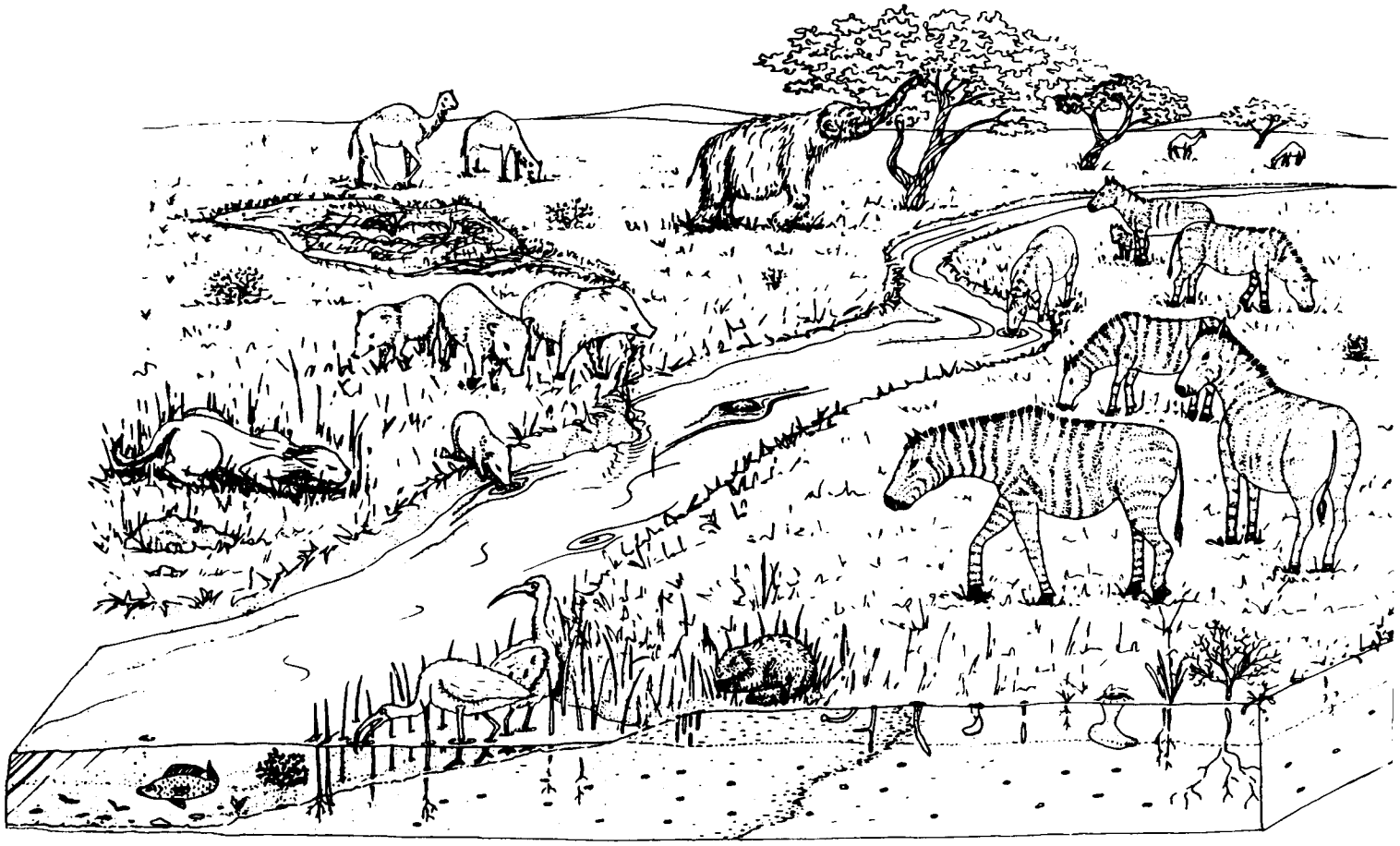
PRELIMINARY VERTEBRATE FOSSIL RESOURCE SURVEY OF MEADE STATE PARK (LAKE LARRABEE 7.5' QUAD), MEADE COUNTY, KANSAS



BY
ALBERT J. ROBB, III

KANSAS GEOLOGICAL SURVEY
OPEN FILE REPORT 96-008
November 21, 1996

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OPEN FILE REPORT 96-008

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November 21, 1996

Kansas Geological Survey
Open-file Report

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EXECUTIVE SUMMARY

PRELIMINARY VERTEBRATE FOSSIL RESOURCE SURVEY OF MEADE STATE PARK (LAKE LARRABEE 7.5' QUAD), MEADE COUNTY, KANSAS

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The Plio-Pleistocene sediments of southwestern Kansas have commonly yielded scientifically important vertebrate fossils and were most notably studied by Claude W. Hibbard between the period 1936 to 1972. Evidence of illegal collection of such vertebrate fossils within the Meade State Park motivated this study to characterize what fossils were present within the park and where, so they might be further studied and protected.

A geologic map created details exposure of the upper Pliocene through lower Pleistocene silt, sand, and gravel sequence present in the northwestern half of the park. Vertebrate fossils correlative to the Deer Park Local Fauna (Blancan; latest Pliocene) were found to occur within the Missler Silt Member of the Ballard Formation (Meade Group). The most abundant members of the fauna include: *Plesippus (Equus) simplicidens* (extinct American zebra), *Nannippus phlegon* (gazelle-horse), *Stegomastodon* (gompothere), *Camelops* (camel), *Platygonus* (peccary), and *Trigonictis* (grison). Of particular scientific importance is the presence of the type locality of the Deer Park Local Fauna in the northwestern half of the park.

A locality map identifies several sensitive sites most likely to yield vertebrate fossils to the casual park visitor or determined collector alike. Sensitive vertebrate fossil-bearing sediments are exposed in approximately 25% of the undeveloped northwestern half of the park. Recommendations for protection and conservation of these vertebrate fossil resources include: 1) development of a visitor education program (handouts & display kiosk); and 2) if additional pilfering is detected, it would be desirable to post combination interpretive and warning signs (but only if increased policing is possible).

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Presented at the 1996 Annual Meeting of the Geological Society of America in Denver, Colorado on October 30, 1996

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Cover Illustration Caption:

Ecosystem reconstruction of the Meade State Park area during Deer Park (Blancan) time. The fauna includes (clockwise from upper left): Camels (*Camelops* sp.); Wonderful Stegomastodont (*Stegomastodon mirificus*); Extinct American Zebra (*Plesippus simplicidens*); Sweets Beever (*Procastoroides sweeti*); Ibis (family Threskiornithidae); Sunfish (family Centrarchidae); Gazins Grisson (*Trigonictis idahoensis*); and Cope's Peccary (*Platygonius bicalcaratus*). Note the artesian spring adjacent to a shallow meandering stream through a short-grass savanah with infaunal activity in the soil (Drawing by C.J. Criss and A.J. Robb)

INTRODUCTION

Within the past two decades, the drastically increased public interest in fossils, and paleontology in general, has brought about the need to characterize and protect these potentially valuable resources from accidental or intentional damage or theft in various settings across the United States and abroad.

The Plio-Pleistocene age sediments of southwestern Kansas have commonly yielded scientifically important vertebrate fossil faunas that have provided valuable insights into ice-age paleobiology and climatic conditions.

Evidence of illegal collection of such potentially important vertebrate fossils on public land within Meade State Park motivated this study to characterize which fossils were present within the park, and where, so they might be protected.

The objectives of this study are as follows:

a) determine local geology and stratigraphy within park boundaries;
b) identify vertebrate fossil faunas present at the park;
c) document location of fossil-bearing deposits within the park boundaries;
d) determine sensitivity of the vertebrate fossil resources; and
e) make recommendations for preservation/conservation of vertebrate fossil resources.

METHODS - The geology of the northwestern half of the park was examined by walking transects across the terrain so that existing surface geology maps could be verified and areas of interest to this study identified. Observed stratigraphic units were compared to those exposed on adjacent land out of the park boundaries. Extensive surface reconnaissance for macro fossils was conducted beginning in the Spring of 1996, after permission to surface collect was granted by the Kansas Department of Wildlife and Parks (Appendix A). Vertebrate fossils collected during the surface reconnaissance will be reposited with the Sternberg Museum at Fort Hays State University, Hays, Kansas.

BRIEF HISTORY OF LOCAL PALEONTOLOGICAL ACTIVITIES

A significant amount of vertebrate fossils, including mastodont, horse, and camel remains, were discovered in early 1936 by workers at a Civilian Conservation Corp (CCC) camp in a gravel pit in Meade County, Kansas (Hibbard, 1938).[1]

Extensive fieldwork to study Plio-Pleistocene geology and paleontology was subsequently conducted in southwestern Kansas, most notably by Claude W. Hibbard and his field parties from the University of Kansas during the years 1936 to 1946, and from the University of Michigan during the years 1947 to 1959.

Fieldwork by Hibbard and others in the region resulted in the recognition of at least 35 local vertebrate faunas (Figure 1 & Appendix B), documenting the most nearly complete Plio-Pleistocene faunal succession (Figure 2) known from anywhere in the world (Hibbard and Taylor, 1960; Hibbard, 1970b).

Claude Hibbard and his field parties often used the Lake Larrabee area as a base camp for their reconnaissance and sediment washing operations in Meade County (Hibbard, 1949c; Meade Globe Press, 1974).

Sediment washing operations were first set up within Meade State Park in the 1937 and 1938 field seasons due to the availability of a constant supply of running water from the artesian well that existed there at the time (Hibbard, 1941, 1949c), and were continued sporadically as required by collecting activity until the last known camp was set up in 1959 to support Hibbards' study of microtine rodents from the Rexroad Local Fauna (Hibbard, 1970a; Meade Globe Press, 1974).

