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GUIDE FOR A FIELD CONFERENCE ON THE TERTIARY AND PLEISTOCENE OF NEBRASKA

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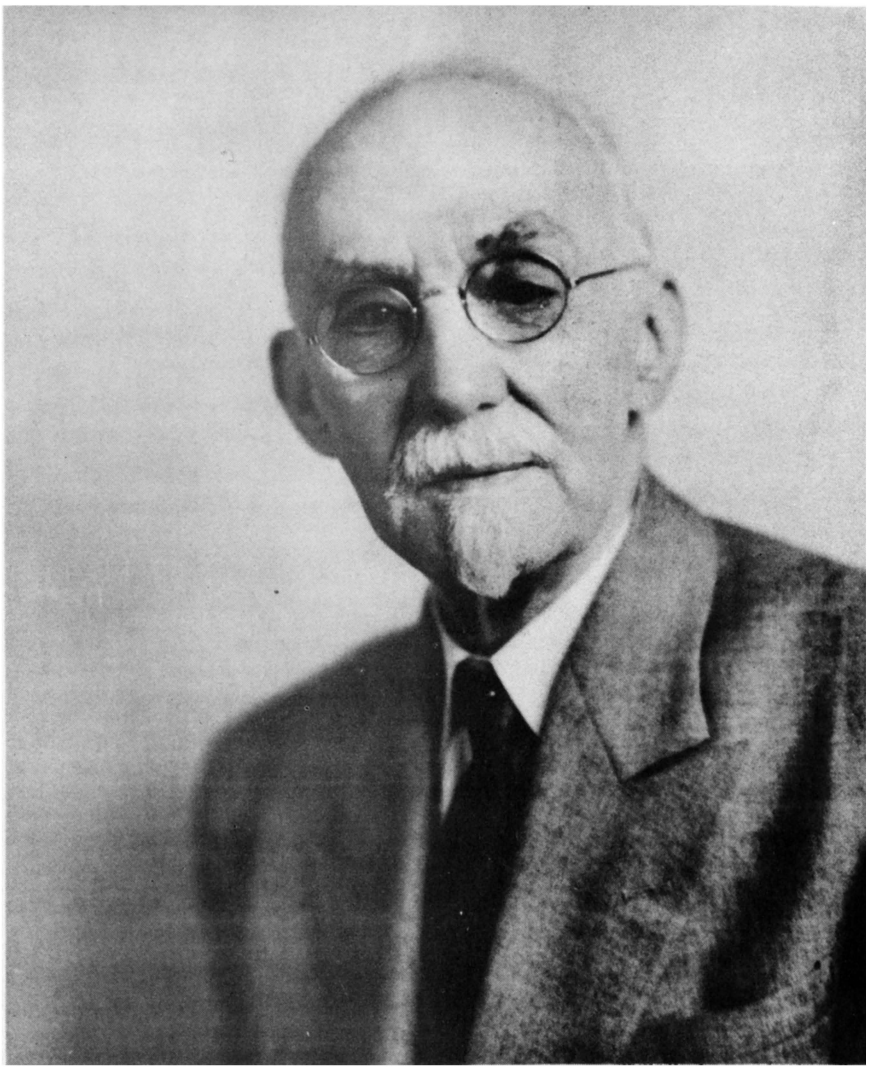

Erwin Hinckley Barbour

GUIDE FOR A FIELD CONFERENCE ON THE TERTIARY AND PLEISTOCENE OF NEBRASKA

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Dedicated to Dr. Erwin H. Barbour

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UNIVERSITY OF NEBRASKA STATE MUSEUM EXPLORATIONS, 1891-1941

The earliest record of the Museum states that in June of 1874 Professor Samuel Aughey was appointed Director of Cabinets. He was succeeded by Professor Lewis E. Hicks in June, 1885. Little work was carried on in paleontology, however, until Dr. Erwin H. Barbour took charge in 1891 and organized the first expeditions. In 1893, Mr. Charles H. Morrill began his generous support of the field work, and since that time important contributions by him and others have enabled this work to continue. The search for fossil remains has taken Museum parties to every county in Nebraska, and to several other states, including Arkansas, Colorado, Illinois, Iowa, Kansas, Missouri, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming.

It is particularly fitting that the University of Nebraska State Museum should at this time, on the completion of fifty years of active field work, be chosen as host institution for the first field conference of the newly-formed Society of Vertebrate Paleontology. The Society thus honors not only the Museum and the University of Nebraska but also pays tribute to the accomplishments of Professor Erwin H. Barbour, who has just completed fifty years as Director of the Museum. To Professor Barbour, leader in paleontological research in Nebraska, this guide is respectfully dedicated.

INTRODUCTION

It is not the purpose of this guide to repeat or even to summarize to any extent what has already been written concerning the Tertiary and Pleistocene stratigraphy and paleontology of Nebraska. The method of treatment is rather to focus attention on the local stratigraphy and faunal relationships at important locations within the State and to draw attention to places where the evidence for certain conclusions is good and where it appears to be weak or unsubstantiated. When one becomes familiar with the variable lithology and known successions at critical sections, a regional concept begins to form. This is decidedly important in understanding the processes which have played a part in the geomorphologic development of the Great Plains and furnishes a background for comprehending the slow but progressive changes in the animal life.

A generalized classification of the Tertiary deposits of Nebraska is given in Table 1, and the Pleistocene classification is shown in Table 2. Both of these have undergone numerous changes in the last few years, but it is believed that the general stratigraphic relationships are now fairly well understood although much remains to be done to clarify the details of the regional picture.

The Tertiary sequence in Nebraska may best be explained as being composed of four groups, or sedimentary "cycles", beginning with the lower Oligocene.[1] These are (1) the White River Group, (2) the Arikaree Group, (3) the Hemingford Group, and (4) the Ogallala Group (see Lugn, 1939B). The Pleistocene sequence is more complex.

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[1] The Eocene is absent in Nebraska and the Yoder member is now regarded as of lower Chadron age.

Table 1. THE TERTIARY FORMATIONS OF NEBRASKA[1]

PLIOCENE

IV. Ogallala Group
- Kimball formation
- Sidney gravel

- Ash Hollow formation
- Valentine formation (Burge sand member at top)

UNCONFORMITY

MIOCENE

III. Hemingford Group
- Sheep Creek formation (a complex not yet fully understood)

(Unconformity)
- Marsland formation (="Upper Harrison")

UNCONFORMITY

II. Arikaree Group
- Harrison formation
- Monroe Creek formation

(Unconformity)
- Gering formation

UNCONFORMITY

OLIGOCENE

I. White River Group

(Whitney member="Leptauchenia zone").
- Brule formation

(Orella member = "Oreodon zone").
- Chadron formation ("Yoder member" at base)

UNCONFORMITY

MESOZOIC - CRETACEOUS, mainly Pierre and Lance

[1] Modified from Lugn (1939B).

Table 2. THE PLEISTOCENE FORMATIONS OF NEBRASKA[1]

STANDARD CLASSIFICATION	EASTERN NEBRASKA	CENTRAL AND SOUTH-CENTRAL NEBRASKA	CORRELATIONS WITH WESTERN NEBRASKA
RECENT	River floodplains; alluvium	River floodplains; alluvium	River floodplains; alluvium; latest Sand Hills
IV WISCONSIN	Late terrace development; alluvium, loess, soil	Late terrace development, alluvium, loess, soil	Late terrace development, alluvium, loess, late Sand Hills, soil
PEORIAN	Yellow loess = Peorian (Soil): Citellus zone.	Yellow loess = Peorian. Soil: Citellus zone.	Yellow loess = Sand Hills formation = Peorian. Soil: Citellus zone.
	Terrace development		
IOWAN	Todd Valley formation	Terrace development	Terrace development
	UNCONFORMITY	UNCONFORMITY	UNCONFORMITY
SANGAMON	Loveland formation: (Red loess; volcanic ash; valley phase)	Loveland formation: (Red loess; volcanic ash; valley phase)	Loveland formation: (Red loess; volcanic ash; valley phase)
III ILLINOIAN			
	(Unconformity)	(Unconformity)	-Erosion-
YARMOUTH	Kansan gumbotil	Upland formation	High "terrace" of the Niobrara River: (Hay Springs-Rushville-Gordon sites)
II KANSAN	Kansan till	Grand Island formation	
	(Unconformity)	(Unconformity)	-Erosion-
AFTONIAN	Nebraskan gumbotil	Fullerton formation	
			High "terrace" (?) of the North Platte River: (Broadwater-Lisco sites)
I NEBRASKAN	Nebraskan till David City formation	Holdrege formation	
	UNCONFORMITY	UNCONFORMITY	UNCONFORMITY

[1] Modified from Lugn (1935).

CONFERENCE PROGRAM

The field conference is scheduled to begin on Sunday, August 31, 1941, starting at Bridgeport, Nebraska. However, those who wish to do so may start at Lincoln, Nebraska, on Friday, August 29, two days prior to the conference proper. A number of stops will be made en route to Bridgeport to examine important Pliocene and Pleistocene locations. The general route of the conference is shown in Fig. 1 and is summarized below:

Friday, August 29 : Pre-conference trip, Lincoln to Ogallala (315 miles).
Saturday, August 30: Pre-conference trip, Ogallala to Bridgeport (121 miles).
Sunday, August 31: First day of conference, Bridgeport to Scottsbluff (135 miles).
Monday, September 1: Second day of conference. Scottsbluff to Crawford (154 miles).
Tuesday, September 2: Third day of conference, Crawford to Ainsworth (258 miles).
Wednesday, September 3: Fourth day of conference, Ainsworth to Lincoln (320 miles).
Thursday, September 4: Informal discussions and study of collections at The University of Nebraska State Museum, Lincoln.

Emphasis will be placed on the local stratigraphy to be seen along the route, and each section will be interpreted as nearly as possible into the regional sequence. Road itineraries with scheduled stops have been prepared for each day. A summary of the necessary or pertinent information and a discussion of the most important topics considered during the day will follow each day's road log.

ROAD LOG FOR PRE-CONFERENCE TRIP

Friday, August 29, 1941
Lincoln to Ogallala, Nebraska
Route distance about 315 miles

Meeting Place: Lincoln, Nebraska, at Morrill Hall, The University of Nebraska State Museum. Leave at 9:00 A. M.

0.0 Cars line up headed west at north side of Morrill Hall. Go west one block, turn left and go south to "O" Street. Turn right and go west on U. S. 6 about 102 miles to Hastings.

103.5 STOP 1. Brief stop at Hastings to visit the Hastings Municipal Museum through the courtesy of Mr. A. M. Brooking, director.

104.0 Leave Hastings; take U. S. 6 about 24.5 miles west to a point 2 miles southwest of Heartwell and take cut-off 6.5 miles west to highway 10. Follow highway 10 north 6 miles and then west 2.8 miles to the site of Fort Kearney. This fort (the second of that name and originally Fort Childs) was one of the most important

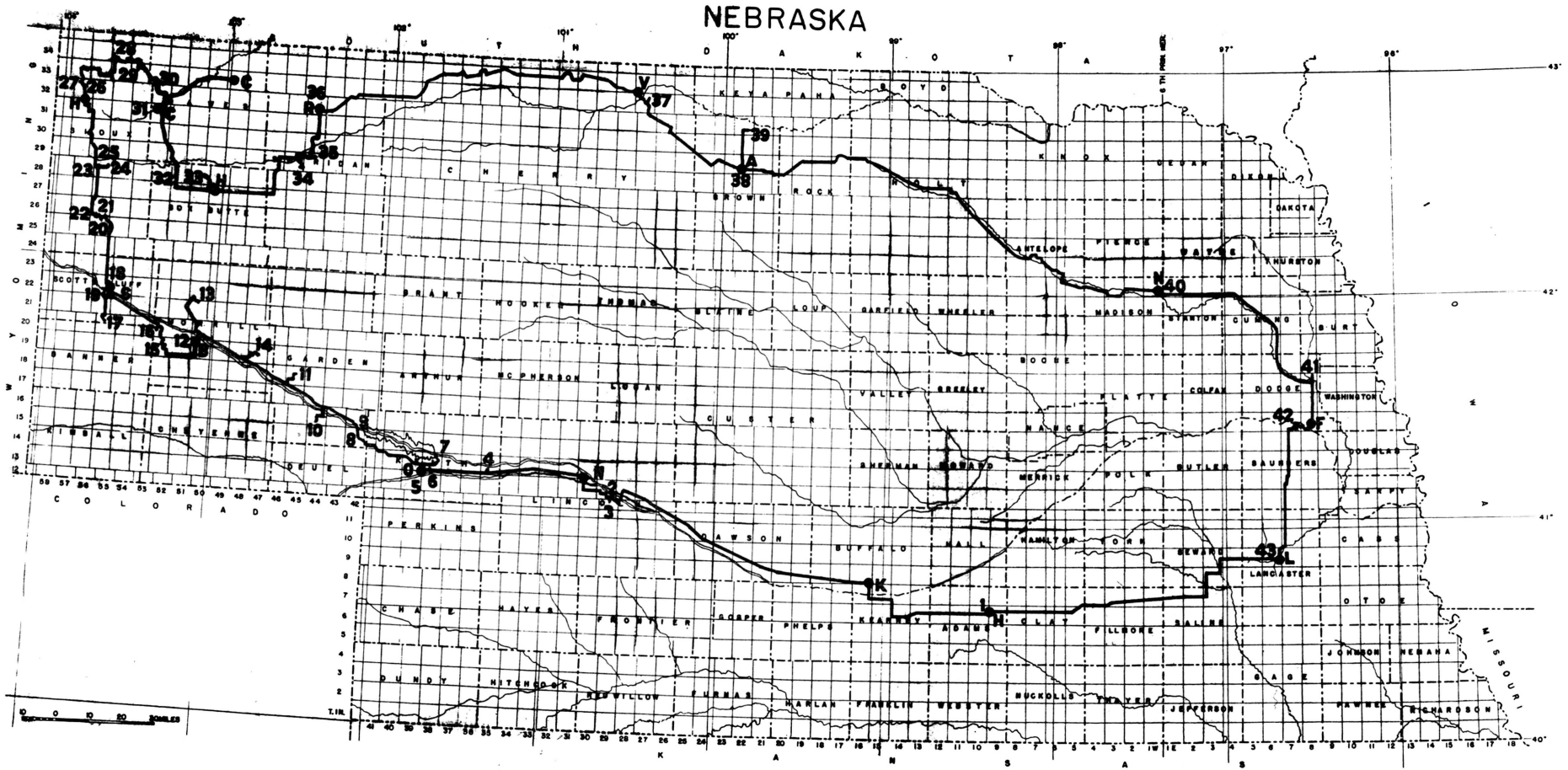

Figure 1. Generalised map of Nebraska showing route and stops of first field conference of the Society of Vertebrate Paleontology.

military posts in the West. It was established (as Fort Childs) in June, 1848, and abandoned in 1871. Both the fort and present city of Kearney were named after General Stephen W. Kearny (note spelling). From Fort Kearney continue west 4.2 miles, then north 4.5 miles across the Platte River to Kearney.

