1957

Multiple Till in North Dakota

William E. Flewitt

MULTIPLE TILL IN NORTH DAKOTA

A Thesis

Presented to

the Faculty of the Department of Geology

University of North Dakota

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science of Geology

---

by

William E. Flewitt

January 1957

Approved

Gr

CONTENTS

ILLUSTRATIONS

MULTIPLE TILL IN NORTH DAKOTA

by

W. E. Flewitt

ABSTRACT

The purpose of this paper has been to provide more detailed information on the pleistocene geology of North Dakota. Field and laboratory studies have been completed on a glacial till exposure in the Inkster area. From the results obtained, it is the belief of the author that multiple till does occur in North Dakota.

INTRODUCTION

Purpose of the Survey.

Because of the relatively small part of the glaciated portion of the state that is geologically mapped in detail, the Pleistocene stratigraphy of the state is as yet largely unknown. This invertigation was conducted in order to study the exposed till separated by striated boulder pavement along the Forest River.

Method of Investigation.

Automobile transportation was utilized for travel to the site of study. Three days were spent in the field mapping the topography, measuring a vertical section, and describing the stratigraphy of the till. Samples were collected for sieve analyses of the lower gray till, the upper buff till, and the channel deposits in the upper buff till. Field work was completed in October, 1956.

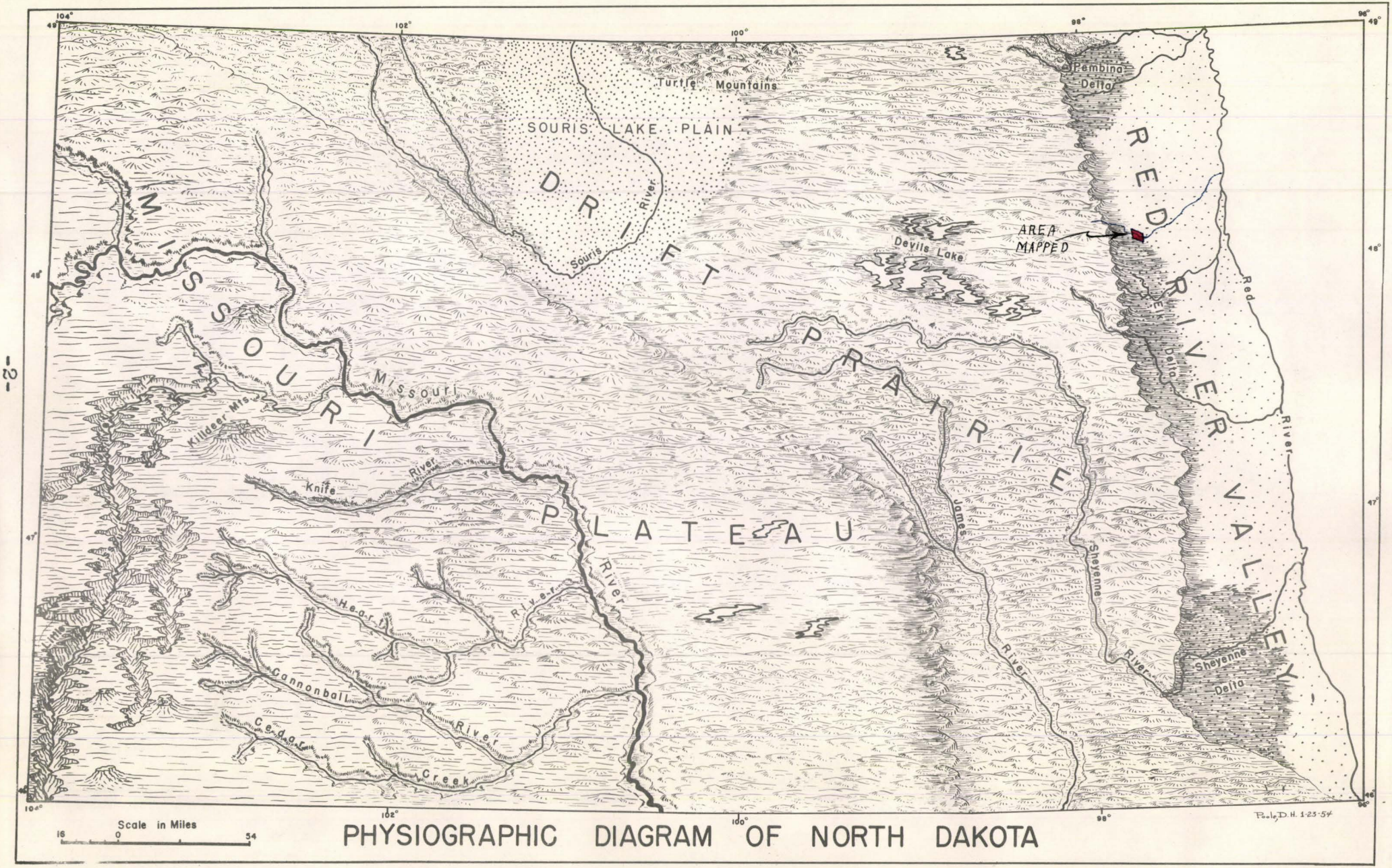


Figure 1. Index Map of North Dakota

Location of the Area.

Geographically, the area of investigation is located in the S. W. $\frac{1}{4}$, Sec. 11, T. 154 N., R. 55 W., in northwestern Grand Forks County, North Dakota. (Figure 1.) The exposure of till is on the north cut bank of the Forest River, two miles west and one mile north of the town of Inkster. The University of North Dakota Biological Grounds are adjacent to the east as shown on the topographic map in figure 2.

Physiographically, the area lies within the Glacial Lake Agassiz Lake Plain. The Forest River drains the area to the west and flows east at this point toward the Red River. It has cut down through the general lake level and also at this point, through the Norcross beach which trends west of north.

The dimensions of the area included in this report are 900 feet by 600 feet.

Acknowledgments.

I wish to express my deep appreciation to Dr. Gordon L. Bell for suggesting this problem, his invaluable suggestions, assistance, criticisms and continued interest in the preparation of this report. To Fred M. Julian, I express appreciation for his helpful field assistance and contribution of the photographs.

