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Field Conference on the Tertiary and Pleistocene of Western Nebraska (Guide Book for the Ninth Field Conference of the Society of Vertebrate Paleontology)

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Twentieth Anniversary Conference
(1941-1961)

Ninetieth Anniversary of
The University of Nebraska State Museum
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ABSTRACT

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(Guide Book for the Ninth Field Conference of the Society of Vertebrate Paleontology)

C. Bertrand Schultz *Thompson M. Stout*

(With Contributions by Charles H. Falkenbach and Lloyd G. Tanner, and Field Conference Assistance from Harold J. Cook and A. L. Lugn)

This Field Conference is scheduled for five days, July 31-August 3 (main excursion) and August 4 (post-conference excursion), 1961. Its purpose is to consider recent work and problems in stratigraphy and vertebrate paleontology concerned with deposits ranging in age from Oligocene through Pleistocene, in western Nebraska. The Guide Book is the Ninth issued by sponsoring institutions for the Society of Vertebrate Paleontology (the others having been published in 1941, 1947, 1948, 1950, 1951, 1953, 1956, and 1958). It thus commemorates the 20th Anniversary of the First Field Conference of the Society, as well as the 90th Anniversary of the establishment of the University of Nebraska State Museum (1871-1961). In addition to the discussion and itinerary provided by the authors, there is included a "Faunal List of the Oreodonts from Nebraska," by C. Bertrand Schultz and Charles H. Falkenbach. Lloyd G. Tanner provided a road-log check and assisted with other arrangements; Harold J. Cook and A. L. Lugn also aided with arrangements for the Field Conference.

CONTRIBUTION OF *the Department of Geology, College of Arts and Sciences, and the Division of Vertebrate Paleontology of the Museum, July 1961*

Schultz[1] *Stout*[2]

(With Contributions by Charles H. Falkenbach[3] and Lloyd G. Tanner[4] and Field Conference Assistance from Harold J. Cook[5] and A. L. Lugn[6])

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INTRODUCTION

The University of Nebraska takes particular pleasure in again welcoming the members and guests of the Society of Vertebrate Paleontology to Nebraska, on the 20th anniversary of the First Conference of the Society. There has been much progress in the exploration and understanding of the Tertiary and Pleistocene of the State since the First Conference was held in Nebraska in 1941. The present excursion is concerned, however, only with the paleontology and geology of western Nebraska.

Upon this happy occasion, it has been possible to center some of the activities of the Conference at the new University of Nebraska Trailside Museum at historic Fort Robinson, near Crawford, in northwestern Nebraska (see Map). This branch museum was dedicated and officially opened to the public on

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[2] Associate Professor of Geology, University of Nebraska; Associate Curator of Geology in the Museum.

[3] Assistant Curator, Frick Laboratory, American Museum of Natural History, New York City.

[4] Assistant Curator of Vertebrate Paleontology, University of Nebraska State Museum.

[5] Cook Museum of Natural History, Agate, Nebraska.

[6] Professor of Geology, University of Nebraska.

July 3, 1961, only a few weeks before this field meeting of the Society. The exhibits and services of this new branch museum will be greatly expanded during the next few years. The vertebrate paleontology and geology of western Nebraska will be featured.

Fort Robinson is the latest of several historic sites in the region, also famous in the early annals of Western fossil-collecting, to be preserved for the future generations. The Fort Laramie National Monument (near Torrington, Wyoming) and the Scotts Bluff National Monument (near Scottsbluff and Gering, Nebraska), both with fine museums, have been open to the public for many years. In addition, it has been learned just recently that the Agate Spring Fossil Quarries at Agate, Nebraska, have been also officially selected for a proposed National Monument.

Fort Robinson is situated only about a mile away from the site of the old Red Cloud Agency.[1] Both of these places were first visited by Professor O. C. Marsh from Yale University in November of 1874 (Schuchert and LeVene, 1940, p. 139-145; Osborn, 1929, vol. 1, p. xxi-xxii).

Because of this first scientific record of the discovery of fossils in the "Little Badlands" of the Crawford area, the year 1874 constitutes a pertinent reference point. The first fossils from the "Big Badlands," probably in what is now South Dakota, were found in 1846 (Osborn, 1929, vol. 1, p. 1, 141; Trumbull, 1958, p. 900). Hayden's earliest expedition there was in 1855, and by the time of the Hayden-Warren expedition of 1857 (upon which Leidy's 1869 memoir on "The extinct mammalian fauna of Dakota and Nebraska" was chiefly based), the fame of the fossils from "the vast Eocene cemetery of Nebraska" (Leidy, *in* Owen, 1852, p. 551, 539) allowed it to be compared with the Paris Basin.

Professor Marsh himself had first come west in the summer of 1868, attracted by the report of fossils from a well at Antelope Station, Nebraska (Marsh, 1868), and in later years he attempted to follow Hayden's route on the Middle Loup and Niobrara rivers. Meanwhile, Nebraska became a State in 1867, the University of Nebraska was established in 1869, and Prof.

[1] The participants of the Conference are urged to visit the Fort Robinson Historical Museum (a branch of the Nebraska State Historical Society Museum, Lincoln), which is located north of the Inn at the Fort Robinson State Park. Fort Robinson also is the field headquarters of the University of Nebraska State Museum.

Samuel Aughey became the first Professor of Natural Science at the University and curator of the Cabinet (as the Museum was first known) in 1871. Professor Aughey was interested in vertebrate paleontology and made his first contribution five years later (Aughey, 1876), when he reported on the discovery in Omaha of an artifact found associated with "elephant" remains. This early work of Professor Aughey has been strikingly verified during the past ten years by a number of additional discoveries of Late Pleistocene mammoth bones in excavations near the same spot, within the present city limits of Omaha.

Extensive search for vertebrate fossils began at the University of Nebraska when Dr. Erwin H. Barbour, one of Prof. O. C. Marsh's former students, arrived in 1891. Dr. Barbour privately financed the first expedition to the Fort Robinson area during the summer of 1891, only a few months after the Battle of Wounded Knee, the last major Indian engagement in the Plains. Since that time there have been annual expeditions in search of fossils, except in 1943 and 1944 (during World War II). Many hundreds of thousands of dollars have been contributed to this work from private sources; also additional funds have been made available from other sources. During the past thirty years the stratigraphic approach to the collecting of vertebrate fossils has been emphasized. As the result of this extensive field-collecting program, the University of Nebraska State Museum now has one of the outstanding research collections of Medial and Late Cenozoic fossil mammals in the United States.

The extensive drilling program and studies of the subsurface geology of Nebraska by the Nebraska Geological Survey (Conservation and Survey Division of the University of Nebraska), under the supervision of Prof. Eugene C. Reed, State Geologist, have yielded a tremendous amount of important geologic information. The relationship between the surface exposures and the subsurface sediments has been made clearer because of this work, and thus additional evidence has been provided to confirm the validity of correlations in the State.

Many other institutions also have made outstanding contributions to the vertebrate paleontology of the State during the past ninety years, and these too have helped build a strong foundation for future work in this field. It is hoped that the present Guide Book, like its predecessor in 1941, will in some small measure help to summarize the University of Nebraska's activities in developing a better understanding of the State's prehistory and animal life.

Stratigraphy

The Great Plains Standard[1] for the continental Medial and Late Cenozoic is shown pictorially in Figure 1 and more diagrammatically in Figure 2. Utilizing representative geologic sections, the total composite thickness from Oligocene through Pleistocene approximates perhaps 3,000 feet. It is proposed to summarize here the basic classification and to discuss only briefly some of the more recent work. The progression is from oldest to youngest, in the same general geologic order as that planned for the Stops of the Field Conference (see Map). The illustrations have been arranged similarly in this Guide Book and will be found mostly grouped together for convenience, following the text material and references but preceding the Itinerary. Emphasis is to be placed upon the major classification (Lugn, 1939b), under five principal headings (Fig. 2).

White River Group (Oligocene).—This division consists of two formations, the Chadron below and the Brule above, and the latter is divided into the Orella and Whitney members. The total thickness in northwestern Nebraska is almost 700 feet (Fig. 2, column A; Figs. 4-11) whereas it may exceed slightly that figure farther south in the North Platte Valley (Figs. 12-13; Schultz and Stout, 1955, tables 1-2). The lithology consists principally of alluvial and loessic silt and clay, nodular clay and silt, and river-channel sandstones, but correlations over the entire western Nebraska region and portions of adjoining States depend upon the correct recognition of volcanic ash beds (Schultz and Stout, 1955; Stout, 1960a) and paleosols (Schultz, Tanner, and Harvey, 1955; Falkenbach and Schultz, 1951) as well as faunal zonation.

In the last four decades there has been a marked tendency toward developing a distinct stratigraphic terminology in South Dakota (Bump, 1956; Clark, 1937, 1954; Wanless, 1922, 1923), and also in northeastern Colorado (Galbreath, 1953; Wilson, 1960) and eastern Wyoming (Schlaikjer, 1935b), areas peripheral to the region visited on the present Conference. This practice is questioned by the writers (Schultz and Stout, 1955; Stout, 1960a) because it appears to ignore completely the fact

[1] The nomenclature shown on Figure 1 is also that of the Nebraska Geological Survey, except that Ogallala is considered to be a formation, with three members.

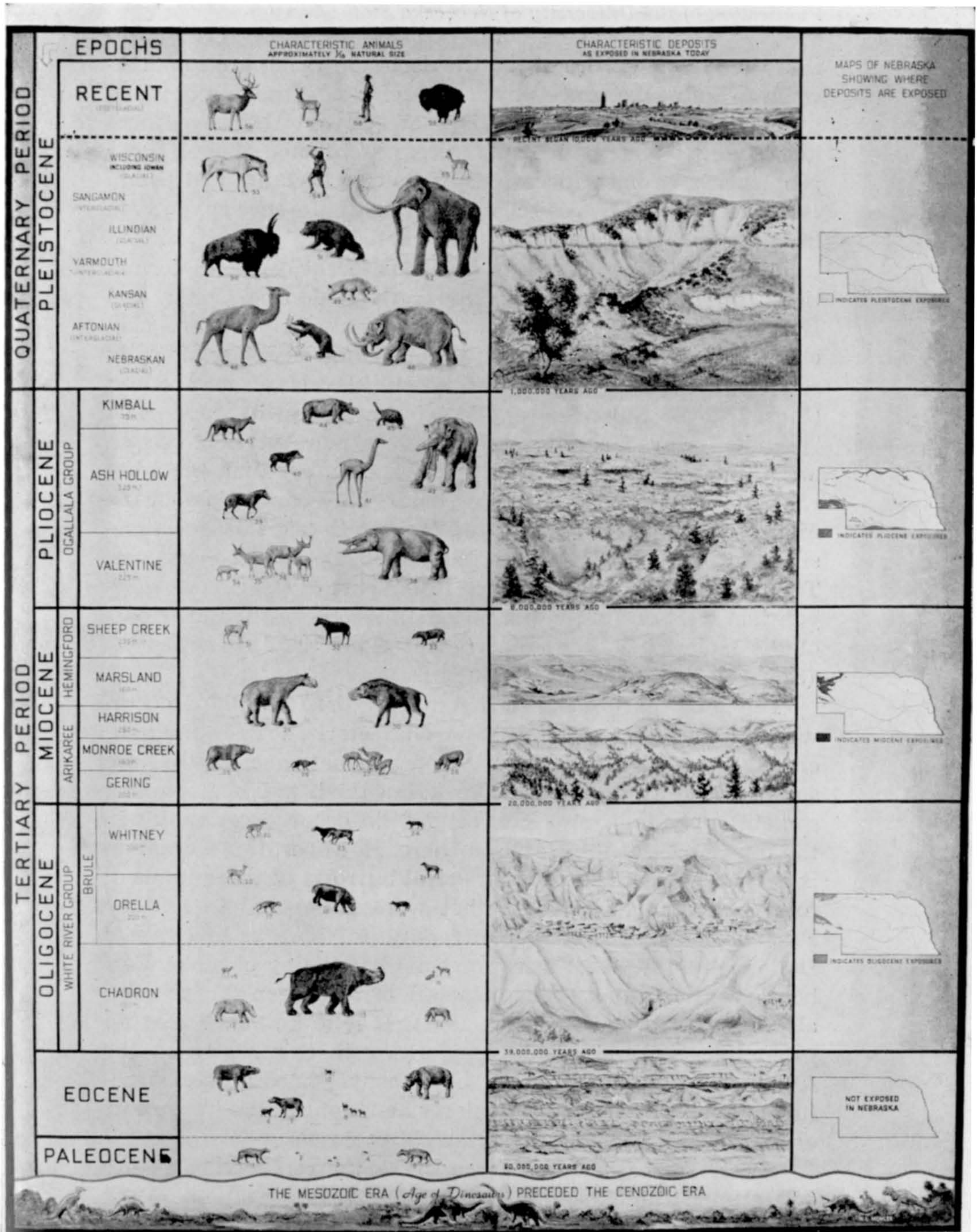

FIG. 1—"The Age of Mammals," a generalized classification of the Central Great Plains Cenozoic. Chart (painted by Nathan Mohler, under the direction of C. Bertrand Schultz) on exhibit at University of Nebraska Trailside Museum, Fort Robinson. (From Schultz and Stout, 1948, Pl. 1; 1955, Fig. 1.)

that the type localities of the Chadron and Brule are in northwestern Nebraska, since physical tracing of units and detailed lithologic and faunal correlations are possible between these key localities and the marginal areas mentioned above. These problems have been discussed previously (Schultz and Stout, 1955), and should be rediscussed on this Conference as the type localities and other exposures are visited.

Arikaree Group (Early to Medial Miocene).—Three formations constitute this group: the Gering, Monroe Creek, and Harrison (Fig. 2). In contrast to the dominantly silt and clay character of the White River, these sediments are principally sand but with several characteristic levels of concretions (Figs. 18-20; Schultz, 1941a). The Gering has in its upper part "pseudo-" pipy concretions that have a more vertical section and pendant form (Schultz, 1941a, Figs. 31, 33) than the more rounded, massive and elongate "true-" pipy concretions of the Monroe Creek. At the top of the Monroe Creek, there occurs a silty unit with small, rounded and knobby "potato" concretions. This bed is well exposed in the lower part of the Smiley Canyon just west of Fort Robinson (Stop 9) and in the upper part of the main Pine Ridge escarpment along the Bryan Canyon (Stops 10-11), both near Crawford.

The lower part of the Harrison along the Pine Ridge northwest of Harrison, Nebraska, is characterized by numerous, closely-spaced levels of "sheet" concretionary masses that are smaller than in the Monroe Creek, but the heavy, massive and sometimes hollow, pipy concretions do occur occasionally in the upper part of the Harrison there. However, this formation is best known for the peculiar spiral burrows of three kinds of fossil beavers (Figs. 23-24) that were discovered in 1891 by Prof. E. H. Barbour of the University of Nebraska and named Daimonelix (see references for complete listing of all of Barbour's contributions, chronologiclaly arranged, on this subject; also Schultz, 1942, and Lugn, 1941). It is to be hoped that all paleontologists and geologists working in this region in the future will aid in preserving these easily-eroded unique structures which were once particularly abundant in the upper part of the Harrison, below the principal paleosols.

