THE GEOLOGY OF SOILS IN

RICE COUNTY, MINNESOTA

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INTRODUCTION

Several recent studies have been conducted looking at the soils of Southeastern Minnesota, including Thompson et al. 1998, Lively et al. 1987, and Carlson et al. 1975. In 1998 Thompson et al. examined the soil properties that control water movement through the soil. In the process of studying the water movement and terrain analysis, Thompson and colleagues developed a soil profile of their study site in Fairbault, MN. The components of the hill slope studied were classified as: loess summit (fine-loamy, mixed, mesic Typic Hapludoll); till shoulder (fine-loamy, mixed, mesic Mollic Hapludalf); silty footslope (fine-silty, mixed, mesic Aquic Hapludoll); silty toeslope (fine-silty, mixed, mesic Aquic Hapludoll); and silty drainageway (fine-loamy, mixed, mesic Cumulic Epiaquoll) resting over sandy colluvium. Thompson, 1998 found that the presence of a sandy layer over dense till promoted lateral shallow subsurface flow down the hill slope.

In 1987 Lively et al. did an analysis of a particular soil formation along country road 18 in southeastern Minnesota. This study described the Sangamon Paleosol developed into silt loam and silty clay loam below the Peoria Loess. Below the paleosol they found the New Richmond Sandstone. Lively et al. described a soil profile including the Peoria Loess (3.20-3.81 m deep) as light brownish gray silt loam, weak fine platy structure to massive, very friable, strong effervescence, abrupt smooth lower boundary, common course strong brown mottles, common course iron concretions spherical and elongate pipestems.

A formal governmental soil survey of the location of our study site in Rice County, Minnesota mapped the soil at our site as part of the Colo Series – 98. The survey, completed by Carlson et al. in 1975, defines the Colo Series as fine-silty, mixed, mesic Cumulic Endoaquolls. The survey describes the soil as mostly black silt loam, very dark gray in color, dry, weak fine granular structure with no course fragments throughout the profile, moderately acid, and with boundaries ranging from smooth to gradual with about 10% inclusions (Epsom and Biscay and similar soils). The A horizon is described as having a hue of 10YR or neutral in the upper part and 2.5Y or 5Y in the lower part, a value of 2 or 3, chroma of 0 or 1, and texture of silt loam or silty clay loam. The major uses of this particular unit are as cropland and hayland with a slope range of 0-2 percent.

The study presented in this paper focuses on an area along MN 246 southeast of Northfield, Minnesota. Figure 1 shows the location of the study site and Figure 2 is a photo of the soil outcrop.

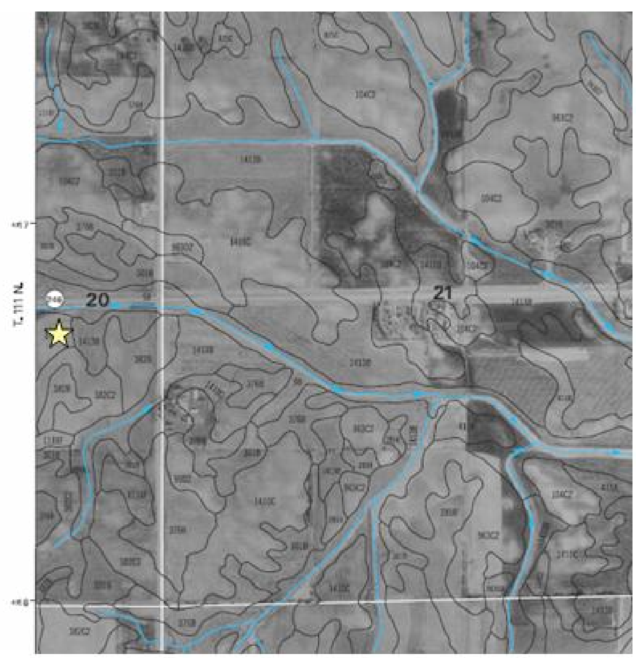

Fig. 1 Map of the study site adapted from the *Soil Survey of Rice County*. This soil profile was done on an outcrop in a ditch along MN 246 near Northfield, MN.

Fig. 2 Picture of outcrop showing three distinct layers and a person for scale. The topmost organic layer is covered in grass, the second layer down is dark in color and the third layer is yellowish brown with poorly sorted larger stones throughout. The dark colored soil toward the bottom of the outcrop was the same as the third layer, only moist due to water from a passing stream.

There is a small stream running along the side of the road allowing for erosion of the soil and soil accessibility. This is the first in depth study of this particular site. The soil was classified as having an organic layer, silty loam layer, and a loamy layer with glacial deposits. Field methods included a soil analysis kit, pH testing and observation under a binocular microscope.