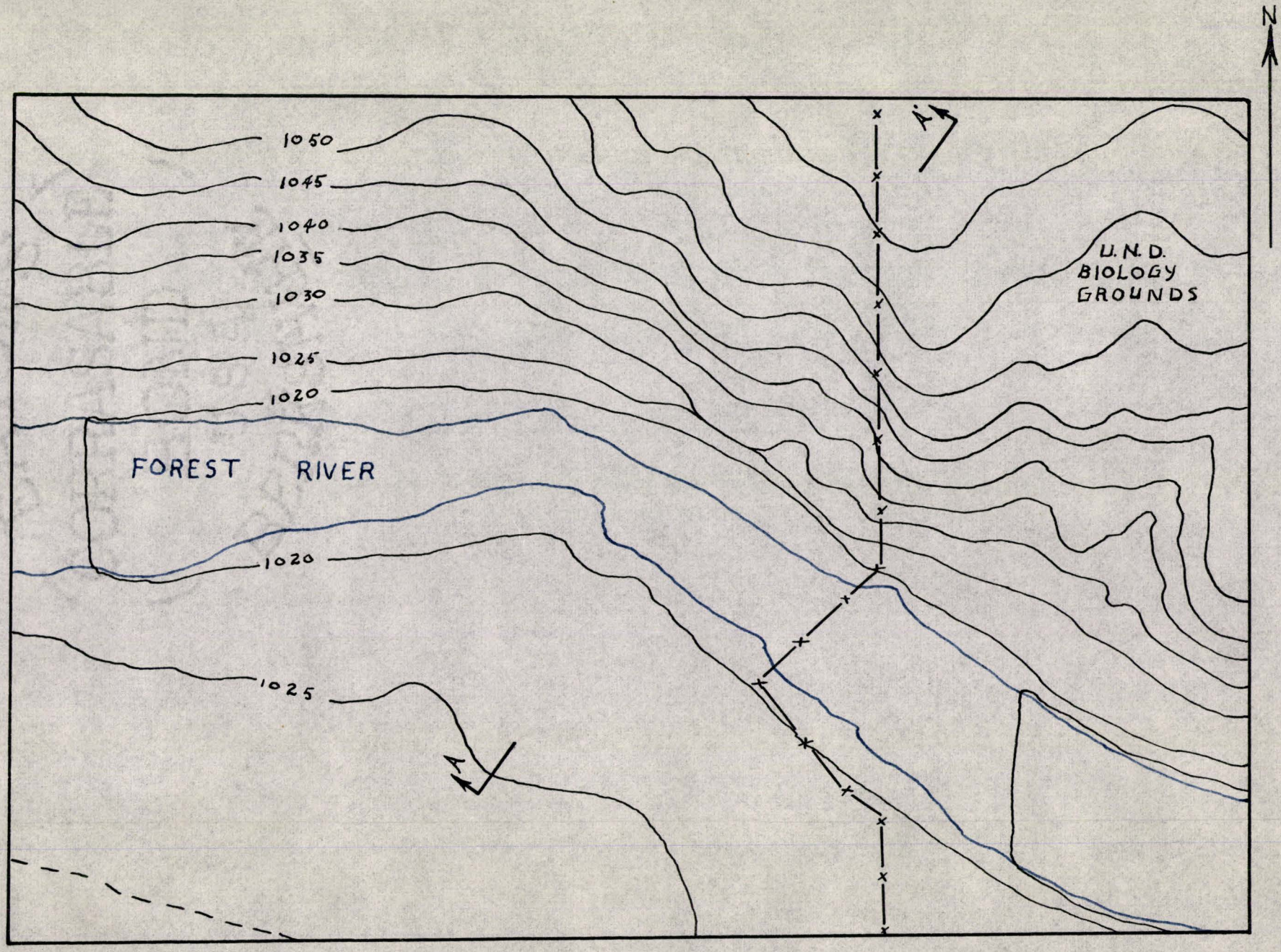


Figure 2. Topographic Map of Till Area

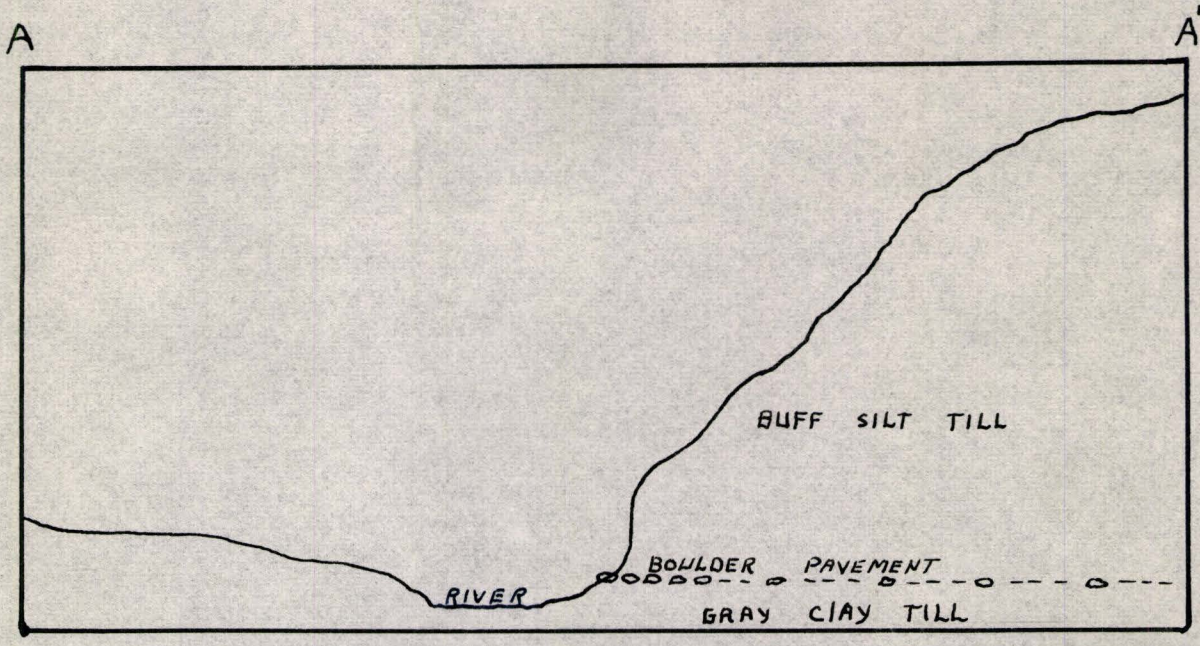
GENERAL SETTING

The topography of the area under consideration as shown in figure 2., is characterized by landslides. These landslides have apparently developed in the upper buff silt till in response to oversteepening as the Forest River dissected the Norcross beach. The till under consideration is exposed along the north bank of the stream in a vertical cliff 15 feet high, see figure 3.

