today in which droughts are common. If droughts were frequent, water was scarce. The stratigraphy of the area is favorable for a spring to form which would be an added inducement for habitation. Upstream, the very slowly permeable Pierre Shale is overlain by more permeable Foxhills Sandstone and glacial outwash. Water which infiltrates this material would surface where Pierre Shale became the uppermost bedrock. Another advantage to the site is that the floodplain would be visible in both the upstream and downstream directions, particularly if trees were not numerous on the floodplain. If trees were previously on the floodplain, they may have prevented cliff dune formation by protecting the escarpment from wind erosion. With a more arid climate and less vegetation, winds (Zingg, 1953) could erode the escarpment and deposit layers 1, 2, and 3.

Although highly speculative without additional isotope dating, the fluvial sediment probably was deposited about 10,000 years ago. Flooding stopped at that time. Soil formed in the upper part of the fluvial sediment for about 6,000 years. Carbonates were leached, bedding layers were mixed, and organic matter was added. Habitation occurred sometime in the last 4,000 years after the soil had formed. Eolian sediment accumulated rapidly in an un-named drought cycle (Bluemle and Clayton, 1982) of the Holocene (2,500 to 1,000 years BP) to bury the cultural layer dated at 3142 years BP (1192 BC). The cliff was unprotected by vegetation during the drought when the eolian sediment was blown from the cliff and deposited on the terrace. Since then with a more humid climate, vegetation has protected the cliff from further wind erosion and a soil has formed in the eolian sediment.

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