Of particular importance is Hibbards' Faunal Locality 1 (later known as KU Locality 1) which is the type locality for the Deer Park local fauna, and is within the current boundaries of the state park.

[1]According to Hibbard (1938), researchers were unable to acquire any of the discovery fossils from the CCC workers, and the original faunal descriptions were based on specimens recovered by careful sifting of the overburden diggings at the otherwise exhausted site. It is believed however that Walter and Ruth B. Dingess (parents of Martha Sneath) were able to acquire some of the discovery specimens from CCC workers for their collection, that eventually was displayed for years at the Dalton Gang Hideout Museum in Meade. Unfortunately, these specimens were sold to an anonymous private collector at public auction in Dodge City in January, 1996.

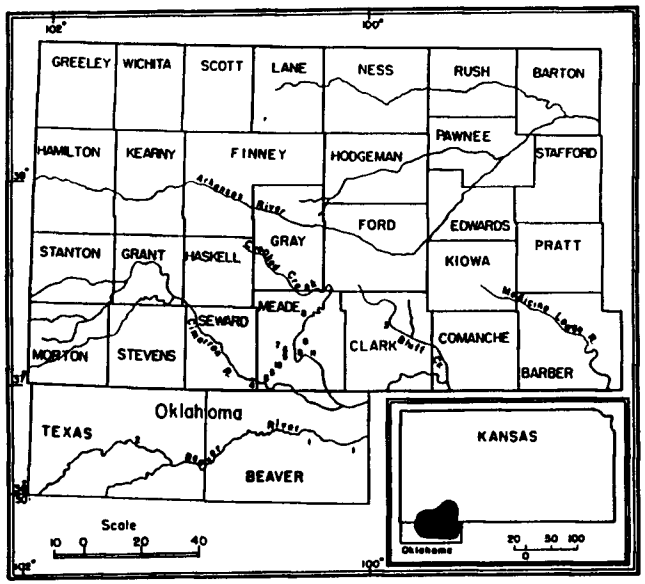

FIGURE 1. Map showing location of most significant Plio-Pleistocene local faunas in the Meade County region. Local faunas identified as follows: 1, Beaver; 2, Optima; 3, Swayze Quarry; 4, Saw Rock Canyon; 5, Rexroad; 6, Deer Park; 7, Seger gravel pit; 8, Cudahy; 9, Borchers; 10, Jinglebob; and 11, Jones Ranch. (from Hibbard, 1953b)

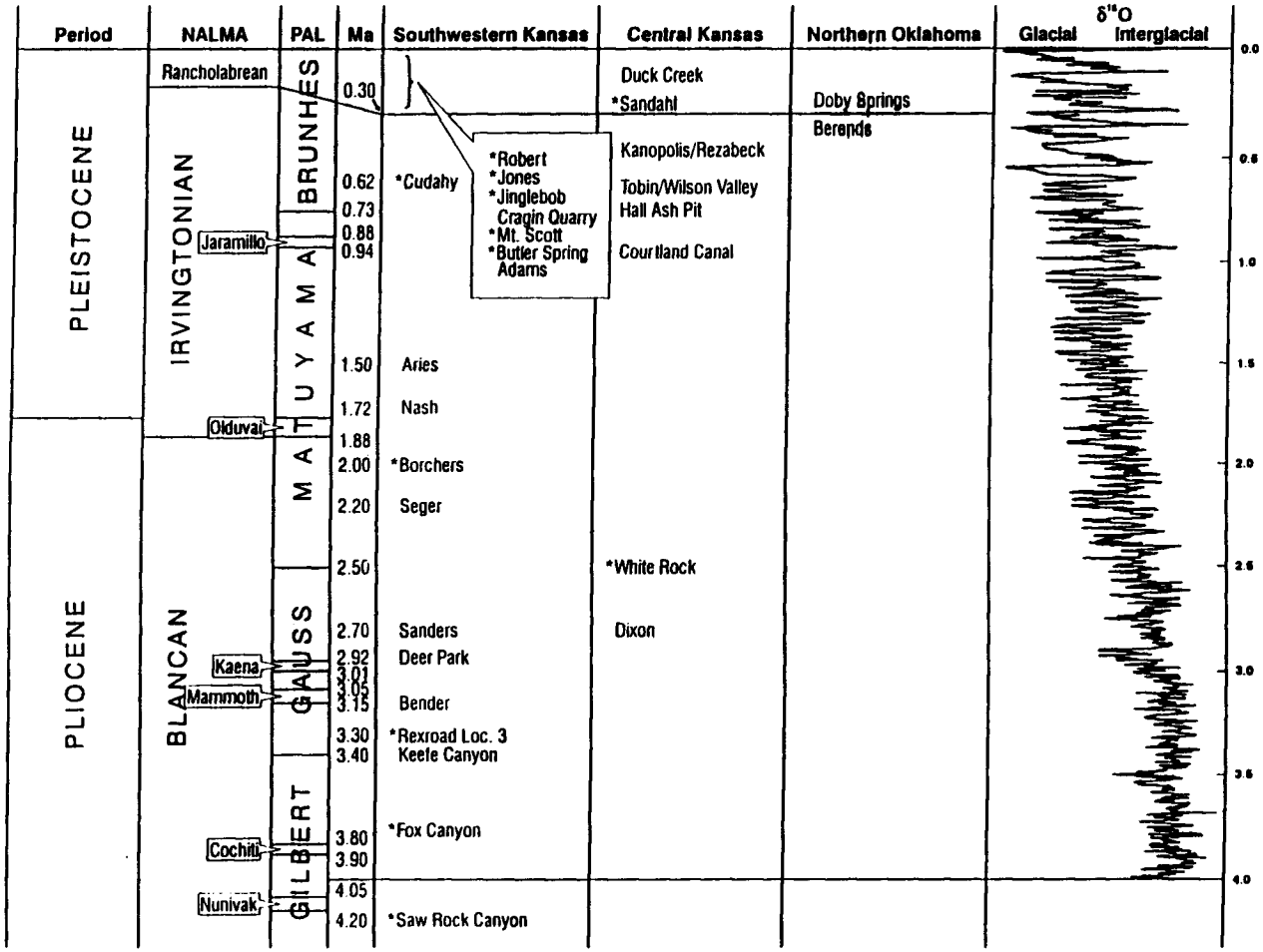

FIGURE 2. Diagram demonstrating the time correlation and stratigraphic relationship of significant regional Plio-Pleistocene local faunas. (unpublished figure courtesy of Bob Martin, Murray State University)

GENERAL GEOLOGY AND STRATIGRAPHY

Upper Pliocene through lower Pleistocene clays, silts, sands, and gravels are exposed in-place in the higher elevations of the northwestern half of the park (Figures 3 & 4).

The lowermost units exposed at the park belong to the Pliocene Rexroad Formation. Overlying it is the Plio-Pleistocene Meade Group that contains the Ballard Formation overlain by the Crooked Creek Formation. Above the Meade Group is the Pleistocene Sanborn Group that consists of the Kingsdown Formation overlain by the Vanhem Formation (Figure 3).

Meade State Park is located in a faulted area, that is known to contain several pre late-Pliocene stratigraphic displacements related to the Crooked Creek Fault (Figure 4). This fault system, that follows Crooked Creek from Fowler, Kansas southeast to the Cimarron River (Frye and Schoff, 1942), created the Meade Artesian Basin and Valley (Frye, 1940, 1942; Frye and Hibbard, 1941). According to Hibbard (1970a), the local artesian aquifer is the result of the down thrown side of faulted lower Pliocene sands and gravels.

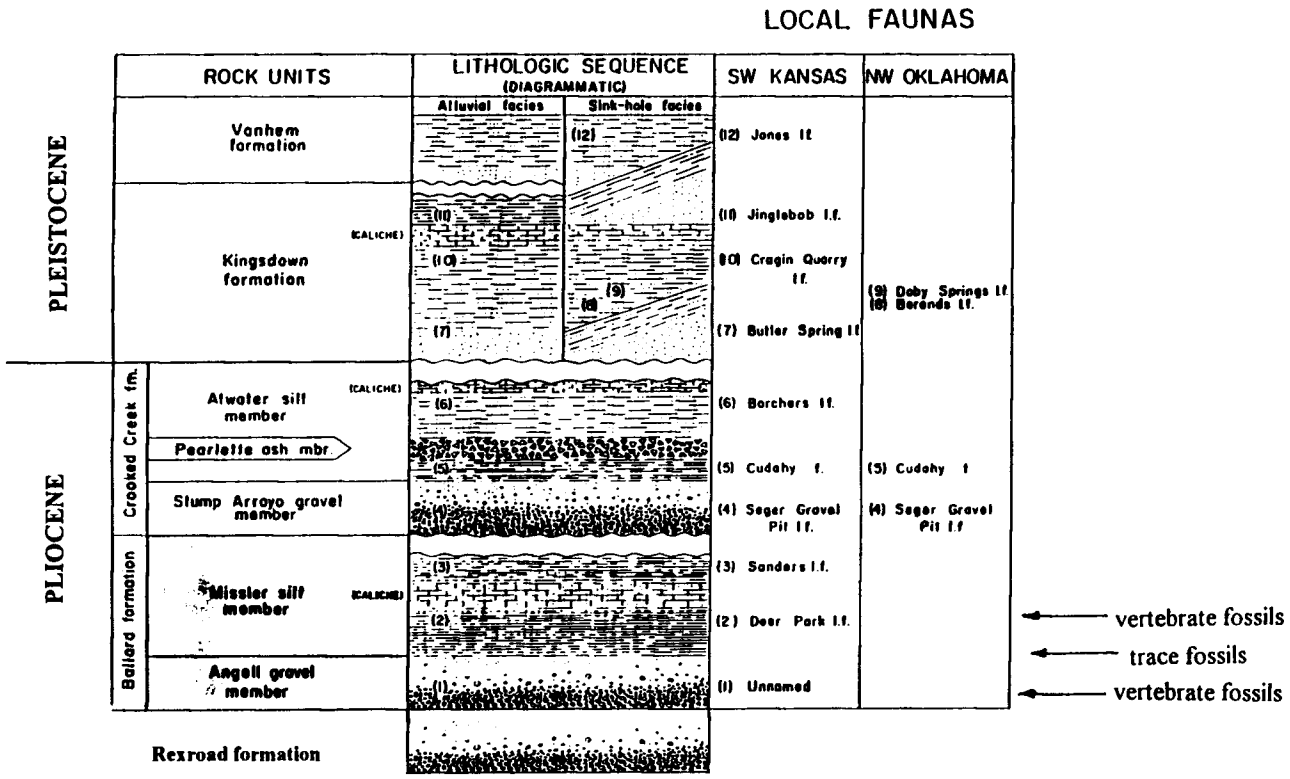

FIGURE 3. Generalized stratigraphy of units exposed at the northwestern half of Meade State Park (adapted from Hibbard and Taylor, 1960).

