GEOLOGY OF VALLEY COUNTY NEBRASKA

by

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assisted by
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Preliminary Report for

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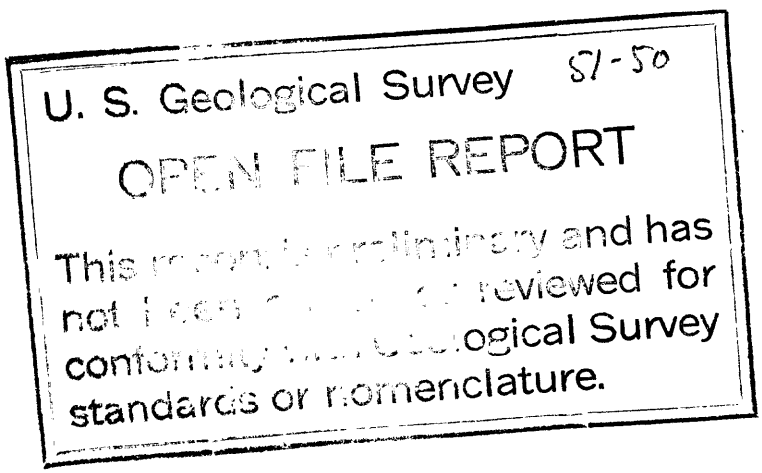

Prepared as a part of the Department of Interior's program for development of the Missouri River Basin

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Introduction

The geology of Valley County, Nebraska was mapped in the summer and fall of 1950 as part of the general inventory, geologic mapping, and investigation of mineral resources being made in conjunction with studies of the Missouri River Basin. The primary objective of the investigation was to accumulate all data pertaining to geologic materials and their distribution in Valley county. The possible utilization of these materials in the construction of irrigation canals, highways, dams, or other engineering structures is considered in this report.

Location

Valley county, in the central part of Nebraska is bounded by parallels $41^{\circ}24'$ and $41^{\circ}44'$ north latitude, and meridians $98^{\circ}45'$ and $99^{\circ}12'$ west longitude. The county comprises sixteen townships and covers an area of 576 square miles. It is bordered by Custer county on the west, Garfield county on the north, Greeley county on the east, and Sherman county on the south.

Investigation Procedure

The base map for this report was constructed from aerial photographs with the aid of a sketch master. All geologic contacts and

other data were plotted on aerial photographs in the field and the sketchmaster was used to reduce and transfer this information to the base map. The locations of political boundarys were taken from the Nebraska Highway and Transportation Map of Valley County, prepared by the Nebraska Dept. of Roads and Irrigation. Roads were checked in the field, and necessary corrections were made on the base map. The completed map was reduced photographically to 1/48,000 for this report.

Sample data collected by the Nebraska Dept. of Roads and Irrigation, Bureau of Highways, are used in this report. Additional samples were collected in the field and tested by the Bureau of Highways. This information is presented in Chart 1.

Terminology of the formations and materials is that used by the Nebraska State Geological Survey.

Acknowledgments

Genereous assistance and advice by the following persons is appreciated; Dr. E. C. Reed, Assoc. Director, Conservation and Survey Division, Nebraska Geological Survey, who gave freely of his time and experience; Mr. George Swatek, Materials Engineer, and Mr. O. L. Lund, Soils Engineer, Nebraska Dept. of Roads and Irrigation, Bureau of Highways, who made available the sample test information in their files and provided test results of additional samples collected in the field.

Descriptive Geology

Principal Features

Valley county is in the small loess plains, canyon, and hill region Lugn and Wenzel (1938) of the High Plains section of the Great Plains. Fenneman, (1930). The oldest material that crops out in the county is the Ogallala formation of Pliocene age. The Ogallala is exposed in the bluffs along the North Loup River east of Ord, in the hills bordering Myra Valley, and along Messenger Creek. It is mostly covered by Pleistocene deposits over the remainder of the county.

The Grand Island formation of Pleistocene age is exposed in quantity only in the terraces along the North Loup River near the east edge of the county. Both the North Loup and the Middle Loup rivers flow on sand and gravel beds which, for the most part, are reworked deposits of the Grand Island formation. Erosion has contributed additional materials from both earlier and later deposits. In the remainder of the county the Grand Island formation crops out mostly in small isolated exposures in deep canyon-like ravines, and in the bluffs along Myra Valley and Woods Park.

