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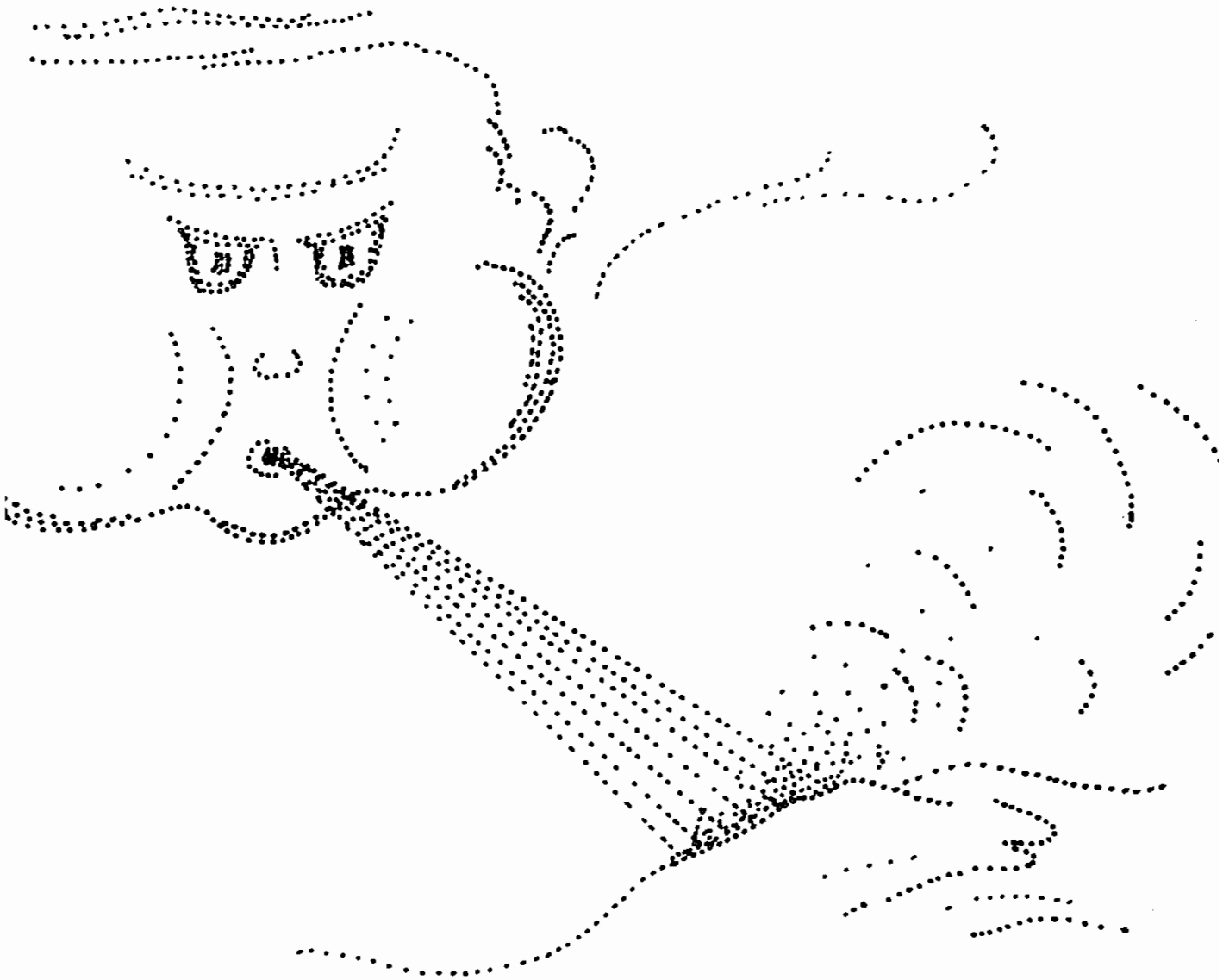
QUATERNARY LOESS IN SOUTHWESTERN SOUTH DAKOTA

by J.C. Harksen, 1967



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QUATERNARY LOESS IN SOUTHWESTERN SOUTH DAKOTA [1]