Figure 3. Photo of General Area

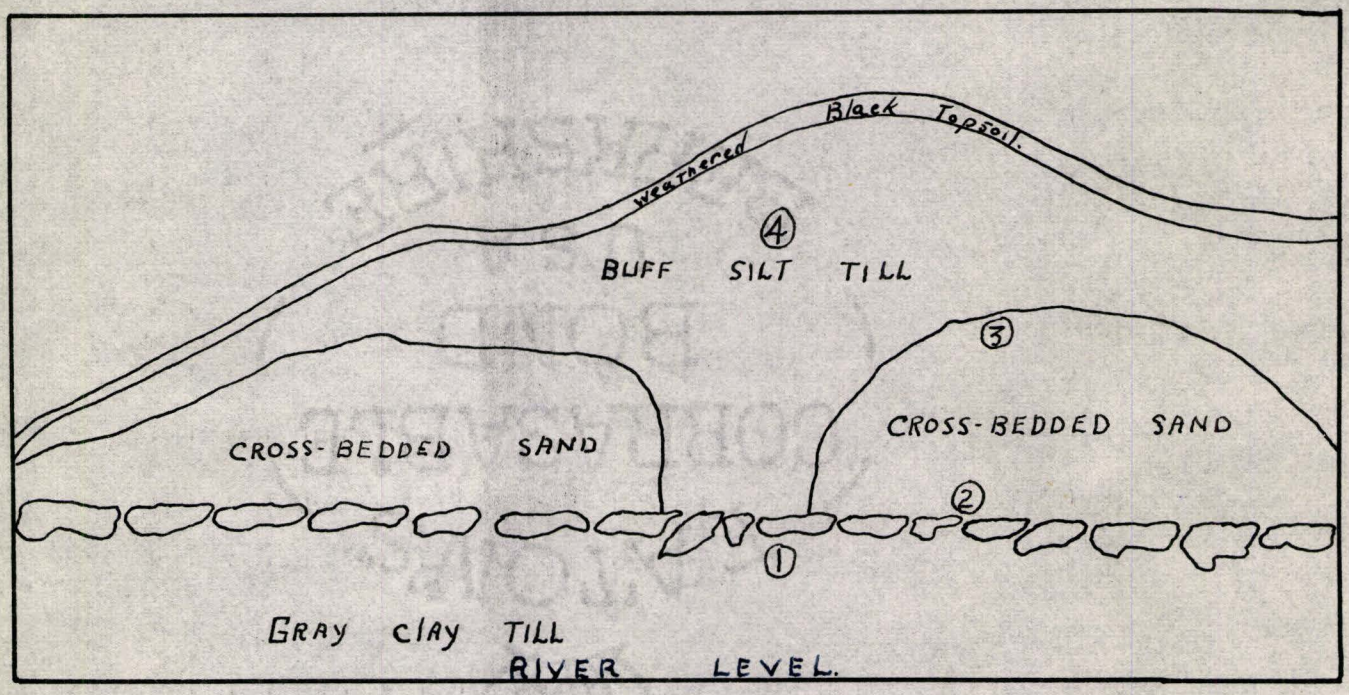
STRATIGRAPHY

As shown in figure 3 and figure 4, the contrasting gray lower till with well developed boulder pavement and the overlying tan silt till are suggestive of two distinct glacial tills.



Horizontal 1" = 50'
Vertical 1" = 20'

Figure 4. Cross-section Showing North Cut Bank of Till Exposure.



Horizontal 1" = 10'
Vertical 1" = 5'

Figure 5. Line-drawing Showing North Bank of Exposure Site.

Detailed Stratigraphy.

Three feet of uniform gray clay till are exposed above the stream level. This material is carbonaceous with included pebbles up to 15 mm. in diameter. Thin lenses of brown silty clay are in evidence. A high shale content was noted. The mass is tightly compacted.

Firmly embedded at the top of the gray till is a boulder pavement, one foot thick, with the surface of the boulders uniformly beveled. Some show triangular facets with the last facet parallel or sub-parallel with the major bevelled edges of the other boulders. All boulders in the pavement are uniformly striated S. 20° E., see figure 6. Many boulders show iron staining. Kinds of boulders found were: limestone, granite, diorite, gabbro, dolomitic limestone, very fine grained sandstone, and a few Pierre shale fragments. Elevation of this point of the boulder pavement is 1020 feet above sea level. The pavement has a two degree dip to the east.

Overlying the boulder pavement is eleven feet of exposed buff silt till, see figure 7. This overlying silt till contains irregular zones of cross-bedded torrential sand and gravel (figure 8) with the appearance in part of outwash type material, see figure 5. Also this till shows vertical joints with a strike of N. 25° W. A low shale content was noted and a few pebbles and cobbles.

Figure 6. Photo of Straie on Boulder in Place.

Figure 7. Photo of Contact of Tills with Pavement.

SEDIMENTOLOGY

Sieve analyses were made of the samples of the various types of till collected.

Sample number one was collected directly below the boulder pavement of the compact gray clay till in a one foot vertical section. From the histogram in figure 9, it can be seen that this material is completely unassorted and is four modal. According to Wentworth's Grade Scale the largest percentage is classified as silt and below into the clay size. This is with a diameter of .062 and smaller. The second mode occurs in the fine sand grade with a diameter of .250 mm. to .125 mm. The material

Figure 8. Photo of Channel Deposits.

classified in the pebble and granule size is mostly fragments of Pierre shale, these constitute phenoclasts embedded in a clay matrix. The cumulative curve of figure 10 is characteristic of unassorted material in that it has no regular pattern, rising sharply at two points.