The Arikaree in the Monroe Creek Canyon section (Stops 6-7) attains a thickness of over 600 feet (Fig. 2, column B). At the base there, the Gering locally reaches 200 feet where a valley was deeply carved into the faulted and fractured silts of the Whitney member of the Brule formation; this basal uncon-

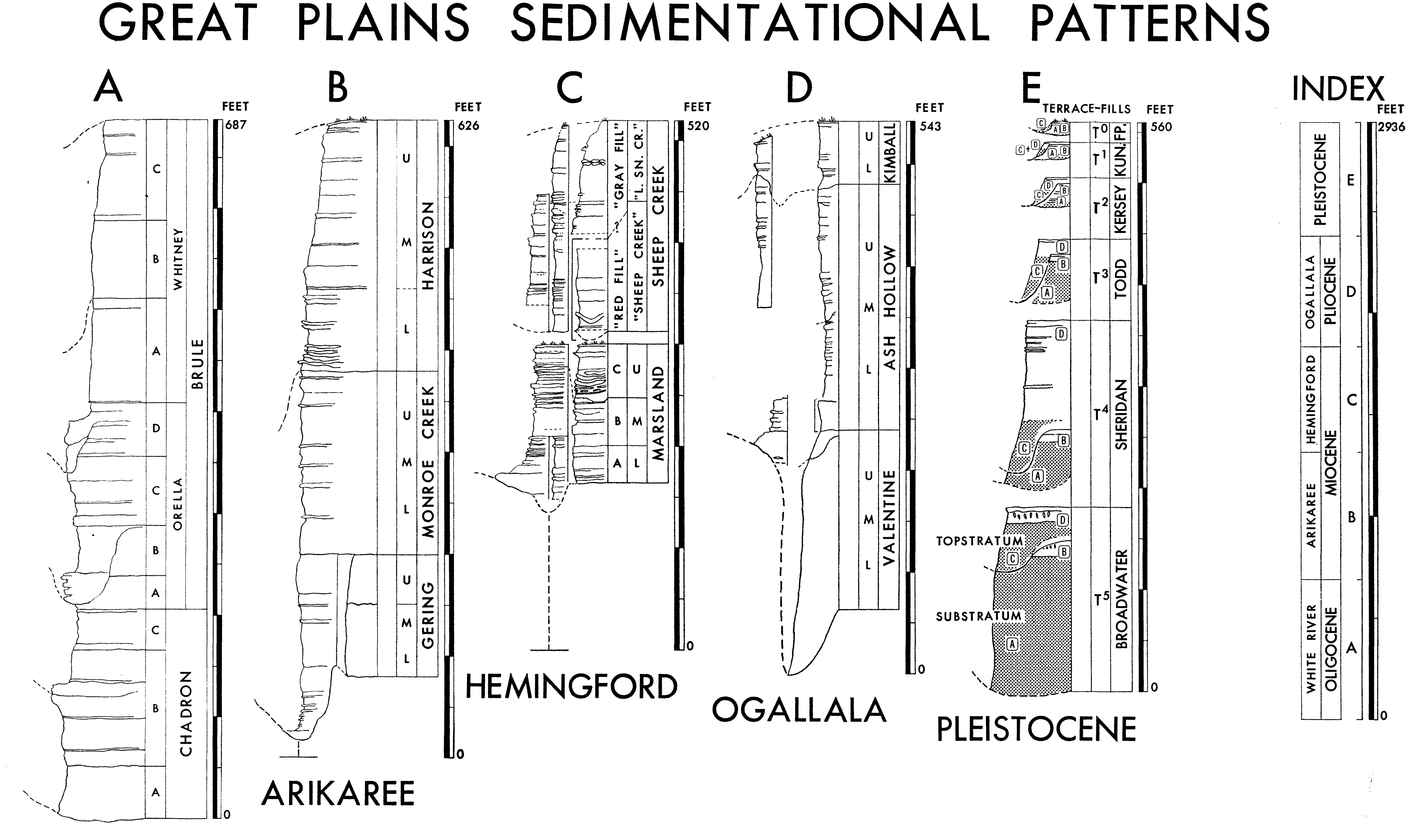

FIG. 2—Diagram of Great Plains sedimentational patterns for the Medial and Late Cenozoic. (Prepared by T. M. Stout.) L = Lower, M = Middle, U = Upper, KUN. = Kuner, and FP. = Floodplain.

T. M. STOUT

formity is of regional importance, being characteristic of the base of each of the Gering valleys so far studied. At the type Gering exposures (Stop 26), south and west of Gering, Nebraska, this axial-thickening of the Gering valley-fill is well displayed and has lately been carefully studied by Mr. Carl F. Vondra in a recently-completed but unpublished doctoral dissertation on the Gering Formation at the University of Nebraska.

The name "Sharps Formation" has been newly proposed by Harksen, Macdonald, and Sevon (1961) for a unit that occupies the position of the Gering, between the upper part of the Brule and the Monroe Creek, in Shannon County, South Dakota. These authors state in their type description that "it seems to be recognizable 75 miles southwest, near Harrison, in Sioux County, Nebraska." It is the writers' considered opinion that this proposed new name is invalid, being a synonym of Gering.

Hemingford Group (Medial to Late Miocene).—Another unconformity of regional extent separates the Hemingford from the Arikaree (Fig. 2), and it has been known for some time (Schultz, 1938a, 1941b; Lugn, 1939b; and an unpublished report of Schultz and Stout) that this is between the Harrison (old "Lower Harrison") and Marsland (old "Upper Harrison") formations. There also is a major faunal break at this level in the geologic sequence. Thus, any inclusion of the Marsland in the Arikaree, as Wilson (1960) suggests, would seem to have neither stratigraphic nor faunal support, and is indeed contrary to everything known about these beds in some 25 years of careful stratigraphic study and collecting by the writers and their associates. Similarly, the proposal that a "true" Upper Harrison unit occurs between the Harrison and Marsland (Cook and Gregory, 1941)—recently expanded (Cook, 1960) into a proposed division of the Marsland into this "true" Upper Harrison and a "new" formation ("Runningwater")—appears to again require firm refutation (see also Schultz, 1941b).

The Hemingford includes the Marsland and Sheep Creek formations, but the latter is now considered to include only two rather poorly-named members, the restricted "Sheep Creek" below and the "Lower Snake Creek" above. The divisions proposed by Elias (1942) are at least partly preoccupied by these two earlier names, and the name "Box Butte" (Cady, 1940; Elias, 1942; Lugn, 1939b) appears also to be invalid.

Ogallala Group (Pliocene).—The Ogallala includes from oldest to youngest the Valentine, Ash Hollow, and Kimball

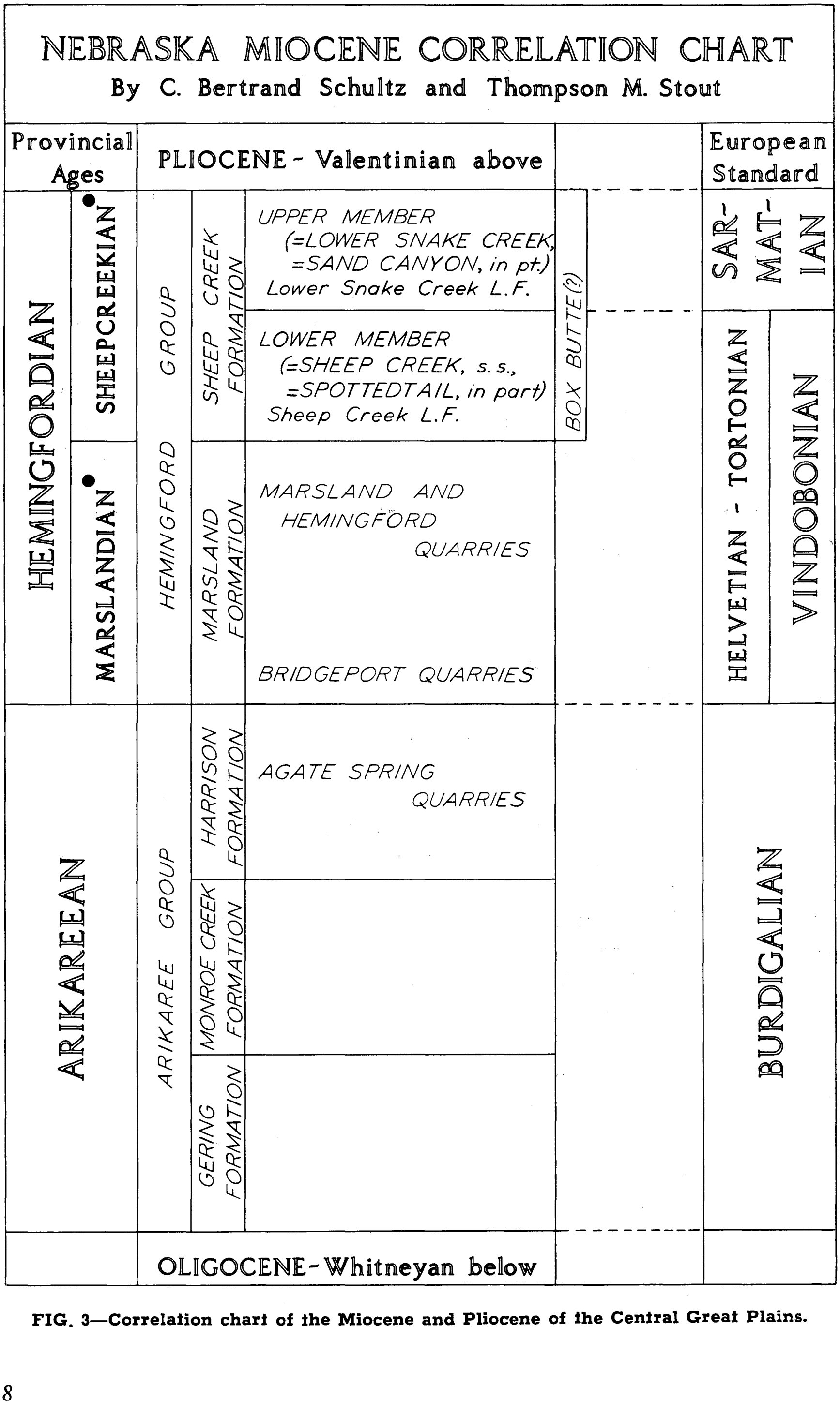

FIG. 3—Correlation chart of the Miocene and Pliocene of the Central Great Plains.

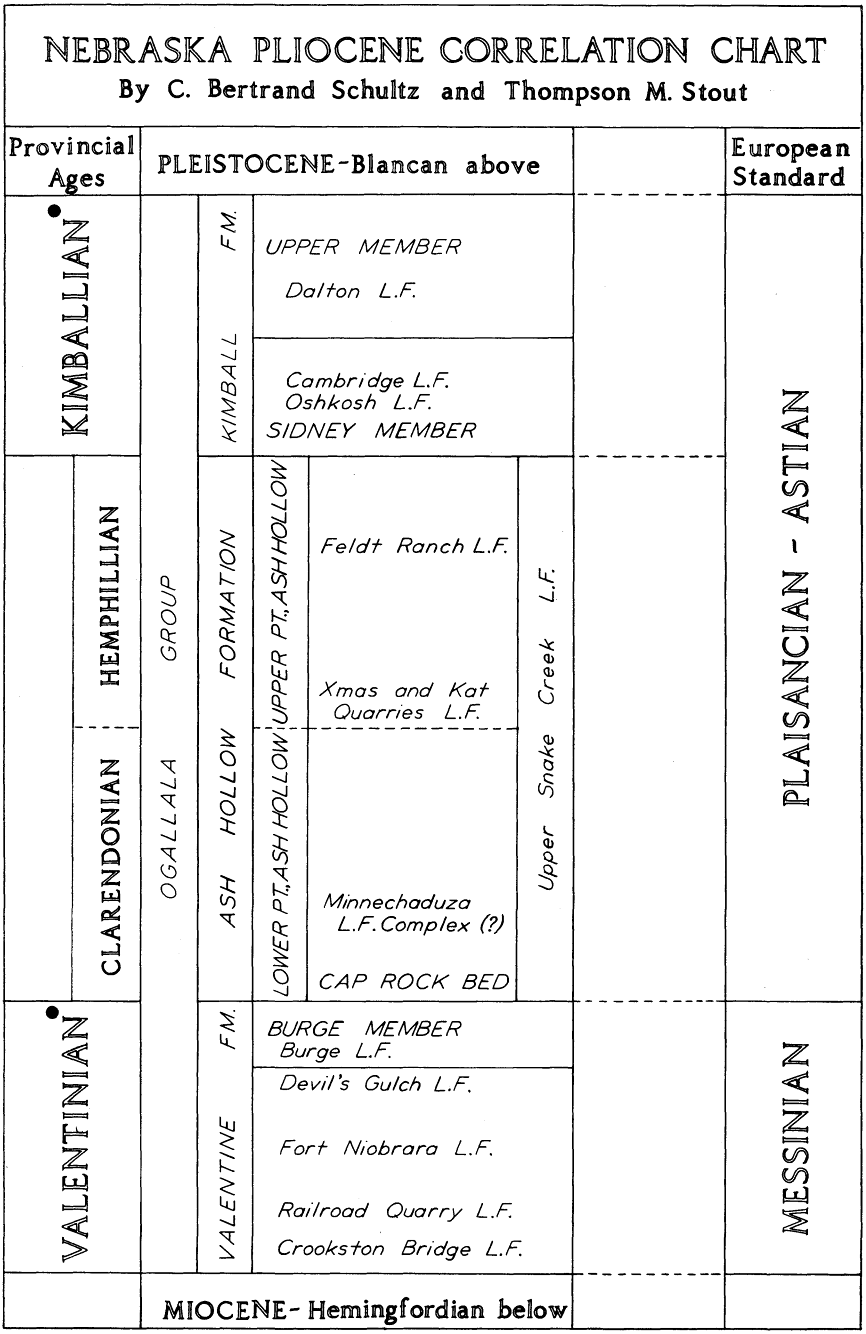

FIG. 3 (continued)—The black dots refer to terms suggested by the writers for use by a committee of the Society of Vertebrate Paleontology (see Wilson, 1960). L.F. = Local Fauna.

(Fig. 2), with the Burge Sand at the top of the Valentine, the Cap Rock Bed at the base of the Ash Hollow (Johnson, 1936, 1938), the Sidney Gravel (Lugn, 1939b) at the base of the Kimball, and algal limestones and caliche in the upper part of the Kimball. The Ogallala valley-fills represent the latest Tertiary aggradation of the Central Great Plains, prior to the uplift and associated climatic changes that inaugurated the Pleistocene (Schultz and Stout, 1945, 1948).

Pleistocene.—The Pleistocene of Nebraska has been the subject of continuing exhaustive investigation by many persons. The earlier basic summaries (Lugn, 1934, 1935; Condra, Reed, and Gordon, 1947 and 1950; Schultz, 1934; Schultz and Stout, 1941, 1945, 1948; Schultz, Lueninghoener, and Frankforter, 1951; Schultz, Reed, and Lugn, 1951) should be consulted for pertinent background information. The terrace-fill succession (Schultz and Stout, 1945, 1948; Schultz, Lueninghoener, and Frankforter, 1948, 1951; Lueninghoener, 1947; Schultz and Tanner, 1957; Stout, 1955, 1956, 1960b) is especially to be stressed on this Conference, and it has been the subject of nearly continuous joint study by the writers and their associates since about 1936. The problems with regard to the time of Man's first entrance on this continent have not been neglected, and much documentation supports present views.

Paleontology

The distribution of the fossil mammals in the Great Plains succession just described is shown pictorially in Figure 1, and it is not an exaggeration to state that from the base of the Oligocene to the Recent there are at least some fossils known from almost every ten feet of the geologic section. Although studies have been long under way toward the stratigraphic revision of most of the principal groups of fossil mammals of this region, it seems appropriate at this time to draw particular attention to a summary of one of these groups (faunal list by Schultz and Falkenbach, with accompanying Chart 1, summarizing the stratigraphic distribution of the oreodonts).

Faunal List of the Oreodonts from Nebraska

By C. Bertrand Schultz and Charles H. Falkenbach

The following oreodont faunas of Nebraska are based on a revision of the Merycoidodontidae by the writers. A full consideration of the stratigraphic and morphologic evidence has been considered in the oreodont study. Seven reports covering eight subfamilies have been published (see Schultz and Falkenbach, 1940, 1941, 1947, 1949, 1950, 1954 and 1956; also Falkenbach and Schultz, 1951):

WHITE RIVER GROUP

Oreodont Faunal "Zone C" of Chadron

(= Upper Chadron)

Stenopsochoerus (Pseudostenopsochoerus) chadronensis
S. (P.) douglasensis var.
Merycoidodontinae (revision forthcoming)[1]

Oreodont Faunal "Zone A" of Brule

(= Lower and Middle Orella)

Miniochoerus battlecreekensis
M. (Paraminiochoerus) affinis
M. (P.) gracilis
Platyochoerus platycephalus
Stenopsochoerus sternbergi
S. (Pseudostenopsochoerus) chadronensis var.
S. (P.) douglasensis
Merycoidodontinae (revision forthcoming)

Oreodont Faunal "Zone B" of Brule

(= Upper Orella)

Subdesmatochoerus socialis
Miniochoerus starkensis
M. (Paraminiochoerus) helprini
Platyochoerus heartensis
Stenopsochoerus joderensis
Merycoidodontinae (revision forthcoming)

[1] Schultz and Falkenbach have just completed a manuscript on the revision of the subfamilies Merycoidodontinae, Leptaucheniinae, and Eporeodontinae. The latter subfamily, however, has not been recognized from Nebraska.

