Origin and Extent of the Greenwood Moraine: A Landform Representing the Early Deglacial History of South-Central Indiana

Tyler Hickey-Geosciences Program, Indiana University Southeast, New Albany, IN

Abstract

The Greenwood Moraine is a recessional feature representing the early deglacial history of south-central Indiana. Surficial geologic mapping and an analysis of data provided by the Indiana Geological and Water Survey were used to extend the lateral extent of the moraine and interpret the early deglacial history of the region. Through mapping and stratigraphic/sedimentologic analyses, the Greenwood Moraine can be extended from east of Greenwood to south of New Castle, Indiana using clearly defined heads-of-outwash and topographic features. The chronology of deglaciation beginning with the Last Glacial Maximum, about 25,000 years ago, will also be discussed.

Introduction/Purpose and Scope

The geologic landscape of south-central Indiana has been the focus of numerous studies for many years due to its unique glacial history and formations. Throughout the Pleistocene epoch of the Quaternary Period (approximately 2.6 Mya-11,700 years ago), episodes of widespread continental glaciation occurred in the northern latitudes of North America. During these glacial periods massive ice sheets, or lobes, continuously advanced and retreated across the continent, ultimately merging into what is known today as the Laurentide Ice Sheet (LIS). The LIS flowed southward from Canada and reached the southern parts of Indiana, Ohio and Illinois at the maximum extent of the Illinoian glaciation. The purpose of this project, however, is concentrated on the Last Glacial Maximum (LGM), which occurred about 28,000 to 24,000 years ago (Dalton et al., 2020) during the Late Wisconsin glaciation period (Figures 1 and 2).

As can be seen in Figures 1 and 2 below, the LGM of the Late Wisconsin glaciation extended to south-central Indiana, with the furthest point reaching southeast of Columbus. Just north of the glacial boundary lies the Greenwood Moraine, a recessional feature consisting of unconsolidated sediments known as till and stratified drift. Unlike terminal moraines, which generally mark the limit of glacial advance, recessional moraines form behind the glacial boundary when retreat has been interrupted and deposition occurs.

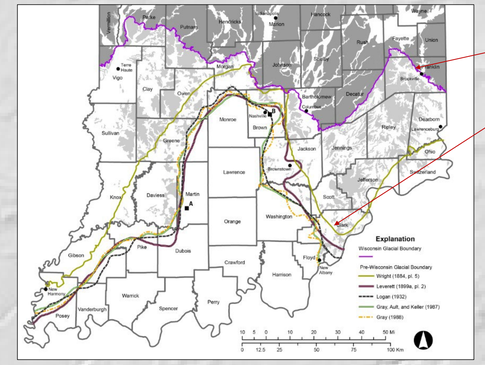
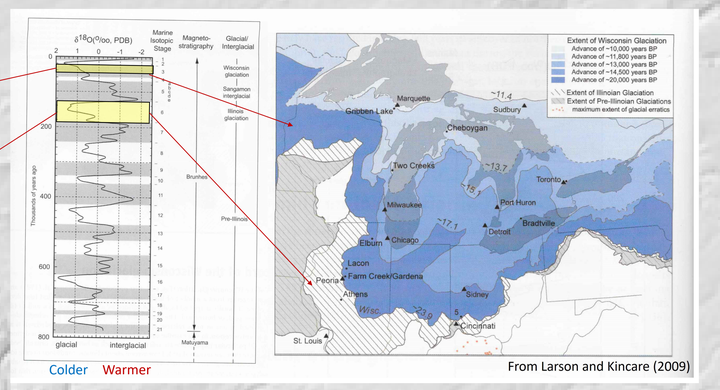


Figure 1. Map of the LGM of the Late Wisconsin glaciation. Various interpretations of Illinoian and pre-Illinoian glacial extents also shown. From Gray and Letsinger (2011).



