

A Graduate-Undergraduate Seminar on the Soils of Southwestern Michigan: In the Field, the Lab and Using a GIS

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Abstract

Soils on many of the outwash plains of southwestern Michigan have loamy upper profiles, despite being underlain by coarse, sandy sediment. As part of an MSU seminar class, students analyzed the spatio-textural characteristics of these loamy-textured sediments, in order to ascertain their origin(s). The textural curves of this material are bimodal, with both silt and sand peaks (Fig. 4). Because the sand peaks align with those in the outwash below, we concluded that the upper, loamy sediment represents a blend of an initially silty sediment with the underlying sand, i.e., it has formed by pedoturbation (soil mixing). A textural filtering operation allowed us to determine its original textural characteristics, indicating that nearly all of the soils originally had silt loam upper profiles, typical for loess (wind-deposited silt). Field data showed that the silty (now loamy) material is thickest slightly east of a large, broad, N-S trending valley (the Niles-Thornapple Spillway) that once carried glacial meltwater (Figs. 2, 3). The sediment gets thinner, better sorted, and finer textured farther east from this channel. We concluded that the loamy mantle on many of the adjacent outwash plains of SW Lower Michigan is silt-rich loess that was derived from the Niles-Thornapple Spillway and its major tributary channels (Fig. 1). The Spillway was active for approximately 500 years, between ca. 17,300 and 16,800 cal. yrs. ago. At this time, a large network of tunnel channels was forming beneath the Saginaw glacial lobe. Meltwater from these channels mined the silt-rich glacial sediment, funneling silt into the Spillway and rendering it a prodigious silt source.

Introduction

- Soil parent materials can provide insight into past sedimentologic and depositional systems
- Soil maps can therefore become excellent surrogates for geologic maps, especially within a GIS
- Correct identification of soil parent materials has potential to improve our understanding of present and past environments, and foster better soil management practices
- Soils on outwash surfaces in southwestern Michigan vary in texture. Some are sandy throughout, while most others get increasingly loamy in the upper profile

Statement of Purpose

Analyze the spatio-textural characteristics of loamy-textured soils (mainly the Kalamazoo and Schoolcraft series) on outwash plains of SW Michigan, identify their parent materials, and ascertain the geologic origins of these materials

Research Hypothesis

Loamy-textured soils on outwash plains in SW Michigan have had surface additions of loess (wind-blown silt)