152.5 Reach Kearney; take U. S. 30 about 82 miles west to Maxwell, a small town 13.5 miles east of North Platte.

234.5 Reach Maxwell; leave U. S. 30, turn left at railroad crossing and go south 3.3 miles across the Platte River to a point just north of the Fort McPherson National Cemetery. Turn right and go west 1 mile, northwest 1.2 miles, west 2.2 miles, north and northwest 1.3 miles to Bignell.

243.5 Reach Bignell; turn left and go south .9 mile to Stop 2.

244.4 STOP 2. Brief stop to examine outcrop near road of Citellus zone, with the red sands of the "valley phase" of the Loveland formation below and the yellow "Peorian" loess above the zone. The Citellus zone is one of the important late Pleistocene levels in Nebraska, and it has been recognized all over the State. (See discussion). Continue .8 mile south to top of Bignell Hill.

245.2 STOP 3. Brief stop at top of Bignell Hill, 1.7 miles south of Bignell, to observe late Pleistocene (Wisconsin) soil and general terrace relationships in the loess canyons here. The road between stops 2 and 3 crosses the outcrop of the Citellus zone, and passes over the entire thickness of the yellow "Peorian" loessic silts.

247.0 Return to Bignell; turn left and continue west 1.5 miles; then go north 1 mile, west 2 miles, north 1 mile, and west 4.7 miles to The University of Nebraska Experimental Station. This road passes by Sioux Lookout, a prominent loess bluff, and roughly parallels the loess escarpment. Before reaching the Experimental Station, the road passes by the power plant and upper diversion dam of the Central Nebraska Public Power and Irrigation District. This is part of one of the large power and irrigation projects to be observed at a number of places along the route of the conference.

257.2 Reach The University of Nebraska Experimental Station. Excavations near here have revealed a considerable thickness of the Ogallala (Pliocene). Turn right and go north across the South Platte River about 3.5 miles to North Platte, Nebraska.

260.7 Reach North Platte; resume route on U. S. 30 and go west 32.7 miles to Paxton. Note: North Platte is on Central Standard Time, but west of North Platte Mountain Standard Time is used (e.g., 4:00 C.S.T. 3:00 M.S.T.).

293.4 Leave U. S. 30 at east edge of Paxton; turn right and go north about .8 mile on main road and trail to point where the Paxton Cut may be observed.

294.2 STOP 4. Brief stop at the Paxton Cut. This cut has been made through the divide ridge between the North and South Platte Rivers and allows the diversion (from the Kingsley Dam) of the North Platte River water. Near the east edge of Paxton this water enters a large siphon which goes under the nearly dry South Platte River. The water is then conducted by way of a canal system to the Sutherland Reservior and other reserviors further east, after which it is allowed to return to the Platte River by way of a series of large power plants near North Platte and Gothenburg, where electricity is generated. The water is then used again downstream for irrigation purposes. (See discussion as to the geology of the Paxton Cut).

295.0 Return to U. S. 30 at Paxton; follow U. S. 30 about 20.0 miles west to Ogallala.

315.0 STOP 5. Ogallala, Nebraska.

DISCUSSION AND SUMMARY NOTES

The Citellus Zone.--This zone, which has proved to be one of the most extensive late Pleistocene levels in Nebraska, was first defined (Schultz, 1934, p. 359-60) as follows:

"The Loveland and Peorian loesses are well distributed throughout most of Nebraska. In southeastern Lincoln County, the Loveland and Peorian reach a thickness of 120 and 200 feet or more, respectively. A soil zone, varying in thickness from a few inches to four feet, occurs at the top of the Loveland loess. Its absence in places is due to post-Loveland and pre-Peorian erosion.

"During July of the 1934 collecting season, Mr. Thompson M. Stout and the writer visited all of the sites in southeastern Lincoln County from which Pleistocene fossils have been collected. The results of this survey show that all specimens under consideration from this area are either from the soil zone which rests upon the Loveland loess, or from the lower four feet of the Peorian loess directly above the soil zone. There does not seem to be a sharp division between the upper part of the soil zone and the basal part of the Peorian. The soil zone and the Peorian gradational layer are here grouped together and called the Citellus faunal zone because of the abundance of fossil remains of the ground squirrel Citellus found in this zone. The importance of this faunal zone lies in the fact that it furnishes a definitely dated late Pleistocene fauna. The Citellus faunal zone is post-Loveland and pre-Peorian or early Peorian. This zone, insofar as it has been investigated has definitely yielded the remains of Citellus cf. elegans (Kennicott); Thomomys talpoides (Richardson); Mustela vison Schreber; Archidiskodon imperator (Leidy); Archidiskodon imperator maibeni (Barbour) type; Parelephas columbi (Falconer); Platygonus sp.; Camelops sp.; and Bison sp."

University of Nebraska State Museum parties have since made numerous additions to the Citellus zone fauna, particularly during the seasons of 1940 and 1941. Study and preparation of these new collections is still in progress. Discussions on the importance and possible correlation of the Citellus zone have been published by Lugn (1934, p. 347-9; 1935, p. 136-55; and 1939C, p. 877-81).

The Paxton Cut.——The excavations here have been made through Pleistocene gravels which have yielded Stegomastodon mirificus. Mainly on this evidence it is suggested that these gravels may be of about the same age as those at the Broadwater and Lisco sites. This may be of importance in interpreting the earlier course of the North Platte River.

ROAD LOG FOR PRE-CONFERENCE TRIP

Saturday, August 30, 1941
Ogallala to Bridgeport, Nebraska
Route distance about 121 miles

Meeting Place: Ogallala, Nebraska, Duchess Hotel. Leave at 8:00 A.M. Lunches are to be taken.

0.0 Cars line up headed east at south side of hotel. Take old highway (which parallels U. S. 30), and go east past the Feldt Ranch.

2.0 Reach gate on north side of road at mouth of small gully. Leave road and follow trail up the gully.

2.8 STOP 6. Feldt Ranch Site. This has sometimes been called the "type locality" of the Ogallala. Upper part of the Ash Hollow formation. (See discussion). Return to Ogallala by same route.

5.6 Reach Ogallala; take U. S. 26 north out of town about 2.5 miles, then take side road east and north about 6.5 miles to Kingsley Dam.

14.6 STOP 7. Brief stop at the Kingsley Dam. The Ash Hollow formation is well exposed in places along the escarpment south of the North Platte River from here east to Cedar Point. However, the Ash Hollow formation will be considered in more detail later in the day at the type locality.

21.0 Return to U.S. 26; go west and northwest about 22 miles to Ash Hollow Canyon. Along this road the Ash Hollow formation is well exposed in the escarpment along the south side of the North Platte River. The section at Eagle Canyon, south of Belmar, was reported upon by Robert Hay as early as 1895(see discussion). Above the Ash Hollow formation in places a considerable thickness of yellow loess (=Peorian; Hay's "Tertiary or Plains Marl") may be observed.

43.0 STOP 8. Brief stop at entrance to Ash Hollow Canyon. Here gravels

of probable Sidney age overlie the typical Ash Hollow formation. Above the Sidney gravels near here remnants of the Kimball formation have been found in place (Lugn). The Sidney and Kimball formations will be studied in greater detail later in the day.

Descending Ash Hollow Canyon we pass over the entire thickness of the Ash Hollow formation. This is one of the most famous spots along the Oregon Trail. At the left of the old stone house one may see the Windlass Hill where travelers on the Oregon Trail lowered their wagons from the tableland into the Ash Hollow Canyon. The highway crosses the Oregon Trail at many points.

Observe the Ash Hollow Spring at right side of the highway. This was made famous by Capt. Frémont in 1842 as the spring of the "Coulée des frènes", thus giving the Canyon its picturesque name. Recent excavations of the Ash Hollow Cave above this spring by the Nebraska State Historical Society under the direction of Mr. A. T. Hill and studies of the collections by Mr. Hill and Prof. John Champe of The University of Nebraska show the presence of "some variant of the Woodland culture" at the third of the four occupational levels. (See Nebraska History Magazine, vol. 21, no. 3, p. 224-7, pl. 23, May, 1941 issue).

46.0 STOP 9. Near mouth of Ash Hollow Canyon, turn off to right of highway to examine outcrop of lower contact of Ogallala basal conglomerate on Brule (?) silty clay. (See discussion as to age of this basal conglomerate).

Opposite this outcrop on the other side of Ash Hollow Canyon are the graves of Rachel Pattison and two children, buried here along the Oregon Trail in 1849.

To the north along the river bank a low mound of earth is all that remains of Fort Grattan (September 8 - October 1, 1855), a temporary post erected by General William S. Harney at the time of the Battle of Ash Hollow. This battle was essentially a massacre of 86 of the small band of Brule Sioux under Little Thunder, accused of depredations and of being involved in the "Grattan Incident" at Fort Laramie on August 19, 1854. The Ash Hollow massacre actually occurred on Blue Creek (Blue Water), northwest of Ash Hollow, on September 5, 1855, but General Harney's forces of 700 or 800 men were camped opposite Ash Hollow. General Harney had delayed his departure from Fort Leavenworth waiting for the camels which had been imported for a "camel corps" experiment, but since the camels did not arrive he started the expedition which resulted in this first engagement between soldiers and Indians in Nebraska. Lieutenant G. K. Warren was present at the Battle of Ash Hollow and made a map of it.

Follow U. S. 26 south and west to Lewellen, Nebraska and then about 11 miles west to Oshkosh, Nebraska.

60.0 Leave Oshkosh, take highway 27 south about 3 miles to junction with an old road. Turn right on this old road and go about 2 miles up the canyon.

65.0 STOP 10. Oshkosh Locality A quarry sites. (See discussion).

70.0 Return to Oshkosh by same route; take U. S. 26 west about 10 miles to Lytle Station.

80.0 Leave U. S. 26 and turn north at the Lytle Beet Loading Station on a winding country road.

84.2 STOP 11. Lisco Locality C quarries. These are some of the sites which have yielded remains of the remarkable giant camelid, Gigantocamelus fricki. (See discussion for first day, August 31).

88.5 Return to U. S. 26 by same route; continue west to Northport.

120.0 Reach Northport, turn south on U. S. 19 and cross the North Platte River to Bridgeport.

121.0 STOP 12. Reach Bridgeport.

DISCUSSION AND SUMMARY NOTES

The "Type Locality" of the Ogallala Group.—The Ogallala was first employed as a formational term by Darton in several preliminary papers (1898; 1899A), and formally proposed in his more extensive reports (1899B, p. 734-5, 741-2; 1903A, p. 16-7, 23-4; 1905, p. 178-9). No definite designation of a type locality was made by Darton until many years later (1920, p. 6), when he wrote:

> "The Ogallala formation is believed to be a stratigraphic unit and to be continuous from the type locality near Ogallala station in western Nebraska."

The problem of a definite type locality for the Ogallala "formation" has been discussed by Elias (in Stirton, 1936, p. 184) and by Hesse (1935B) and the Feldt Ranch site has been suggested by them as the type locality.

It may be noted that as early as 1895, Robert Hay (1895, p. 580-1) published a geologic section for Eagle Canyon and vicinity (near Belmar, Nebraska), northwest of Ogallala. He referred to these rocks (of Ash Hollow age) as "Tertiary grit". This work preceded that of Darton by several years.

The Ogallala has been recently elevated to the rank of a group (Lugn, 1938, p. 223-5; 1939A, p. 433-4; 1939B, p. 1258-60), including by definition, from oldest to youngest, the Valentine (Burge member at top), Ash Hollow, Sidney, and Kimball formations.

The Feldt Ranch Site.—This site, discovered by Elias in 1931 and located in the SW. $\frac{1}{4}$NE. $\frac{1}{4}$, sec. 33, T. 14 N., R. 38 W., two miles east

and one-half mile north of Ogallala, Keith County (relocation by Lugn), has been reported upon or mentioned in papers by Hibbard (1933), Hesse (1935A; 1935B), Stirton (1936, p. 184; with Teilhard de Chardin, 1934, p. 282, 284), and others. Much of the described material is fragmentary or immature, and even generic identifications cannot safely be made on some of the specimens. The maximum thickness of sediments exposed here does not exceed 120 feet (Lugn).

The Feldt Ranch site can be correlated without difficulty into the sequence of sediments in the upper part of the Cedar Point section, and this in turn allows correlation with the upper Ash Hollow sediments throughout the North Platte River valley. Its stratigraphic position seems to be in the upper part of the Ash Hollow formation.