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INTRODUCTION

Regional Distribution

During the Quaternary the unglaciated area of the northern Great Plains was the depositional site for great amounts of eolian materials. During this period of time the Sand Hills region of Nebraska and South Dakota was formed; an area covering 20,000 square miles in Nebraska alone (Lugn, 1935). In addition to the formation of the Sand Hills, vast areas of the northern Great Plains were covered with loess. Lugn (1962) states that 42,000 square miles of Nebraska are covered by loess deposits. Frye and others (1963:111) states:

> One of the large, loess-blanketed regions of the world occurs in midwestern United States of America. Loess ranging in thickness from a few feet to as much as 200 feet, mantles upland surfaces and some slopes and terraces across an east-west distance of more than 1000 miles. This loess region starts in eastern Colorado and northwestern Texas and extends eastward across Kansas and Nebraska, northern Missouri and Iowa, Illinois, Indiana, and into Ohio.

This blanket of loess also extends into South Dakota. The study of loess in western South Dakota (here defined as that area of South Dakota west of the Missouri River) has generally been ignored. While some authors have mapped loess in southwestern South Dakota (Baker, 1951; Petsch and Curtiss, 1950) the great majority of geologists refuse to treat it as either a rock stratigraphic or time stratigraphic unit and summarily ignore it in geologic mapping.

Loess Defined

Loess, as used in this report, refers to deposits (in which silt size particles are the predominant constituent) that were deposited through the action of wind but may have been modified through colluvial movement. These loess deposits usually weather vertically, are grey or tan in color, and are massive on megascopic inspection.

Although it is assumed that minor thicknesses of loess are present or have contributed to soil formation over the major part

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of the area covered by this report, only those deposits of 4 feet or more in thickness are considered in this report.

SOME NEW IDEAS

Erosion versus Deposition

For the past several years the author has been mapping the late Cenozoic geology in Shannon and Bennett Counties, South Dakota (see fig. 1). These investigations have shown that while loess is present, it is of small geographic extent and the deposits are generally less than 40 feet thick.

Reed and Dreeszen (1965) list eleven named Quaternary loesses as being present in Nebraska. Loess deposits in western South Dakota are not named; furthermore loess was not generally considered as being present. Thus one may ask the question why the abundance of loess in Nebraska over that present in South Dakota?

The source area for the greater percentage of the Nebraska loesses has been said to be the Sand Hills area of Nebraska and South Dakota. The wind direction during the Quaternary was presumed to be from the northwest. The wind supposedly reworked exposures of the Ogallala Group leaving the coarser materials behind in the form of Sand Hills and carrying the finer materials downwind to form the major percentage of the late Quaternary loess deposits of central and eastern Nebraska.

The writer feels that the above statement gives only a partial explanation. The major reason for the small amount of loess in South Dakota is not so much a lack of deposition as it is a greater amount of Quaternary erosion in South Dakota as compared to Nebraska.

Throughout the Great Plains, the Quaternary was a period in which erosion was a dominant geologic process. Near the end of the Pliocene Epoch the base level for drainageways in the northern Great Plains began to lower. Streams began to cut down through the pre-existing bedrock and became intrenched. In the area of longitude 102 degrees west, the White River and its post-Ogallala ancestors have cut down more than 1,200 feet below the level of the High Plains (Harksen, 1966). At the same longitude the Platte River, in the same period of time, has cut down about 600 feet. The rapid erosion in South Dakota has generally served to remove the loess at a rate commensurate with deposition.

