GEOLOGY OF

CEDAR BOG NATURE PRESERVE

Accessible boardwalk leading into the biodiverse nature preserve with the cedar forest in the background.

by Tyler Norris - 2023

OHIO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

geology.ohiodnr.gov

OHIO HISTORY CONNECTION

Introduction

The glacial sediments and unique flora within and surrounding Cedar Bog Nature Preserve highlight the unique geologic history leading up to the formation of this boreal (colder, northern) relict of the Ice Age. A cooling climate towards the end of the Pliocene Epoch led to multiple glaciations during the subsequent Pleistocene Epoch, which dramatically modified the landscape across Ohio and much of the northern United States (fig. 1). Today (in what is known as the Holocene Epoch), much of the evidence of early geological events is hidden beneath hundreds of feet of glacial material. These deposits, along with both extinct and extant wildlife from the most recent Ice Age, created what is now known as Cedar Bog and contributed to the area's unique ecosystem.

Preglacial Landscape

Before the Pleistocene Epoch glaciations covered this part of Ohio, the landscape surface consisted of gently rolling hills composed of solid bedrock with valleys carved by streams, all of which are now buried beneath the younger glacial sediments at Cedar Bog. Locally, the underlying carbonate bedrock is composed of Ordovician-age (485–444 million years ago) limestone interbedded with shale and Silurian-age (444–419 million years ago) dolomite. This bedrock landscape was shaped by millions of years of weathering and erosion. Most of the erosion was caused by surface water drainage of the Teays River System (fig. 2), which once flowed through the area encompassing present-day Cedar Bog.

Effects of Early Glaciations

During the Pleistocene Epoch, the global climate cooled, and North America began to experience periods/intervals of glacial advance and retreat (fig. 1). Early glacial advances that occurred before about 190,000 years ago are known as pre-Illinoian glaciations. At least once during the Pleistocene, pre-Illinoian glacial ice from Canada advanced southward, blocked the northwestward course of the Teays River in Ohio, and created a large *proglacial lake* (known as Lake Tight) that filled tributaries and lowlands to the south (fig. 2). This ice-dammed lake environment allowed small particles to settle through the calm water and accumulate onto the lake floor, creating thick silt-and-clay layers called *lacustrine (*or *slack-water) deposits.* As the lake levels rose, water spilled over high points and incised channels on the landscape. Water levels eventually became so high that the Teays reversed course and began flowing to the southeast, establishing a completely different drainage system that ultimately led to the creation of the modern Ohio River.

Over the course of many thousands of years, ice from the pre-Illinoian and subsequent Illinoian glaciations buried the Teays River Valley and altered the landscape surrounding present-day Cedar Bog. As glaciers melted and retreated northward, they left behind a mixture of boulders, gravels, sands, silts, and clays in a material known as *glacial till*. They also discharged meltwater and deposited *outwash*, or sands and gravels "washed out" of the glacier. Much of the evidence for these early glaciations were buried, altered, or destroyed by ice from the Wisconsinan Glaciation during the most recent Ice Age in the vicinity of present-day Cedar Bog.

The Last Ice Age

The landscape within and surrounding Cedar Bog provides evidence of recent Ice Age events from the Wisconsinan Glaciation. Most of the hills and valleys around Cedar Bog were formed about 20,000 to 17,000 years ago by the complex interactions between ice and meltwater. Three major episodes of outwash pulses incised and filled meltwater valleys in the region surrounding Cedar Bog, which are separated in some places by patches of glacial till (see map, back page).

The oldest and highest elevation (about 1,145 ft above mean sea level [a.m.s.l.]) of outwash is the Kennard Outwash terrace, located about 6 miles east of Cedar Bog. The next outwash terrace is the Intermediate or Urbana Outwash (about 1,045 ft a.m.s.l.), about a mile northeast of Cedar Bog,

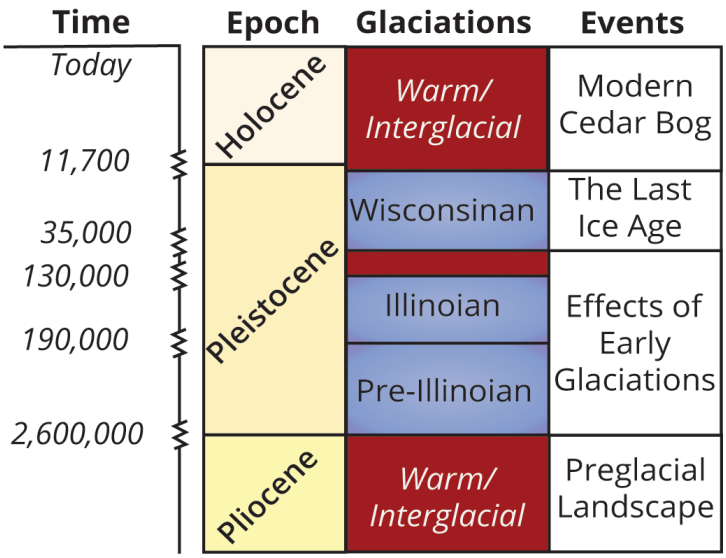


Figure 1. Generalized timeline of geologic events during the late Neogene and Quaternary Periods. Time in years.

