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Plio-Pleistocene Glacial Deposits in Northeastern Nebraska: New Exposures and Interpretations

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PLIO-PLEISTOCENE
GLACIAL DEPOSITS
IN
NORTHEASTERN NEBRASKA:
NEW EXPOSURES
AND INTERPRETATIONS

M.R. Voorhies & R.G. Goodwin

Courtesy
of



**PLIO-PLEISTOCENE GLACIAL DEPOSITS IN NORTHEASTERN
NEBRASKA:
NEW EXPOSURES AND INTERPRETATIONS**

A field trip sponsored by the Nebraska Geological Society.

Trip Leaders:

Dr. M.R. Voorhies, University of Nebraska State Museum.

&

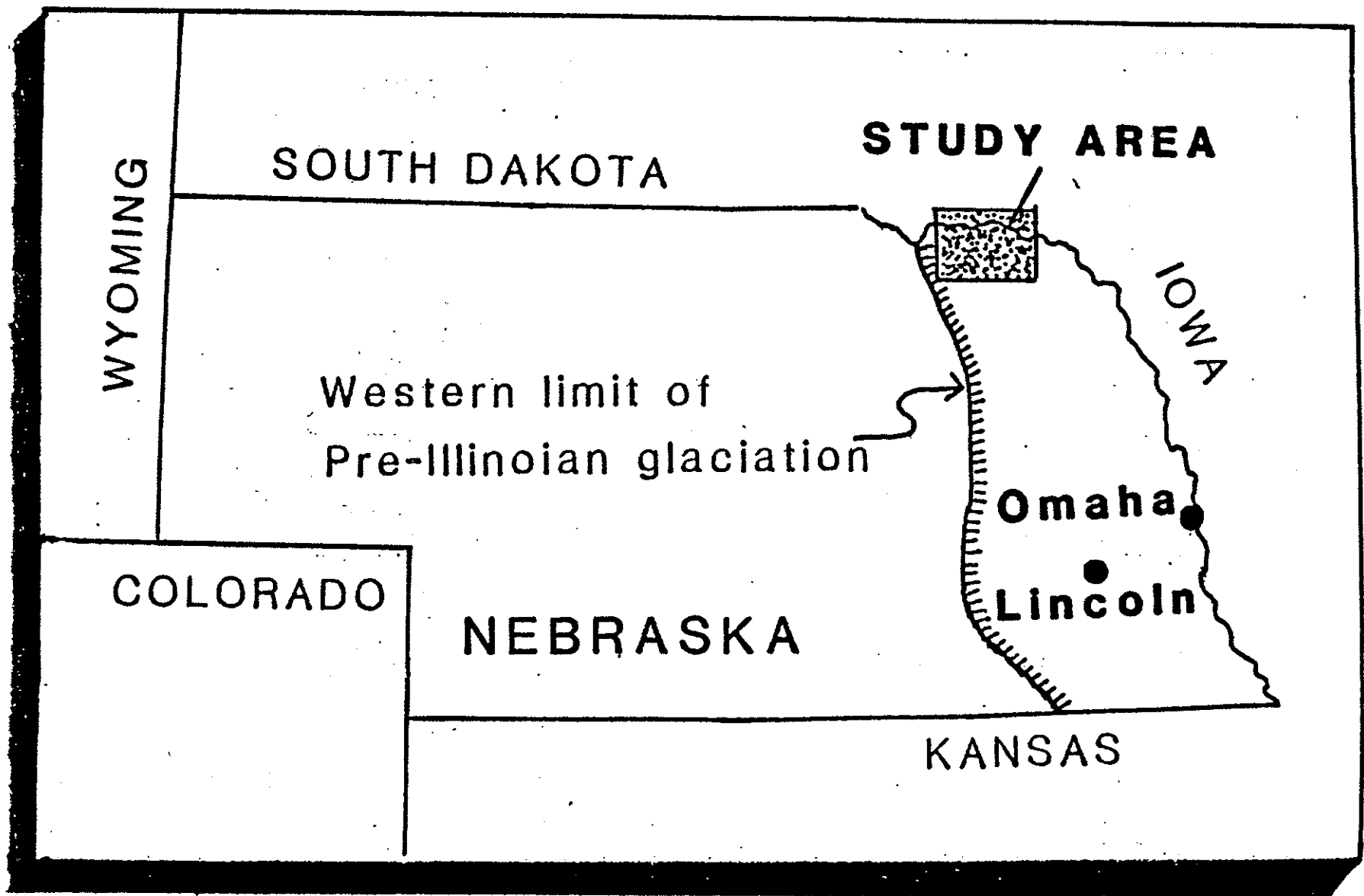
Dr. R.G. Goodwin, HWS Technologies Inc.

Spring 1989

INTRODUCTION

Recent interpretation of oxygen isotopic data for benthic and planktonic foraminifera recovered during ocean drilling programs suggest that world ice volume was greater than the ice volume of 18 thousand years ago (Late Wisconsinan) approximately 2.5 million years ago (Prentice and Matthews, *Geology*, November, 1988). This agrees well with biostratigraphic and paleoecologic interpretations drawn from sediment cores obtained from the Arctic Ocean Basin. The latter data suggest complete ice cover of the basin during the period 2.2-2.4 million years ago (Scott et al., *G.S.A. Bulletin*, February, 1989).

John Boellstorff inferred that one or more glacial tills of the North American mid-continent were deposited at this time. Boellstorff drew his conclusions primarily from subsurface samples and from volcanic ash horizons dated by the fission-track method. The purpose of this trip is to examine fossil-bearing outcrops of sand and gravel or silt that are associated with volcanic ash or glacial till and that provide information about the timing of glacier advance into northeastern Nebraska. The trip will begin at the Knox County Court House, Center, Nebraska at noon on Saturday May 6, 1989. Participants are responsible for providing their own transportation.



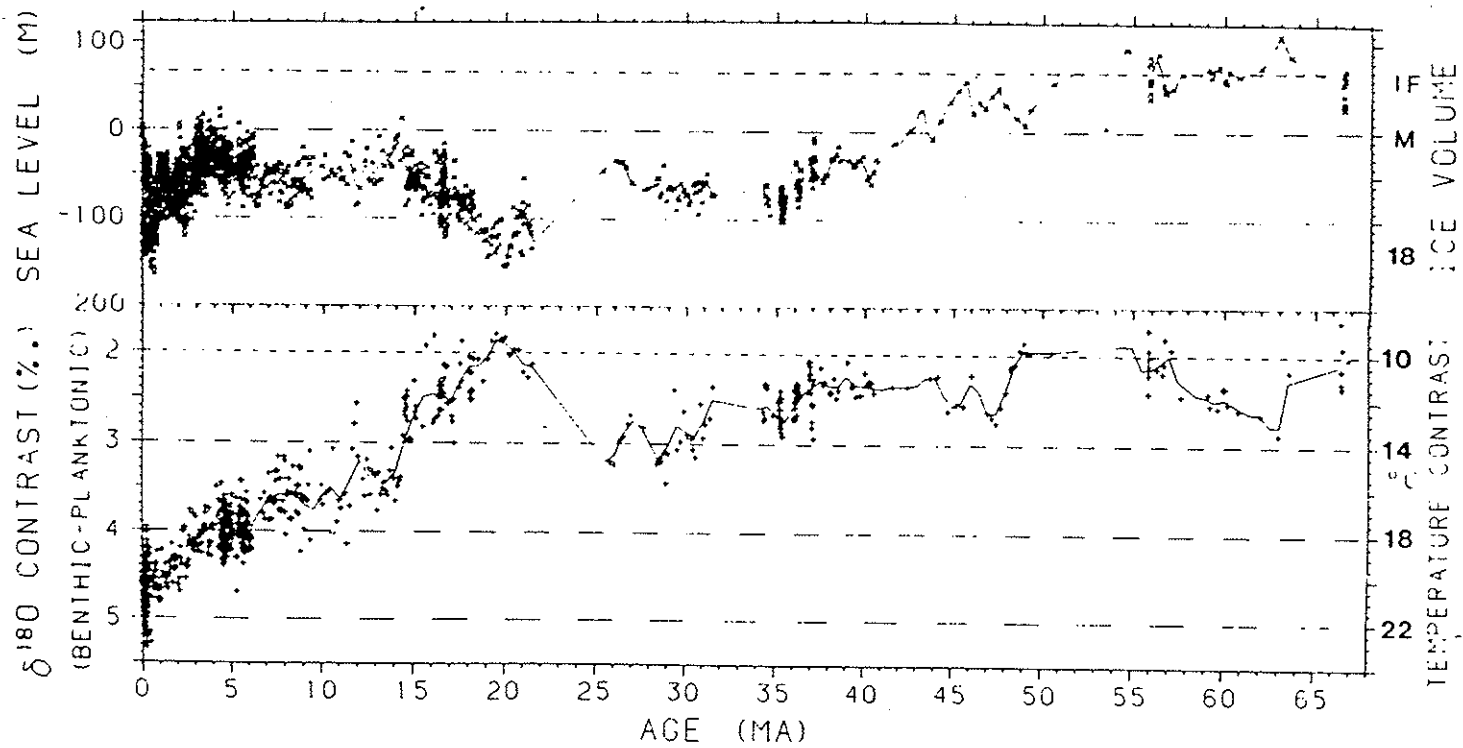


Figure 3. Glacioeustatic sea level for Cenozoic based on planktonic composite (upper). Interpretation scheme discussed in text. IF = ice-free, M = modern, 18 = 18 ka. Difference between benthic and planktonic composites (lower). Temperature-contrast scale assumes no $\delta^{18}\text{O}$ contrast between deep water and tropical surface water.