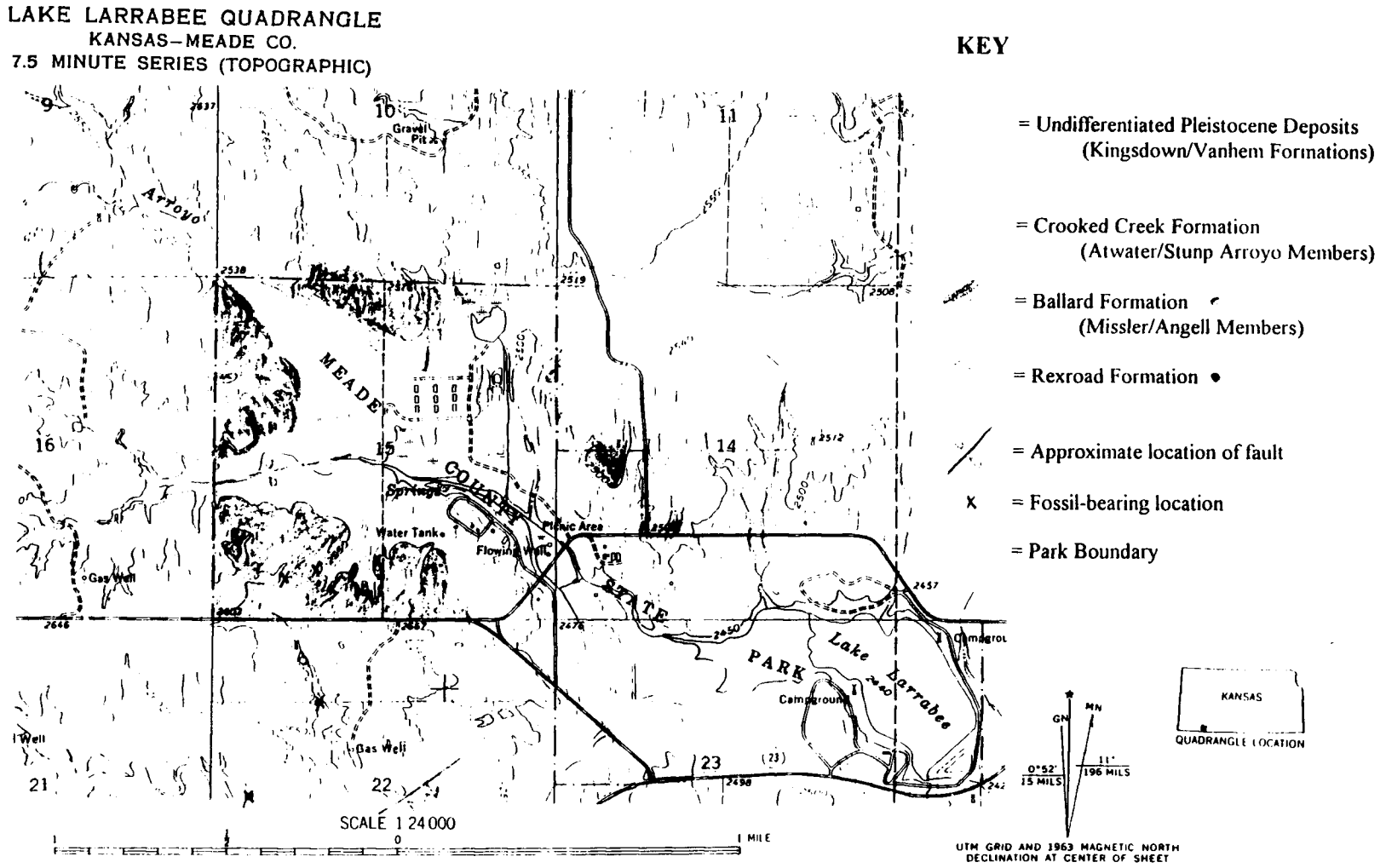

FIGURE 4. Generalized geologic map of the western half of Meade State Park. (geology adapted from Stevens, 1965)

Rexroad Formation: Only the uppermost part of this unit is exposed in topographic lows within the parks boundaries. This unit consists of a generally fining upward sand, silt, and clay interval, that is sometimes thin and cross-bedded. Near the top of the unit are well developed, but localized caliche horizons. Although the base of the Rexroad Formation is not exposed within the park boundaries, drilling records indicate that the unit ranges from 90 to 120 feet in total thickness (Stevens, 1965). Hibbard's Faunal Localities 2, 2a, and 3 (later known as KU Localities 2, 2a, and 3), from which he described the Rexroad Local Fauna, are from "boil spring" deposits in the finer-grained upper parts of this unit in the section directly south (W/2, sec. 22, T33S, R29W) of the park (Hibbard, 1938). There appears to be an erosional unconformity between the Rexroad and the overlying Ballard Formation (Figure 3).

Ballard Formation: This unit consists of the basal Angell and overlying Missler Members. Within the park, the Angel Member consists of fining upward, cross-bedded, mostly sands and gravels. There is a gradual contact between the Angell Member and the overlying silts of the Missler Member. The Missler Member is an unbedded to thin bedded silt. It contains at least two laterally uncontinuous and unstratified nodular caliche horizons up to 18 inches thick. Total thickness of the Missler Member within the park is highly varied, reaching up to 70 feet in places, depending on localized topography. Nearly all of the vertebrate fossils observed during this study occurred within the Missler Member. Hibbard's Faunal Locality 1 (later known as KU Locality 1), from which he originally described the Deer Park Local Fauna (Hibbard, 1938, 1949a), occurres in Missler deposits within the park (SW/4, SE/4, sec. 15, T33S, R29W). There is an apparent erosional unconformity between the Ballard and the overlying Crooked Creek Formation (Figure 3).

Crooked Creek Formation: This unit consists of the Stump Arroyo Member and the overlying silts of the Atwater Member. Only the lower portions of the fining upward sand and gravel Stump Arroyo Member are present, capping the ridges in the western half of the park. These sands and gravels are locally cross-bedded (Figure 3). Interbedded near the base of the overlying Atwater Member, in sections outside the park, are the Pearlette Ash Beds (Carey, et al., 1952).

Pleistocene Deposits: The Pleistocene silts, sands, and gravels that mantle the lowland drainages consist of Sanborn Group deposits from the Kingsdown and Vanhem Formations (Figure 3). These deposits were primarily introduced into the region by aeolian and fluvial processes.

Surface Soil Associations: According to the county soil survey, the primary surface soil associations in the study area are the Otero-Mansic complex in the relative high ground with the Lincoln soils, Likes loamy sands, and Leshara clay loams in the drainages (Tomasu, 1977). Mineralogic analysis demonstrates that these soils are a combination of logical derivatives of the underlying host sediments and matrix alluvially and fluvially transported during the latest Pleistocene and Holocene into the area (Stevens, 1965).

PALEONTOLOGY

Both traces and vertebrate fossils were observed in various geologic units within the park. The most significant accumulation of fossil vertebrates occurres within the Missler Member of the Ballard Formation (Figure 3) at several locations in the northwestern half of the park (Figure 4).

Trace fossils, consisting mostly of tapering vertical tubes and borrows that likely represent plant roots (mostly grasses) and infaunal insects respectively, were observed most commonly at and above the Angell-Missler Member (Ballard Formation) boundary (Figure 5).

The vertebrate fossils recognized from within the Missler Member (Ballard Formation) appear to be biochronically correlative to the Deer Park Local Fauna described by Hibbard (1938, 1949a, 1970b). The vertebrate fauna here recognized from within the Missler Member (Ballard Formation) consists of a relatively high diversity, almost exclusively mammal assemblage (Figures 6 to 10), occurring in locally common, but widespread deposits within the park (Figures 3 & 4).

Non-mammalian vertebrates, including fish, reptiles/amphibians, and birds have been reported from the Plio-Pleistocene sediments of the region. Bird remains (Figure 11A) were recognized during this study, however other non-mammalian taxa were not recognized, partially due to a sampling bias towards macro fossils.

The vertebrate fauna is represented by disarticulated and fragmentary skeletal elements that can display clean, relatively unabraided fractures, or less commonly a well worn and rounded appearance (Figure 11B).

