Proceedings of the Iowa Academy of Science

Volume 66 | Annual Issue Article 42

1959

Characteristics and Distribution of Some Missouri River Deposits

J. L. Glenn
Iowa State University

A. R. Dahl
Iowa State University

Characteristics and Distribution of Some Missouri River Deposits

By J. L. GLENN and A. R. DAHL

Abstract. The alluvial valley of the Missouri River adjacent to Iowa is being investigated to determine the geologic and engineering properties of alluvial deposits. The environment in which the alluvium accumulates is believed to control the nature and distribution of the deposits. The fundamental methods and tools of geomorphology are being used to delineate alluvial environments. Data are presented on the range of particle size and frequency of textural distribution for several deposits mapped as occurring in similar environments.

The purpose of this research is to determine the relationships between the occurrence and distribution, and physical, chemical and mineralogical properties of Missouri River alluvial deposits. The data necessary for the development of stabilization methods for base and subbase road construction with alluvium will be derived from the results.

This research, conducted jointly by the Iowa Engineering Experiment Station and the Geology Department, Iowa State College, is part of the Iowa Highway Research Board Project HR-1, Iowa Engineering Experiment Station Project 283-S. Special acknowledgment is given to Dr. C. J. Roy of the Geology Department and to members of the staff of the Iowa Engineering Experiment Station for many helpful suggestions concerning the organization and presentation of this subject matter.

PREVIOUS STUDIES

Many workers in recent years have made significant contributions to an understanding of stream processes and sedimentation. Some attempts have been made to understand better the complex factors involved in erosion and deposition by streams on floodplains (Leopold and Miller, 1956; Leopold and Wolman, 1957; Wolman and Leopold, 1957).

Many of the data now available on the Missouri River and its tributaries have been collected and published in various government publications. The accumulated records of the Corps of Engineers (1935; Memo. 18) are being used to describe the nature of the modern Missouri River and its sediment load. Records of borings by the Corps of Engineers, both to bedrock and to moderate depths, are available to supplement borings made during this research.

Previous work conducted by the Engineering Experiment Station and the Geology Department directly applicable to the present study includes the work on the "blanket bar" sand deposit (Williams, 1953) associated with Blue Lake near Onawa, Iowa. The work on the fine-grained deposits associated with the Fairbanks-Big Delta (Lindholm, *et al.*, 1957) and Matanuska Valley (Stump, *et al.*, 1956) regions of Alaska are important for the concepts developed therein. Studies on the silt deposits (Dahl, 1958; Davidson, 1956; Handy and Davidson, 1956) genetically related to the Missouri River are also of interest to the present study.

In the 1940's the Mississippi River Commission, recognizing the importance of alluvial deposits to river control problems in the lower Mississippi River Valley, sponsored a series of geological investigations to determine the nature and effects of alluvial deposits on river activity. The published results comprise the basic literature on alluvial geomorphology and alluvial deposits (Fisk, 1944, 1947, 1952).

Three major and three minor environments of alluvial deposition are recognized. The deposits in each of these are sufficiently different to permit separation on the basis of textural characteristics. The environments are: (1) lakes or slack water areas in abandoned channels and sloughs, (2) flood basins, (3) deltaic plains, (4) braided channels, (5) point bars, and (6) natural levees. All of these environments of deposition except the deltaic plains should occur, at least locally, in the Missouri River Valley.

Geomorphology of the Floodplain

The alluvial valley of the Missouri River adjacent to Iowa may be divided into three segments on the basis of floodplain width and channel characteristics.

The upper segment extends from Sioux City to Crescent City, Iowa. In this segment the floodplain is widest, ranging from five to sixteen miles. The channel, under natural conditions, is of the meandering type with an average gradient of 1.00 foot per mile.

The middle segment extends from Crescent City, Iowa, to the mouth of the Platte River, some 29 river miles. Here the valley is conspicuously narrow, averaging 4.5 miles in width. The channel meanders, and the average gradient is .47 feet per mile.