Oreodont Faunal "Zone C" of Brule

(= Lower Whitney)

Miniochoerus nicholsae
M. (Paraminiochoerus) ottensi
Platyochoerus hatcreekensis
Stenopsochoerus berardae
Merycoidodontinae (revision forthcoming)

Oreodont Faunal "Zone D" of Brule

(= Middle and Upper Whitney)

Subdesmatochoerus shannonensis
Miniochoerus cheyennensis
Merycoidodontinae (revision forthcoming)
Leptaucheniinae (revision forthcoming)

ARIKAREE GROUP

Gering

Mesoreodon cheeki
Mesoreodon megalodon sweeti
Merycoides nebraskensis
Desmatochoerus hatcheri geringensis
Desmatochoerus (Paradesmatochoerus) grangeri
Desmatochoerus (Paradesmatochoerus) sanfordi
Desmatochoerus (Paradesmatochoerus) wyomingensis
Leptaucheniinae (revision forthcoming)

Monroe Creek

Mesoreodon megalodon
Mesoreodon cheeki scotti
Megoreodon grandis loomisi
Desmatochoerus hatcheri niobrarensis
Desmatochoerus (Paradesmatochoerus) sanfordi var.
Leptaucheniinae (revision forthcoming)

Harrison

Merychyus crabilli
Merychyus siouxensis
Promerycochoerus carrikeri
Phenacocoelus typus
Hypsiops brachymelis petersoni
Desmatochoerus curvidens gregoryi

HEMINGFORD GROUP

Lower Marsland

Merycochoerus matthewi
Merychyus arenarum
Merychyus minimus
Phenacocoelus stouti

Middle Marsland

Merycochoerus proprius magnus

Upper Marsland

Merycochoerus proprius
Mediochoerus johnsoni
Merychyus elegans
Merychyus elegans bluei

"Sheep Creek"

Brachycrus wilsoni
Brachycrus wilsoni longensis
Ticholeptus tooheyi
Merychyus (Metoreodon) relictus taylori

"Lower Snake Creek"

Brachycrus siouense
Ticholeptus hypsodus
Mediochoerus blicki
Merychyus (Metoreodon) relictus

OGALLALA GROUP

Valentine

Ustatochoerus medius
?Ustatochoerus schrammi

Lower Ash Hollow

Ustachoerus profectus
Ustaochoreus skinneri

Middle-Upper Ash Hollow

Ustatochoerus major
Extinction of the oreodonts in Nebraska occurred prior to the end of Ash Hollow times.

Geological Terminology for Western Nebraska and Adjacent Areas			Oreodont Faunal Zones	South Dakota Faunal Zones
BRULE FORMATION	Whitney Member	Upper	"D"	"Leptauchenia"
		Middle		
		Lower	"C"	"Upper Oreodon"
	Orella Member	Upper	"B"	"Middle Oreodon"
		Middle	"A"	"Lower Oreodon"
		Lower		

CHART 1—Correlation chart relating Brule Formation paleosols to oreodont faunal zones (based on correlation chart by Falkenbach and Schultz, 1951, p. 49; chart frm Schultz, Tanner, and Harvey, 1955, Fig. 2). It is of interest to note that the major paleosols and paleosol complexes occur at the oreodont faunal breaks observed by Schultz and Falkenbach throughout the revision of the oreodonts (Merycoidodontidae). The Chadron Formation is also divided into oreodont faunal zones "A," "B," and "C." Prominent paleosol complexes occur at the top of the Middle Orella, Upper Orella, Lower Whitney, and Upper Whitney in Nebraska; also at top of the "Lower Oreodon," "Middle Oreodon," "Upper Oreodon," and "Leptauchenia" zones in South Dakota. Paleosols are also present in the Chadron formation but further study of these is necessary before their relative importance can be ascertained. A very prominent paleosol complex (= "Interior Formation"), probably of Eocene age, is present at the top of the Pierre Shale (below the Chadron deposits) in Sioux County and adjacent areas.

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[1] Copies of all of the works listed, except for the bulky monographs of Osborn and Leidy, will be carried along on the Conference for consultation by the participants at any time.

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OLIGOCENE

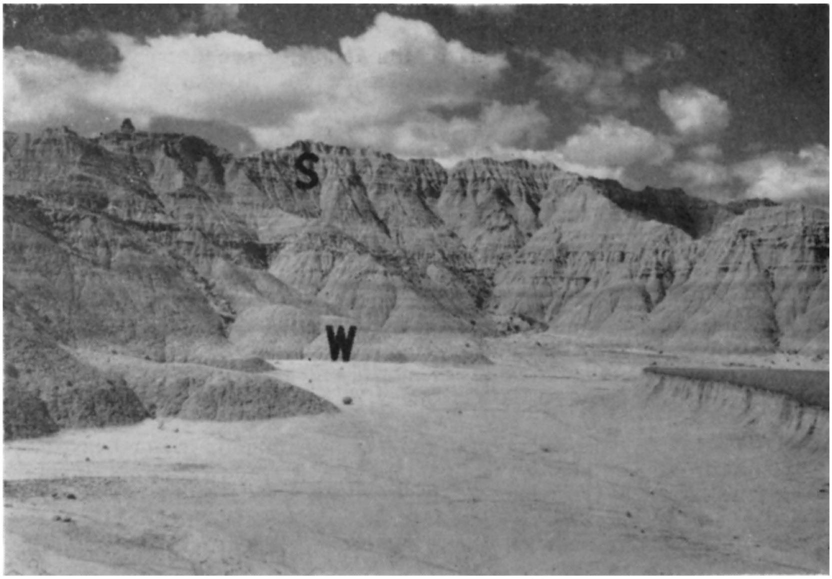


FIG. 4—Oligocene badlands, Toadstool Park area, Sioux County, Nebraska. W = Upper Purplish White layer at top of Chadron Formation, S = major paleosol complex at top of Middle Orella Member of Brule Formation. See Fig. 7. (From Schultz, Tanner, and Harvey, 1955, Fig. 3.) STOP 2.

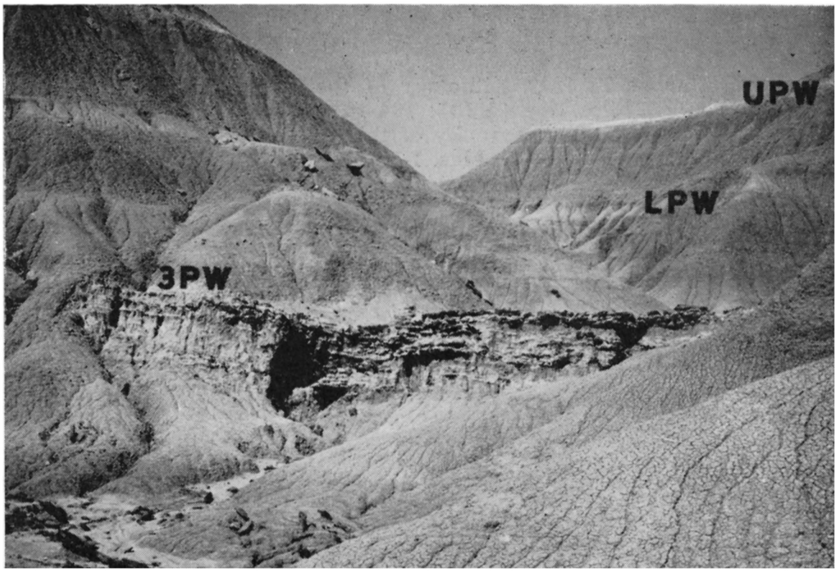
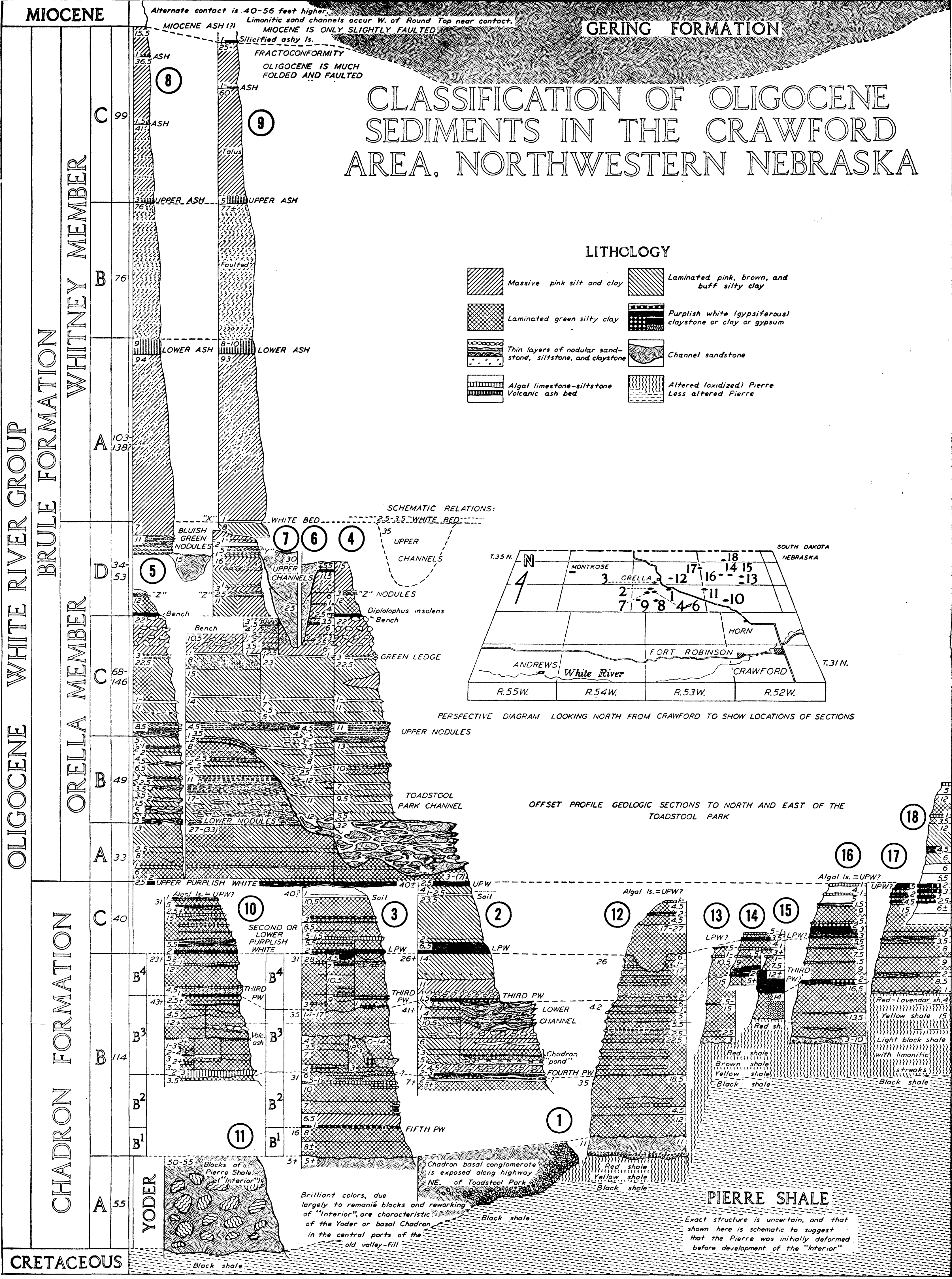


FIG. 5—Lower Channel Sandstone and three Purplish White Layers at the top of the Chadron Formation, at type locality of the Chadron, Toadstool Park area. See Fig. 6. (From Schultz and Stout, 1955, Fig. 4.) STOP 3.



CLASSIFICATION OF OLIGOCENE SEDIMENTS IN THE CRAWFORD AREA, NORTHWESTERN NEBRASKA
MIOCENE
GERING FORMATION
OLIGOCENE
WHITE RIVER GROUP
BRULE FORMATION
WHITNEY MEMBER
ORELLA MEMBER
CHADRON FORMATION
YODER
CRETACEOUS
PIERRE SHALE
Alternate contact is 40-56 feet higher.
Limonitic sand channels occur W. of Round Top near contact.
MIOCENE ASH (?)
MIOCENE IS ONLY SLIGHTLY FAULTED
Silicified ashy ls.
FRACTOCONFORMITY
OLIGOCENE IS MUCH FOLDED AND FAULTED
UPPER ASH
LOWER ASH
WHITE BED
SCHEMATIC RELATIONS: 2.5-3.5 WHITE BED
UPPER CHANNELS
BLUISH GREEN NODULES
"Z" NODULES
Diplolophus insolens
Bench
GREEN LEDGE
UPPER NODULES
TOADSTOOL PARK CHANNEL
LOWER NODULES
UPPER PURPLISH WHITE
UPW
SECOND OR LOWER PURPLISH WHITE
LPW
THIRD PW
LOWER CHANNEL
Chadron "pond"
FOURTH PW
FIFTH PW
Volc. ash
Soil
Algal ls. = UPW?
Blocks of Pierre Shale ("Interior")
Chadron basal conglomerate is exposed along highway NE. of Toadstool Park
Brilliant colors, due largely to remanié blocks and reworking of "Interior", are characteristic of the Yoder or basal Chadron in the central parts of the old valley-fill
Black shale
Red shale
Yellow shale
Brown shale
Red-Lavendar sh.
Light black shale with limonitic streaks
Exact structure is uncertain, and that shown here is schematic to suggest that the Pierre was initially deformed before development of the "Interior"
LITHOLOGY
Massive pink silt and clay
Laminated pink, brown, and buff silty clay
Laminated green silty clay
Purplish white (gypsiferous) claystone or clay or gypsum
Thin layers of nodular sandstone, siltstone, and claystone
Channel sandstone
Algal limestone-siltstone
Volcanic ash bed
Altered (oxidized) Pierre
Less altered Pierre
T.35 N.
T.31 N.
SOUTH DAKOTA
NEBRASKA
MONTROSE
ORELLA
HORN
FORT ROBINSON
ANDREWS
White River
CRAWFORD
R.55W.
R.54W.
R.53W.
R.52W.
PERSPECTIVE DIAGRAM LOOKING NORTH FROM CRAWFORD TO SHOW LOCATIONS OF SECTIONS
OFFSET PROFILE GEOLOGIC SECTIONS TO NORTH AND EAST OF THE TOADSTOOL PARK

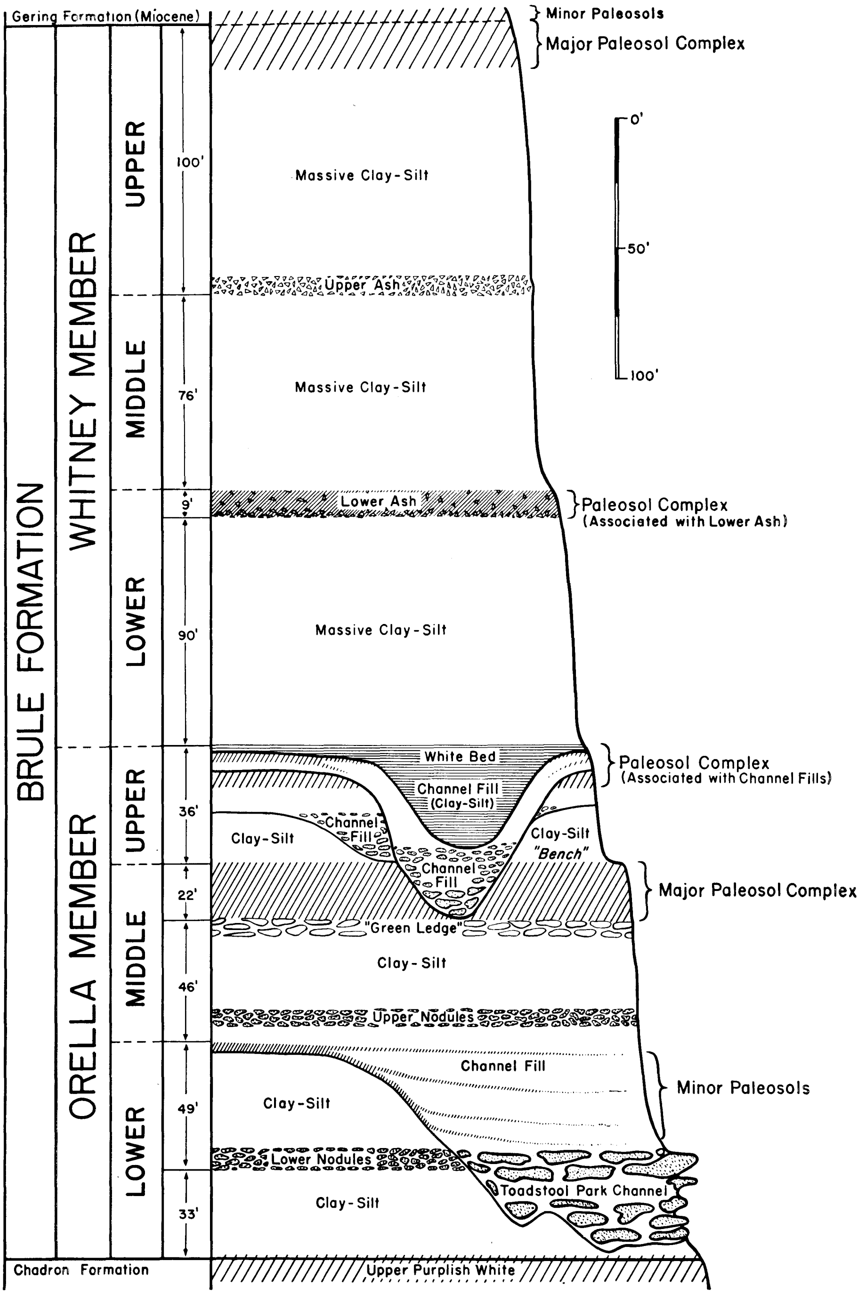


FIG. 7—Sequence of Oligocene paleosols at type locality of Brule Formation, Orella Member, and Whitney Member, Toadstool Park area, SW. of Orella, Sioux County, Nebraska. (From Schultz, Tanner, and Harvey, 1955, Fig. 1.) For use at STOPS 2 and 3.