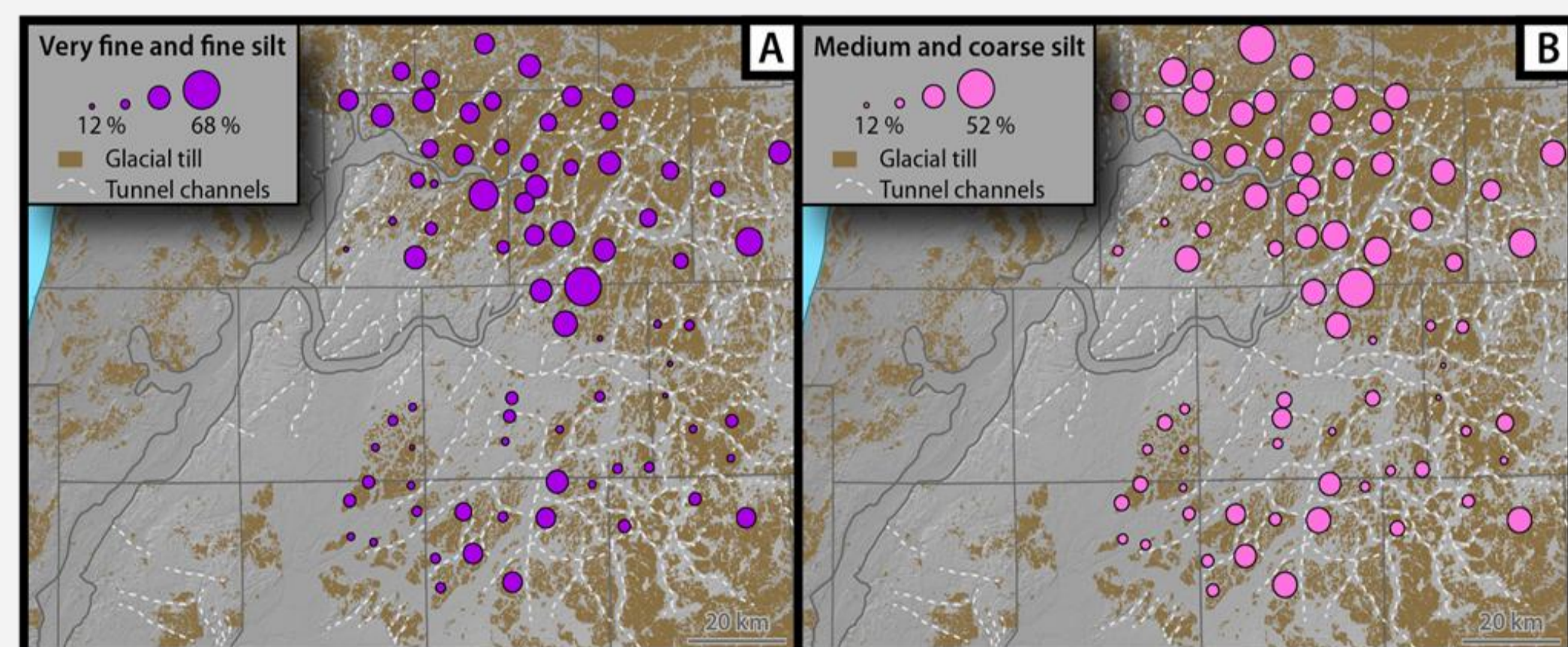


Fig. 1. Graduated circle maps of the silt contents of the till samples acquired across the study area.

Methods

- We sampled loamy sediment from soils on outwash plains at 167 sites. We also sampled the deep outwash at 49 of these sites, for comparison (Fig. 3)
- Samples were analyzed for textural properties (Fig. 4)
- Data analysis using ordinary kriging in ArcGIS, to determine spatial patterns

Results

- Kalamazoo and Schoolcraft soils become progressively finer in their upper profiles; most are loam textured in their upper profiles
- The loamy material in upper profiles is loess mixed with sand from below, by pedoturbation
- The loamy material is thickest near the Niles-Thornapple Spillway, thinning to the east (Figs. 2, 3). This type of pattern suggests that the Spillway was the source for the silty sediment, and that the sediment is loess
- Other data on spatial patterns, such as mean particle size, sorting coefficient and silt/sand ratios, support the conclusion that the loamy material is loess (Fig. 5)
- Meltwater in the Spillway was likely to have been silt-rich because widespread stagnation of Saginaw lobe allowed silt-rich meltwater, derived from silty tills (Fig. 1), to be funneled down the valley
- The spillway was likely active for approx. 500 yrs., ca. 17,100 cal. yrs. ago
- Paucity of loess west of the spillway (Figs. 2, 3) suggests that loess transport was predominantly by westerly winds

