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Asymmetrical Distribution of Quaternary Alluvial Fills, Pumpkin Creek Drainage Basin, Western Nebraska

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ABSTRACT

A remnant alluvial fill of early Pleistocene age exposed in Pumpkin Creek Valley, Banner and Morrill counties, Nebraska, has yielded fossils of *Mammuthus meridionalis* (Nesti) and *Equus* sp. cf. *E. scotti* Gidley. Younger fill remnants of trunk and tributary streams allow a refinement of earlier views on the development of the Pumpkin Creek drainage basin during the Quaternary Period. Ancestral Pumpkin Creek both shifted to the north and entrenched its valley several times during the Quaternary Period leaving alluvial fills at three levels or more south of the present creek. Piracy of the headwaters of ancestral Pumpkin Creek took place after the last of these erosional events, probably in middle or late Pleistocene time.

Asymmetrical distribution of alluvial fills occurs in Pumpkin Creek Valley, along the north side of parts of the North Platte River in western Nebraska, and along streams east of the Black Hills. The asymmetrical distribution of these deposits may have been due to structural warping, which could have caused these streams to shift their courses laterally and to entrench their valleys repeatedly.

INTRODUCTION

Pumpkin Creek (Pumpkinseed Creek of some older reports) is an underfit stream that today heads in a poorly drained area in southwestern Scotts Bluff County, Nebraska. The creek, a tributary of the North Platte River, flows through parts of Scotts Bluff, Banner, and Morrill counties (Fig. 1) and enters the North Platte about 8 km southeast of Bridgeport, Nebraska. Some reaches of the creek are either intermittent or ephemeral, but others are perennial. The drainage basin of Pumpkin Creek also includes parts of easternmost Laramie and Goshen counties, Wyoming.

Purposes

The purposes of this report are threefold: to outline the general sequence of Quaternary erosional and depositional events in the Pumpkin Creek drainage basin; to establish a general age for the oldest Quaternary deposits in the eastern part of the valley, using vertebrate fossils as evidence in support of this age; and to stimulate others to examine the Quaternary sequences along streams in western Nebraska and adjacent states more carefully for fossils and other materials, which can provide better dates for important Quaternary events in the area.

GEOLOGIC SETTING

The Quaternary geologic history of Pumpkin Creek Valley has been described in a general way by Darton (1899), Adams (1902), Darton (1903a, 1903b, and 1903c), Wenzel and others (1946), Babcock and Visher (1952), Rapp and others (1957), and Smith and Souders (1975).

Detailed areally restricted studies of the general geology have been done by Vondra (1963), Vondra and others (1969), and Aadland (1959) for the Wildcat Ridge, and by Breyer (1974, 1975, and 1981) and Diffendal (1980b, 1982) for parts of the Cheyenne Tablelands. Stanley (1971a, 1971b, 1976) and Stanley and Wayne (1972) have reported on variations in sediment characteristics and source areas of sediments deposited in Nebraska and southeastern Wyoming, including the Pumpkin Creek drainage basin.

Darton's geologic maps and sections of the Camp Clarke (1903b) and Scotts Bluff (1903c) quadrangles, and the sections prepared by Smith and Souders (1975), show the general relationships between the older Tertiary formations at the surface of and beneath the drainage basin of Pumpkin Creek. On the Wildcat Ridge part of the drainage basin in Nebraska, the oldest rocks exposed belong to the Whitney Member of the Brule Formation, a part of the White River Group of Oligocene age. The Whitney in this area is primarily a siltstone but may

TABLE 1. AVERAGE COMPOSITIONS OF GRAVELS (16 TO 32 mm) IN PERCENT

	Older Quaternary tributary alluvium				Pumpkin Creek alluvial fills			
Composition	Qal_2 1	Qal_1 2	Qal_2 3	Qal_1 4	W 5	L 6	L 7	L 8
Quartz	8.8	7.4	3.7	5.2	5.2	3.8	6.0	5.9
Granite	61.7	73.2	78.7	73.2	55.3	56.8	36.9	53.9
Graphic Granite	. .	. .	. .	. .	. .	0.2	0.2	0.5
Orthoclase	1.4	. .	0.4	. .	. .	0.4	1.3	2.0
Anorthosite	. .	4.7	T	6.3	28.8	29.2	38.8	25.7
Volcanics	4.5	4.7	5.3	3.3	2.0	1.5	2.1	1.8
Quartzite	0.7	3.8	0.8	0.9	. .	. .	. .	1.5
Other metamorphics	20.4	6.2	8.9	8.7	0.5	4.3	1.9	7.1
Silica varieties								
Flint, Jasper, etc.	0.9	T	. .	. .	3.5	1.5	5.5	0.8
Sandstone	0.8	T	1.1	1.5	2.5	0.4	3.4	0.8
Carbonate	. .	T	. .		1.0	. .	1.9	0.3
Shale/Siltstone	. .	. .	. .	0.9	. .	1.1	0.2	0.3
Unknown	0.9	. .	. .	1.1	1.2	0.7	1.5	. .

Note: T = Observed at site but not collected in samples. For legal descriptions of sample sites, see

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also contain sandstones and conglomerates filling channels within the siltstone. Unconformably above the Brule are rocks belonging to the Arikaree Group of late Oligocene(?) to Miocene age. The Arikaree primarily consists of fluvial and aeolian volcaniclastic sands and friable sandstones containing abundant volcanic glass shards. Calcium carbonate concretions of various shapes and sizes occur within the group as well as in the upper part of the Whitney. Above the Arikaree in at least two places on the Wildcat Ridge are remnants of the Ogallala Group. All three of these groups also may contain sediments derived from local stream erosion of older beds and from stream erosion of igneous, metamorphic, and sedimentary rocks exposed in the Rocky Mountains to the west.

The rock groups exposed on the surface and buried directly beneath the Cheyenne Tablelands to the south of Pumpkin Creek are the same as those from the Wildcat Ridge. Breyer (1974, 1975), Smith and Souders (1975), and Diffendal (1982) have described parts of this sequence in detail. In contrast to the exposures along the Wildcat Ridge, the Ogallala Group generally is thicker to the south beneath the Cheyenne Tablelands, whereas the Arikaree Group is commonly either thin or absent. Loose sand and gravel deposits, and conglomerates, derived from both local and distant sources and generally filling deeply incised paleogullies and larger paleovalleys, are also common in the Ogallala. Some of these deposits occupy channels and channel remnants exposed at several sites along the edge of the tableland escarpment forming the south side of Pumpkin Creek Valley. These gravels and conglomerates are not homogeneous. In fact, as Table 1 indicates, there are major compositional differences among them, reflecting the fact that streams crossing the area during Ogallala time flowed from different source areas in the Rocky Mountains, and that sometimes these streams were either locally tributary to one another or were reworking older gravel deposits and incorporating these gravels into their own sediments.

The Whitney Member of the Brule Formation directly underlies the Quaternary deposits beneath the valley floor of Pumpkin Creek. Springs flowing from volcanic ash beds and fractured zones within the Whitney, as well as along the contacts between the other formations previously described, may have helped to widen the valley by spring sapping (Babcock and Visher, 1952).

