

Undergraduate Honors Seminar: Kame deltas in central Lower Michigan provide evidence for a previously unknown, high-level glacial lake

Emma Treiber, Marion Goeddeke, Ryan Pearce, Ryan Fitton, and Randall Schaetzl (mentor)

Abstract

In an Honors Seminar, we studied two small kame deltas in central Lower Michigan. Kame deltas develop as glacial meltwater deposits sediments in lakes. The recently identified deltas provide key evidence for a large and previously unknown proglacial lake, which we named **Glacial Lake Roscommon**. Our goal was to document and characterize these deltas, and to determine the age of one of them. In this poster, we focus on one of these two deltas - the **Cottage Grove Delta**.

Students used augers to sample sediment across the delta, and also obtained samples for luminescence dating. The samples were analyzed for particle size; spatial analysis was performed using GIS software.

The delta is composed of well-sorted sands with little gravel, and with only small variations in texture. Nonetheless, the delta does exhibit a general fining toward its outer margins. Gullies on the steeper, outer margins of the delta likely formed by runoff during a period of frozen ground, following lake drawdown.

The delta is tied to an ice-contact ridge that marks the former position of the ice margin. Luminescence ages obtained from the delta indicate that it formed rapidly, as ≈ 23.1 ka. At this time, ice would have covered all of Michigan, except for the open space that was flooded by Glacial Lake Roscommon.

Introduction

The Cottage Grove Delta is one of several small deltas within the Houghton Lake Basin, a sandy upland in central Lower Michigan (Figs. 1, 2). It was only recently identified (Luehmann 2015). The Cottage Grove Delta provides evidence for a previously unknown, high-level, proglacial lake, which we informally named Glacial Lake Roscommon. The delta formed in association with the North Higgins Lake Ridge (Burgis 1977), an ice-contact ridge that marks the former position of the ice margin. Thus, dates obtained from the delta can reveal when the retreating ice margin was at this position.

Statement of Purpose

The purpose of this study was to characterize the Cottage Grove Delta and to constrain the timing of the ice retreat in central lower Michigan.

Methods

After introductory lectures and discussions, students were divided into groups of six. At each of 48 sites on the delta, samples were obtained by bucket auger, from the upper 1.5 m, and site locations were recorded in a GPS (Fig. 3). All samples were air-dried and passed through sieves to determine the very coarse sand fraction. The remaining sediment was analyzed by laser diffraction. Spatial trends were then examined in ArcMap using kriging and graduated symbols (Fig. 4).

Six samples (two each from topset beds, foreset beds, and gully locations) were obtained for optically stimulated luminescence (OSL) dating, to estimate the age of the Cottage Grove Delta. The samples were taken from between ≈ 115 and 150 cm depth, in freshly exposed pits (Fig. 3), and analyzed at the Luminescence Laboratory at North Dakota State University.