The Type Locality of the Ash Hollow Formation.—This formation was first recognized by Henry Engelmann in a report written in 1860, but delayed in publication by the Civil War and not published until 1876 (Engelmann, 1876; see especially p. 260-2, 283). This report has unfortunately been overlooked by all writers on the Great Plains Tertiary until very recently. Engelmann was geologist of the expedition commanded by Capt. J. H. Simpson, organized for the purpose of opening new wagon routes for military purposes across the Great Basin of Utah. His observations, made during 1858 and 1859, began with the region about Fort Leavenworth and southeastern Nebraska, and followed the route of the expedition up the Platte River to the junction of the North and South Platte Rivers, then up the South Platte and along the Oregon Trail to Ash Hollow and the usual route up the North Platte River past Scotts Bluffs. Engelmann had previously accompanied the expedition under Lieutenant F. T. Bryan, U. S. Topographical Engineers, from Fort Leavenworth to Bryan's Pass, in the Rocky Mountains, in 1856 (Engelmann, 1858), which included some study of the Republican River valley. His remarks on Tertiary geology are remarkably clear and accurate. He seems to have been the first person to note the abundant Celtis seeds in the Ash Hollow formation.

The term "Ash Hollow formation" was independently suggested by Lugn (1938, p. 220-8), who did not realize that Engelmann had previously made use of the term in a less formal way for the same deposits. The Ash Hollow formation is defined and discussed by Lugn (1939A, p. 435-6; also 1939B, p. 1261) as follows:

> "The type section of this formation occurs in exposure in Ash Hollow Canyon southeast of Lewellen, Nebraska. The beds belonging to this formation in Ash Hollow Canyon, above about 55 feet of Brule formation, consist of layers of gravel and sand, silt, and fine sandy clay, with some beds of volcanic ash, all more or less indurated into hard caliche beds at fairly regular intervals. The total thickness of the beds believed to belong to the Ash Hollow formation, from the top of the Brule clay to the base of the overlying Sidney formation, is from 250 to 265 feet. This thickness includes a layer of conglomeratic limy sand and gravel which appears to lie below the Krynitzkia fossil seed zone, and this bed may be found to correlate with the Burge channel member of the Valentine formation. The Sidney gravel formation and remnants of the Kimball formation (Lugn, 1938) occur at elevations above the top of the Ash Hollow under the High

Plains tableland level to the south of the canyon. The Ash Hollow formation in the type locality includes the 'cap rock bed' (in the main the Krynitzkia fossil seed zone) at the base and the fully developed Biorbia seed zone above, exactly as in the Valentine, Nebraska, vicinity, except that the Biorbia zone is not as fully developed or it has been in part eroded away in the northern part of the State. The detailed bed-by-bed description of the type section of the Ash Hollow formation will appear in a Nebraska Geological Survey Bulletin now nearing completion.

"It has come to the writer's attention recently that the 'Ash Hollow formation' is not a new or even recent name, as was at first supposed (Lugn, 1938). The term Ash Hollow formation was applied to exactly the same beds in Ash Hollow Canyon, the same location and exposures noted above, and they were said to 'attain a thickness of over 250 feet' first by Henry Englemann in 1858 or 1859 (Engelmann, 1876). It is a source of gratification that the recent redefinition (or reapplication) of the Ash Hollow formation by the writer and others matches perfectly in every way--lithology, thickness, location, and type section--the original definition of the "Ash Hollow formation' by Engelmann. It is a pleasure to attribute to Engelmann the original authorship for this formation.

"By right of absolute priority no part of the 'Valentine beds' can be assigned to this formation without adequate justification for redefining it. The top of the Valentine formation, including the Burge channel member in the upper part, is at the base of the 'cap rock bed' or Krynitzkia seed zone, as previously noted. If the conglomeratic sand or gravel bed at the base of the 'Ash Hollow formation' in the type locality can be demonstrated to not belong to the Krynitzkia zone, and if it can be shown to correlate with the Burge member, it would seem at the present writing to be advisable to retain the Burge member in the Valentine formation as proposed (Lugn, 1938), and to redefine Engelmann's Ash Hollow formation to the extent of shifting this lowest conglomeratic bed into the Valentine formation."

The Oshkosh Locality A Quarry Sites. These quarries were first opened in 1937 by members of The University of Nebraska State Museum field party, assisted by S. R. Sweet, T. C. Middleswart, W. F. Chaloupka, and Lester Truscott. This and subsequent work has revealed an extremely interesting faunal assemblage of probable late Pliocene age. These sites are believed to be in the Sidney gravels, and a part of the Kimball formation is in place above. These quarries are some of the most important yet discovered in Nebraska and work is being continued to recover more of the fossil remains here.

The Sidney Gravel and Kimball Formation.--The uppermost formations of the Ogallala group have been designated the Sidney gravel and Kimball formation (Lugn, 1938, p. 224), and defined as follows (Lugn, 1939B, p. 1261-3):

"The third formation of the Ogallala group is known as the Sidney gravel from occurrences at Sidney, Nebraska. It ranges in thickness from 15 to 50 feet and is widespread in southwestern Nebraska, northeastern Colorado, and in parts of western Kansas. It is the upper

part of the 'Biorbia fossil seed zone', although Biorbia also occurs in the Kimball formation.

"The type exposure of the Sidney gravel is located in the high bluff at the north side of the town of Sidney, Nebraska, a few rods west of the elevated water tanks which are a part of the Sidney water supply system. The gravel bed at this location is 20 feet thick and consists of crystalline sand and gravel ranging in texture from fine and medium river sand to pebbles and cobbles as much as 4 to 6 inches in diameter. Many of the pebbles are covered with a thin dark coating of mineral and clay which give to the deposit a characteristic darkish appearance in many fresh exposures. The gravel bed rests on a hard caliche sandstone or 'grit' layer, belonging in the Ash Hollow which is commonly quite characteristically pitted with old 'fossil' potholes, some of which are as much as 5 or 6 feet deep and several feet in diameter. Many potholes may be observed below the gravel at the type exposure, but none at this place seem to attain the maximum size observed at a few other exposures. . . .

"A fourth and uppermost formation of the Ogallala group is known as the Kimball formation from its typical occurrence at the highest remnant levels of the High Plains in Kimball county, Nebraska. The thickness of the Kimball formation ranges from 25 to 50 feet where present in its full development and consists of silt clay, and fine sand, partly cemented with caliche, with one or two algal limestone beds at the top. . .

"The Kimball formation in general consists of three beds or zones. The lowest bed, resting with apparent conformity on the Sidney gravel at most places, is a grayish and pinkish 'grit' or caliche sandstone, composed of fine to coarse sand, with small granule pebbles in some places. It may contain nodular bands of milky chert or chalcedony, generally fairly hard and indurated, forming a more or less prominent ledge. This lowest zone ranges from 5 to 10 feet in thickness. The middle bed of the Kimball formation, 18 to 22 feet thick, consists of fine silty sand, pinkish and brownish, and for the most part soft. The uppermost or algal limestone zone generally is one conspicuous bed of whitish hard algal limestone 2 to 3 feet thick; but it may consist of two or even three algal limestone layers with interbedded soft pinkish to grayish fine silty sand and marly clay, in all ranging up to 12 to 15 feet in thickness. Milky chert also may be a constituent of this uppermost bed of the Kimball formation and minute siliceous structures strongly suggestive of spore cases of the algal genus Chara are also present.

"The lower part at least of the Kimball formation generally contains Biorbia fossil seeds and certain other fossil seeds, as noted above, which Elias believes to be restricted to the uppermost beds of the Ogallala group. A typical exposure of the Kimball formation occurs at the High Plains level about 2 miles south of Kimball, Nebraska, in the vicinity of the adjoining corners of sections 5, 6, 7, and 8, T. 14 N., R. 55 W.; and many other good exposures occur from this point southward into Colorado. Typical development of the Kimball formation where the beds are well exposed, may be seen also at these locations: south of Harrisburg, Nebraska, in Banner County, in the SE. $\frac{1}{4}$, sec. 26, T. 18 N., R. 56 W.; at 9 miles east of Sidney, Nebraska, in Cheyenne County, the SW. $\frac{1}{4}$, sec. 23, T. 14 N., R. 48 W.; near the Lone Star School in Colorado, 20 miles south of Kimball, Nebraska; and at innumerable other locations in southwestern Nebraska, northeastern Colorado, and western Kansas."

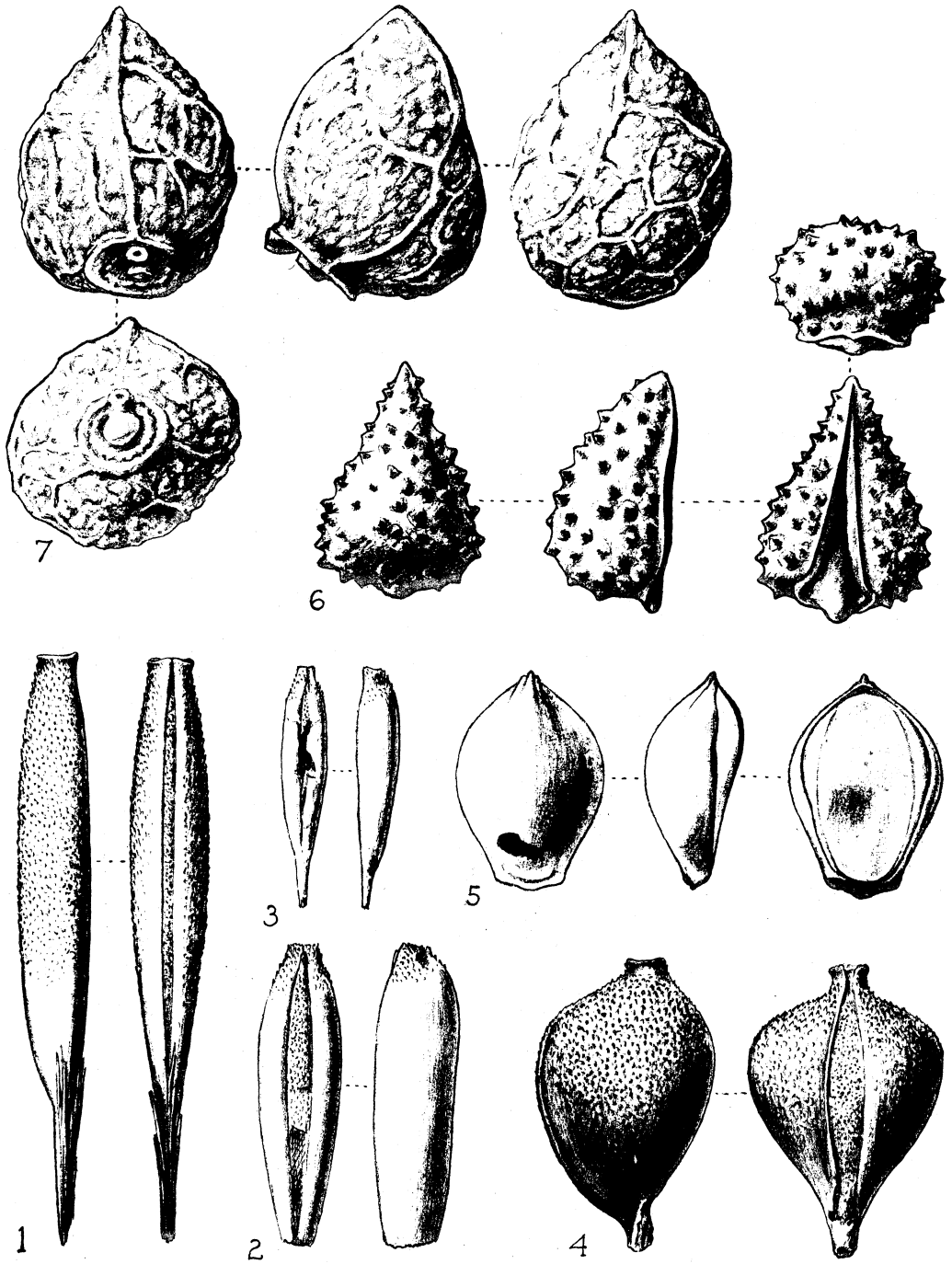

Figure 2. Late Tertiary prairie vegetation. 1- Stipidium sp., Valentine fm., x 12. 2 and 3- Stipidium sp., Merychippus quartus and M. quintus zone, Sheep Creek fm., x 12. 4- Berriochloa sp., Ash Hollow fm., x 12. 5- Panicum elegans Elias, middle part of Ash Hollow fm., x 18. 6- Krynitzkia coroniformis Elias, basal part of Ash Hollow fm., x 15. 7- Biorbia fossilia (Berry) Elias, middle part of Ash Hollow fm., x 15.

LATE TERTIARY PRAIRIE VEGETATION IN NEBRASKA

By Maxim K. Elias
Nebraska Geological Survey

The most common remains of the late Tertiary prairie vegetation of Nebraska are the seeds of grasses and of Borage herbs. Usually only the outer, protective parts of these seeds are preserved, such as husks of the grasses.

The comparative study of fossil and related living herbs leads to the conclusion that the successive changes observed in the late Tertiary prairie flora are in part the results of the endemic evolution and in part indicate repeated migration, controlled by climate and edaphic changes.

In the earliest known local occurrence of the prairie herbs, in the Harrison rocks of the lower Miocene, only one small species of Stipidium, closely related to the living spear-grass Stipa, has been found. This form is perhaps the ancestor of the whole tribe of Stipeae. In the Merychippus primus zone of the Sheep Creek, Stipeae become diversified and abundant, three or four species of Stipidium and one of Berriochloa having been found. The husks of nearly all of these grasses are tuberculate like in the living Stipa comata, the dominant spear grass of the mixed prairie of western Nebraska.

In the Merychippus quartus and quintus zone of the Sheep Creek a complete change of the prairie vegetation is observed: although abundant it is represented here by only one species of Stipidium with the smooth husk, like in the living Stipa spartea of the true prairie of eastern Nebraska; also a Carex of Cyperacea, was found.