FIG. 8—Toadstool Park Channel at type locality for Brule Formation and Orella Member, Toadstool Park Draw. (From Schultz and Stout, 1955, Fig. 7.) STOP 3.

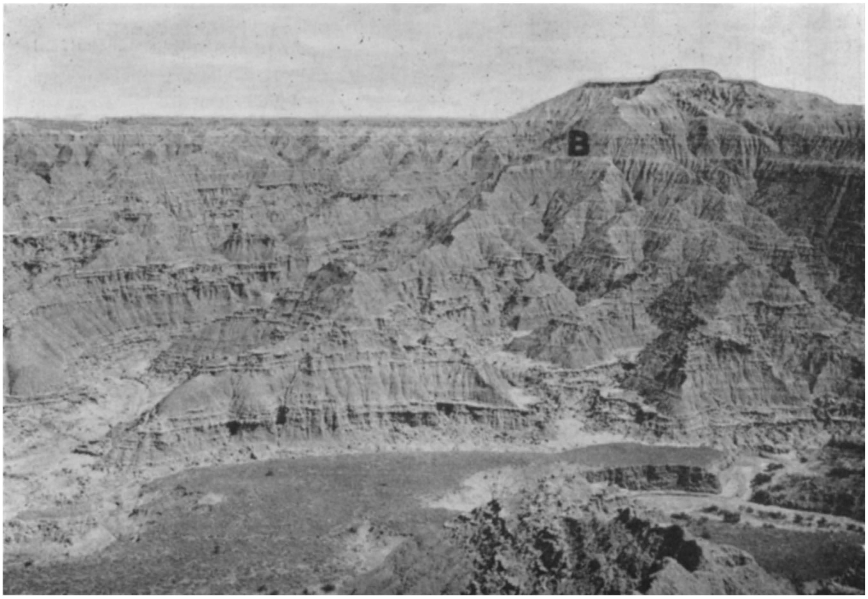


FIG. 9—Type locality for Brule Formation and Orella Member, Toadstool Park Draw (B on top of "Bench," or paleosol complex developed at top of Middle Orella. (From Schultz and Stout, 1955, Fig. 6.) STOPS 2 and 3.

FIG. 10—The "Bench" developed on major paleosol complex at top of Middle Orella Member, Brule Formation, Toadstool Park area. Man standing on "Bench." (From Schultz, Tanner, and Harvey, 1955, Fig. 4.) STOPS 2 and 3.

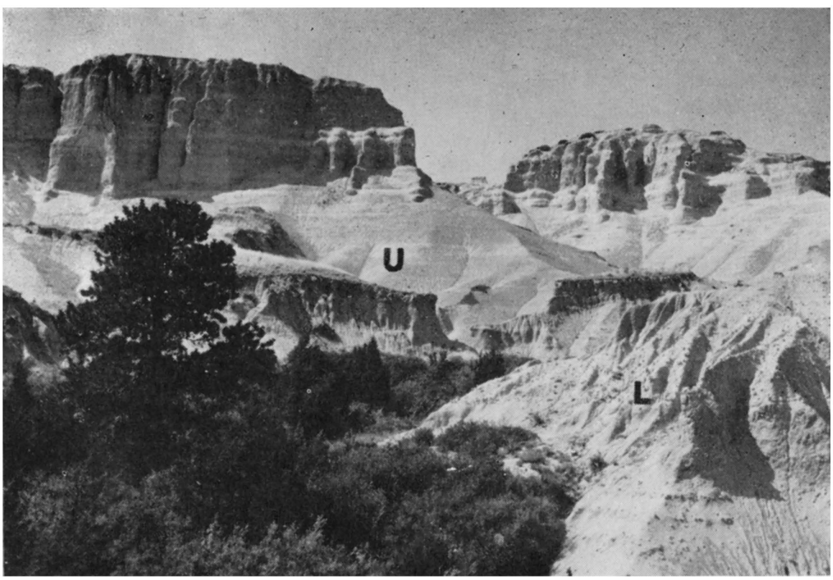


FIG. 11—Type locality for Whitney Member or upper portion of Brule Formation (with Gering Formation at top of exposure), S. of Toadstool Park. U = Upper Ash, L = Lower Ash. (From Schultz and Stout, 1955, Fig. 8.) STOPS 2 and 3.

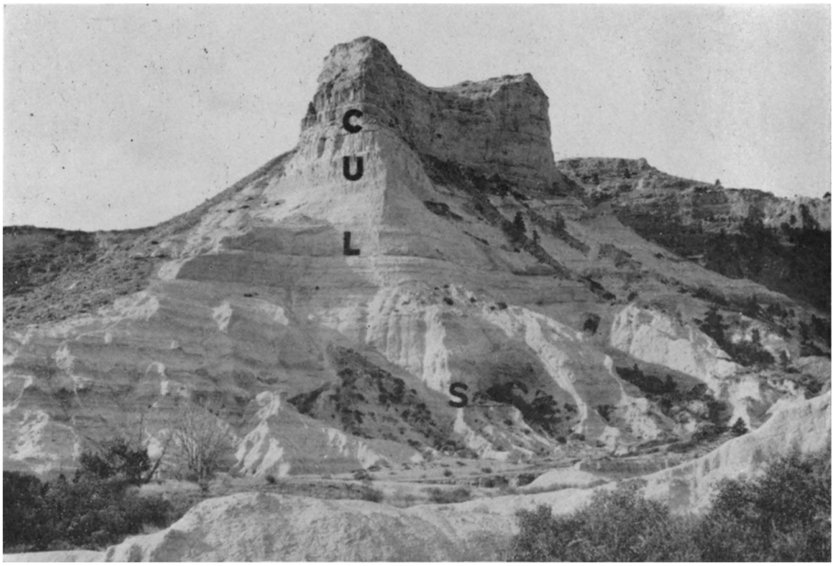


FIG. 12—Whitney Member of Brule Formation, and overlying Miocene formations (Gering and Monroe Creek), at NE. part of Scotts Bluff National Monument. (Base of C = Miocene-Oligocene contact; top of U = Upper Ash; base of L = Lower Ash; S = "Upper Channels." (From Schultz and Stout, 1955, Fig. 12.) STOP 25.

FIG. 13—Oligocene badlands (Orella Member of Brule Formation with uppermost Chadron Formation at base), at NE. part of Scotts Bluff National Monument, Scotts Bluff County, Nebraska. STOP 25.

MIOCENE

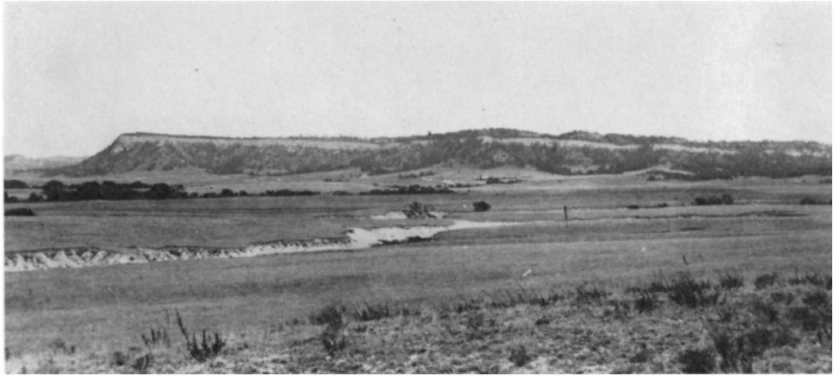


FIG. 14—Pine Ridge east of Five Points, Sioux County, Nebraska. Brule exposures in ravines to left; Gering and Lower Monroe Creek largely talus covered below bare, perpendicular exposures of Upper Monroe Creek; Harrison largely pine-covered at top of ridge. (From Schultz, 1941a, Fig. 28). South of STOP 4.

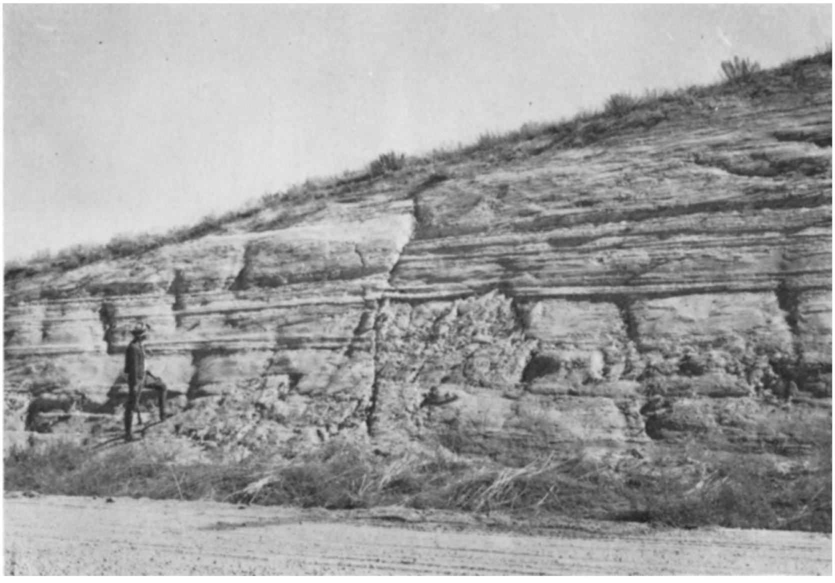


FIG. 15—Gering Formation with fault (2¼ mi. W. of Gering exposure, Pl. 93 in Darton, 1899b), 4½ mi. S. of Crawford, Dawes County, Nebraska. STOP 10.

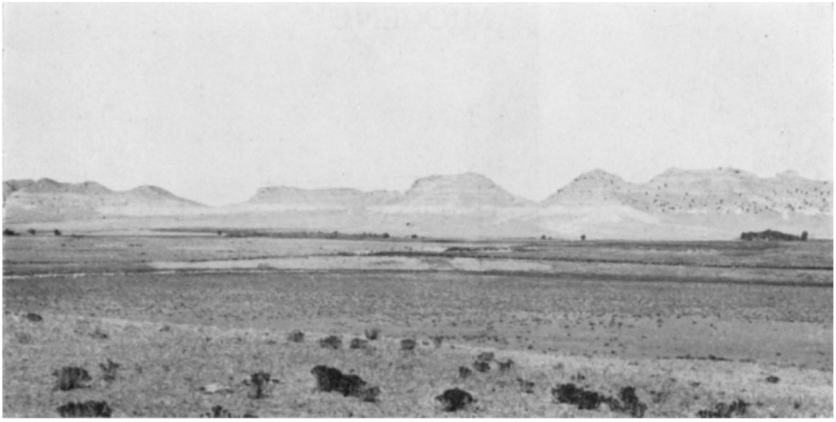


FIG. 16—Wildcat Ridge; Brule (Whitney Member), Gering, and Monroe Creek formations exposed. Redington Gap at left, Morrill County, Nebraska. STOPS 30 and 31.

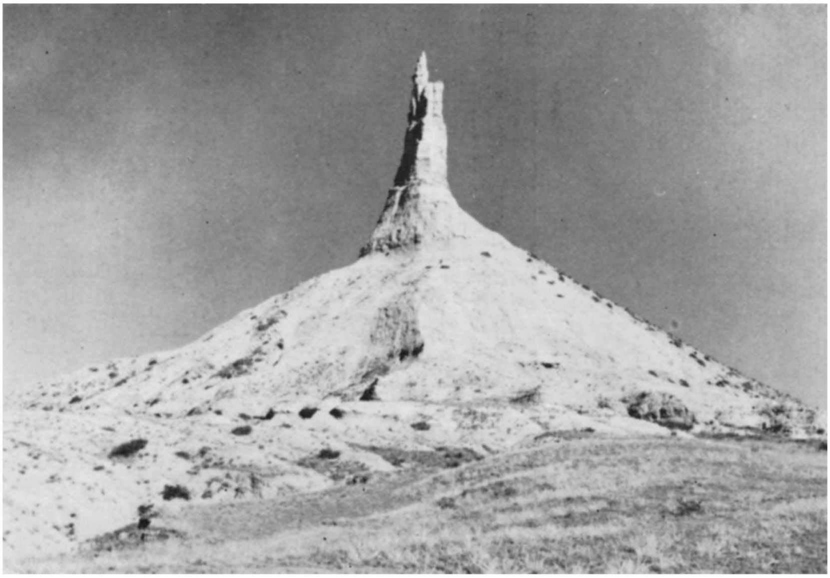
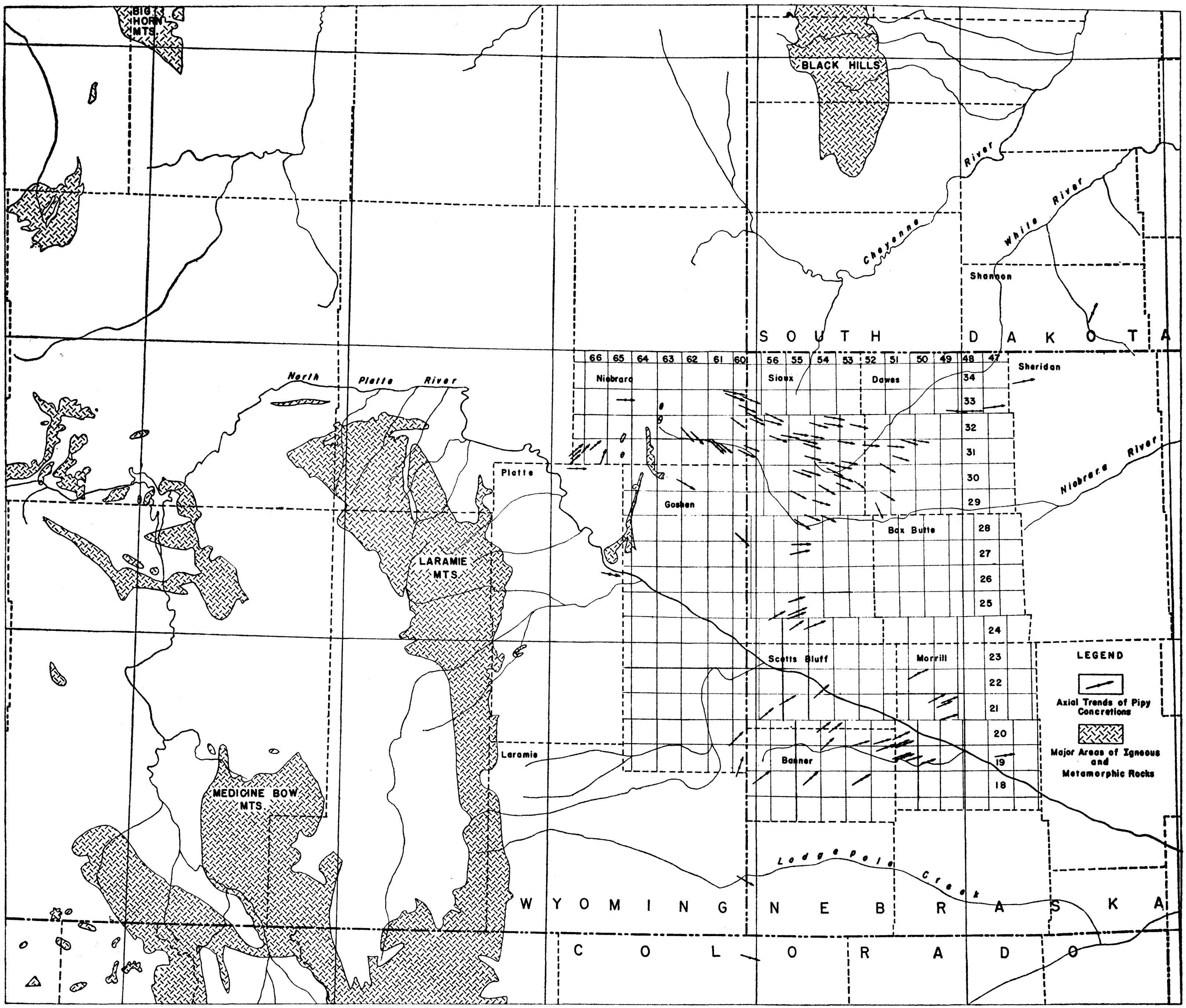


FIG. 17—Chimney Rock, Brule (Whitney Member) and Gering formations exposed. Perpendicular column = Gering; Sloping base = Brule; Upper Ash of Brule near base of exposure. STOP 24.



THE AXIAL TRENDS OF PIPY CONCRETIONS IN THE LOWER MIOCENE DEPOSITS (ARIKAREE GROUP) OF WESTERN NEBRASKA AND ADJACENT STATES

By C. Bertrand Schultz

Base Outline after United States Geological Survey Map

FIG. 19—Typical pipy concretions in Monroe Creek Formation, Wildcat Ridge, Scotts Bluff County, Nebraska. (From Schultz, 1941a, Fig. 30.) Similar to pipy concretions at STOPS 25, 26, and 30, as well as at STOPS 6 and 7, along the Pine Ridge.