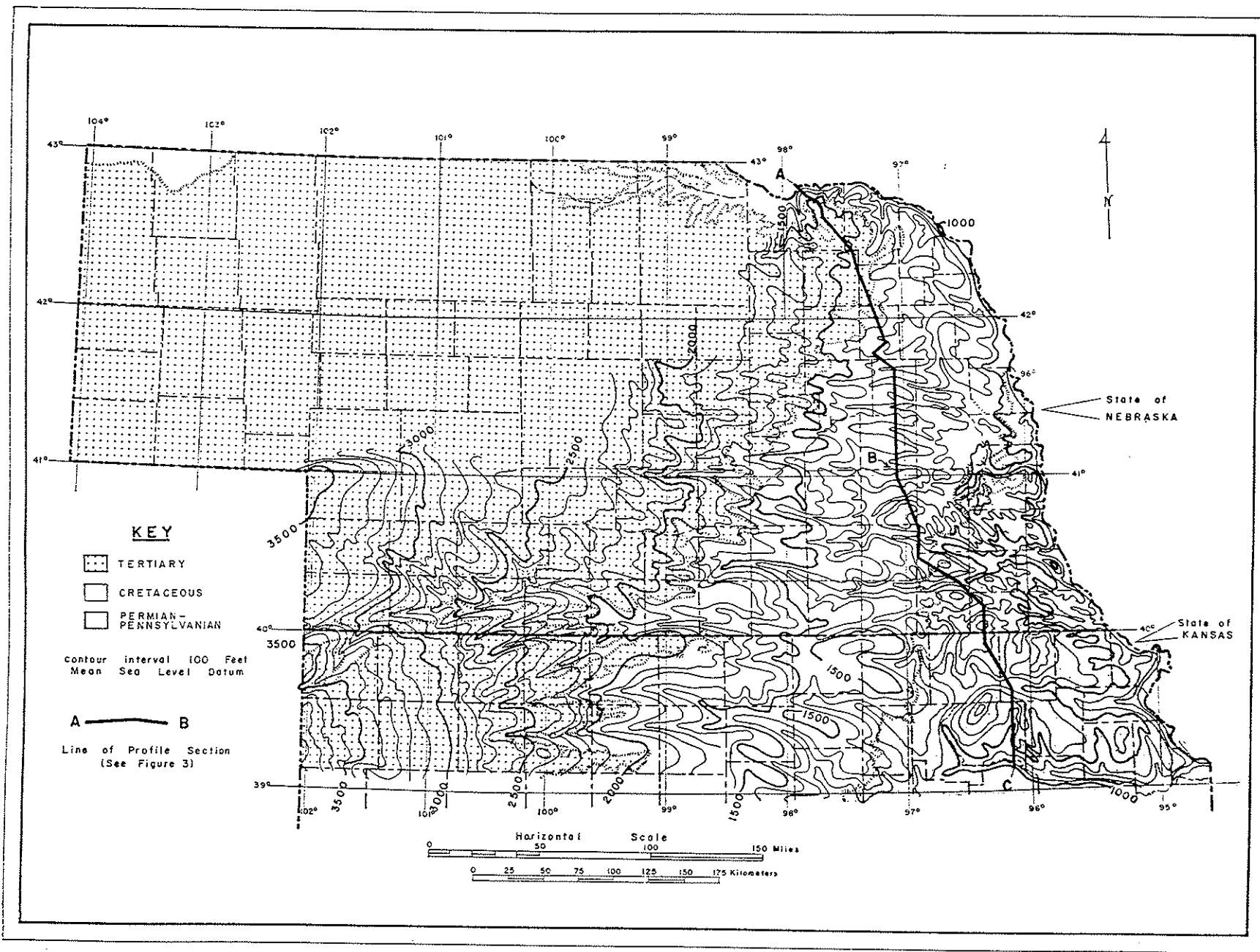
GEOLOGY, November 1988

Prentice & Matthews

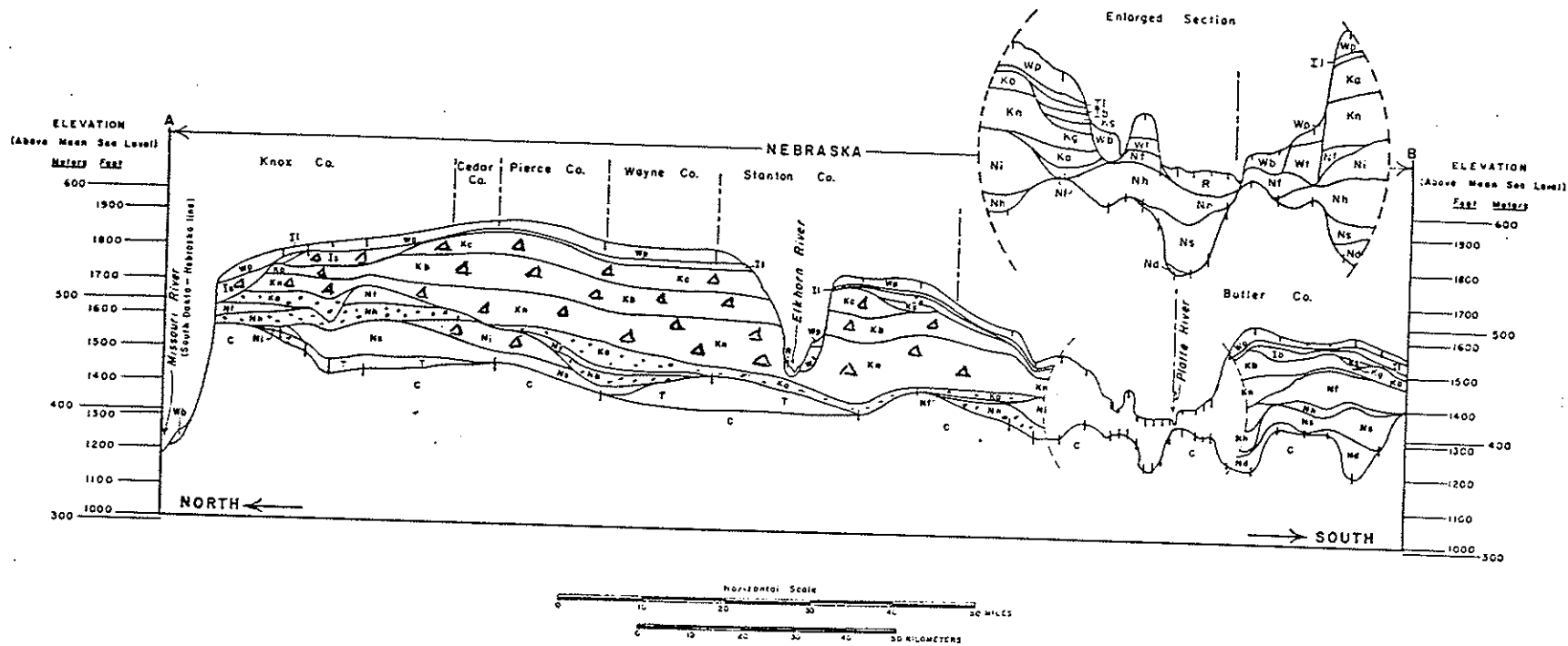
CLASSIFICATION						
TIME STRATI-GRAPHIC	ROCK STRATIGRAPHIC					
	EOLIAN	FLUVIATILE	GLACIAL	SOILS		
WISCONSINAN	Late	Bignell Loess and Dunesand	Bignell Formation	silt sand-gravel	Absent	
	Medial	Peoria Loess and Dunesand	Peoria Formation	silt Todd Valley sand		Brady
	Early	Gilman Canyon Loess	Gilman Canyon Formation		Absent	Unnamed
SANGAMONIAN	Late	Loveland Loess	Loveland Formation	silt Crete sand-gravel	Absent	Sangamon
	Medial	Beaver Creek Loess	Beaver Creek Formation	silt sand-gravel		Unnamed
	Early	Grafton Loess	Grafton Formation	silt sand-gravel		Unnamed
YARMOUTHIAN	Late	Sappa Loess	Sappa Formation	silt Grand Island sand-gravel	Probably Absent	Yarmouth
	Medial	Walnut Creek Loess*	Walnut Creek Formation	silt sand-gravel		Unnamed
	Early	Red Cloud Loess*	Red Cloud Formation	silt sand-gravel		Fontanelle
AFTONIAN	Late	Fullerton Loess*	Fullerton Formation	silt Holdrege sand-gravel		Unnamed
	Early	Seward Loess*	Seward Formation	silt basal sand-gravel		Unnamed
						Iowa Point Till Elk Creek Till David City Sd-Gr

KEY
 Pearlite Volcanic Ash ***** Minor Erosion ~~~~~ Major Erosion =====
 Interstadial Soil ~~~~~ Interglacial Soil ===== *Not Currently Identified

Classification of Pleistocene deposits of Nebraska (from Reed and Dreeszen, 1965).



Configuration of the pre-Quaternary surface showing distribution of Pennsylvanian, Permian, Cretaceous, and Tertiary bedrock and location of schematic profile section (Fig. 5).

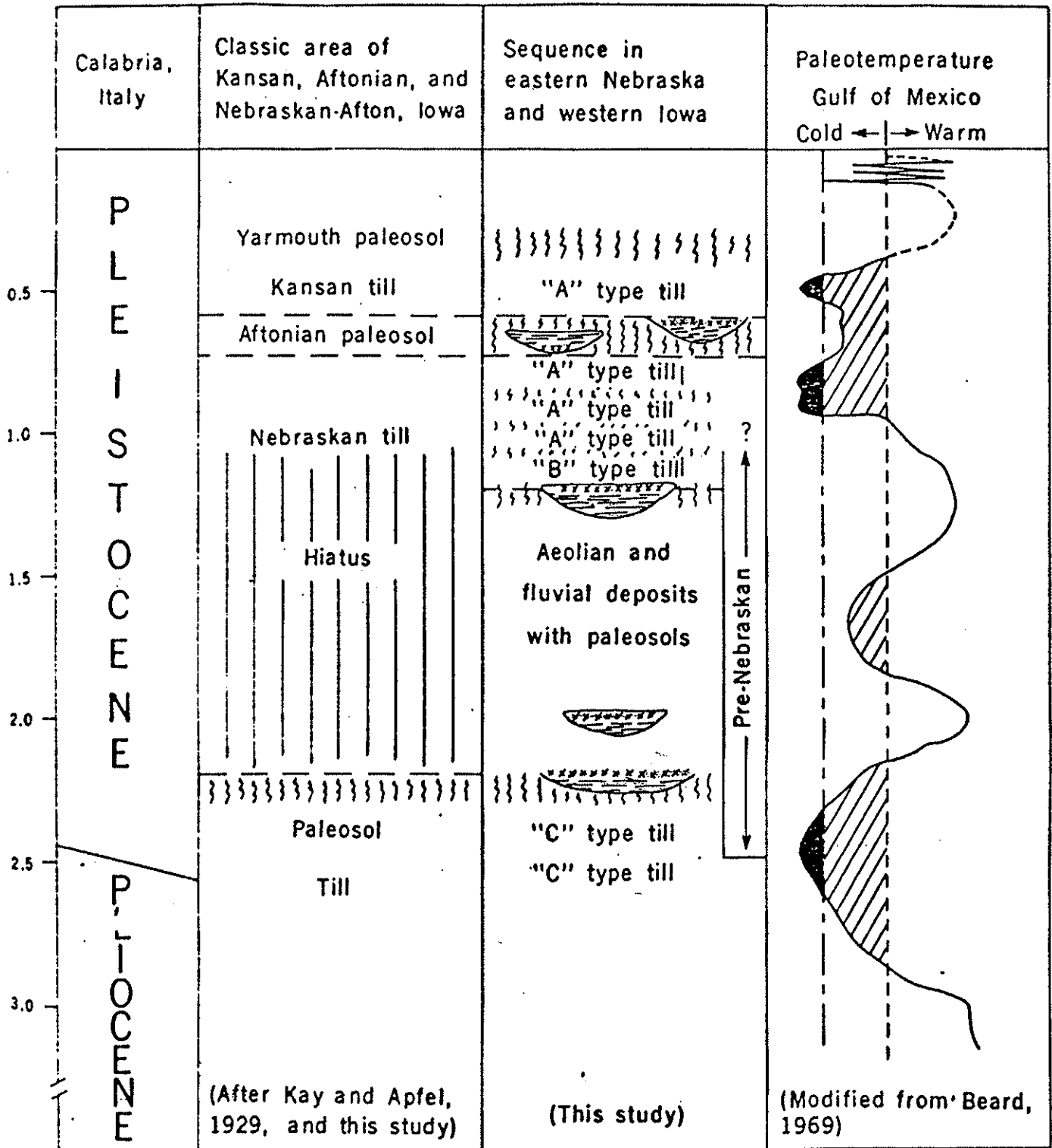


KEY TO SYMBOLS

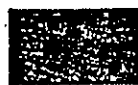
R-Recent silt, sand, gravel; Wb-Bigoneil silt, sand, gravel; Wp-Pearia loess + silt (Gilman Canyon at base locally); Wt-Todd Valley sand; Ii-Loveland loess + silt; Ib-Beaver Creek loess, silt, sand; Is-Santee fill; Kc-Clarkson till; Ks-Scapp loess + silt (includes Peartette); Kg-Grand Island sand, gravel; Kb-Cedar Bluffs till; Kn-Nickerson fill; Ka-Atchison sand; Nf-Fullerton silt; Ni-Iowa Point till; Nh-Haldrege sand + gravel; Ns-Seward silt, fine sand; Nd-David City sand + gravel; T-Tertiary silts + sandstones; C-Cretaceous shale, chalk, limestone, sandstone; P-Permian + Pennsylvania limestone, shale. Location of test holes indicated by vertical lines.

