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The Sidney Gravel and Kimball Formation, Supposed Parts of the Ogallala Group (Neogene), Are Not Objectively Mappable Units

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Abstract

In the 1930's, G. L. Lueninghoener and A. L. Lugn prepared geologic maps of several counties, including Kimball and Cheyenne in the southern Nebraska Panhandle, for the Nebraska Geological Survey. Rock units designated as the Kimball Formation and the underlying Sidney Gravel were shown on these maps. Studies by Swinehart (1974), Breyer (1975, 1981), and Diffendal (1985) demonstrated that these units could not be defined in several areas in western Nebraska. Results of this study show clearly that the Kimball Formation and Sidney Gravel cannot be traced for more than a few kilometers from their type areas.

The Kimball Formation does not have a base that can be traced with confidence away from the type area south of Kimball. No gravel sheet (Sidney Gravel) occurs at this locality beneath the Kimball. Furthermore, at least the lower two of the three gravel lithologies supposedly typical of the formation occur repeatedly throughout the Ogallala sequence.

The discontinuous remnant sand and gravel at the type exposure of the Sidney Gravel have the characteristics of the material originally described by Lugn (1939a). To the north, across an intermittent stream, the lower of two sand and gravel bed sequences separated by caliche sandstones is at the same elevation as the type Sidney and could be the same unit. Farther to the north and east of the type exposure, several sand and gravel bed sequences are laterally and vertically discontinuous. Each one could be equivalent to the original Sidney, but none can be traced back to the type area. Complex geometries and possible post-Ogallala deformation also make correlations questionable.

Arbitrarily designating rocks as part of the Kimball Formation if they occur high in a local section, as Lueninghoener and Lugn did, is poor practice. Designating any sand and gravel in the Ogallala sequence as the Sidney or always assigning the stratigraphically highest sand and gravel observed at each exposure in the southern Panhandle to the Sidney has resulted in miscorrelations. The formations as originally defined are not mappable. Usage of the terms should be abandoned, and the term Ash Hollow Formation should be used in their place.

Introduction

Swinehart (1974), Breyer (1975, 1981), and Diffendal (1985) concluded that the Sidney Gravel and Kimball Formation, originally described by Lugn (1939a) as distinct lithostratigraphic units of the Ogallala Group, are not objectively definable units in the areas that they studied in western Nebraska. However, some workers have continued to treat the Sidney and Kimball as valid stratigraphic units (Tanner, 1975; Schultz, 1981; Gutentag and others, 1984; Skinner and Johnson, 1984, p. 294-295). These differences regarding Ogallala stratigraphic relationships are basically due to the adherence by some workers to a simple depositional model of the Ogallala developed first in the 1920's and 1930's and the adherence to a more complex model developed by several workers, including this author, during the last 10 to 15 years (fig. 1).

Neither Breyer (1975, 1981) nor Diffendal (1985) attempted to trace the Sidney Gravel and the Kimball Formation from their type areas to other areas in western Nebraska. Similarly, other authors who have continued to use these formation designations may not have attempted to trace the Sidney Gravel and Kimball Formation out of their type areas. If these rock units could be objectively defined and traced region-

ally, then the existence of the two formations would be demonstrated. The purposes of this report are to relate the historic development of the concepts of the Sidney Gravel and the Kimball Formation since the 1930's and to describe the results of recent attempts by the author to characterize the two formations and to trace them away from their type areas.

The Cenozoic paleogeography of western Nebraska has recently been described in detail by Swinehart and others (1985). The Miocene Ogallala Group south of the North Platte River consists of an older, unnamed fluviatile unit and the Ash Hollow Formation, which is also largely fluviatile in origin. The older formation consists primarily of silt, sand, and gravel derived from erosion of older Tertiary sedimentary rocks of the High Plains, while the Ash Hollow deposits are in the same general grain-size range but consist principally of metamorphic and igneous debris derived from the Rocky Mountains in Wyoming and Colorado. Both units are complex multiple cut-and-fill sequences that contain diatomites, tuffs deposited in water, and many discontinuous calcium carbonate-rich beds referred to as caliche or calcrete. These latter features crop out over only a few sections at most and may be of ground-water origin in some cases, but no workers have yet offered evidence supporting this origin. Pre- and post-Ogallala folds and pre-Ogallala faults affected

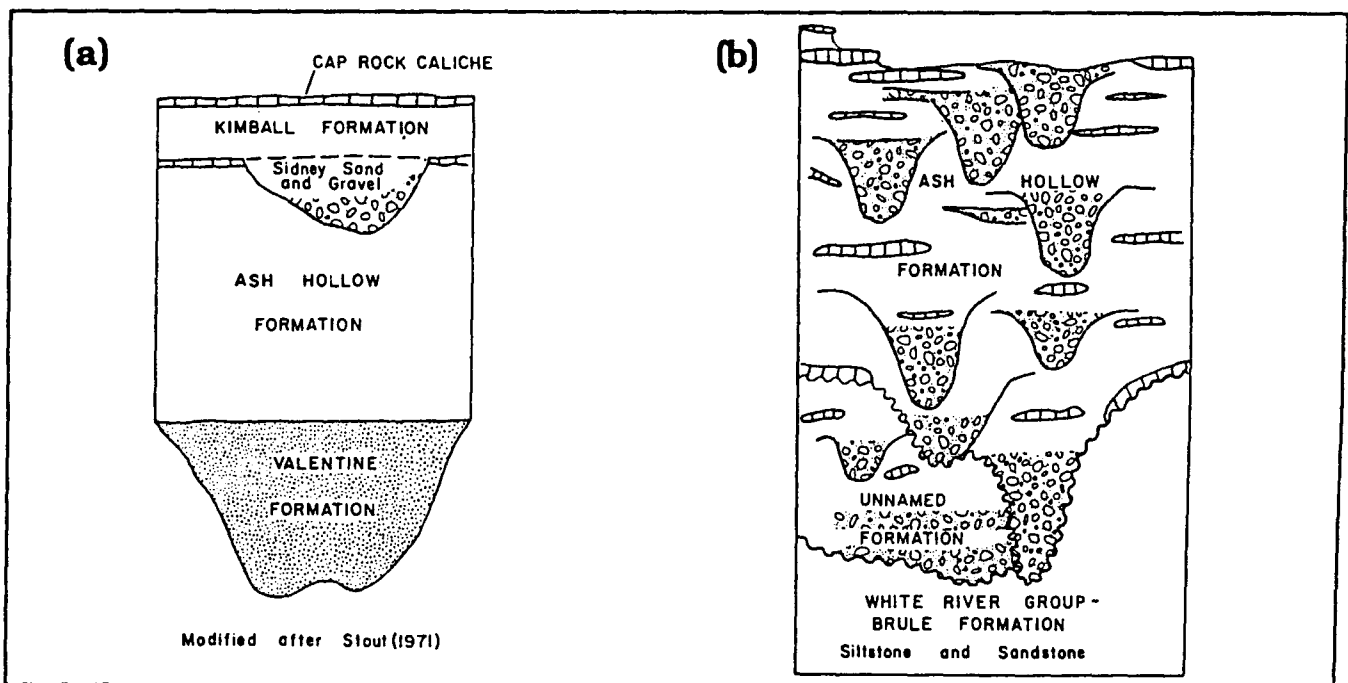


FIGURE 1. Comparison of (a) simpler model (modified after Stout [1971b]) of Ogallala deposition proposed by workers in the 1920's and 1930's with (b) the model supported by field data presented in this paper.

western Nebraska, making complex stratigraphic relationships even more difficult to interpret correctly.

Previous Work

N. H. Darton (1899a, b; 1903a, b, c; 1905) originally defined and later described and mapped the Ogallala Formation. Darton (1899a, b) spelled the name of the formation "Ogallala," but in later publications he changed the spelling to "Ogalalla." In Darton (1920) he used both spellings, but in Darton (1928) he reverted to the original spelling. Darton did not attempt to subdivide the Ogallala in these works.

In 1933, G. C. Lueninghoener, a graduate student at the University of Nebraska, conducted field work on the Ogallala in western Nebraska under the supervision of A. L. Lugn. A thesis (Lueninghoener, 1934) based on this field work and on laboratory study of samples collected in 1933 did not attempt to subdivide the Ogallala Formation.

As reported earlier (Diffendal, 1985), Lueninghoener (personal communication, 1983) related that he and A. L. Lugn produced geologic maps of the counties in the southern Panhandle of Nebraska, probably in 1933 or 1934. The original undated and unpublished maps are on file at the offices of the Conservation and Survey Division of the University of Nebraska-Lincoln. The Ogallala on these maps has been subdivided into Ash Hollow-Valentine, Sidney, and Kimball units.