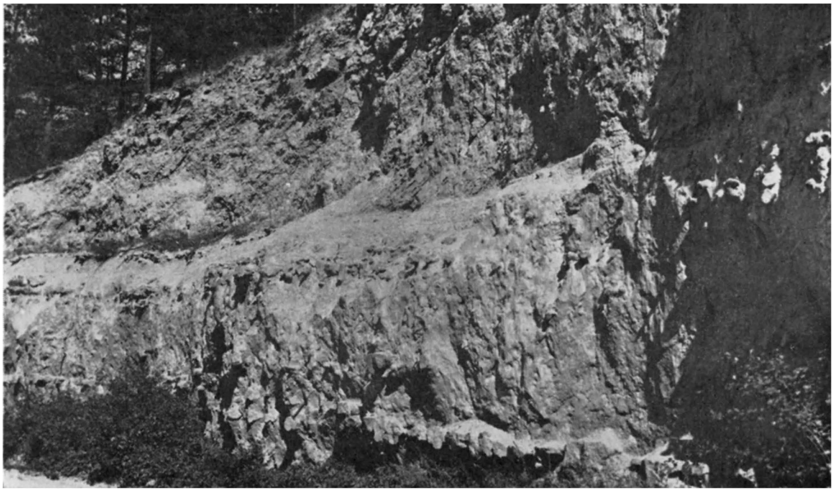


FIG. 20—Layers of typical pipy concretions in Lower Monroe Creek deposits, at type locality of Monroe Creek, along Pine Ridge, N. of Harrison, Sioux County, Nebraska. (From Schultz, 1941a, Fig. 32.) Between STOPS 6 and 7.

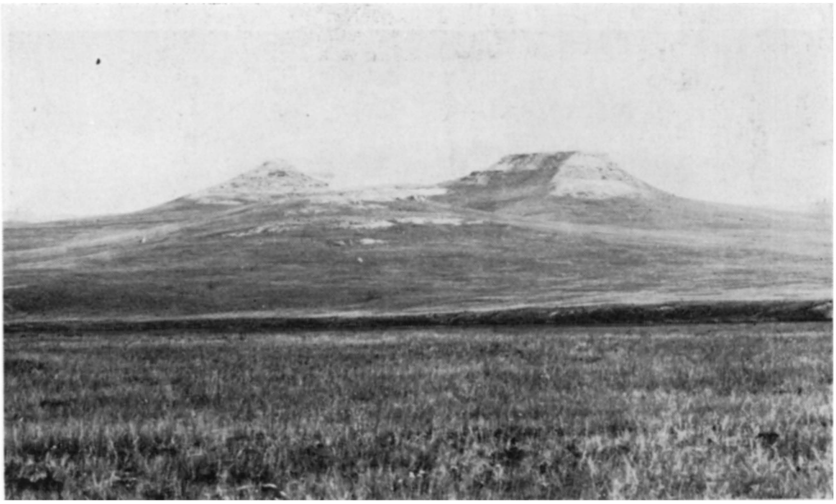


FIG. 21—Agate Spring Fossil Quarries located in University Hill (left) and Carnegie Hill (right), Harrison Formation, S. of Niobrara River, E. of Agate, Sioux County, Nebraska. Fossils first discovered here by Captain James Cook, 1891. (Photograph, 1906.) STOP 14.

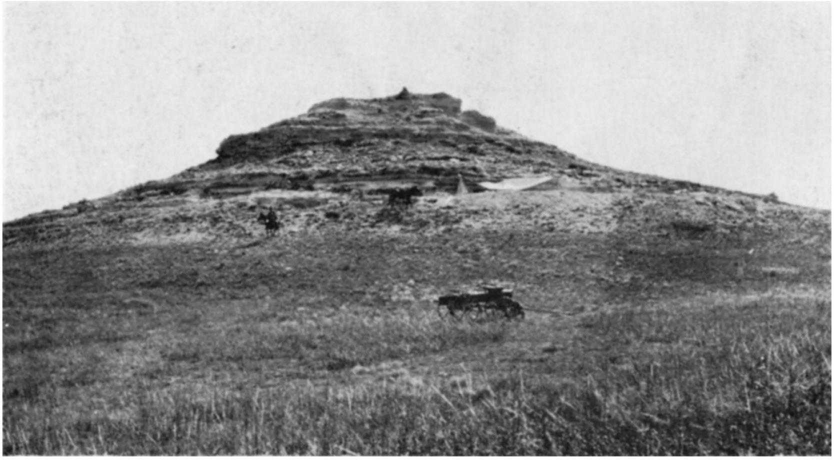


FIG. 22—University Hill, U.N.S.M. Coll. Loc. Sx-72, one of the two Agate Spring Fossil Quarries, fossils quarried from zone where horses are shown at center and canvas shade at right. University of Nebraska State Museum field parties first worked here in 1905. (Photograph, 1908.) STOP 14.

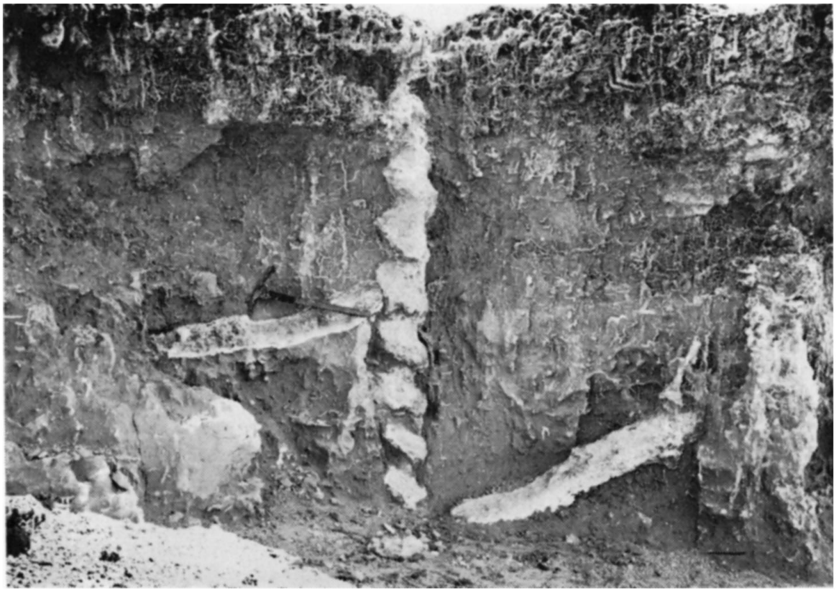


FIG. 23—Daimonelix (in center) with associated beaver (Paleocastor) nest (at lower right), Harrison Formation, near head of White River, Sioux County, Nebraska. Note portion of paleosol complex at top of spiral. (From Schultz, 1942, Fig. 2.) Similar to daimonelices at STOPS 6 and 13.

FIG. 24—Daimonelix exhibit (part of type collection) at the University of Nebraska State Museum, Lincoln. (Exhibit installed in 1961 on the 70th Anniversary of the discovery of daimonelices by Dr. Erwin H. Barbour in 1891.) Specimens collected near STOPS 5 and 6 in Sioux County.

FIG. 25—Marsland Formation, Upper Marsland fossil quarry, U.N.S.M. Coll. Loc. Bx-7, in far center of picture, 12 miles S. and E. of STOP 12, the type locality of Marsland, Box Butte County.

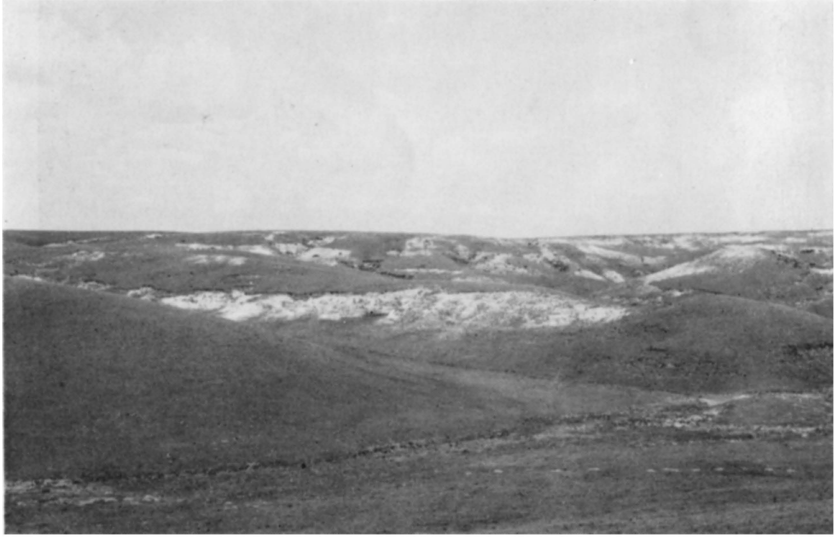


FIG. 26—Type locality (in distance) of Sheep Creek Formation (= "Sheep Creek" and "Lower Snake Creek" of W. D. Matthew and Harold J. Cook), Sioux County. STOPS 15 and 16.

PLIOCENE

FIG. 27—Type locality of Ash Hollow Formation, near mouth of Ash Hollow Canyon, Garden County. Ash Hollow resting on Valentine and earlier Tertiary (?Gering). STOP 34.

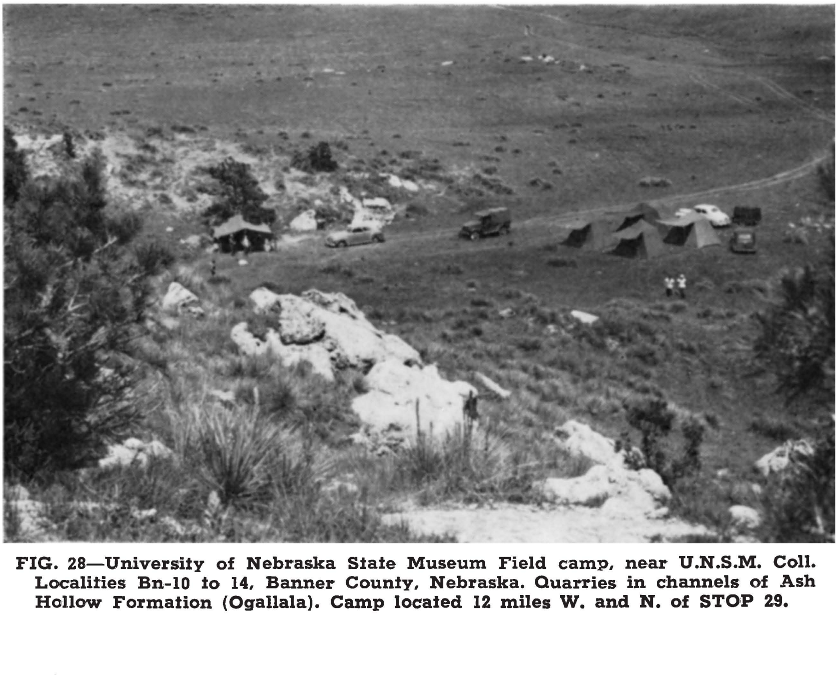


FIG. 28—University of Nebraska State Museum Field camp, near U.N.S.M. Coll. Localities Bn-10 to 14, Banner County, Nebraska. Quarries in channels of Ash Hollow Formation (Ogallala). Camp located 12 miles W. and N. of STOP 29.

FIG. 29—Kimball Formation (uppermost Pliocene) with mantling of Late Pleistocene loess, SW. of Medicine Creek Dam, Frontier County, Nebraska. STOP 38.

FIG. 30—Fossil quarry, U.N.S.M. Coll. Loc. Ft-40, Kimball Formation (uppermost Ogallala), Frontier County, Nebraska. (Holotype of Amebelodon fricki **and other very Late Pliocene fossils were found here.) STOP 39.**

PLEISTOCENE

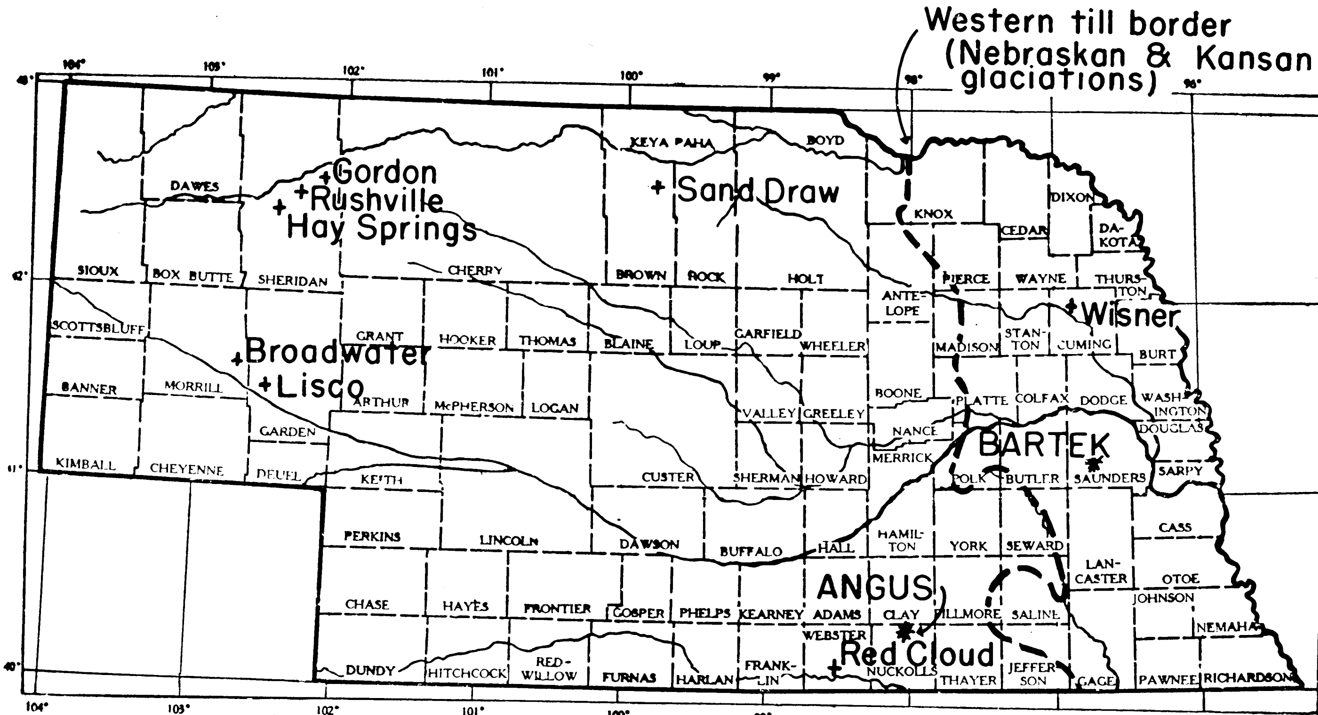


FIG. 31—Map of Nebraska showing important Early and Medial Pleistocene fossil localities (from Schultz and Tanner, 1959). Early Pleistocene: Broadwater and Lisco (Barbour and Schultz, 1937a, 1937b; Schultz and Stout, 1941, 1945, 1948), Sand Draw (McGrew, 1944), Wisner (Frankforter, 1950), Red Cloud (Schultz, Reed, and Lugn, 1951). Medial Pleistocene: Sheridan County—Hay Springs, Rushville, and Gordon (Scott, 1897; Matthew, 1902, 1918; Frick, 1930, 1937; Lugn, 1934, 1935; Schultz, 1934; Barbour and Schultz, 1937a, 1937b; Schultz and Stout, 1941, 1945, 1948). The till border would now be drawn somewhat farther west in places.

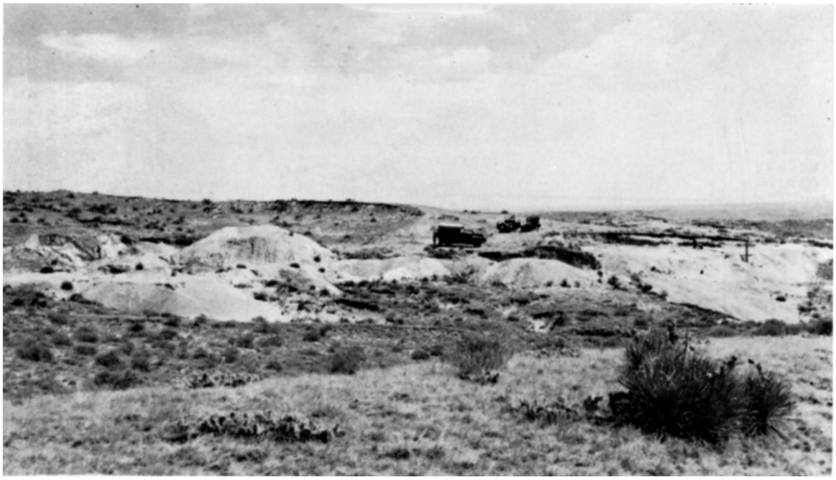


FIG. 32—Broadwater Quarries, U.N.S.M. Coll. Loc. Mo-5, Early Pleistocene, E. and N. of Broadwater, Morrill County, Nebraska. STOP 32.