(For location of Profile Section, see Figure 2)

North-south schematic geologic-profile section based on test drilling of the Kansas and Nebraska Geological Surveys.



Fluvial-lacustrine deposits containing volcanic ash lenses



Approximate continental glaciation south of about 41°30' S



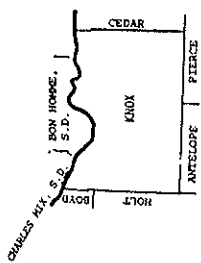
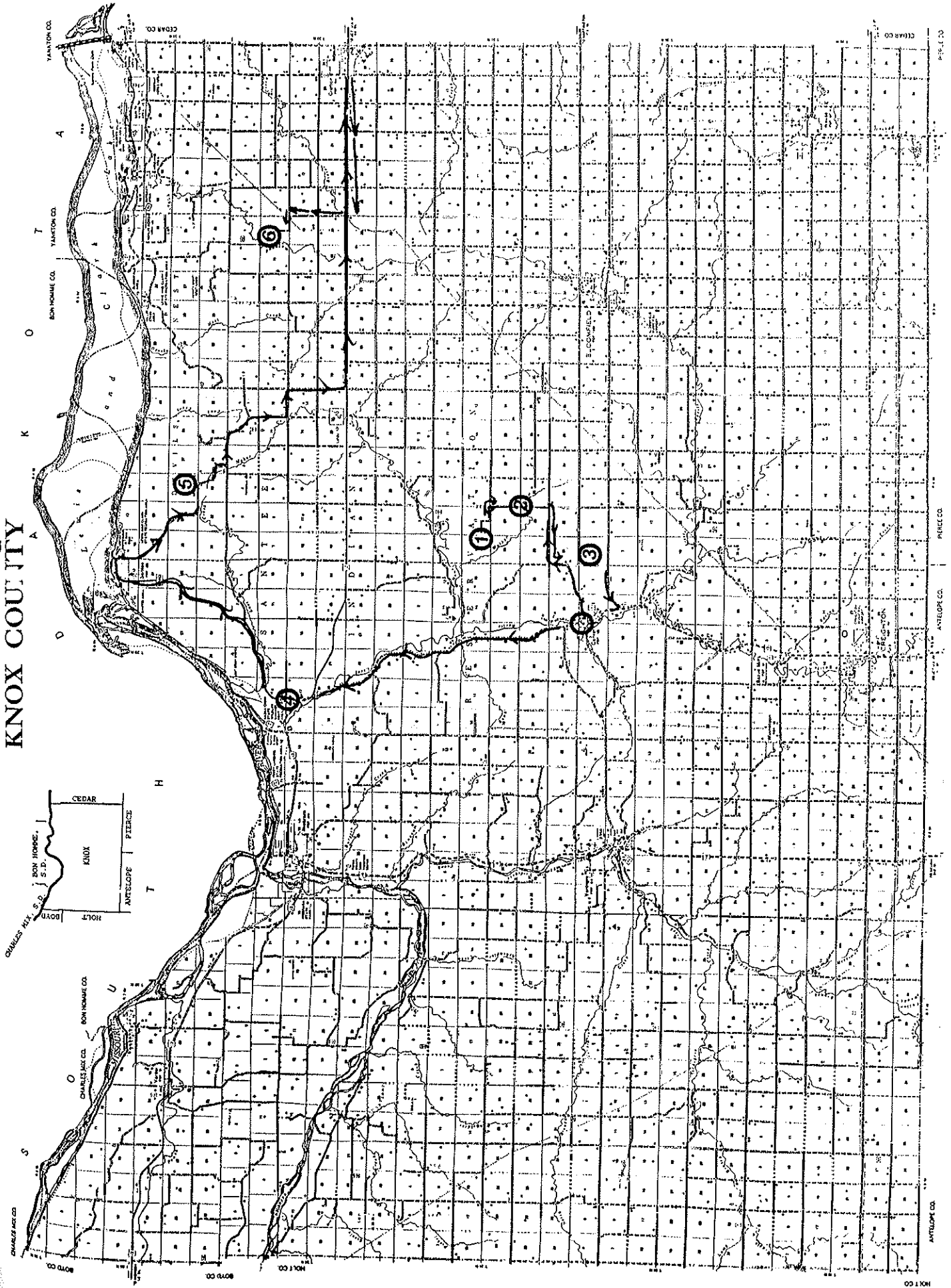
Approximate positions of paleosols



Approximate continental glaciation north of about 41°30' S

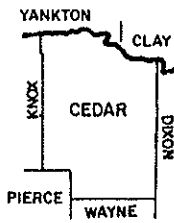
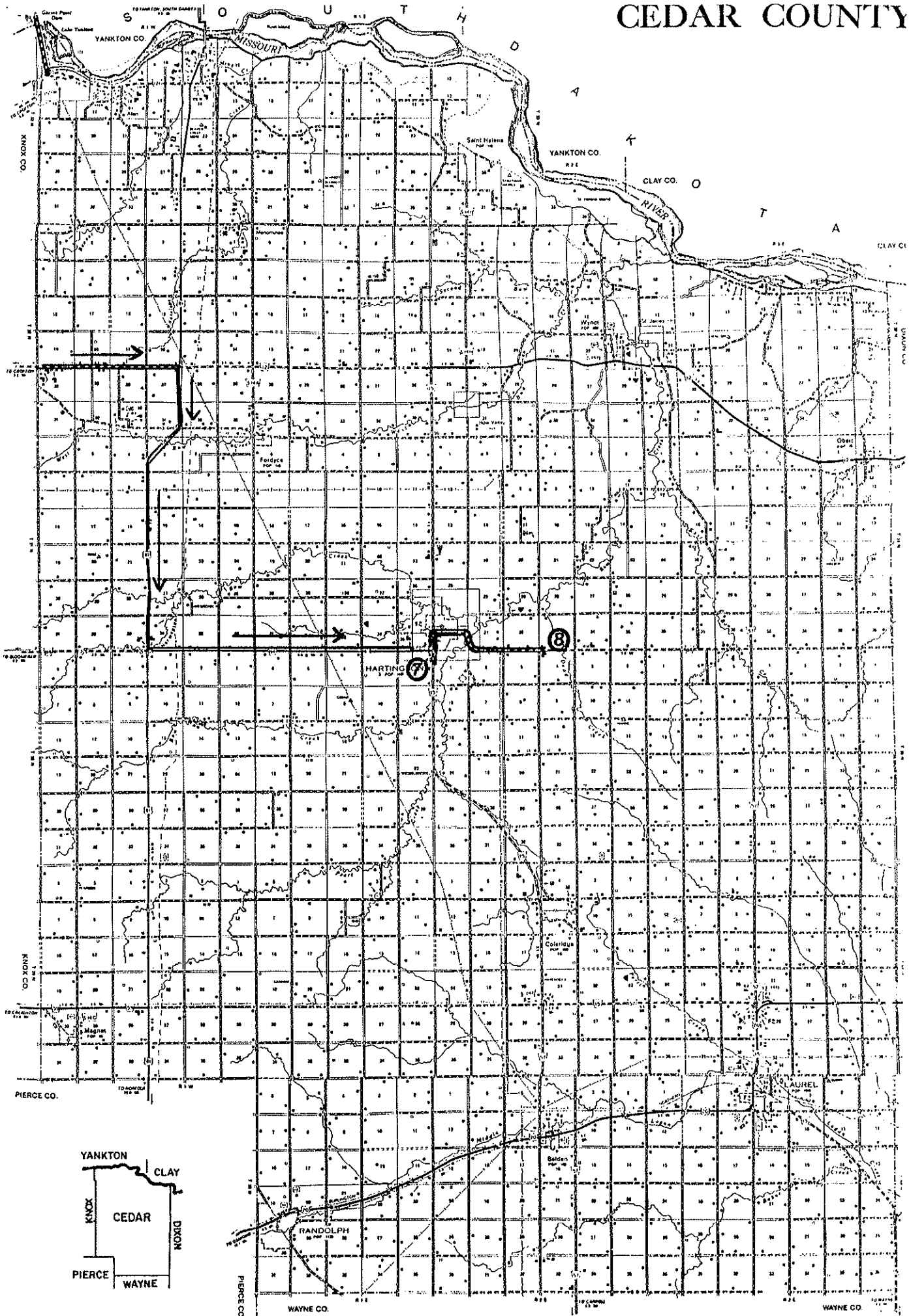
COUNTY MAPS WITH ROAD GUIDES

KNOX COUNTY



BOONE CO. | CHARLES MAR. CO. | HAMILTON CO. | KNOX CO. | TAYLOR CO.
S 10 | O 10 | U 10 | A 10 | K 10 | O 10 | T 10 | H 10

CEDAR COUNTY



STOP 1 (12:30 P.M.) NICKELS GRAVEL PIT, Center of the east side, Sec 18, T31N, R4W (Howe Creek 7.5 min Quad).

At this site, sand and gravel are overlain by fossiliferous silt and volcanic ash (Late Pliocene ~2 m.y. type B Pearlette Ash?). Vertebrate fossils and molluscs have been recovered from the site. Till is present at the top of the section, and clasts interpreted to be derived from till are present in gravel near the base. Striated cobbles have also been recovered from the lower gravels. This suggests glacial transport. The sand and gravel rest directly on Cretaceous marine shale. The micro vertebrates from the pit indicate a Late Blancan (Late Pliocene) age. Much of the fine gravel at the site is composed of pink granitic debris, and some blue-gray plagioclase is present. These clasts were transported to northeast Nebraska from the mountains of southeastern Wyoming. Larger clasts are composed of locally derived Cretaceous chalk, Tertiary quartzite and petrified wood, and a variety of plutonic and metamorphic rocks that originated on the Canadian Shield to the north.