Peorian loess almost completely blankets the remainder of the county. The underlying Loveland formation is exposed only in deep ravines, in road cuts, in bluffs along the major valleys, and in plowed fields where cultivation has removed a thin cover of the Peorian formation.

Sand dunes of Recent age lie along the Middle Loup River near Arcadia. Most of them are grassed over, but blowouts continue to form

at the present time. Older sand dunes of middle to late Pleistocene age, cover part of the northeast township and also enter the county at the northern boundary along the North Loup River. These dunes are considered to be anchored windrift dunes and elongate blowouts, the long axes of which trend northwest with the lee end to the southeast. This orientation indicates that the effective wind was from the northwest at the time the dunes were formed.

Tertiary System

Pliocene Deposits

Ogallala Formation

The Ogallala is the oldest formation exposed at the surface and is the only Tertiary deposit in Valley county. Of continental origin, it once covered Valley county to a depth of several hundred feet. Streams younger than the Ogallala formation but pre-Nebraskan in age cut valleys into it. Well logs indicate that these now buried pre-Nebraskan valleys have exerted much control in determining the positions of the present rivers and their tributarys.

The Ogallala formation underlies the Pleistocene deposits. It crops out prominently along Messenger Creek, along the North Loup River, and along the bluffs and ravines bordering Myra Valley. In the uplands bordering Myra Valley to the south and southeast are some isolated exposures.

Limey pinkish-tan silts, tan to gray silts, compacted white sands, and a lime cemented sandstone, one of the so-called "mortar beds" comprise the typical Ogallala formation in Valley county. Lenticular in form

the facies of the formation change rapidly, though gradationally.

A "mortar-bed" two feet thick crops out about one foot above normal river level in secs. 35 and 36, T. 19 N., R. 13 W. A sample (No. 41) contained 0.84% calcicum carbonate. It was too soft to be subjected to the Los Angeles abrasion tests or freezing and thawing soundness tests. Underlying the terrace on the west side of the North Loup River, the "mortar-bed" is covered by sand and gravel of the Grand Island formation, and by reworked terrace sands and gravels. Tan and gray silts of the Ogallala formation overlie the "mortar-beds" on the east bank of the river. They in turn are overlain by the Peorian loess. The Ogallala formation exposed in cuts along the Chicago, Burlington, and Quincy Railroad in sec. 36, T. 19 N. R. 13 W. consists of tan to buff limey silts.

"Mortar-beds" crop out in a vertical bluff along the North Branch of Myra Creek, sec. 19, T. 18 N., R. 13 W., and along Davis Creek, sec. 26, T. 17 N., R. 14 W. The lime beds are very soft and can be scratched with a fingernail. Thin beds of limestone, four to eight inches thick, crop out in some of the ravines bordering Myra Valley. Float is seen in other ravines.

Vertebrate fossils in the Ogallala are scarce and fragmentary.

Quaternary System

Pleistocene Deposits

Grand Island Formation

The Grand Island formation of Kansan age is largely a fluvial inwash-outwash sand and gravel. The upper 30 to 50 feet, however, in aeolian. It is composed predominantly of quartz and orthoclase feldspar. Mica, quartzite, and chlorite are minor constituents. The feldspars give the formation its characteristic tan to pink color. Stream channeling, cross-bedding, and lenses of silt and sands , though obscure in Valley County, are typical of the Grand Island formation.

A major portion of the material comprising the Grand Island formation in Valley County was deposited by streams that flowed east from the Rocky Mountain region. In the High Plains, the rivers deposited their load at grade level and formed a sandy plain. At the same time, outwash from the till regions to the north and east was deposited by streams that flowed west and south. This combination of sand and gravel, comprising the Grand Island formation, covered the Ogallala formation unconformably to depths of 30 to 150 feet. Post-Kansan erosion has since removed the sand and gravel from local areas.

The Grand Island is exposed in quantity only along the terraces of the North Loup river and in the alluvium of both the North and Middle Loup rivers. In the river channels it extends deeper than 60 feet below river level. The upper part is reworked by the present rivers.

The upper 30 to 50 feet of the Grand Island formation is a fine, clean, white sand. Lugh and Wenzel (1938) In Valley county almost all of the Grand Island exposed in the upland region is composed of this material. It indicates eolian deposition on a vast scale along streams and rivers during Kansan time. Though cropping out only in bluffs, deep canyon-like ravines, or in road cuts, the eolian sand phase of the Grand Island formation underlies the younger Pleistocene deposits in the upland area of the county.