QUATERNARY SURFACES IN PUMPKIN CREEK VALLEY

Remnants of flat-surfaced alluvial fills and the fluvially eroded bedrock floors beneath them in the part of the valley south of Pumpkin Creek have been recognized by a number of workers. These surfaces have been called terraces by Darton (1903a), Adams (1902), and Wenzel and others (1946); pediments by Babcock and Visher (1952); and pediment and terrace surfaces by Smith and Souders (1975). These variations in terms applied to the same features probably reflect differing opinions on their origin and also reflect the numerous and often confusing classifications of terraces in the literature. Some of the variability in descriptions and classifications of features similar to those preserved adjacent to Pumpkin Creek may be seen by studying and comparing the works of Howard (1959), Howard and others (1968), Leopold and Miller (1954), Mackin (1937), de la Montagne (1953), Leopold and others (1964), Cotton (1940), Schultz and Stout (1948), and Ritter (1978).

In Pumpkin Creek Valley, remnants of stream-eroded bedrock surfaces are directly overlain by sand and gravel resting unconformably upon siltstones of the Whitney Member of the Brule Formation. The Whitney-Quaternary contact can be seen in only a few places. The contact surface appears to be a nearly smooth, gently sloping erosion surface, or strath terrace of some of the classifications referred to previously. The alluvium covering the surface also has a planar-appearing upper surface, but whether this surface is an erosional feature produced by more recent fluvial processes, is the remnant of a former flood plain, or is the result of work done by both processes is unknown, so terrace classification cannot be applied to the fill surface. Because the origins of these surfaces remain unclear, we have chosen to avoid attempting to fit them into a category of terrace classification and will merely describe the relationships between the various alluvial fills occupying different positions along Pumpkin Creek.

Three principal Quaternary alluvial fills, here given informal names, occur in Pumpkin Creek Valley (Figs. 2 and 3). The topographically highest and oldest fill, here termed the "Wright alluvial fill," is best exposed at site 5 (Appendix 1) on the Wright Ranch. The next-lower fill, named here the "LaGrange fill," is best exposed along the paved road about 2.6 km east of the town of LaGrange, Wyoming. The lowest fill, a complex including the Holocene alluvium of Pumpkin Creek, is called here the "Bull Canyon alluvial fill." The two

TABLE 1. (*Continued*)

Ogallala gravels							
9	10	11	12	13	14	15	16
7.7	3.7	6.3	5.3	10.0	9.1	6.8	10.6
49.8	57.2	72.7	75.6	71.6	58.0	68.4	70.3
. .	. .	. .	0.4	. .	. .	0.3	. .
. .	. .	. .	. .	0.5	1.2	0.1	0.7
21.4	22.9	0.2	0.9	0.5	0.3	0.3	0.4
2.6	5.8	5.8	11.7	4.8	4.2	5.0	5.3
2.0	2.1	0.6	3.4	2.0	0.6	0.7	0.7
3.8	1.8	11.0	2.6	9.8	26.2	17.9	11.7
1.1	1.2	. .	. .	0.3	. .	. .	. .
4.7	3.4	2.4	. .	0.5	0.3	0.4	0.4
0.5	1.8	. .	. .	. .	. .	. .	. .
. .	. .	0.9	. .	. .	. .	0.1	. .
1.0	. .	. .	. .	. .	0.2	. .	. .

Appendix 1. At least 350 pebbles were collected at each sample site. Qal_2 and Qal_1 identified in Figure 3. W is Wright alluvial fill. L is LaGrange alluvial fill.

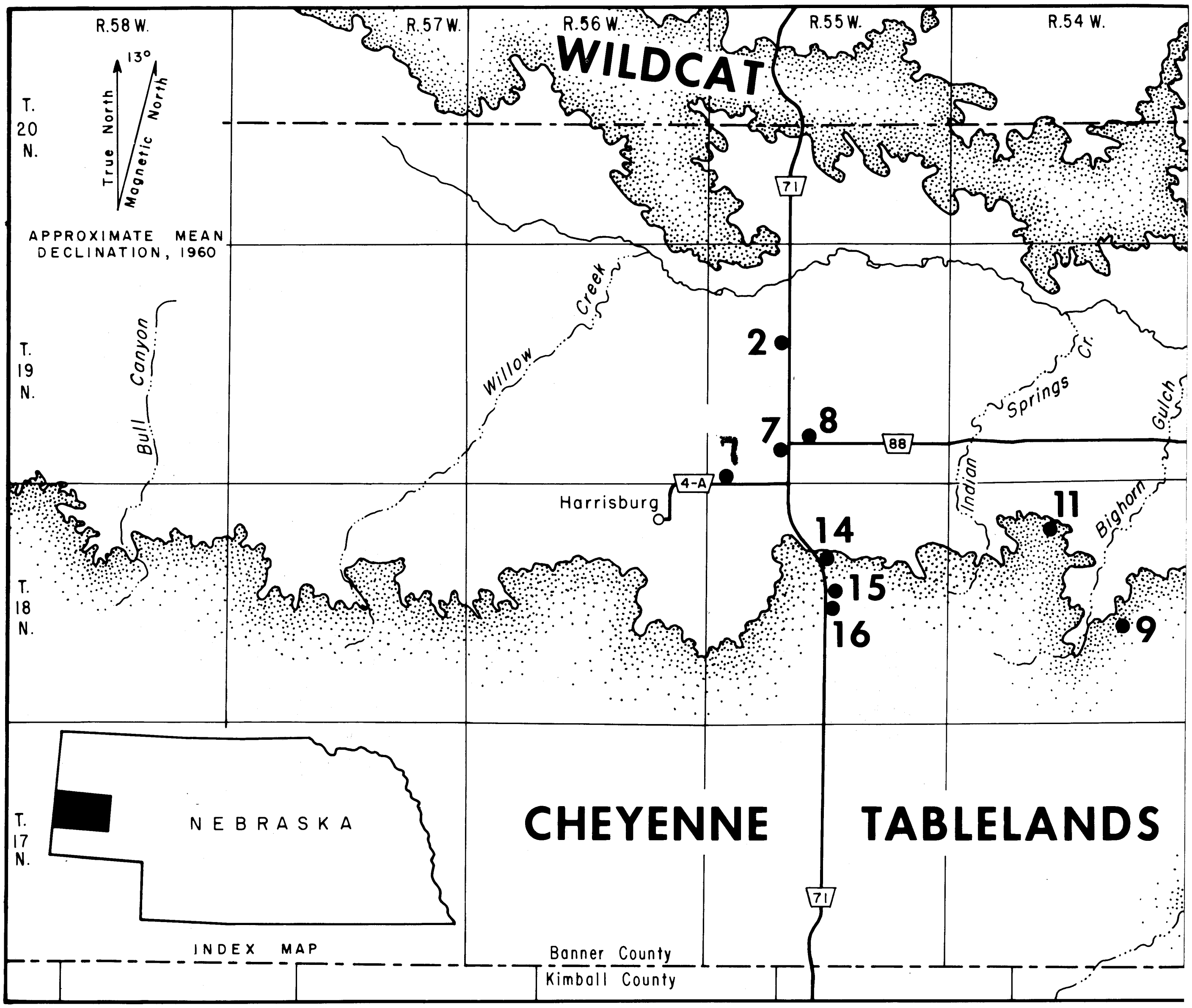


Figure 1. Physiographic features of western Nebraska study area. Locations of numbered sample sites are shown in Appendix 1.

lower fills include tributary alluvium (designated Qal_2 and Qal_1, respectively, in Fig. 3) derived from erosion of the rocks beneath the Cheyenne Tablelands to the south.

