John C. Frye *, *H. D. Glass* *,
A. Byron Leonard **, *H. B. Willman* *

LATE PLEISTOCENE LOESSES OF MIDWESTERN UNITED STATES OF AMERICA

INTRODUCTION

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 (Frye & Leonard 1951) and Nebraska, northern Missouri and Iowa, Illinois, Indiana, and into Ohio.

In this report *loess* is used as a litho-genetic term, as is the general practice in midwestern United States, to refer to a deposit in which silt is the predominant constituent, but ranging from sandy silt to clayey silt. It is generally massive on megascopic inspection, but where coarse may display distinct, although inconspicuous lamination or even micro-cross-bedding. Where it has not been modified by weathering it is commonly more or less calcareous and contains fossil snail shells. It is generally gray, yellow-tan or tan. The term *loess* is restricted to those deposits that were deposited primarily by wind, although at some places they may have been modified by subsequent (or pene-contemporaneous) colluvial movement. Deposits that may have similar textural compositions but that are known from field relations (bedding, fauna, or micro-structure) to have been deposited primarily by water are referred to as silts but are not classed as loess.

Within this region loess constitutes the parent material of the surface soils over more area than any other rock type. Surficial loess deposits as thin as 1 to 2 feet exert an important influence on the development of soils, but because the stratigraphic relations of the very thin loesses are difficult to determine, the discussions here deal with the deposits that are more than 3 feet thick.

* Illinois State Geological Survey, Urbana, Illinois.
** University of Kansas, Lawrence, Kansas.

The loess deposits are generally derived from the broad alluvial flats of the valleys that carried outwash from late Pleistocene glaciers (Leonard & Frye 1954). The loess is thickest and coarsest on the downwind sides of the major source valleys (Swineford & Frye 1951; Smith 1942) but generally occurs at least as a thin veneer over the extensive upland divide areas. In the part of the region covered by continental glaciers, loess occurs interbedded with glacial till and outwash (figs. 1 and 2) and its characteristic molluscan faunas may thus be intercalated with the glacial deposits.

It is our purpose here to summarize the stratigraphy, mineralogy, and paleontology of the Illinoian and younger loess deposits of this region, show their age and stratigraphic relations to the glacial pulsations of the Lake Michigan glacial lobe, and briefly discuss their origin.

PHYSICAL STRATIGRAPHY

The rock-stratigraphic names used in this report are shown in figure 1. Rock-stratigraphic units (Frye & Leonard 1952; Frye & Willman 1960) are recognized for loess, as for other rock units, on the basis of li-

	ILLINOIS		CENTRAL GREAT PLAINS
WISCONSINAN	VALDERAN TWOCREEKAN		Bignell loess Brady soil
	WOODFORDIAN	Peoria loess / Richland loess (till) / Morton loess	Peoria loess
	FARMDALIAN	Farmdale silt and peat (till)	Basal transition zone
	ALTONIAN	Roxana loess and silt	Sand and gravel
SANGAMONIAN		Sangamon soil	Sangamon soil
ILLINOIAN	BUFFALO HART	Loveland loess	Loveland loess
	JACKSONVILLE PAYSON	(till)	Crete sand and gravel
		Petersburg loess and silt	
YARMOUTHIAN		Yarmouth soil	Yarmouth soil

Fig. 1. Stratigraphic names used for the loesses of midwestern United States in this report