The first published indication that a traceable rock unit in the Ogallala of the southern Nebraska Panhandle could be defined occurred in Lugn (1935, p. 163, 200). Specifically, Lugn stated that "the blow out depressions on the Cheyenne table and south of the Lodge Pole Valley are eroded in the upper part of the Ogallala formation, and their depth of about 40 feet is limited by a bed of coarse heavy gravel in the Ogallala formation. This gravel layer is from 15 to 50 or more feet thick and occurs widespread in southwestern Nebraska and in northeastern Colorado" (Lugn, 1935, p. 163). He also said that "there is at least one very extensive Tertiary bed of sand and gravel in the Ogallala formation. It occurs high in the formation and is widely distributed in Banner, Kimball, Cheyenne, Morrill, Garden, Deuel, Keith, Perkins, and a few other counties in the western part of the state" (Lugn, 1935, p. 200).

Lugn (1938a, p. 225) related that in March of 1936 he and other geologists had met and agreed

to redefine the Ogallala as a group composed of four mappable formations: the Valentine, Ash Hollow, Sidney Gravel, and Kimball. He also claimed (Lugn, 1938a, p. 225) that the formations had been mapped in detail and that the maps and a report would be published soon. An unpublished geologic map of southwestern Nebraska prepared by Lugn (1938b) is on file in the offices of the Conservation and Survey Division. The map, reproduced in part in figure 2, shows units of the subdivided Ogallala and gives a clear indication of which rocks Lugn believed to belong to each Tertiary unit exposed in the area. From that time to the present, most of the published works on the Ogallala of western Nebraska noted the presence of the Kimball Formation, and a few authors continued to designate a Sidney Gravel.

Lugn (1939a) expanded on the descriptions of the formations in the Ogallala, shortened the name Sidney Gravel Formation to Sidney Gravel, and provided a map dated 1938 showing the distribution of Tertiary rock units in western Nebraska (fig. 3). On the map the Kimball is combined with the Sidney and the Ash Hollow is combined with the Valentine because of the scale used. The initial text statement on the Sidney Gravel (Lugn, 1939a, p. 1261) is essentially the same as part of the earlier quote from Lugn (1935). Furthermore, Lugn (1939a, p. 1261) went on to say that "the Sidney Gravel in the main is a quite widespread sheet-like complex of channel deposits, but there are small areas where it is not developed; and, in such places, the Kimball formation rests directly on the Ash Hollow formation commonly with apparent lithologic continuity." On the next page he seems to have changed his mind about the presence of units he recognized on his map of southwestern Nebraska (Lugn, 1938b) by saying that the Sidney is not fully differentiated from Pleistocene terrace gravels "in southern Garden, Deuel, and perhaps in parts of Keith counties." In another article, Lugn (1939b, p. 874-875) briefly discussed the Sidney Gravel using words similar to those used in 1935 to describe the unnamed gravel occurring in the upper part of the Ogallala.

Condra and Reed (1940) lumped the Kimball and Sidney together on their geologic map of Nebraska and showed a distribution for them in the southern Panhandle essentially like that shown by Lugn (1939a), except in western Keith County. Later, Condra and Reed (1950) published a revised geologic map of Nebraska. The Ogallala part of it was essentially unchanged from the 1940 edition.

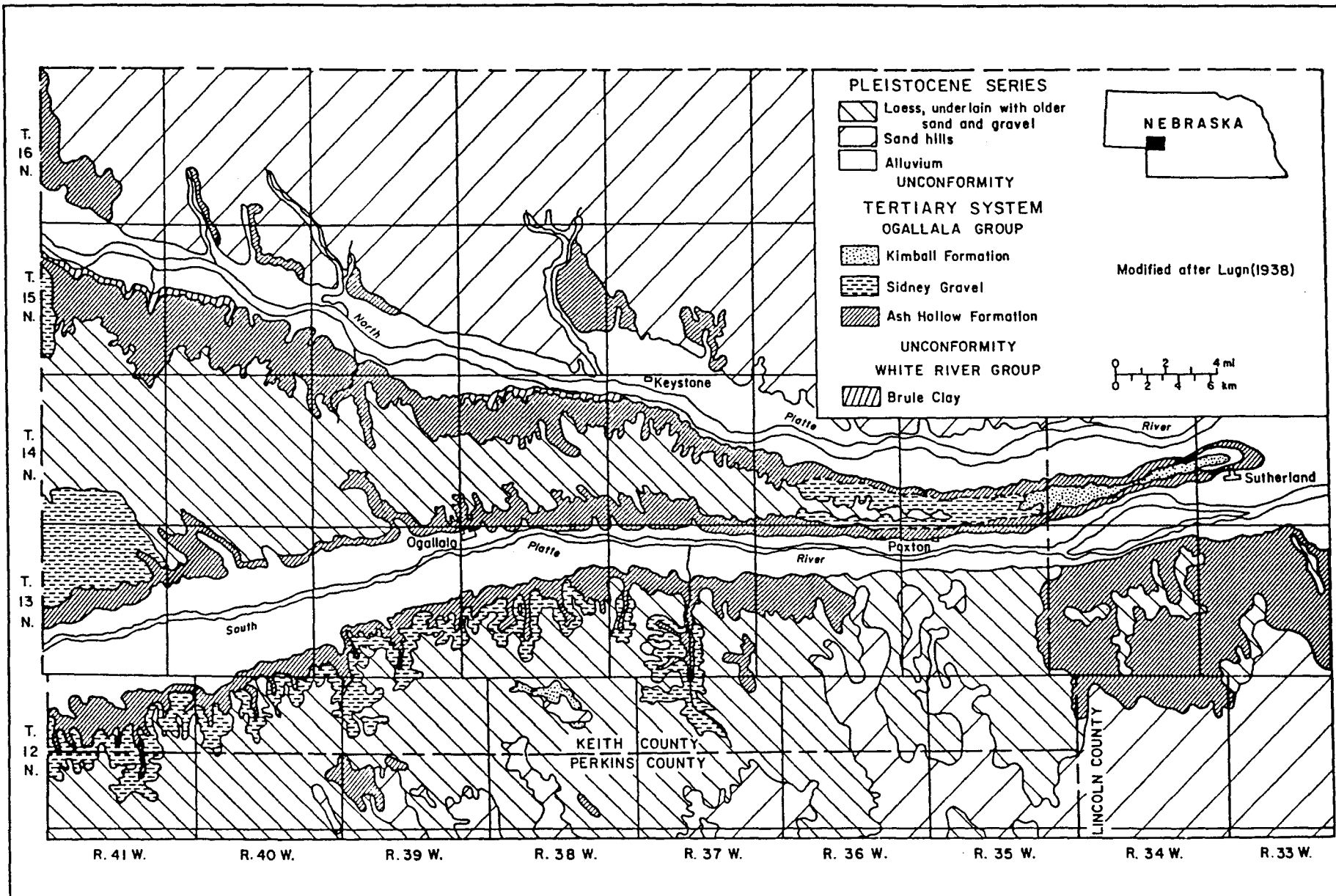


FIGURE 2. Part of geologic map of southwestern Nebraska prepared by A. L. Lugn (1938b).