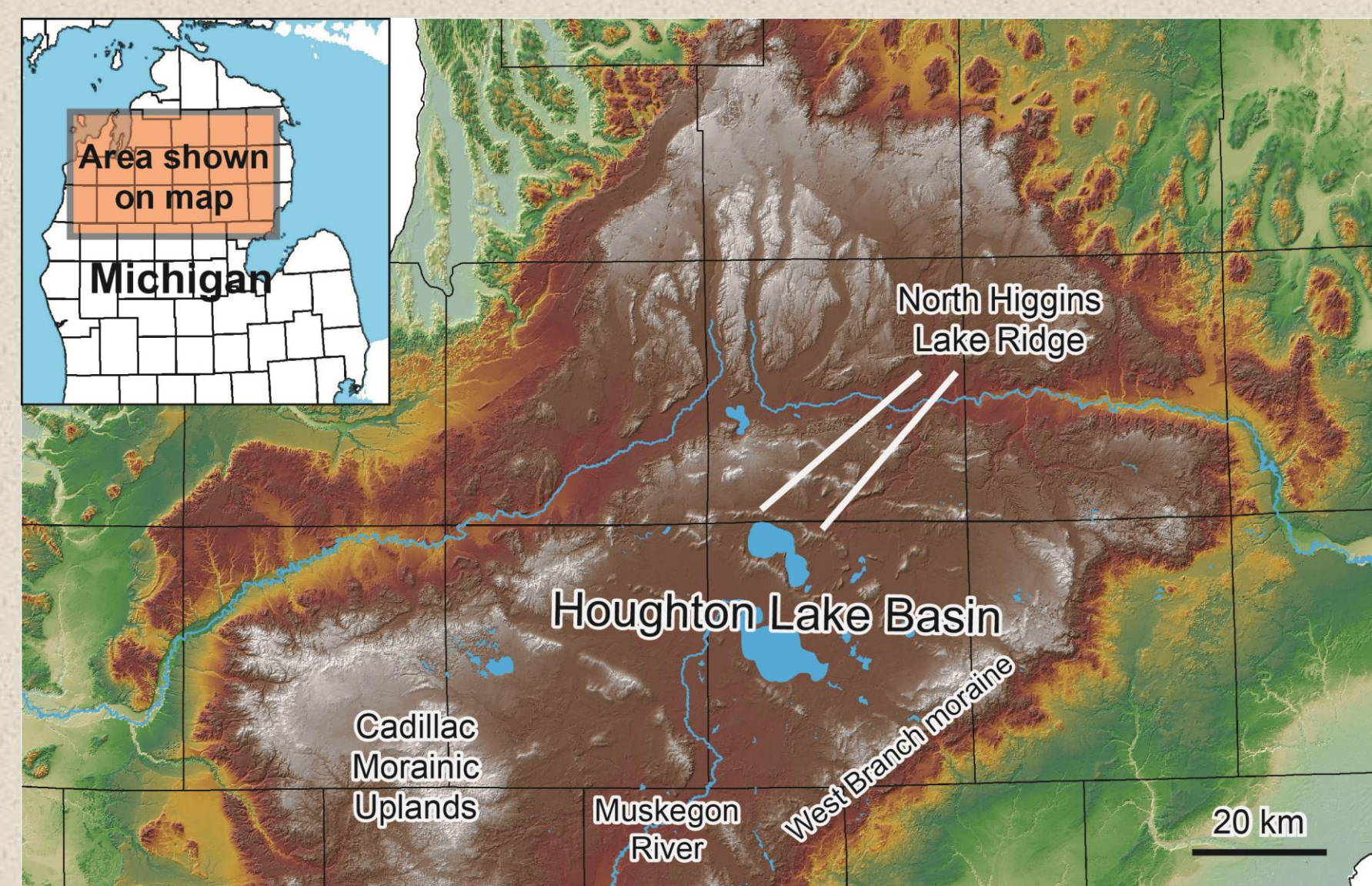


Figure 1. Map of the topography in and around the Houghton Lake Basin.