Sites of Loess Deposition

The scattered remnants of the High Plains serve as stable areas which are presently loess covered. Figure 2 is a diagramatic representation of the manner in which many loess-covered buttes are formed. Some very good examples of loess-capped buttes formed

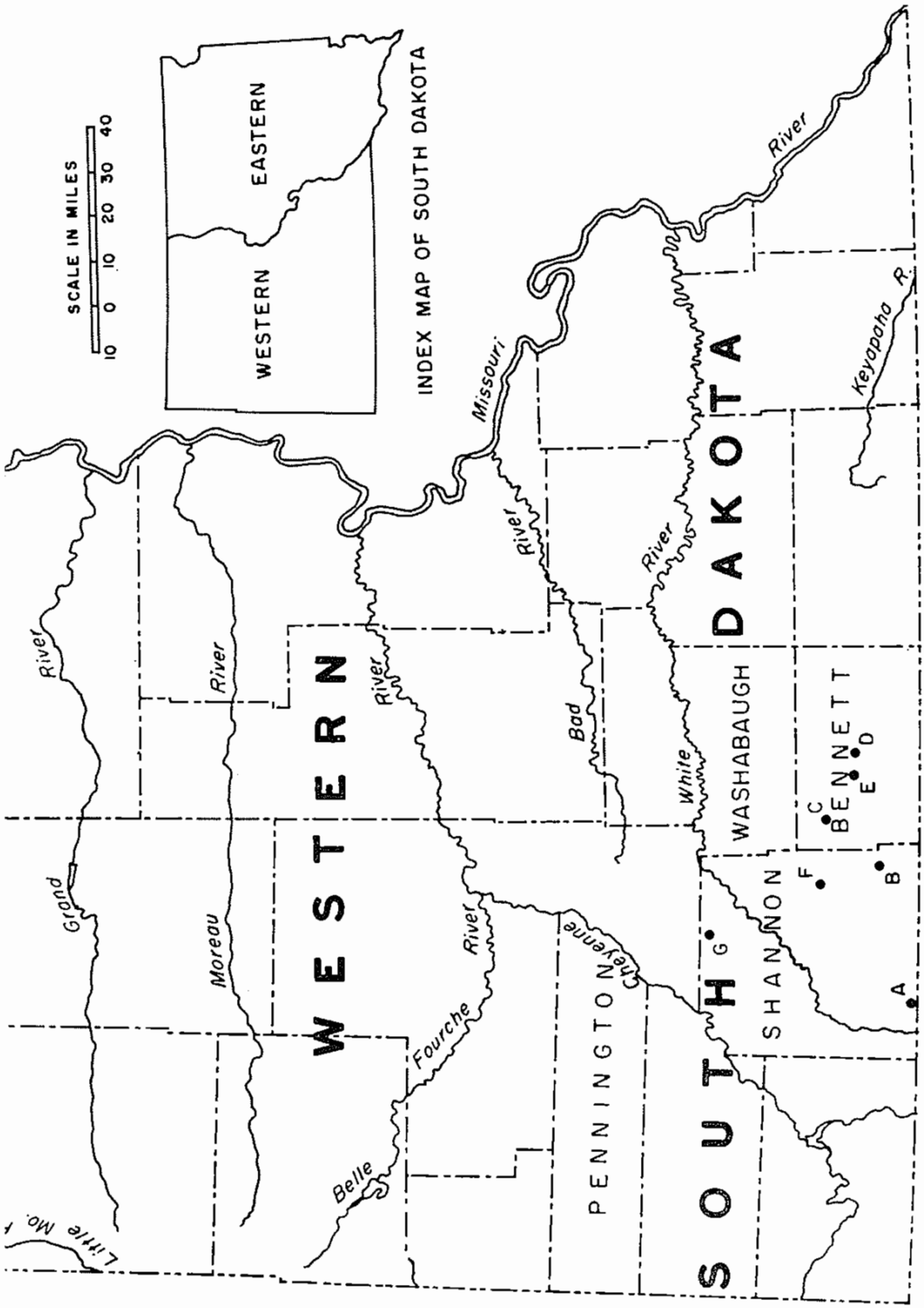
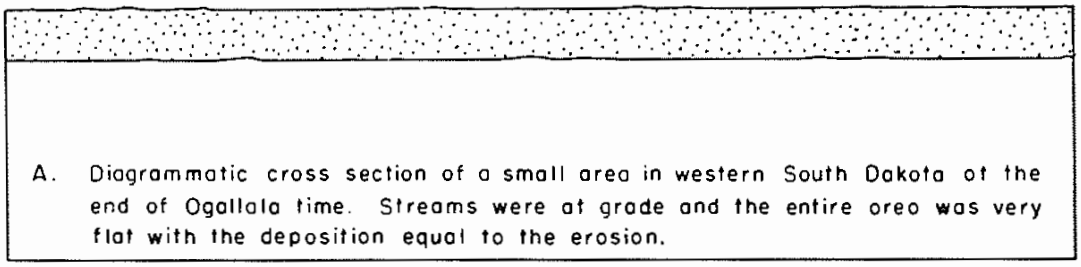
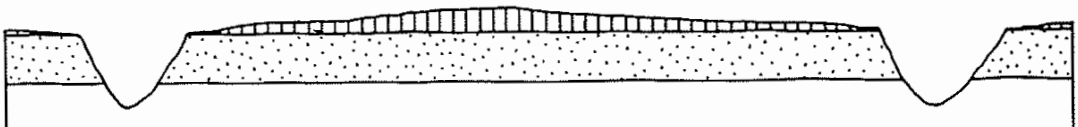