QUATERNARY ALLUVIAL FILLS IN PUMPKIN CREEK VALLEY

General Geomorphology

Darton (1903b, 1903c), Babcock and Visher (1952), and Smith and Souders (1975) mapped the general distribution of alluvial sand and gravel fills covering portions of the valley floor of Pumpkin Creek Valley. Darton (1903b and 1903c) separated these sediments into Recent (sic) alluvium and an older upland gravel and sand unit. While this twofold separation does show gross relationships, it does not show the complex geomorphic relationships between gravel masses having different geometries and source areas that either merge into one another or cut across one another at various places along the south side of Pumpkin Creek Valley. These relationships were briefly alluded to by Darton (1903b, 1903c) but otherwise have been previously undescribed.

Comparison of topographic maps with a Landsat image of the area (Fig. 2A) shows that Darton's Quaternary upland gravel and sand unit (part of the alluvial fills discussed in this paper) generally occupies high topographic positions. The unit occurs on top of narrow elongate hills whose long axes slope generally to the north from near the base of the Cheyenne Tablelands escarpment; on top of broad, more gently sloping surfaces, also sloping north; and on top of a series of flat-topped hills whose long axes trend about S10°E. Figure 2B shows the locations of the narrow elongate hills that are remnants of Quaternary gullies that headed in the area underlain by the Ogallala sand- and gravel-filled and conglomerate-filled channels occurring just to the south. These hills are remnants of tributaries to ancestral Pumpkin Creek. The gently sloping gravel-covered surfaces east of Nebraska Highway 71 are probably remnants of a complex Quaternary alluvial fan.

Relation of Gravel Composition to Geomorphology

While the study of the geomorphology of Pumpkin Creek Valley partially helps to

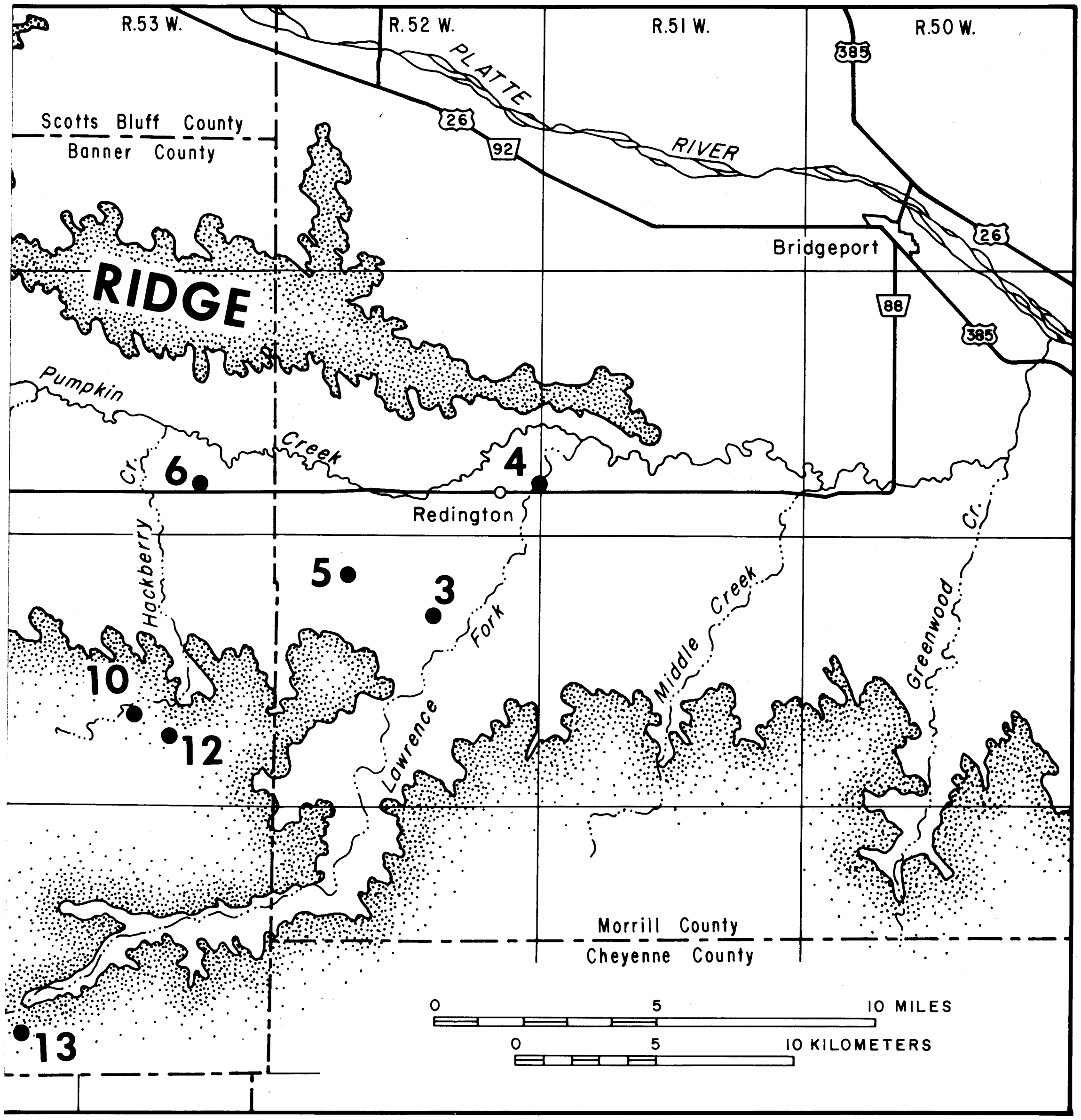


Figure 1. ***(Continued).***

separate complex alluvial fills from one another, study of differences in gravel compositions also can help to determine relationships between various fills and surfaces (Stanley, 1971a, 1971b, 1976; Stanley and Wayne, 1972). Differences in Quaternary gravel compositions may be great at sites separated from one another by less than 1 km (Fig. 1 and Table 1). These dissimilarities reflect different rock types in gravel source areas, changes due to mixing of gravels from two or more distant sources, and possibly changes in the importance of one tributary source area over another within the drainage system of ancestral Pumpkin Creek.