The lower segment extends from the mouth of the Platte to the Iowa-Missouri state line. Here the channel is of the braided type with a gradient of 1.33 feet per mile. In the lower segment the valley width ranges from five to seven miles.

Each of the environments and associated deposits of the modern river has a particular geomorphic expression and as such can be delineated on aerial photographs or on accurate topographic maps.

In the northern part of the valley, which includes the upper and middle segments, the river has a sinuous channel which is free to fashion its course in alluvium. The environments in this segment are those associated with a meandering stream. They are: (1) channel and slough, (2) flood basin, (3) point bar, and (4) natural levee.

Channel and slough deposits occupy arcuate areas with a width and curvature of typical Missouri River channels. The concave bank is marked by a relatively abrupt scarp ranging from three feet to about twenty feet in height. The convex bank merges gradually with the undulating swells and swales of the point bar deposits. The geomorphic expression of a channel fill and associated point bar on the Browers Bend traverse is shown (Figure 1).

Figure 1. Channel and point bar geomorphic expression on the Brower's Bend traverse. The constriction of the channel on the lower arm of the lake was probably the primary factor which caused the upstream and downstream arms of the old channel to converge and cut off the meander loop.

Point bar deposits are the accretion deposits on the convex side of the channel inside meander loops. The topographic expression is characterized by parallel, arcuate ridges and swales (chutes). On

Proceedings of the Iowa Academy of Science, Vol. 66 [1959], No. 1, Art. 42

aerial photographs the chutes appear darker than the ridges, and some may be occupied by lakes.

Since the Missouri River has no pronounced natural levees, it has no environment strictly analogous to the "flood basin" of the lower Mississippi valley. For the present at least, we are using the term "flood basin" for that portion of the floodplain which is periodically covered by flood waters, and on which little or no relief is apparent. The relief present is that inherited from buried channels and point bars, or channels of tributaries which, prior to the levee system, wandered over this surface and served as sites of local deposition. The geomorphic expression of the flood basin environment near Luton, Iowa, along the Browers Bend traverse is shown (Figure 2).

Figure 2. Geomorphic expression of the "flood basin" environment near Luton, Iowa. The only appreciable relief of this, that of an old channel of a small tributary stream which once flowed through the town of Luton.

From Plattsmouth, Nebraska, south to Nebraska City, Nebraska, the gradient of the river is 1.33 feet per mile and the channel is braided, or at least it assumes a pattern intermediate between meandering and braiding (Figure 3). Within this segment, floodplain relief is somewhat subdued and irregular. Deposits in old channels and on point bars are similar, and extensive areas of sand occur at or near the surface. It appears that this area represents an extensive alluvial fan of the Platte River which is being reworked by the Missouri River. Additional field work will be necessary to permit a final analysis.

Figure 3. Nature of the Missouri River and geomorphic expression of the floodplain environment below the mouth of the Platte River and along the Nebraska Bend traverse.

Field Work

Preliminary study of the valley using detailed topographic maps, controlled mosaics, and stereoscopic aerial phtotographs permitted detailed planning of the field work.

Four areas, having geologic significance by showing obvious, mappable, recent alluvial features typical of the floodplain, were selected for traverse locations. In order to check the influence which the Platte River exerts on the Missouri, one traverse was located below the Platte and extends from Nebraska Bend (River mile 581) to the bluffs near the Waubonsie State Park in Fremont County. Since no significant changes could be correlated with other major tributaries, the remaining 3 traverse areas were selected primarily on the basis of obvious alluvial features, and spaced to provide maximum coverage of the valley. These traverses are (1) from Pigeon Creek Bend (River mile 645) to the bluffs near Crescent City, Iowa, (2) from Sand Point (River mile 678) to the mouth of Willow River, and (3) from Brower's Bend (River mile 746) to the bluffs near Luton, Iowa.