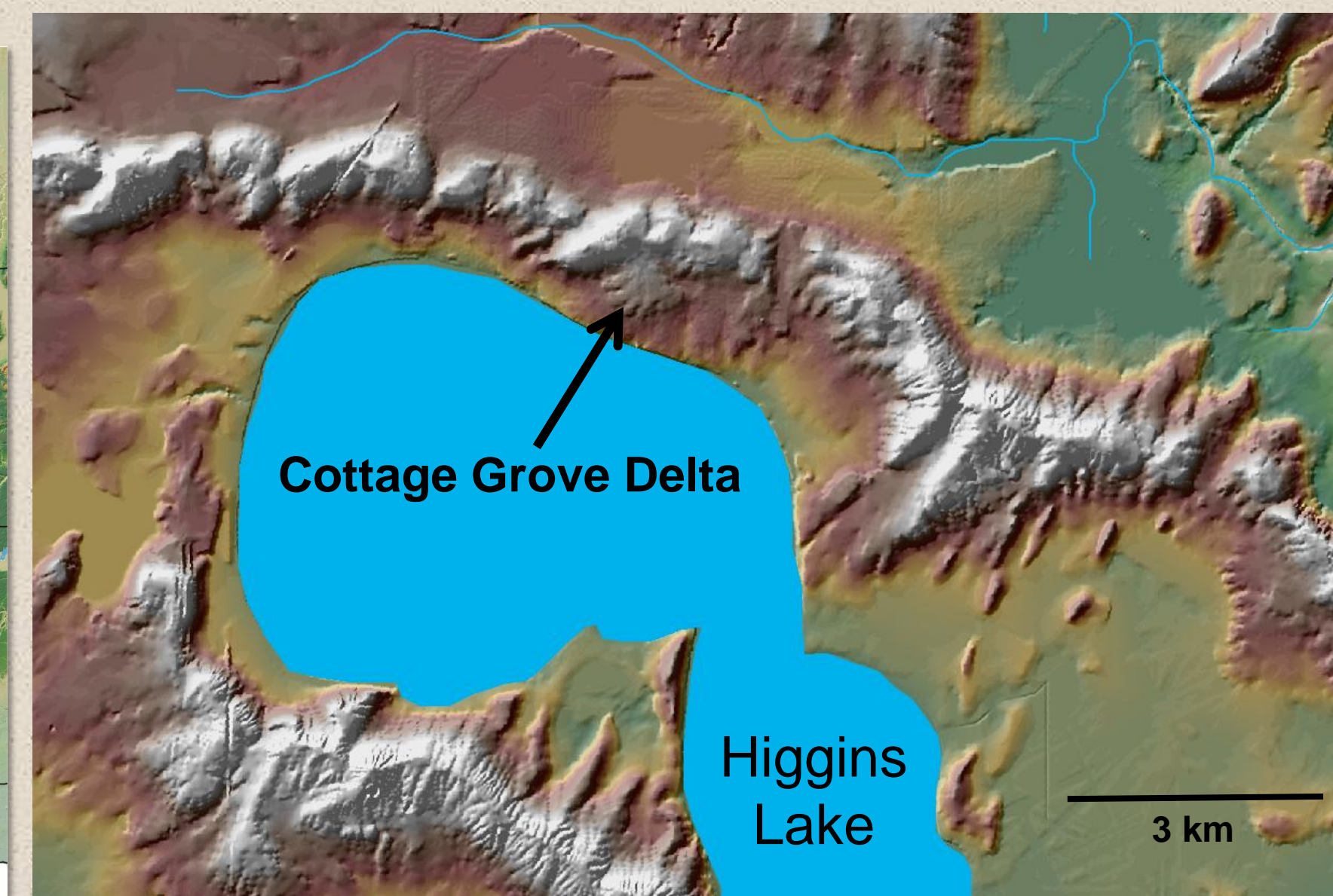


Figure 2. Map of the topography in and around the Cottage Grove Delta.



Figure 3. Students sampling using a bucket auger (left), while also recording the sample location in ArcGIS software on a laptop computer. Obtaining samples (right) for luminescence dating.