The dune like nature of the upper part of the Grand Island formation is displayed by an exposure along Davis Creek in sec. 34, T. 17 N., R. 13 W. A small dune of the white, clean, frosted sand is unconformable on silts of the Ogallala formation. It is believed to be typical of the Grand Island formation in the upland region of the county.

Along the terraces of the North and Middle Loup rivers the Grand Island formation is composed of fine to coarse pinkish-brown sand that contains scattered pebbles. A cut bank along Gravel Creek in sec. 20, T. 20 N., R. 14 W. (Sample No. 9, Chart 1) contains one of the two known coarse sand and gravel deposits of the Grand Island formation in the upland region of the county. The other such deposit is shown in exposures along an unnamed creek in secs. 28 and 29, T. 20 N., R. 14 W., three-fourths of a mile east of Gravel Creek.

The Grand Island formation is an excellent water bearing strata, and inasmuch as it underlies most of the region, most of the shallow

water wells in the county are supplied from it. In the upland region of the county, most wells have to extend deeper than 100 feet to reach water, but in the valleys of the present rivers and in the valleys of the larger tributaries, the loess cover is thinner and the water wells are shallow. On the terraces along the rivers the wells are about 15 feet deep. In Myra Valley some of the wells are about 40 feet deep.

The Grand Island formation is used for road metal. Pumps remove the sand and gravel from the rivers and the material is then screened. The coarse fraction is retained, and the fine fraction and oversize are returned to the river.

Sappa Formation

Originally named the Upland formation, a new name, the Sappa Formation, has been proposed by Condra, Reed and Gordon (1950) and will be used in this report. The Sappa formation is believed to be a lagoon or pond deposit of late Kansan and Yarmouth age. It overlies the Grand Island formation, and is subdivided into three members, the Lower Sappa silt, the Pearlette Ash member, and the Upper Sappa silt. Condra, Reed and Gordon, (1950). The lower silt cannot be distinguished in the field from the upper silt where the Pearlette ash is absent. The Sappa formation is characteristically a blocky, greenish-gray clayey silt, quite plastic when wet. In certain good exposures, mild stratification can be seen. The Sappa formation is generally recognized by its color, lithology and stratigraphic position. In Valley county, however, a fine white

to greenish-gray sand is common in many exposures, but in some exposures the green clay is absent. Facies changes, and the absence of the Loveland and/or Grand Island formations makes positive determination of some outcrops very difficult.

In later Kansan time, many ponds, lakes, and lagoons on the Grand Island formation provided excellent traps for fine silts and sands blowing over the sandy plain. These lakes and lagoons were of relatively short life, and were either filled with the wind blown silts, or were evaporated to dryness. In Yarmouth time, much of the silt was removed by erosion. Small beds of clay and isolated hills of the Sappa formation were later covered by the Loveland loess. The Sappa formation therefore, is exposed in very few places in Valley county. Most exposures are in steep bluffs along the major drainage lines, or on the sides of old pre-Loveland valleys where they have been bared by recent plowing or road excavating.

Pearlette Ash -- The Pearlette ash member of the Sappa formation was described and named by Cragin in 1896. Its type locality is near the now abandoned Pearlette postoffice, Meade Co., Kansas. Many writers have referred to the ash since Barbour described it in 1916. Cragin thought the ash was Pliocene in age but studies by Dr. John Frye and others indicate that it is Pleistocene. It has been correlated with deposits in Nebraska. Deposits are lenticular in shape and represent accumulations of fine chards of volcanic glass in quiet lakes, lagoons, or ponds. Some exposures are stratified and the laminae contain small

amounts of sand and scattered pebbles. The ash is generally pure and uniform in size. The chards are angular to round; small broken bubbles and their fragments comprise the greater amount. The ash in Valley county averages four feet in thickness, but an exposure in sec. 24, T. 18 N., R. 14 W. was augered to a depth of 12 feet. The total measured thickness of the deposit is 21 feet, and the ash is of excellent quality throughout.

The general belief concerning the source of the ash is that it came from volcanic centers in the southwestern and western regions of the continent. In support of this concept is the fact that the deposits of volcanic ash become of finer grain to the northeast. The ash in Valley county is much finer than along the Republican River, 120 miles to the south.