In the Box Butte clay member of the Sheep Creek the same species of Stipidium with smooth husk is found accompanying another species of the genus which has tuberculate husk and which become the characteristic grass of the succeeding Valentine vegetation.

Only the seeds of Stipidium are known in the Valentine rocks, one species of which is very abundant and resembles the dominant living Stipa comata. In the basal part of the succeeding Ash Hollow rocks Stipidium is well represented, but is by far overshadowed by the predominant borage herb, Krynitzkia, the migration of which into the region seems to indicate a step toward more mesic conditions. The optimum mesic conditions seem to have been reached in the next, medial part of Ash Hollow time. The most abundant form of this time was a borage herb Biorbia, an ancestor to the living Lithospermum, which is a fairly common member of the true prairie in eastern Nebraska. Besides this form we find in this time also an abundance of Stipeae, which tribe was represented, in the order of prominence, by Berriochloa, Stipidium, Nassella, and an ancestor of Eriocoma; also a species of Panicum of the Millet tribe appeared here for the first time and became more and more prominent with the advance of Ash Hollow time. However, the whole vegetation becomes impoverished in later Ash Hollow time.

In the Kimball, which is the youngest formation of the Ogallala group, occurrences of seeds are rare. The known seeds consist of Setaria and Panicum of the Millet tribe, with an addition of a borage herb intermediate in character between Biorbia and Lithospermum. This flora seems to indicate a rise of ground water level. This conclusion is supported by the widespread occurrence at the end of Ogallala time of the algal (Chlorellopsis) limestone, which was apparently deposited in large, though shallow lakes.

ROAD LOG FOR FIRST DAY OF FIELD CONFERENCE

Sunday, August 31, 1941
Bridgeport to Scottsbluff, Nebraska
Route distance about 135 miles

Meeting Place: Bridgeport, Nebraska, Iddings Hotel. Leave at 8:00 A.M. Lunches are to be taken.

0.0 Cars line up headed west at north side of hotel. Turn right and go north on U. S. 19 toward Angora.

12.8 Turn right on trail at a point about 1.2 miles south of Angora. Follow trail about 1.5 miles to the Bridgeport Quarries.

13.3 STOP 13. Bridgeport Quarries Marsland formation. (See discussion) Return to Northport by same route

25.6 Reach Northport; follow U. S. 26 about 13 miles to Broadwater, Nebraska.

38.6 Reach Broadwater; take old highway at east edge of town and go east about 5.5 miles past Break-neck Hill.

44.1 STOP 14. Broadwater Locality A Quarries. Lower Pleistocene. (See discussion). Return to Bridgeport.

63.6 Reach Bridgeport, take highway 88 south 5.9 miles and then west 9 miles to Redington. This road turns west near Court House and Jail Rocks, famous landmarks on the Oregon Trail, and then passes along the south side of Wild Cat Ridge in the Pumpkin Creek valley. Other points of interest are Round House Rock and Bird Cage Gap. Along this route the Whitney member of the Brule formation is at the base of the local section, disconformably overlain by the Gering formation, with the Monroe Creek formation at the top.

78.5 Reach Redington, go north 2.3 miles to Redington Gap.

80.8 STOP 15. Redington Gap. Whitney member of the Brule formation disconformably overlain by the Gering and Monroe Creek formations. (See discussion).

Pass through Redington Gap; continue north about 5.3 miles, then west 1 mile, north 1 mile, west 2 miles north, 1 mile, and west about 1.2 miles to gate. Pass through gate and follow trail south about .7 mile to Chimney Rock.

Figure 3. Giant camel remains (*Gigantocamelus fricki*) at Lisco Locality C. Lower Pleistocene.

Figure 4. Broadwater Locality A quarry site, showing diatomaceous earth and peat bed overlain by gravels. Lower Pleistocene.

Table 3.

REVISED LIST OF MAMMALS FROM THE BROADWATER AND LISCO LOCALITIES

	BROADWATER	LISCO		
	A	A	B	C
INSECTIVORA				
Sorex sp.	—			
EDENTATA				
Mylodon sp.	—			
Megalonyx sp.	—?—		—	
LAGOMORPHA				
Lepus or *Hypolagus* sp.	—			
Sylvilagus sp.	—			
RODENTIA				
Sciurid (*Citellus* group?)	—			
Sciurid (*Cynomys* group?)	—?—		—	
Geomys sp. (large form)	—		—	
Geomys sp. (small form)	—			
Thomomys sp.	—			
**Procastoroides sweeti* Barbour & Schultz	—		—?—	
Peromyscus sp.	—			
***Pliopotamys meadensis* Hibbard	—			
Pliophenacomys primaevus Hibbard	—			
Microtine	—			
Zapodid (*Pliozapus*? sp.)	—			
Neotoma? sp.	—			
CARNIVORA				
Canis sp.	—		—	—
Borophagus sp.	—	—	—	—
Satherium piscinaria middleswarti Barbour & Schultz	—			
Mephitis sp.	—			
Smilodon sp.	—		—	—
PROBOSCIDEA				
Stegomastodon mirificus primitivus Osborn	—			
Mastodon sp.			—	
PERISSODACTYLA				
Equus (near *Plesippus*) sp.	—		—	—
Equid (near *Nannippus*)	—			
ARTIODACTYLA				
Platygonus sp.	—			
Camelops sp.	—			
Tanupolama sp.	—			
Gigantocamelus fricki Barbour & Schultz	—	—	—	—
Antilocaprid	—			

* Probable synonym: *Eocastoroides lanei* Hibbard.
** Probable synonym: *Neondatra kansasensis* Hibbard.

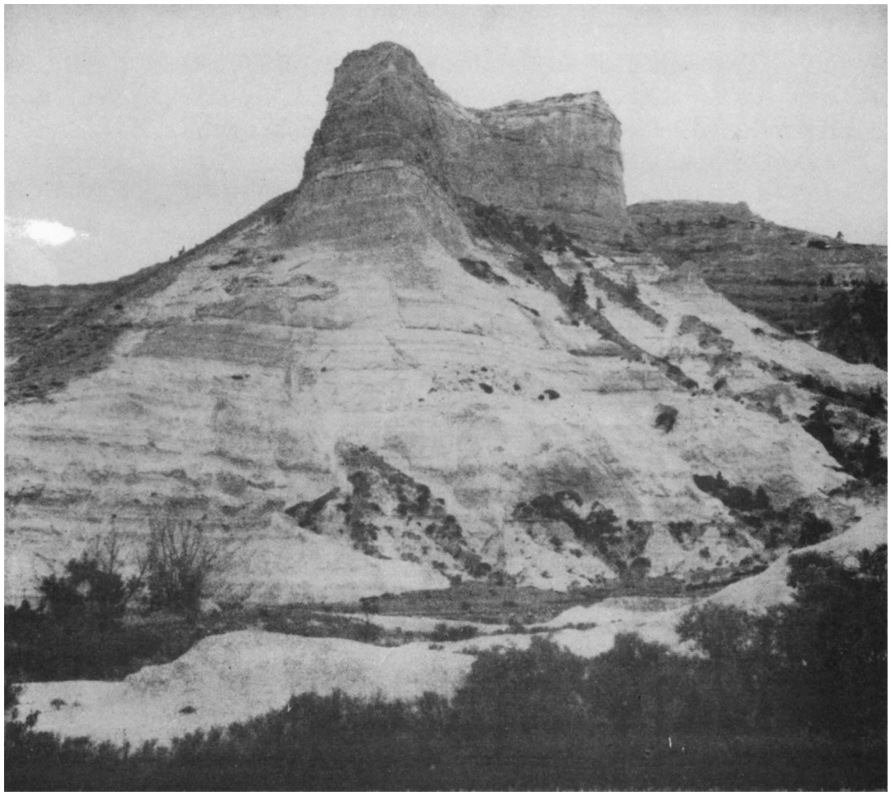

Figure 5. North face of Scotts Bluff National Monument, near Scottsbluff, showing Oligocene (mainly Whitney member, Brule formation) overlain by Miocene (Gering and Monroe Creek formations).

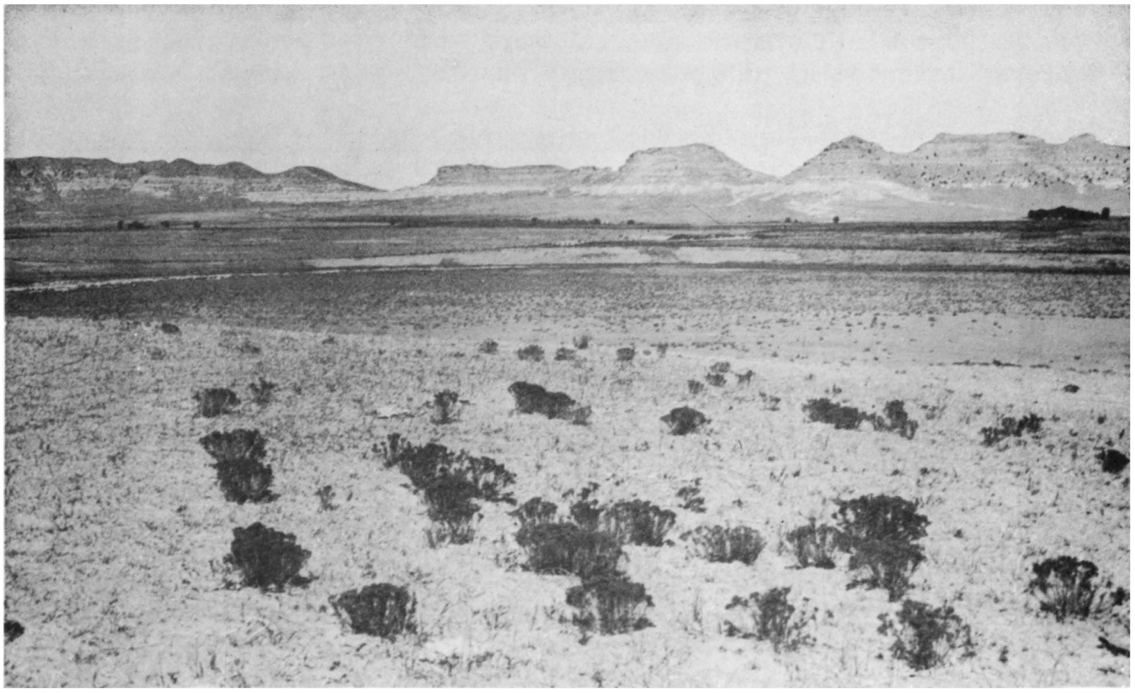

Figure 6. Wildcat Ridge near Redington, southwest of Bridgeport. Redington Gap at the left.

93.0 STOP 16. Chimney Rock. Whitney member of the Brule formation disconformably overlain by Gering, and to the south the Monroe Creek formation above this (See discussion). This is one of the most famous historic landmarks along the old Oregon Trail. Return by same trail to gate; pass through gate, go east about .8 mile then north .5 mile to highway 86

95.0 Reach highway 86 near South Bayard; turn west and follow highway 86 about 18.6 miles to Gering.

113.6 Reach Gering; continue west .7 mile, turn left and go south 8.5 miles to top of Stage Hill.

122.8 STOP 17. Top of Stage Hill. Return to Gering.

132.0 Reach Gering; go north 2.5 miles to Scottsbluff.

134.5 STOP 18. Reach Scottsbluff.

Note: All members of the conference are cordially invited to visit the Scotts Bluff National Monument during the evening, through courtesy of Mr. Merrill J. Mattes.

DISCUSSION AND SUMMARY NOTES

The Bridgeport Quarry Sites. These quarries were discovered in 1931 by a University of Nebraska State Museum field party and have been worked almost continuously since. The type specimens of Probarbouromeryx sweeti, Aletomeryx lugni, and Pseudoblastomeryx schultzi, described by Frick (1937), have come from these sites. Recent field studies (by Schultz and Stout) show that the quarries occur in rocks of Marsland age.

The Broadwater-Lisco Collecting Localities.--The first notice regarding the Broadwater quarry sites appeared soon after their discovery (Barbour and Schultz, 1936). This was followed by other papers announcing progress in the excavations, description of new forms, and the discovery of the Lisco quarry sites (Barbour and Schultz, 1937A; 1937B; 1939; Schultz and Stout, 1940). One of the most remarkable of the new forms is the giant camelid, Gigantocamelus fricki.

The Broadwater Locality A quarry sites have been worked almost continuously since their discovery in 1936, including the winters of 1939 and 1940. The Lisco Locality A sites were discovered in 1937 and the Locality B and C sites were found in 1938. The Lisco sites have been worked at intervals since they were found. Messrs. S. R. Sweet, T. C. Middleswart, and W. F. Chaloupka have been of great help in the discovery and development of these quarries, and the Works Projects Administration has coöperated in the excavation and preparation of the material.

A revised list of the mammals from the Broadwater and Lisco localities is included here from a paper now in press by Schultz and Stout.

Wildcat Ridge.--This ridge separates the Pumpkin Creek valley from the North Platte River valley. Wildcat Ridge has upper Oligocene sediments (Whitney member, Brule formation) at the base, overlain by Gering, Monroe Creek, and (in places) Harrison formations. The Ogallala sediments cap Hogback Mountain and Wild Cat Mountain to the west. The general stratigraphic relationships along this ridge were described by Darton many years ago (1899B; 1903A; 1903B; 1905) and more recently by Lugn (1939B).

The Gering Formation.--This formation was defined by Darton (1898; 1899A) and discussed in several papers (1899B; 1903A; 1903B; 1903C; 1905). These lower Miocene sediments are now considered to constitute the basal formation of the Arikaree group (Hatcher, 1902; Schultz, 1938; Lugn, 1939B). The Gering in most places is disconformable on the upper Oligocene (Whitney member, Brule formation), and the change in lithology from massive clay to gray or grayish blue sand is usually quite pronounced.