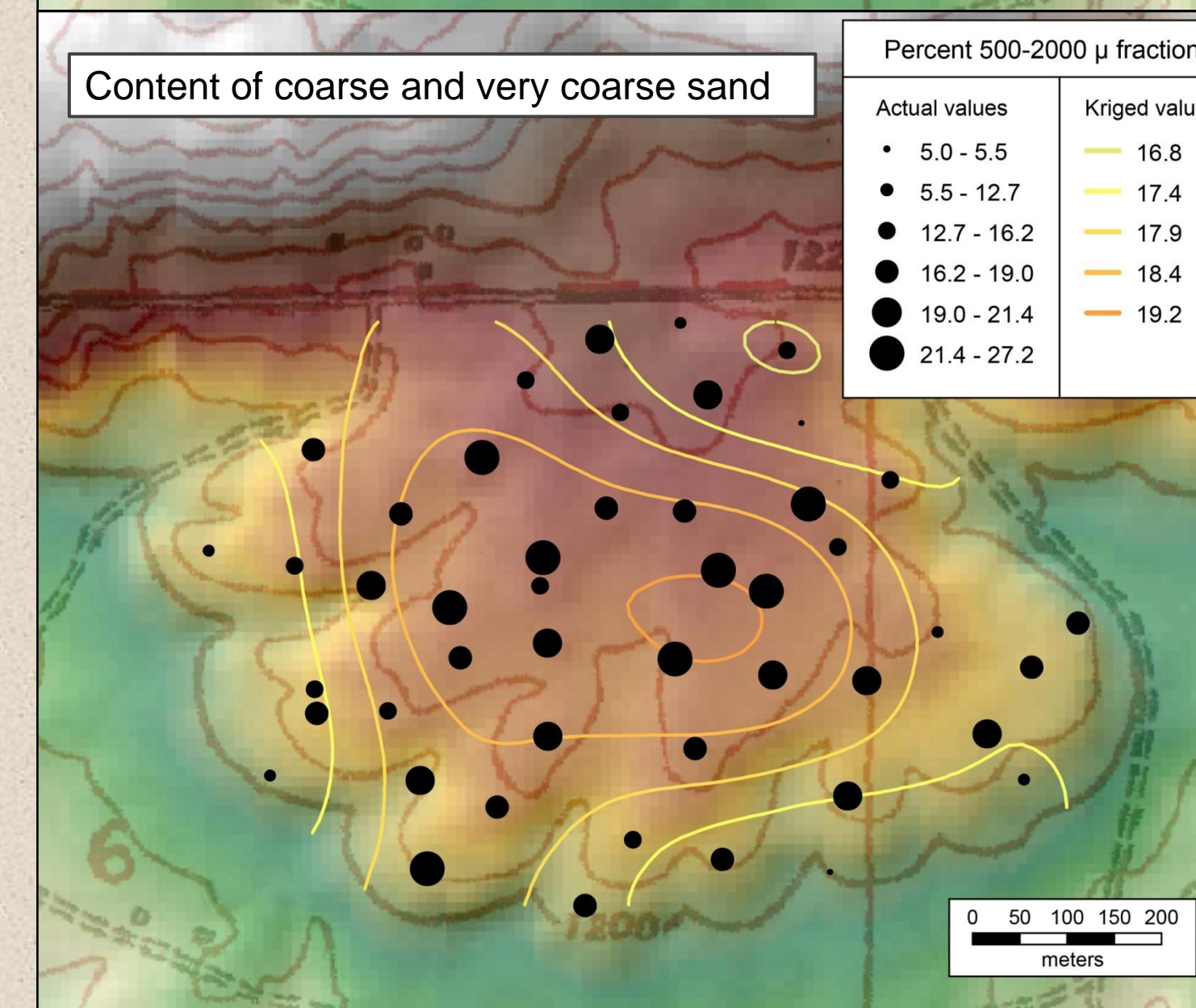