Differences in source area can be illustrated by comparing compositions of gravel samples collected from sites 1, 3, 5, 11, and 15 (Table 1). The sample from site 5 comes from the top of the highest and oldest preserved Quaternary alluvial fill of ancestral Pumpkin Creek Valley (Wright alluvial fill). At this locality, the gravels not derived by erosion of the Whitney siltstone and Arikaree and Ogallala groups are dominantly Sherman Granite and Laramie Anorthosite clasts eroded by streams from the Laramie Range about 160 km to the west. The presence of small quantities of volcanic clasts probably indicates that tributary streams draining the Cheyenne Tablelands were contributing reworked Ogallala gravels to ancestral Pumpkin Creek even at this early time in the history of the valley's development. Examples of more or less continuous remnants of alluvial fills of high-gradient tributary gullies occur between Pumpkin Creek and the escarpment on the north side of the Cheyenne Tablelands in both Morrill and Banner counties (Figs. 2 and 3). Gravels at sites 1 and 3 from these tributary deposits generally lack anorthosite, have more than twice as many volcanic clasts, have greater quantities of metamorphic clasts, and have considerably more granite than do the gravels from site 5. On the other hand, they more closely resemble Ogallala gravels outcropping along the rim of the Cheyenne Tablelands at sites 11 and 15. This similarity in composition between sites 1, 3, 11, and 15 is due to the fact that the source areas of the gully-fill gravels were these dominantly nonanorthositic Ogallala gravels exposed along the edge of the tableland to the south.

Differences produced by mixing of two distinct gravel suites can be seen by comparing the gravel composition at site 1 with that at site 2. Samples from both of these localities are part of the alluvial fill of the same

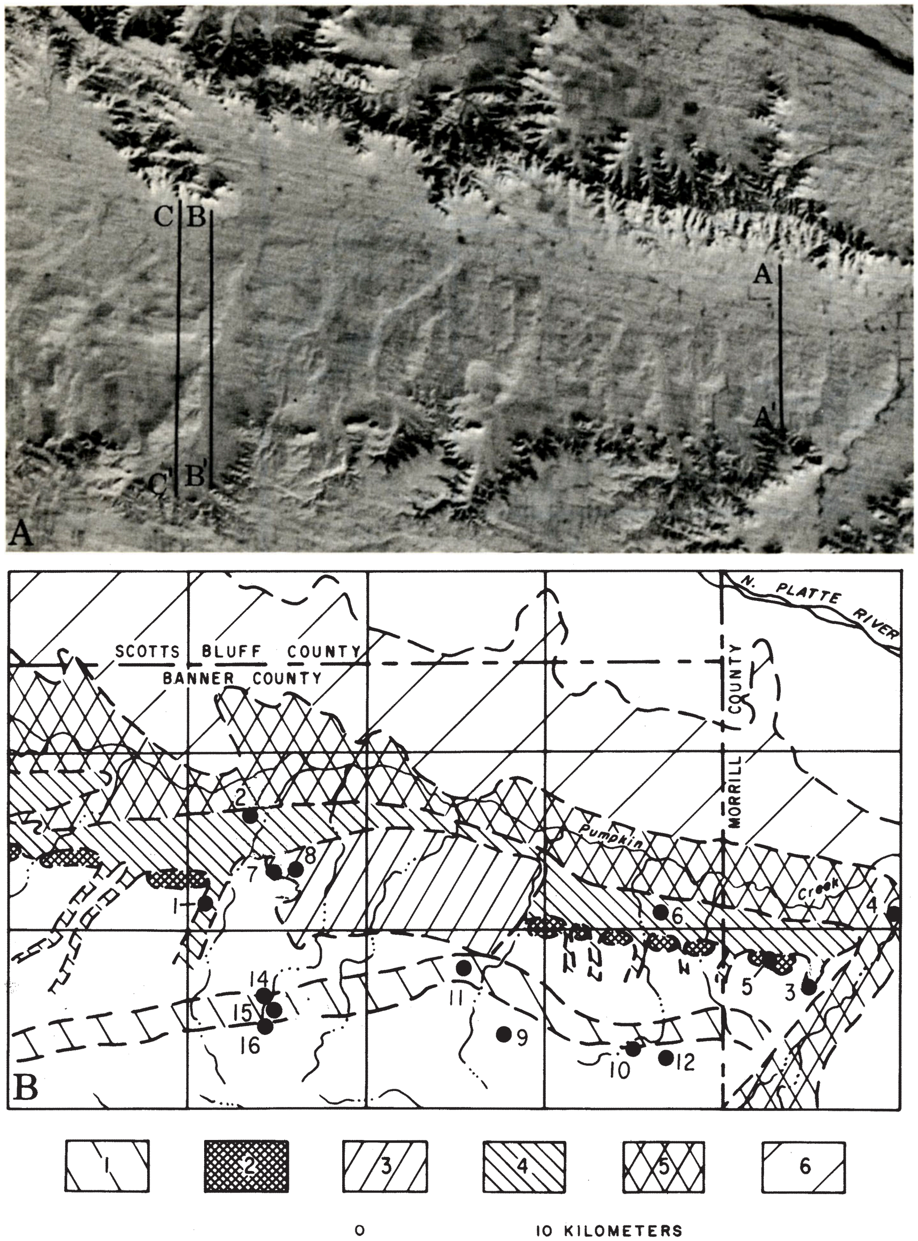


Figure 2. A. Landsat image of study area. B. Areal distribution of key Cenozoic features in area covered in Figure 2A. Numbered patterns are as follows: 1. Sand- and gravel-filled channel of Ogallala Group. 2. Early Pleistocene Wright alluvial fill of ancestral Pumpkin Creek. 3. Complex remnant alluvial fan deposit (covering older alluvial fill in places). 4. LaGrange alluvial fill with remnant tributaries. 5. Bull Canyon alluvial fill. 6. Wildcat Ridge. Locations of numbered sample sites are shown in Appendix 1. Site 13 is south of area shown.

tributary gully (designated Qal_2 in Fig. 3). The sample from site 2 shows an increase in granite and anorthosite and a decrease in metamorphic clasts when compared to a sample from site 1. This change reflects addition of reworked deposits carried down the gully to the gravels that were being transported by ancestral Pumpkin Creek.

Differences in composition due to changes in drainage positions in the major sediment source area of Pumpkin Creek (that is, Laramie Range) may be seen by comparing the gravels from sites 5 and 7, two separate ancestral Pumpkin Creek fills of different ages. The LaGrange alluvial fill from site 7 has proportionately more anorthosite and less granite than a sample from the Wright alluvial fill at site 5. This may reflect either a shift through time in major drainage from granitic terranes at the southern end of the Laramie Range to anorthosite sources farther north, or may possibly indicate changes in runoff from one part of the upper drainage basin to another.

Table 1 also illustrates the variability of Ogallala gravels in the study area that were in part later reworked, transported, and deposited along former tributaries to ancestral Pumpkin Creek. These Ogallala gravels are still the source of some sediment carried along tributaries to Pumpkin Creek.

Compositional changes similar to those noted above have been observed in sequences of alluvial fills in other areas. Mackin (1937), for example, reported similar differences in his study of the Big Horn Basin.

Fill Distribution

The ancestral Pumpkin Creek alluvial fills are distributed asymmetrically (Figs. 3 and 4) and occur only on the south side of the creek, except for the area west of its intersection with Bull Canyon Draw. This pattern was illustrated and described in general by Wenzel and others (1946, p. 19–21).

Terrace and alluvial-fill asymmetrical distribution has been reported along other drainages on the Great Plains as well as along Pumpkin Creek. Wenzel and others (1946) reported asymmetrical distribution of terraces along the North Platte River in Scotts Bluff County, Nebraska; Plumley (1948) reported a similar developmental pattern along streams east of the Black Hills in South Dakota. Terrace asymmetry also seems to occur along the Niobrara River and at least some of its tributaries north of Alliance, Nebraska.