METHODS

Three different layers of soil were extracted from the outcrop: a top layer which was dark, a middle layer, and the bottom layer of exposed soil. There was a difference between layers based on the visible colors of the soil. The topmost layer was a dark grayish brown, the bottom layer was a tan, yellowish brown color and the transition layer in the middle was a mixture of the two colors. The lowest layer was observed to have a lot of poorly sorted pebbles, possibly indicating glacial deposits. The thickness of the different soil layers was also measured using a meter stick. The top layer was about 70 to 85 cm thick, the middle layer was 15 to 20 cm and the visible part of the glacial layer was about 100 cm, but this layer may go deeper than observed.

Using a soil analysis kit, acid was first added to each of the soils from the respective layers. No reaction occurred between the acid and the soil indicating that there is no calcium carbonate present in the soil. The lack of calcium carbonate in the soil shows that soil is not lime-based.

The pH of the three layers was also analyzed using a pH testing kit. First, a bit of soil was put in a small basin. Then drops of indicator solution were added and the liquid was churned with the soil until it was uniformly mixed. White powder was sprinkled over the mixture and let stand for several minutes. The resulting color depicted the acidity of the soil. The top layer was found to have an acidity of 7.0 or neutral. The middle layer was an intermediate color between the top and bottom and the bottom layer had an acidity of 6.5. Therefore, the middle layer must have had an acidity of about 6.75. This result could be due to leaching; as water goes down through the soil perhaps it dissolves acidic ions and brings them down with it. Nevertheless, the change in pH is very small, the color change was very slight and there is a possibility of error.

In order to determine the type of soil found in each layer, a series of experiments were performed following a step-by-step guide. First, a tablespoon of soil was wet in the hand so that it became sticky and formed a ball. Then the soil was squeezed into a ribbon by pinching the wet soil between the thumb and fingers. Based on the soil's ability to make a ribbon, a different procedure was followed to determine the composition of the soil. The top layer was found to be silt loam because of its inability to make a ribbon, slimy texture and lack of sand grains. The transition layer had the same results. The bottom layer felt a bit sandier, made a better ribbon, and was a little stickier. This layer wad determined to be loam based on in-hand analysis and the chart in figure 3.

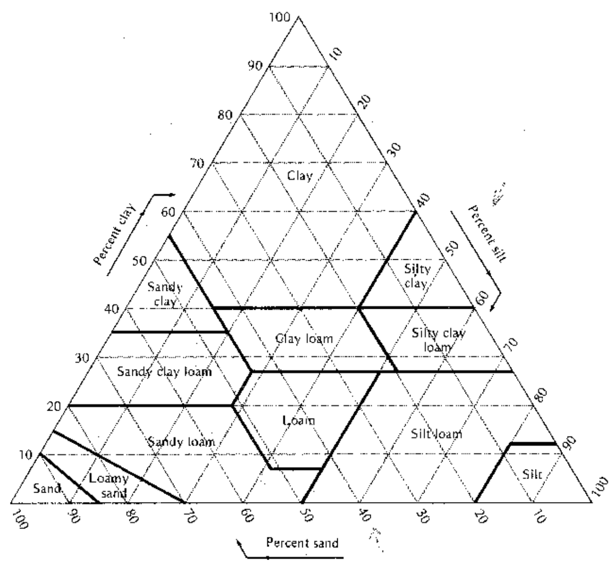

Fig. 3 Percentages of sand, silt, and clay in the major soil textural classes. Adapted from The Nature and Properties of Soils, by Nyle C. Brady copyright 1996. Upper Saddle River, N.J. : Prentice Hall, c1996. Edition 11th ed. The percentage of clay is matched up with the percentage of silt or sand and the point of intersection determines the class name.

The various soils were also looked at through a binocular microscope. The bottom layer had slightly larger grains intermingled among fine grains while the top two layers had almost identical finer grains. We observed some sparkle in the top two layers, indicative of micas. The third layer down had a much yellower color, even under the microscope, denoting a difference in composition from the top two layers.

RESULTS

Based on the data found in this study, the following soil profile was determined:

O layer – assumed to be very thin, partially decomposed plant materials

A layer – 70-85 cm thick, silt loam with organic materials

E layer – greater than 100 cm thick, loam containing rocks of different sizes, suspected glacial origin

DISCUSSION

The presence of well rounded, poorly sorted rocks in the C layer is indicative of glacial deposits. Although three different layers of soil other than the O layer we thought to exist at the beginning of the investigation, laboratory analysis concluded that only two distinct layers were present. Organic material has caused the A layer to have a dark color. The gradual color change between the A layer and the E layer is caused by leaching through the soil creating layers of silt loam and loam ranging from dark black near the surface to lighter yellow-brown towards the bottom of the E layer. Though we could not see any bedrock, a sandstone formation similar to the one described by Lively et al 1987 may be below our study site.

CONCLUSION

In summary, three distinct layers were found in a soil outcrop along MN 246 outside of Northfield, MN. The layers were composed of organic materials, silt loam, and a sandy loam glacial deposit. These results are in accordance with similar studies conducted in southeastern Minnesota.

References

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