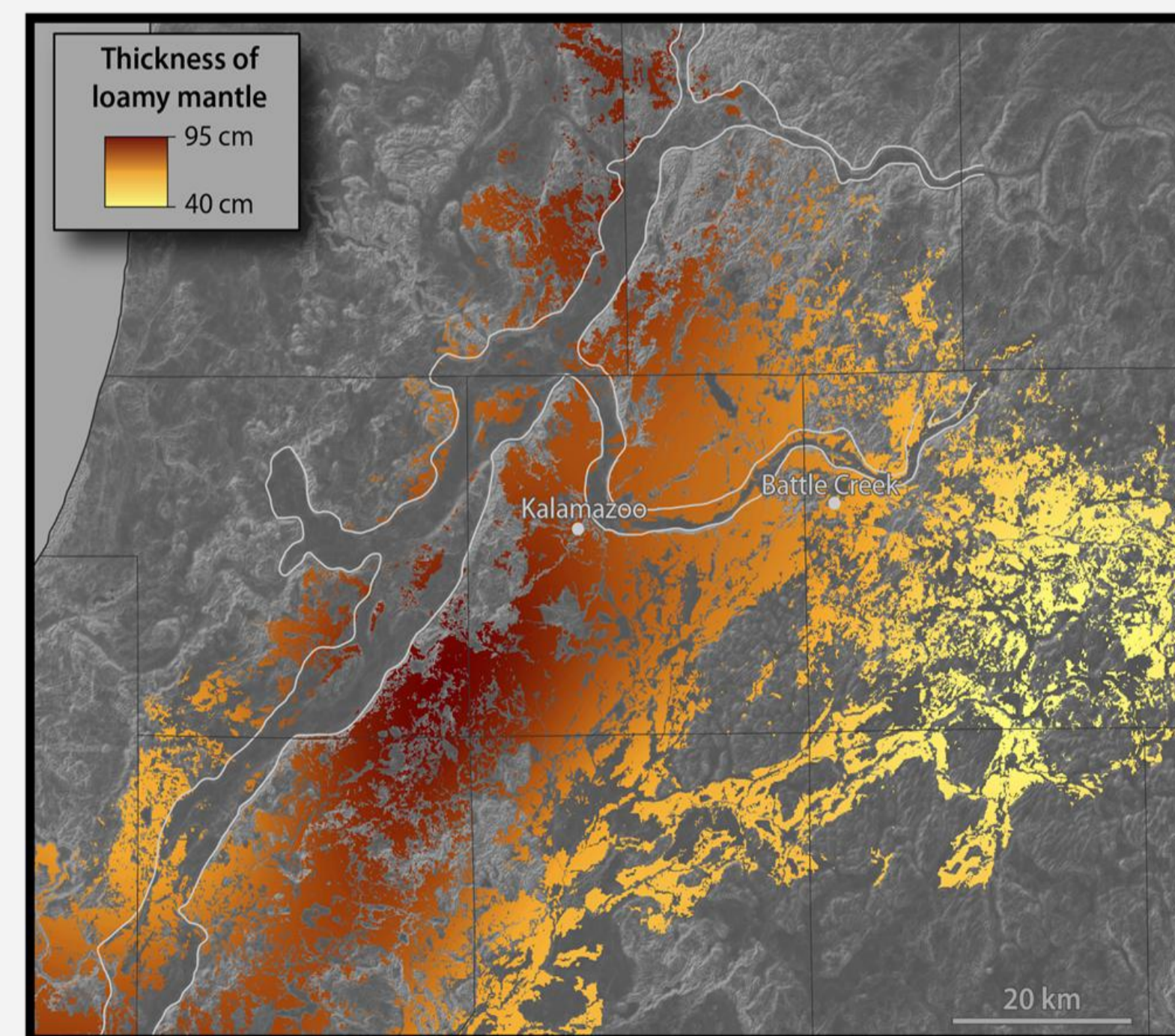


Fig. 2. Interpolated, kriged map of the thickness of the upper loamy sediment, which we interpret as loess, across southwestern Michigan. Interpolated data are shown only in areas where our target soils are mapped.