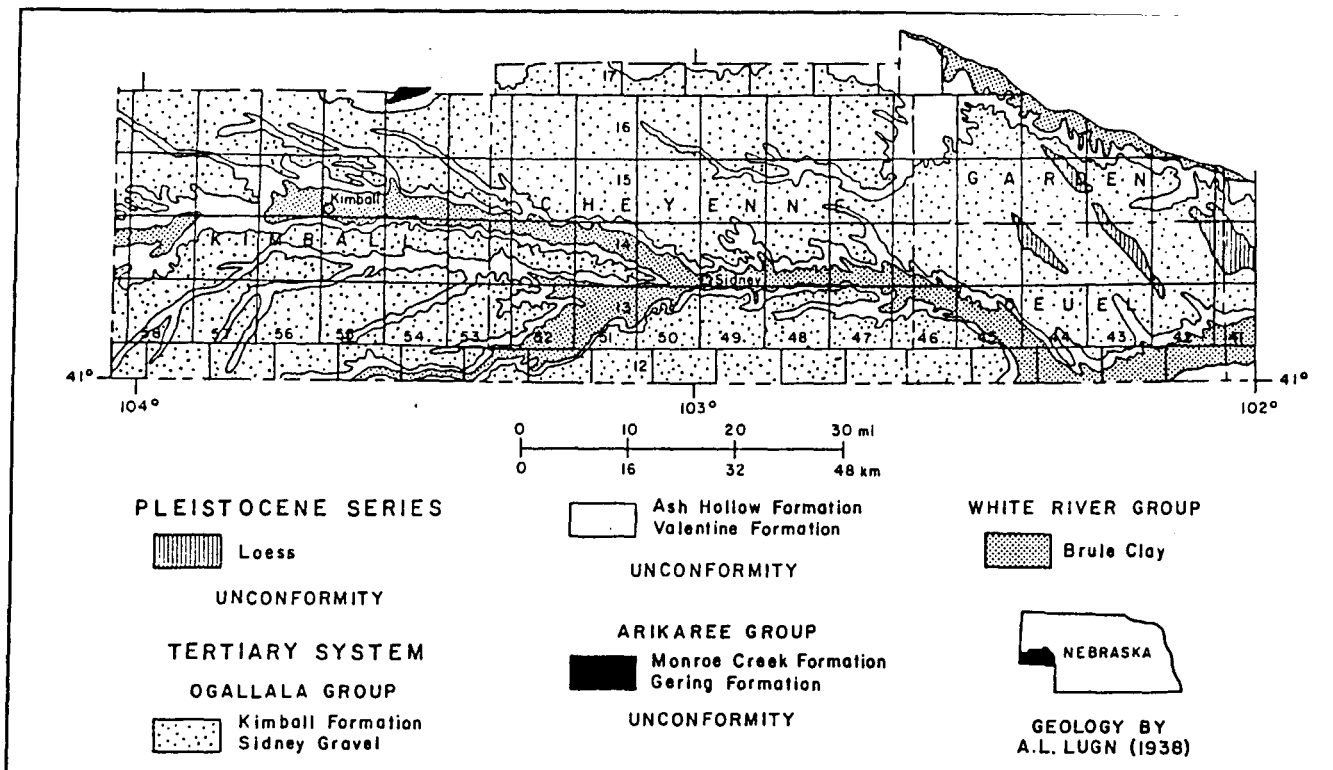


FIGURE 3. Part of geologic map of the Nebraska Panhandle prepared by A. L. Lugn (1939a).

Schultz and Stout (1940) referred to the distinct types of fossil mammals found in the Sidney and Kimball sediments. Schultz and Stout (1941, p. 15-16) reported on the Sidney, Kimball, and Oshkosh Locality A sites and reprinted the map from Lugn (1939a).

Condra and Reed (1943, p. 10-11) described the units of the Ogallala Group. They changed the name of the Kimball to the Kimball Limestone Formation and claimed that the Sidney Gravel was not widely persistent even though it was said to occur in "southwestern Nebraska, northeastern Colorado and at places in northwestern Kansas."

Schultz and Stout (1948, p. 555), without explanation, changed the definition of these units by stating that "the youngest Ogallala sediments of the Great Plains constitute the Kimball formation with the Sidney gravel and silt member at the base locally unconformable on older beds, but generally affording a transition from the latest Ash Hollow sand and gravel channels." They referred to the unnamed portion of the Kimball Formation above the Sidney as the "upper part" of the Kimball (Schultz and Stout, 1948, p. 557) and listed fossils found in both parts of the Kimball.

Lugn and Lugn (1956) returned to the use of the name "Sidney Gravel formation" but did not elaborate further on the nomenclatural and con-

ceptual problems that had come about since 1939.

Schultz and Stout (1961, p. 9, 10, 52, 54) briefly commented on the Kimball Formation. They designated a Sidney Member and an upper member.

Lugn (1962, p. 63, 65-66) once again briefly discussed the Sidney and Kimball. He said that "blowout depressions in certain local areas of southwestern Nebraska, northeastern Colorado, and western Kansas have been limited in depth to about 40 feet or even less by the presence of the coarse channel fills of Sidney gravel where they occur. The Sidney gravel is from 15 to 50 feet thick locally and has limited the depth of eolian erosion, because most of the material is too coarse to be much handled or reworked by the wind."

None of the previously mentioned accounts contain measured sections and descriptions of either the Kimball Formation or the Sidney Gravel. D. C. Kent (1963) may have been the first to formally present such sections and descriptions. This work, done under the supervision of C. B. Schultz and T. M. Stout with help from G. C. Lueninghoener and A. L. Lugn, showed more clearly than any previous study how difficult it is to subdivide the Ogallala. It is impossible to tell which formations or parts of formations were measured by Kent

because formation names are not included in either the graphic sections or written descriptions, but Kent (1963, p. 17) did say that he made step trenches to expose the Kimball Formation, so it is possible that the entire rock mass he described is the Kimball (in the sense of Schultz and Stout, 1948). Kent (1963, p. 1) further illustrated the difficulties of subdividing the Ogallala by assigning a volcanic ash bed to the upper part of the Kimball and then later (1963, p. 37) describing the "Sidney gravel channel which cuts through the [same] ash and underlying beds."

Mention of the Sidney and Kimball was made by Stout (1965, p. 63, 68). No significant new information about the units was given in this work.

Schultz and others (1970, p. 26) claimed that the Kimballian provincial time term is based on vertebrate fossils collected from the type area of the Kimball Formation in Kimball and Cheyenne Counties, and from other areas in southwestern Nebraska. However, there are no published records of vertebrate fossils collected from either of these sites.

Stout (1971a, b) and Stout and DeGraw (1971) prepared measured sections of the Ogallala with descriptions and an annotated road log, respectively. Stout's measured sections are the first that show clearly his concept of the Kimball and Sidney units of the Ogallala. Stout reported the Kimball Formation at Dalton, Greenwood Canyon, Oshkosh, Ash Hollow, Cedar Point, and Cambridge, whereas the Sidney Sand and Gravel Member was said to occur at these localities, except at Dalton and Cedar Point. In all cases, the term Sidney Sand and Gravel Member was used to designate the first gravel encountered below the top of each stratigraphic section.

Schultz and Martin (1977, p. 290) discussed the Kimball Formation (of Schultz and Stout, 1948) and claimed that the upper part of the Kimball is unfossiliferous in Nebraska. However, Schultz and Stout (1948) and Kent (1963, p. 117) reported vertebrate fossils from areas assigned to the upper Kimball.

Schultz (1981, p. 59) said Kimball vertebrate fossils occur only in the lower and middle parts of the formation. He referred to Schultz and Stout (1948) for support of this assertion.

The first suggestion of the misapplication of the terms Kimball Formation and Sidney Gravel came when Reed (in Condra and Reed, 1959, unnumbered page following title page) reduced the Ogallala Group to formational rank and recognized three members, the Valentine, Ash Hollow, and Kimball. He did not offer reasons

for the change in unit rank or for the abandonment of the term Sidney Gravel.

Objections to the idea that the Kimball and/or Sidney are valid lithostratigraphic units have been published at least five times since the mid-1970's. Swinehart (1974) said that he could not correlate the two units in southwestern Nebraska. Breyer (1975, 1981) suggested that the terms Sidney and Kimball should be abandoned because they are not mappable units. Macdonald and Macdonald (1976) discussed the problems of biostratigraphic and lithostratigraphic correlations of the Kimball and Kimballian Provincial Age and said that they should be reassessed. Finally, Diffendal (1985) offered evidence that the Sidney and Kimball could not be recognized in southern Banner County, Nebraska, and that the terms should be abandoned. None of these workers reported in detail on the type areas of these units, so criticism could be levelled that they had misinterpreted the areas they had studied. This paper reports the results of studies at the type areas and supports the conclusions previously cited concerning the invalid application of the two units.

Results of Investigation

To test the existence and mappability of previously defined, but debated, lithostratigraphic units such as the Kimball Formation and the Sidney Gravel, one should first examine original documentation of the units and then visit the sites to see if it is possible to reproduce the original work. In the cases of the Kimball and Sidney, specific typical exposures were designated by Lugn (1939a), and county geologic maps showing the areas covered by the two units were prepared at a scale of 1:63,360 by Lueninghoener and Lugn (1933-1934? a, b). A very clear picture of the original concepts of the formations can be gained from comparison of the maps and the published work.