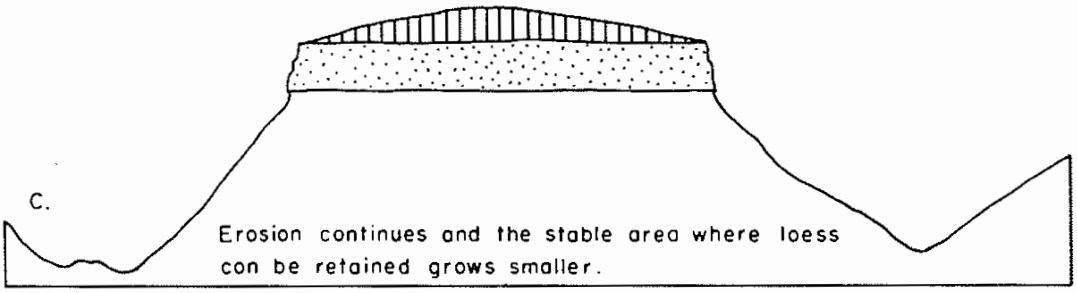
Figure 1. Index map of western South Dakota showing the relatvie location of points referred to in the text of this paper. A, sec. 11, T. 35 N., R. 46 W.; B, sec. 20, T. 37 N., R. 41 W.; C, sec. 6, T. 38 N., R. 39 W.; D, sec. 12, T. 37 N., R. 37 W.; E, sec. 5, T. 37 N., R. 37 W.; F, secs. 11, 12, 13, 14, T. 38 N., R. 42 W.; G, secs. 21, 22, 27, 28, 33, 34, T. 43 N., R. 43 W.



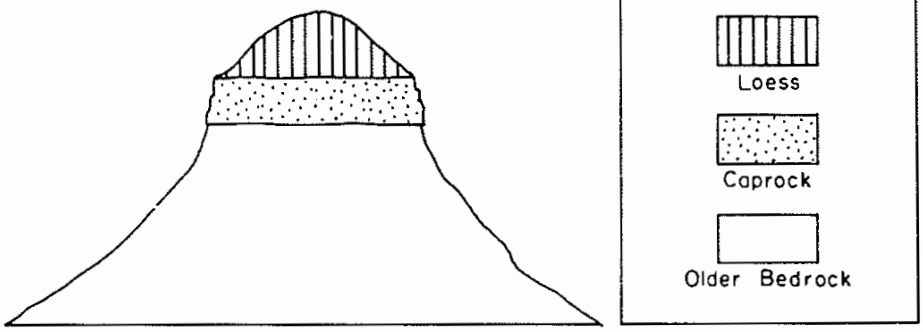
A. Diagrammatic cross section of a small area in western South Dakota at the end of Ogallala time. Streams were at grade and the entire area was very flat with the deposition equal to the erosion.