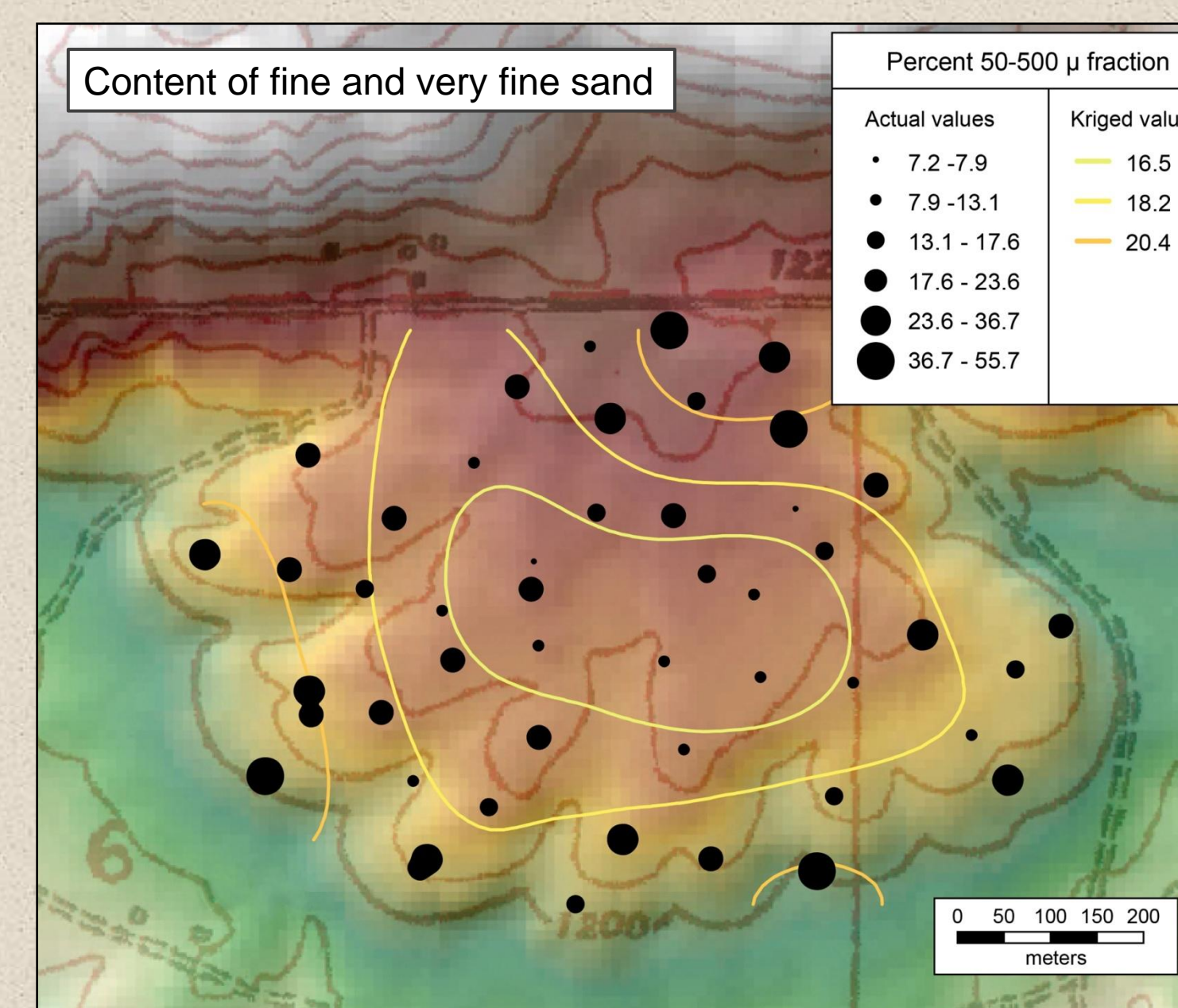