Sample number two was collected directly above the boulder pavement in the upper buff till of sorted sand and gravel deposits. The histogram, see figure 11, of this material shows a marked difference from the former histogram of the underlying till. This sand, as classified with the Wentworth Grade Scale, is primarily coarse with a diameter varying from 1.00 mm. to .500 mm. This sample contains 5.5 percent of fine pebbles, but only one percent silt. The accompanying cumulative curve of figure 12, shows very nicely the uniform rise with a gradual levelling off to 100 percent.

The third sample collected five feet above the boulder pavement consists of unassorted cross-bedded sand and gravel. The histogram of figure 13 illustrates that the zone of channel deposits in the upper till is gradational from a sorted coarse sand upward to an unassorted sand and gravel. Very little very sand and silt are present with the larger percentages of 17.5 percent to 23.5 percent having a diameter range from eight millimeters to .250 millimeters.

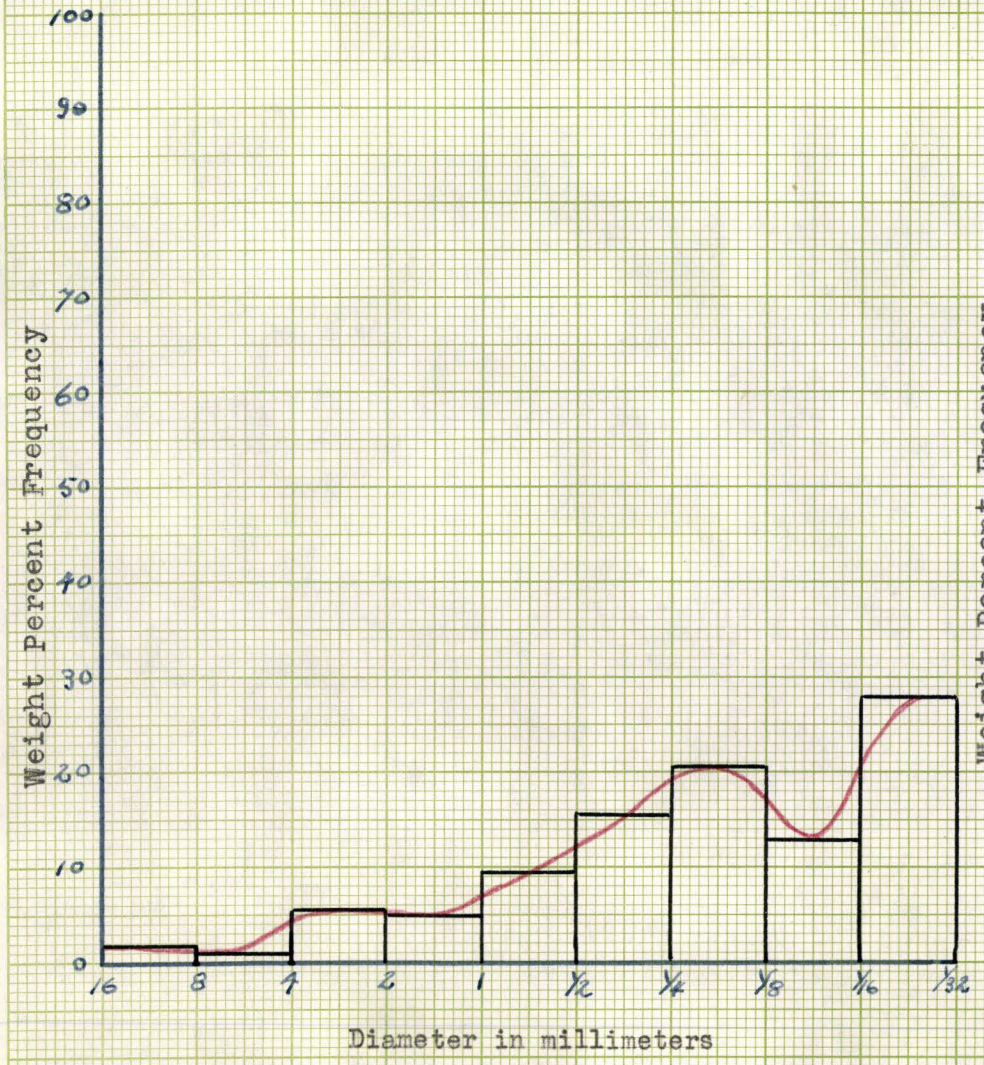


Figure 9. Histogram of Sample Number 1.