B. Near the end of the Pliocene Epoch the baselevel of the streams in western South Dakota dropped. The streams began to erode away the previously deposited sediments, and loess is deposited in the interfluves.



C. Erosion continues and the stable area where loess can be retained grows smaller.



D. Local relief becomes greater both through erosion in the lowlands and deposition in the highlands. Areas where loess can be deposited and not subjected to immediate erosion are at a minimum. Buttes which show the type of loess deposition shown in sequence D can be found in Sections 11, 12, 13 and 14, Township 38 North and Range 42 West, Shannon County, South Dakota.

Figure 2. Sequence of diagramatic cross sections of a hypothetical area in western South Dakota. This sequence shows how the greater percentage of western South Dakota loess was formed and protected from erosion.

in this way exist in secs. 11, 12, 13, and 14, T. 38 N., R. 42 W., Shannon County, South Dakota. Here the buttes have a maximum loess cover of 46 feet. Approximately 90 percent of the loess in Bennett County is found above deposits of the Ogallala Group while the remaining 10 percent is found above the terrace levels along the major drainages and adjacent to probable source areas.

		WIND		PRECIPITATION 6" 4" 2"
		P. W.	A. S.	
1962	Jan.	NNW	11.8	
	Feb.	NNW	11.5	
	Mar.	NNW	12.2	
	Apr.	NNW	13.0	
	May	NNW	13.4	
	Jun.	SSE	10.5	
	July	NNW	9.9	
	Aug.	NNW	9.2	
	Sept.	NNW	11.1	
	Oct.	NNW	10.7	
	Nov.	NNW	9.9	
	Dec.	NW	10.4	
1963	Jan.	NNW	11.8	
	Feb.	NNW	11.7	
	Mar.	NNW	12.1	
	Apr.	N	12.3	
	May	NNW	11.3	
	Jun.	NNW	10.0	
	July	NNW	8.9	
	Aug.	NNW	9.1	
	Sept.	NNW	10.3	
	Oct.	NNW	10.3	
	Nov.	NW	10.3	
	Dec.	NW	11.7	
1964	Jan.	NNW	11.6	
	Feb.	NNW	13.6	
	Mar.	NNW	13.0	
	Apr.	NW	15.4	
	May	SE	13.8	
	Jun.	NNW	10.8	
	July	NNW	9.9	
	Aug.	NW	13.4	
	Sept	NNW	12.6	
	Oct.	NW	11.3	
	Nov.	NNW	11.1	
	Dec.	ESE	10.9	

Figure 3. Graph showing the monthly amounts of precipitation in Martin, Bennett County, South Dakota, and tables showing the average monthly wind direction and speed in Rapid City, Pennington County, South Dakota for the years 1962 to 1964. Figures are from the U. S. Weather Bureau.
Abbreviations: P. W., prevailing wind; A. S., average speed.

Source Area

The White River Badlands, a semiarid region of exposed Tertiary sediments with a minimum of vegetative cover, is an ideal source area for the loess deposits in Shannon, Bennett, and Washabaugh Counties. The climatological data for western South Dakota showing wind direction and precipitation (fig. 3) substantiates this theory; the wet season is from April through June, and the dry season is from October through January. The wind direction at Rapid City is fairly constant from the north-northwest throughout the year.

In many parts of the Badlands of southern Pennington and northern Shannon Counties are small areas of the Sand Hills Formation. Many parabolic dunes are present and these dunes indicate a paleowind direction of azimuth 330 degrees (fig. 4), which coincides remarkably well with the climatologic data presented in figure 3.

Besides giving an indication of paleowind direction, the Sand Hills indicate one possible source area for the loess deposits of Bennett, Washabaugh, and Shannon Counties. Possibly the sand is a residue left behind when the wind was removing the smaller particles of the White River or Arikaree Groups to be deposited downwind as loess. It is doubted that the Sand Hills of the Badlands area are reworked remnants of the Ogallala Formation as they occur 900 feet lower in elevation than the deposition surface on the top of the Ogallala Formation in this general region.