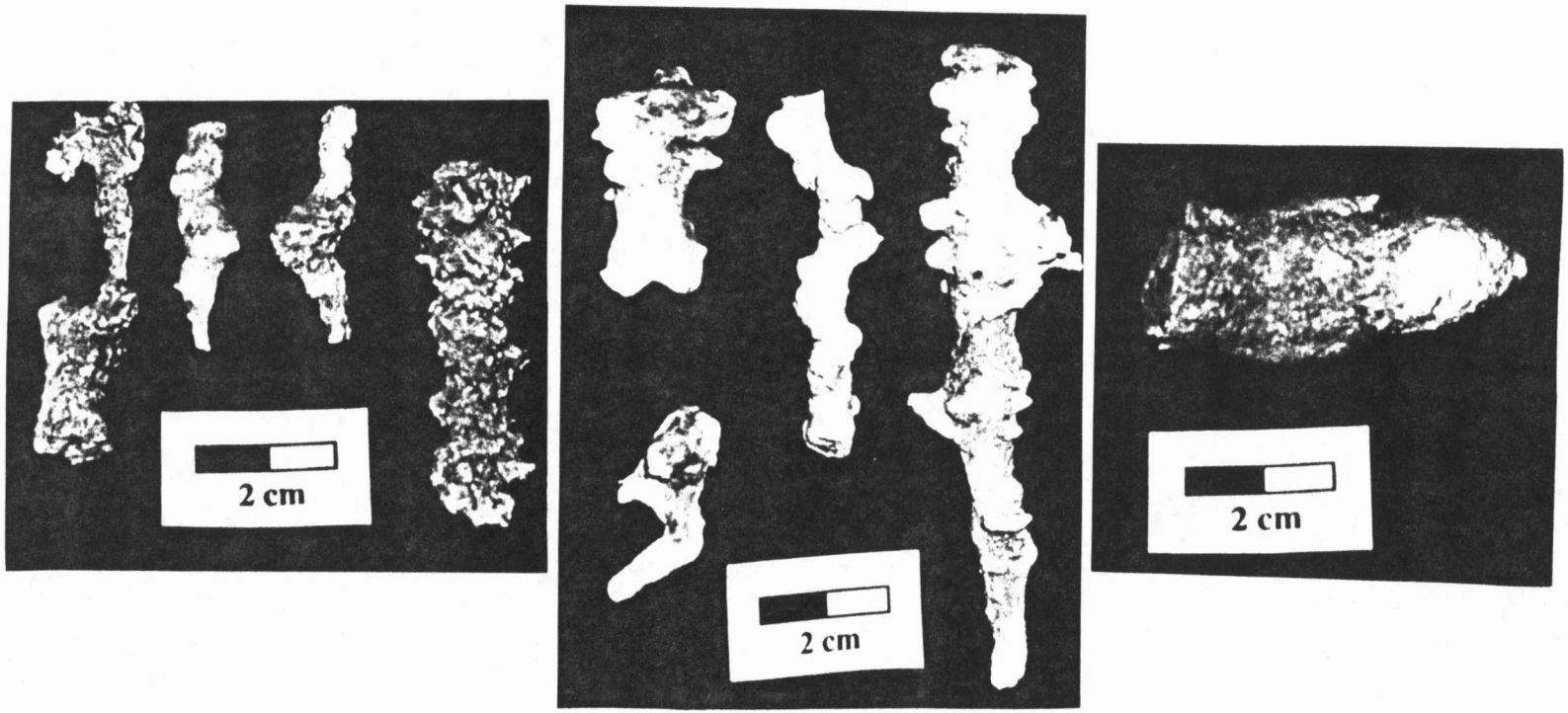

FIGURE 5. Examples of trace fossils (left & center) from the Angell-Missler Member (Ballard Formation) boundary and a suspected coprolite (right) from within the Missler Member.

Taxa Recognized During this Study	Latin Name	Common Name
X	*Trigonictis idahoensis* (Gazin)	Gazins Grison
	Buisnictis sp.	Skunk
	Mephitis sp.	Skunk
	Cynomys meadensis Hibbard	Prairie Dog
?	*Spermophilus* sp.	Squirrel
	Geomys quinni McGrew	Quins Pocket Gopher
	Procastoroides sweeti Barbour and Schultz	Sweets Beaver
	Pliopotamys meadensis Hibbard	Meade Muskrat
	Ogmodontomys poaphagus Hibbard	Grass-Eating Furrow Toothed Vole
?	*Pliolemmus antiquus* Hibbard	Ancient Lemming Vole
X	*Stegomastodon mirificus* (Leidy)	Wonderful Stegomastodont
	Rhynchotherium sp	Rhynchothere
?	*Hypolagus* sp.	Rabbit
X	*Platygonus bicalcaratus* Cope	Cope's Peccary
X	*Nannippus phlegon* (Hay)	Gazelle-Horse
X	*Plesippus simplicidens* (Cope)	American Zebra
?	*Equus (Asinus) cumminsii* (Cope)	Cummins Ass
X	*Camelops* sp.	Camel

FIGURE 6. Fossil mammal taxa recognized during this study and those previously reported from the Deer Park Local Fauna by Hibbard (1949a, 1970b).

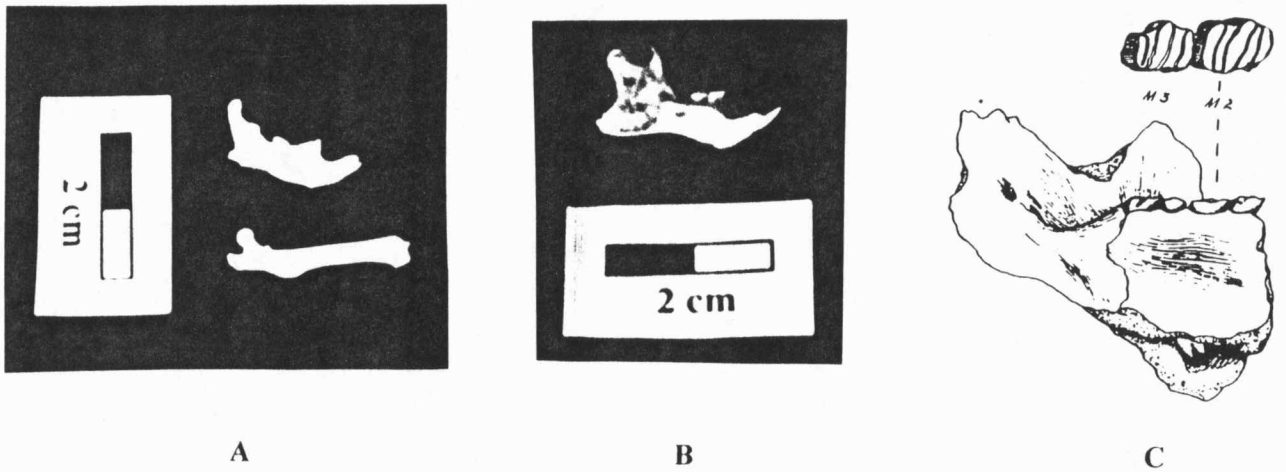

FIGURE 7. Small mammal taxa. A) mandible and femur of *?Spermophilus* sp.; B) mandible of *?Pliolemmus* sp.; C) mandible of *Procastoroides sweeti* (x1, from Hibbard, 1938).

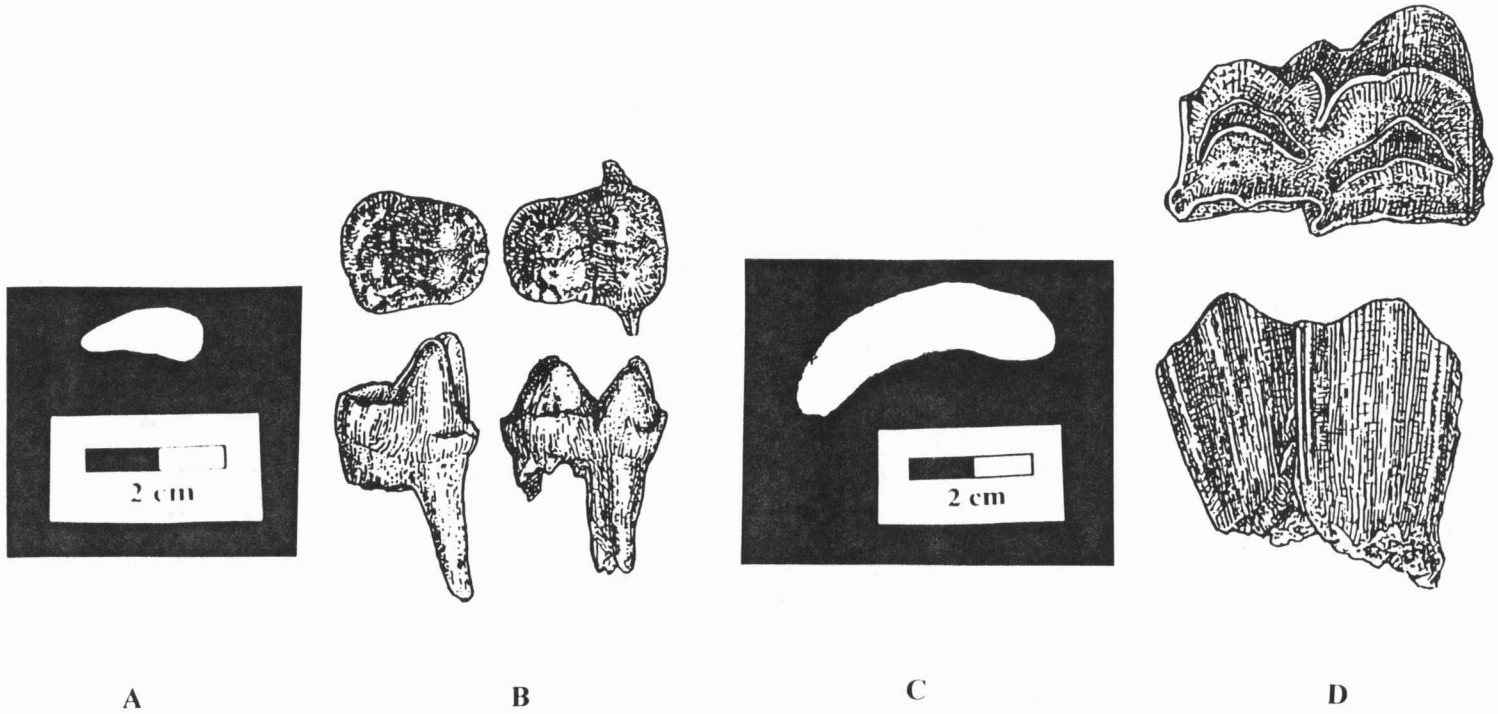

FIGURE 8. Assorted mammal taxa. A) claw core of *Trigonictis idahoensis*; B) molars of *Platygonus bicalcaratus* (x2, from Hibbard, 1938); C) canine of *Camelops* sp.; D) molar of *Camelops* sp. (X1, from Hibbard, 1938).