STOP 2 (2:45 P.M.) HEAD OF WALKER DRAW, West side, NW 1/4 NW 1/4 Sec 28 T31N R4W (Howe Creek 7.5 min Quad).

Glacial till rests on outwash sand and gravel that contains Late Pliocene vertebrate fossils similar to those at the Nickels Pit. Cobbles similar to ones in the till are present in the sand and gravel. Very poorly sorted lenses of debris-flow sediments like those found near the margins of modern glaciers are present in the sand and gravel.

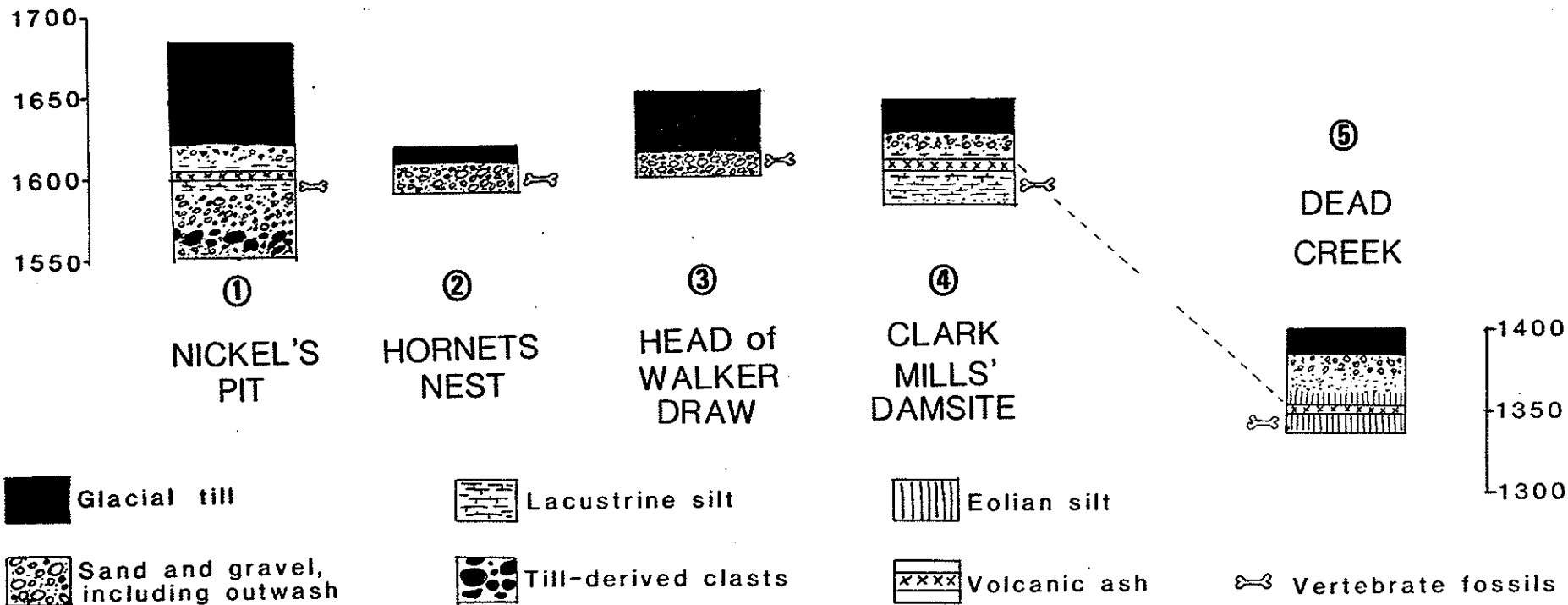
STOP 3 (3:30 P.M.) CLARK MILLS DAMSITE, Center of Sec 6 T30N R4W (Howe Creek 7.5 min Quad).

Lacustrine silts and clays with cool-water molluscs and cool-climate vertebrates. This site has produced mammals, fish, amphibians and birds. The fossiliferous horizons are overlain by volcanic ash (type B Pearlette?). The silts rest on well sorted sand and are overlain by outwash sand and gravel and glacial till. Paleomagnetic analyses indicate that the silts were deposited in a reversed magnetic field (Matuyama Reversed Epoch). The fossil evidence indicates that this is also a Late Blancan site.

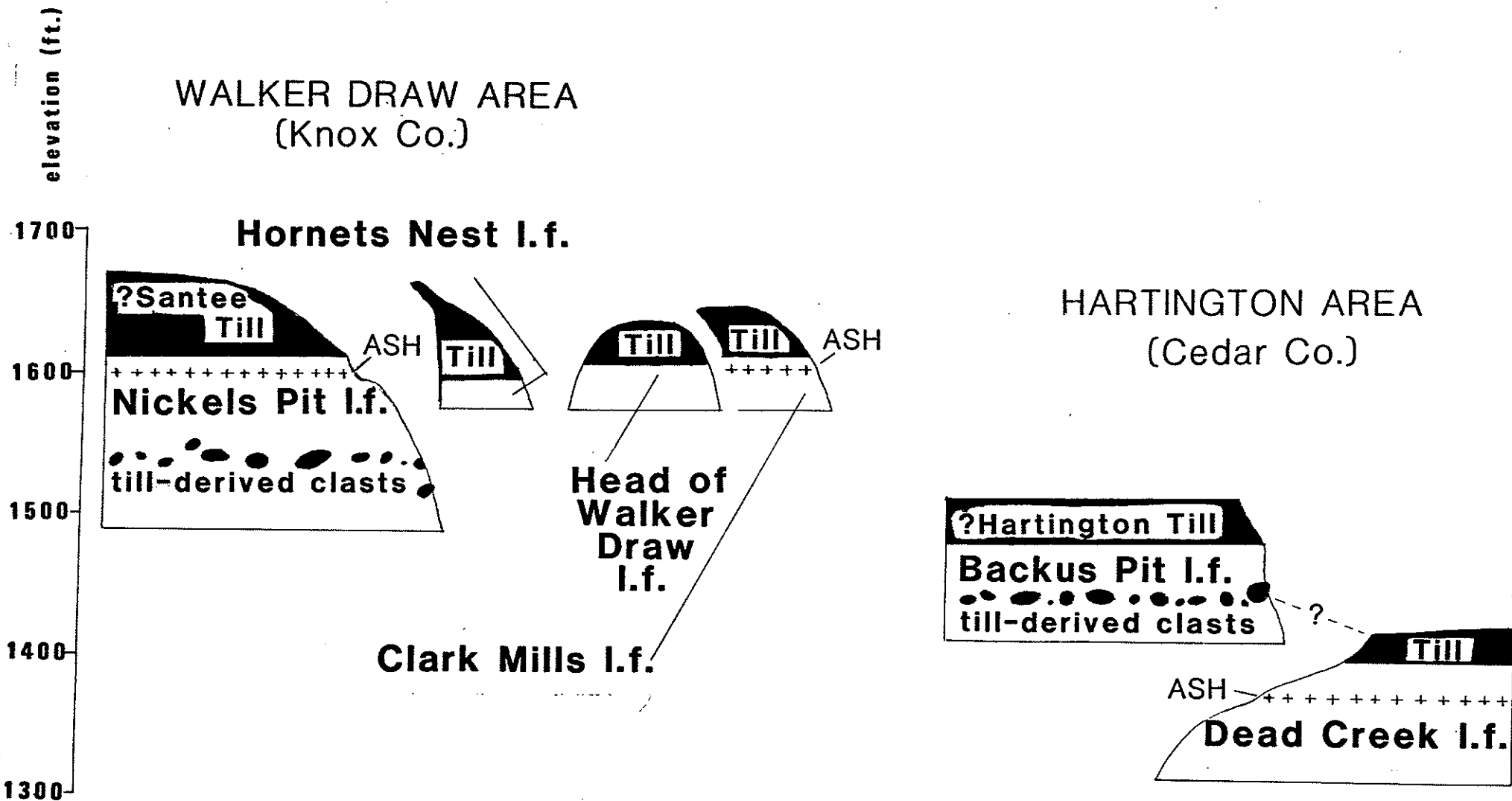
OPTIONAL STOP, GOMPERT GRAVEL PIT AND HWY 84 ROAD CUTS, South side SW 1/4 Sec 1 T30N R5W and north side NW 1/4 Sec 12 T30N R5W (Center East 7.5 min Quad).

Elev. (ft)