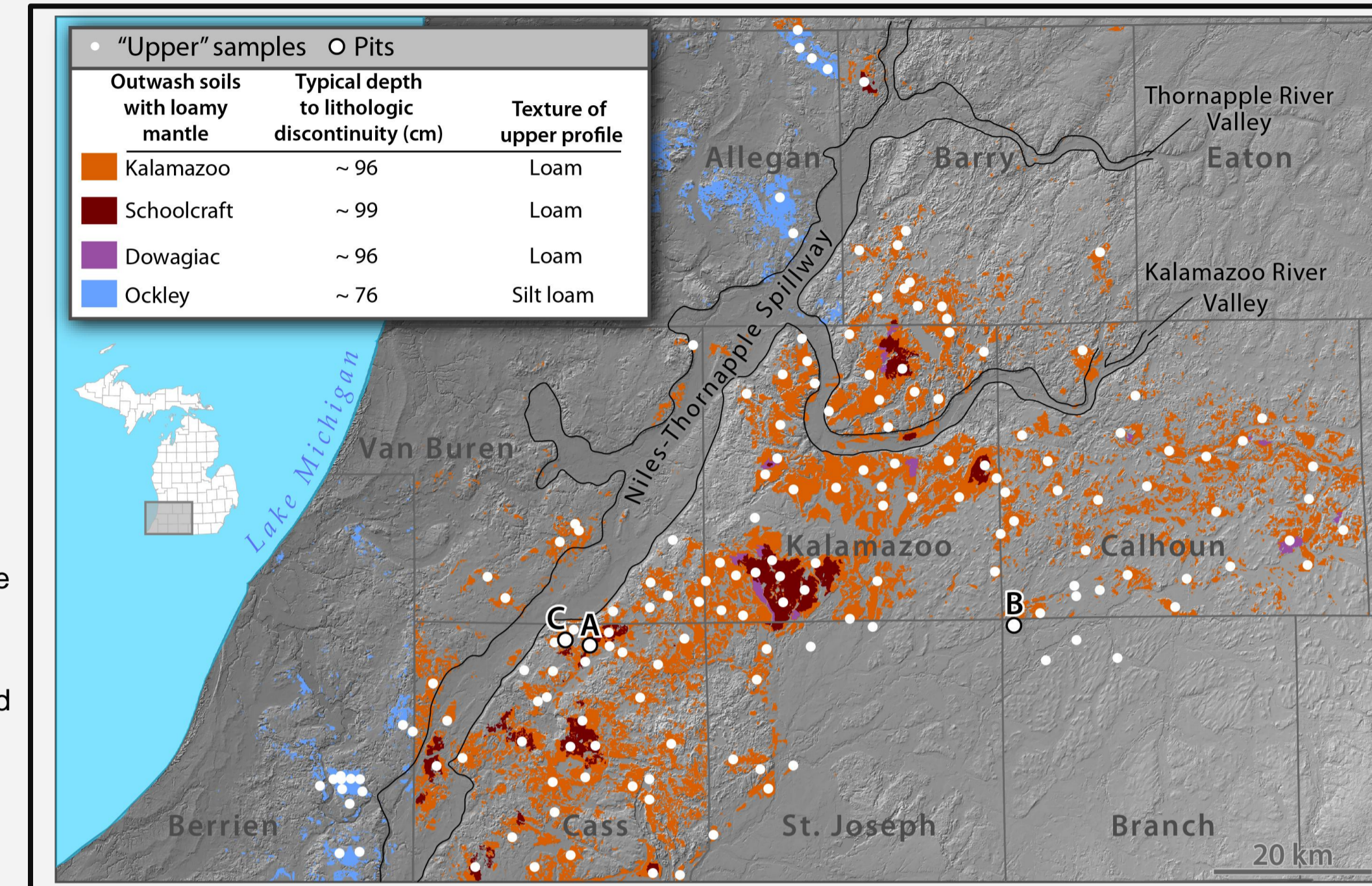


Fig. 3. The major soil series of outwash plains in the study area that have loamy mantles, set on a hillshade base. Sample sites are shown in white. Sites A, B and C are areas where more extensive research was performed, in a soil pit.

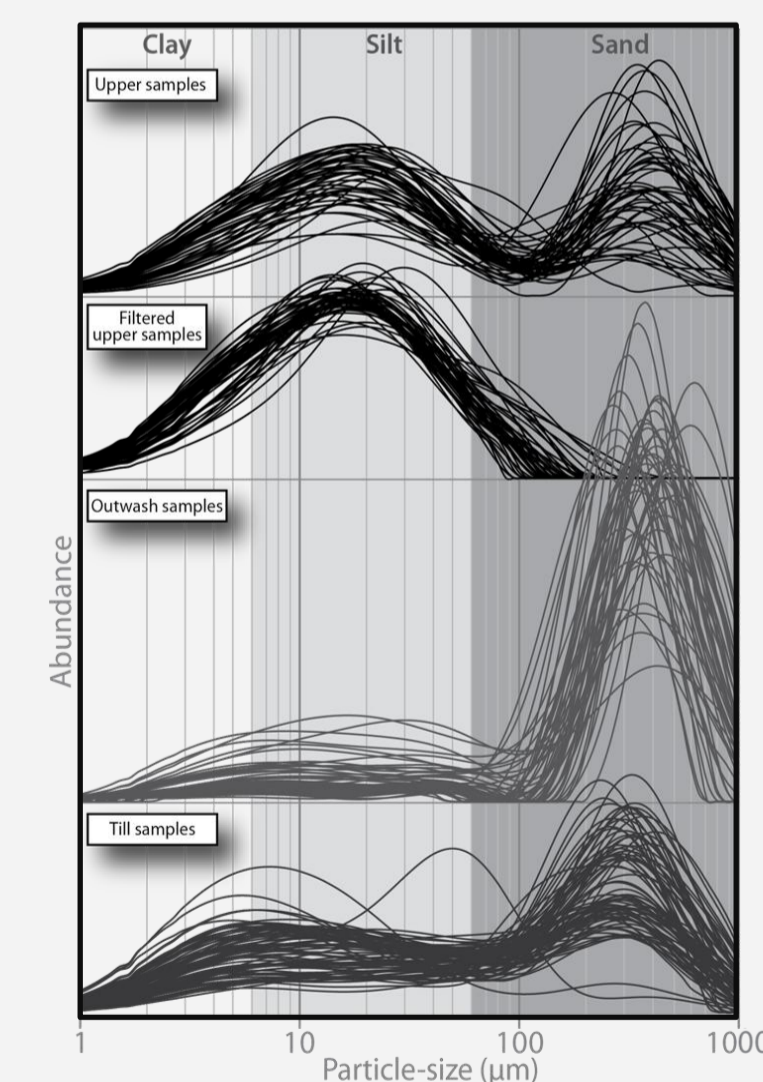


Fig. 4. Particle size curves for the samples taken in this study. Shown are the 164 "upper" loamy material samples, before and after the filtering process, the 49 outwash samples, and the 78 till samples.