The problem of whether Lugn was referring to the same units in 1939 as those he had mapped earlier with Lueninghoener can be easily resolved. As pointed out previously, Lugn prepared a 1:1,000,000-scale geologic map of the Nebraska Panhandle (Lugn, 1939a) in which the Kimball and Sidney are undifferentiated (fig. 3). If the Kimball-Sidney contact with the Ash Hollow-Valentine at the type areas of the

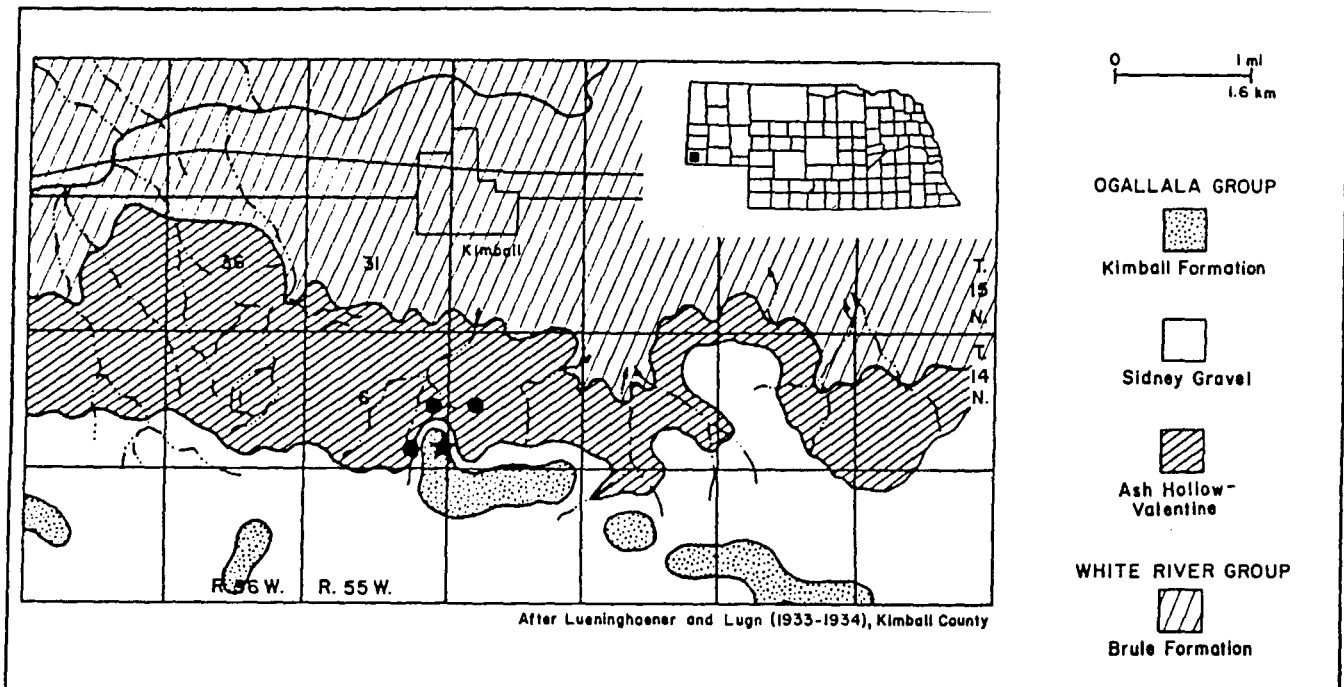


FIGURE 4. Part of geologic map of Kimball County prepared by G. C. Lueninghoener and A. L. Lugn (1933-1934?a). Star is location of typical exposure of Kimball Formation. Dots are locations on D. Kent's measured sections.

two formations on this map (fig. 3) is compared with the same contact line shown on the maps of the Kimball area (fig. 4) and the Sidney area (fig. 5) prepared earlier, a very close correspondence can be seen in the positions of the contacts. It seems likely that the units Lueninghoener and Lugn mapped in the early 1930's and the units described and mapped together in 1939 were the same.

Lugn (1939a, p. 1262-1263) described the Kimball, where fully developed, as generally consisting of three beds ranging in aggregate thickness from 25 to 50 ft (7.6 to 15.2 m). The Kimball was said to rest "with apparent conformity on the Sidney Gravel at most places." Lugn then designated a type exposure of the formation "in the vicinity of the adjoining corners of sections 5, 6, 7, and 8, T.14N., R.55W." (location shown on fig. 3). Kent (1963, p. 24, 144-147) reported a gravel lens somewhere in unit 1 of his section IA but went on to say that sand is the predominant grain size in the Kimball. It is clear from Kent's work that no gravel sheet occurs at the type exposure of the Kimball Formation, even though Lueninghoener and Lugn mapped the Sidney Gravel at that site (fig. 3). It is also clear from Kent's work that Lugn's description is a very general one, because unit descriptions and thicknesses measured by Kent vary greatly from those of

Lugn. Furthermore, Kent (1963) did not designate a base for the Kimball at the type area, and no base has ever been proposed that is equally agreeable to all workers and objectively definable and traceable. The "grayish and pinkish 'grit' or caliche sandstone, composed of fine to coarse sand, with small granule pebbles in some places" that Lugn (1939a, p. 1263) called the lowest bed of the Kimball is a recurrent sandstone type in the Ogallala of the southern Panhandle and often overlies sand and gravel deposits. The middle fine silty sand described by Lugn also recurs throughout the group. These beds are not marker beds, and they are not blanket deposits.

The Sidney Gravel is as interesting to search for as the Kimball. Lugn (1939a, p. 1261) proposed a type exposure for the unit "located in the high bluff at the north side of the town of Sidney, Nebraska, a few rods west of the elevated water tanks which are a part of the Sidney water supply system." The Sidney was 20 ft (6.1 m) thick at this site and varied from fine sand to cobbles as much as 6 inches (0.15 m) in diameter when Lugn originally studied it. Subsequently, the City of Sidney removed some of the gravel from the type area and replaced the water tanks with standpipes erected in the same general area (C. B. Schultz, personal communication, 1984). Today a thickness of only 5

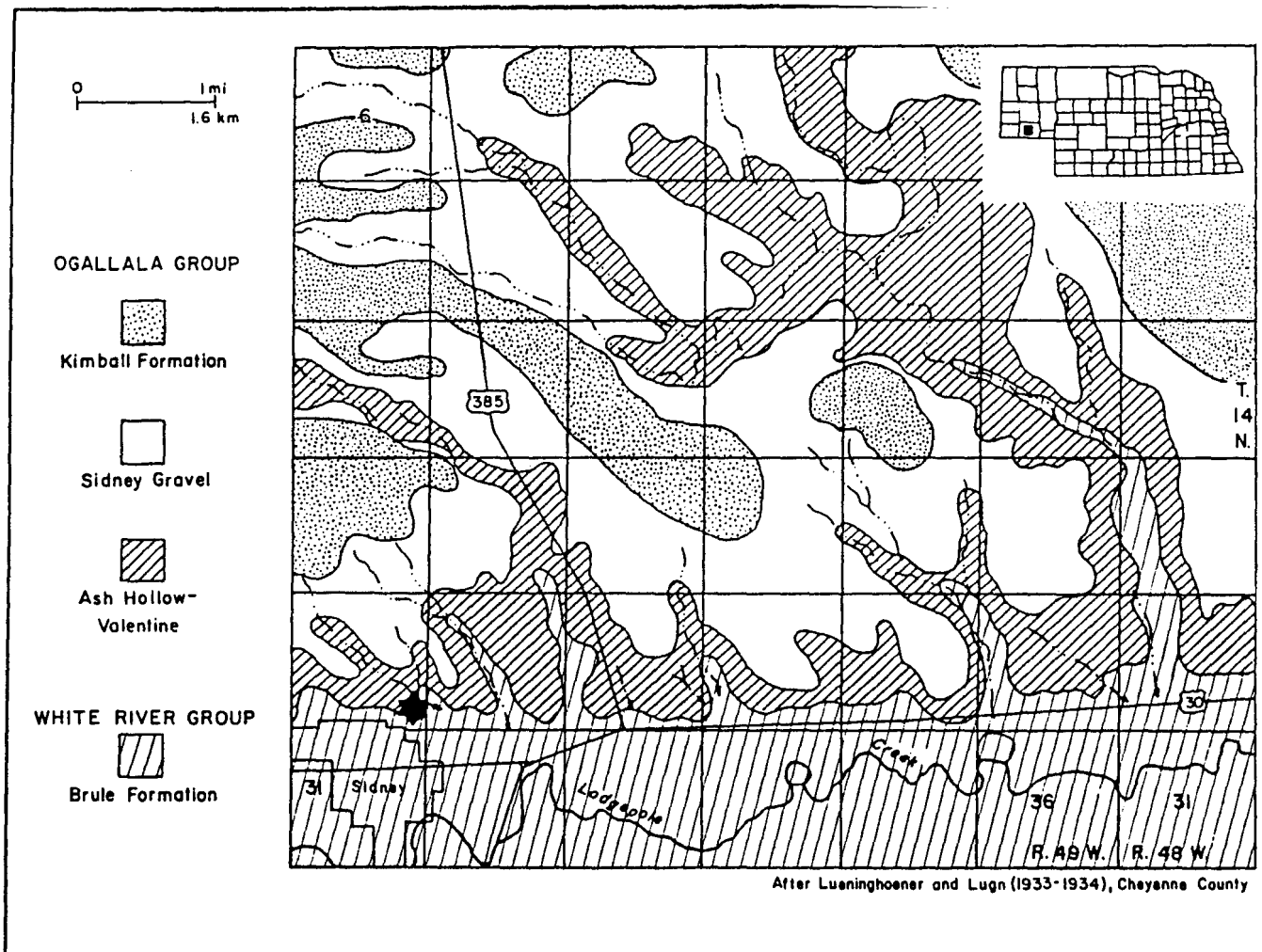


FIGURE 5. Part of geologic map of Cheyenne County by G. C. Lueninghoener and A. L. Lugn (1933-1934?b). Star is location cited by Lugn (1939a) of typical exposure of Sidney Gravel.

to 10 ft (1.5 to 3.0 m) of sand and gravel is present at the site.