CORRELATION of PLIOCENE SITES in KNOX and CEDAR COUNTIES

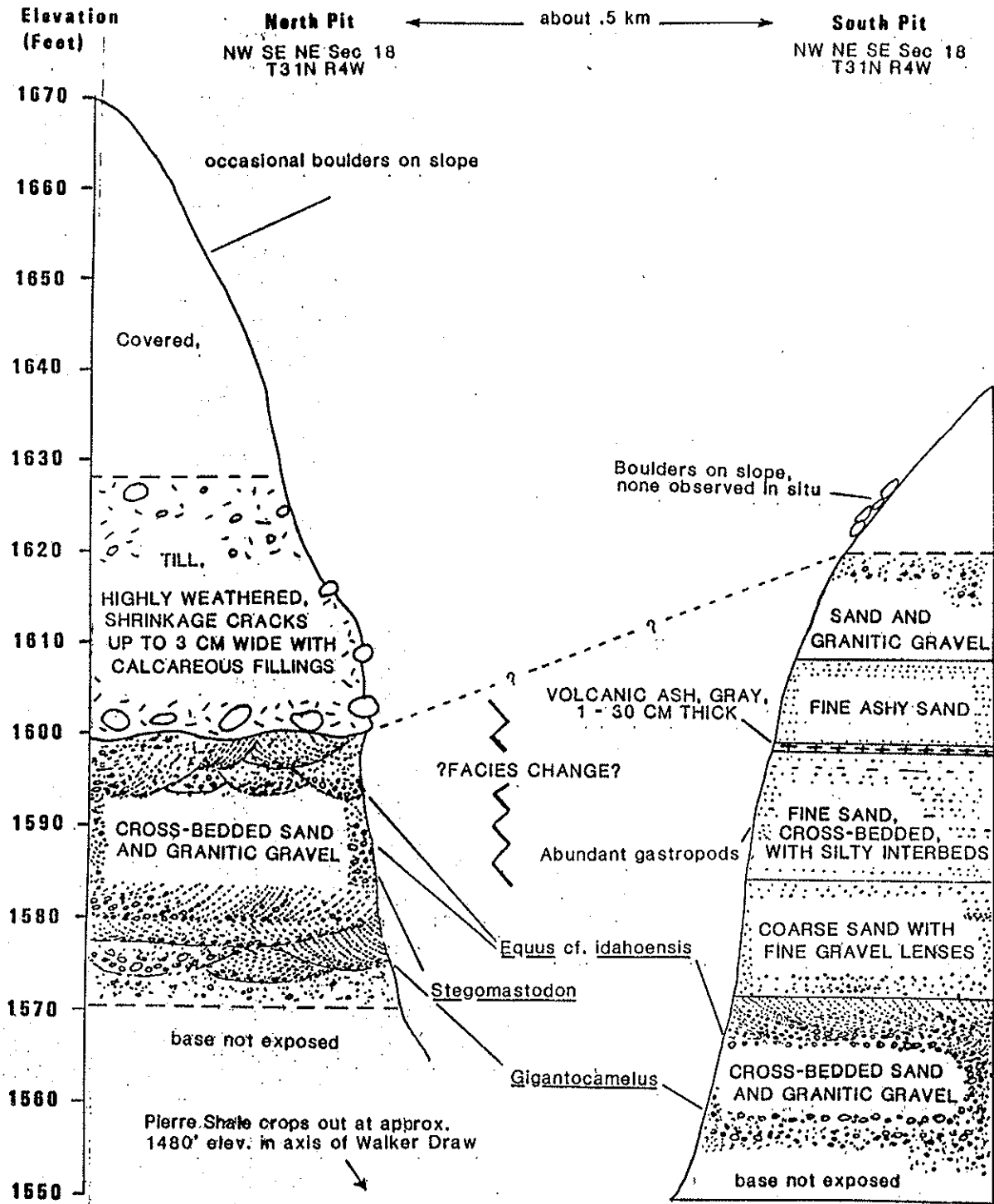


RELATIONSHIP of VERTEBRATE FAUNAS to GLACIAL TILLS
Knox and Cedar counties, Nebraska



NICKELS GRAVEL PIT, WALKER DRAW UNSM FOSSIL VERTEBRATE LOCALITY KX-109

(Section measured by MRV Aug. 1984)



**KEY VERTEBRATE TAXA USED IN AGE DETERMINATION
OF INTERTILL VERTEBRATE FAUNAS**

LATE BLANCAN (ca. 2.2 ± 0.3 Ma) (Nickels Pit, Hornets Nest, Head of Walker Draw, Clark Mills, Dead Creek)		
EARLY OCCURRENCE	LATE OCCURRENCE	LIMITED OCCURRENCE
Titanotylopus Lepus Synaptomys (Metaxyomys) Synaptomys (Synaptomys)	Gigantocamelus Hypolagus	Ondatra idahoensis Loupomys Equus idahoensis
EARLY IRVINGTONIAN (ca. 1.5 ± 0.5 Ma) (Backus Pit)		
EARLY OCCURRENCE	LATE OCCURRENCE	LIMITED OCCURRENCE
Mammuthus Equus semiplicatus Euceratherium	Stegomastodon Titanotylopus	Ondatra annectens Allophaiomys Synaptomys (Kentuckomys) Equus giganteus

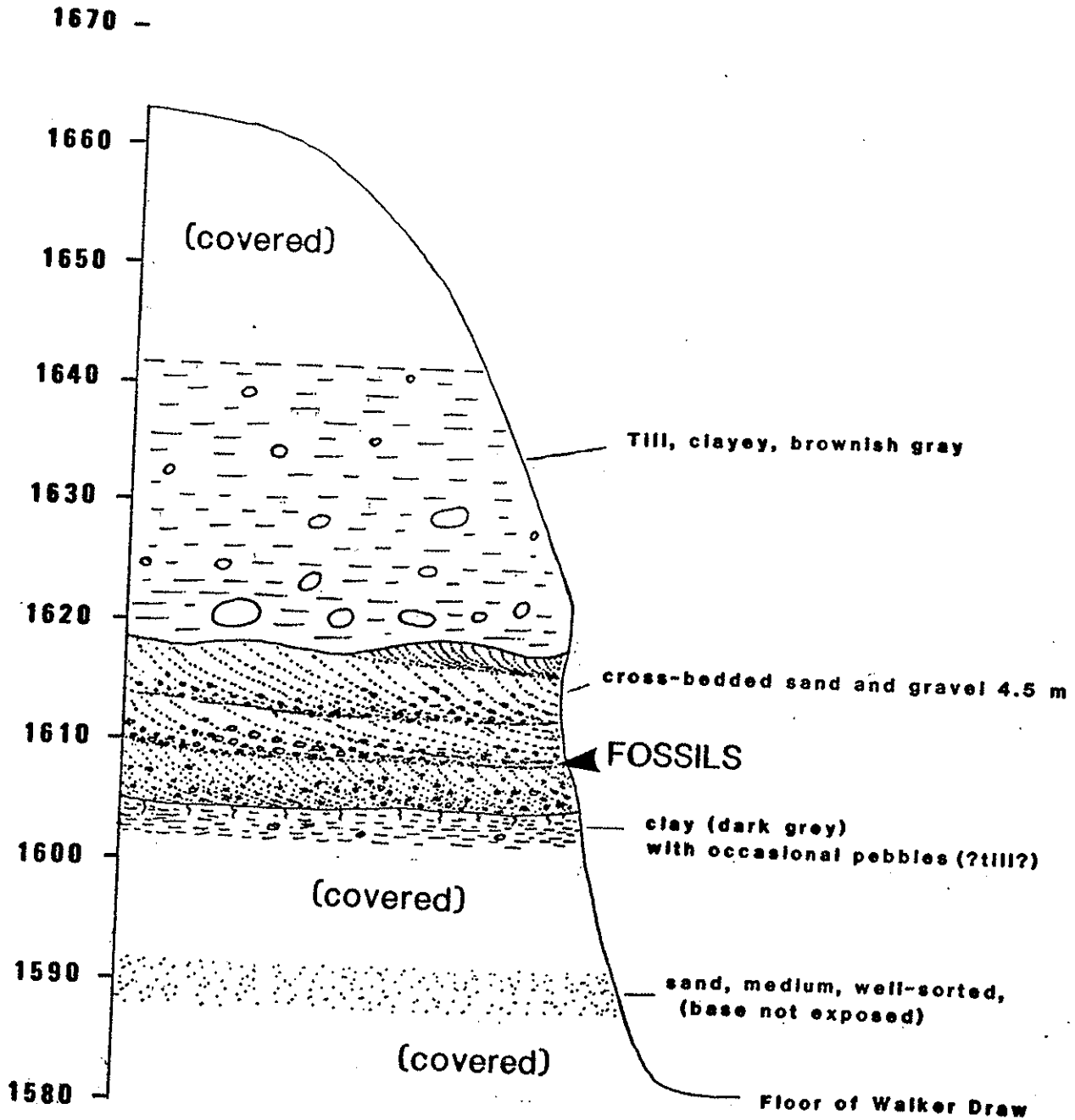
HEAD OF WALKER DRAW

UNSM FOSSIL VERTEBRATE LOCALITY KX-141

SW-SW-NW-NW-NW Sec. 28, T31N, R4W, Knox Co., Ne.

**Elevation
(Feet)**

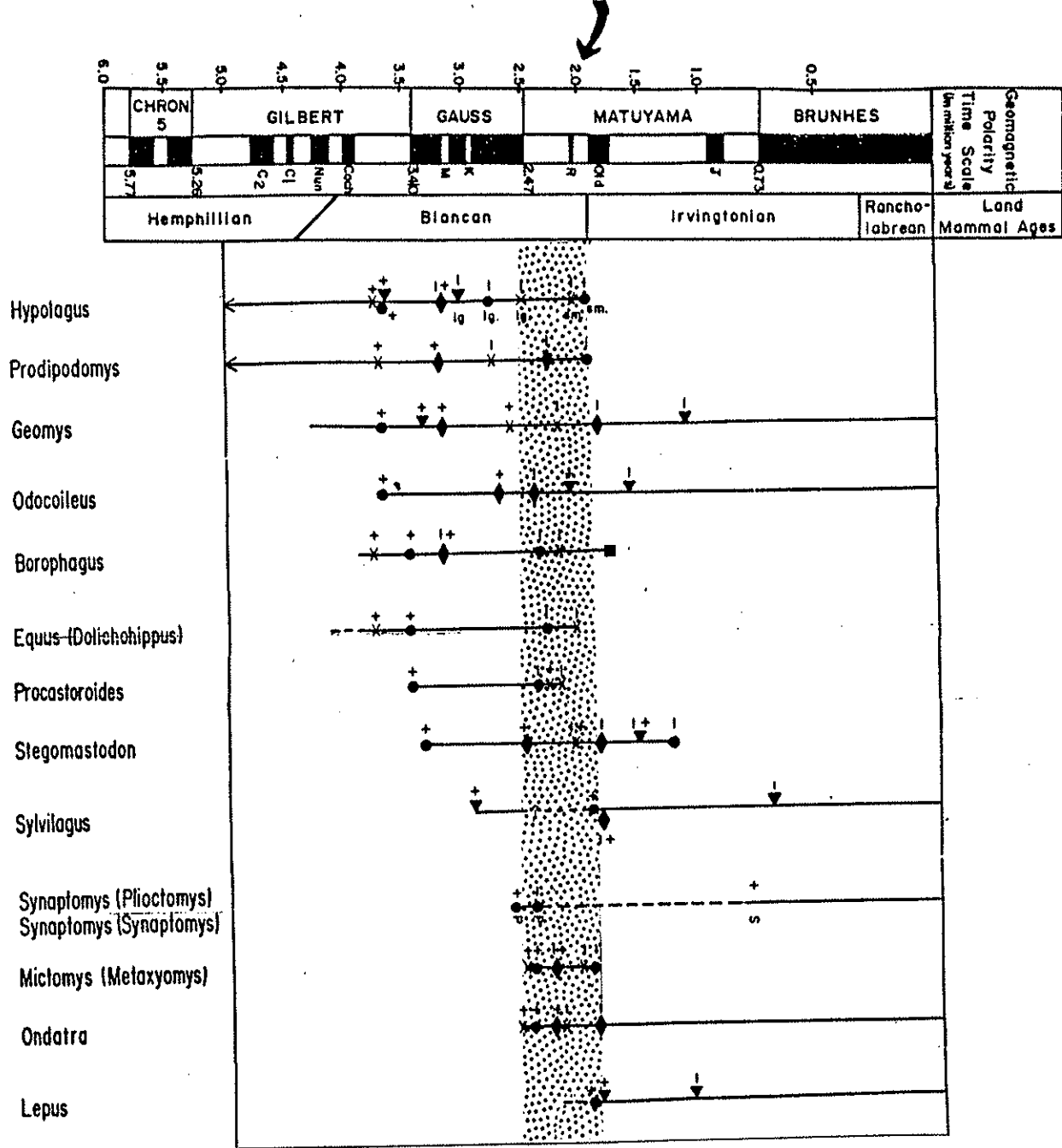
(section measured in roadcut between sections 28 and 29 beginning where road crosses Walker Draw and ending at shared corners of secs. 28, 29, 20, and 21, MRV Aug., 1983.)