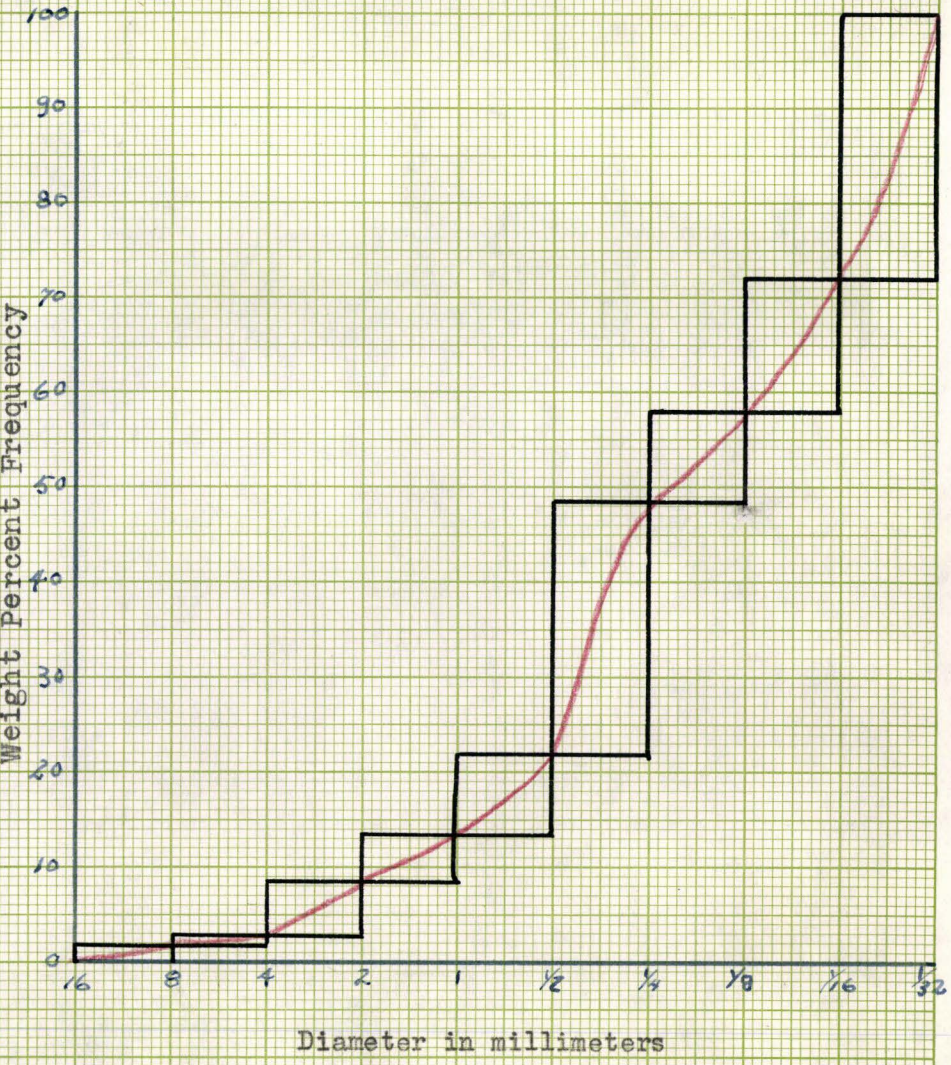


Figure 10. Cumulative Curve of Sample Number 1.

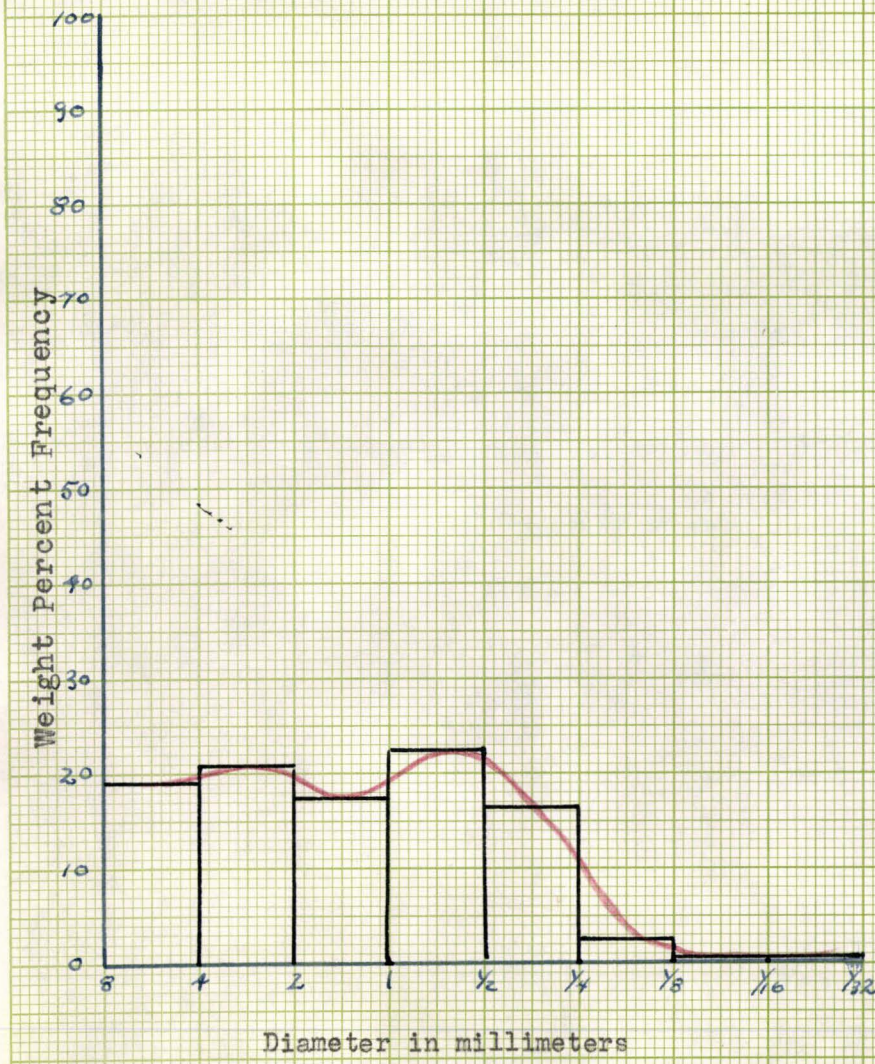


Figure 13. Histogram of Sample Number 3.