ROAD LOG FOR SECOND DAY OF FIELD CONFERENCE

Monday, September 1, 1941
Scottsbluff to Crawford, Nebraska
Route distance about 154 miles

Meeting Place: Scottsbluff, Nebraska, Lincoln Hotel. Leave at 8:00 A.M. Lunches are to be taken.

0.0 Cars line up headed west at north side of hotel. Turn left on highway 29 and proceed to Gering, then take highway 86A to the Scotts Bluff National Monument Museum and National Park Service road to the top of the Monument.

6.7 STOP 19. Brief stop at the top of the Scotts Bluff National Monument (see discussion). Monroe Creek formation may be observed.

13.4 Return to Scottsbluff; follow U. S. 26 1.6 miles north and west to intersection with highway 87. Take highway 87 and proceed north 20.6 miles, then turn west through wire gate and follow main trail about 4.5 miles to Olcott Hill.

40.1 STOP 20. Hesperopithecus site, Olcott Hill. Follow trail 2.3 miles west and north to Stonehouse Draw quarry sites.

42.4 STOP 21. Stonehouse Draw. Sheep Creek formation. Take trail northwest.

44.3 STOP 22. Type section of the Sheep Creek formation. Follow trail about 1.7 miles west to highway 29.

46.0 Reach highway 29; turn right and go north 16.0 miles to Agate.

62.0 STOP 23. Reach Agate; stop for lunch. All members of the conference are cordially invited to visit the Cook Museum through courtesy of Mr. and Mrs. Harold J. Cook and Capt. James Cook. Take trail east 3 miles along Niobrara River to University Hill and Carnegie Hill.

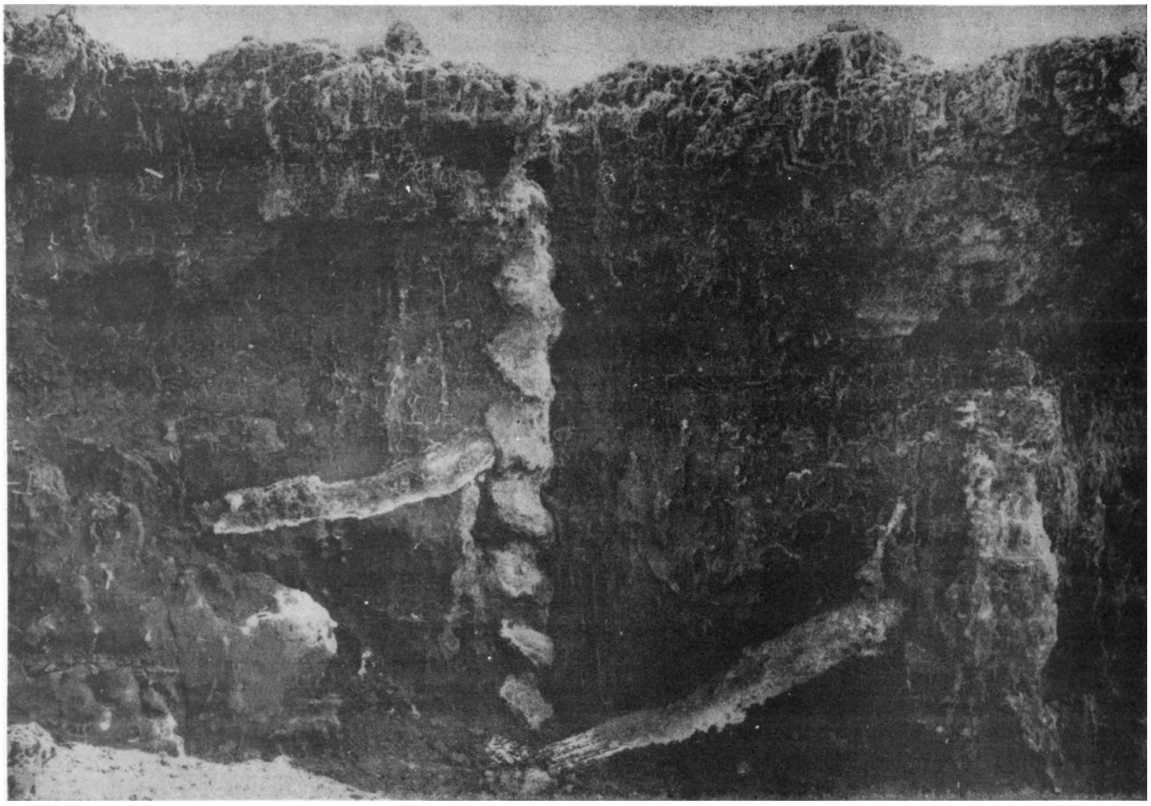

Figure 7. Daimonelix, Harrison formation, Sioux County.

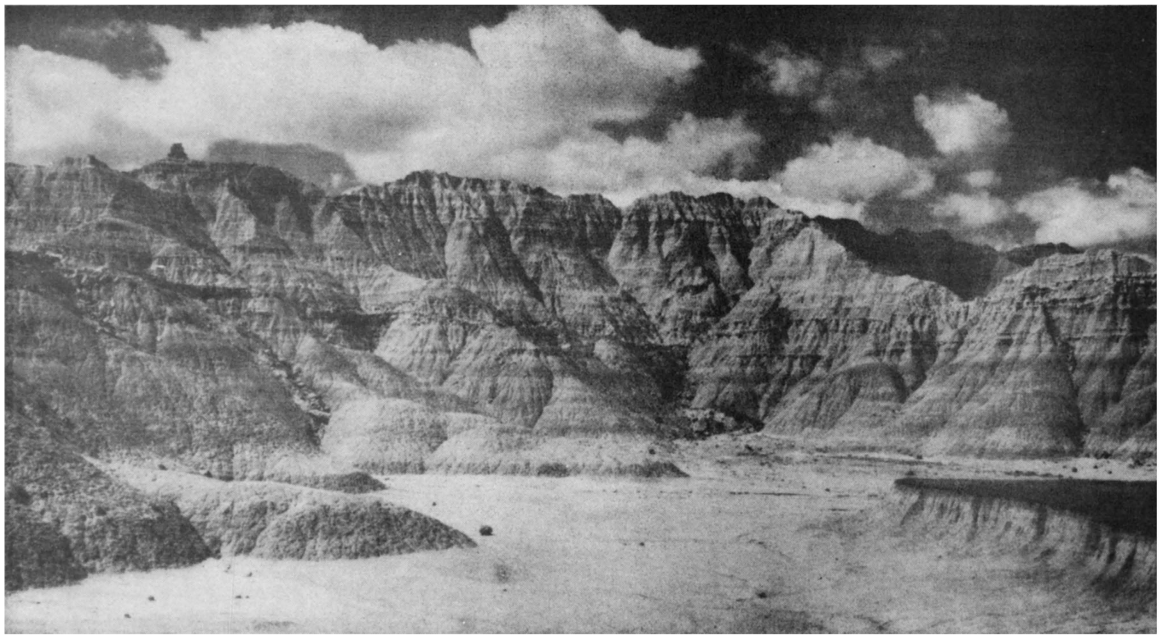

Figure 8. Badlands near Toadstool Park, near Orella and northwest of Crawford, showing characteristic erosion of the middle Oligocene deposits (type locality, Orella member, Brule formation).

65.0 STOP 24. University Hill and Carnegie Hill Quarry sites of various museums. Harrison formation. Return to Agate.

68.5 Reach Agate; take highway 29 north about 1.5 miles.

70.0 STOP 25. Brief stop along highway to observe Daimonelix (see discussion). Harrison formation. Continue on highway 29 north 19.1 miles to Harrison.

89.1 Reach Harrison; take road due north about 4 miles to Monroe Creek Canyon.

93.1 STOP 26. Brief stop at head of Monroe Creek Canyon to observe Harrison formation. The type sections of the Monroe Creek and Harrison formations may be observed in Monroe Creek Canyon. Continue down the Canyon about 2 miles.

95.1 STOP 27. Brief stop at mouth of Monroe Canyon to observe the relationships of Pine Ridge escarpment to the Hat Creek basin. Continue north 3.8 miles.

98.9 Turn right at Anderson ranch (old Warbonnet Ranch or Brewster and Emmons ranch of Hatcher's day, now owned by Mr. John T. Coffee). Continue east 6.8 miles on badlands trail, parallel to the badlands and the Pine Ridge escarpment, then turn and go south 2 miles, east 4 miles (notice the fine view of the Monroe Creek escarpment here), north 5.5 miles, and east 4.3 miles.

121.5 STOP 28. Outcrop of basal member of Chadron formation. Continue east 3.9 miles to intersection with highway 2 south of Orella.

125.4 Reach highway 2 about 1.2 miles south of Orella; turn right and follow highway 2 southeast about 4.2 miles.

129.6 Leave highway 2 at ranch buildings; follow trail west about 4 miles to Toadstool Park.

133.6 STOP 29. Toadstool Park, a locality made famous by Darton. Type locality of the Orella member, Brule formation, with the Whitney member above and the Chadron formation below. (See discussion).

137.6 Reach highway 2; turn right and follow highway about 5.3 miles southeast to Sand Creek.

142.9 STOP 30. Brief stop at Sand Creek to observe late Pleistocene varved clays and late Pleistocene to Recent terrace and alluvial fill sequence. Yuma-Folsom artifacts and associated extinct mammals are found at a definite point in this stratigraphic sequence. Continue south and east about 11.9 miles on highway 2 to Crawford.

154.0 STOP 31. Reach Crawford.

Note: All members of the conference are cordially invited to visit the museum of the Chadron State Normal College at Chadron during the evening, through the courtesy of Mrs. Eleanor B. Cook and Mr. Albert Potter. Chadron is 23.1 miles east of Crawford. Crawford will be the starting point for the third day of the conference.

DISCUSSION AND SUMMARY NOTES

The Scotts Bluff National Monument Section.--The upper few feet of the Chadron formation are exposed at the base of this section, overlain by a typical development of the Orella and Whitney members of the Brule formation (Schultz and Stout, 1938). The Gering formation (lower Miocene) disconformably overlies the Oligocene, and the Gering is succeeded by the Monroe Creek formation, which is well exposed at the top of the Monument.

The Sheep Creek and Snake Creek Deposits.--This locality has become well known from papers by Matthew and Cook (1909), Matthew (1918, 1923, 1924, 1932), Osborn (1918, 1936), Cook and Cook (1933), and Frick (1937). The Sheep Creek deposits are disconformably overlain by the upper Snake Creek (Ogallala) gravels (Matthew and Cook, 1909; Matthew, 1924; Lugn, 1939B; Schultz and Falkenbach, 1940). Much work remains to be done in this area before the exact sequence of the channel fills is fully understood.

The University Hill and Carnegie Hill Sites.--These Agate quarries have been worked for many years and by many institutions. A very extensive literature has developed with regard to this area (see particularly Peterson, 1906; Cook, 1915; Cook and Cook, 1933). The quarries occur in the upper part of the Harrison formation.

The Daimonelix Problem. These queer corkscrew-like structures were first recognized by Barbour in 1891. There have been many explanations for the origin of them, some maintaining that they represent plant remains and others that they represent old rodent burrows. The structures are peculiar to the Harrison formation.

The Monroe Creek Canyon Section The road down Monroe Creek Canyon passes over the type section for the Harrison and Monroe Creek formations (Hatcher, 1902; Cook, 1915; Schultz, 1938; Lugn, 1939B). The Monroe Creek formation overlies the Gering formation, and this in turn rests unconformably on the Oligocene. The Monroe Creek formation forms the main part of the Pine Ridge escarpment.

The "Yoder Problem". The name "Yoder formation" was proposed by Schlaikjer (1935A; 1935B) for basal Oligocene sediments exposed along the Fort Laramie irrigation canal in an area of not more than five square miles extent, about one to three miles northwest of Yoder, Goshen Hole, Wyoming. (See also Cook and Cook, 1933; Wood et al, 1941). After considerable field study and additional collecting at the Yoder locality in connection with work on Oligocene stratigraphy in Nebraska, it is the present opinion of the writers that the Yoder is to be correlated with the basal member of the Chadron formation of northwestern Nebraska. The basal Chadron in northwestern Nebraska is characterized in many places by basal conglomerate,

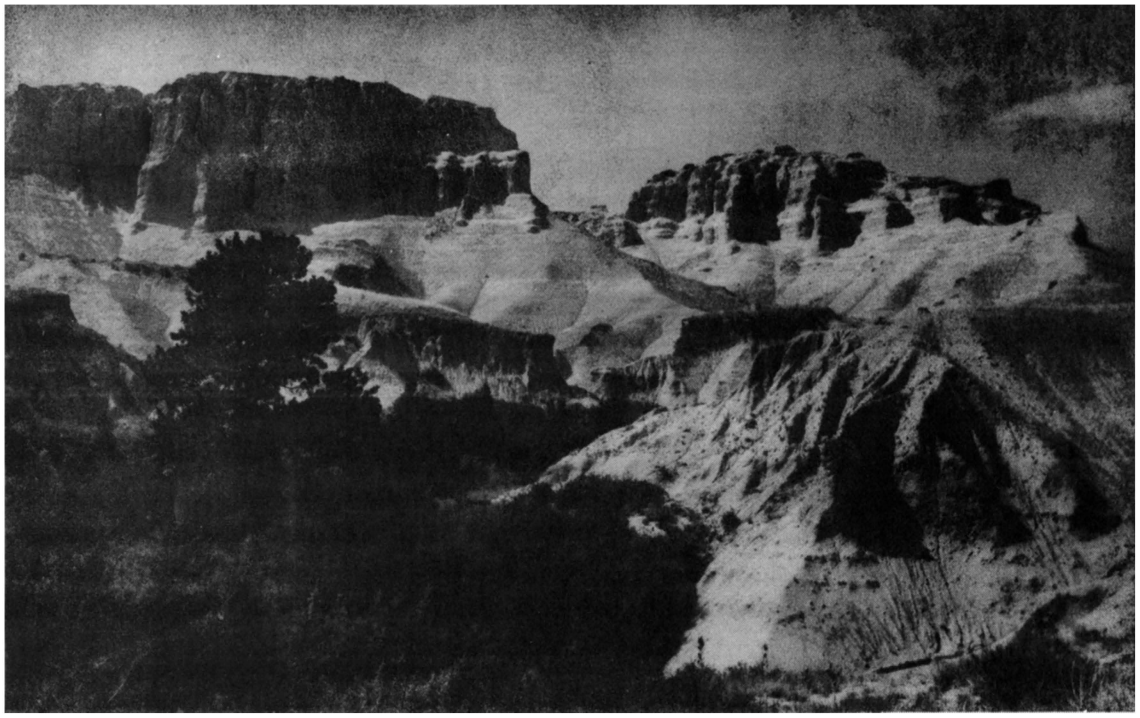

Figure 9. The type locality of the Whitney member, Brule formation (upper Oligocene), near Round Top, west of Whitney and northwest of Crawford.