Kent (1963) showed a long-distance photograph of the Sidney type exposure, but he seems not to have measured the section or done any other work there. Apparently he did not attempt to trace the Sidney Gravel from the water tank location to other nearby areas where he worked.

It is understandable that no one has spent much time at the Sidney type exposure. Part of the unit had been removed and, even when originally studied by Lugn, the gravel had no other beds above it that could be used to define the formation accurately (T. M. Stout, personal communication, 1984). The type Sidney could even be Quaternary in age and not part of the Ogallala Group at all because the gravel mineralogies of Quaternary alluvium (site LD-19-84) in the area are similar to some Ogallala gravels (table 2) and the Quaternary alluvium is derived from the Ogallala.

Assuming that the type Sidney was a part of the Ogallala Group, I went to the type area and tried to find characteristics of the gravel composition that could be useful for lithologic correlation. Gravel was sampled from the type exposure northeast of Sidney, Nebraska, and from other areas in the Lodgepole Creek drainage basin in Nebraska (tables 1 and 2), including the Quaternary site (LD-19-84) mentioned previously. The lithologies of more than 300 pebbles were determined for each sample (table 2). The large quantity of dark gray quartzite and the small quantity of maroon rhyolite stand out as key elements in the type Sidney gravel composition and indicate that the principal stream carrying these sediments probably headed in the vicinity of the Medicine Bow Range in Wyoming, a site of abundant quartzite (Karlstrom and Houston, 1979; Lanthier, 1979). Pieces of gravel are often coated with a dark mineral, as noted by Lugn (1939a).

TABLE 1. Locations of gravels sampled.*

Site number	Legal description	County
LD-2-84	NW1/4 SW1/4 NW1/4 sec. 19, T13N, R41W	Deuel
LD-9-84	SE1/4 SW1/4 SE1/4 sec. 27, T14N, R49W	Cheyenne
LD-10-84	NW1/4 NW1/4 SW1/4 sec. 6, T13N, R47W	Cheyenne
LD-11-84	NE1/4 NE1/4 NE1/4 sec. 4, T15N, R57W	Kimball
LD-16-84	SE1/4 NE1/4 NE1/4 sec. 20, T12N, R45W	Deuel
LD-17-84	NW1/4 SW1/4 SW1/4 sec. 27, T13N, R45W	Deuel
LD-18-84	SW1/4 SW1/4 NW1/4 sec. 10, T13N, R45W	Deuel
LD-19-84	SW1/4 NE1/4 NE1/4 sec. 34, T15N, R57W	Kimball
LD-25-84	SW1/4 SE1/4 SE1/4 sec. 30, T14N, R49W	Cheyenne
LD-26-84	SW1/4 SW1/4 SW1/4 sec. 20, T14N, R49W	Cheyenne
LD-30-84	NW1/4 NW1/4 SW1/4 sec. 2, T14N, R49W	Cheyenne
LD-31-84	NE1/4 NE1/4 NE1/4 sec. 24, T14N, R44W	Deuel
LD-32-84	NE1/4 NE1/4 NE1/4 sec. 34, T14N, R44W	Deuel
West Kimball	SE1/4 NW1/4 SW1/4 sec. 1, T14N, R56W	Kimball

*All are of Tertiary (Miocene) age except for LD-19-84, which is Quaternary.

The general lack of gray quartzite in the Quaternary gravel sample makes it unlikely that the type Sidney is Quaternary.

Having characterized the composition of the remnant Sidney at its type exposure, I then attempted to trace it laterally. This proved to be impossible because the unit is discontinuous. What further complicated this attempt to trace the gravel was the presence of at least two gravel bodies separated by sandstone beds and/or caliches, as some workers call them, in the Ogallala section less than 0.5 mi (0.8 km) to the northeast of the type exposure (fig. 6). Lugn (1939a, p. 1262) claimed that normal faulting occurred along this drainage but did not show the location or position of the fault(s). Whereas the contact between the Ogallala and older beds exposed along the drainage does dip 3° to 4° to the southeast (fig. 6), no evidence of faulting could be found. All of the gravels to the northeast of the type area contain gray quartzite, so any of them could be equivalent to the Sidney. However, there is no way of proving which, if any, of these possible correlations is correct.

East of Sidney, Nebraska, multiple sand and gravel bodies occur in the Ogallala sequence. At one site (figs. 6-8, Section A-A') the Brule-Ogallala contact is well exposed. The contact has much relief, and basal Ogallala sands and gravels fill deeply incised channels at least 40 ft (14 m) deep and 0.18 mi (0.25 km) wide. Two other gravel beds separated by caliche sandstones similar to Lugn's lower Kimball bed occur above the basal sands and gravels. The basal and middle sands and gravels contain gray quartzite and have little or no maroon rhyolite, whereas the upper gravel contains

abundant rhyolite and little quartzite (fig. 6). The question of which of these sequences of sand and gravel, if any, may be equivalent to the type Sidney cannot be answered with any degree of confidence at this site, either. However, one thing is clear from studying the distribution of these gravels: none of them has an extensive sheetlike geometry. They all crop out transverse to their channel trends for less than a section or two and either grade laterally into sandstones or end abruptly at the sides of narrow paleovalleys.

One interesting feature along section A-A' that also merits some discussion is the mass of sedimentary rock labeled "Tmo colluvium" (fig. 7). This mass rests against the older Brule Formation along a contact dipping as much as 80° to the southwest to west (fig. 9). The colluvium was deposited with dips of 25° to 35°. Each bed is wedge-shaped and thickens down-dip. The beds contain cobbles and boulders of sandstone and siltstone derived from rocks higher up the paleovalley side. Pebble-sized pieces of granite and other Rocky Mountain-source pebbles also occur in the colluvium.

A sand and gravel body occurs near the north end of section B-B' (fig. 10; table 2, sample LD-30-84). This sand and gravel is the highest one stratigraphically in the local section and occurs in an area mapped as Sidney Gravel by Lueninghoener and Lugn (fig. 4). Only trace quantities of gray quartzite occur in this body, whereas maroon rhyolite is a major component. As pointed out by Diffendal and Corner (1983), the source area of the rhyolite is in north-central Colorado. The principal drainage carrying the sediment at site LD-30-84 seems then to have

TABLE 2. Average composition of gravel clasts (16 to 32 mm), in percent.