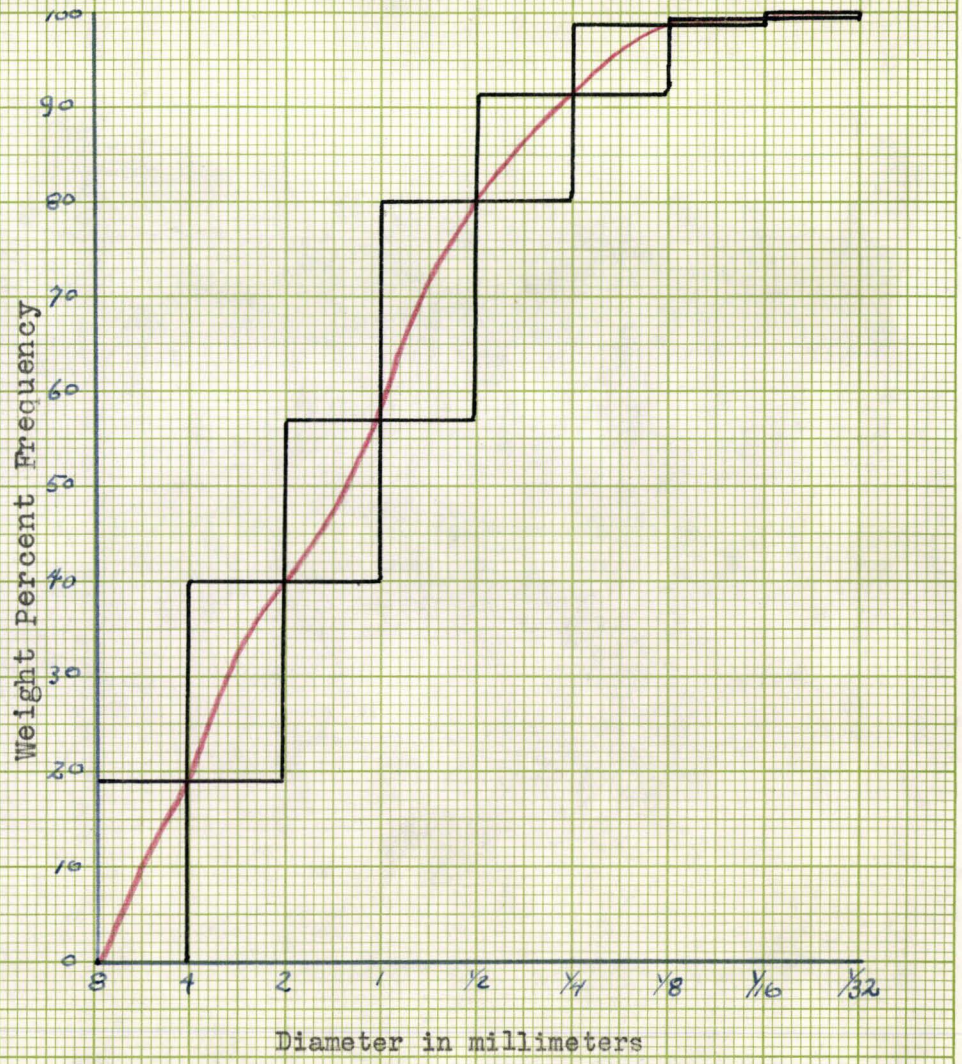


Figure 14. Cumulative Curve of Sample Number 3.

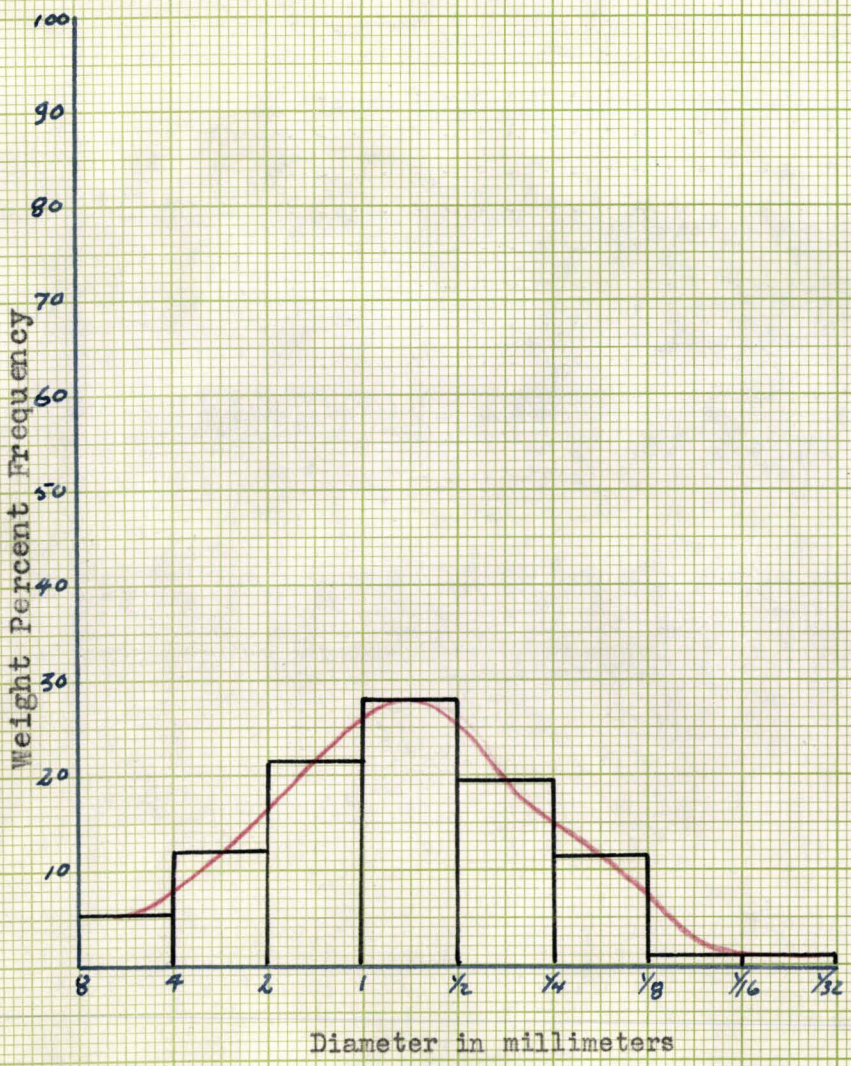


Figure 11. Histogram of Sample Number 2.