From Larson and Kincare (2009)

Figure 2. Map demonstrating the extent of Wisconsin glaciation and deglaciation at different times. MIS 1 (top yellow) represents Wisconsin glaciation boundary. MIS 2 (bottom yellow) represents pre-Wisconsin glacial boundary.

Methods

The currently accepted location of the Greenwood Moraine lies in the northern part of Johnson County, Indiana. However, through the use of high-resolution light detection and ranging (LiDAR) imagery and surficial geologic mapping, the Greenwood Moraine can be interpreted to extend east-northeast through Shelby and Rush County into the western part of Fayette County. LiDAR imagery application has become a key component in understanding the composition and distribution of glacial landforms in recent years (Salcher et al., 2009). Analyses of sedimentologic and stratigraphic data of the region suggest that the recessional moraine can be linked to distinguished heads-of-outwash within numerous valleys.

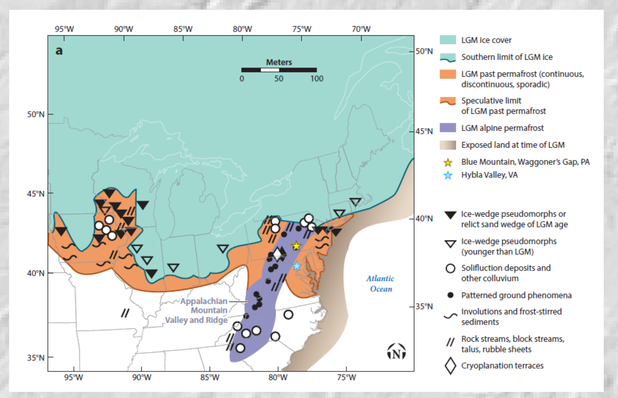
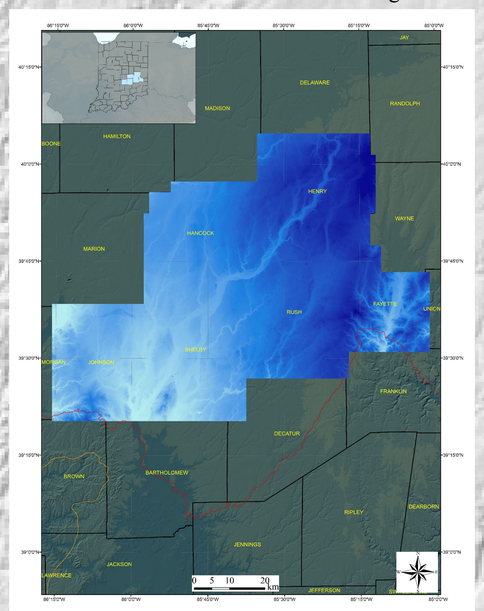


Figure 3 (above). A map highlighting the areas where permafrost developed as the glacier receded north.

Figure 4 (right). High-resolution LiDAR imagery (6 in resolution) of the study area depicting heads-of-outwash as well as regional topography.



Study Area

The area of focus for this project includes the landscapes of Johnson, Shelby, Hancock, Henry, Fayette, and Rush Counties. The paleoenvironment of these counties was much different during the Late Pleistocene than it is today. Central Indiana was a mosaic of periglacial tundra and spruce/pine parkland and forest environments and a much colder climate than today. The plants that inhabited the recently deglaciated area had a major influence on the depositional setting, and scientists are able to reconstruct the paleoenvironment by studying pollen from trees that have been preserved in lake sediments (*Late Pleistocene Biomes | Explore the Ice Age Midwest*, n.d.).

Key Points and Limitations

- Sedimentological analyses revealed that the region is largely comprised of silt- and clay-rich diamicton (till) as well as Wisconsin outwash (stratified drift), post-glacial alluvium, and aeolian sediments.
- The depositional units and landscape were largely influenced by the icesheet itself, and proglacial and subglacial channel rivers that formed due to the influx of large volumes of meltwater that were transported down by already established river valleys as the glacier retreated northward. Wind was also an important process in front of the ice sheets
- LiDAR imagery and digital terrain models (DTMs) reveal similar topography and elevated areas with distinct ridges, proposing that the moraine can be traced to the east towards Fayette County.
- Much of the terrain in Shelby County has been eroded due to significant incision of multiple rivers valleys, making the reconstruction of the moraine difficult.
- Future work and absolute dating should be conducted in order to verify the hypothesis of the extension of the Greenwood Moraine.

