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Visualizing point data across landscapes in a GIS: Examples from loess deposits in the northern Great Lakes region

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Abstract

We highlight the various ways in which GIS point data can be visualized. Because these methods can be used with any kind of point data, they have potentially wide application within the Earth Sciences. Our analysis included textural and thickness data for loess samples from northeastern Wisconsin and Michigan's western Upper Peninsula. Loess here was derived from several outwash plains that formed during ice retreat, as well as more localized sources. Previous work has established that most of this loess, because it was strongly influenced by local sources, has complex spatial patterns that change rapidly over short distances. This stands in contrast to the loess of the southern Great Lakes region, which was largely derived from one source, resulting in smooth, predictable spatial trends. In previous work on this loess, the data were presented only as isoline maps of kriged surfaces. In this poster, the data, again presented as isoline maps, are also compared using as graduated symbols, graduated colors, graduated colors and symbols, and filled isolines masked to the extent of the loess soils. Our goal is to highlight the various ways in which point data can be visualized, thereby showing the strengths and weaknesses of each presentation method. The data are also intended to show how interpretations may be affected by the manner in which the data are displayed. We hope that this poster will facilitate discussion not only of GIS and cartographic symbology, but also generate ideas as to details of the loess depositional systems in the region.

Introduction

Recent work has documented new, often localized, loess sources on landscapes across the upper Midwest, e.g., glacial lake plains (Schaetzl and Loope 2008), hummocky end moraines (Stanley and Schaetzl 2011), outwash plains (Schaetzl 2008, Schaetzl and Attig 2013), and meltwater rivers and valley trains (Schaetzl and Hook 2008, Luehmann et al. 2013). Research that has helped to document these deposits – both their extent and their likely source areas – has largely come from point-based sampling campaigns. Analysis of the spatial data from these samples has been used to characterize the loess and in so doing, ascertain its likely sources. Nonetheless, the manner in which such "point data" are presented can affect interpretations. The purpose of this study is to present several different cartographic visualization schemes for such data, and to show the potential advantages and disadvantages of each.

Study Area, Sampling, and Data Mapping

Our study area is the loess-covered uplands of northeastern Wisconsin and the western Upper Peninsula of Michigan (Figs. 1, 2). For this area, we analyzed 387 loess samples, with an average distance between them of 2399 m; we deleted points that were within 2500 m of each other in order to achieve a regular point distribution. For each sample, particle size analyses were done in duplicate; mean values were used for further analyses. Textural data were "filtered" to remove coarse materials, mainly medium and coarser sands, that had been mixed into the loess from below (Luehmann et al. 2013). Subsequent analyses were run on the filtered data. In a GIS, we used simple kriging to map textural, sorting, and thickness characteristics of the loess. Map data are presented as graduated symbols, graduated colors, graduated colors and symbols, isolines, and filled isolines masked to the extent of the loess soils.

Study Area Background

The study area is a re-entrant area between former ice margins in NE Wisconsin and the western UP of Michigan. Here, loess is mainly found on uplands, and is particularly thick on uplands that are farthest from former ice margins. According to Schaetzl and Attig (2013), most of the loess was derived from the outwash plains that surround the region. Loess in the UP was likely derived mainly from small valley trains that anastomose through the area, as well as large outwash plains on the eastern margins of the region.

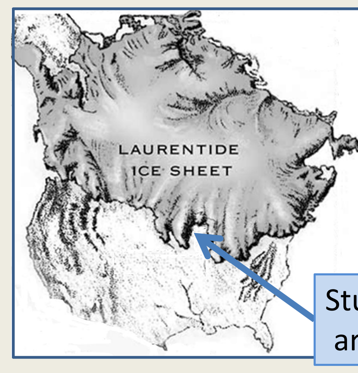


Figure 1. The near-maximum extent of the Laurentide Ice Sheet in North America during MIS 2.

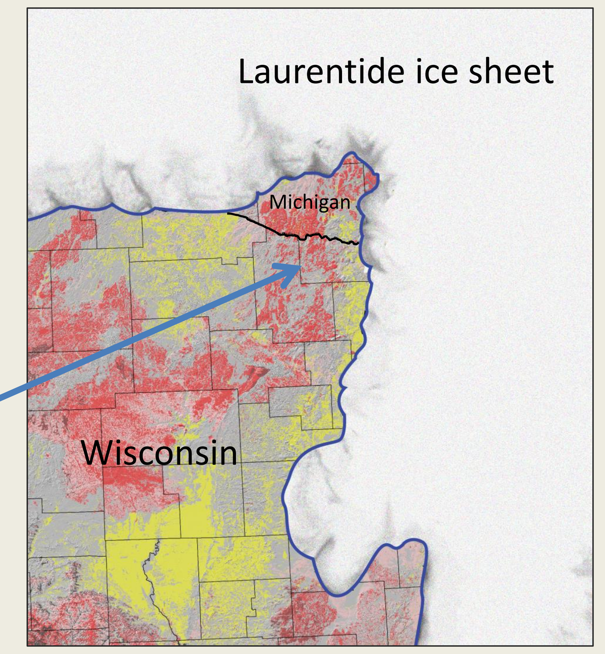


Figure 2. Ice configuration at the time of loess deposition, on a hillshade DEM background. The thickness and distribution of loess in the study area is shown in shades of red; outwash areas are yellow. Note the prominent re-entrant configuration of the study area.