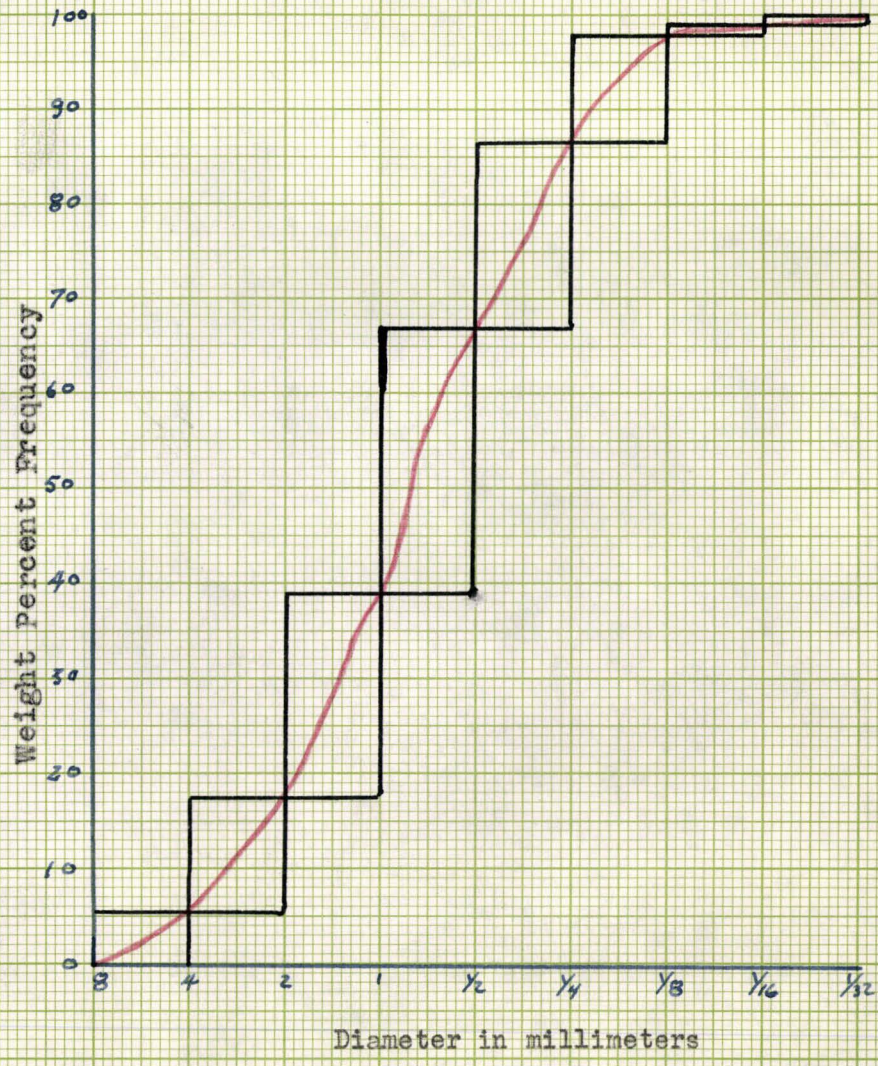


Figure 12. Cumulative Curve of Sample Number 2

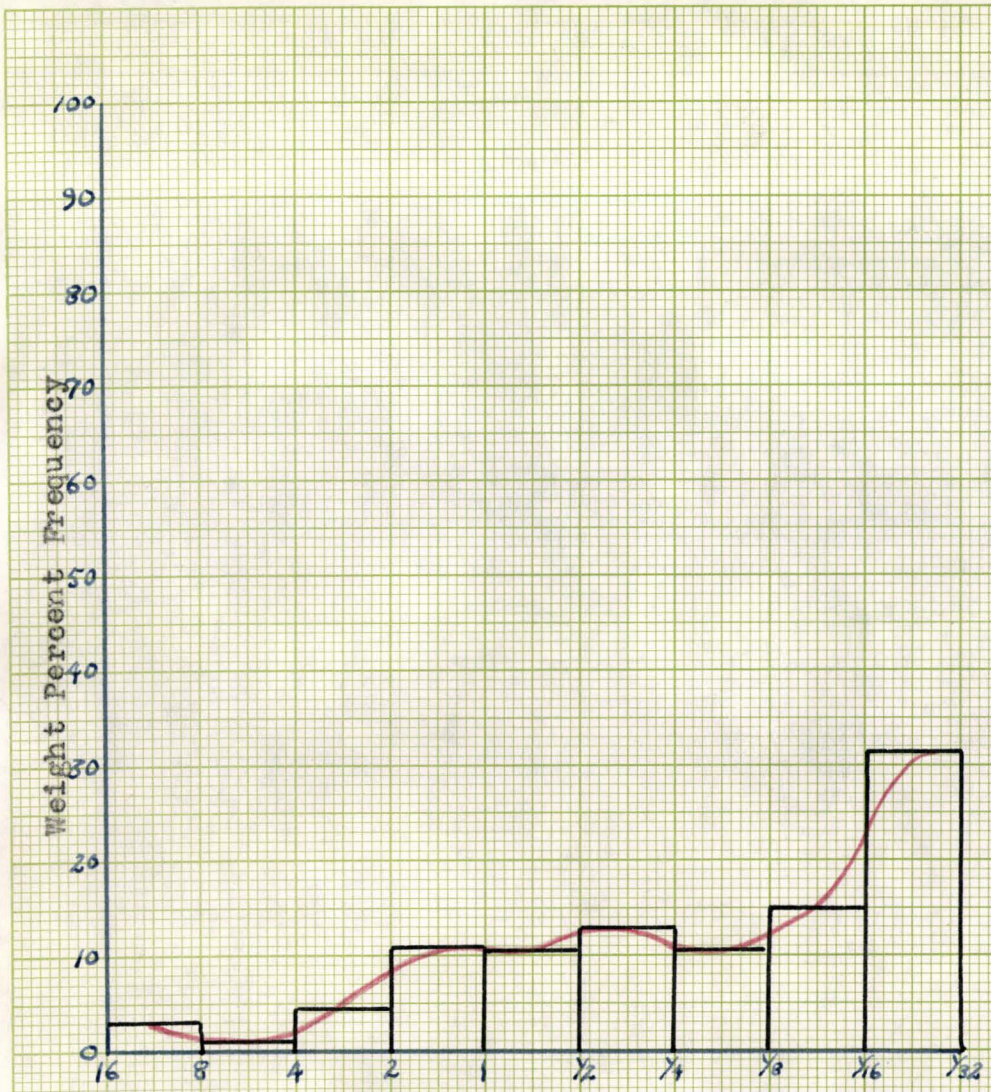


Figure 15. Histogram of Sample Number 4.

