

LUMINESCENCE AGES ON A KAME DELTA CONSTRAIN THE GLACIAL RETREAT FROM CENTRAL LOWER MICHIGAN



Abstract

In association with a freshman Honors Seminar at Michigan State University, we studied two small kame deltas in central Lower Michigan. Only recently identified, the deltas provide key evidence for a previously unknown proglacial lake (Glacial Lake Roscommon) in this broad, sandy, interlobate upland. Our goals were to document and characterize the deltas and their geomorphologies and to determine the age of one of the deltas. Both deltas are composed of well-sorted sands, with little gravel. Samples taken across the deltas display little variation in texture, aside from fining toward their outer margins. Gullies on the outer margins of both deltas probably postdate the formation of the deltas proper, formed instead by runoff during a permafrost period that followed lake drawdown. Because both deltas are tied to ice-contact ridges that mark the former position of the retreating ice margin within the lake, the luminescence ages we obtained for one of the deltas constrain the timing of ice retreat in this portion of Michigan, for which no information currently exists. Six OSL ages were obtained for the Cottage Grove Delta, from topset and foreset bed locations, and from gullies. Five of these dates clustered tightly around a mean age of 23.1 ± 0.4 ka. At this time, ice covered all of southern Michigan, but here, within central Lower Michigan, ice had retreated to the point that an opening was present. Waters within this opening formed a lake which we name Glacial Lake Roscommon.