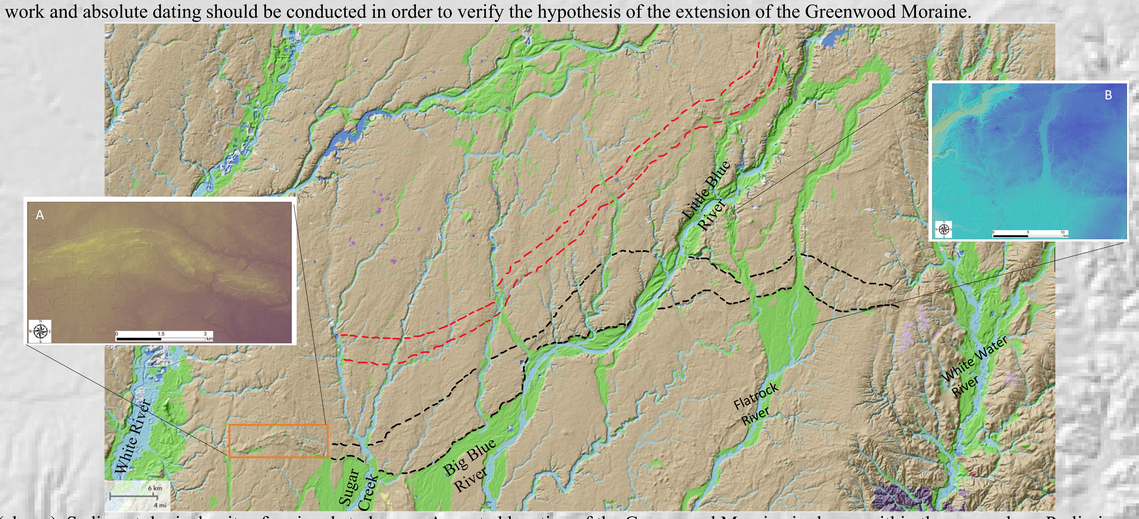


Figure 5 (above). Sedimentological units of regional study area. Accepted location of the Greenwood Moraine is shown within the orange box. Preliminary extension of the moraine is traced in black and unidentified moraine in red. Inset represents a closer view of the Greenwood Moraine. Inset A - High-resolution LiDAR image of the Greeenwood Moraine and the original Geological Survey mapping outline. Inset B - High-resolution LiDAR image of the proposed eastward extension of the moraine.

Legend

- Wisconsin outwash
- Glacial till (diamicton)
- Recent alluvium
- Aeolian sand
- Loess (wind blown material)

Figure 6 (left). Picture of Wisconsin outwash.

Figure 7 (right). Picture of both Wisconsin outwash (upper section) and glacial till (lower section).

(both photos were taken at a sand and gravel quarry in the Whitewater River valley.)

Conclusion

The Greenwood Moraine is the most significant glacial feature found within Indiana that represents the deglacial history of the LGM that occurred in the Late Wisconsin glaciation period. High-resolution LiDAR imagery and digital terrain models can contribute to the reconstruction of the moraine as well as provide information on how meltwater played an important role in its formation and distribution. Based upon data gathered by Loope et al. (2017), the formation of the moraine occurred approximately 23,000-21,000 years ago, and is supported by the recent work of Dalton et al. (2020). Absolute dating coupled with additional surficial mapping interpretation in future studies should not only solidify the lateral extension of the Greenwood Moraine hypothesis, but also the identification and classification of previously unmapped recessional features to the north.

Data Sources

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