Figure 4. Textural data for the Cottage Grove Delta, using both graduated symbols and kriged isolines. The data were derived from auger samples recovered from the upper 1.5 m.

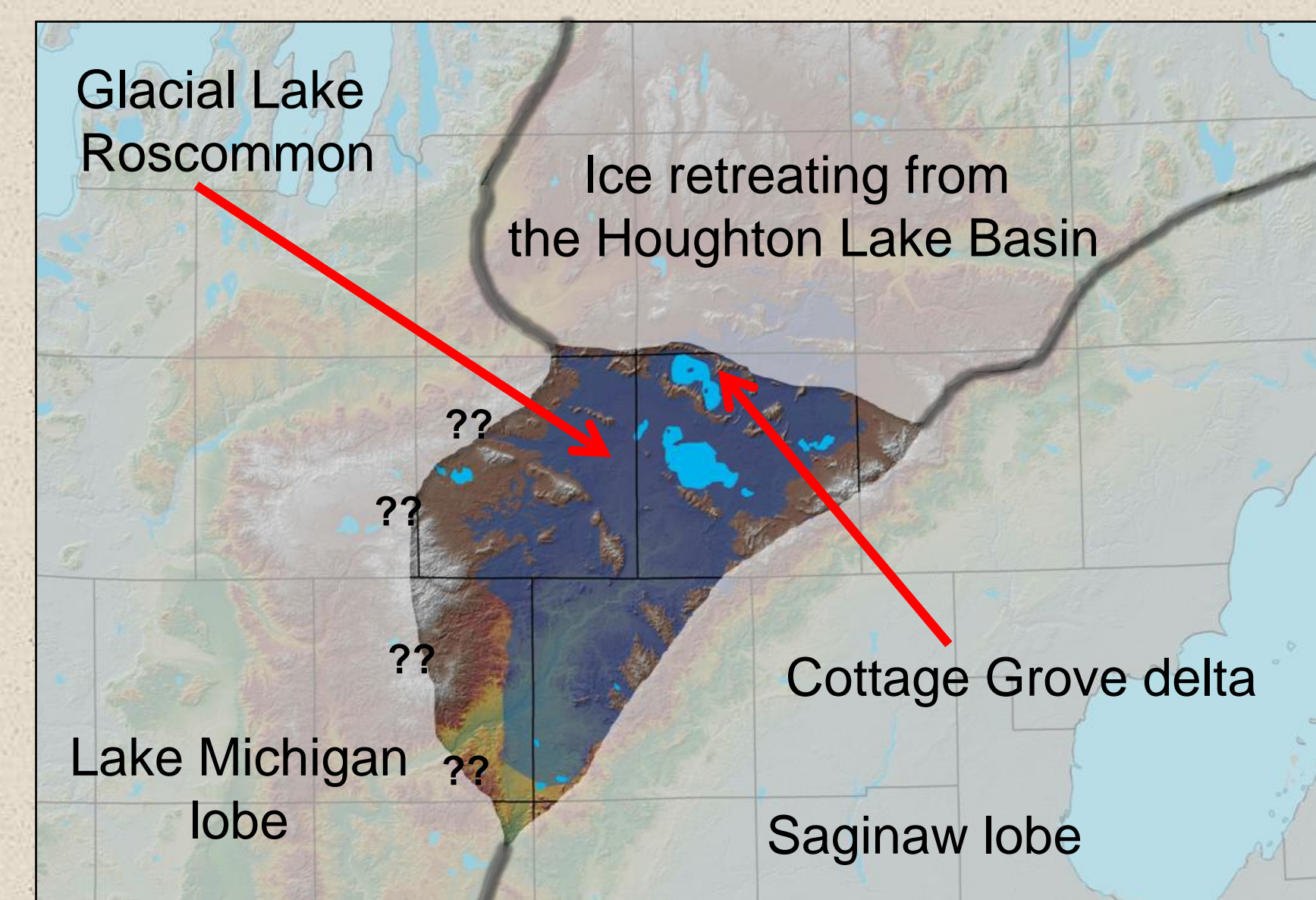


Figure 6. One possible configuration of the Laurentide ice sheet when the Cottage Grove Delta formed. Although we have good data to support the location of the ice margin at the North Higgins Lake Ridge, the location of the ice elsewhere remains conjectural.

Acknowledgements

We thank the MSU Honors College for financial support, and the Department of Geography for a course-release for Dr. Schaetzl. We thank local landowners Bill Baker and Van Sandstrom from the Cottage Grove Association for their cooperation. Kelsey Nyland helped in the field.

Results and Discussion

Delta Morphology

The fan-shaped Cottage Grove Delta is ≈ 1 km in width (Figs. 2, 4). The steep outer margins are suggestive of wave-driven erosion and fairly constant lake levels (Vader et al., 2012). Several large gullies are present at the outer margins. These probably occurred after lake drawdown, when permafrost enhanced runoff.

Delta Sediments

The sediments of the Cottage Grove Delta are sandy and remarkably well sorted, with $<4\%$ silt + clay. We believe that the delta is also sandy at depth. The sediments are uniform across the delta surface, but become slightly finer toward the margins (Fig. 4). Overall, textural data support the traditional model of a Gilbert-type delta, composed of wave-worked, well-sorted, sands.

Glacial Lake Roscommon

The presence of deltas, wave-cut benches or bluffs, spits, and outlets at corresponding elevations in the Houghton Lake Basin provide unequivocal support for a large paleolake: Glacial Lake Roscommon. Preliminary research has identified outlets and hence possible lake stages at ≈ 372 m, ≈ 365.5 m, ≈ 355 m, and ≈ 346 m. The Cottage Grove Delta correlates well with the 372 m lake stage.

Age of the Cottage Grove Delta

Although the ice-contact ridges and deltas within the Houghton Lake Basin (Figs. 1, 2) have long suggested that the Laurentide ice sheet retreated in a SW to NE direction in this area, our study provides the first evidence that constrains the timing this retreat. Five of the six OSL samples produced consistent ages, indicating that the delta was deposited relatively rapidly. Based on the five dates, we estimate that the delta formed over a few hundred years, at ≈ 23.1 ka (Fig. 5).

Conclusions

Our data on the Cottage Grove Delta in central Lower Michigan confirm the presence of a previously unknown, high-level glacial lake in this area: Glacial Lake Roscommon. The lake was variously walled in by ice and surrounding uplands. The Houghton Lake Basin has many features that are associated with proglacial lakes, e.g., deltas, overwidened outlets, wave-cut bluffs and beach ridges, and spits. Set within this lake are a series of ice-contact ridges that represent stillstands of the retreating ice margin. OSL dates from the Cottage Grove Delta suggest that the ice margin was positioned at the North Higgins Lake Ridge at $\approx 23.1 \pm 0.4$ ka ago. Our work is significant because it confirms that, during glacial retreat, an opening developed between the three ice lobes (Fig. 6). This pattern of retreat had never been postulated until now.