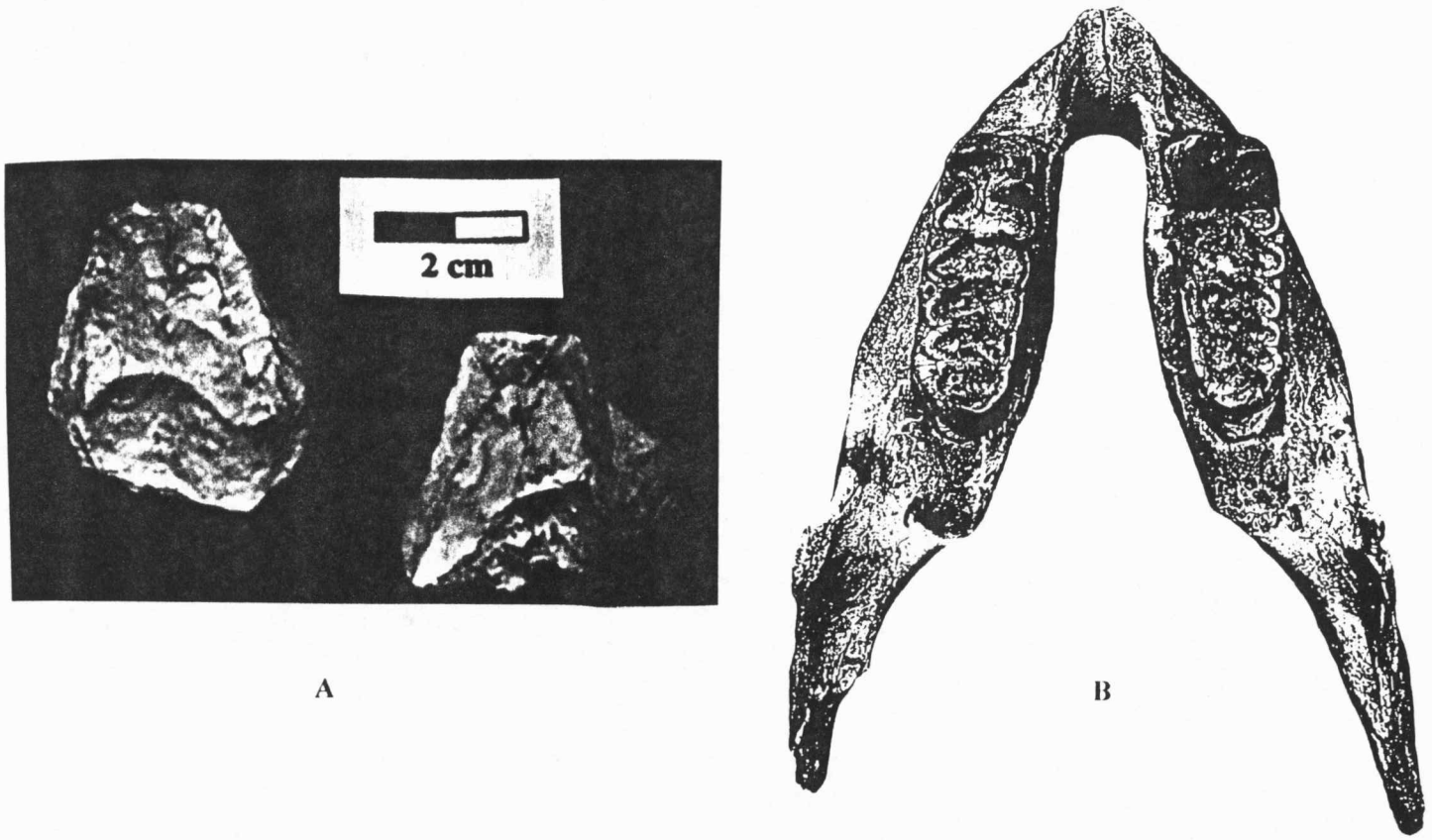

FIGURE 9. Stegomastodont (*Stegomastodon mirificus*) fossils. A) fragments of molar crowns; B) mandible (x 3/10, from Hibbard, 1951).

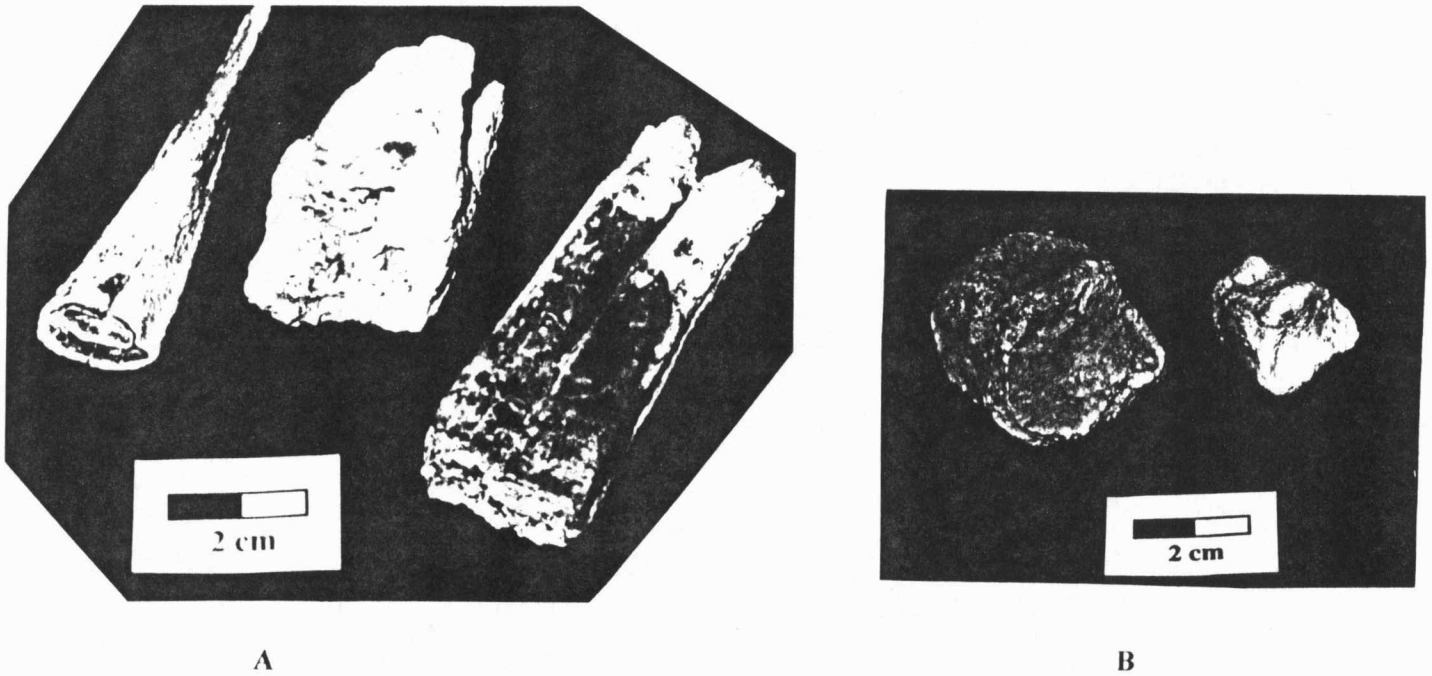

FIGURE 10. "Horse" fossils. A) teeth of *Plesippus simplicidens* (left to right are incisor, upper molar, & lower molar); B) comparison of toe bones (*Plesippus* on left, *Nannippus* on right).