Loveland Formation

Shimek, (1909) named the Loveland Loess in 1909, and regarded it as fluvial in origin. Kay in 1944 redescribed it and gave to it the name, Loveland Formation. It is now considered Illinoian and the soil is considered Sangamon. The new name includes a fluvial and an eolian phase of deposition. The fluvial or valley phase normally consists of stratified silts and clays, and laminae of very fine sand. Condra, (1950). The eolian or upland phase normally consists of massive reddish-brown loess. The two phases grade into each other.

The Sangamon soil on the Loveland formation is a dark purplish-black soil zone 1 to 2 feet thick. The Loveland formation, though

strongly eroded in Illinoian time, generally has a remnant of the soil zone present. In some instances the soil has been removed by recent erosion or by cultivation. Though the soil on the Loveland formation is included in the Citellus zone, no fossils were found in it in Valley county.

The eolian cycle of the Loveland formation in Valley county is generally a massive reddish-brown silt, and has the characteristic vertical jointing of loess. In some exposures the loess can be traced downward into a fine reddish-brown sand. In other exposures the Loveland formation consists entirely of a well sorted, fine, reddish-brown sand. Though not restricted entirely to any specific locality, exposures of the sandy Loveland are more common along the present and ancient major drainage systems. Samples Nos. 20, 21, and 22, were collected from an exposure of this sandy Loveland. The Loveland formation exposed in the uplands between the North and Middle Loup rivers is predominately massive loess.

In sec. 1, T. 18 N., R. 15 W. stratified reddish-brown sands and silts are exposed between the Loveland formation and the Peorian formation. These sands and silts may correspond in age to the Todd Valley formation found further east.

Non-stratified sand in the Loveland formation is eolian in origin, and is not a fluvial deposit. This sand was blown into mounds or hills from the channels of ancient rivers flowing through the county in Illinoian

time, and were then blanketed by silt. The predominance of sand in the hills and bluffs along the courses of the present rivers indicates that pre-Peorian rivers flowed along the same channels as they do today.

Myra Valley is an exception. This broad valley has several intermittant streams flowing through it today, and exposures of the sandy phase of the Loveland formation in the bluffs bordering the valley indicate that a large river flowed through the valley during Illinoian and Sangamon time. Subsurface data supports this belief inasmuch as the Loveland formation is absent under the Peorian loess in the valley.

Exposures in the upland indicate that the Loveland formation was severely eroded. It dissected into hills and canyon-like ravines before the Peorian loess was deposited. Roadcuts on the road west from Ord to Sargent expose buried hills of Loveland loess completely blanketed by the Peorian loess. Because the Loveland formation is blanketed by the Peorian, it crops out only in steep bluffs, in deep ravines where recent erosion has cut through the cover of Peorian loess, in artificial excavations such as road cuts, and in fields where cultivation has removed the Peorian loess. The maximum thickness of the Loveland formation observed in Valley county was about 20 feet.

The Loveland formation is believed to have originated from the reworking of alluvial deposits, dune sands, and older exposed Pleistocene deposits. Exposed sands and silts of the Ogallala and older Tertiary deposits may have provided some of the material.

The characteristic coloring of the Loveland formation is one of the important criteria for its field identification. The coloring is the result of oxidation of iron in the loess, which in turn is the result of weathering in a humid climate during Sangamon time.

Peorian loess

The Peorian formation consists of yellow-gray eolian silt and clay. It mantles the Loveland formation on an irregular surface, and is the most common and widespread deposit in Valley county. It ranges in thickness from an average of 15 feet in the central part of the county, to over 55 feet in the northwestern township.

The Peorian loess constitutes deposition from the Iowan to the Mankato substages. The Tazewell, Cary, and Mankato ice sheets never reached Valley County but deposits corresponding to their ages are represented by almost continuous deposition of loess. The greater portion of the Peorian loess is believed to have been derived from river alluvium, that is, from the sand bars, beaches, and dry channels in the beds of rivers flowing from the outwash plains along the margins of the till sheets. The loess also thins eastward from the Sand Hills, indicating that the Sand Hills may have been an auxillary source of the loess.

As used in this report, the term Peorian loess includes not only the Peorian but also all younger loesses, including the Bignell. Described and named by Schultz and Stout, (1945) the Bignell formation is Mankato to Recent in age, is a yellow-gray loess, variable in thickness, and is separated from the Peorian loess by a buried soil, the Brady soil.

This soil zone is the main guide in the field for discriminating the Peorian from the Bignell. Inasmuch as this soil is rarely exposed all yellow-gray loess overlying the Loveland formation is here mapped as Peorian loess.