Age of Walker Draw - Dead Creek Vertebrate Assemblages

NO YOUNGER THAN 2.0 M.a.

Last Appearances of Dolichohippus, Prodipodomys, and Hypolagus

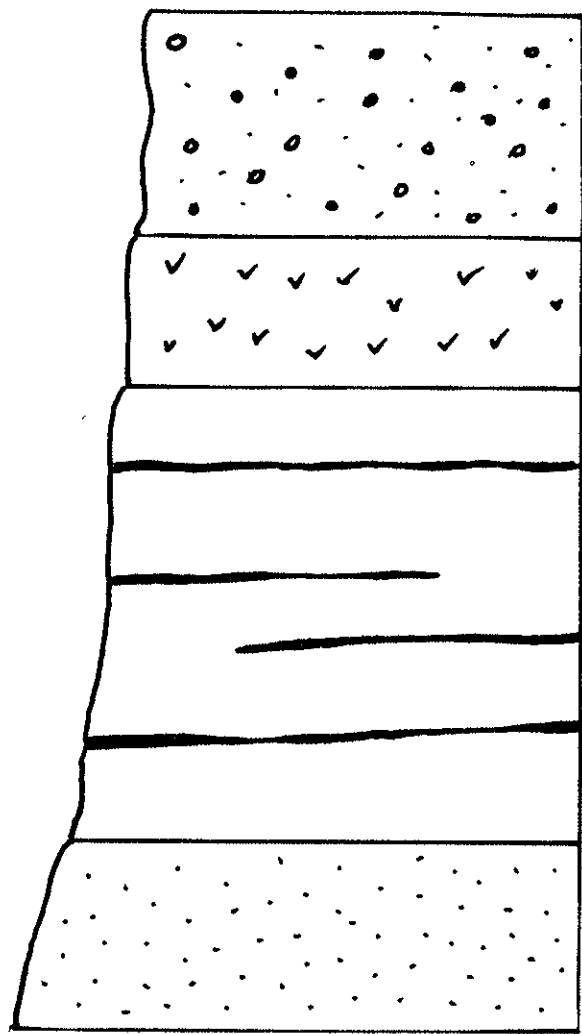


NO OLDER THAN 2.5 M.a.

First Appearances of Ondatra, Synaptomys, and Metaxyomys

ranges of genera published by Lundelius et al., 1987: fig. 7.2

~1590'



Northern Sourced
sand, gravel and
cobbles

1610' impure vitric
ash

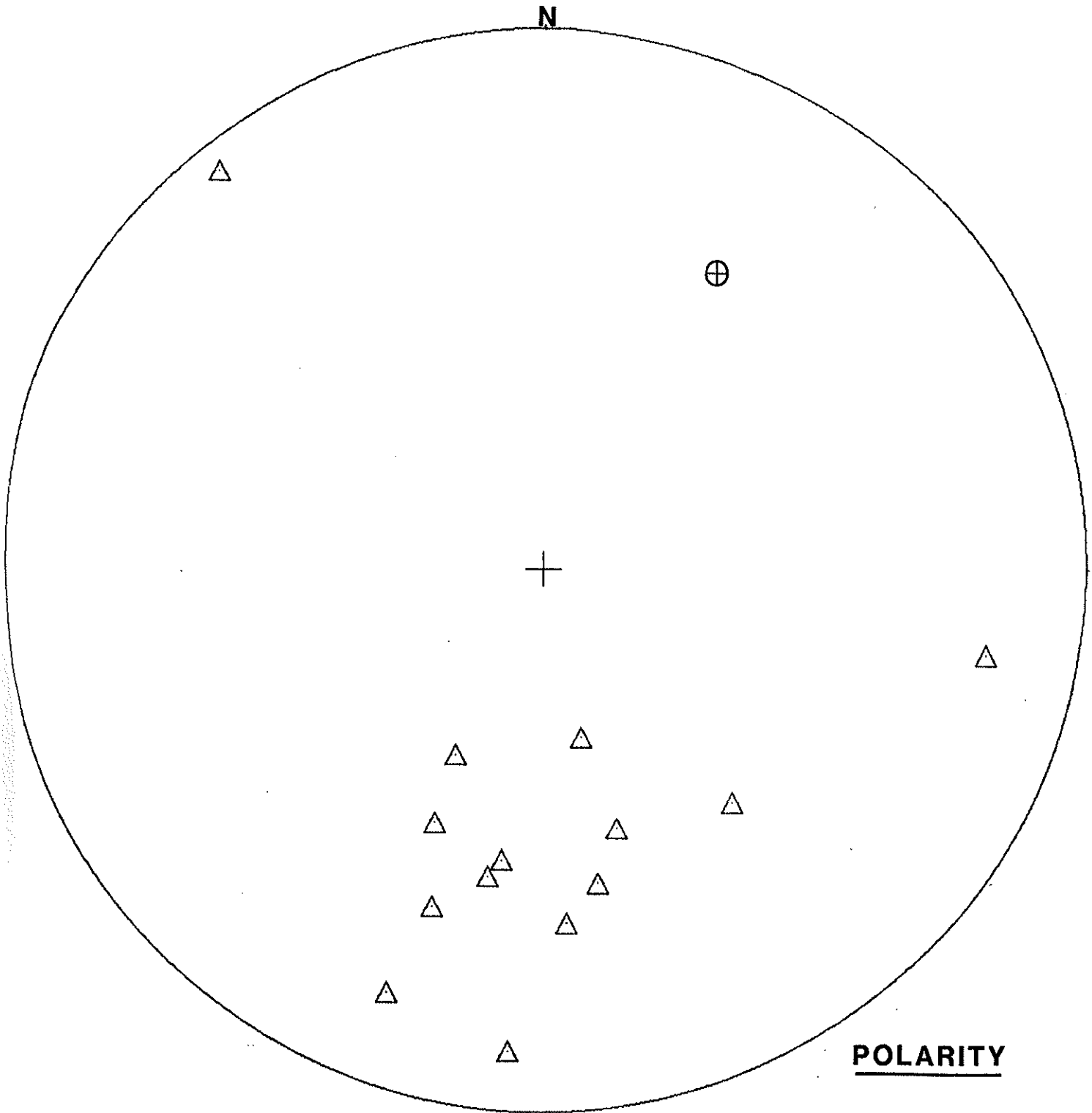
1600' gray brown
silt with many
molluscs and
vertebrate
fossils

fine sand

Clark Mills Dam Site

CLARK MILLS DAMSITE

**EQUAL AREA POLAR PROJECTION of MAGNETIZATION
for 15 SITES in FOSSILIFEROUS SILT**
(Demagnetized A.F. at 100 Oersteds)

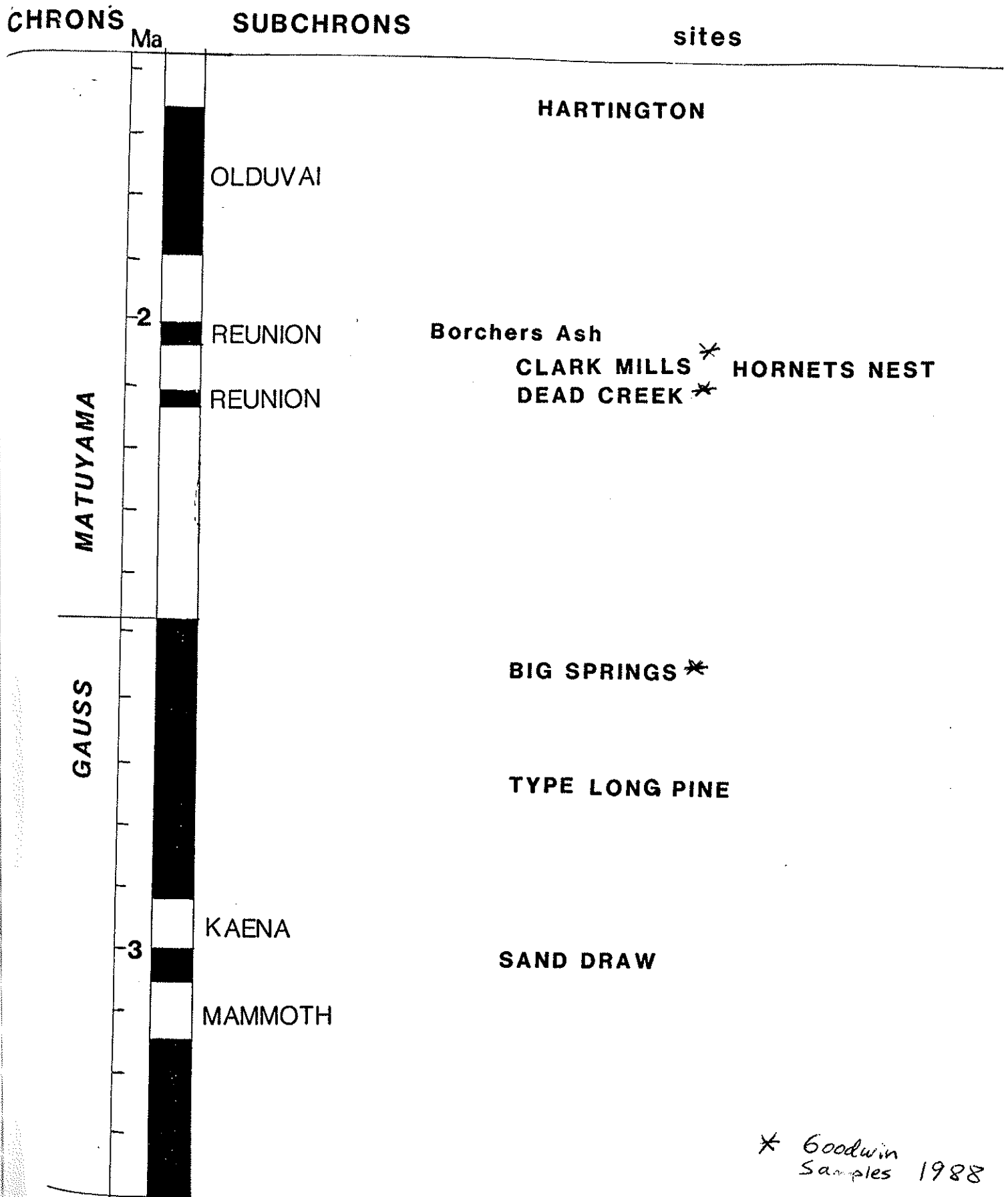


POLARITY

⊕ = NORMAL

△ = REVERSED

PRELIMINARY CORRELATION OF LATE PLIOCENE SITES IN NORTHEAST NEBRASKA WITH PALEOMAGNETIC TIME SCALE



FISHES CLARK MILLS LOCAL FAUNA

LATE BLANCAN, KNOX COUNTY, NEBRASKA

LEPISOSTEIDAE

Lepisosteus cf. L. osseus LONGNOSE GAR

HIODONTIDAE

Hiodon sp. GOLDEYE/MOONEYE

SALMONIDAE

Gen. et sp. indet. TROUT

ESOCIDAE

Esox cf. E. lucius NORTHERN PIKE

Esox cf. E. masquinongy MUSKELLUNGE

CYPRINIDAE

Hybopsis cf. H. gracilis FLATHEAD CHUB

Notropis spp. SHINERS

Pimephales sp. MINNOW

Rhinichthys sp. DACE

Semotilus atromaculatus CREEK CHUB

CATOSTOMIDAE

cf. Catostomus sp. SUCKER

ICTALURIDAE

Ictalurus sawrockensis EXTINCT CATFISH

Ictalurus cf. I. punctatus CHANNEL CATFISH

Noturus (Rabida) sp. MADTOM

CENTRARCHIDAE

Lepomis serratus EXTINCT SUNFISH

Lepomis sp. SMALL SUNFISH

Ambloplites sp. ROCKBASS

PERCIDAE

Stizostedion vitreum WALLEYE

SCIAENIDAE

Aplodinotus grunniens FRESHWATER DRUM

CLARK MILLS DAMSITE

Mollusca determined by H.L. Pierce April, 1989

GASTROPODS

c.f. Succinea
Valvata, c.f. V. lewisi
V. tricarinata
Helisoma trivolvis
Gyraulus parvus
Promenetus exacuus
P. umbilicatellus
Omalodiscus pattersoni
Planorbula armigera
Lymnaea humilis
L. palustris
L. haldemani
Physa gyrina
Acroloxus coloradoensis