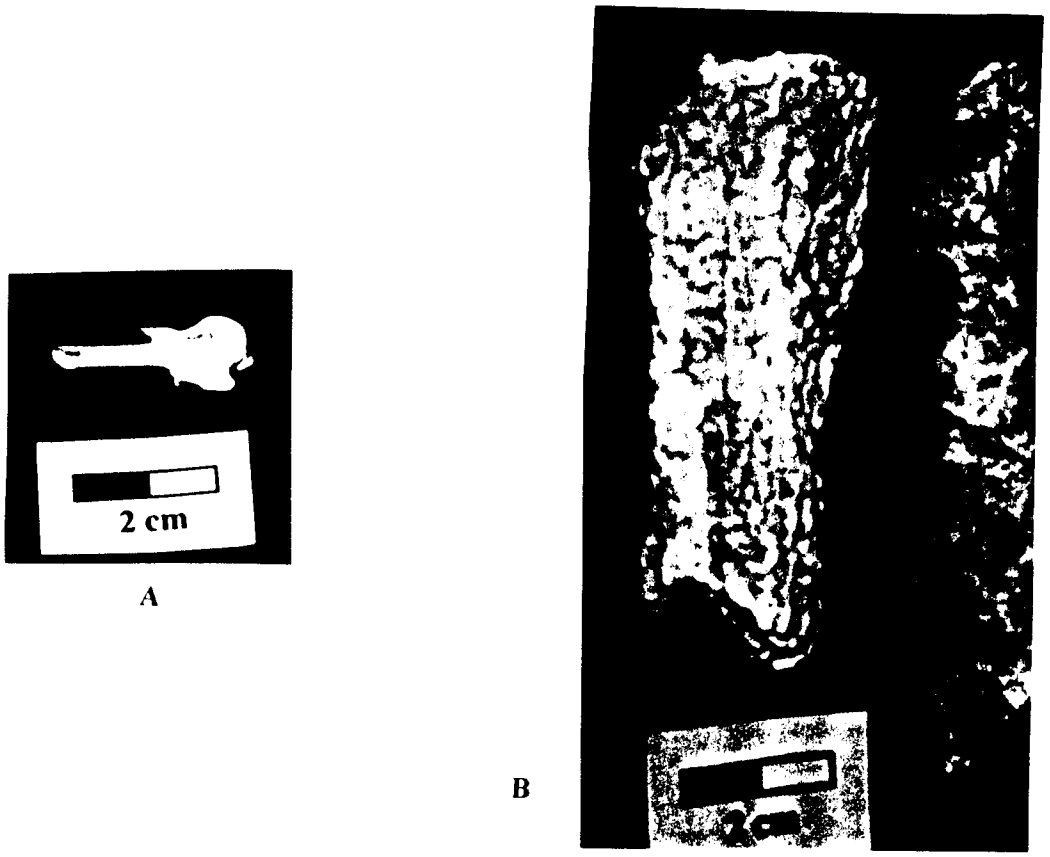

FIGURE 11. Avian fossil and taphonomic example. A) bird ?tarsometatarsus (family Threskiornithidae); B) mammal bone fragments demonstrating various states of taphonomic exposure (highly abraided and weathered bone on left; cleanly fractured and unweathered bone on right).

PALEOECOLOGY

The fossil-bearing Ballard Formation consists of fining upward (gravel to silts) sequences containing multiple caliche horizons. These fining (silting) upward sequences grading into zones of unstratified caliche, suggest a decrease in regional stream gradient and possible decrease in rainfall.

Sedimentologic data indicates possible shifting climatic conditions from a relatively humid climate (during Rexroadian time) to a semiarid one (Hibbard, 1948). Hibbard (1948, 1949a) postulated cooler conditions during Deer Park time than Rexroad time based on comparative faunal compositions.

An ichnocoenosis dominated by vertical tubes and borrows likely representing plant roots (mostly grasses) and infaunal insects, preserved within the Ballard Formation, suggests a grassland savannah environment possibly adjacent to the wooded stream valleys of Deer Park time.

Although Hibbard (1970a) describes the Deer Park Local Fauna (as recovered from his Faunal Locality 1/ KU Locality 1) as being an artesian sand tube assemblage (Figure 12), geologic and taphonomic evidence does not support this origin for a majority of the vertebrate fossils currently observed from within the park.

The relatively widespread aerial, but stratigraphically localized distribution of the fossil-bearing deposits suggests deposition by fluvial (meandering stream) processes. Fossils are uncommonly observed within, and most commonly observed adjacent to lense-shaped coarse (up to gravel sized grains) horizons indicative of fluvial trough (channel lag) deposition.

Fossils are generally not observed complete or articulated, and appear to have been subjected to limited physical and biologic taphonomic processes such as short-term transport (indicated by complete disarticulation but minimal abrasion) or trampling (indicated by clean fracturing of long bones). In contrast, a small percentage of specimens exhibit a relatively higher degree of abrasion suggesting possible longer periods of fluvial transport and subsequent deposition as clasts (Figure 11B).

A majority of the fossils occur in the finer-grained portions of the sequences, suggesting their deposition during the channel-fill mode as compared to the channel-lag mode as described by Behrensmeyer (1988). Behrensmeyer (1982, 1988) describes channel-fill assemblages as more autochthonous and habitat-specific than channel-lag assemblages in her discussion of vertebrate preservation in fluvial channels.

Based on these observations, the vertebrate fossils present at Meade State Park may have been deposited in an environment containing tree-lined shallow stream valleys, that meandered through short grass savannas, bordered by occasional artesian springs present due to aquifer conditions (Figure 13).

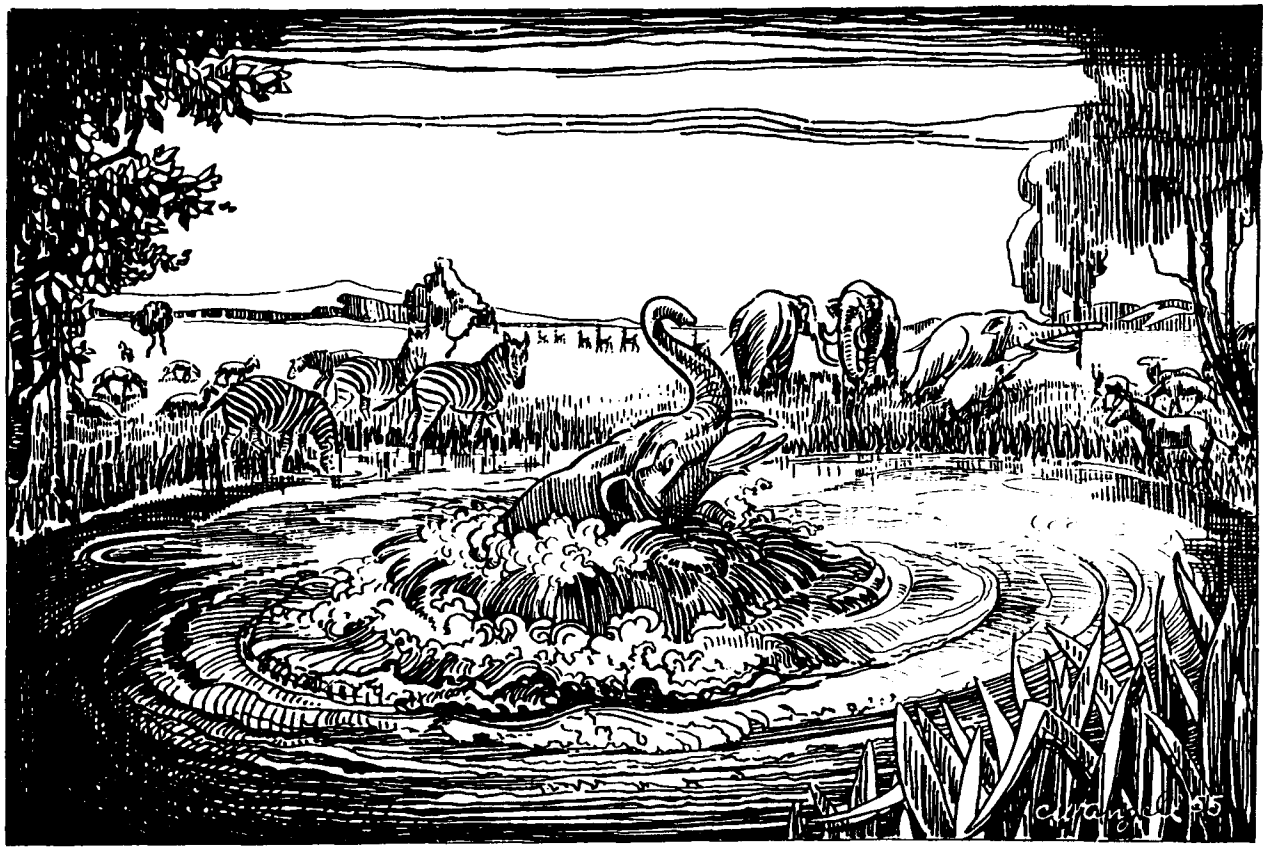

FIGURE 12. Reconstruction of the "boil spring" environment that Claude Hibbard postulated for his Faunal Locality 1 (also known as KU Locality 1) during Deer Park (Blancan) time (Drawing by C.W. Angell; from Hibbard, 1970a).