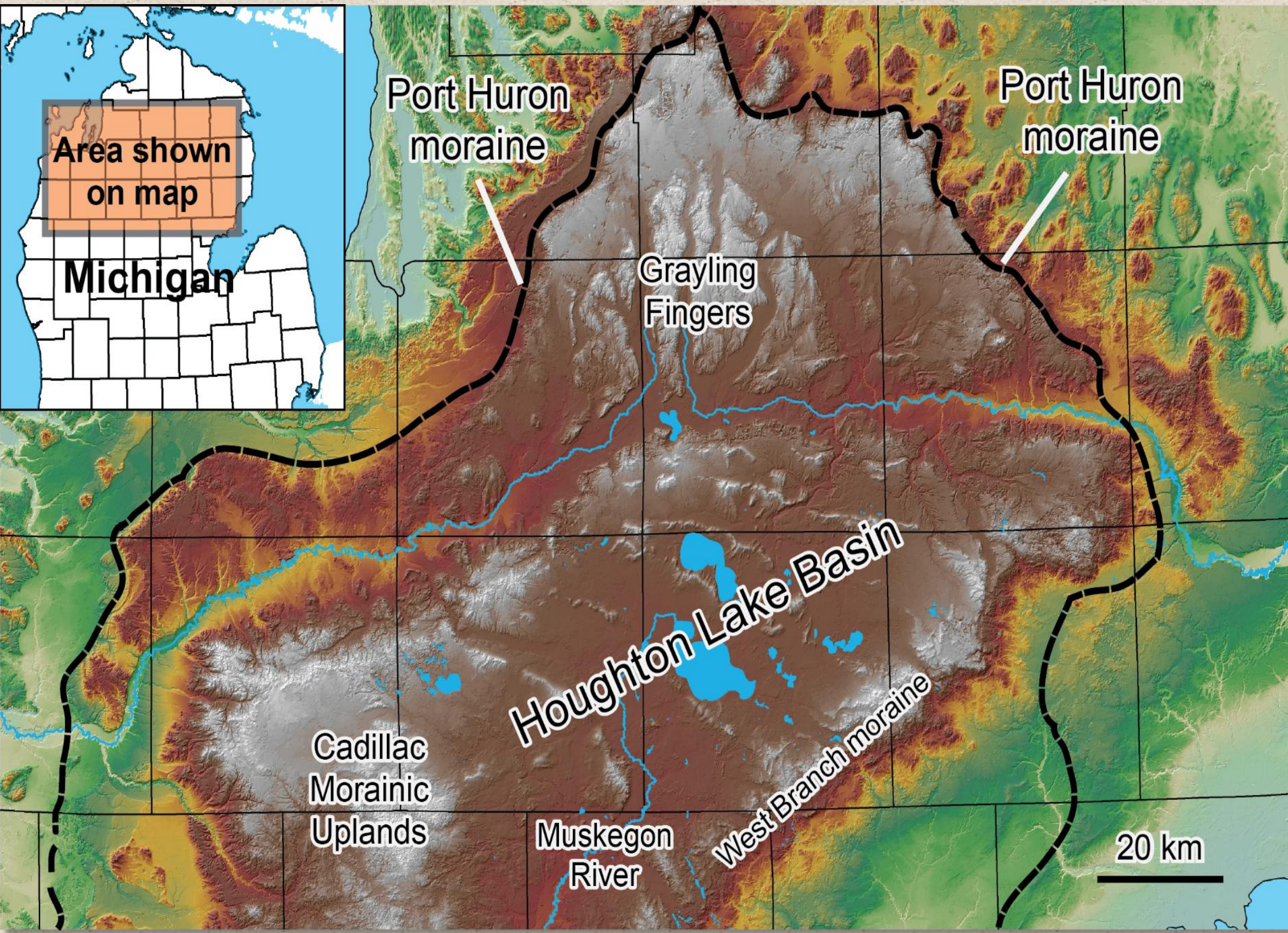


Figure 1. Regional physiographic map of the study area, broadly defined, on a color elevation base.