Field work in these areas consisted of detailed confirmation and extension of descriptive data on all recognizable geomorphic features. Investigation of the deposits associated with identifiable environments was made by boring with hand and power augers. Depths of penetration ranged to sixty feet.

Samples of the deposits in each environment were then analyzed for textural variation in the laboratory.

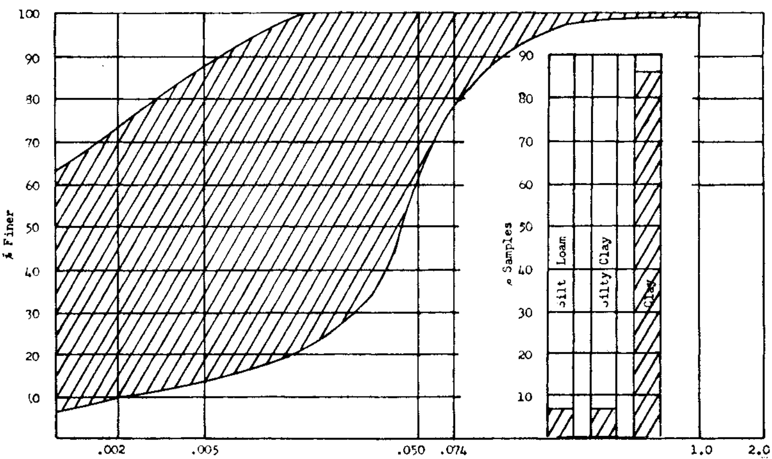
Presentation of Data

Channel and Slough Fillings

The most easily recognized areas of deposition are former channels cut off and isolated from the present river, but not so completely filled as to obscure old bank lines. The most distinctive features of the channel fill material are the blue-black color, the odor of decaying organic matter, and the high percentage of fine-grained material. The material is generally calcareous and plastic. The water table is variable, ranging from three to eighteen feet. The maximum thickness of such a deposit was not reached, but it is more than twenty-eight feet. The thickness is governed primarily by the shape attained by the former stream cross-section. Table 1 shows the range in cumulative curves and the frequency distribution for forty-three samples from thirteen holes drilled in nine different channel and slough fillings.

Table 1

Range in Cumulative Curves for 43 Samples From 13 Different Channel Fillings and Percentage of Each Textural Class Represented. In this and the Following Tables, Textural Classes Are Those of the U. S. Bureau of Public Roads Classification Scheme. Grade Limits Are: Clay Less Than 5 Microns; Silt Greater than 5 Microns and Less than 74 Microns; Sand Greater than 74 Microns and Less than 2 mm.

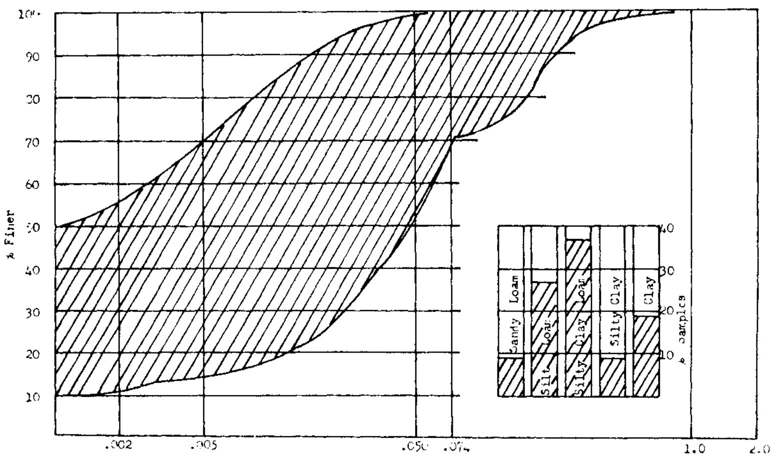


Point Bars

Point bars of the modern river accumulate on the inside of actively enlarging bends and are almost entirely of sand and silt-sized particles. When the meander loop is first cut off, the old channel receives a reduced volume of water and begins to fill. During floods, the point bars also become inundated and mantled with fine-grained alluvial material. Deposits of the point bar environment can naturally be divided into the fine grained *topstratum* and the *substratum* sands and silts.