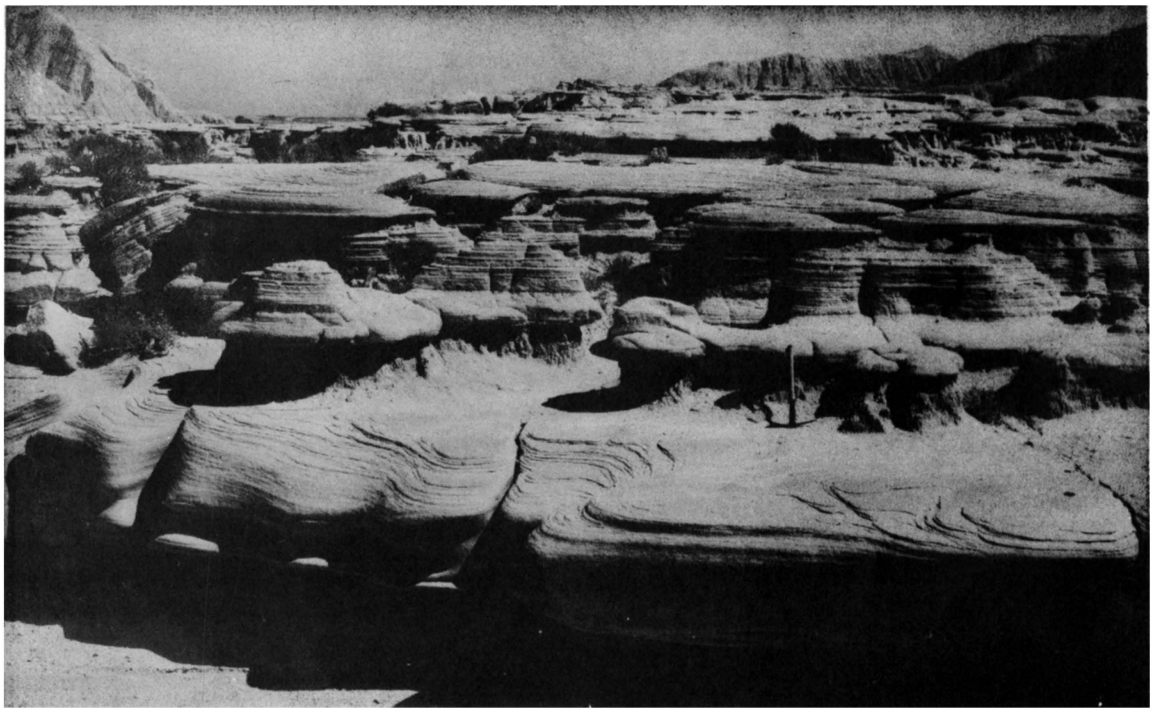

Figure 10. Close-up view of "toadstool" erosional features in middle Oligocene (Orella member, Brule formation) channel sandstone at Toadstool Park, northwest of Crawford.

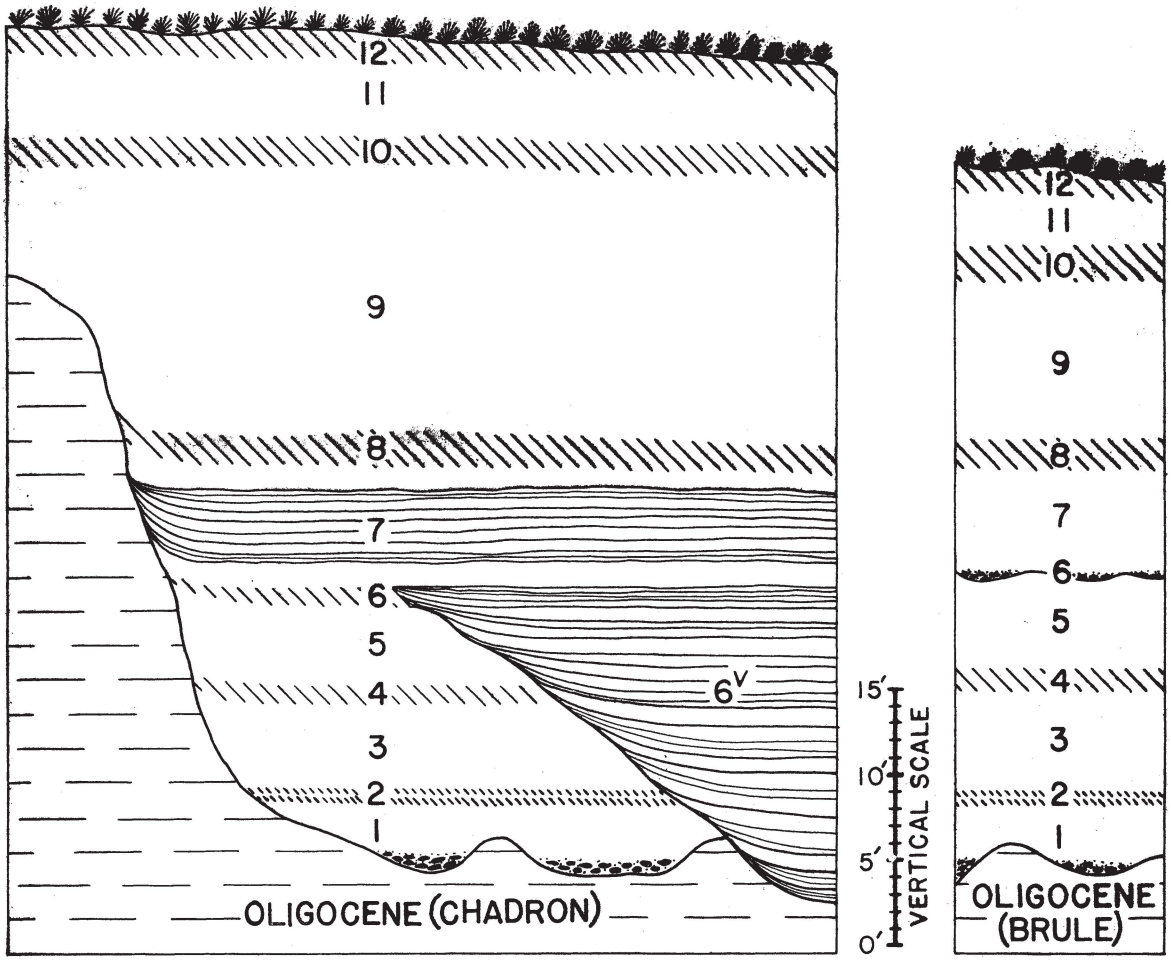

Figure 11. Section measured at Sand Creek varve location northwest of Crawford (at left), compared with section measured north of Harrison (at right). Diagonal shading indicates old soils while horizontal shading shows varved clays and unshaded areas loess and silt.

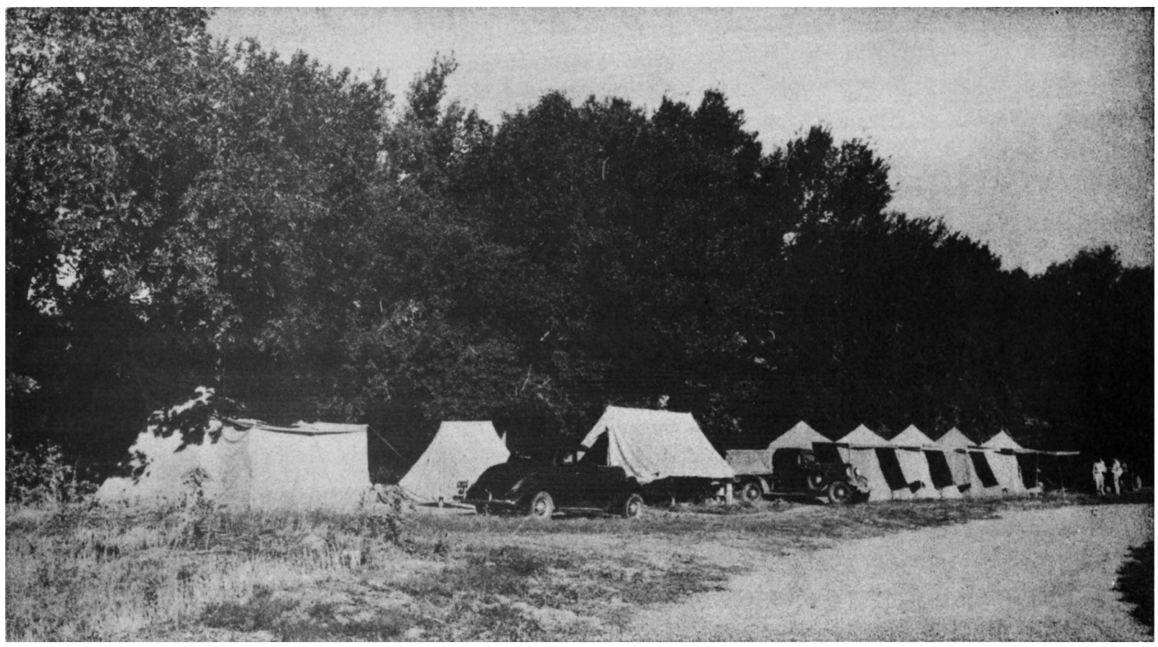

Figure 12. Field camp of University of Nebraska State Museum expedition at Crawford.

overlain by sand and sandy clay which is often brilliantly colored. The paleontological evidence is not opposed to this interpretation. Clark (1937, p. 328) has expressed a similar opinion based upon his studies of the Chadron formation in South Dakota.

The Orella and Whitney Members, Brule formation.--These member names for the old terms "Oreodon beds" and "Leptauchenia beds" have been suggested and defined by Schultz and Stout (1938) as follows:

"For the past few years (1931-1938) the field parties of the Nebraska State Museum, University of Nebraska, have been engaged in making a careful stratigraphic collection of vertebrate fossils from the Oligocene deposits of Nebraska. A detailed stratigraphic study of the Oligocene of Nebraska has also been made. In northwestern Nebraska the Oligocene deposits consist of the Chadron and Brule formations of Darton. The contact between these two formations is now provisionally drawn at the base of a certain continuous purple-tinted white, sometimes silicified, limestone layer, which is the upper of several such limestone beds in the lower part of the local section. A lithologic break and in places a significant and pronounced disconformity divide the Brule formation into two widespread lithologic units which, it is suggested, should now be considered as stratigraphic members. For the lower or Oreodon zone portion of the Brule formation as it occurs in northwestern Nebraska the name Orella member is proposed. Typical exposures of this member, attaining a thickness of about 150 feet, are to be found about 2½ miles southwest of Orella station in the vicinity of Toadstool Park, in sec. 8, T. 33 N., R. 53W., Sioux County, Nebraska. Here the Orella member is disconformably overlain by the massive clays of the upper or Leptauchenia zone portion of the Brule formation for which the name Whitney member is proposed. This member occurs typically and attains the thickness of about 290 feet to the east of Toadstool Park along the escarpment near Round Top, in secs. 16 and 21, T. 33 N., R. 53 W., about 16 miles west and 3 miles north of Whitney, Nebraska. Certain correlations of these members of the Brule formation with similar divisions of the Oligocene deposits farther south in the North Platte Valley are suggested."

The Sand Creek Pleistocene Location--This locality has been mentioned or discussed in several papers (MacClintock, Barbour, Schultz, and Lugn, 1936; Barbour and Schultz, 1936, 1937; Schultz, 1938). The sequence of soils and silts, including the varved clay, in the older terrace here is shown diagrammatically in Fig. 11. Yuma-Folsom artifacts and remains of extinct bison and mammoth have been found in this area in deposits which antedate the varved clay.

ROAD LOG FOR THIRD DAY OF FIELD CONFERENCE

Tuesday, September 2, 1941
Crawford to Ainsworth, Nebraska
Route Distance about 258 miles

Meeting Place: Crawford, Nebraska, Gate City Hotel. Leave at 8:00 A.M. Lunch will be at Rushville.

0.0 Cars line up headed east at north side of hotel; go east to junction with highway 2, turn right and continue south on highway 2 through

Bryan Canyon. On this route the following formations may be observed in passing over the Pine Ridge escarpment: Brule (Whitney member mainly), Gering, Monroe Creek, Harrison, and Marsland, while the highest beds of the tableland surface are Marsland and Sheep Creek. In the Niobrara River valley the Harrison may be observed below the Marsland in places.

18.2 Pass Marsland; continue south 4.4 miles on highway 2.

22.6 STOP 32. Typical section of the Marsland formation, and Marsland Quarry site (Hemingford Quarry 22). (See discussion). Continue south 3.8 miles to intersection with highway 87.

26.4 Reach highway 87; turn left and go east 11 miles to power line 1 mile west of Hemingford Turn left and go north 4 miles to farm house and take trail northwest and west about 1 mile to quarry site.

42.4 STOP 33. Hemingford Quarry 7B. Marsland formation. Return by same route to highway 87, turn left and go 1 mile east to Hemingford.