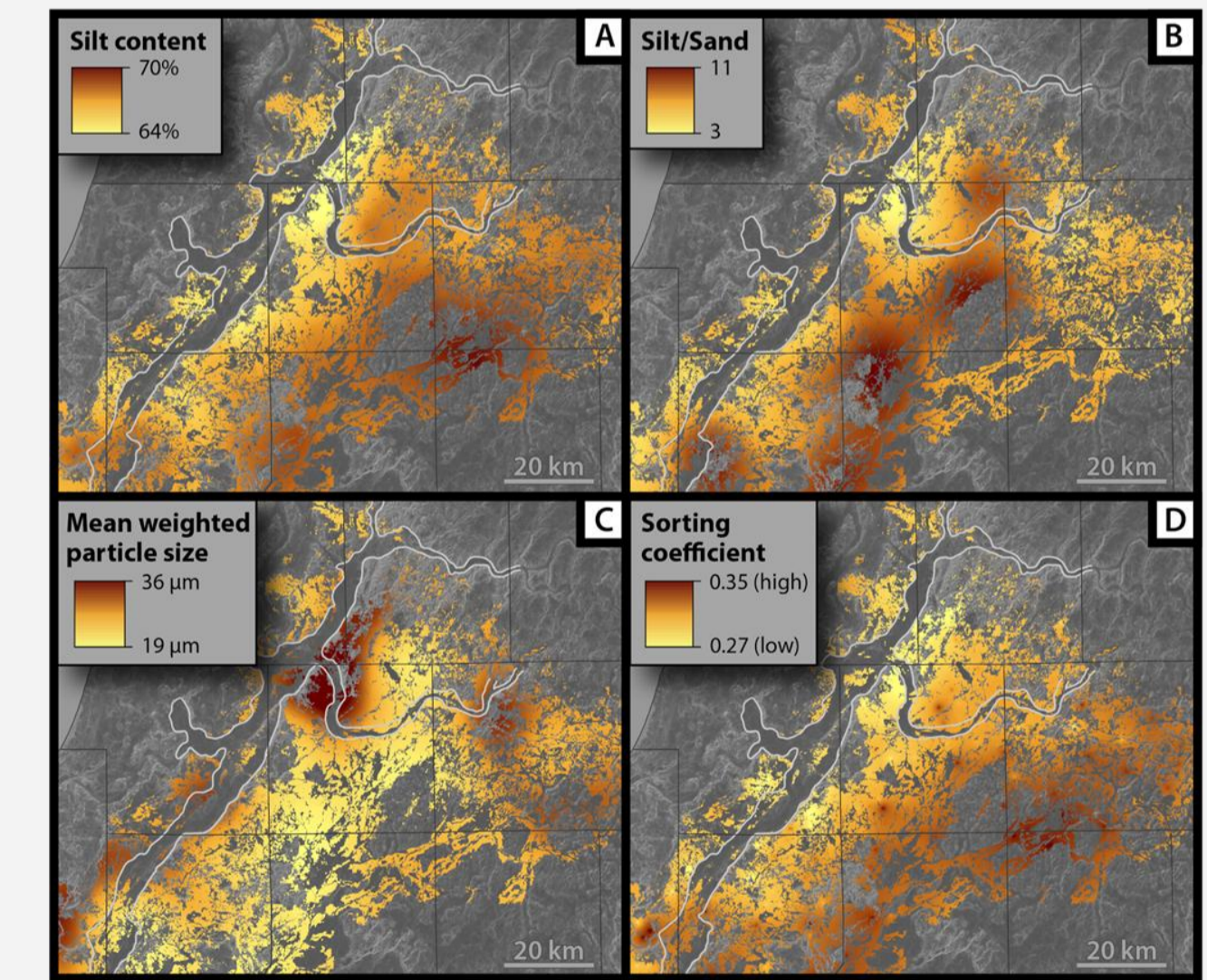


Fig. 5. Interpolated, kriged maps of textural data (filtered) for the upper loamy sediment, which we interpret as loess, across southwestern Michigan. Interpolated data are shown only in areas where our target soils are mapped.

Acknowledgements

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