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Late- and Post-Glacial History of the Greenwood Moraine and Adjacent River Valleys of South-Central Indiana

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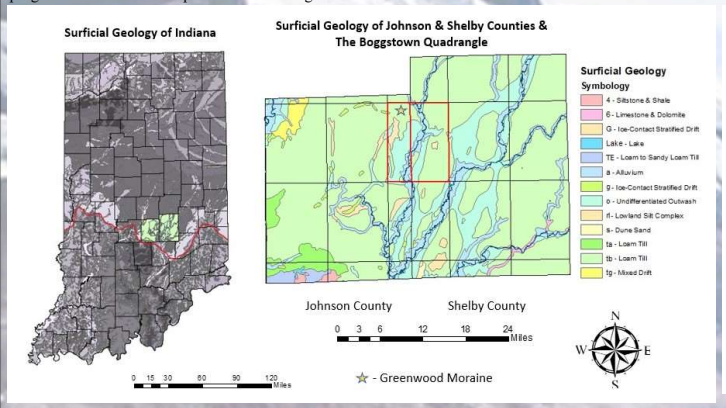
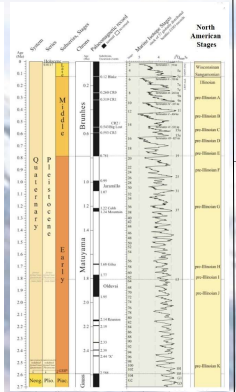
ABSTRACT

At the height of the last Ice Age, the northern part of North America was covered by the Laurentide Ice Sheet which contributed to the formation of the recessional feature found in south-central Indiana known as the Greenwood Moraine. Rivers draining from the moraine, flowing adjacent to it, and cutting through it evolved during the late- and post-glacial times. The purpose of this project is to understand the late- and post-glacial chronology of river development using absolute age data. Preliminary analyses suggest a straight-forward river evolution model consisting of several geomorphic processes, are presented herein..

Introduction

The Greenwood Moraine is a recessional moraine which means it is composed of unsorted sediments (glacial till) that was deposited by the Laurentide Ice Sheet during the Last Glacial Maximum 24,000-20,500 years ago (Dremanis & Goldthwait, 1973). This occurred in the Late Pleistocene of the Quaternary Period. The Greenwood Moraine is found just above the maximum extent of the ice sheet during the Wisconsin Limit. The outwash valley south of the moraine was formed by glacial meltwater. Sugar Creek is the river located in the study area, and it is a proglacial river because its path had been changed due to the influence of the Laurentide Ice Sheet.





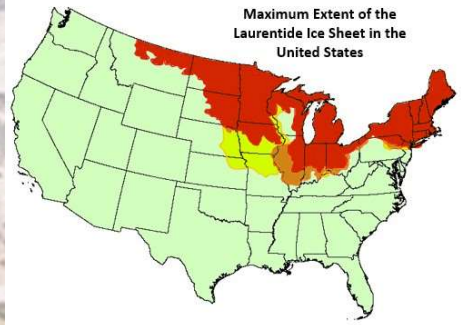
http://quaternary.stratigraphy.org/wp-content/uploads/2018/04/quaternarychart2009a.pdf

Maximum Extent of the Laurentide Ice Sheet During the Wisconsin Limit and Previous Limits

The Laurentide Ice Sheet advanced down from Canada and then retreated during the Last Glacial Maximum with what is known as the Wisconsin Limit. The Late Wisconsin Limit occurred 25,000-10,000 years ago (Dyke, 2009). The Illinoian and Pre-Illinoian Limits that preceded were either destroyed or buried by the advancement and retreat of the ice sheet during the Wisconsin glaciation (Larson & Kincare, 2009). Right now, we are in an interglacial phase known as the Holocene Interglacial Phase.

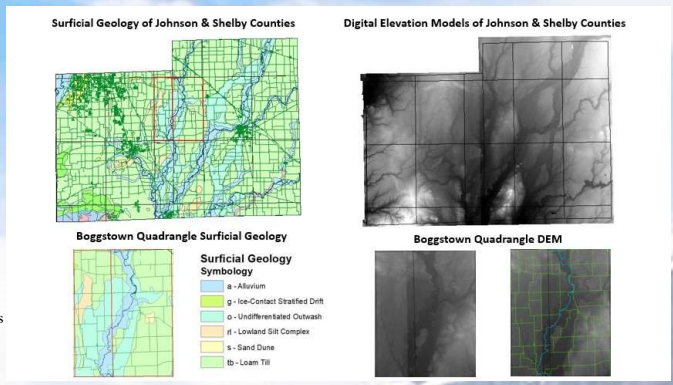
Lobes are pieces where the ice sheet broke off in different directions. Lobes named for the direction in which they came. The study area was formed by the influence of the Huron-Erie Lobe.