Table 2

Range in Cumulative Curves for 11 Point Bar "Topstratum" Samples From 10 Different Holes and the Percentage of Each Textural Class Represented



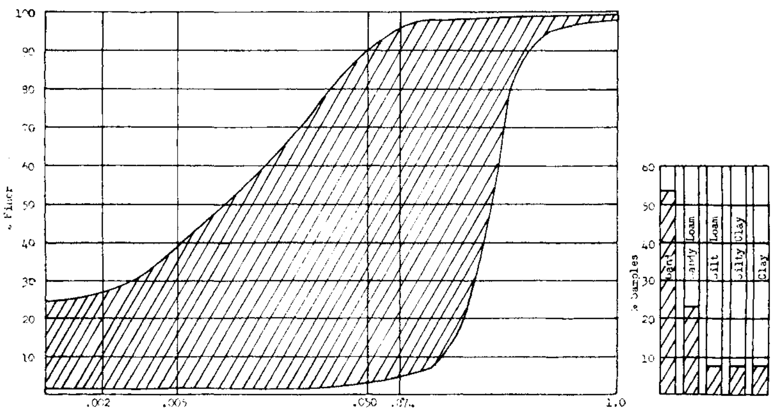
The thickness of the topstratum varies from zero in the most modern to twelve, plus or minus a few feet, in the recognizable deposits of this nature in the oldest meanders. The color varies from organic rich black to gray and red. The water table usually is at or near the base of the topstratum. The topstratum is generally calcareous, and small concretions may occur in the deposit.

The substratum sands form the base upon which fine-grained material is deposited in varying thicknesses. The sands are generally gray in color and calcareous, with scattered thin lenses of silt and clay throughout. Textual analyses show a progressive coarsening in texture downward. The maximum thickness of this type of deposit is unknown. The lateral margins are the convex inside boundaries of cut-off meander loops with which they are associated.

Ten holes were bored into recognized deposits of point bars and twenty-three samples were taken. Table 2 and Table 3 show the frequency distribution and range of particle size for eleven topstratum and twelve substratum samples.

Table 3

Range in Cumulative Curves for 13 Point Bar "Substratum" Samples From 10 Different Holes and the Percentage of Each Textural Class Represented



Flood Basin

The flood basin environment is the most extensive of the three major types occurring in the northern segment of the valley. It is bounded on the riverside by easily recognized meander belt scars of the modern river and extends to the bluffs. Sites of minor tributary deposition are undifferentiated and are included in the flood basin environment.

The deposits of this environment are generally mottled yellow-brown in color, locally rich in organic matter, and calcareous. The thicknesses of these deposits vary widely. Sediments having the characteristic color of channel filling deposits may be at varying depths. When the surface deposits of the flood basin environment are penetrated they are underlain by sands which coarsen progressively downward.

Table 4 shows the range in cumulative curves and the frequency distribution of textural classes for fifty-five flood basin samples from eighteen different holes.

Natural Levee

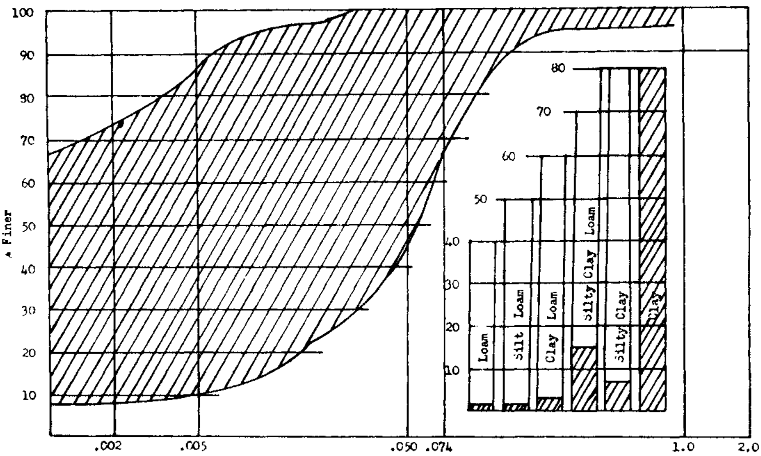
The environments and associated deposits of the Missouri River Valley are similar to those in the lower Mississippi River Valley, except for the lack of prominent natural levee deposits. The reasons for this difference are not well understood.