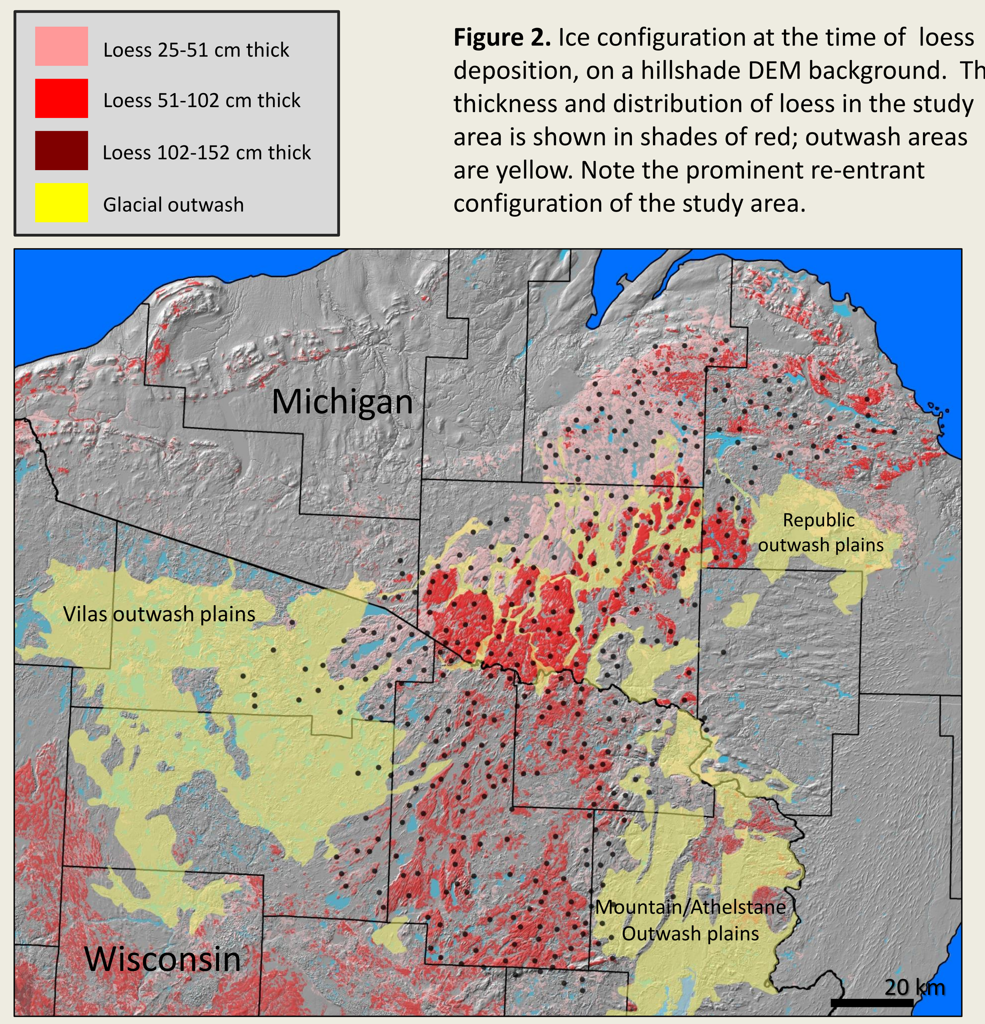
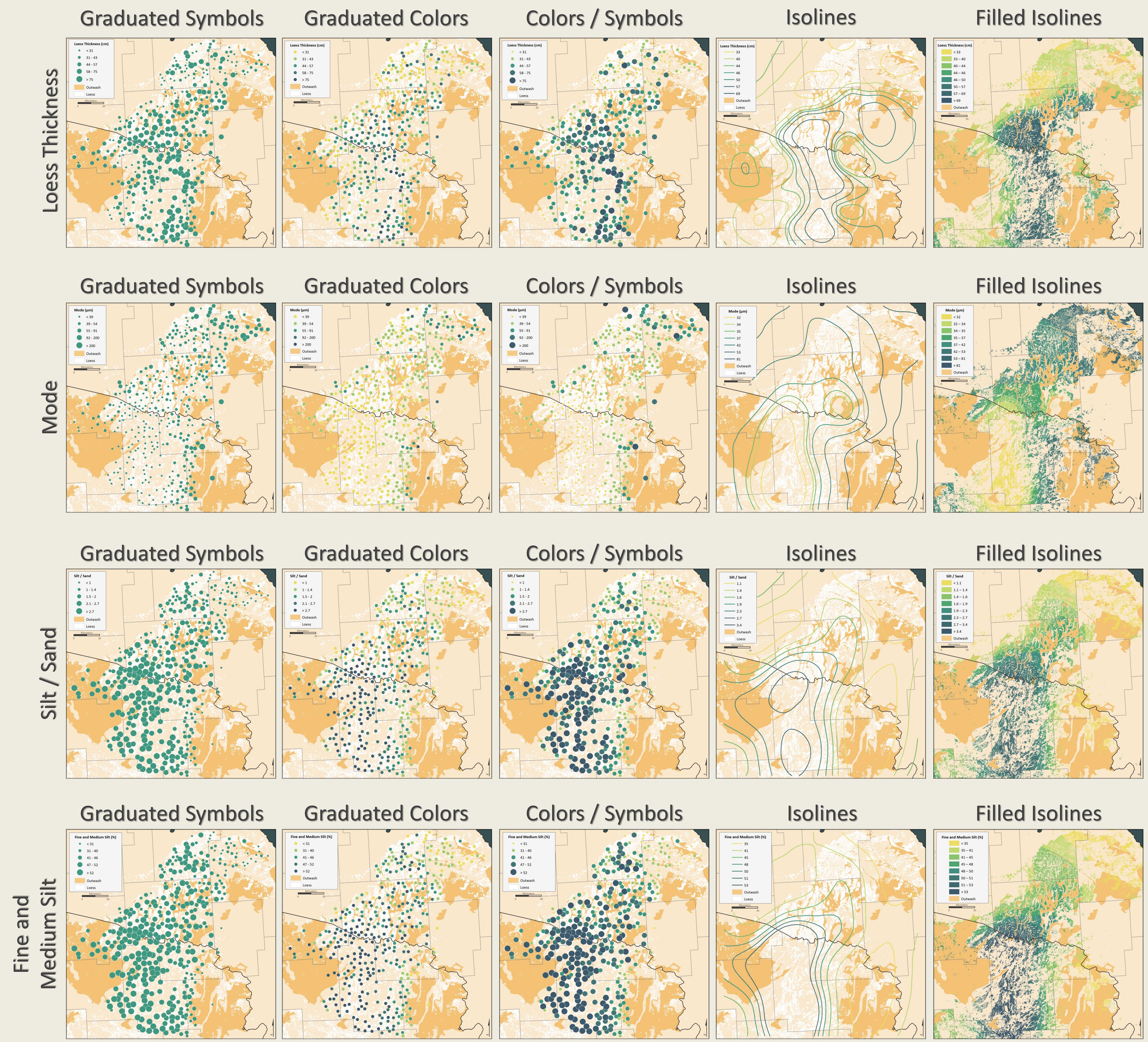