48.4 Reach Hemingford; cross railroad tracks at east edge of town and follow highway 87 east 18.6 miles, then turn left and go north 8 miles, east .8 mile, and north about 3 miles to Niobrara River.

78.8 Reach Niobrara River; continue north about 1 mile, turn right and go east about 6.1 miles to Niobrara River. Turn right and go across river southeast and east about 1.8 miles on winding trail.

87.7 STOP 34. Hay Springs quarry sites. Middle Pleistocene. (See discussion). Return to and cross Niobrara River by same route.

89.5 Reach point on north side of Niobrara River; turn right and go north 1 mile, then turn right and go east about .8 mile to the Niobrara River. Along the river bank near the road, notice the old Jules Sandoz place which was made famous in the best-seller "Old Jules" by Marie Sandoz. Cross the Niobrara River and go east about 3.6 miles on winding road to a main north-south road. Cross this road and go .4 mile east to Rushville quarry sites.

95.3 STOP 35. Rushville Locality A quarry sites. Middle Pleistocene. (See discussion). Return to north south road.

95.7 Reach north south road; turn right and go north via the Colclesser Bridge 16.8 miles to Rushville.

112.5 STOP 36. Rushville; lunch stop. Take U. S. 20 about 108 miles east to Valentine. This road passes through the northern edge of the Sand Hills region of Nebraska (late Pleistocene).

220.5 Reach Valentine; continue on U. S. 20 across Niobrara River and southeast about 3.5 miles. Turn left on trail and go about .2 mile northeast.

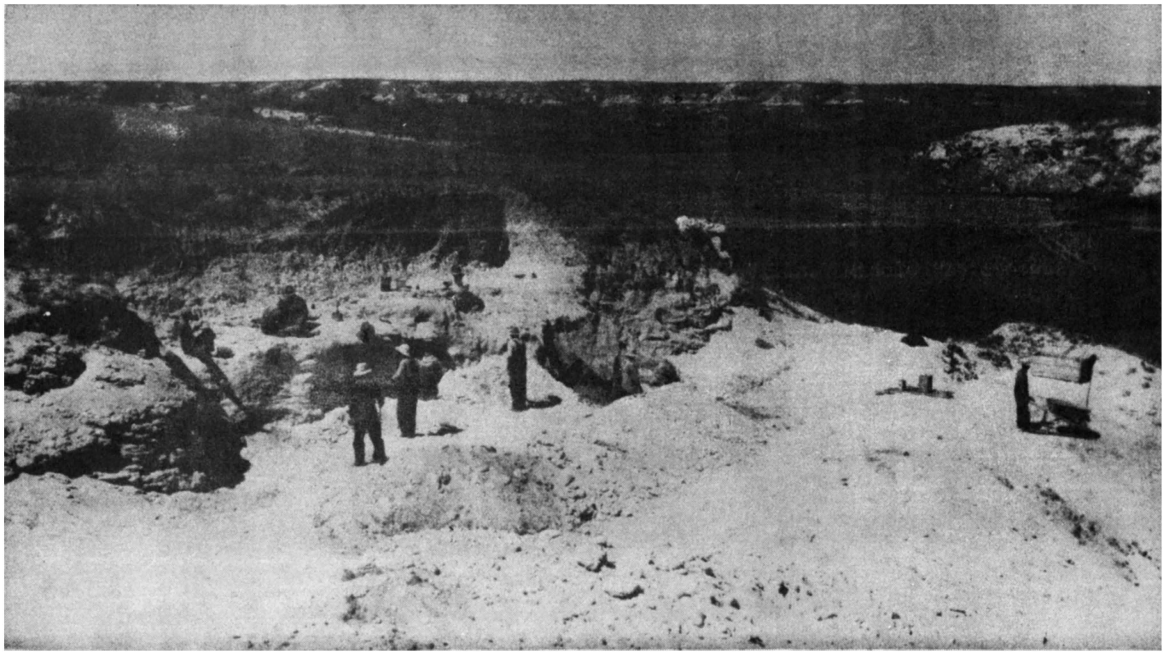

Figure 13. Hemingford Quarry 7B, near Hemingford. Marsland formation.

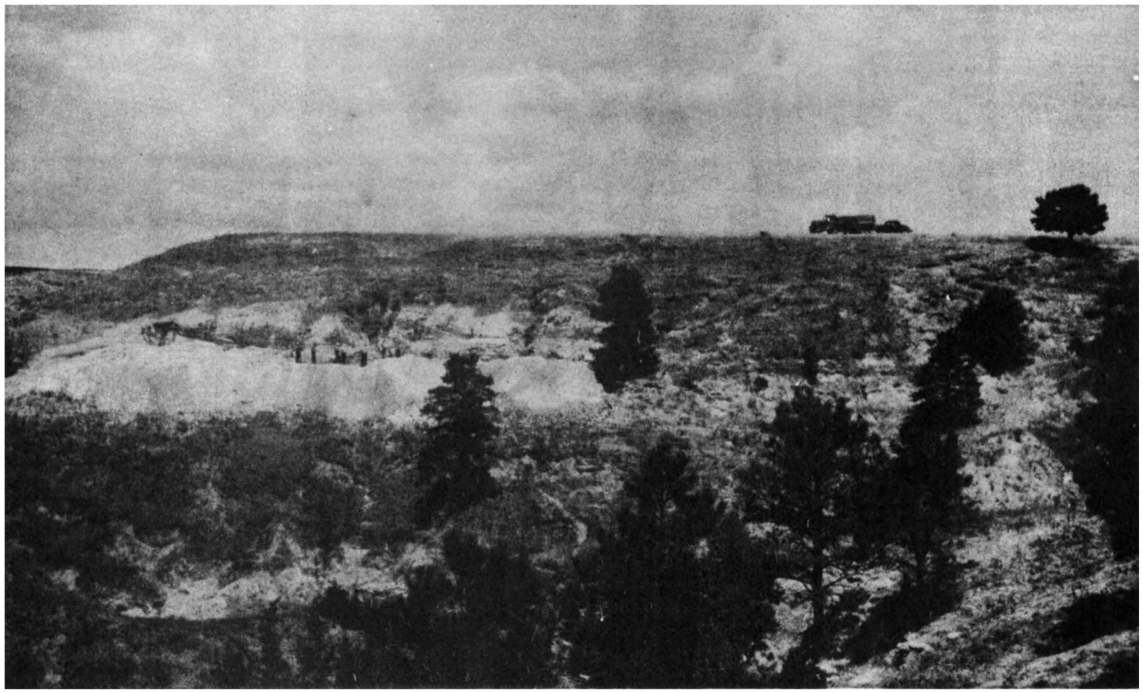

Figure 14. Rushville Locality A quarry site, near Rushville. Middle Pleistocene.

Table 4.

REVISED LIST OF MAMMALS FROM THE SHERIDAN COUNTY LOCALITIES

	HAY SPRINGS	RUSHVILLE	GORDON
INSECTIVORA			
Sorex? sp.		—	
EDENTATA			
**Mylodon nebrascensis* Brown	—		—
Megalonyx leidyi Lindahl	—		—?—
LAGOMORPHA			
Lepus sp.		—	
RODENTIA			
Sciurid (*Citellus* group?)		—	
Cynomys niobrarius Hay	—	—	—
Geomys sp. (large)		—	—
Geomys sp. (small)		—	—
Castoroides nebraskensis Barbour	—	—	
Castor sp.		—	—
Peromyscus sp.		—	
Ondatra nebrascensis (Hollister)	—	—	—
Microtine		—	
Dipodomys sp.		—	
CARNIVORA			
Canis sp., near *C. latrans*	—	—	
Canis (*Aenocyon*) *dirus nebrascensis* Frick	—	—	
Urocyon? sp.		—	
Arctodus simus nebrascensis Frick	—		—
Procyon sp.		—	
Mustelid	—	—	
Smilodon nebrascensis Matthew	—	—	—
Felis atrox?			—
PROBOSCIDEA			
Archidiskodon imperator (Leidy)	—	—	—
PERISSODACTYLA			
Equus excelsus Leidy	—	—	—
Equus calobatus nebrascensis Frick	—	—	—
ARTIODACTYLA			
Platygonus vetus Leidy	—	—	—
Camelops kansanus Leidy	—	—	—
Tanupolama americana (Wortman)	—	—	
Odocoileus sheridanus Frick	—	—	
Capromeryx furcifer Matthew	—	—	—
Hayoceros falkenbachi Frick	—	—	—
Bootherium? sp.			—

* Probable synonym: *Mylodon garmani* Allen.

224.2 STOP 37. Valentine Locality A and B quarry sites. Return to U. S. 20.

224.4 Reach U. S. 20; turn left and continue east about 33.5 miles to Ainsworth.

258.0 STOP 38. Ainsworth.

DISCUSSION AND SUMMARY NOTES

The Marsland formation.——This name was proposed by Schultz (1938A) to replace the name "Upper Harrison" of Peterson (1906B) for a formational unit overlying and quite distinct from the Harrison formation (the "Lower Harrison" of Peterson) as originally defined by Hatcher (1902). The Marsland is defined as follows by Schultz (1938, p. 443-4):

> "... To the deposits ('upper Harrison beds') which immediately overlie the Arikaree Group and which are faunally and lithologically distinct from the typical Arikaree, the writer suggests the name Marsland formation. This formation is best exposed in Nebraska in the region about Marsland along the Niobrara River where it includes some 150 feet of buff and gray, soft sandstones. The Marsland consists, in part, of valley fills, and in places seems to mantle the slopes of certain large valleys. The upper part of the Marsland in this region is more gritty and is mostly buff-colored. The fauna of the Marsland formation seems to be intermediate between that of the Harrison formation and the overlying Sheep Creek formation and perhaps should provisionally be considered as the lower part of the upper Miocene. The characteristic fossils are Merycochoerus, Merychyus, Aletomeryx, Oxydactylus, and advanced Parahippus or (and) Merychippus, etc."

The Marsland formation is particularly well exposed in the vicinity of the Marsland Quarry (Hemingford Quarry 22), south of Marsland, Nebraska. The name "Box Butte member" has recently been proposed by Cady (1940) for a part of the Sheep Creek formation in this general area.

The Hay Springs and Rushville quarry sites.—The Hay Springs area has become well known as a result of the explorations and collections made by many workers. Samuel Garman collected the type specimen of Mylodon garmani Allen (1913) in this vicinity in 1880. Hatcher explored this area in 1886 for the United States National Museum and in 1893 for Princeton University and the American Museum of Natural History (Hatcher, 1894). The name "Sheridan beds" was given by Scott (1895) as a result of this work. The Hay Springs quarry was worked by the American Museum expeditions of 1893, 1897, and 1916(?) (Matthew, 1902, 1918). Yale University opened a quarry near here in 1915. The Hay Springs quarries were extensively worked by Charles H. Falkenbach from 1928-30 for the Frick Laboratory, American Museum of Natural History (Frick, 1929, 1930). The University of Nebraska State Museum first became interested in this area by the discovery of a Castoroides specimen in 1901 by Jules A. Sandoz. R. W. Ellis worked this general vicinity for the University of Nebraska State Museum in 1917 and subsequent work has been carried on in the Hay Springs-Rushville area in the years 1932-33, 1937-38 and 1940. The Gordon quarries were worked from 1937-39 and in 1941.

The general stratigraphy and paleontology of this area has been discussed by Lugn (1934, 1935), Schultz (1934), and Barbour and Schultz (1937A, 1937B). The Pleistocene channel deposits disconformably overlie the sediments of the

Ogallala group. The Hay Springs, Rushville and Gordon quarry sites are now considered on both stratigraphic and faunal evidence to be of Yarmouth (middle Pleistocene) age. A revised faunal list of the mammals from these quarries is included here from a paper now in press by Schultz and Stout.

The Valentine formation.- The Valentine (Railway) Locality quarry sites were discovered in 1915 by J. B. Burnett of the University of Nebraska State Museum expedition, were reopened in 1930 and have since been worked by several institutions. The type specimens of Aelurodon platyrhinus Barbour and Cook (1917), Prosthennops xiphodonticus Barbour (1925), Cupidinimus nebraskensis Wood (1935), and Blastomeryx gemmifer valentinensis Frick (1937) have come from these sites.

The area near the quarries constitutes the type locality of the Valentine formation (Barbour and Cook, 1917; Johnson, 1936, 1938). There exists a voluminous literature concerning the "Valentine Problem" (Stirton, with Teilhard de Chardin, 1934; Stirton and McGrew, 1935; Stirton, 1936; Johnson, 1936; McGrew and Meade, 1938; Lewis, 1938; Colbert, 1938; Johnson, 1938; Lugn, 1938; Stirton, 1939; Lugn, 1939A, 1939B; and Wood et al, 1941). The Valentine formation is now generally accepted as a valid formational unit of the Ogallala group (Lugn, 1939B).

The Burge sand (Stirton and McGrew, 1935; Johnson, 1936, 1938; Frick, 1937; McGrew, 1938; Lugn, 1939B) and basal Ash Hollow (Stirton, 1939; Lugn, 1939A, 1939B) sediments may be seen in this vicinity and along the Snake River southwest of Valentine. The local stratigraphic relations are shown in Fig. 16 and have been discussed by Johnson (1936, 1938). The local stratigraphy of this area has been carefully studied by Morris F. Skinner.

ROAD LOG FOR FOURTH DAY OF FIELD CONFERENCE

Wednesday, September 3, 1941
Ainsworth to Lincoln, Nebraska
Route distance about 320 miles

Meeting Place: Ainsworth, Nebraska. Leave at 8:00 A.M. Lunch will be at Norfolk.

0.0 Cars line up headed east; go east .5 mile and take highway 7 north about 12 miles.

12.5 Leave highway 7; turn right and go east about 3 miles on side road to Devil's Gulch.

15.5 STOP 39. Devil's Gulch, famous collecting locality (lower to middle Pliocene). (See discussion). Return to Ainsworth.