The writer disagrees with Lugn (1962:64, 65) who insinuates that Badland areas could not directly contribute significant amounts of materials to the formation of loess.

Analyses of Samples

Several samples of loess were collected for analysis and the results are revealed in the histograms, figure 5. No interpretation of the histograms is presented here because the number of analyses is far too small to show any trends or to give more than a general indication of what is present. However, one characteristic noted in all samples was the relatively high percentage of volcanic ash in the very fine sand. Estimates of this percentage range from 7 to 40 percent ash for the five samples.

CONCLUSION

This paper serves mainly to call attention to the fact that loess, in mapable quantities, is present in South Dakota. In continued research, the writer intends to present more data on the age, rate of deposition, composition, correlation, and geographic distribution of loess in western South Dakota.

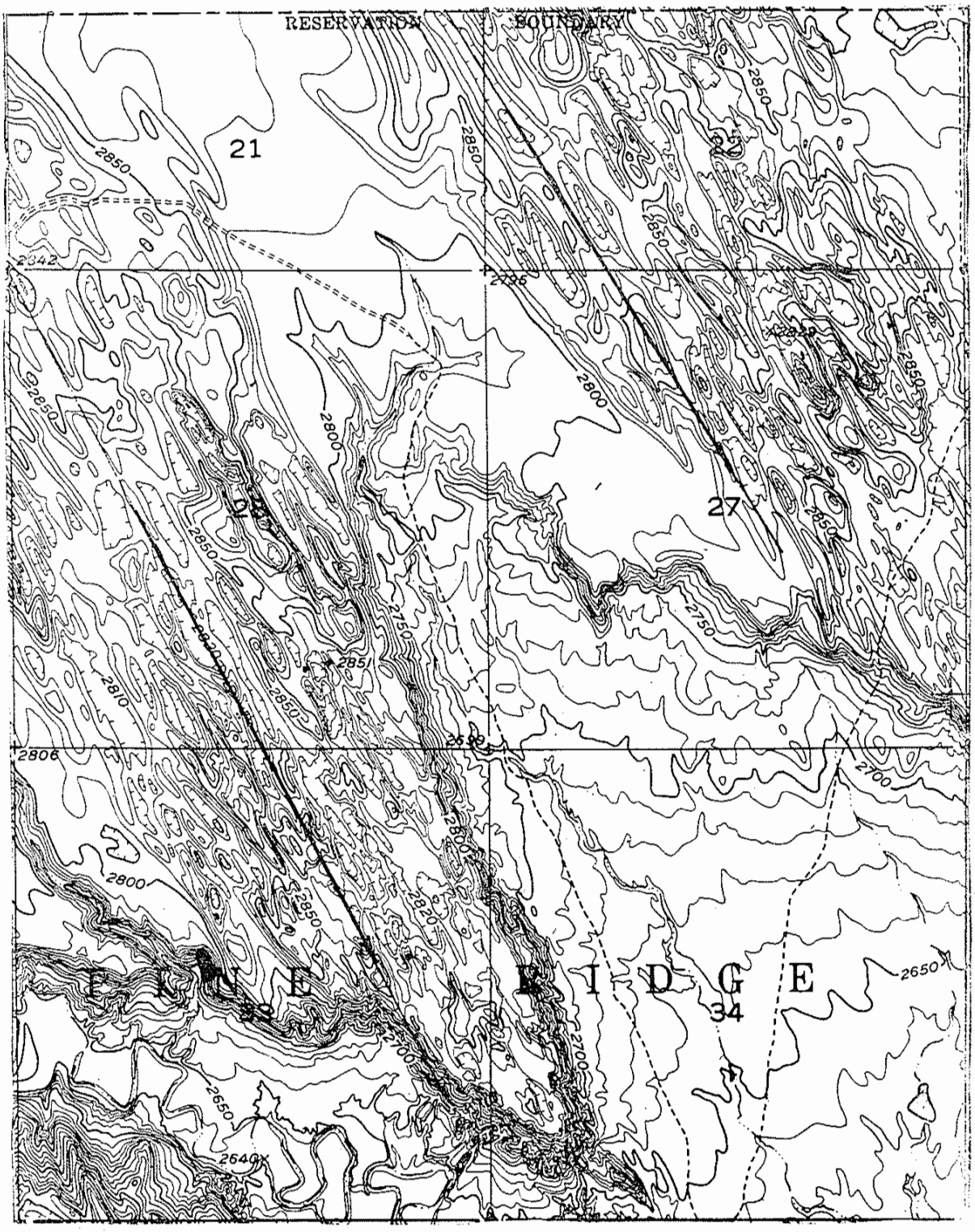


Figure 4. A portion of the Imlay quadrangle (United States Geological Survey, 1950) showing Sand Hills Formation in the White River Badlands. These sand dunes indicate a paleowind direction of azimuth 330 degrees. Arrows show the paleowind direction indicated by the dunes.