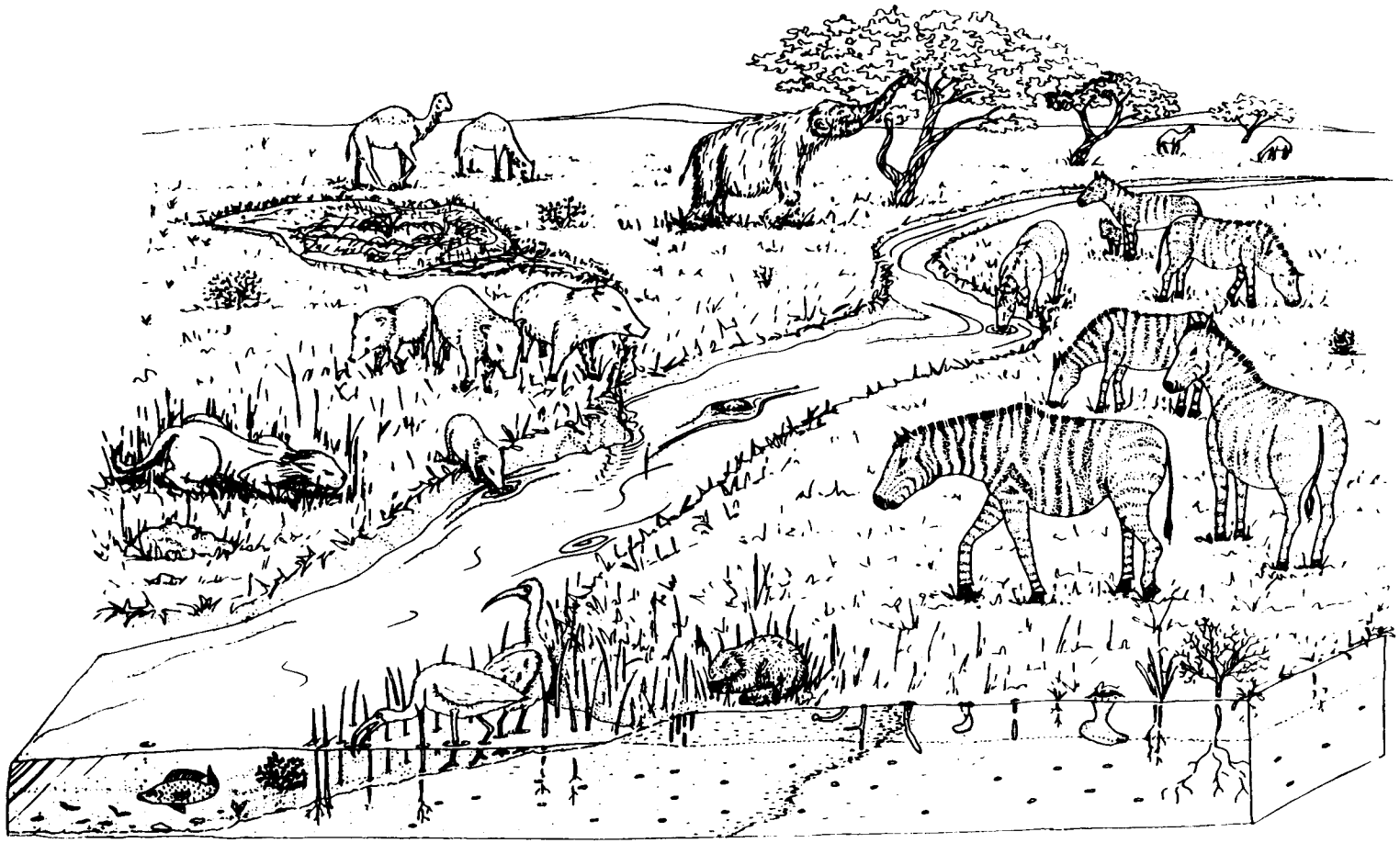

FIGURE 13. Ecosystem reconstruction of the Meade State Park area during Deer Park (Blancan) time. The fauna includes (clockwise from upper left): Camels (*Camelops* sp.); Wonderful Stegomastodont (*Stegomastodon mirificus*); Extinct American Zebra (*Plesippus simplicidens*); Sweets Beever (*Procastoroides sweeti*); Ibis (family Threskiornithidae); Sunfish (family Centrarchidae); Gazins Grisson (*Trigonictis idahoensis*); and Cope's Peccary (*Platygonius bicalcaratus*). Note the artesian spring adjacent to a shallow meandering stream through a short-grass savanah with infaunal activity in the soil (Drawing by C.J. Criss and A.J. Robb)

KANSAS LAW GOVERNING THE COLLECTION OF FOSSILS

There is significant interest and activity concerning the regulation of fossil collecting both in Kansas and nationally (West, 1989). There are currently no regulations which prohibit the collection of fossils in Kansas by enthusiasts for private collections or for academic research, except on state or federal managed lands.

In Kansas, the collection of geological and paleontological materials, including vertebrate fossils, on public or state managed lands is regulated by the Kansas Department of Wildlife and Parks. The Public Lands Regulation dated January 1, 1993 that governs this concern is K.S.A., 1989 Supp. 115-8-20, entitled DESTRUCTIVE ACTS OR ACTIVITIES PROHIBITED. The regulation reads as follows:

The following acts or activities shall be prohibited on department lands and waters except as provided for by rules and regulations or as authorized by the department:

a) digging holes or pits;
b) destruction, defacing, degrading or removal of:
1) signs;
2) real or personal property;
*3) **geologic formations**;* (< interpreted to include fossils)
4) historic sites;
5) archaeological relics or ruins;
6) vegetation, except for non-commercial use of edible wild plants, wild fruits, nuts, or fungi.

This regulation also requires written consent from the Park Director authorizing collection for scientific or educational purposes.

CONCLUSIONS AND RECOMMENDATIONS

This study confirms the presence of potentially scientifically important vertebrate fossil-bearing deposits (Figure 3), including the type locality for the Deer Park Local Fauna (Blancan), within Meade State Park.

The most abundant vertebrate fossils, that occur within the Missler Silt Member of the Ballard Formation (Meade Group)(Figure 3), constitute a relatively diverse Plio-Pleistocene (Blancan) mammal fauna correlative to the described Deer Park Local Fauna (Figure 6).

These vertebrate fossils occur in the publicly accessible northwest half of the park (Figure 4). Data from this study suggest that these vertebrate fossil resources should be preserved from natural deterioration and human destruction, including unauthorized collection.

While there has not been much publicly available research on the deterioration and protection of fossil resources, Nickens (1991) addressed archaeological resource destruction from both natural (geomorphic processes, erosion, precipitation, weathering, and faunal & floral activity) and human agents (accidental/incidental and intentional). Protection from natural agents include protective shelters or area sterilization of the resource. Protection from human activities includes policing, signage, or area sterilization of the resource.

In discussion concerning signage as a means of protecting archaeological sites, Jameson and Kodack (1991) state: a) it is better to have signs except in remote areas; b) signing is most effective when accompanied by enforcement and monitoring activity; and c) signs should include warning about what laws will be broken, what specific actions are against the law, and information on possible penalties.

Given the circumstances at Meade State Park, the following recommendations are provided for consideration:

1) **Development of visitor education programs (handouts and display kiosk); and**
2) **If additional pilfering is detected, it would be desirable to post combination interpretive and warning signs (but only if increased policing is possible).**

ACKNOWLEDGMENTS

I thank Roger J. Cuffey (Pennsylvania State University), who by virtue of his association with Claude Hibbard, first brought to my attention the vertebrate fossils present at Meade State Park. Don Dick with the Kansas Department of Wildlife and Parks facilitated my access to the park, Bob Martin (Murray State University) provided Figure 2 along with other valuable supporting information, and Cathleen Criss created most of Figure 13. Janice Sorenson (KGS) provided a KANSREF printout to help locate several important references during the early stages of this project, and facilitated the presentation of this project as a KGS open file report.

REFERENCES CITED

Behrensmeyer, A.K. 1982. Time resolution in fluvial vertebrate assemblages. Paleobiology, vol. 8, no. 3, pp. 211-227.

Behrensmeyer, A.K. 1988. Vertebrate preservation in fluvial channels. Palaeography, Palaeoclimatology, Palaeoecology, vol. 63, pp.183-199.

Carey, J.S., Frye, J.C., Plummer, N., and A. Swineford. 1952. Kansas Volcanic Ash Resources. State Geologic Survey of Kansas, Bulletin 96, 68p.

Frye, J.C. 1940. A preliminary report of the water supply of the Meade Artesian basin, Meade County, Kansas. Bulletin of the University of Kansas, State Geological Survey of Kansas, Bulletin 35, 39p.

Frye, J.C. 1942. Geology and Ground water resources of Meade County, Kansas. State Geological Survey of Kansas, Bulletin 45, 152p.

Frye, J.C. and C.W. Hibbard. 1941. Pliocene and Pleistocene stratigraphy and paleontology of the Meade Basin, southwestern Kansas. State Geological Survey of Kansas, Bulletin 38, pp.389-424.

Frye, J.C. and S.L. Schoff. 1942. Deep-seated solution in the Meade Basin and vicinity, Kansas and Oklahoma. Transactions of the American Geophysical Union (1942), pp. 35-39.

Hibbard, C.W. 1938. An upper Pliocene fauna from Meade County, Kansas. Transactions of the Kansas Academy of Science, vol. 40, pp. 239-265.

Hibbard, C.W. 1941. Paleoecology and correlation of the Rexroad Fauna from the upper Pliocene of southwestern Kansas, as indicated by the mammals. The University of Kansas Science Bulletin, vol. 27 (1), pp. 79-104.

Hibbard, C.W. 1948. Late Cenozoic climatic conditions in the High Plains of western Kansas. Geological Society of America Bulletin 59 (6), pp. 541-630.

Hibbard, C.W. 1949a. Pleistocene stratigraphy and paleontology of Meade County, Kansas. University of Michigan, Contributions from the Museum of Paleontology, vol. 7 (4), pp. 63-90.

Hibbard, C.W. 1949c. Techniques of collecting microvertebrate fossils. University of Michigan, Contributions from the Museum of Paleontology, vol. 8 (2), pp. 7-19.

Hibbard, C.W. 1953b. The Saw Rock Canyon Fauna and its stratigraphic significance. Michigan Academy of Science, Arts, and Letters, vol. 38, pp. 387-411.

Hibbard, C.W. 1970a. A new microtine rodent from the upper Pliocene of Kansas. The University of Michigan, Contributions from the Museum of Paleontology, vol. 23 (7), pp. 99-103.

Hibbard, C.W. 1970b. Pleistocene mammalian local faunas from the Great Plains and Central Lowland Provinces of the United States. University of Kansas, Department of Geology, Special Publication 3, pp. 395-433.

Hibbard, C.W. and D.W. Taylor. 1960. Two late Pleistocene faunas from southwestern Kansas. University of Michigan, Museum of Paleontology Contributions, vol. 16 (1), 223p.