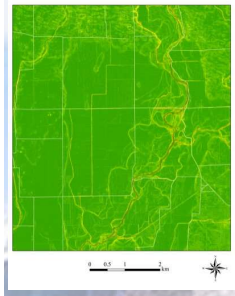
Red – Wisconsin Limit (70,000-10,000 years ago)
Orange – Illinoian Limit (180,000-130,000 years ago)
Yellow – Pre-Illinoian Limits (300,000-230,000)
(480,000-330,000)
(Rohli & Vega, 2018)
Gaps in geologic time represent interglacial periods. Sangamon Interglacial occurred between Wisconsin and Illinoian glaciation.



Study Area

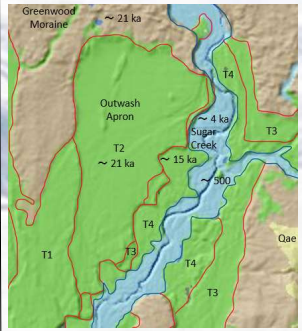
Sugar Creek is the main river found in this study area. Within the Sugar Creek Valley, proglacial river terraces exist and formed due to meltwater release from the glacier during the Ice Age. In post-glacial times, downcutting of the river at various points, created additional low-level terraces. An important part of this study is to determine the age of the Greenwood Moraine and terraces within the adjacent river valley so that river responses to glaciation, climate and possibly human impacts can be assessed. The current land cover/land use within the Sugar Creek Watershed is a mix of agriculture, forest and woodland and residential areas. Some small areas of wetlands also exist.



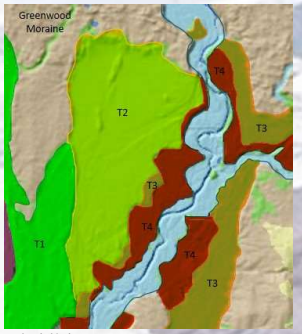


Above is a LiDAR map, (Light Detection and Ranging), that shows where there are differences in elevation.

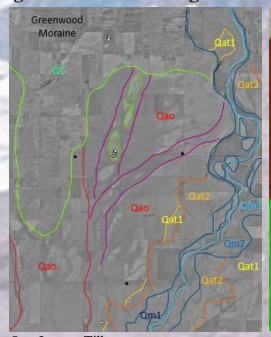
Absolute Age Data (OSL – Optically-Stimulated Luminescence) Dating & River Terrace Ages



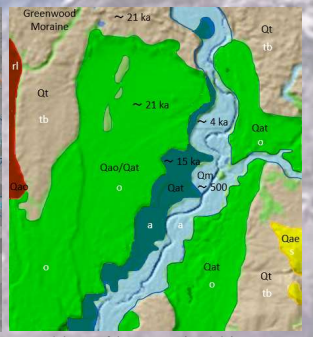
Greenwood Moraine – Last Glacial Maximum
Age ~21,000 years
Outwash Apron/Valley – Last Glacial Maximum
Age ~21,000 years / ~15,000 years
Sugar Creek – Historic/Recent
Age ~4,000 years / ~500 years



Fluvial/River Terraces
T1 – oldest / formed by meltwater
T2 – second oldest / formed by meltwater
T3 – second youngest / erosion from warming
T4 – youngest / influenced by Paleo-Indians
Younger alluvial/river terraces also influenced by the interaction of people with the river.



Qt – Loamy Till
Qao – Outwash (T1, T2)
Qat1/Qm1 – High Terrace/Alluvium (T3)
Qat2/Qm2 – Low Terrace/Alluvium (T4)
Qm3 – Historic/Recent Alluvium
Qae – Eolian/Wind Dunes
Paleo-rivers (purple) indicate glacial history



Qt / tb – Trafalgar Formation (Pleistocene / Greenwood Moraine)
Qao/Qat/Qae – Atherton Formation (Pleistocene / Outwash Apron/Valley)
Red – rl, Green – o, Blue – a, Yellow – s
Qm / a – Martinsville Formation (Holocene / Sugar Creek)

Conclusion

The history of the Sugar Creek Valley begins with its relationship to the Greenwood Moraine. When the Laurentide Ice Sheet was at the location of the Greenwood Moraine, large volumes of meltwater and sediment were flowing from the ice. Several phases of water and sediment release produced the glacial outwash terraces. The youngest outwash terrace is related to the younger ice margin to the north of the Greenwood Moraine. After the Ice Age ended, the river attained a meandering stream pattern and produced lower river terraces, likely in response to climate shifts. The youngest and lowest landform, the modern floodplain, contains evidence of human impacts on the river system.

Data Sources and Methods

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- OSL dating used to find the ages of the river terraces from the 2017 Midwest Friends of the Pleistocene Field Guide
- GIS used to create study area map and surficial geology maps
- Soil maps used from https://soilexplorer.net/
- Image of Pleistocene timescale from http://quaternary.stratigraphy.org/wp-content/uploads/2018/04/quaternarychart2009a.pdf
- Glacial lobes image created by author and information on the image of glacial lobes from https://www.sciencedirect.com/science/article/abs/pii/S1040618211004022
- Maximum extent image of Laurentide Ice Sheet limits created by author and information on the image of the Laurentide Ice Sheet limits from https://www.britannica.com/science/glaciation