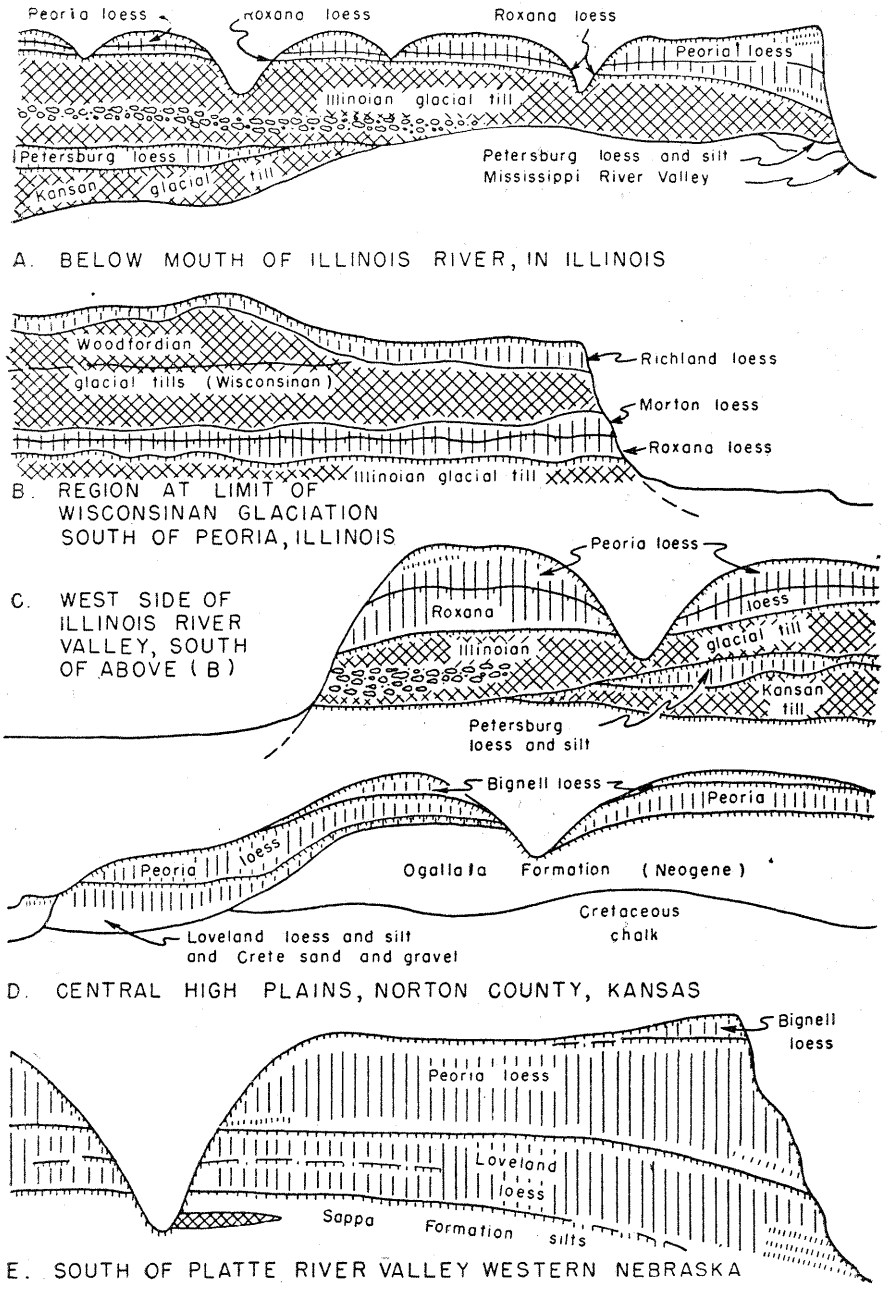

Fig. 2. Idealized sections showing the relations of the several late Pleistocene loesses in midwestern United States

thologic homogeneity, continuity, and the pressence of recognizable and traceable bounding units. In the region that is covered by glacial tills of the several advances of Illinoian and Wisconsinan glaciers, loess sheets occur stratigraphically between tills (figs. 2 and 3) and overlie the young till sheets. They also are bounded by buried soils, by zones of leaching that lack the morphologic character of soil profiles, by distinct changes in color or mineral composition, and (in the thick calcareous loesses) by characteristic and distinctive assemblages of fossil mollusks.

Within the glaciated region the various loess units can be stratigraphically related to the tills produced by the several glacial advances. Beyond the glaciated region the loess units are correlated with the glacial succession by stratigraphic tracing, by their contained buried soil profiles, by radiocarbon dates (in the Wisconsinan only) and by fossils. This permits the placement of the rock-stratigraphic units within the time-stratigraphic framework that has been developed for the glacial deposits of the Lake Michigan glacial lobe (fig. 1). For example, although the Peoria loess ranges somewhat in age, it essentially falls within the Woodfordian Substage of the Wisconsinan Stage, whereas the Richland and Morton loesses (which also fall within the time span of the Woodfordian) are time transgressing and represent only a part of the age of the Peoria (figs. 2, 3). The Roxana loess, on the other hand, embraces all of the loess of Altonian age and locally some of Farmdalian age.