References

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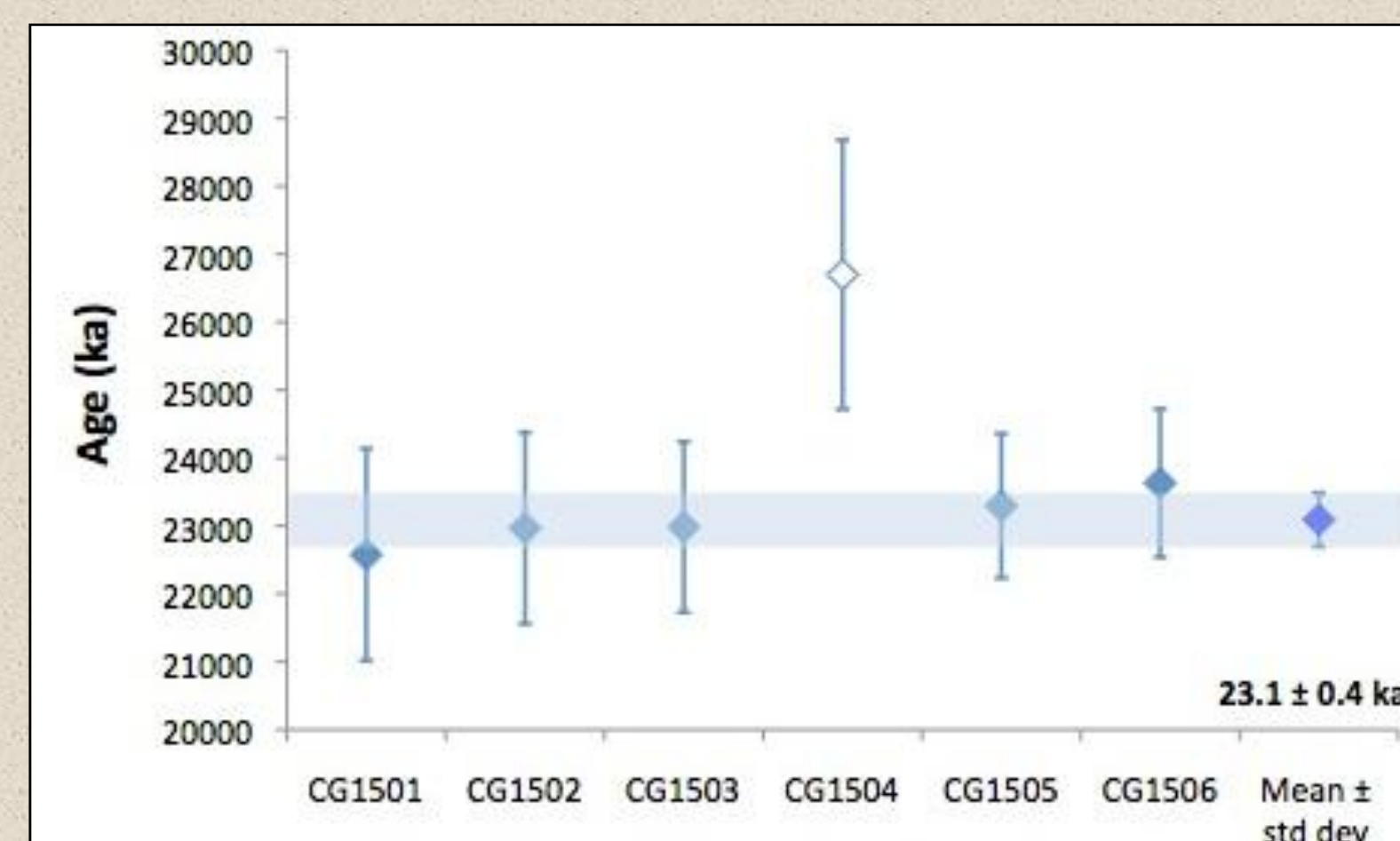


Figure 5. Ages for the Cottage Grove Delta obtained by OSL dating.