Results and Conclusions

Any positive conclusions about Missouri River deposits are believed to be premature. With additional field observations and more detailed property studies (petrography, X-ray, DTA, etc.,) a more

Table 4

Range in Cumulative Curves for 55 Flood Basin Deposits From 18 Holes and the Percentage of Each Textural Class Represented



accurate evaluation may be made. The method of mapping deposits definitely has merit in that it is relatively easily accomplished, and, with field observations of a number of deposits, it may lead to correlations in both geologic and engineering properties.

Literature Cited

Corps of Engineers. 1935. Report on the Missouri River: House Document No. 238 United States Government Printing Office, Washington, D. C.

Corps of Engineers. Sediment Characteristics of the Missouri River Soux City to Mouth. Memorandum No. 18. (Mimeograph) Corps of Engineers, Omaha, Nebraska.

Dahl, A. R., *et al.* 1958. Variation of Loess Thickness and Clay Content in Southern Iowa. Iowa Acad. Sci. Proc. V. 64.

Davidson, D. T., *et al.* 1956. Depth Studies of the Wisconsin Loess in Southwestern Iowa. Iowa Acad. Sci. Proc. V. 63.

Fisk, H. N. 1944. Geological Investigation of the Alluvial Valley of the Lower Mississippi River, Mississippi River Commission, Vicksburg, Miss.

———. 1947. Fine-Grained Alluvial Deposits and Their Effects on Mississippi River Activity, Waterways Experiment Station, Vicksburg, Miss., V. 1 and 2.

———. 1952. Geological investigation of the Atchafalaya Basin and the Problem of Mississippi River Diversion, Waterways Experiment Station, Vicksburg, Miss., V. 1 and 2.

Handy, R. L. and Davidson, D. T. 1956. Evidence of Multiple Loess Deposition in Western Iowa. Iowa Acad. Sci. Proc. V. 63.

Leopold, L. B., and Miller, J. P. 1956. Ephemeral Streams—Hydraulic Factors and Their Relation to the Drainage Net. Geol. Survey Prof. Paper 282-A. United States Government Printing Office, Washington, D. C.

Leopold, L. B., and Wolman, M. G. 1957. River Channel Patterns: Braided, Meandering and Straight. Geol. Survey Prof. Paper 282-B. United States Government Printing Office, Washington, D. C.

Lindholm, G. F., *et al.* 1957. Geologic and Engineering Properties of Silts Near Big Delta and Fairbanks, Alaska. Iowa State College Engr. Exp. Sta. Project 320-S. Report for Office of Naval Research. Contract Nonr 530(04).

Spangler, M. G. 1951. Soil Engineering. International Textbook Company, Scranton, Pa.

Stump, R. W., *et al.* 1956. Properties Studies and Geological Occurrence of Silt Deposits in the Matanuska Valley, Alaska. Iowa State College Engr. Exp. Sta. Project 320-S. Report for Office of Naval Research.

Williams, W. W. 1953. Properties of Five Iowa Fine Sands. Iowa Acad. Sci. Proc. V. 60.

Wolman, M. G. and Leopold, L. B. 1957. River Flood Plains: Some Observations in Their Formation. Geol. Surv. Prof. Paper 282-C, United States Government Printing Office, Washington, D. C.

IOWA ENGINEERING EXPERIMENT STATION
IOWA STATE UNIVERSITY
AMES, IOWA