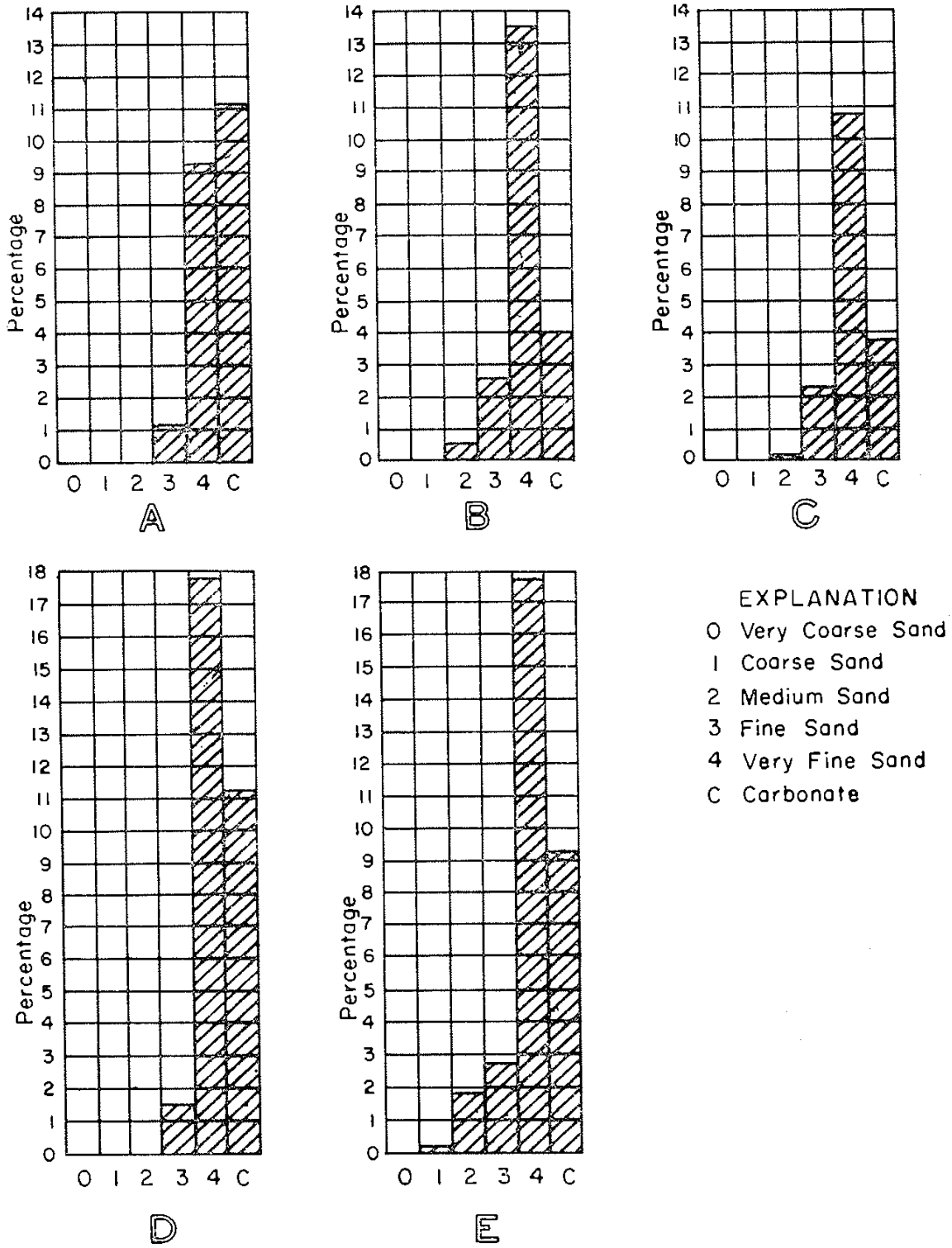


Figure 5. Histograms showing noncarbonate sand size (Wentworth scale) and carbonate percentages by weight of 5 samples of South Dakota loess. Samples A, B, D, and E are surface collected. Sample C is an auger sample taken between 14 and 19 feet in depth. Silt and clay factions were not determined.

A, SE¼ SE¼ sec. 11, T. 35 N., R. 46 W., Shannon County; B. sec. 20, T. 37 N., R. 41 W., Shannon County; C, SW¼ SW¼ sec. 6, T. 38 N., R. 39 W., Bennett County; D, NW¼ NE¼ sec. 12, T. 37 N., R. 37 W., Bennett County; E, NE ¼ sec. 5, T. 37 N., R. 37 W., Bennett County, South Dakota.

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CRETACEOUS ROCKS IN EASTERN PENNINGTON COUNTY, SOUTH DAKOTA

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ABSTRACT

The Cretaceous rocks that crop out in eastern Pennington County are the upper part of the Pierre Shale and the Fox Hills Formation. These strata are especially well exposed along the bluffs of the Cheyenne River and in the Creighton area.

The upper part of the Pierre can be traced over wide areas owing to the presence of several fossiliferous concretion zones.

In this area, the Fox Hills consists of a lower fossiliferous sandy shale herein called the Cheyenne River facies; the overlying Bullhead and "Colgate" Members, in most respects, are similar to their other exposures elsewhere in the State. Fossils can be collected from the upper members also.

In many places, these Cretaceous rocks are covered by the White River Group of Oligocene age or by chemically altered strata that represent an Eocene soil profile.