Figure 3. Locations of the 387 sample points within the study area. Areas of loess are shown in shades of red, as determined by thickness (based on NRCS soil maps). Outwash plains and valley trains are shown in yellow. Samples points within outwash plains were derived from isolated uplands capped with sandy loess.



Results and Discussion

Traditionally, isolines have been used to map trends in point data for loess deposits. Isolines, generated by kriging, show overall spatial trends well, but because they do not show individual data points, they can mask outliers. Additionally, the investigator is required to determine the isoline interval, and thus, can be accused of hiding details in the data by, for example, using large isoline intervals. Alternatively, small isoline intervals can lead to complex, spaghetti-like maps that are difficult to interpret. Filled isoline maps have similar advantages and disadvantages, but show the data "more completely" across the landscape, eliminating the need to mentally "interpret" the isolines. One advantage of filled isolines is that they report data only for areas where loess soils (in this case) exist. A disadvantage to kriging across a surface is its ability to extrapolate beyond the sample points and present data where it has not been collected. The author needs to be diligent when presenting this data and the results should be interpreted intelligently where extrapolation is present. Dot/point maps, whether graduated circles, graduated colors, or their combination, have the advantage of showing all the data, but where spatial patterns are complex, they make comprehension more difficult. These types of maps may work better for smaller study areas, for studies with smaller sample numbers, or across areas where most samples have similar values, i.e., where outliers are few. Graduated symbols provide perhaps the best compromise between a data presentation method that allows for rapid comprehension while still retaining all of the original data in the map.

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Acknowledgements

We acknowledge support from the National Science Foundation, Geography and Spatial Sciences Program, grants BCS-0422108,BCS-0851108 and BCS-0850593. Mike Luehmann, Brad Miller, Trevor Hobbs and Kristy Gruley assisted with field and/or lab work. Some of our data were originally from Mike Bigsby's MS thesis in Geography at MSU; we thank him for his help in this project.