On both sides of the North and Middle Loup rivers are broad loess-covered terraces one-half to one mile wide. State Road 11 along the North Loup River is built on one of these. The loess on these terraces is mapped as Peorian, but it is realized that future work may define it as Bignell. Some of the material is reworked, but most of the silt examined was not visibly reworked and is considered to be true loess.

The color of the Peorian is a secondary feature influenced by the type and amount of minerals present in the loess and their degree of oxidation and hydration. The colors are modified by the finely divided quartz and clay particles that give the loess deposits a light color. Limonitic staining and reprecipitated limonite nodules indicate former saturation by stagnate groundwater. Some limonitic nodules have a diameter of three inches.

Similar concretions of lime are common in most exposures of the upper 10 feet of the Peorian loess. The lime has been leached from the upper few feet by groundwater and reprecipitated at a lower level, the B zone, in a horizon of lime enrichment. Some of these lime concretions are three inches in diameter.

In some exposures the lower part of the Peorian formation consists of a very fine tan sand. This sand grades upward into the silt and

massive loess. The loess has characteristic vertical jointing and, in the northwestern part of Valley county , stands in vertical cuts as much as 45 feet deep. Normal runoff of water along road sides undercuts the loess and causes it tc slump. If the lower part of the loess is sandy, the loess is undercut more readily.

In the upland areas of Valley county deep canyon-like ravines are cuts in fine silts which appears to be entirely Peorian loess. Some of these ravines are over 60 feet deep and indicate a large thickness of Peorian loess. This, however, is not necessarily the case. Before the Peorian loess was deposited, the Loveland formation was severely eroded and formed deep ravines. The Peorian loess covered more or less evenly this pre-Peorian topography and in so doing covered the area of deep dissection. It did not fill these deep ravines, but merely blanketed their sides and bottoms in a comparatively thin layer. Much of the Peorian loess in these canyons is only five to ten feet thick. Thus, the present topography reflects the pre-Peorian topography and indicates that the landscape at the time of Peorian deposition was very similar to that of the present time, though the hills of Loveland formation were steeper.

The Peorian loess in the northwestern corner of the county is exceptionally thick. The Peorian loess is at least 30 feet thick as seen in vertical road cuts between secs. 6, and 7. T. 19 N., R. 16 W. The close proximity of such source areas as the Sand Hills and the North Loup River is believed to account for this thickness.

Sand Hills

The Sand Hills of west central Nebraska extend into the northern part of Valley county and are prominent in the northeastern township. The dunes are composed of fine to very fine, tan, æolian sand, and they cover a flat basin-like area. Numerous ridges rise above the general level, forming a gently rolling, grass covered plain. Most of the dunes are stationary, but blowouts forming today are common.

The sand area is internally drained. Consequently, many of the low valleys between the dune ridges contain intermittent ponds. A six inch impervious layer of clay is present about 4 feet below the ground surfaceforming a perched water table. It is the general consensus that the Sand Hills are middle to late Pleistocene, but inasmuch as Sand Hills deposits overlap the Peorian loess, the influx of the Sand Hills into Valley county from the northwestern region of Nebraska was in post Peorian time.

Grazing is the primary occupation in the Sand Hill region, though hay is raised and cut, and some corn crops are grown in the low areas between the dune ridges.

Recent Deposits

Terrace Deposits

More than one terrace level is recognized in the county, but all terraces below the flat, Peorian-covered terrace are grouped together in this report. The material in these terraces is all of similar character.

Coarse pinkish sand, fine sand, and channels of gravel all covered by fine silt and soils, comprise the terraces along the North and Middle Loup rivers. The terrace material in the tributaries is derived from the deposits through which the streams flow. For the most part, these terraces are composed of fine sand and silt reworked from the Loveland and Peorian deposits. They are covered by very silty soil. Some terraces lack the sand. In others a coarse sand is common.

Sand and gravel formerly was taken from the terraces along the rivers for use in the county, but at the present time all commercial sand and gravel is obtained from the river channel.

Dune Sand

The sand dunes northeast of Arcadia cover the lower terraces and are believed to be younger than the Sand Hills in the northeastern part of the county. Most are stationary and are grass covered but a few blowouts are forming today.

Grazing and hay production are the main occupations in the sand dune area.

Alluvium

As used in this report, alluvium includes those deposits in river valleys that are subject to high water and floods. Coarse sand, channels of gravel, and fine sand mainly reworked from the Grand Island formation comprise the alluvium. Feldspar and quartz are the most common minerals.