Causes have been suggested for the asymmetrical arrangement of terraces and alluvial fills along the North Platte River and along streams draining the Black Hills. Wenzel and others (1946, p. 19) suggested that in the cases of both the North Platte and Pumpkin Creek the asymmetry was "caused by unequal distribution of gravel on the tablelands near them, and on their slopes." Plumley (1948, p. 538–539) reviewed the possible causes of terrace development restricted to only one side of the streams he studied in South Dakota and said that the most likely cause was regional downward tilt to the south. During the Quaternary Period, downfolding associated with the development of the Rush Creek–Lisco structural basin (Diffendal, 1980a, p. 127–138), about 40 km east of the study area, at least in part, may have been respon-

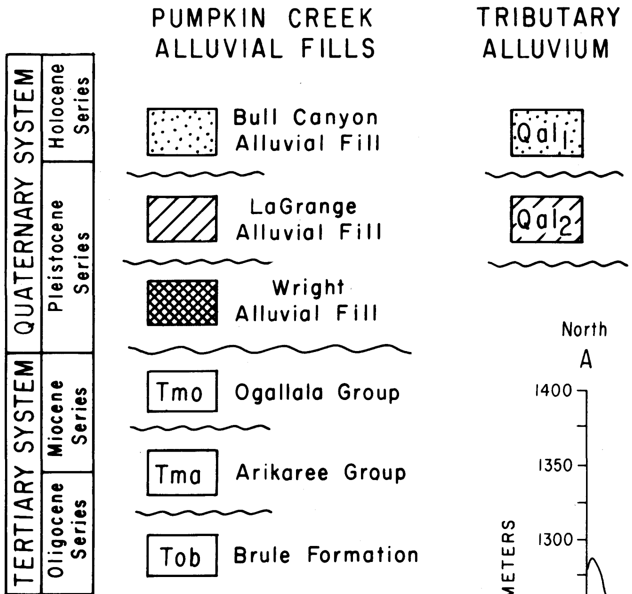
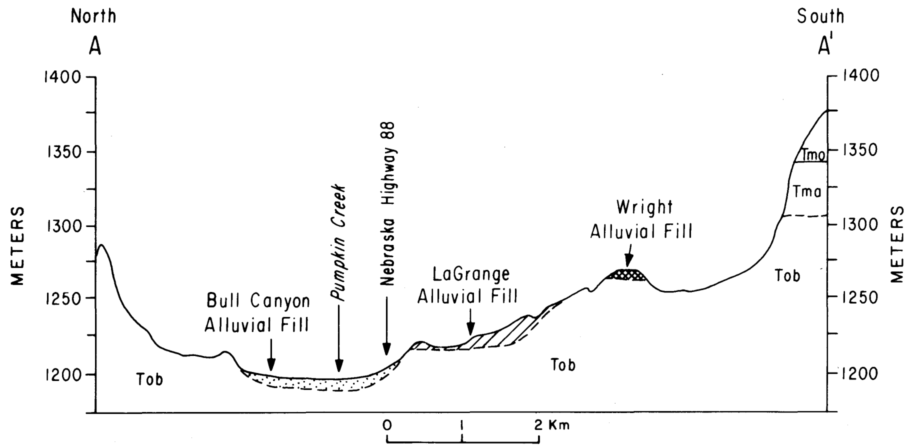
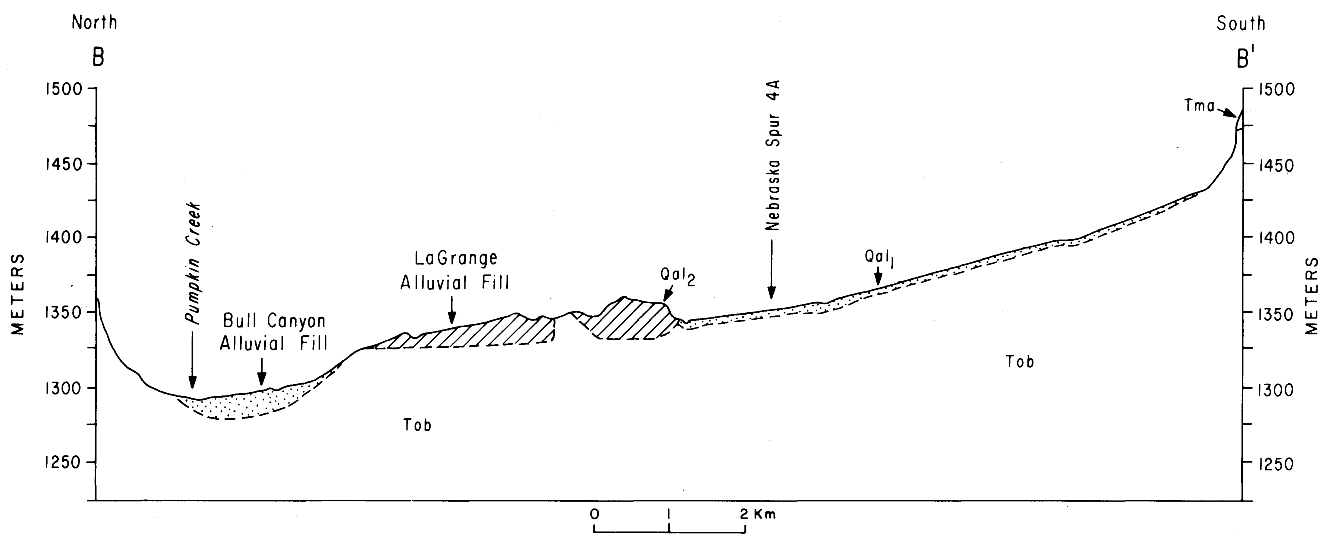
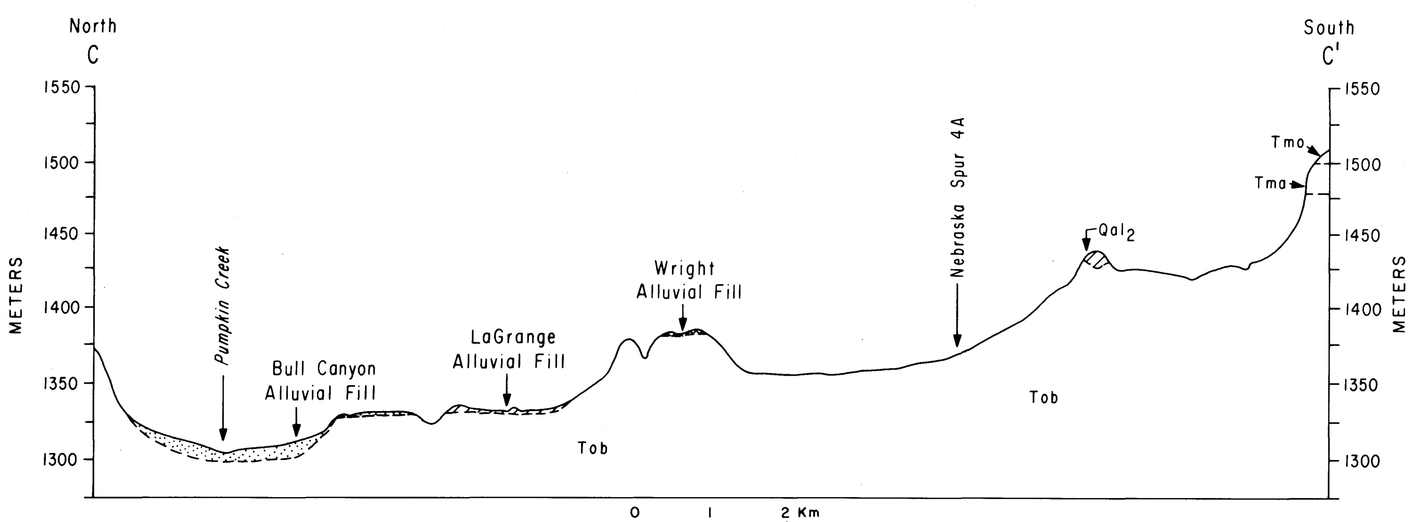