30.5 Reach Ainsworth; take U. S. 20 east about 9 miles to Long Pine. (Time changes east of here: 10:00 M.S.T. = 11:00 C.S.T.). This was the home of John Bell Hatcher and O. A. Peterson, famous fossil collectors. Continue east about 74 miles to junction with highway 275; then take highway 275 east about 67 miles to Norfolk.

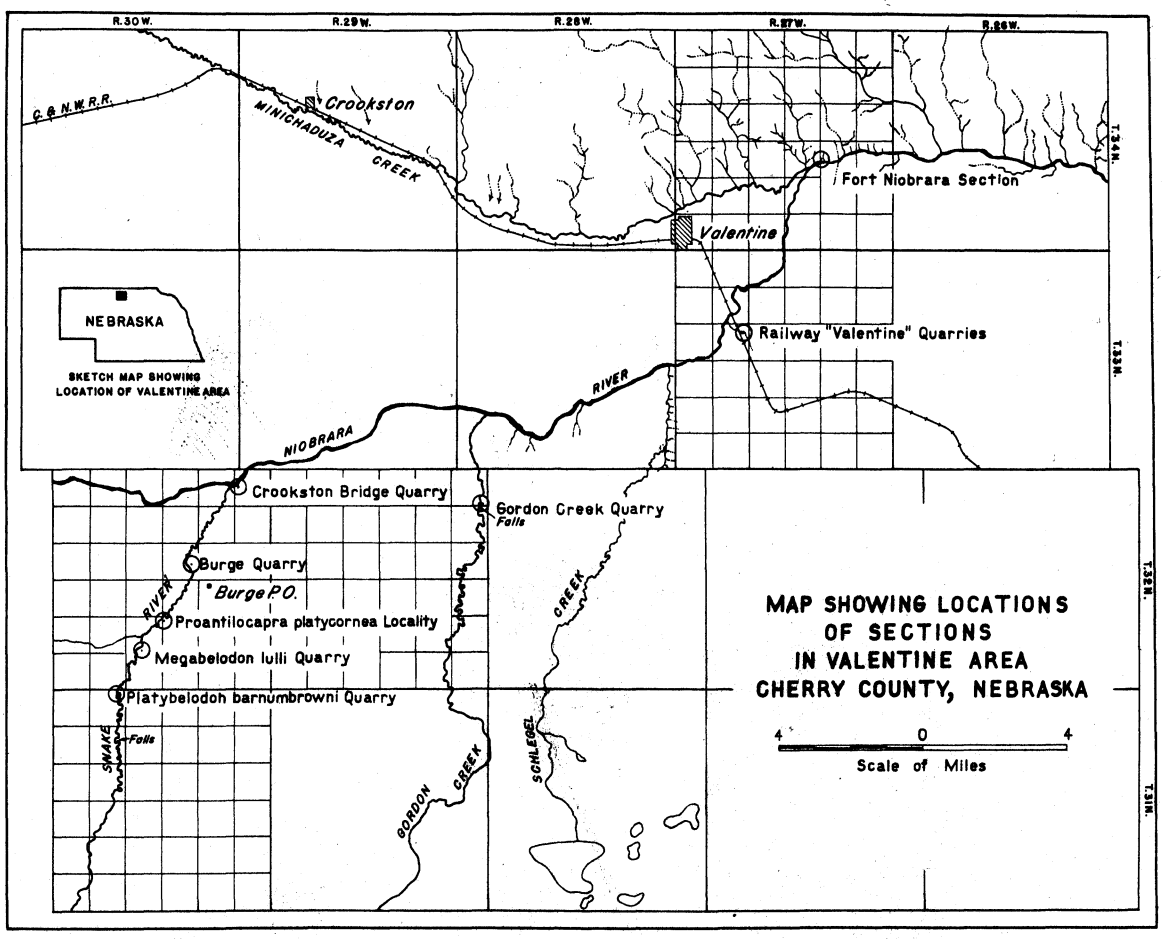

Figure 15. Map showing locations of sections in Valentine area (after Johnson, 1936).

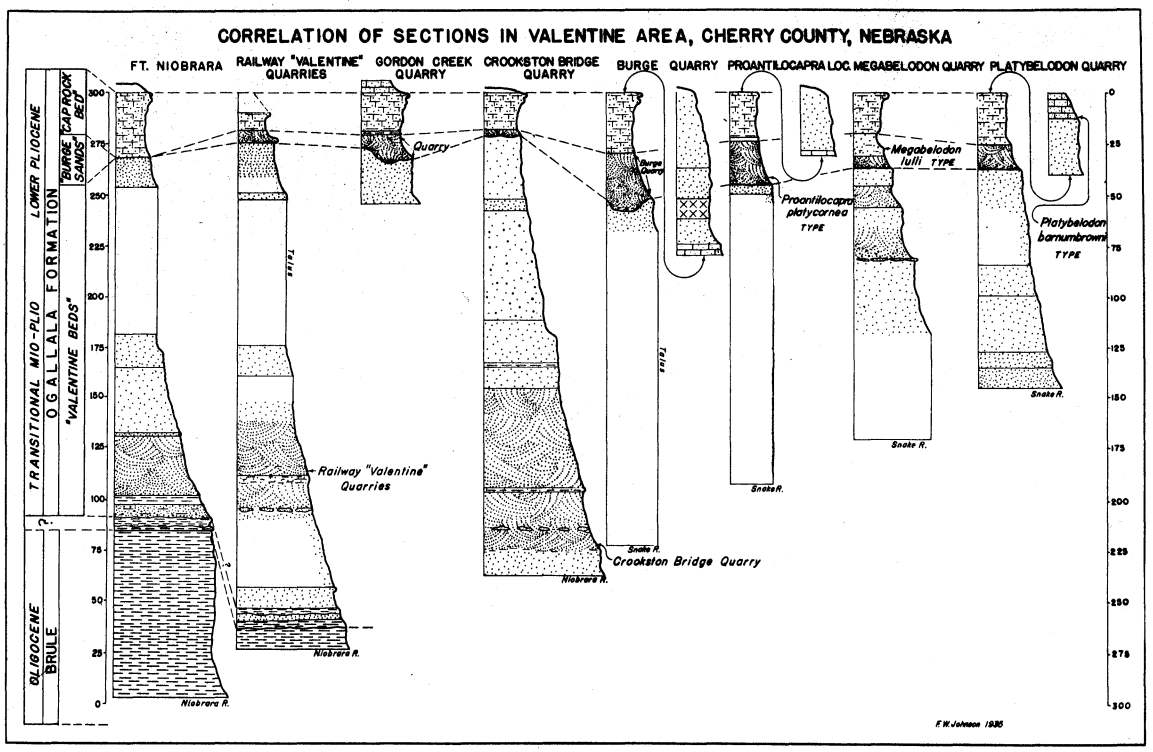

Figure 16. Correlation of sections in Valentine area (after Johnson, 1936). The Valentine formation is now considered to be lower Pliocene.

180.0 STOP 40. Reach Norfolk; lunch stop. Continue east on highway 275 about 65 miles to junction with highway 77, near Winslow.

245.0 Take highway 77 north at junction; turn left and go about 2.5 miles north through Winslow.

247.5 STOP 41. Road cut. Excellent outcrop of Citellus zone, with soil well developed; Loveland loess and Kansan till below, with Peorian loess above the soil. Return to Winslow, and continue south on highway 77 about 11 miles to Fremont.

261.0 Reach Fremont; continue south on highway 77 about 3.6 miles to a point on the south side of the Platte River; turn right on side road and go about 3 miles west and northwest, then turn north .5 mile, west .5 mile, north .5 mile, and east .2 mile to Graham's summer lodge.

269.3 STOP 42. Graham's summer lodge section, near Fremont (one of the finest Pleistocene sections in Nebraska). (See discussion). Go .2 mile west, .5 mile south, .5 mile east, .5 mile south, .5 mile east, and 1 mile south to highway 77.

272.5 Reach highway 77; turn right and follow this highway 47.7 miles to Lincoln. This road passes through Todd Valley (see discussion).

320.0 STOP 43. Lincoln, Nebraska, The University of Nebraska State Museum. This concludes the field excursion. As previously noted, Thursday, September 4 will be devoted to informal discussions and study of the displays and collections at The University of Nebraska State Museum.

DISCUSSION AND SUMMARY NOTES

Devil's Gulch.--This locality was first reported upon by Barbour and the type specimens of Trilophodon willistoni, Eubelodon morrilli, and Megahippus matthewi described (Barbour, 1914A, 1914B, 1914C). Trilophodon abeli is based upon a specimen from Devil's Gulch (Barbour, 1925B), and the type specimens of Cranioceras (Procranioceras) skinneri and Blastomeryx mefferdi, described by Frick (1937), also came from this canyon.

The sediments in Devil's Gulch belong to the Ogallala group, and are said to rest unconformably on Oligocene sediments, and these in turn on Pierre shale (Barbour, 1914A, 1914B). Morris F. Skinner has made a careful study of the stratigraphy of this area. Brief discussions on Devil's Gulch are to be found in the Proboscidea Monograph of Professor Osborn (1936, p. 317, 601-10).

The Fremont Pleistocene Section.--Excellent Pleistocene exposures may be seen in the bluffs along the south side of the Platte River near Fremont. The Graham's summer lodge section has been measured by Lugn (1935, p. 42), and consists of Nebraskan till at the base, overlain by Nebraskan gumbotil, Kansan till, Loveland loess, and Peorian loess.

Todd Valley.--This post-Loveland pre-Peorian valley, which repre-

sents a former course of the Platte River, is a conspicuous topographic feature some 28 miles long and 6 to 8 miles wide extending from near North Bend to Ashland. The importance of Todd Valley in any consideration of the late Pleistocene history of eastern Nebraska has been fully discussed by Condra (1903) and Lugn (1935, p. 153 8; 1939C).

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ACKNOWLEDGMENT

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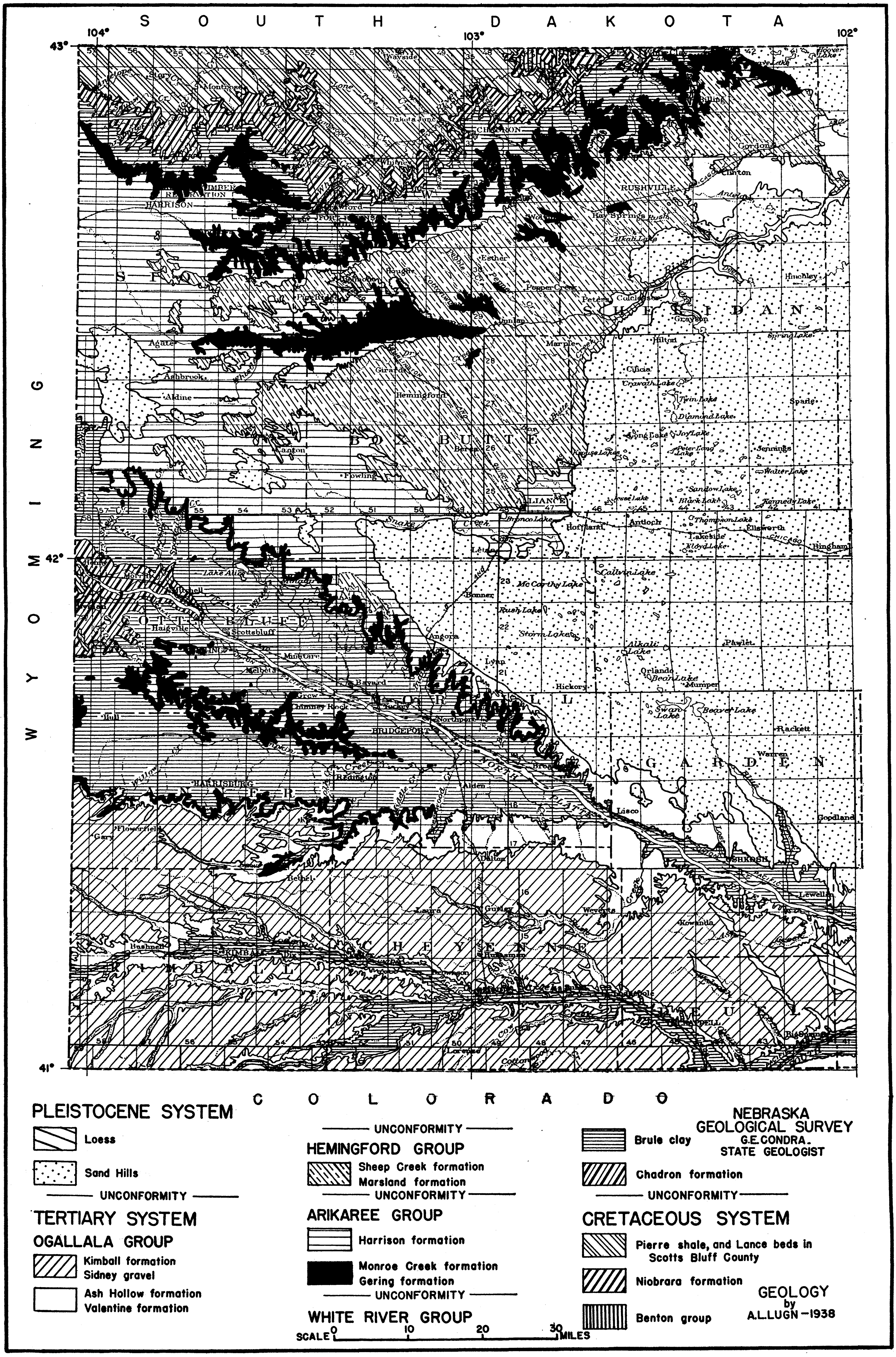

TERTIARY GEOLOGIC MAP OF WESTERN NEBRASKA (from Lugn 1939B).