FIG. 33—Quarry face at Broadwater Quarries, U.N.S.M. Coll. Loc. Mo-5 showing diatomaceous earth and peat bed overlain by sand and gravel (Early Pleistocene fossils are found in the diatomaceous and peat deposit as well as in the sand and gravel). STOP 32.

FIG. 34— Giant camel bones (Gigantocamelus fricki) **in silts of Lisco Member of Broadwater Formation, U.N.S.M. Coll. Loc. Gd-13, Early Pleistocene, Garden County, Nebraska. (From Schultz and Stout, 1941, Fig. 3.) Eighteen miles S. and E. of STOP 32.**

FIG. 35—Rushville Fossil Quarry, U.N.S.M. Coll. Loc. Sh-3, Medial Pleistocene, Sheridan County, Nebraska. (Five miles N. and E. of Hay Springs Quarries, U.N.S.M. Coll. Loc. Sh-1, STOP 20.) STOP 21.

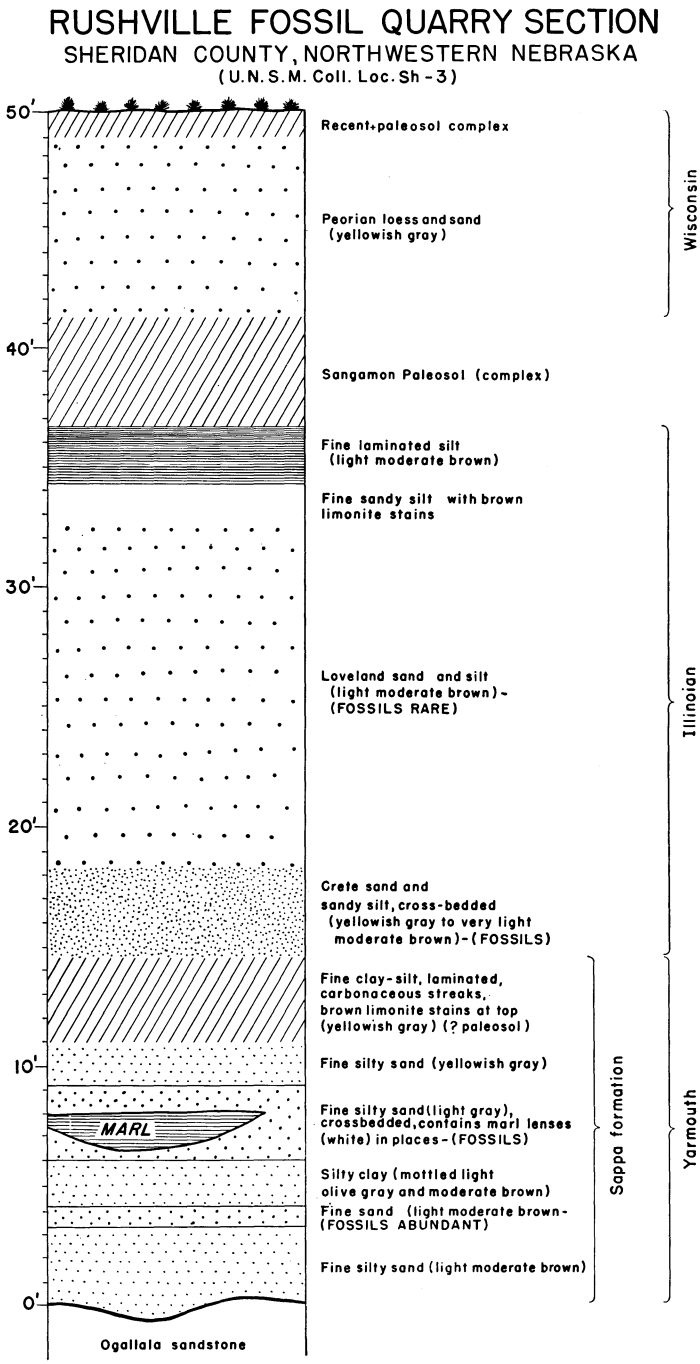


FIG. 36—Rushville Fossil Quarry section, U.N.S.M. Coll. Loc. Sh-3, Sheridan County. (From Schultz and Tanner, 1959, Fig. 5.) STOP 21.

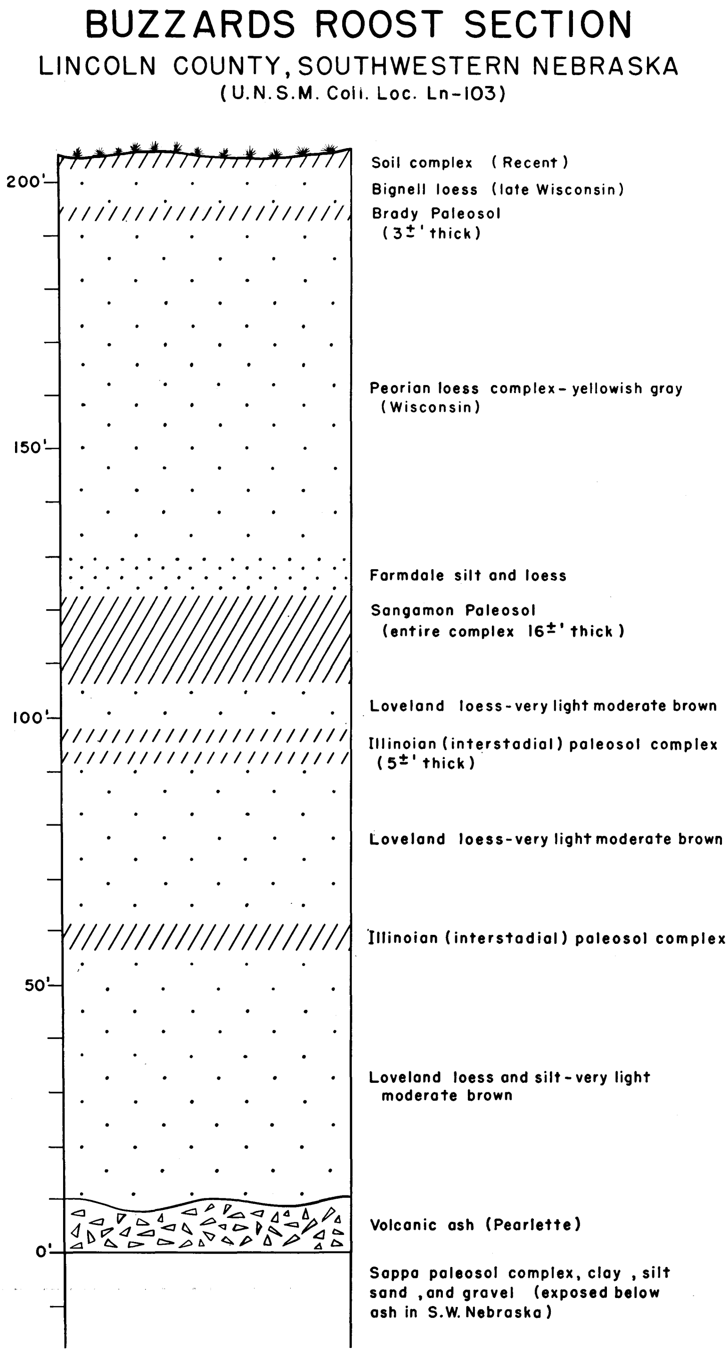


FIG. 37—Buzzard's Roost section, U.N.S.M. Coll. Loc. Ln-103, Lincoln County. (From Schultz and Tanner, 1959, Fig. 7.) STOPS 36 and 37.

FIG. 38—Rushville Fossil Quarry, U.N.S.M. Coll. Loc. Sh-3, removing overburden from directly over fossil layer, Medial Pleistocene, Sheridan County. STOP 21.

FIG. 39—Loess deposits in vicinity of Buzzard's Roost, U.N.S.M. Coll. Loc. Ln-103, Lincoln County. Similar to Loess deposits at STOP 35. STOPS 36 and 37.

FIG. 40—Early Man site at base of Terrace-2A fill, U.N.S.M. Coll. Loc. Ft-42, evidence of human occupational zones at 16 levels at this site, Late Pleistocene (Libby, radiocarbon date of 8862 ± 230 years before present for one of upper occupational zones), Frontier County. (From Schultz, Lueninghoener, and Frankforter, 1951, Fig. 11.) STOP 40.

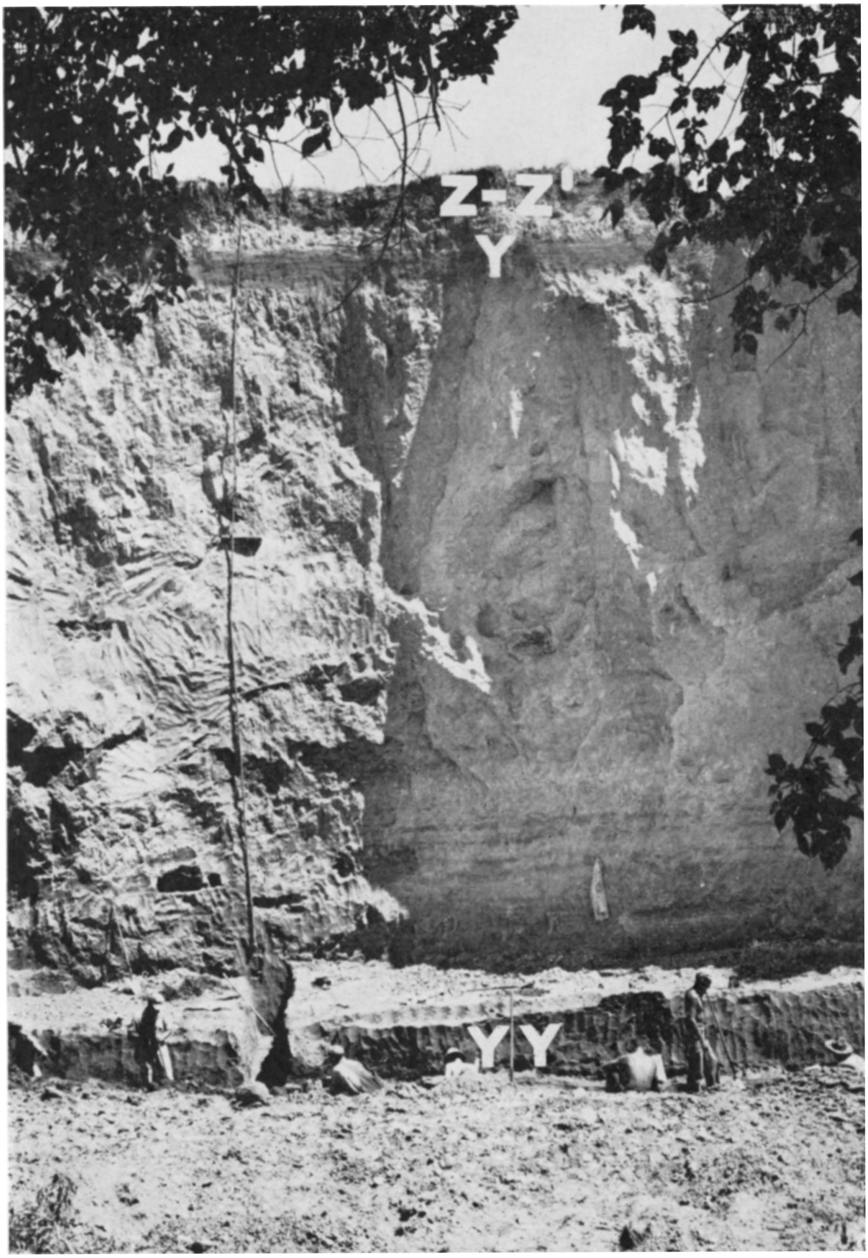


FIG. 41—Early Man site at base of Terrace-2A fill, U.N.S.M. Coll. Loc. Ft-41. Evidence of human occupational zones at several different levels at this site, Late Pleistocene (Libby, radiocarbon date of 9524 ± 450 years before present for the lowest occupational zone), Frontier County. STOPS 39 and 40.

FIG. 42—Same site as Fig. 41, but with trench cut into face of terrace-fill, a human occupational level exposed in bottom of 5-foot excavation squares. (STOPS 39 and 40.)

FIG. 43—Terrace-fills and surfaces along White River. Similar to terraces at STOPS 1 and 18, as well as at various localities along the conference route.

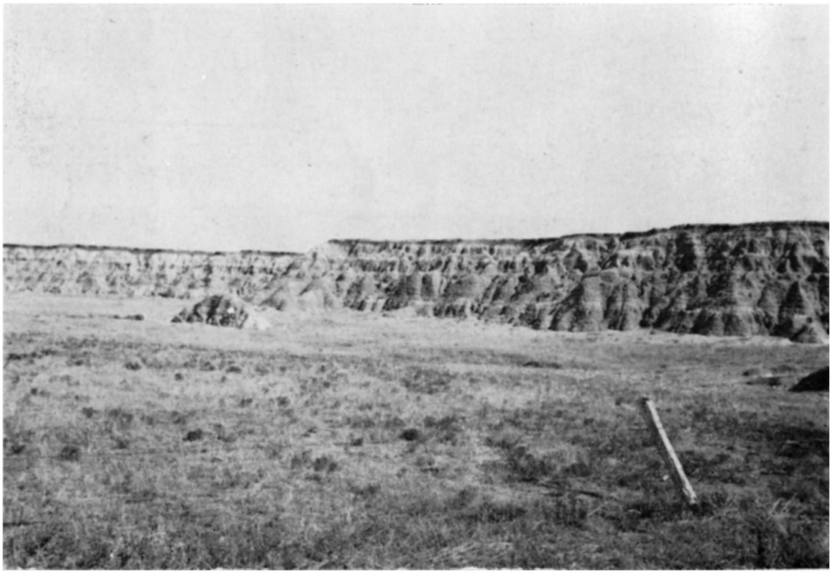


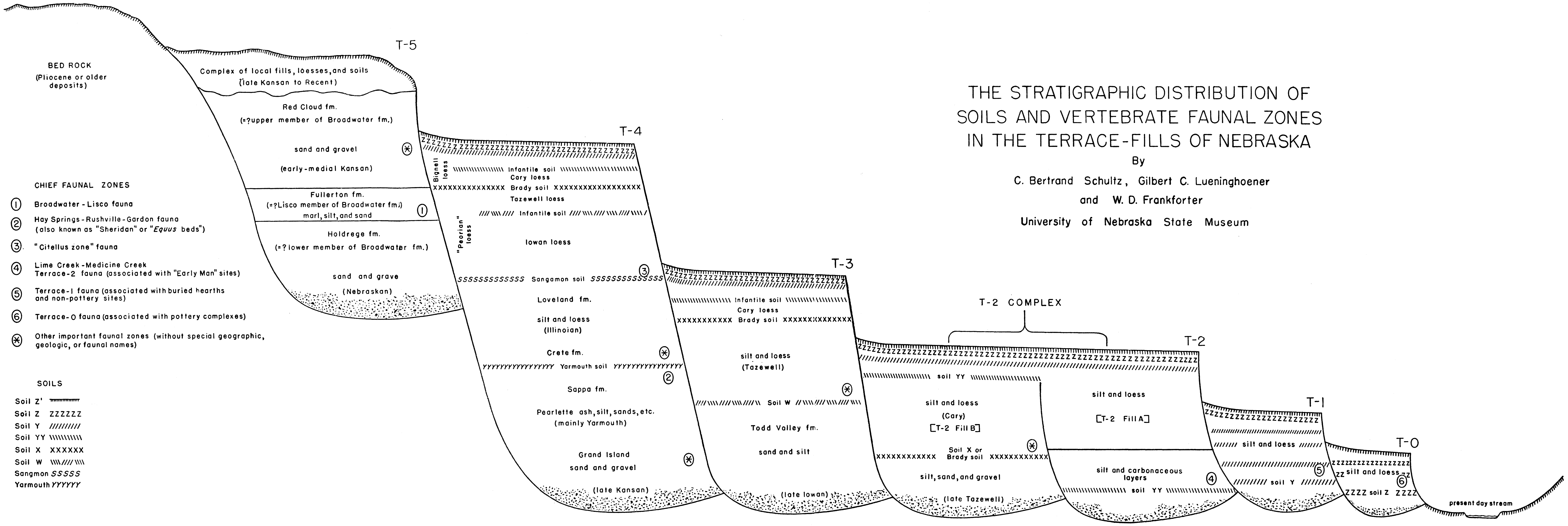
FIG. 44—Terrace-2 fill (Late Pleistocene), exposed on Sand Creek, a tributary of White River. STOP 1.

THE STRATIGRAPHIC DISTRIBUTION OF SOILS AND VERTEBRATE FAUNAL ZONES IN THE TERRACE-FILLS OF NEBRASKA

By

C. Bertrand Schultz, Gilbert C. Lueninghoener and W. D. Frankforter

University of Nebraska State Museum



Base of Terrace-2A fill more than 10,000 years Before Present (Libby dates for upper part of SOIL YY: 10,493± 1500, 9880± 670, etc.)

Base of Terrace-1 fill, 3500± years B.P. (Libby date for SOIL Y: 3100± 400).