In Illinois the time-stratigraphic substages are placed in time by radiocarbon dates determined in the Washington laboratory of the U. S. Geological Survey. Shells from the Roxana loess have yielded dates of 37 000 $\pm$ 1 500 (W-869), and 35 200 $\pm$ 1 000 (W-729) before the present (B. P.) which fall within the estimated time span from 28 000 to perhaps as old as 70 000 radiocarbon years for the Altonian. One radiocarbon date on shells and 10 dates on wood or peat from deposits of Farmdalian age range from 26 800 $\pm$ 700 (W-871) to 22 200 $\pm$ 450 (W-867). The Morton loess has yielded three radiocarbon dates on wood and moss which fall in the interval of 20 000—22 000 radiocarbon years B. P. Two dates on shells from the Peoria loess are 20 300 $\pm$ 400 (W-870), and 17 100 $\pm$ 300 (W-730).

Both the Loveland and Petersburg loesses occur within the Illinoian Stage. Both loesses are locally gradational with water-laid silts, and the rock-stratigraphic units — designated silts — contain both the loess and stratigraphically continuous water-deposited silt and are time-transgressing as shown in figure 3.

In the Great Plains (Swineford & Frye 1951) and in Illinois (Smith 1942), the several loess units have their maximum thicknesses

along the edges of the major valleys and thin progressively away from them, generally in an east-southeast direction. The rate of thinning is greater along the Mississippi, Illinois, and eastern Missouri River valleys than along the major valleys of the High Plains.

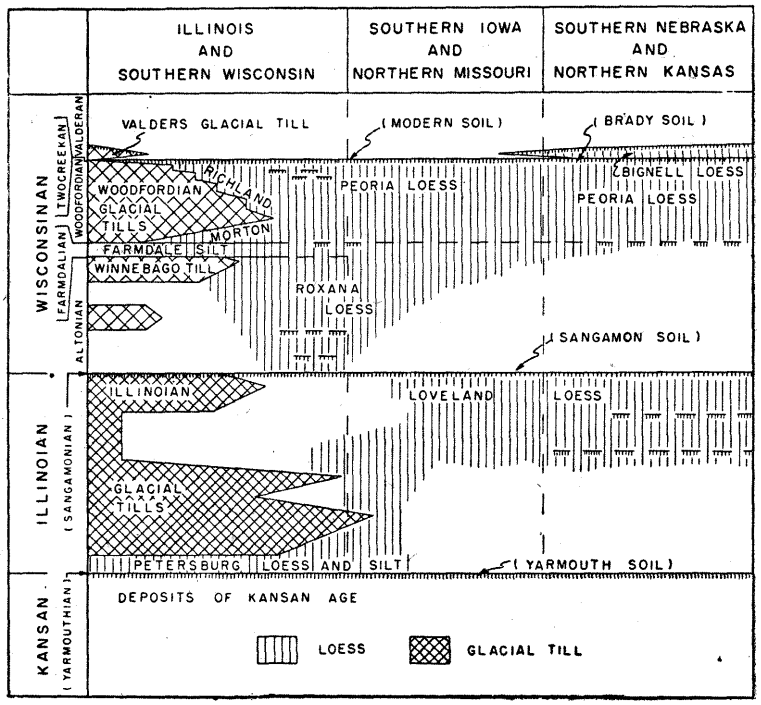

Fig. 3. Diagram showing the time-space relations of the several named stratigraphic units in the loesses to the glacial stages of the Lake Michigan glacial lobe of the midwestern United States of America

The buried soils developed in the loess deposits range widely in the great soil groups. The Sangamon soil is generally more maturely developed than today's surface soils of the same area and suggests a slightly wetter climate than that now prevailing. Across Illinois and Iowa and into eastern Kansas the Sangamon soil, where developed in well drained situations, ranges from Podzolic soils to Prairie Earth, and in poorly drained situations contains examples of Humic-gley or Wiesenboden. Westward across the High Plains this soil is progressively a Chernozem, Chestnut, and Brown soil. Where drainage conditions are similar, the several soils in the stratigraphic succession of a particular area fall within the same great soil group even though they have different degrees of development.

PETROLOGY AND MINERALOGY

The texture of midwestern loess has been extensively described (e. g., Smith 1942; Swineford & Frye 1951; Kay & Graham 1943). The loess falls predominantly within the size range from 10 to 50 microns, and quartz grains comprise 50 percent to 75 percent of this size fraction in unweathered loess; feldspar ranges from 10 percent to 20 percent; and calcite and dolomite range from 5 percent to 25 percent. Volcanic ash shards common in western Kansas (Swineford & Frye 1955), become progressively more rare eastward. Clay commonly comprises 5 percent to 20 percent of unweathered loess and the weathered loess may contain as much as 40 percent.