BIVALVES

Pisidium, c.f. P. casertanum
Sphaerium, c.f. S. simile*
S., cf. partumeum

Ostracodes

Large candonid

PLANT

Chara, oogonia
?Seed hulls

Environment: Cool, spring fed pond or stream, well vegetated, sand to fine gravel bottom, adjacent more stagnant water. Nearly all species found are presently living in the ponds at Fort Niobrara. Probable maximum summer water temperature less than 15°C. Lack of terrestrial taxa suggests that shoreline may be remote.

The Gompert Gravel Pit exposes outwash sand and gravel capped by glacial till. The gravel rests on gray silt similar to the silt at Clark Mills Damsite. Late Blancan vertebrate fossils have been obtained from the gravel, but too few fossils have been obtained from the silt to provide a definitive age assignment. Gray silty till with prominent calcareous fracture fillings and oxidation halos can be seen above the outwash.

Road cuts on the north side of Hwy 84 near the pit suggest that a thin cover of silty pink colluvium with western sourced gravel rests on Cretaceous shale and Ogallala(?) sandstone. Sand and gravel with interbedded lenses of silty gray till or glacial debris-flow sediment rest on the colluvium. This sequence probably underlies the sequence exposed in the gravel pit, but given the present exposures, this is only an assumption.

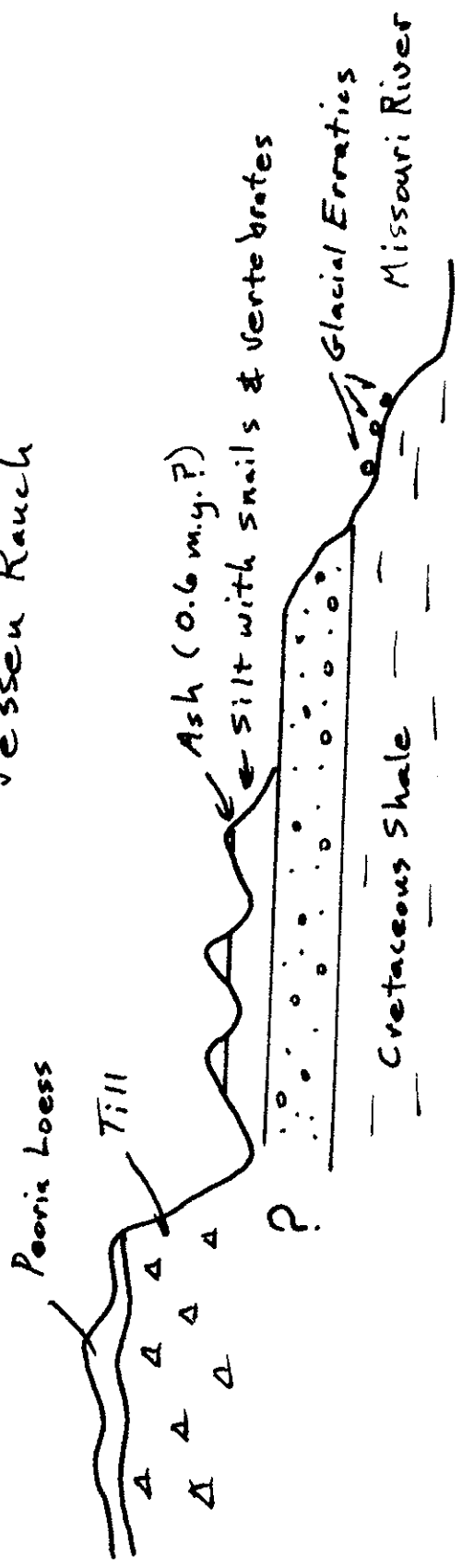
STOP 4 (5:00 P.M.) SANTEE JUNCTION, Center of the NW 1/4 Sec 17
T32N R5W (Springfield S.D.-Nebr. 7.5 min Quad).

Road cuts along Hwy S54D to Santee expose sand and gravel of a dissected Late Pleistocene terrace of the Missouri River at the mouth of Bazile Creek. Rancholabrean (Late Pleistocene) vertebrate fossils have been recovered from these sediments. Gravels of similar age are found along Verdigre Creek and its tributaries. These relationships suggest that the major drainageways in this region were in place during the last glacial cycle (Wisconsinan Stage). Aggradation in the Missouri Trench took place to an elevation of at least 1400 feet.

STOP 5 (5:45 P.M.) JESSEN RANCH GRAVEL PITS, NE 1/4 Sec 28 and
SE 1/4 Sec 21 T33N R4W (Santee 7.5 min Quad).

Late Pliocene/Early Pleistocene gravels rest on Cretaceous shale and are overlain by silts that contain the type O Pearllette (Cudahy) ash that has been dated at about 0.7 million years. Micro vertebrate and molluscan fossils have also been sampled from the silts. The ash appears throughout this area at an elevation of approximately 1640 feet. Glacial till is exposed along the road to the gravel pits between 1700-1800 feet. It's not clear if the fossil-bearing silts lie stratigraphically under the till or if they rest on an erosional surface that postdates till deposition and that is related to the erosional scarp south of the silt and gravel exposures. If the latter relationship is the correct one, then the till is older than the ash and the Cudahy fauna. This would also constrain formation of at least part of the Missouri Trench to Late Kansan time or earlier. In the lower gravels, pink and orange quartzites and a variety of plutonic rock types are mixed with locally derived green Ogallala quartzites, Cretaceous shale, and orange concretions from the shales.

Generalized Stratigraphic Relationships at the Santee Gravel Pits
Jessen Ranch



SUPPER (7:00 P.M.) BOGNER'S STEAKHOUSE, Crofton, NE.

Overnight accommodations are left to the individual. There is a municipal campground in Crofton. Lewis and Clark Lake is nine miles north of Crofton. There is a State Park on the Nebraska side, and an entry permit is required. A motel is associated with the steakhouse. They usually have only one or two rooms available (402 338-4626). A number of motels are located in Yankton, SD, fifteen miles north and east of Crofton. The only one listed by AAA Motor Club is the Lewis and Clark Resort (605 665-2680), but a number of motels are located in Yankton. If you plan to stay at one, call ahead and secure a guaranteed late arrival.

SUNDAY, MAY 7

BREAKFAST: Arrangements are left to the individual.

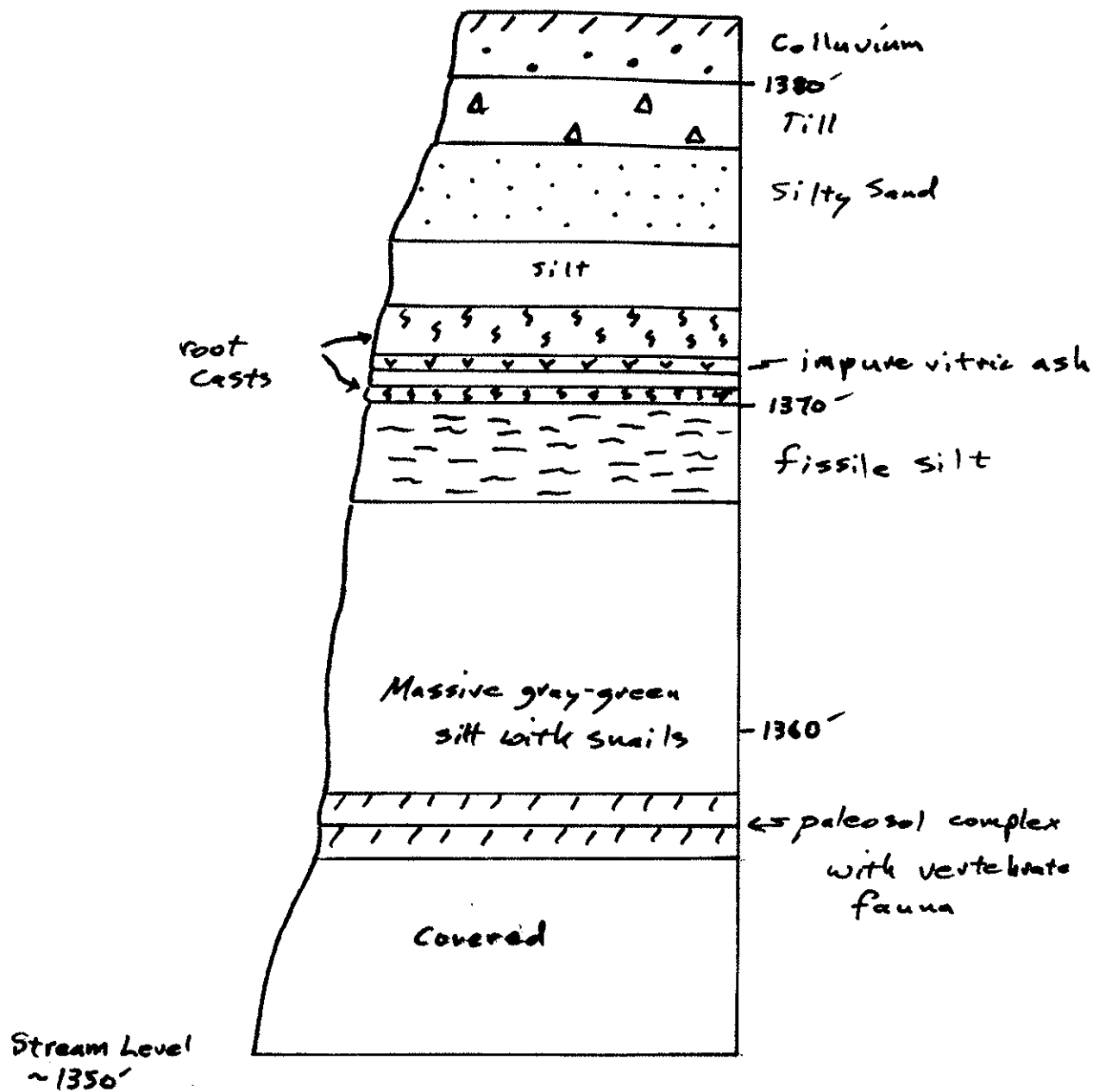
We will meet at 8:30 a.m. at the intersection of State Highways 12 and 121 in Crofton.