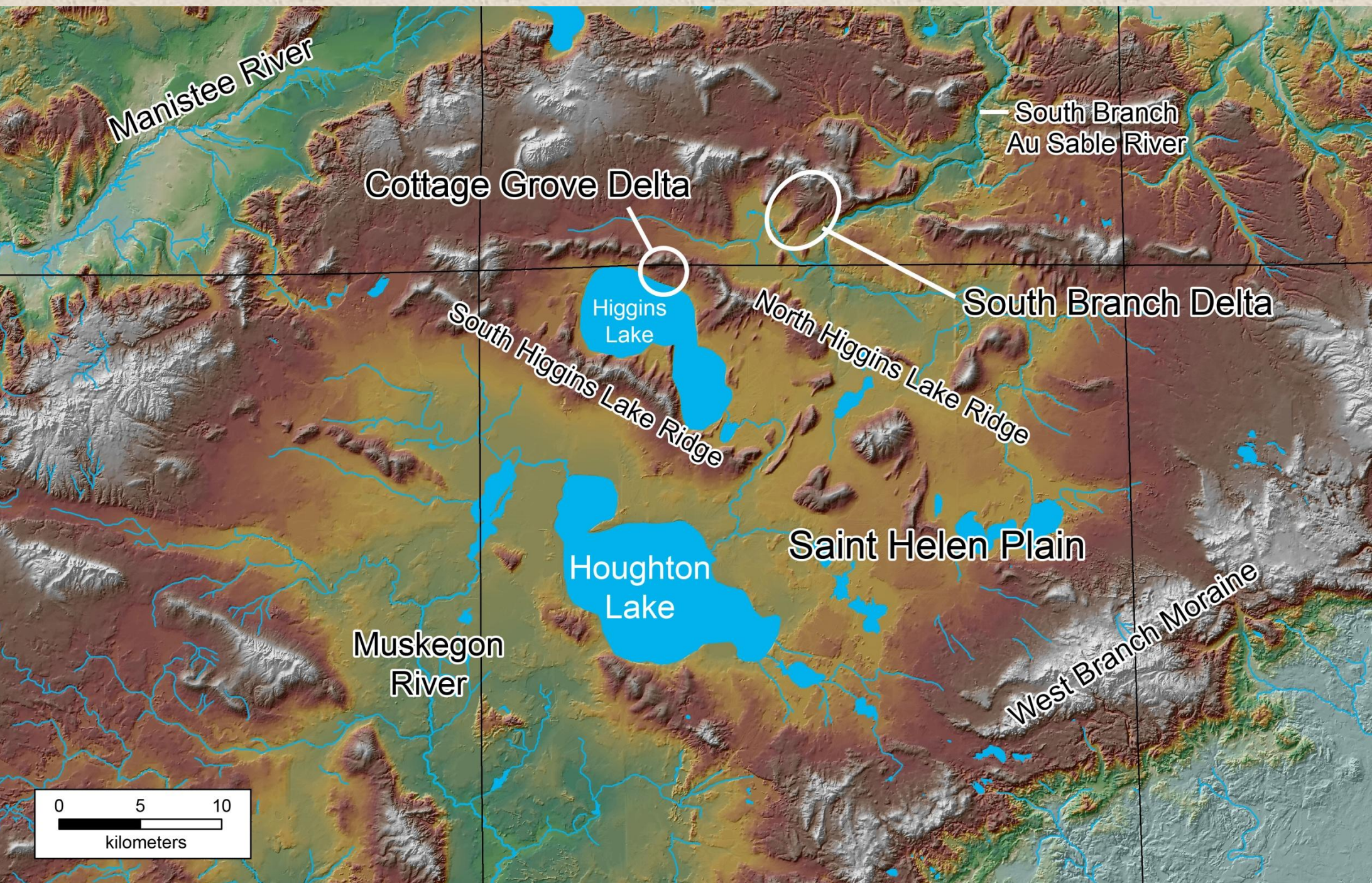


Figure 2. Physiographic map of the Houghton Lake basin, showing the general topography, and providing names for important physical features.

Acknowledgements

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Introduction

As a class project at MSU, we studied two small, kame deltas located in the Houghton Lake Basin (Fig. 1), which lies within the high, sandy uplands of central Lower Michigan. We named these deltas the Cottage Grove Delta and the South Branch Delta (Fig. 2). Both both formed in close association with large, sandy, ice-contact ridges that mark a stationary position of the ice sheet as it retreated from the region. Together, the deltas support the existence of a previously unknown, high-level proglacial lake, which we here informally name *Glacial Lake Roscommon*. The purpose of this study was to examine the physical characteristics of these deltas, and constrain the location of the ice margin by obtaining samples for luminescence dating from one of the deltas (the Cottage Grove Delta).

Methods

- Students in the Freshman Honors seminar were divided into two groups of six; each group was assigned a delta.
- In the field, each group used a field laptop computer to georeference the locations of samples of the upper 2 m, taken with a bucket auger (Fig. 3).
- Samples were air-dried and prepared for particle size analysis on a laser particle size analyzer.
- The data obtained were imported into a GIS project. To examine spatial trends, the data were portrayed as graduated symbols and isolines developed using simple kriging.
- Six samples were taken for OSL dating, from sediment freshly exposed in 2m deep pits. Two were taken from an area representing topset beds, two from foreset beds, and two from deep gullies that occur at the margins of the delta (Fig. 4). Ages were determined at the Optical Dating and Dosimetry Lab at North Dakota State University.



Figure 3. Fieldwork, illustrating (left) augering into the Cottage Grove Delta, while other students enter date into the ArcGIS shapefile, and mark sample bags, and (right), a completed OSL sample.