Rock Type	Sample numbers													West Kimball (est.)	
	LD- 2-84	LD- 31-84	LD- 32-84	LD- 16-84	LD- 17-84	LD- 18-84	LD- 10-84	LD- 9-84	LD- 25-84*	LD- 26-84	LD- 30-84	LD- 11-84	LD- 19-84		
Quartz	15.3	13.3	13.6	13.1	9.1	10.6	8.6	12.2	5.1	10.2	9.9	6.4	18.5	(14.9)	5.3
Pegmatite	4.4	0.5	0.2	0.5	—	—	0.5	0.3	1.3	5.6	—	—	—	—	—
Granite	56.2	65.1	64.7	65.4	71.9	67.0	71.7	67.8	69.6	55.0	67.8	74.4	49.8	(40.0)	47.4
Graphic granite	1.6	0.7	0.4	0.4	—	0.8	—	0.7	0.2	—	0.6	—	—	—	—
Orthoclase	1.1	0.4	0.4	0.9	1.6	0.6	0.7	0.8	0.9	—	1.3	2.1	—	—	—
Anorthosite	—	—	—	—	—	0.3	—	—	—	—	0.3	—	0.4	(0.4)	15.8
Volcanic rock - Maroon rhyolite	3.2	0.5	—	—	—	2.2	3.1	3.5	1.6	1.0	10.9	3.7	7.4	(5.9)	10.5
Volcanic rock - Other	0.4	3.0	4.1	4.8	3.2	5.3	5.0	2.3	3.3	6.1	0.7	3.6	2.2	(1.8)	—
Gneiss and schist	6.2	6.9	5.9	4.8	1.9	7.0	3.8	4.8	9.4	9.4	3.7	6.9	15.2	(12.2)	5.3
Quartzite	8.1 ^a	4.8 ^a	5.0 ^a	4.7 ^a	8.6 ^b	3.6 ^c	4.5 ^a	4.3 ^a	7.6 ^b	10.9 ^b	0.9 ^c	0.9	2.9	(2.3)	—
Epidote	0.2	0.2	0.5	—	—	0.3	—	—	0.2	—	1.2	1.8	2.0	(1.6)	—
Amphibolite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chert	0.6	—	0.4	0.2	0.3	0.6	—	—	—	0.3	—	—	0.4	(0.4)	5.3
Sandstone	2.5	4.4	4.7	4.7	2.4	1.7	1.4	1.5	0.7	0.8	1.3	—	1.1	(0.9)	5.3
Carbonate	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.3
Shale/siltstone	0.1	0.2	0.2	0.4	1.1	—	0.7	1.7	—	—	—	—	—	—	—
Local reworked	0.1	—	—	0.2	—	—	—	—	—	—	1.3	—	—	(19.6)	—
Unknown	—	—	—	—	—	—	—	—	—	0.8	—	0.3	—	—	—
Total	100.0	100.0	100.1	100.1	100.1	100.0	100.0	99.9	99.9	100.1	99.9	100.0	100.0	(99.9)	100.2

^aGray quartzite.^bMuch gray quartzite.^cMinor to trace gray quartzite.

*Sidney type area.

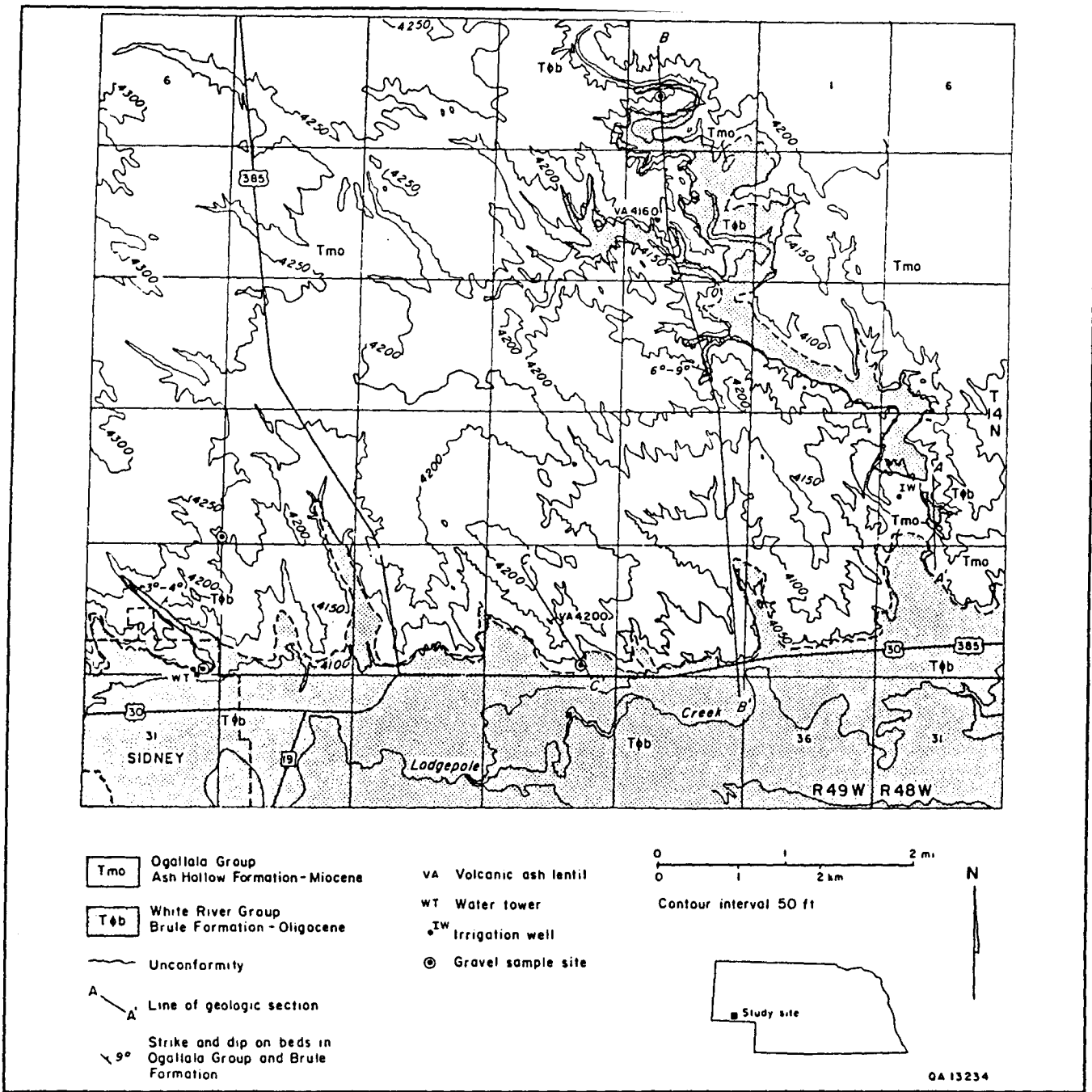


FIGURE 6. Bedrock geologic map of area shown in figure 5 prepared by the author for this report. This is Lugn's typical area of the Sidney Gravel. A-A', B-B', and C-C' are lines of section in figures 7, 8, 10, and 11.

headed far to the south of the principal drainage, carrying quartzite-dominated sediment to the type Sidney area. In all likelihood two different river systems of different ages transported these two very different gravels.

Section C-C' (figs. 6 and 11) is closer to the type Sidney area than are the first two sections. The three gravels along this line are separated from one another by sandstones and other lithologies. The beds have an apparent dip to

the southeast toward Lodgepole Creek. This dip may be the result of postdepositional deformation rather than primary dip because the dipping beds are along the trend of the Rush Creek structure, a post-Ogallala structural feature in Garden, Morrill, and Cheyenne Counties (Swinehart and others, 1985). Gravel composition varies significantly from one bed to another, and none of these gravels can be correlated with the type Sidney with any degree of certainty.