Figure 3. North-south cross sections showing principal rock units and alluvial fills in Pumpkin Creek Valley. Qal_1 and Qal_2 are gully-fill deposits in tributaries equivalent in age to two Pumpkin Creek alluvial fills. Note the change in altitude of Qal_2 from section B-B′ to section C-C′. Lines of section shown on Figure 2A.







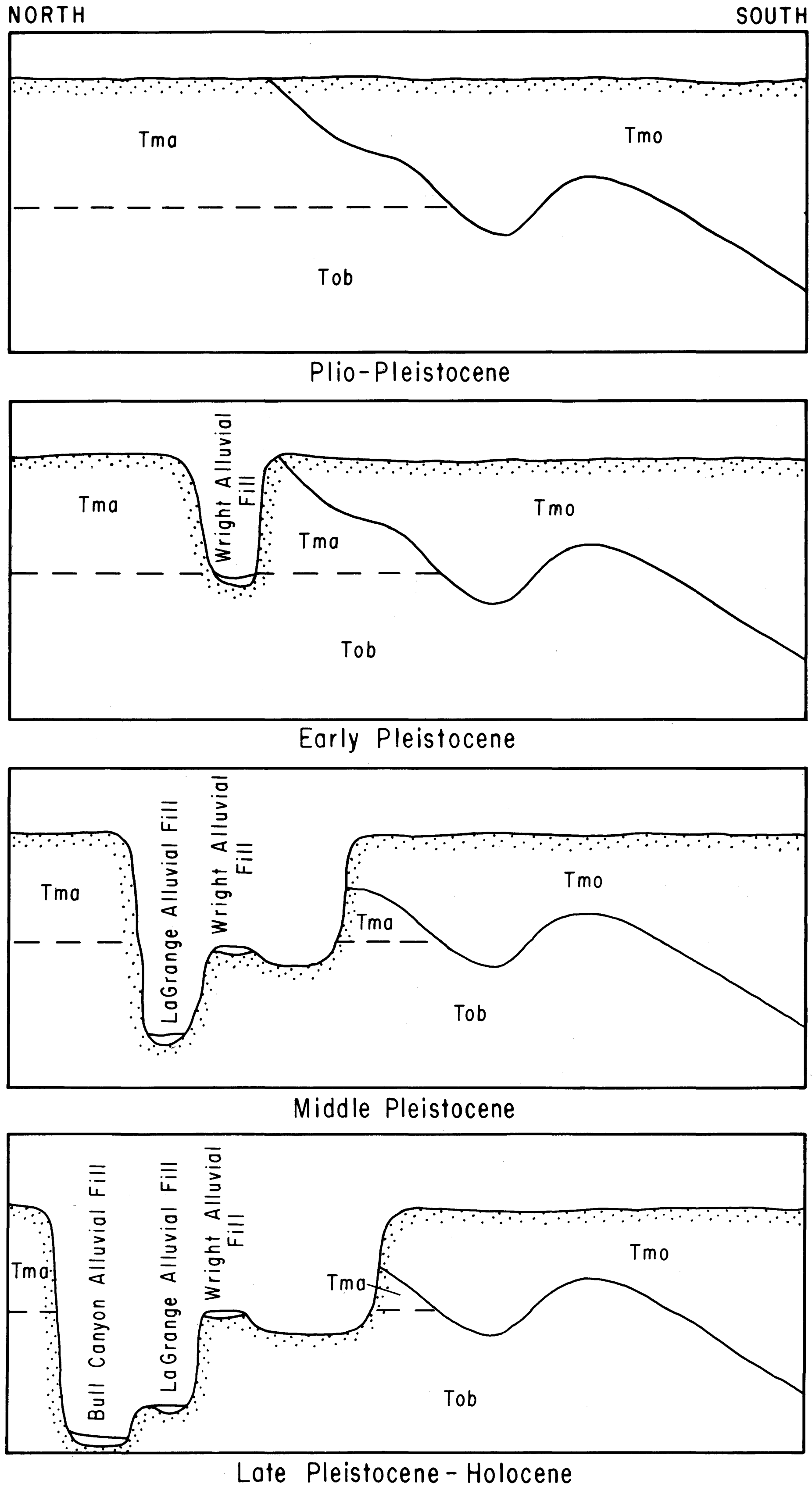


Figure 4. Hypothetical development of Pumpkin Creek Valley and alluvial fills during Quaternary. Not to scale. Symbols for geologic units same as Figure 3.

sible for the changes in distribution of the terraces and alluvial fills that have been observed along the North Platte–Pumpkin Creek drainages. Quaternary uplift of the Laramie Range (Stanley, 1971a, p. 70) may have played a key role in alluvial-fill development as well.

PREVIOUS REPORTS OF AGES OF ALLUVIAL FILLS ALONG PUMPKIN CREEK

The ages of the alluvial fills and terraces in Pumpkin Creek Valley have not been firmly established by previous workers. Babcock and Visher (1952, p. 7) attempted to correlate pediments (terraces of other workers) in the Pumpkin Creek drainage with similar features along the North Platte River Valley and said that the highest Pumpkin Creek Valley pediment was equivalent to their second pediment above the third terrace north of the North Platte River. Stanley and Wayne (1972, p. 3677, 3679–3680) reported a gravel site in Pumpkin Creek Valley as early Pleistocene or as probably mid-Pleistocene (1972, p. 3687). In view of the complex relationships of alluvial fill and terrace histories from one area to another (Johnson, 1944; Frye and Leonard, 1954; and Schumm, 1977), we believe it is too early to attempt more than tentative correlations between alluvial fills in the valleys of western Nebraska if datable material has not been obtained from the fills.

DESCRIPTION OF FAUNAL SITE

Quaternary fossils occur in the anorthosite-rich Wright alluvial fill capping the highest stream-eroded surface developed on the Brule Formation at two localities south of Pumpkin Creek, in southwestern Morrill and in east-central Banner Counties. The composition of gravel at site 5 in the 16 to 32 mm range, excluding locally derived clasts, is shown in Table 1. Table 2 combines the data in Table 1 with the locally derived material included to show its importance in these samples. This local material includes gravel clasts eroded from the Brule Formation and the Arikaree and Ogallala groups. Most of this local material is so mechanically weak that it would not survive transport for more than short distances, and so it has been excluded from Table 1.