Base of Terrace-0 fill more than 1,000 years B.P. (based on dendrochronology and radiocarbon dates).

Modified from University of Nebraska State Museum Bulletin, Vol. 3, No. 6, 1951.

FIG. 45—Hearth of prehistoric man and associated charcoal layers in middle part Terrace-1 fill, U.N.S.M. Coll. Loc. Sx-101, Recent (Libby sample 469, radiocarbon dates, 2379 ± 430 and 1993 ± 190 years before present, Cedar Canyon, Sioux County. (From Barbour and Schultz, 1936, Fig. 208.) Near STOPS 2 and 3.

FIG. 46—Trench cut into Terrace-1 fill 100 ft. E. of hearth in Fig. 46. Two men in rear are examining the top of another hearth at a lower level (Libby sample 330, radiocarbon dating, 2675 ± 280 years before present). The oldest radiocarbon date for Terrace-1 fill at this locality is 3100 ± 410 years before present (Libby sample 931). Man in foreground examining chalcedony, flint, and bones cemented in reworked Brule Clay. Near STOPS 2 and 3.

FIG. 47—Some of participants of First Field Conference of the Society of Vertebrate Paleontology at Stop 19 (September 1, 1941), at top of Scotts Bluff at the National Monument. STOP 25 of 1961 Conference.

ITINERARY

By C. Bertrand Schultz and Thompson M. Stout
(with Road-Log check by Lloyd G. Tanner)

First Day of Conference (July 31, 1961)

Map A (Alliance Sheet, 1:250,000 Series) provides the only map coverage. Cars will line up at 8:00 A.M., headed east alongside the University of Nebraska Trailside Museum at Fort Robinson. Turn left (north) on Highway 20, proceeding to the junction with Highway 2. Turn north along the east side of Crawford and go north and northwest to the Sand Creek Bridge, at the entrance to the Badlands area.

STOP 1. Just north of the Sand Creek Bridge. The Terrace-2, Terrace-1, and Terrace-0 fills are well exposed here (Fig. 44). Note the typically rounded slopes and green silt and clay of the Chadron Formation; also the reworked Oligocene in the terrace-fills, which has been confused by both geologists and paleontologists with Oligocene *in situ*.

STOP 2. Proceeding northwest toward Orella, leave Highway 2 along new road toward Toadstool Park. Stop near the Badlands escarpment (Fig. 4). This is the type locality of the Orella Member, Brule Formation, and is the Adelia Section of Darton, hence should be considered as the type localities for the Brule and Chadron formations (Schultz and Stout, 1955). Utilize the chart (Fig. 6) and also Fig. 7 to identify units. The top of the Upper Purplish White Layer is the Chadron-Brule contact; note the faulting that involves this bed.

STOP 3. Drive into Park Circle just west of Stop 2. Walk into the Toadstool Park (Fig. 8) after examining the channel sandstone ("Lower Channel") of the Chadron Formation and the three purplish white layers (Fig. 6, geologic section 2, and Fig. 5) near the entrance. Next, note the Toadstool Park Channel ("Middle Channel") and Fault, with the paleosol relation at the top of the Lower Orella (top of Orella B); see Figure 6, geologic sections 4-7, and Figures 7-9. It is proposed that the escarpment be climbed, to the level of the "Bench" (base of Orella D), utilizing Figures 6, 7, and 10 for geologic orientation. The "Upper Channels" and "White Bed" at the Orella-Whitney contact may be seen near here, and the massive loessic silts of the Whitney together with the Lower Ash and Upper Ash of the Whitney occur on the higher slopes leading to the outlier of the Pine Ridge escarpment known as Round Top. The Pine Ridge escarpment consists here of Arikaree (Gering, Monroe Creek, and Harrison formations). The faulting (and folding) so characteristic of the Chadron and Orella only rarely persists into the Arikaree (Fig. 15); most of the faulting appears to have been post-Whitney and pre-Gering, but in places just as in the vicinity of Douglas, Wyoming, some faulting was observed to terminate at the top of the Lower Ash. The slopes leading to Round Top constitute the type locality of the Whitney Member (Fig. 11; see also Fig. 6, sections 9 and 8).

STOP 4. Returning to Highway 2 briefly, cross railroad just south of Orella and proceed west to Bridge site to see the contact of the Pierre Shale and Chadron (Interior Paleosol Complex) and the basal conglomerate of the Chadron. There is now known to be a volcanic ash bed at this locality lower than the mid-Chadron ash shown on Fig. 6; it has been reported upon by Vondra (1960).

STOP 5. Continuing west and then southwest (Fig. 14), follow the "Mail Route" road east of the Sow Belly Canyon past the "Pants Butte." This stop is to observe the Pine Ridge escarpment (Arikaree) and the Black Hills in the distance. Professor Barbour's initial discoveries of Daimonelix (see Figs. 23-24; references under Barbour, also Schultz, 1942) were made in the Harrison in the upper reaches of the Sow Belly Canyon. Proceed to within a short distance of Harrison and turn into the road leading down the Monroe Creek Canyon.

STOP 6. This stop is at the top of the Monroe Creek Canyon (edge of the Pine Ridge escarpment), just north and northwest of Harrison, to see the characteristic erosional features of the Harrison Formation before going down the Monroe Creek Canyon across the outcrop belt of the type Monroe Creek and then across the Gering. Note the volcanic ash bed near the base of the Gering.

STOP 7. Continuing to the base of the Pine Ridge escarpment at the mouth of the Monroe Creek Canyon (Fig. 20), leave the main road and go east along a trail to the second canyon east. There is a fine channel development of the Gering Formation at this locality, allowing discussion of the recently proposed "Sharps Formation" (regarded here as an invalid synonym of the Gering). The higher Arikaree (Fig. 2, column B) can be measured here very well indeed: the total Arikaree thickness was determined as 626 feet. Now return *via* the Monroe Creek Canyon road to Harrison; turn west on the oiled Highway 20 and proceed through Harrison exposures to the Nebraska-Wyoming boundary and on to Van Tassel, Wyoming. Turn south at Van Tassel.

STOP 8. This stop is south of Van Tassel, Wyoming, nearly on the Nebraska-Wyoming line and on the right bank of the Niobrara River, to observe the great unconformity at the base of the lower part of the Marsland as well as to see the relation of the Lower Marsland fill to the Harrison. Return to Van Tassel and to Harrison, proceeding east on Highway 20 toward Crawford. The route is through Harrison and some Lower Marsland to the head of Smiley Canyon, then rapidly down the Harrison, Monroe Creek, and Gering outcrop to the base of the escarpment at the mouth of Smiley Canyon.

STOP 9. Park along the road beyond the bridge at the mouth of Smiley Canyon. Then, walking back up into the Canyon, note the Brule-Gering contact below the bridge, the Gering and Monroe Creek outcrops below and along the road, and the "potato-nodule" unit at the top of the Monroe Creek high above the road on the north side.

NOTE: Return to the Trailside Museum of the University of Nebraska State Museum at Fort Robinson, which is only a short distance east of Stop 9. The old Red Cloud Indian Agency was situated between the Fort and the present town of Crawford. Colored movies and slides of the First Field Conference (1941) will be shown at 8:00 P.M. at the Trailside Museum.

Second Day of Conference (August 1, 1961)

Map A (Alliance Sheet, 1:250,000 Series) again provides the principal map coverage, but Stop 12 is on the Marsland 1949 topographic sheet, and Stops 13-17 are on the old Whistle Creek 1895 topographic sheet. Cars will again line up at 8:00 A.M. on the north side of the Trailside Museum, as for the First Day, and proceed on Highway 20 to the south side of Crawford. Follow Highway 2 south, toward the Pine Ridge escarpment.

STOP 10. This stop is at the base of the Pine Ridge escarpment, near the mouth of Bryan Canyon, to see the base of the Gering and the fault that here cuts the Gering. Darton (1899b, Pl. 93) has published a photograph near this outcrop (Fig. 15), but it is one of the very few faults recognized as cutting Arikaree sediments, in contrast to the badly fractured and broken White River. Continue up the Bryan Canyon, noting the Monroe Creek and the "potato-nodule" bed at its top, then the Harrison sediments above.

STOP 11. The summit of Pine Ridge is developed mainly on the Harrison here, but the Marsland fill comes in rapidly to the south as one approaches the ancient axis of the Marsland valley near Marsland. The Sheep Creek caps the Marsland. Continue south on Highway 2, crossing the Niobrara River at Marsland. Immediately south of Marsland notice the Arikaree pipy concretions below the Marsland Formation.

STOP 12. This is the Marsland Quarry (U.N.S.M. Coll. Loc. Bx-22), and it is within the type section of the Marsland Formation. An enlarged diagram showing the stratigraphy and classification will be displayed. It is now necessary to turn around, and to return to the Niobrara River Bridge at Marsland. Turn west along the north side of the Niobrara River, following the river road to Agate.

STOP 13. Agate, the home of Dr. and Mrs. Harold J. Cook. The Cook Collection in the Cook Museum of Natural History may be seen here, through the kind permission of Doctor and Mrs. Cook. Now proceed east along the south (right) bank of the Niobrara River to the world-famous Agate Spring Fossil Quarries.

STOP 14. The Agate Spring Quarries at University and Carnegie hills (U.N.S.M. Coll. Loc. Sx-72), named for the University of Nebraska and Carnegie Museum; see Figs. 21 and 22. Next return to Agate, and turn south on Highway 29 toward Mitchell.

STOP 15. Leave Highway 29 at a point about 16 miles south of Agate, turning east on the ranch road leading to the Sheep Creek-Snake Creek collecting area (Fig. 26). Please make certain that gates are closed, and note that there is to be *No Smoking*. Entry onto this private property is by the gracious permission of Mr. and Mrs. Vance Johnson, with special arrangements for this excursion having been made by Dr. Harold J. Cook and directly with the owners. The early workings of the American Museum of Natural History and Princeton University have been succeeded by the numerous excavations of the Frick Laboratory, American Museum of Natural History. The first stop is in *Merychippus* Draw to see the volcanic ash bed, used initially for the separation of the "Sheep Creek" and "Lower Snake Creek" units. The "Upper Snake Creek" channels occur to the SE., and in a branch of East *Pliohippus* Draw there are reworked blocks of Sheep Creek; these channels are now considered to be properly part of the Ash Hollow Formation (Pliocene). Next continue on east and southeast along the trail; please do not depart from the trail.

STOP 16. Stonehouse Draw, one of the main "Sheep Creek" quarry sites. Continue southeast along the trail.

STOP 17. Olcott Hill site, where the famous and controversial specimen of *Hesperopithecus haroldcooki* was discovered long ago. Go north to the ranch house, then east and southeast to the oiled road, Highway 87.

Now turn north and follow Highways 87 and 2 back to Crawford, going past the Marsland Quarry (Stop 12) just north of the junction of these two highways.

Third Day of Conference (August 2, 1961)

Both Maps A and B (Alliance and Scottsbluff Sheets, 1:250,000 Series) may be used for this portion of the excursion. Stop 20 is on the Skunk Lake 1948 topographic map, and the route thereafter crosses the following topographic sheets in order (geologic folios are indicated with an asterisk): Box Butte Northeast, Box Butte, Berea Creek East, Alliance, Bronco Lake, Lynn (old Browns Creek), *Camp Clarke, *Scotts Bluff, and Scotts Bluff National Monument. Cars will once again line up at 8:00 A.M. at the Trailside Museum. Please take luggage, for the night stop will be at Scottsbluff. Follow Highway 20 toward Chadron.

STOP 18. This stop, midway between Whitney and Chadron, is to see the terraces and terrace-fills of the White River, as exposed along the highway. Continue on Highway 20 east to Chadron and southeast to Hay Springs. At Hay Springs turn south on Highway 87.

STOP 19. This stop along the Highway 87 just south of Hay Springs is to observe the Miocene exposures. Continue south, but before reaching the Niobrara River turn east and proceed to the Niobrara River crossing at the Peters Ranch. Cross the river and take the winding road over the splendidly-developed terraces to the flat developed approximately at the Sangamon Soil horizon at the summit of the Terrace-4 fill (Fig. 2). Proceed along the fence and stop above the Hay Springs Quarries, which are situated on the Constance Sandoz Ranch.

STOP 20. Hay Springs Quarries (U.N.S.M. Coll. Loc. Sh-1), initially worked by the American Museum of Natural History but chiefly developed by Mr. Charles H. Falkenbach and party for the Frick Laboratory, American Museum of Natural History. The earliest collecting at this locality seems to have been by the Hayden-Warren expedition of 1857 (for further historical notes see Schultz and Stout, 1948). Return to the Peters Bridge, go north and then east and south on trail to the Rushville Quarries on the Bud Beguin Ranch.

STOP 21. Rushville Quarries (Figs. 35-36, 38; U.N.S.M. Coll. Loc. Sh-3), one of the principal quarry areas opened by the University of Nebraska expeditions in this region, were initially a prospect discovered by Mr. Charles H. Falkenbach. The quarries are in the lower part of the Terrace-4 fill (Fig. 2), and the Sangamon Soil is well exposed high above the quarry level. Hibbard's (1956) contention that the "Hay Springs fauna" is of Sangamon age appears to be in error (Schultz and Tanner, 1957). Return to Highway 87, then go south across the Niobrara River (notice the terraces here) and on southwest through Sheep Creek exposures, thence south to Alliance. Proceed through Alliance, turning south on Highway 385 toward Bridgeport.

STOP 22. In the vicinity of Angora, notice the roadside outcrops of Sheep Creek. This stop is to examine the regional relations. Continue on south only a short distance to the next observation point.

STOP 23. From this point one may observe the Lower Marsland valley-fill resting on the Harrison. The Bridgeport Quarries (U.N.S.M. Coll. Loc. Mo-113 to -118) may be seen to the east of the highway; they are situated in the Lower Marsland. To the northwest, the high-level Pliocene (Ash Hollow or Kimball) gravels may be seen, dissected by a northwest-southeast Broadwater (Early Pleistocene) or Terrace-5 valley-fill that trends across the highway just south of the Angora Junction. Then as one continues south, down Angora Hill, the basal Harrison conglomerate may be easily distinguished by the sharp change in plant cover at the contact. Continue on Highway 385 to Northport, cross the North Platte River to Bridgeport, and take Highway 26 up the south side (right bank) of the North Platte, along the Oregon Trail.

STOP 24. This stop is to see the Chimney Rock (Fig. 17), south of Bayard, and the north side of the Wildcat Ridge with its numerous butte outliers. Continue northwest to Gering and the entrance to the Scotts Bluff National Monument.

STOP 25. Scotts Bluff National Monument and Museum. Park at the Museum after a drive up to the top of the Scotts Bluff to see the regional relations. Arikaree sediments here rest unconformably on the White River (Schultz and Stout, 1955, Fig. 10, geologic sections 1-5). After a visit to the attractive Museum here, the excursion returns to Gering and crosses into Scottsbluff for the night. (See Figs. 12-13, 47.)

Fourth Day of Conference (August 3, 1961)

Maps B and D (Scottsbluff and North Platte Sheets, 1:250,000 Series) constitute the most useful maps for this day's trip. However, the following topographic sheets (geologic folios are indicated with an asterisk) are crossed in order from west to east: *Scotts Bluff, *Camp Clarke, Browns Creek, Sidney, Chappell, and Ogallala. Cars will line up at 8:00 A.M., headed south, just beyond (south of) the junction of the Main Street of Gering with Highway 26-Scottsbluff Monument (east-west) road. Proceed south on this Highway 29 toward Kimball, but travel only a few miles before taking a secondary road west to the type locality of the Gering.

STOP 26. Type locality of the Gering Formation. This is the spot "6 miles" S.-SW. of Gering mentioned by Darton. The selection of this as a type section seems excellent, for the Gering was here deposited along the general axis of a valley that was deeply incised into the Whitney Member of the Brule Formation. Return to Highway 29 and continue south along the winding canyon road over the same Arikaree section seen at the Scotts Bluff National Monument, to the vicinity of the Wildcat Hills Recreation Grounds and Buffalo Refuge.

STOP 27. Near the Recreation Grounds and Refuge one may observe the Lower Marsland disconformable on the Harrison. Continue south on Highway 29 to the vicinity of Funnel Rock.

STOP 28. From near Funnel Rock and the base of Wildcat Mountain, one may observe from the south the western end of the Wildcat Ridge. Arikaree sediments overlie the Whitney Member of the Brule Formation, whereas at the summit of the Wildcat Mountain and a few other similar outliers there are channel sediments of Ogallala (Pliocene) age. Continue south on Highway 29 to the junction of the old highway route south of Harrisburg with the new road; turn west on the old road toward Harrisburg.

STOP 29. This stop is to observe a characteristic development of the Kimball (summit sediments and caliches of the High Plains surface), with the Sidney Gravel Member at the base, cut into the Ash Hollow Formation. The latter is clearly a valley-fill, with harder sediments than in the underlying Miocene valley-fills, so the Ogallala butte-cappings allow the reconstruction of the Pliocene valley forms. Continue north to Harrisburg, then back to Highway 29 (*via* Highway 129), turning north for a short distance before taking Highway 88 east to Redington along the valley of the Pumpkinseed Creek and south of the Wildcat Ridge. Note the bold Arikaree escarpment resting on the White River. Turn north at Redington to the Redington Gap through the Wildcat Ridge.