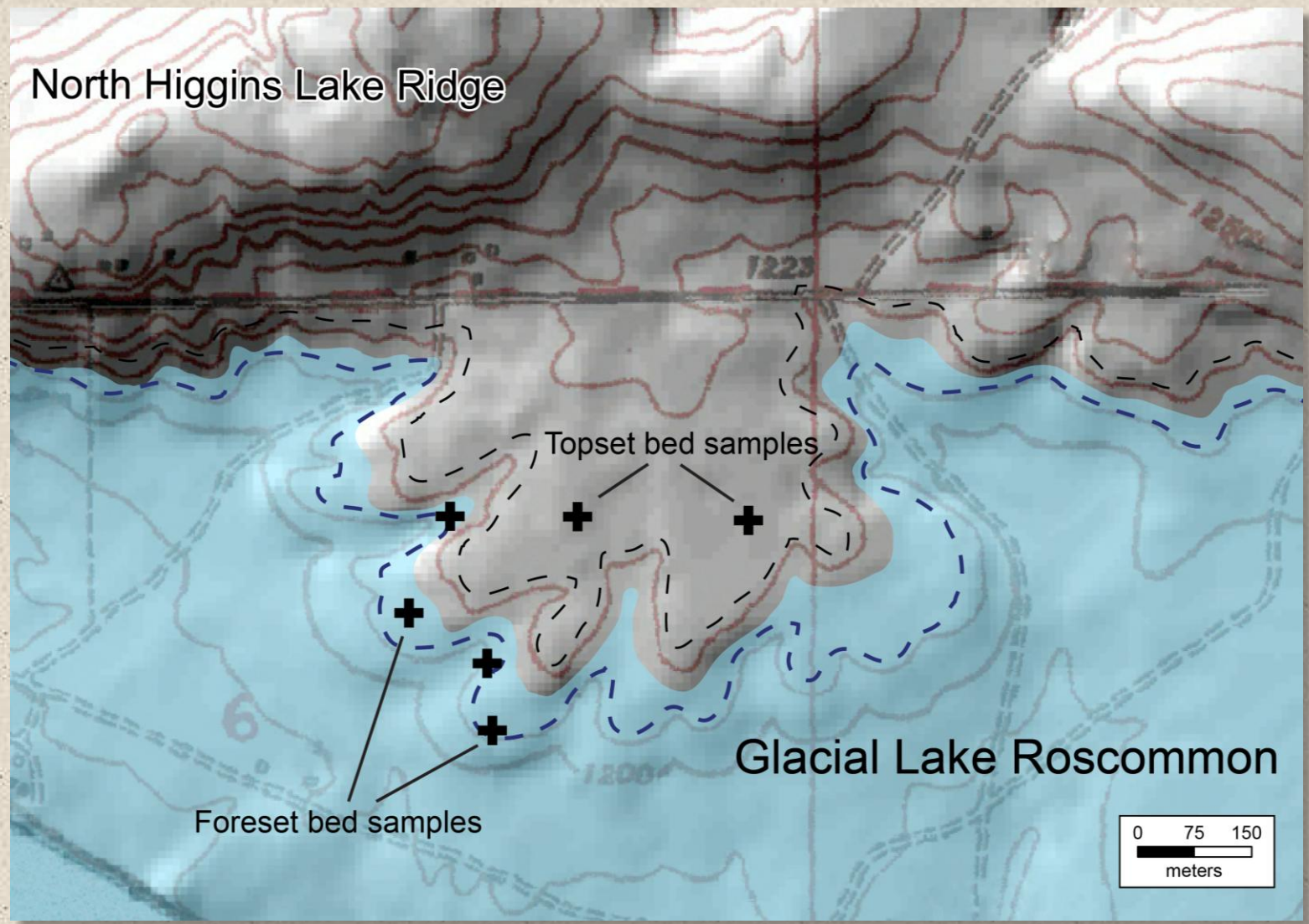


Figure 4. Map of the Cottage Grove Delta, flooded to ≈ 372 m. Dotted lines show an error envelope of ± 1 m. Also shown are the locations of the OSL samples, and their possible interpretations.