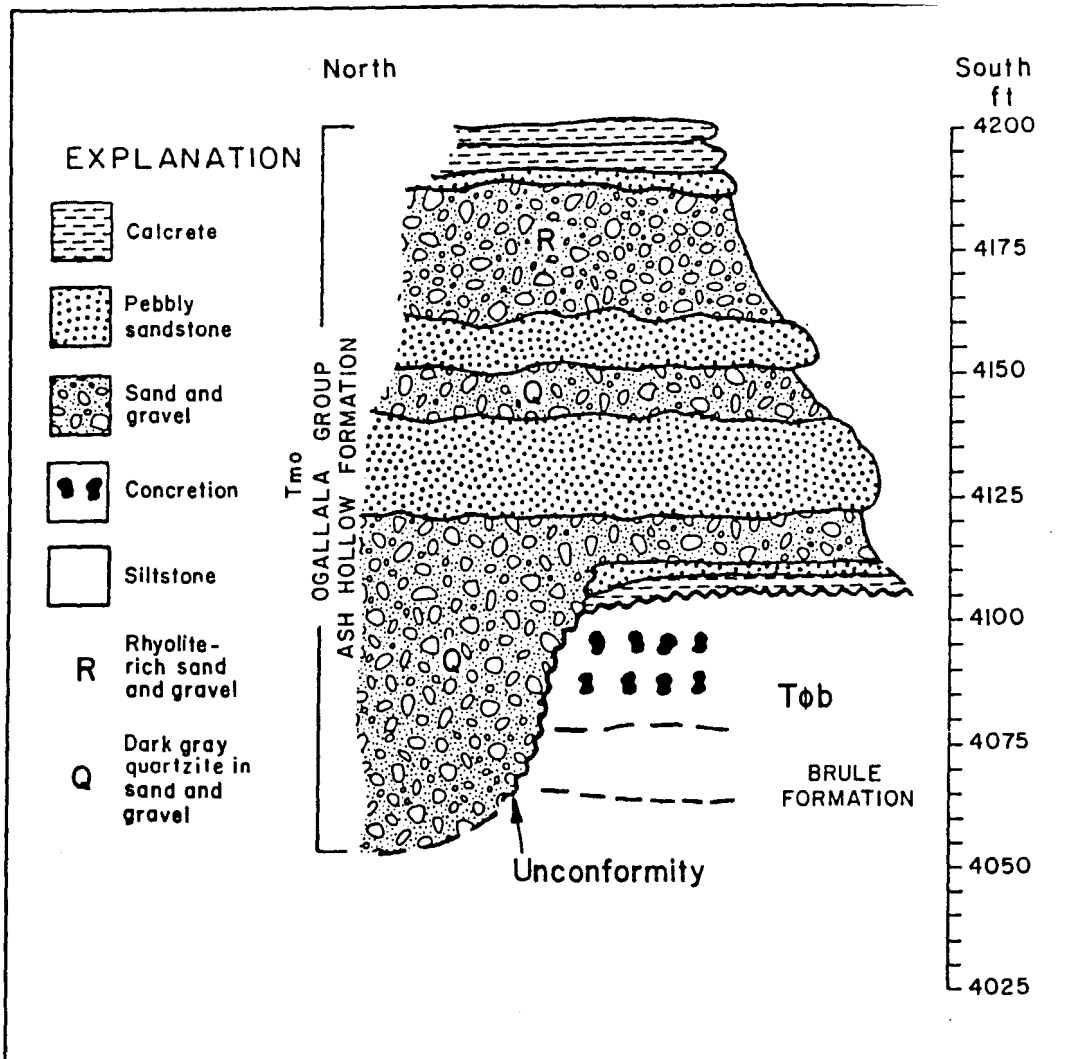


FIGURE 7. Diagram of area along and on either side of line A-A' (fig. 6).

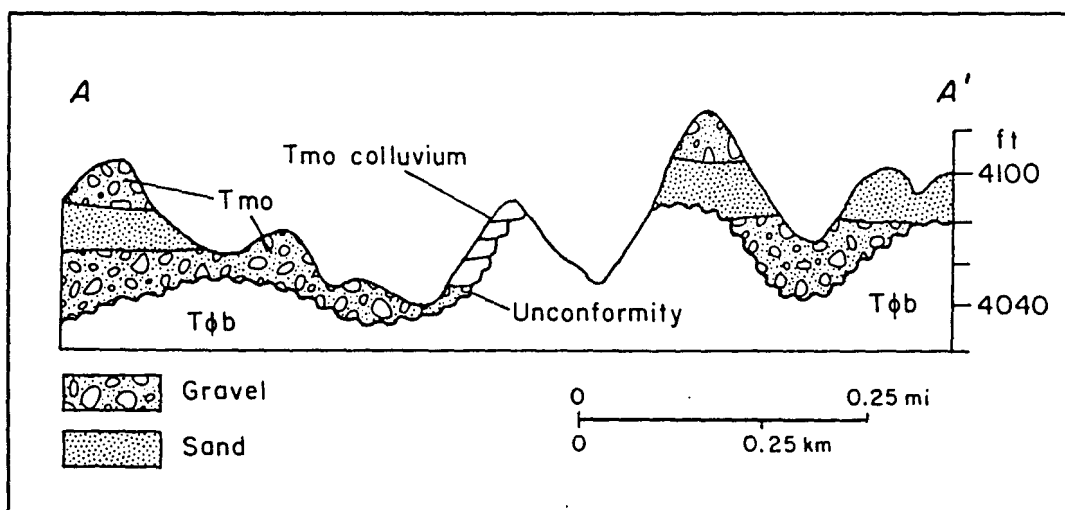


FIGURE 8. Profile section along line A-A' (fig. 6). Tmo is Ogallala Group, Ash Hollow Formation. Tφb is Brule Formation. Unit symbols same as in figure 6.

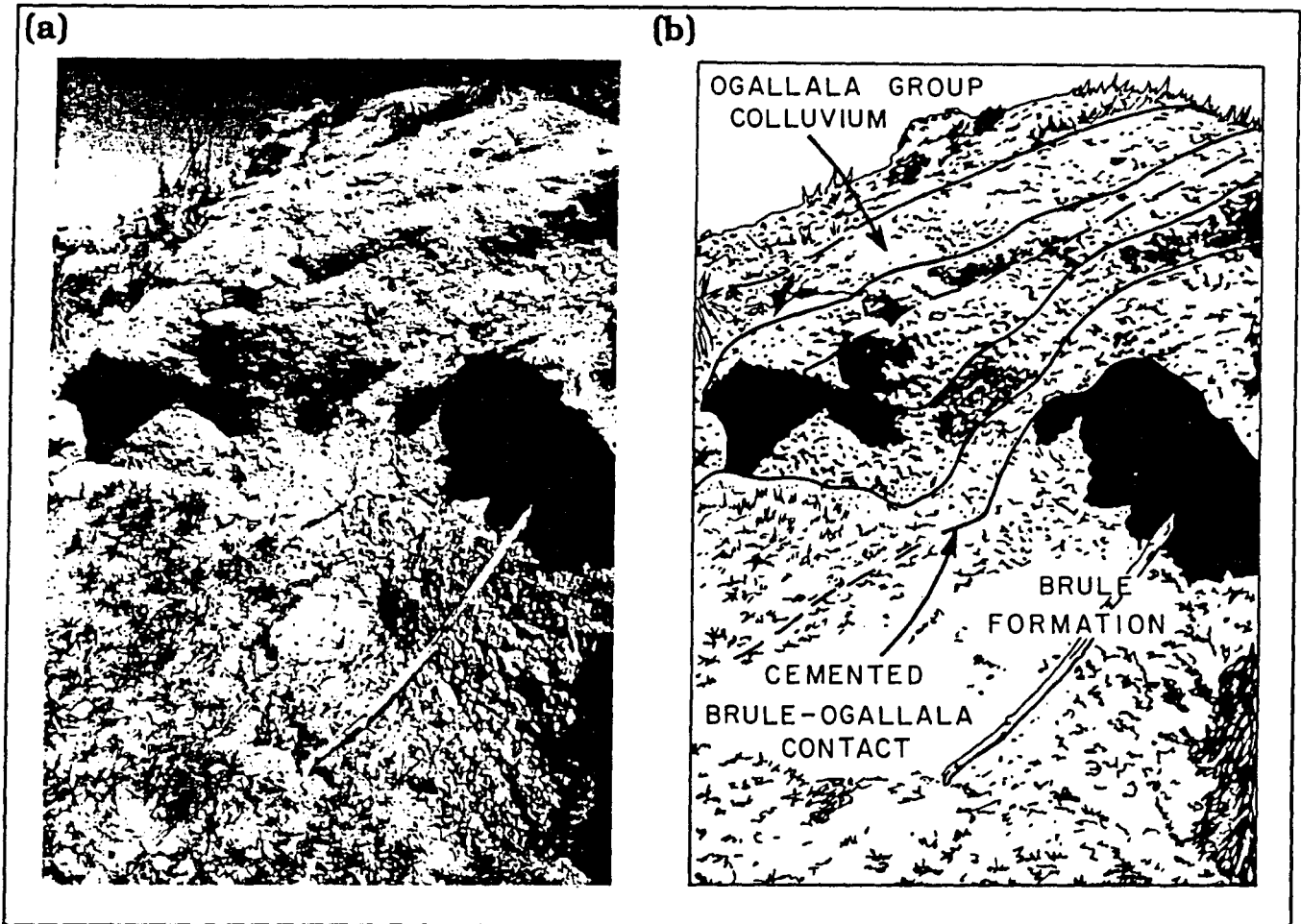


FIGURE 9. (a) Ogallala colluvium dipping to southeast at 25° to 35°. Stick is 1.2 m long and is on Brule Formation. (b) Diagram showing relationships depicted in figure 9a.