STOP 30. Redington Gap (Fig. 16). Because of the narrow road through the Ridge at this point, it is necessary to proceed on through the Gap to the north side of the Ridge where the cars can turn around and stop in a line facing south near the Gap. Note the Brule-Gering contact and the relation of the Lower and Upper Ash beds of the Whitney Member of the Brule. An enlargement of a diagram (by Stout) will be displayed. Return to Redington and Highway 88, turning east and proceeding to Birdcage Gap.

STOP 31. Birdcage Gap may be seen from the road. The relations are much the same as at the Redington Gap. Continue east, past the Courthouse and Jail Rocks, then turn north to Bridgeport. Cross the North Platte River to Northport, and go east to Broadwater on Highway 26. At the east edge of Broadwater, jog slightly north and take a graded road east up the Breakneck Hill, past exposures of White River, Gering, and Monroe Creek, to an Ash Hollow sand-and-gravel deposit and ash bed at the top. Continue east and northeast to the Broadwater Quarries.

STOP 32. Broadwater Quarries (Figs. 32-33; U.N.S.M. Coll. Loc. Mo-5) of Early Pleistocene age (Fig. 2; Schultz and Stout, 1941, 1945, 1948), resting on Ash Hollow, with Valentine lower in the valley toward the river. *This completes the scheduled route of the Conference proper. The remaining stops are Post-Conference.* Return to Broadwater, continue southeast on Highway 26 to Oshkosh. Go south from Oshkosh, turning to the right (west) up the canyon from Highway 27 soon after crossing the North Platte River.

STOP 33. Oshkosh Quarries (U.N.S.M. Coll. Loc. Gd-10), in the Sidney Gravel Member of the Kimball Formation (Late Pliocene). Return to Oshkosh and Highway 26, continuing east past Lewellen and then south to the mouth of the famous Ash Hollow.

STOP 34. Mouth of the historic Ash Hollow (Fig. 27), and type locality of this formation. Note the White River or Gering silts below, with the pebble conglomerate and silts resting unconformably, above. The latter are now considered to be of Valentine (including Burge) age, and the heavy ledges are the Cap Rock Member of the Ash Hollow Formation. The Ash Hollow begins at the base of the Cap Rock, and it may be followed along the Canyon road south to where it is overlain by Kimball and some Broadwater sediments. Before the last ascent at the head of the Canyon, note the historically-interesting Windlass Hill, down which the Oregon Trail covered wagons were lowered by block and tackle anchored to a cedar post; the deep wagon-cut ruts are still visible. From the head of the Ash Hollow, the Highway 26 begins to traverse a series of "Hanging Valleys," which are the Early Pleistocene (Broadwater or Terrace-5) valleys that flowed northwest-southeast across the present divide ridge of Ogallala that separates the present North and South Platte valleys. Between the Broadwater valleys, the flat-lying High Plains surface is capped by Kimball. The Broadwater valleys contain a magnificent record of Early Pleistocene sedimentation (Fig. 2), with a very thick loess cover above; the caliches at the top of the Broadwater just east of the head of the Ash Hollow have been the subject of special study by Stout (1955, 1956), who considers them to be both the "true" Yarmouth and Sappa. The "Hanging Valleys" may be seen as far east as Ogallala, which is the night-stop.

Post-Conference: Fifth Day of Conference (August 4, 1961)

Maps D and E (North Platte and McCook Sheets, 1:250,000 Series) are of greatest use, but the following topographic sheets will be traversed in order: Ogallala, Paxton, North Platte, Gothenburg, Jeffrey Reservoir Southwest, Stockville Northeast, Moorefield, Curtis, Curtis Southeast, Stockville, Stockville Southeast, Medicine Creek Dam, Freedom, and Cambridge. The cars will assemble at 8:00 A.M., headed east on Highway 30 at the east edge of Ogallala. Since the group is expected to be somewhat smaller, only the stops will be listed in this part of the Itinerary. Proceed east to North Platte on Highway 30, turn south on Highway 83 to the south side of the Platte River, then go east to Bignell. The Bignell Hill Section is just south of Bignell.

STOP 35. Bignell Hill Section (Schultz and Stout, 1945, 1948). Loveland, Peorian, and Bignell loesses; note the Sangamon Soil at the base, and the type Brady Soil at the top, of the thick Peorian Loess. These paleosols have received special study by the writers and their associates and have been found to be excellent stratigraphic markers.

STOPS 36 and 37. Buzzard's Roost Section (Figs. 37, 39). Loveland Loess, with Pearlette Ash at the base, and with the Sangamon Soil and Peorian Loess above.

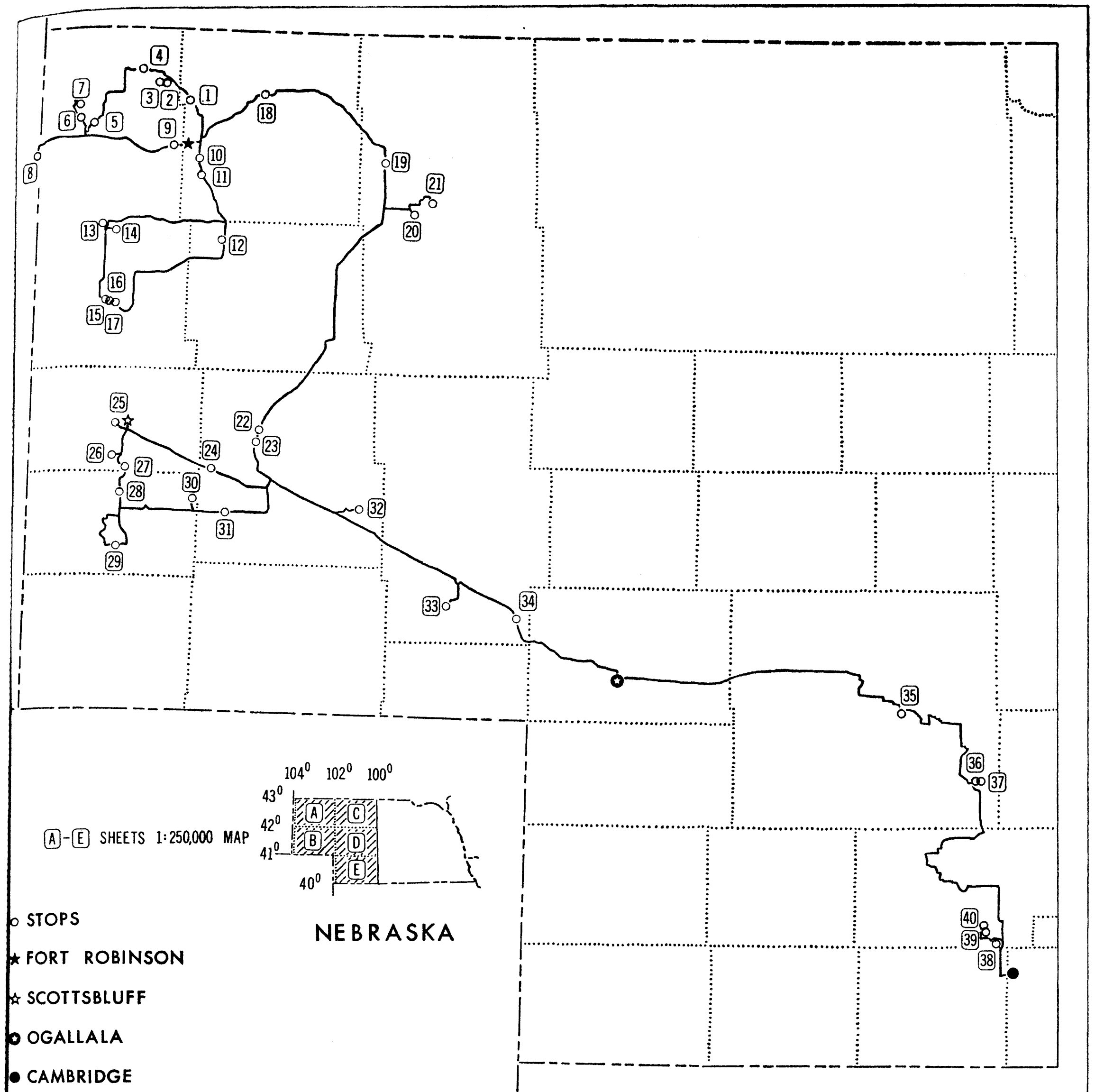
STOP 38. Pliocene (Kimball) lake-bed (Fig. 29) resting on Ash Hollow near the Medicine Creek Dam.

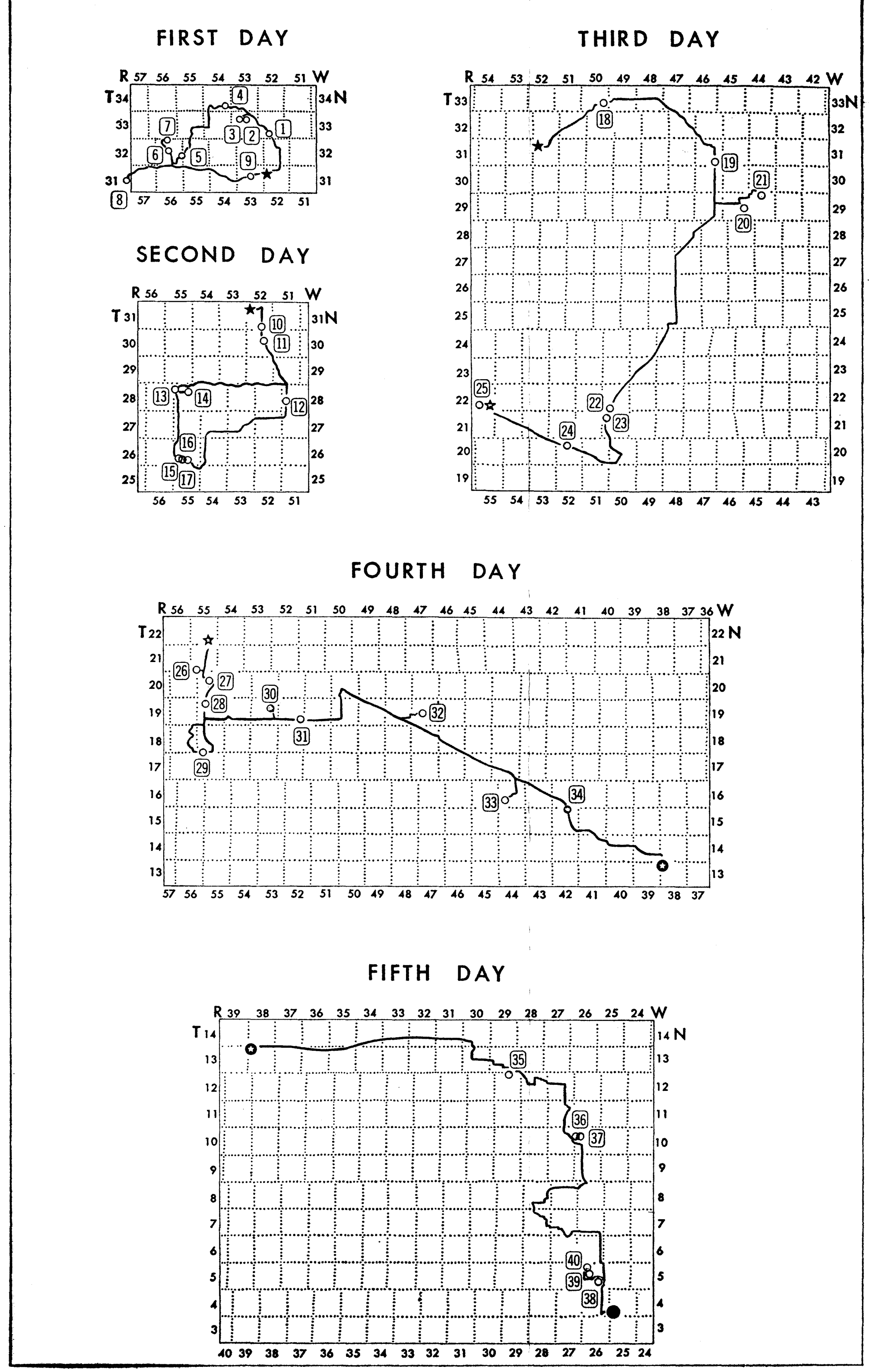
STOP 39. *Amebelodon fricki* Quarry (Fig. 30; U.N.S.M. Coll. Loc. Ft-40), northwest of Cambridge. First reported by Barbour (1927), this is perhaps the most important quarry site yet discovered in the Sidney Gravel Member of the Kimball Formation (Late Pliocene). The fossil beaver, *Dipoides,* found here in some abundance, is of great importance in fixing the Pliocene-Pleistocene boundary and in correlating with the Eurasiatic record (Stout, 1953; Fig. 3). Continue north to the nearby "Early Man" sites.

STOP 40. This last stop of the 1961 Field Conference (Figs. 40-42), fittingly enough, considers the problems of the dating of the coming of Man to North America. Go south to Cambridge, where the group will disband. If possible, however, all of the participants are urged to travel on to Lincoln *via* Highways 6-34 to see the displays and research collections of the University of Nebraska State Museum.

Members of SVP Who Served on the Local Committee for the Ninth Field Conference

C. BERTRAND SCHULTZ, *Chairman*
THOMPSON M. STOUT, *Co-Chairman*
ROBERT EISELE
CHARLES H. FALKENBACH
WELDON D. FRANKFORTER
JOHN A. HOWE
GEORGE JAKWAY
HENRY P. REIDER
MARIAN R. SCHULTZ
LLOYD G. TANNER





NINTH FIELD CONFERENCE OF SOCIETY OF VERTEBRATE PALEONTOLOGY 1961

MAP-Route of Ninth Field Conference of the Society of Vertebrate Paleontology, July 31-August 4, 1961, showing Stops 1-40

Previous Field Conferences and Guidebooks of the Society of Vertebrate Paleontology

1) August 29-30 (pre-conference), August 31-September 3, 1941. Guide for a Field Conference on the Tertiary and Pleistocene of Nebraska, by C. B. Schultz and T. M. Stout (in collaboration with A. L. Lugn, M. K. Elias, F. W. Johnson, and M. F. Skinner). Special Publ. Univ. Nebr. State Mus., Lincoln, (1): 1-51, Frontispiece, Figs. 1-16, Pl. 1, 4 tables. (Multilithed.)

2) July 20-24, 1947. A Guide to the Continental Triassic of northern Arizona, by C. L. Camp, E. H. Colbert, E. D. McKee, and S. P. Welles. Plateau (Publ. Northern Ariz. Soc. Science and Art, Mus. Northern Ariz., Flagstaff) 20 (1): 1-9, Figs. 1-2, Map, Chart. (*See also* News Bul. Soc. Vertebrate Paleontology no. 22: 1-2.)

3) August 2-5, 1948. Guidebook for the Third Field Conference of the Society of Vertebrate Paleontology, by Paul O. McGrew. Publ. Univ. Wyoming, Laramie. (*See also* News Bul. Soc. Vertebrate Paleontology no. 24: 1-2.)

4) June 20-24, 1950. Guidebook for the Fourth Field Conference of the Society of Vertebrate Paleontology in northwestern New Mexico; edited by E. H. Colbert and S. A. Northrop. Publ. Amer. Mus. Nat. Hist., New York City, and Univ. New Mexico, Albuquerque: 1-91, illust.

5) August 29-September 1, 1951. Guide Book, Fifth Field Conference of the Society of Vertebrate Paleontology in western South Dakota; edited by James D. Bump. Publ. Mus. Geol., So. Dak. School of Mines and Technology, Rapid City: 1-87, illust. (*Also* mimeographed Supplement: 1-8, Columnar Section.)

6) August 21-23, 1953. Guide Book, Sixth (misnumbered Fifth) annual Field Conference of the Society of Vertebrate Paleontology in northeastern Utah; edited by J. LeRoy Kay and Vaughan Garwood. Publ. Utah Field House Nat. Hist., Vernal, Utah, and Carnegie Mus., Pittsburgh: 1-35, illust.

7) August 7 (pre-conference), August 8-10, 1956. (Guidebook) Society of Vertebrate Paleontology Field Conference; Miocene, Texas Coastal Plain, by John A. Wilson. Publ. Dept. Geol. and Bureau Econ. Geol., Univ. Texas, and Texas Memorial Mus., Austin: 1-14 (mimeographed), Chart, 16 Maps. (*See also* News Bul. Soc. Vertebrate Paleontology no. 48: 4-5.)

8) August 20-24, 1958. Guidebook, Eighth Field Conference, Society of Vertebrate Paleontology, Western Montana; edited by Robert W. Fields. Publ. Montana State Univ., Missoula: 1-50, and Appendix; illust.