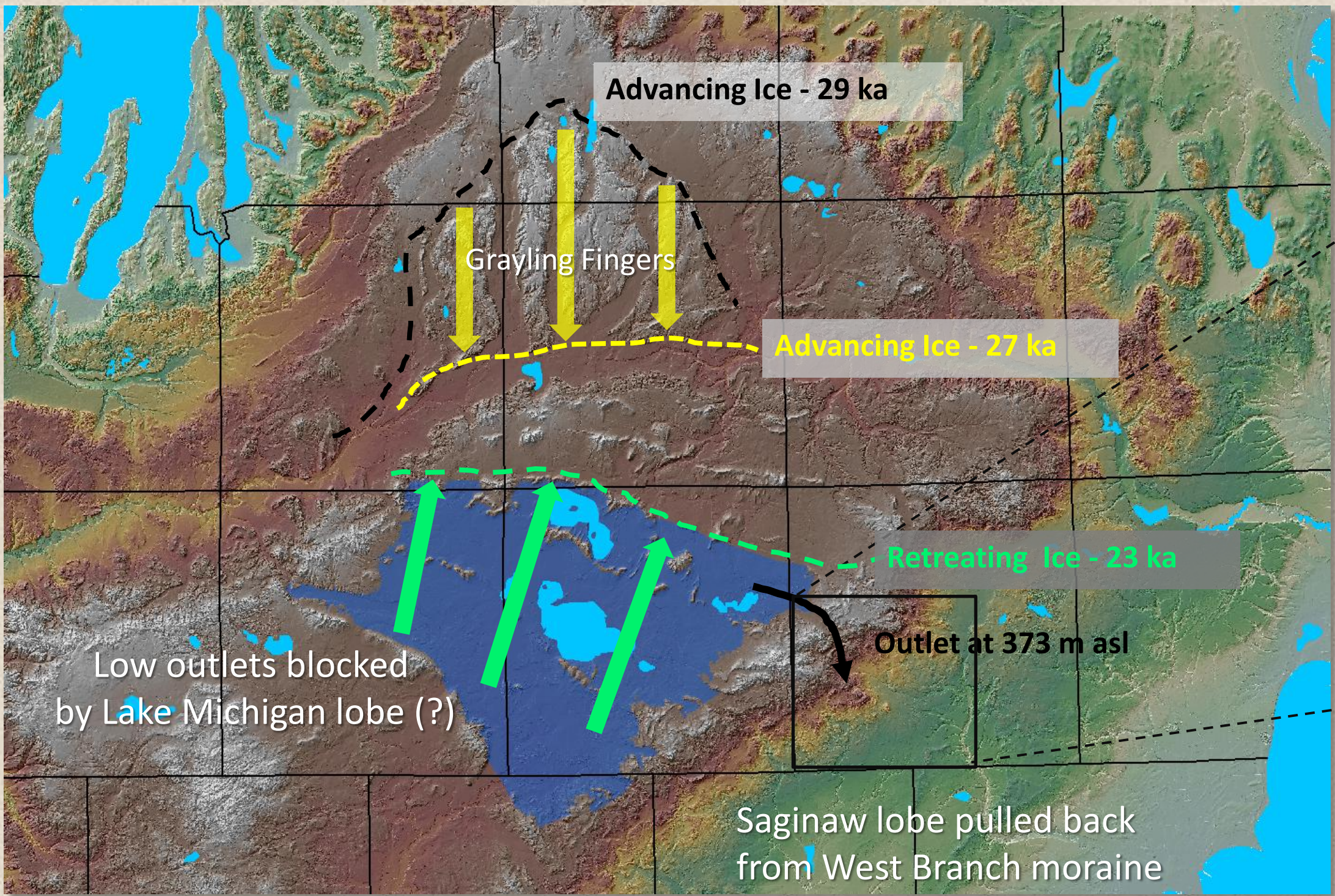
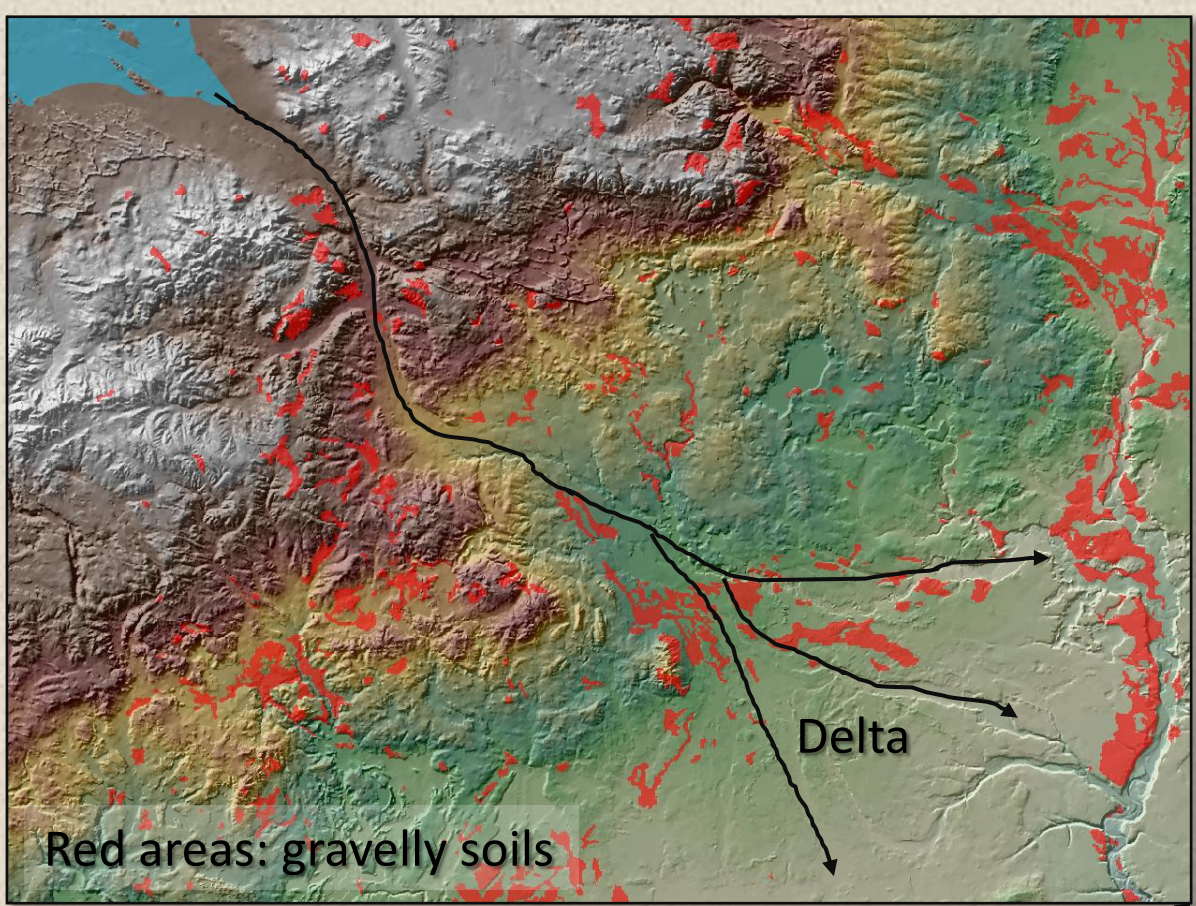