The clay mineral composition of loess may be expressed in amounts of four common clay minerals — montmorillonite, illite (mica), kaolinite, and chlorite. Identification and quantitative estimates are made by X-ray diffraction methods using oriented aggregate techniques.

Variation in composition is observed to depend on proximity to known sources. Compositions from the Illinois River Valley westward show a dominance of montmorillonite, but this mineral decreases in amount eastward from the Illinois Valley. The reverse is true for illite and chlorite.

Composition of the tills that reached Illinois from the east and northeast show a dominance of illite and chlorite, whereas compositions of tills from the western center show a dominance of montmorillonite. Loess may be considered as a physical mixture, the composition of which depends on the amount of contribution from different sources.

BIOSTRATIGRAPHY

Generally the late Pleistocene loesses of midwestern United States contain abundant stratigraphically and ecologically distinctive fossil molluscan assemblages, although the loesses of Illinoian age are locally barren. The Petersburg loess yields a fauna distinctly different from the overlying Roxana loess. The Petersburg fauna is comprised mainly of pupillids and other small gastropods of prairie and forest-border habitat preference, while the Roxana fauna is composed of species found in mesophytic hardwood forests. The Loveland loess fauna of the western-central United States is almost entirely a prairie fauna, except for the occurrence of a few hardy entodontids capable of living in habitats of shrubs and small trees. Everywhere in the region, the Illinoian loess faunas, when compared with the older Kansan faunas, evoke an ecological picture of lesser precipi-

tation and more extensive prairies. For example, extensive populations of varied kinds of branchiate snails occurring in Kansan deposits are unknown in Illinoian loess faunas (Leonard 1950, 1952). Biostratigraphic subdivision of Illinoian loesses is nowhere feasible.

Within the Wisconsinan substages, biostratigraphic subdivision has been made of the loesses both in the Great Plains region and in Illinois. In Illinois the Roxana loess yields a fauna characterized by large species of *Polygyridae* and *Entodontidae* endemic in forests; the Farmdale silt, from which only a few adequate faunas are known, possesses molluscan faunas lacking in large woodland species; whereas the Woodfordian loesses reveal abundant gastropod faunas characterized by large numbers of small species known to inhabit prairies and forest-border situations.

Four distinctive biostratigraphic zones are known from Wisconsinan loess in the Great Plains region. The basal zone of the Peoria loess contains a sparse fauna of small drought-resistant species; a middle zone produces extremely abundant and varied faunas characteristic of prairies and forest--border situations, such as might be found near streams, and the upper zone has an increased number of species related to sparse woodlands. In none of these biostratigraphic zones, however, are found the large woodland polygyrids and entodontid species, such as those found in the Roxana loess. Above the Brady soil of the Great Plains region, the Bignell loess contains a fauna essentially like the Recent and characterized by the absence of the greater part of the species found in the Peoria loess.

The correlation of the biostratigraphic zones in the Wisconsinan loesses of the Great Plains and of Illinois is inhibited by the lack of faunas in the intervening areas and the paucity of radiocarbon dates from the Great Plains region.

GENESIS

The loess deposits of midwestern United States are primarily the product of eolian transport and deposition of silts derived from extensive valley flats that were being alluviated during episodes of glaciation. The eolian origin of these loess deposits is demonstrated by the following relationships.

(1) Loess units are stratigraphically continuous from terraces to gentle slopes to upland divides, and in some places buried soils can be traced from one to the other (fig. 2).

(2) The loess is thickest and coarsest along the bluffs of source valleys and becomes thinner and finer across the uplands away from these sources (Smith 1942; Swineford & Frye 1951).

(3) Commonly there is a back slope on the surface adjacent to the

source valleys; furthermore, the minor soils that occur in the upper part of the thickest loess sequences also slope away from the valley bluffs.

(4) The mineralogy of the loess generally reflects that of the outwash in the source valleys.

(5) Radiocarbon dates (Frye & Willman 1960; Leonard & Frye 1960) demonstrate that loess in some places is contemporaneous with nearby glacial deposits.

(6) The fossil molluscan faunas require an ecology that can be accommodated by eolian deposition.

(7) The interrelation of the loess with dune sands in the High Plains and the Illinois River valley suggests an eolian origin.

Although the midwestern loesses are derived from valleys by wind action, colluvial movement has occurred on many slopes, and in some tributary valleys water action has eroded and redeposited these silts to produce a deposit whose appearance is similar to that of the valley fills. Although the deposits on slopes may be referred to as colluvial loess, in the Middle West such water-deposited sediment is classed as alluvial silt and not as loess.

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