STOP 6 (9:00 A.M.) GRAVEL PIT on Weigand Creek, NW 1/4 Sec 12 T32N R3W (Tabor Southeast, S.D.-Nebr. 7.5 min Quad).

A very well developed paleosol formed on slope colluvium that rests on fossil-bearing sand and gravel. Peoria Loess caps the sequence.

STOP 7 (10:15 A.M.) BACKUS SAND & GRAVEL PIT, Hartington, NE,
Center Sec 2 T30N R1E (Hartington 7.5 min Quad).

Till overlying sand and gravel. Spectacular exposures of scour-and-fill structures are enhanced by black manganese dioxide coatings on the gravel. Early Pleistocene (Early Irvingtonian Land Mammal Age) vertebrate fossils are present at this site. The sequence is younger than the ones at the Nickels and Clark Mills sites. It represents ice-marginal deposition during an early, but not the first ice advance into northeast Nebraska. Till derived (?) armored mudballs are present in the gravels. Some microvertebrates and molluscs have been recovered from silt lenses within the gravels.

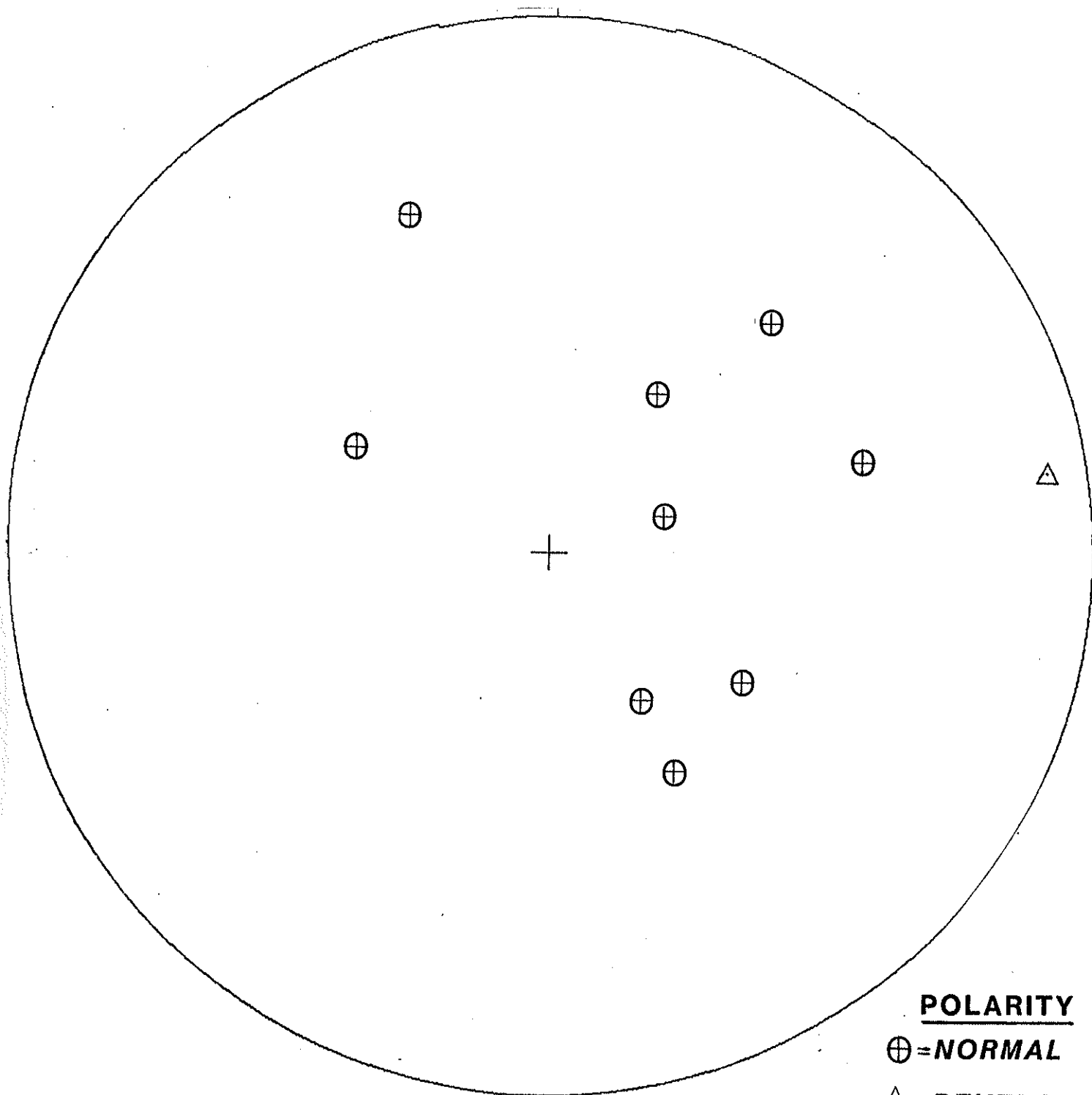


Dead Creek Section

DEAD CREEK

EQUAL AREA PROJECTION of MAGNETIZATION for 10 SITES in FOSSILIFEROUS SILT

(Demagnetized A.F. at 100 Oersteds)



POLARITY

⊕ = NORMAL

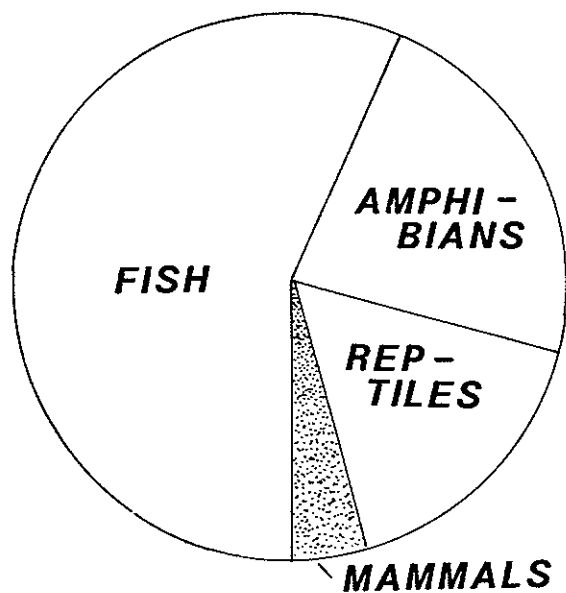
△ = REVERSED

BULK FAUNAL ABUNDANCE

Vertebrates determined by M.R. Voorhies, 1989

CLARK MILLS

Kx 143



ident. elements: 5,000

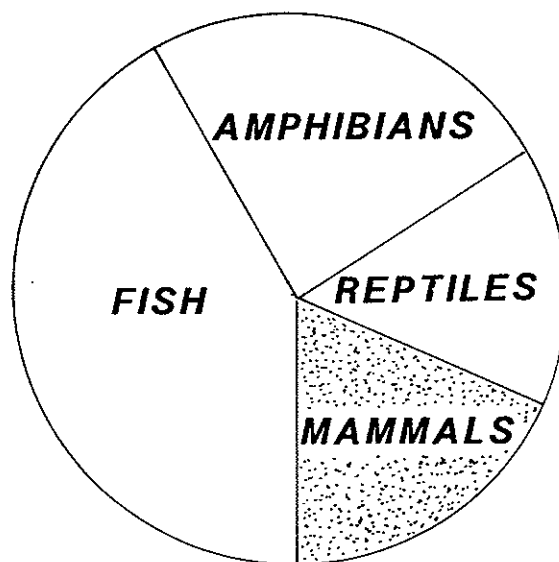
(derived from approx. 1000 kg. bulk sediment sample)

Environment:

LACUSTRINE

HORNETS NEST

Kx 127



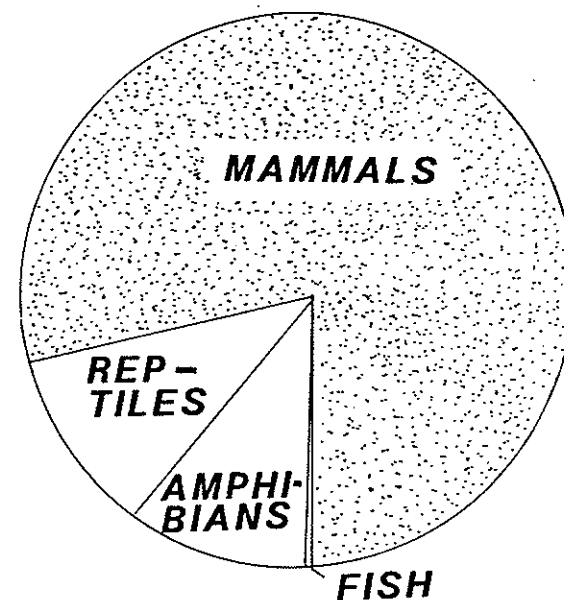
20,000

(derived from approx. 15,000 kg. bulk sediment sample)

FLUVIAL

DEAD CREEK

Cd 104



1,000

(derived from approx. 500 kg. bulk sediment sample)

EOLIAN

STOP 8 (11:15 A.M.) DEAD CREEK STREAM CUT on the D. Provancha farm, SE 1/4 SW 1/4 Sec 32 T31N R2E (Coleridge 7.5 min Quad).

Eolian silts with vertebrate burrows near the base of the exposure and an ashy zone near the top of the silts. Molluscs and vertebrate fossils have been collected from the site. They indicate a Late Pliocene (Late Blancan) age. Many of the vertebrates are indistinguishable from the Clark Mills and Nickels Pit sites. The sediments are of normal magnetic polarity; therefore, they cannot precisely correlate with the Clark Mills sediments. Two normal polarity events (the Reunion Events) occurred just before and just after 2 million years ago. Dead Creek sediments were probably deposited during one of these events. The microvertebrates indicate a cold upland environment at the time of silt deposition. The Dead Creek site is older than the sediments just seen at the Backus Pit.

This stop ends the formal portion of the trip. You may wish to return directly home or take the opportunity to do a bit of sightseeing. The powerhouse at Gavins Point Dam has an interesting tour for instance.

POST SCRIPT: The Coleridge Ash (1.2 m.y.) can be seen in a poorly exposed road cut several miles west of Coleridge, NE. on a section road at an elevation of about 1610 feet. This ash appears to rest above sediments of the Backus Pit. It is concluded that the bulk of the glacial sediments in the Hartington region are older than the Coleridge Ash.