Alluvium is the main source of road metal used in the county. It is pumped from the river channel and screened, the coarse sand and fine gravel are retained for use, and the over size and fine fraction are returned to the river.

Inventory of Construction Materials

Road Metal

As used in this report, road metal is any material that may be applied to a road to improve the performance of the road surface. In Valley county the coarse sand and gravel in the river alluvium is the only large source of road metal now being utilized.

The river terraces contain abundant usable coarse sand and gravel similar to that removed from the river alluvium.

Aggregate

The river alluvium and the sand and gravel of the terraces along the North and Middle Loup rivers contain the only material in the county that could be used as aggregate. Composed mostly of quartz and feldspar, they are predominantly coarse sand and fine gravel. Fine sands and scattered medium-size boulders make up the remainder of the material. Though these are the only known large sources of aggregate in the county, the weathered and fractured feldspars make it doubtful if they would be considered high quality aggregate.

Mineral Filler

Peorian Loess

The Peorian loess is the material most used as a mineral filler in Valley county. Widespread throughout the county, the Peorian loess is easily accessible. Its particle size is within the requirements for a filler, but its cementation may be higher than standard. The cementing material is calcium carbonate and is usually concentrated through the B zone in the soil profile. This is the zone of lime enrichment which also contains other salts and clay particles. The leached loess above this zone contains little or no calcium carbonate. The loess below the B zone contains some lime, but not in such concentrated amounts.

Pearlette Ash

The Pearlette ash, though in small and local deposits, is uniform in size and is of high quality. The chards are angular for the most part, and the ash has a low cementation factor.

Binder

Peorian Loess

The Peorian loess is the predominant material used in Valley county as a binder. The upper few feet of the loess are used, and the B zone of the soil is included in the samples tested. As can be seen from the test results in Chart No. 1 the cementation is quite high.

Ogallala Formation

The Ogallala formation has not been tested for binder properties, but the lime ledges of the formation are soft and could be easily crushed. However, the Peorian loess is so widespread and accessible that the cost involved in the use of the Ogallala probably would be prohibitive.

REFERENCE LIST

Barbour, E. H. (1916) Nebraska pumicite: Nebr. Geol. Survey Publ. (Ser. 1) vol. 4, pt. 27, pp. 355-401.

Condra, G. E., Reed, E. C., and Gordon, E. D., (1947) Correlation of the Pleistocene deposits of Nebraska: Nebr. Geol. Survey Bull. 15.

Condra, G. E., Reed, E. C., and Gordon, E. D. (1950) Correlation of the Pleistocene deposits of Nebraska: Nebr. Geol. Survey Bull. 15A.

Cragin, F. W. (1896) Pearlette ash: Colo. Coll. Studies, vol. 6, pp. 53-54.

Darton, N. H. (1898) Preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian: Geol. Survey 19th Ann. Rept., pt. 4, pp. 732-742.

Fenneman, N. M. (1930) Physical divisions of the United States: U. S. Geol. Survey Misc. Maps.

Kay, G. F., Apfel, E. T. (1944) Pre-Illinoian pleistocene geology of Iowa: Iowa Geol. Survey Spec. Rept., Pt. 1.

Lugn, A. L., Schultz, C. B. (1934) The geology and mammalian fauna of the Pleistocene of Nebraska: Nebr. State Museum Bull. 41, vol. 1, pp. 319-356.

Lugn, A. L. (1935) The Pleistocene geology of Nebraska: Nebr. Geol. Survey Bull. 10, (2nd series).

Lugn, A. L., and Wenzel, L. K. (1938) Geology and groundwater resources of south-central Nebraska U. S. Geol. Survey Water-Supply Paper 779.

Lugn, A. L. (Dec. 1939) Nebraska in relation to problem of pleistocene stratigraphy: Amer. Jour. Sci., vol. 237, no. 12, pp. 851-884.

Melton, F. A. (1940) A tentative classification of sand dunes, its application to dune history in the southern high plains: Jour. of Geol., vol. 48, no. 2, pp. 113-174.

Schultz, C. B., Stout, T. M. (May 1945) Pleistocene loess deposits of Nebraska, Reprint Amer. Jour. Sci., vol. 243, no. 5, pp. 231-244.

Shimek, Bohumil, (1909) Aftonian sand and gravel in western Iowa: Geol. Soc. America Bull. vol. 20, pp. 399-408.