Jameson, J.J. and M. Kodack. 1991. Signing as a means of protecting archaeological sites, pp. 235-246, in, Smith, G.S. and J.E. Ehrenhard, eds., Protecting the Past. CRC Press, Boston, 314p.

Kurten, B. And E. Anderson. 1980. Pleistocene mammals of North America. Columbia University Press, New York, 442p.

Lundelius, E.L., Churcher, C.S., Downs, T., Harington, C.R., Lindsay, E.H., Schultz, G.E., Semken, H.A., Webb, S.D. and R.J. Zakrzewski. 1987. The North American Quaternary sequence, pp. 211-235, in, M.O. Woodburne, ed., Cenozoic Mammals of North America. University of California Press, Berkeley, 336p.

Meade Globe Press. 1974. Dr. Hibbards Wife Visits Meade (June 13, 1974 issue).

Nickens, P.R. 1991. The destruction of archaeological sites and data, pp. 73-81, in, Smith, G.S. and J.E. Ehrenhard, eds., Protecting the Past. CRC Press, Boston, 314p.

Stevens, J.B. 1965. Geology of the Meade County State Park area, Kansas. Papers of the Michigan Academy of Science, Arts, and Letters, vol. 50, pp. 215-233.

Tomasu, B.I. 1977. Soil Survey of Meade County, Kansas. U.S. Department of Agriculture - Soil Conservation Service, 63 p. + maps.

West, R.M. 1989. State regulation of geological, paleontological, and archaeological collecting. Curator, vol. 32 (4), pp. 281-319.

APPENDIX A - KDWP Project Authorization

STATE OF KANSAS
DEPARTMENT OF WILDLIFE & PARKS
Region 3 Office
808 McArtor Rd.
Dodge City, KS 67801
316/227-8609 FAX 316/227-8600

April 8, 1996

Mr. Albert J. Robb III
631 North Clay Avenue
Liberal, KS 67901

Dear Mr. Robb:

Consider this letter as written permission to surface collect samples of vertebrate fossils on the Meade Wildlife area.

This permission is given only if you meet the following stipulations:

1. All collecting will be done from the surface (no excavation allowed).

2. All specimens collected will be donated to the collections of the Sternberg Museum at Fort Hays State University.

3. The Department of Wildlife and Parks receive a copy of any reports or publications resulting from your work.

4. Charles Helms, GMRT at Meade Wildlife Area (316-873-2701) must be informed of the time you are to do the collection.

If you have any further needs or questions, please contact me.

Sincerely,

Donald J. Dick
Wildlife Manager

DD/sm

c: Charles Helms
Mark Sexson

APPENDIX B -
PLIO-PLEISTOCENE LOCAL FAUNAS
IN THE MEADE COUNTY VICINITY

The following information concerning local faunas in the Meade County vicinity (300 mile radius) was compiled from a variety of sources to include: Hibbard, 1970b; Kurten & Anderson, 1980, and Lundelius et al., 1987. The specific references cited with each fauna are from the original sources, and therefore do not necessarily correspond to the reference list of this work. In addition, this compilation has considerable bias towards mammal species, and should not be considered comprehensive.

BLANCAN FAUNAS

Bender (?spp.) Southwest Kansas
Formation: upper Rexroad (above upper caliche)
Refs.: Hibbard, 1970b

Borchers (25 spp.) Meade County, KS
Formation: Crooked Creek, Atwater (upper) Member
Refs.: Hibbard, 1941d, 1951a, 1954a, 1970b; Lindsey et al., 1975

Deer Park (17 spp.) Meade County, KS
Formation: Ballard (= Meade Fm), Missler (upper) Member
Refs.: Hibbard, 1956a, 1970b; Lindsay et al., 1975; Skinner and Hibbard, 1972; D.W. Tayler, 1966

Dixon (14 spp.) Kingman County, KS
Formation: Belleville or Ballard
Refs.: Eshelman, 1975; Hibbard, 1956b, 1970b; Skinner and Hibbard, 1972; D.W. Tayler, 1966

Fox Canyon (30 spp.) Meade County, KS
Formation: Rexroad
Refs.: Hibbard, 1950, 1953a, 1964, 1967, 1970b; Hibbard and Riggs, 1949; Lindsey et al., 1975; Zakrzewski, 1967a

Keefe Canyon (25 spp.) Meade County, KS
Formation: Rexroad
Refs.: Hibbard, 1950, 1953a, 1964, 1967, 1970b; Hibbard and Riggs, 1949; Lindsey et al., 1975; Zakrzewski, 1967a

Rexroad (50 spp.) Meade County, KS
Formation: Rexroad
Refs.: Hibbard, 1950, 1953a, 1964, 1967, 1970b; Hibbard and Riggs, 1949; Lindsey et al., 1975; Zakrzewski, 1967a

Sanders (11 spp.) Meade County, KS
Formation: Ballard (= Meade Fm), ? Missler Member
Refs.: Hibbard, 1956a, 1970b; Lindsay et al., 1975; Skinner and Hibbard, 1972; D.W. Tayler, 1966

Saw Rock Canyon (18 spp.) Seward County, KS
Formation: lower Rexroad
Refs.: Hibbard, 1949, 1964

Seger (4 spp.) Meade County, KS
Formation: Crooked Creek, Stump Arroyo (lower) Member
Refs.: Hibbard, 1941d, 1951a, 1954a, 1970b; Lindsey et al., 1975

White Rock (43 spp.) Republic County, KS
Formation: Belleville
Refs.: Eshelman, 1975

IRVINGTONIAN FAUNAS

Aries (?spp.) Meade County, KS
Formation: ?
Refs.: Izett & Honey, 1995

Berends (16 spp.) Beaver County, OK
Formation: deposits overlying Pearlette-type ash bed
Refs.: Hibbard, 1970b; Starrett, 1956; Taylor, 1954

Courtland Canal (?spp.) Central Kansas
Formation: ?
Refs.: Eshelman & Hager, 1984

Cudahy (37 spp.) Meade County, KS
Formation: just above Cudahy ash bed
Refs.: Hibbard, 1944, 1970b; Leonard, 1950, Lindsay et al., 1975; Paulson, 1961

Hall Ash Pit (?spp.) Central Kansas
Formation: ?
Refs.: Eshelman & Hager, 1984

Kanopolis (34 spp.) Ellsworth County, KS
Formation: fluvial gravels
Refs.: Hibbard et al., 1978; Neff, 1975
Kentucky (20 spp.) McPherson County, KS
Formation: fluvial sediments within McPherson Formation
Refs.: Semken, 1966
Nash (?spp.) Meade County, KS
Formation: ?Pleistocene
Refs.: Eshelman & Hibbard, 1981
Rezabek (9 spp.) Lincoln County, KS
Formation: fluvial deposits
Refs.: Hibbard, 1943a
Tobin (?spp.) Central Kansas
Formation: late Kansan
Refs.: Zakrzewski & Kolb, 1982
Wilson Valley (?spp.) Central Kansas
Formation: late Kansan
Refs.: Zakrzewski & Kolb, 1982

RANCHOLABREAN FAUNAS (Late Illinoian and Sangamonian)

Adams (10 spp.) Meade County, KS
Formation: Fluvium (Butler Spring Basin)
Refs.: Hibbard, 1070b; Hibbard & Taylor, 1960; Kapp, 1965; Lindsat et al., 1975; Schultz, 1967
Butler Spring (18 spp.) Meade County, KS
Formation: alluvium and fluvium (Butler Springs Basin)
Refs.: Etheridge, 1958; Hibbard & Taylor, 1960; Schultz, 1965,1967
Cragin Quarry (28 spp., not type locality) Meade Co., KS
Formation: alluvium and fluvium (Butler Springs Basin)
Refs.: Etheridge, 1958; Hibbard & Taylor, 1960; Schultz, 1965,1967
Cragin Quarry (38 spp., type locality) Meade Co., KS
Formation: Kingstown Formation
Refs.: Hibbard, 1949a; Hibbard & Taylor, 1960; Schultz, 1965
Doby Springs (23 spp.) Harper County, OK
Formation: collapse basin deposits
Refs.: Stephens, 1960

Duck Creek (17 spp.) Ellis County, KS
Formation: fluvial gravels
Refs.: Kolb et al., 1975; McMullen, 1975; Zakrzewski, 1976; Zakrzewski & Maxfield, 1971
Jinglebob (24 spp.) Meade County, KS
Formation: fluvial deposits
Refs.: Hibbard, 1955c; Hibbard & Taylor, 1960; Zakrzewski, 1975a
Mt. Scott (26 spp.) Meade County, KS
Formation: Kingstown
Refs.: Hibbard, 1949a; Hibbard & Taylor, 1960; Schultz, 1965
Sandahl (31 spp.) McPherson County, KS
Formation: McPherson (="Equus beds")
Refs.: Semken, 1966

RANCHOLABREAN FAUNAS (Wisconsinan)

Afton (18 spp.) Ottawa Co., Oklahoma
Formation: spring deposits
Refs.: Hay, 1920
Domebo (8 spp.) Caddo County, OK - Paleoindian mammoth kill
Mammoths found in association with Clovis-type projectile points
Radiocarbon dates available - 11,220±500 ybp
Formation: fluvial deposits
Refs.: Leonhardy, 1966
Jones (26 spp.) Meade County, KS
Formation: sinkhole deposits
Refs.: Downs, 1954; Goodrich, 1940; Hibbard, 1949a, 1970b
Robert (15 spp.) Meade Co., KS
Formation: alluvium and fluvium (Butler Springs Basin)
Refs.: Etheridge, 1958; Hibbard & Taylor, 1960; Schultz, 1965, 1967

RECENT