INTRODUCTION

The exposures of the Pierre Shale and Fox Hills Formation of Late Cretaceous age have been described in considerable detail along the northern part of the Missouri River valley in north-central South Dakota (Waage, 1961; Pettyjohn, 1961, 1964). These same rocks in eastern Pennington County, however, have received little attention. The purpose of this report is to describe the upper part of the Pierre and Fox Hills from the bluffs along the Cheyenne River to the northern edge of the Badlands National Monument in eastern Pennington County.

In its type area in Dewey County, S. Dak., the Fox Hills Formation has been divided into four members on the basis of lithology. These are, in ascending order: the Trail City, a marine fossil-bearing sandy shale; the fossiliferous Timber Lake Member consisting mainly of sand; the Bullhead Member, which locally contains a brackish-water fauna in an interbedded sequence of sand and shale; and the Colgate Member, which is predominantly sand or sandstone that contains oysters, snails, and locally a few marine fossils. In its type area, the Fox Hills conformably overlies the unfossiliferous gray shale of the Elk Butte Member of the Pierre Shale. Underlying the Elk Butte is the calcareous and fossiliferous Mobridge Member. At or near the top of the Mobridge is a concretion zone containing *Baculites clinolobatus* (Cobban, 1958). The top of this zone is about 250 feet below the base of the Fox Hills.