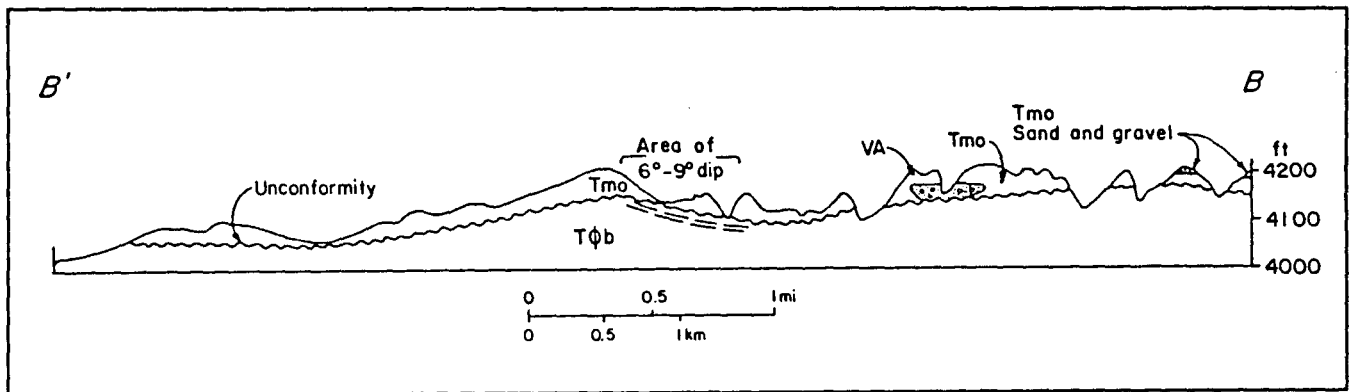


FIGURE 10. Profile section along line B-B' (fig. 6). Unit symbols same as in figure 6. VA is Ogallala volcanic ash.

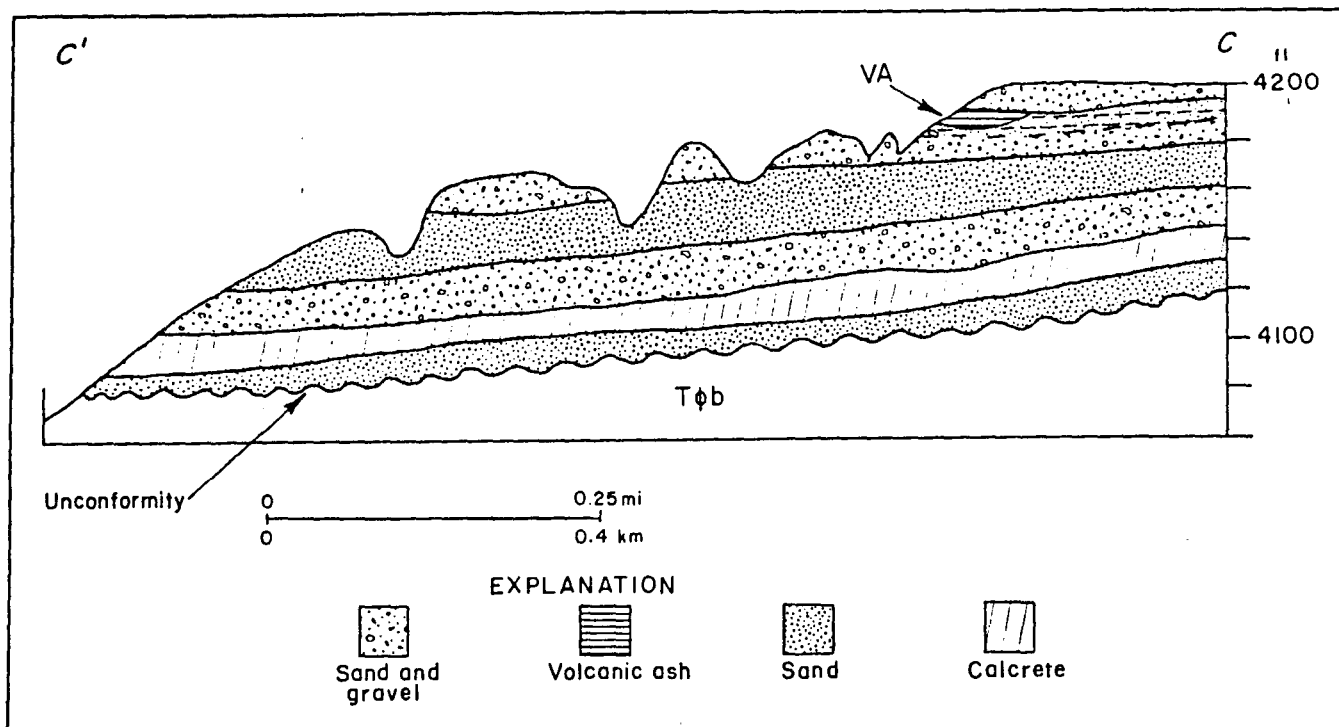


FIGURE 11. Profile section along line C-C' (fig. 6). Unit symbols same as in figure 6. VA is Ogallala volcanic ash.

Conclusions

Comparison of original maps and texts showing the distribution of the Kimball Formation and the Sidney Gravel and describing these two supposed units of the Ogallala Group, combined with the results of current field investigation in the type areas, has demonstrated at least four facts. First, the original concept that the two units are widespread, sheetlike, and mappable is incorrect. Second, no widespread marker beds occur in the units to separate them from the Ash Hollow Formation of the Ogallala. Third, the lithologies supposedly diagnostic of the Kimball and Sidney recur throughout the Ogallala Group in the southern Panhandle of Nebraska. Finally, neither unit can be uniquely defined and traced from its type area. Usage of the Sidney and Kimball as rock units in Nebraska and adjacent states should be abandoned by all workers. The term Ash Hollow Formation should be used in their place.

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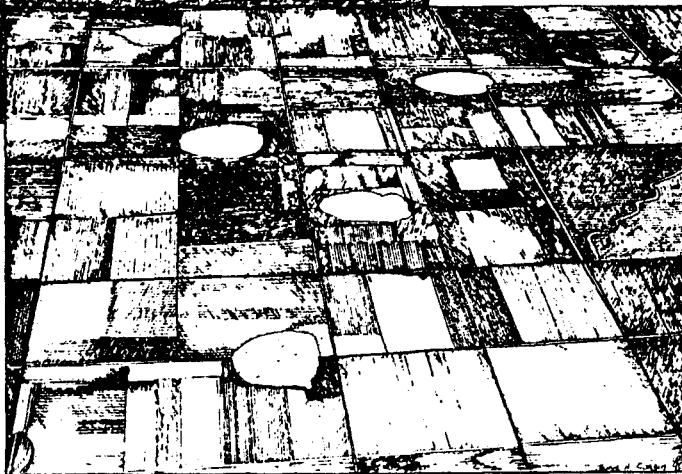
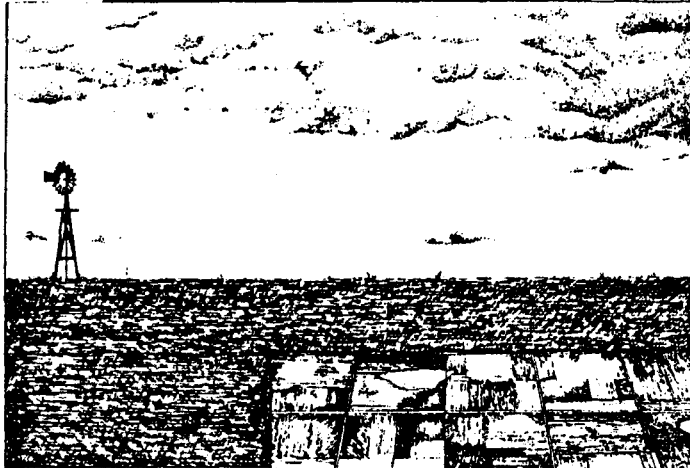
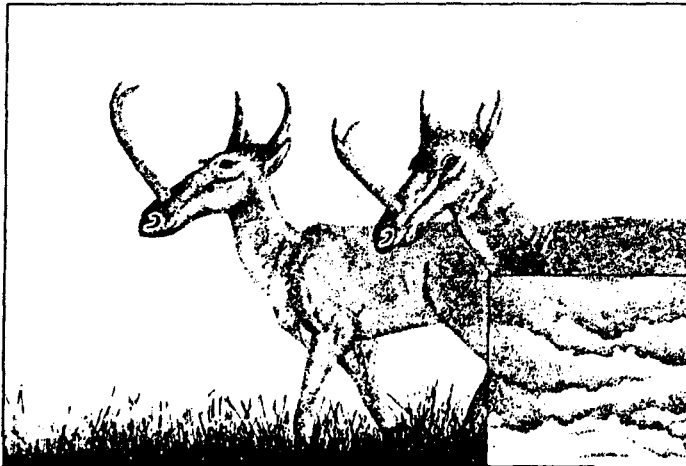
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