The largest clasts in the gravel at site 5 are fragments of locally derived material, but rocks primarily from the Laramie Range

TABLE 2. COMPARISON (PERCENT) OF GRAVEL COMPOSITONS AT TWO SITES

Composition	Site 1*	Site 1†	Site 5*	Site 5†
Quartz	8.5	8.8	2.9	5.2
Granite	56.9	61.7	31.0	55.3
Orthoclase	1.2	1.4	. .	. .
Anorthosite	. .	. .	16.1	28.8
Volcanics	4.2	4.5	1.1	2.0
Quartzite	0.3	0.7	. .	. .
Other metamorphics	18.9	20.4	0.3	0.5
Chert	0.8	0.9	2.0	3.5
Sandstone/Shale	8.5	0.8	44.9	2.5
Carbonate	. .	. .	1.0	1.0
Unknown	0.8	0.9	0.7	1.2

*Local material included.
†Local material excluded.

make up the bulk of the material transported great distances. These boulders are predominantly anorthosite and granite, but quartzite and rhyolite, probably reworked from nearby Ogallala gravels, are also present. A comparison of the 10 largest clasts from site 5 and an Ogallala gravel at site 11 illustrates the differences in composition and size of these clasts at the two sites (Table 3).

The basal 2 to 2.5 m of the alluvial fill at site 5 is cross-bedded sand containing a few gravel clasts. Above this sand, there is a 7- to 8-m thickness of cross-bedded sand and gravel (Fig. 5). The axes of troughs trend east to east-southeast subparallel to the long axes of the hills that the alluvial fill caps. All of the fossils have come from the gravel-rich upper part of the alluvial fill.

FAUNAS FROM THE WRIGHT ALLUVIAL FILL

Two species of fossils have been found in the Wright alluvial fill at site 5 and at a locality about 6 km west. A complete left scaphoid and a cheek-tooth fragment are referred to *Mammuthus meridionalis* (Nesti). A broken left premolar, a broken left lower molar, a fragmental upper molar, a complete lower right premolar, a proximal phalanx, and a right metacarpal are assigned to *Equus* sp. cf. *E. scotti* Gidley. The morphologies of some of these fossils are illustrated in Figures 6 and 7. The material is housed in the collections of the University of Nebraska State Museum (UNSM).

AGE OF THE WRIGHT ALLUVIAL FILL

The vertebrate fossils in the Pumpkin Creek fauna from the Wright alluvial fill would apparently indicate an early Irvingtonian (early Pleistocene) age. Other Great Plains faunas that contain *Mammuthus meridionalis* and *Equus scotti* include the Gilliland fauna of Texas and Cudahy fauna of Kansas (Hibbard and Dalquest, 1966) and Holloman, Oklahoma (Dalquest, 1977), as well as several unpublished faunas

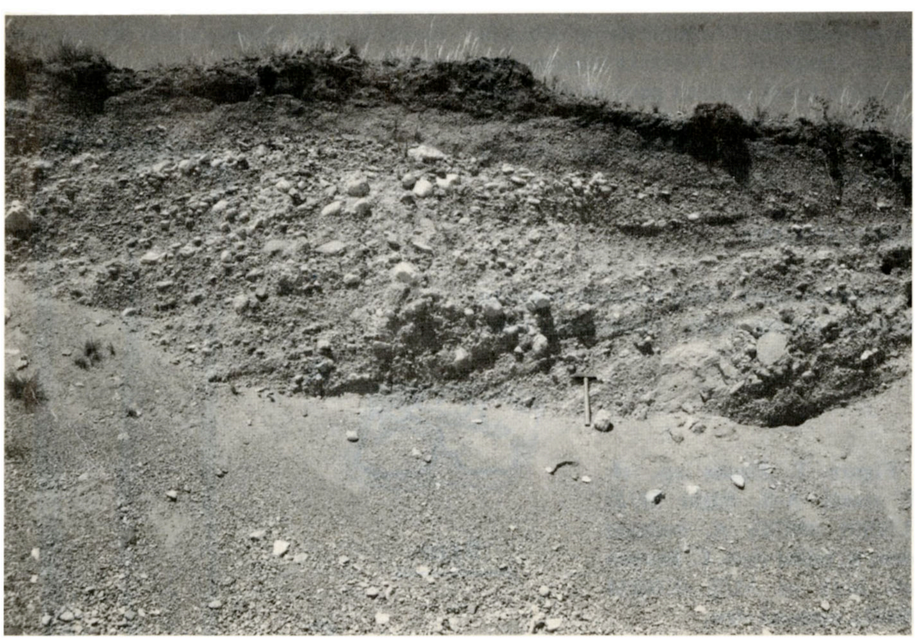


Figure 5. Sand and gravel deposits at Wright Ranch Gravel Pit. Hammer is 40.6 cm long.

TABLE 3. COMPOSITIONS AND SIZES OF TEN LARGEST CLASTS

Rock type	L.D.* (cm)	I.D.† (cm)
	Site 5	
Anorthosite	26.0	17.2
Anorthosite	21.6	17.2
Quartzite	25.4	16.5
Anorthosite	15.9	13.3
Granite	16.5	12.7
Anorthosite	12.7	12.7
Rhyolite	16.5	11.4
Granite	16.5	10.2
Anorthosite	14.0	10.2
Anorthosite	14.0	10.2
$\bar{X}$	17.9	13.2
	Site 11	
Rhyolite	22.2	11.4
Rhyolite	20.6	11.4
Granite	17.8	10.8
Quartzite	17.2	10.8
Rhyolite	16.5	10.8
Volcanic	15.2	10.8
Rhyolite	20.6	10.2
Pegmatite	20.3	10.2
Quartzite	15.2	10.2
Rhyolite	15.2	10.2
$\bar{X}$	18.1	10.7

*Long diameter.
†Intermediate diameter.