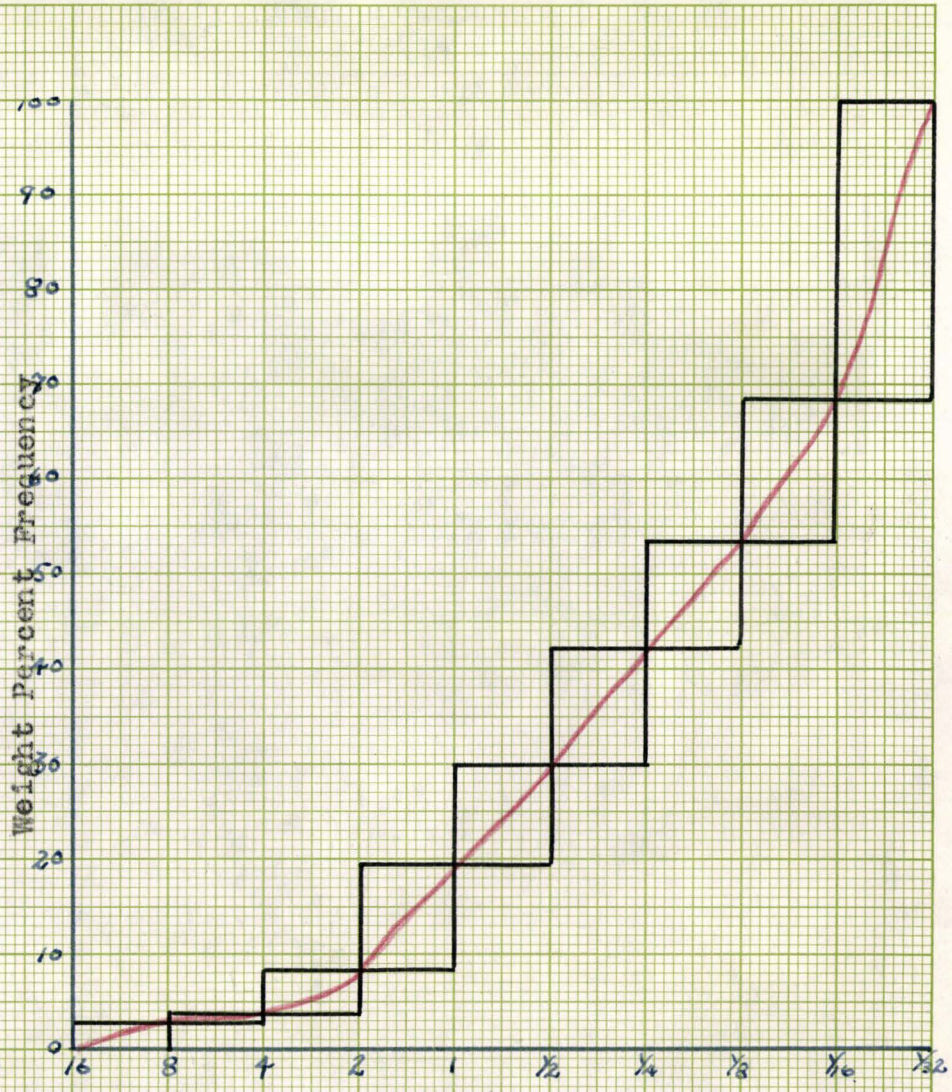


Figure 16. Cumulative Curve of Sample Number 4.

The cumulative curve of figure 14 has an irregular wavy appearance levelling off horizontally toward 100 percent.

As indicated in figure 5 sample number four was collected from the upper buff silt till from a two foot vertical section. The histogram of this sample in figure 15 shows the general character of glacial till in that it is completely unassorted. Material with a diameter under .062 millimeters, classified as silt, composes 31.5 percent of the total sample. The smallest percentages fall into the medium pebble size down to the granule size. A gradual rise is noted in the cumulative curve, see figure 16, from 0 to 8 percent with an increasing rise up to 100 percent.

As Pettijohn (1949, p. 221) states, glacial till consists of a high range of sizes usually unsorted. This point, and the ones following hold true for the tills under investigation. Rock fragments found were usually subangular with several facets and striations. Other larger rock fragments and boulders had a local origin in that they consisted largely of limestones from the Silurian and Ordovician outcrops in southern Manitoba. The matrix was predominantly clay and silt, greatly in excess of fragments. These tills were unstratified and the upper most one was resting on striated rock pavement.

GEOLOGIC HISTORY OF THE AREA

At the start of the Laramide Revolution in upper Cretaceous time, deposits of clay accumulated in the Cretaceous seas and were later indurated to form the Cretaceous shale deposits which underlie this area of glacial till. The deposition of the continental Hell Creek beds closed the Cretaceous period.

During early Tertiary time erosional processes were sculpturing the shale and sandstone into a semi-badland topography. By Pliocene time this weathered shale and sandstone awaited the first glacial advance.

The first sheet reworked the surface transforming weathered topsoil into the gray clay till. As wastage of the glacier took place it deposited a layer of boulders in this vicinity.

At some time later in Pleistocene time a readvance of the glacier striated the boulder pavement depressing them into the lower gray clay till. The high degree of induration of the lower till indicates the passage of a great weight of ice. The ice lobe upon recession deposited a mantle of buff silt till.

Constant retreat by ablation was due to decreased amounts of precipitation and increased solar radiation. Glacial melt waters backed up behind the ice lobe reworked this area into a lake bed, now called the Glacial Lake Agassiz lake plain.

The Norcross beach which trends west of north at this point was next formed on recession of the lake waters. The Forest River, along which the till under investigation is exposed, has cut down through the general lake plain level in an attempt to drain the surrounding area. Increased run-off of the flood of 1950 caused this vertical exposure of the two tills.

From the facts shown in this report it is the author's belief that a multiple till very definitely occurs in North Dakota.

BIBLIOGRAPHY

Flint, R. F., 1953, Glacial Geology and the Pleistocene Epoch: John Wiley & Sons, Inc., New York.

Kresl, R. J., 1956, Geology of the Lower Pipestem Creek Area, North Dakota: North Dakota Geological Survey, Report of Investigation, No. 25.

Leonard, A. G., 1916, The pre-Wisconsin drift of North Dakota: Jour. Geol. 24:521-532.

Pettijohn, F. J., 1948, Sedimentary Rocks: Harpers Geoscience Series, New York.

Thwaites, F. T., 1953, Outline of Glacial Geology: University of Wisconsin.

Upham, Warren, 1895, The Glacial Lake Agassiz: U. S. G. S. Monograph 25, Gov't. Printing Office.