Figure 7. (Left.) Summary of OSL dating results. The light blue rectangle represents the mean and standard deviation of the age determinations, exclusive of sample CG1504.

Figure 8. (Below) Known positions of the ice front at various times in the Late Pleistocene. Glacial Lake Roscommon is shown at the 373 m level, when the Cottage Grove Delta formed.



References

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- Vader, M.J., Zeman, B.K., Schaetzl, R.J., Anderson, K.L., Walquist, R.W., Freiburger, K.M., Emmendorfer, J.A., and H. Wang. 2012. Proxy evidence for easterly winds in Glacial Lake Algonquin, from the Black River Delta in northern Lower Michigan. *Phys. Geog.* 33:252-268.

Results and Discussion

Both deltas have classic Gilbert type morphologies, with a broad, nearly flat, central core that abruptly breaks to a steep delta front (Fig. 5). Both are composed on extremely well-sorted sands that become progressively finer toward their margins (Fig. 6). The Cottage Grove Delta has aggraded ≈ 7 -10 m of sandy sediment above the former lake floor; the South Branch Delta is considerably thicker – 22 to 27 m. Gullies on the outer margins of both deltas may date to a period of permafrost, which has been documented for this area (Schaetzl 2008). The Cottage Grove Delta's almost symmetrical morphology is suggestive of multi-directional, wave-driven erosion along the delta front (Vader et al. 2012).

The presence of deltas in the Houghton Lake Basin supports the hypothesis that a high-level, periodically stable, proglacial paleolake once existed here. Other morphological features associated with semi-permanent glacial lakes – wave-cut benches or bluffs, constructional coastal features such as spits, and outlets at levels consistent with all of the former – are also present within the Basin. Although not shown here, we have identified five different, overwidened outlets from the Houghton Lake Basin, most of which connect to a delta of some type. We name this proglacial lake *Glacial Lake Roscommon*, for its location within Roscommon County, Michigan.

Five of the six OSL samples from the Cottage Grove Delta clustered around a mean value of 23.1 ± 0.4 ka, which can be interpreted as the “age” of the delta (Fig. 7). We regard sample CG1504 as an outlier. The mean ages of the two samples from the topset beds are ≈ 500 years younger than the samples from the gullies, suggesting that the delta formed quickly.

Implications

The implications of these dates for ice dynamics and chronology are considerable. OSL ages from outwash within the Grayling Fingers, due north of the study area (Fig. 8), indicate that ice was at the northern edge of the Fingers by ca. 29 ka (Schaetzl and Forman 2008). The ice crossed over the Grayling Fingers at ca. 27 ka, flowing south. We name the lobe that advanced into the Houghton Lake Basin from the northeast the *Mackinac Lobe*. Its next known position is shown in Figure 8 – retreating but stalled at the North Higgins Lake Ridge at ca. 23 ka, concurrent with the formation of the Cottage Grove Delta. Figure 8 shows one possible extent of Glacial Lake Roscommon at this time, and its likely outlet. In order for this outlet to have functioned, the Lake Michigan lobe or its deposits must have been blocking lower outlets to the southwest, and the Saginaw Lobe must have been pulled back from the West Branch moraine (Fig. 1). Water draining from Glacial Lake Roscommon formed a small delta just south of the city of West Branch.

There is much to learn about ice dynamics in this complex, interlobate area. What we present here is just a start. Nonetheless, our work supports two significant findings: (1) several thousand years before ice started to retreat from southern Michigan, ice of the Mackinac Lobe had retreated so far that an opening formed between it and the Saginaw and Lake Michigan lobes, and (2) this area was variously flooded with proglacial lakes during this retreat.