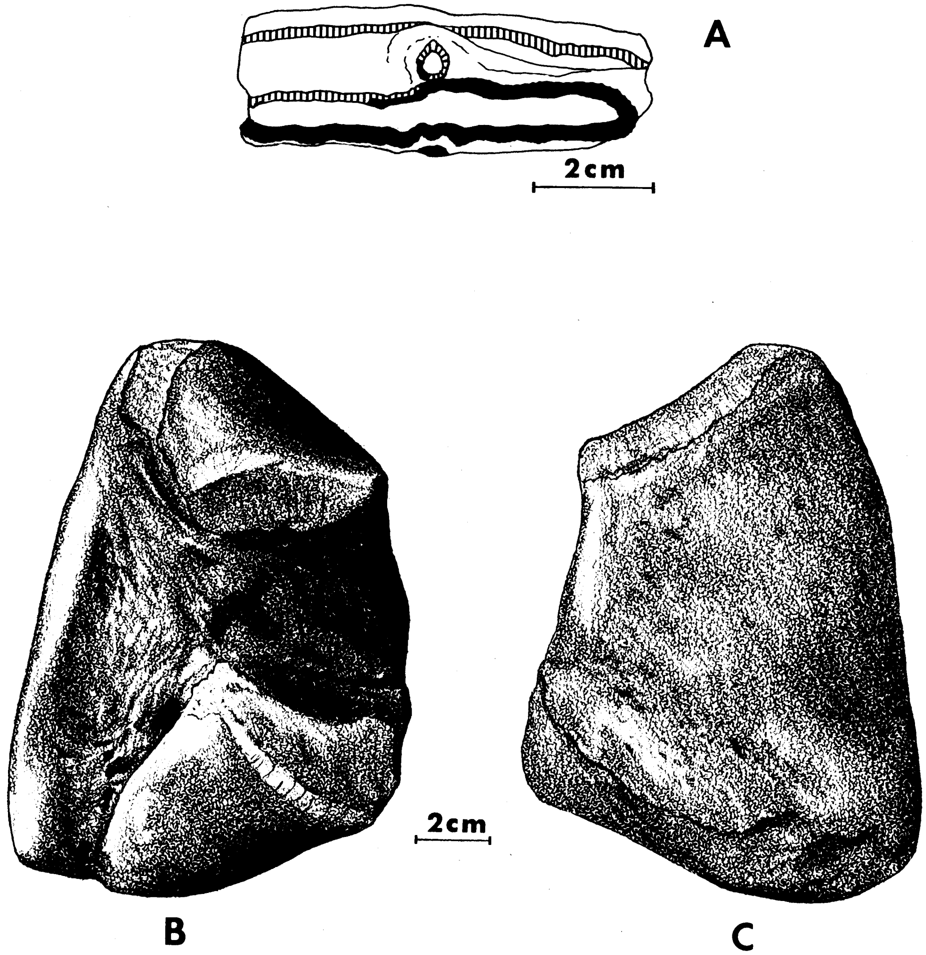


Figure 6. ***Mammuthus meridionalis.*** **A. Cheek-tooth fragment (UNSM 49477), occlusal view. B-C. Left scaphoid (UNSM 49475); B, medial view; C, lateral view.**

from southwestern Nebraska in the UNSM collections. Molars with thick enamel like those of the primitive *Mammuthus meridionalis* are not found in late Irvingtonian faunas (for example, in Sheridan County) or later faunas. The horse *Equus scotti* has also been reported from late Pleistocene faunas in the southwestern United States, including Dry Cave, New Mexico (Harris and Porter, 1980), but is much more common in early Irvingtonian faunas where it is the commonest horse. *Equus scotti* is not known in any of the large samples of late Irvingtonian and Rancholabrean horses housed at UNSM, including the Sheridan County fauna (Howe, 1979).

PIRACY OF PUMPKIN CREEK HEADWATERS

Our sedimentologic and faunal evidence allows a refinement of the ideas of Adams (1902) and Babcock and Visher (1952) on the timing of the piracy of the headwaters of ancestral Pumpkin Creek in southeastern Wyoming by a precursor of Horse Creek. Large quantities of Laramie Range debris in the LaGrange fill in Nebraska indicate that Pumpkin Creek drained parts of the Laramie Range in post–early Pleistocene time. A middle or even late Pleistocene date is probable for the piracy.

CONCLUSIONS

Pumpkin Creek Valley probably began to develop during early Pleistocene time. Pumpkin Creek shifted progressively north and cut increasingly deeply into the rocks beneath its valley floor during the Quaternary Period, probably, at least in part, because of structural warping. Remnants of alluvial fills of Pumpkin Creek and its tributaries, formed during the evolution of the part of the Pumpkin Creek drainage basin in Nebraska, are preserved on topographic highs, because they are more difficult to erode than are the adjacent siltstones of the Whitney Member of the Brule Formation. Because faunas have been found in the highest fill, we are optimistic that future work at younger fill sites may produce additional fossils that will allow an even more precise geologic history of the development of this valley.

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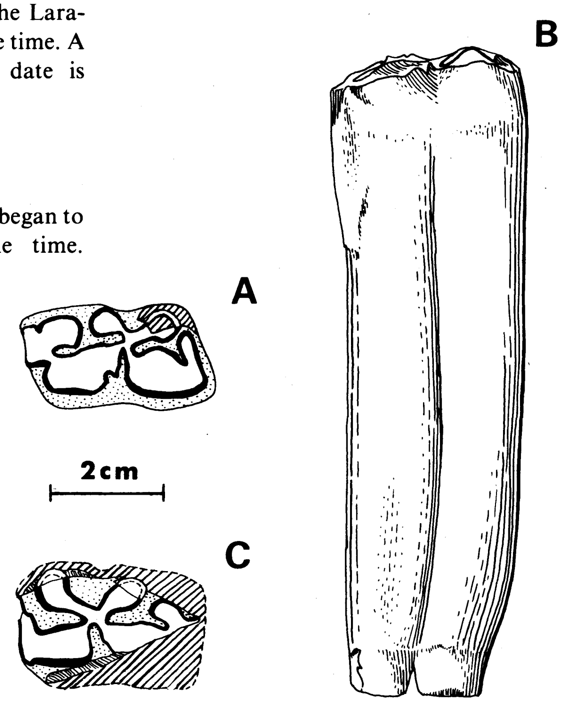

Figure 7. ***Equus*** **sp. cf.** ***E. scotti.*** **A-B. Right M/2? (UNSM 49478); A, occlusal view; B, labial view. C. Broken left M/1 or M/2 (UNSM 49472), occlusal view.**

APPENDIX 1. LOCATIONS OF SAMPLE SITES

Site no.	Legal description	County
1	S½SE¼SW¼ sec. 31, T. 19 N., R. 55 W.	Banner
2	SE¼SE¼NE¼ sec. 17, T. 19 N., R. 55 W.	Banner
3	SE¼SW¼SE¼ sec. 10, T. 18 N., R. 52 W.	Morrill
4	SE¼SE¼SE¼ sec. 25, T. 19 N., R. 52 W.	Morrill
5	SE¼SW¼SE¼ sec. 5, T. 18 N., R. 52 W.	Morrill
6	SW¼SW¼SW¼ sec. 26, T. 19 N., R. 53 W.	Banner
7	NE¼NE¼NE¼ sec. 32, T. 19 N., R. 55 W.	Banner
8	SE¼SE¼SW¼ sec. 28, T. 19 N., R. 55 W.	Banner
9	NW¼NE¼SW¼ sec. 23, T. 18 N., R. 54 W.	Banner
10	SE¼SW¼SE¼ sec. 21, T. 18 N., R. 53 W.	Banner
11	SW¼NE¼ sec. 9, T. 18 N., R. 54 W.	Banner
12	SW¼SW¼NE¼ sec. 27, T. 18 N., R. 53 W.	Banner
13	NW¼NE¼NW¼ sec. 31, T. 17 N., R. 53 W.	Banner
14	SE¼SE¼SE¼ sec. 9, T. 18 N., R. 55 W.	Banner
15	NE¼SW¼NW¼ sec. 15, T. 18 N., R. 55 W.	Banner
16	SW¼SW¼NW¼ sec. 15, T. 18 N., R. 55 W.	Banner

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