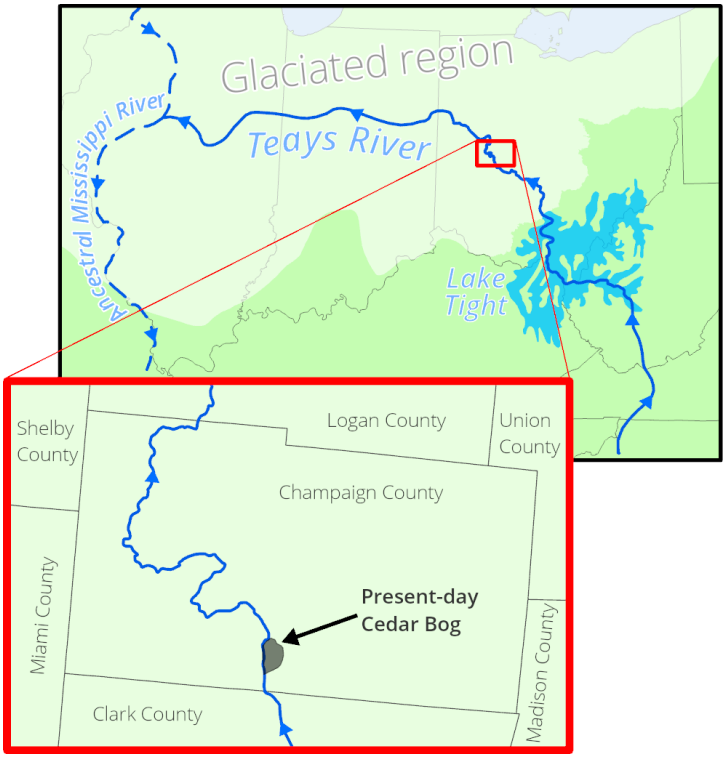


Figure 2. Top: The main path of the ancestral Teays River across several southeastern and midwestern states during the Pliocene Epoch and the extent of the now-drained Lake Tight during the pre-Illinoian Glaciation. Bottom: The buried Teays System in association with the present-day Cedar Bog.

and underlies much of the city of Urbana. *Ice contact deposits* also formed throughout this glacial period, as glacial meltwater in contact with the glacial ice accumulated coarse material as hills (*kames*) or near-linear ridges (*eskers)* of sand and gravel. Oscillating ice advanced over and retreated from the outwash to form thin till layers and large ridge moraines, such as the West Liberty and Springfield Moraines. Additional meltwater pooled to form *lacustrine proglacial lakes*, which eventually spilled over and drained into incised channels. The final and lowest elevation (about 990 ft to 960 ft a.m.s.l.) outwash is the Mad River Valley Train Outwash, which incised through the Urbana Outwash terrace and underlies Cedar Bog. This outwash formed here as ice melted and retreated northward for the final time, leaving behind a thick blanket of *ground moraine*, or till deposited underneath the glacier, that makes up the uplands to the west. After the meltwater supply diminished, the Mad River and its tributaries formed, creating smaller terraces within the Mad River Valley and depositing *alluvium*, or materials transported by water in streams.

Cedar "Bog" Formation

Fens and other *peatlands*, or organic-rich wetland-like areas, are common glacial landscape features that can form in a variety of ways in Ohio. Peatlands are typically found in association with buried and outwash valleys, esker-kame complexes, old glacial lakes, and end moraines. The existence of Cedar Bog is largely attributed to the hydrogeologically connected outwash terraces. Some groundwater is carried through the uplands and then discharged as a spring at the escarpment between Urbana and Mad River Outwash terraces, creating a constant local supply of cool, clear, and alkaline (high pH) water that supports the fen environment (fig. 3). Carbonate-rich gravels, mostly originating from the local limestone bedrock in the outwash and other glacial deposits, cause the water to have a high pH. Cedar Bog is thus classified as a fen and not a bog. To be considered a true bog, the peatland would have contrasting characteristics such as having acidic (low pH) brown water due to poor water circulation. The movement of calcium carbonate-rich groundwater through such deposits may also lead to the precipitation of *marl*, a soft, fine-grained, gray limey material which is also found in Cedar Bog. Cedar Bog and similar patches of peatlands nearby are likely remnants of localized swampy tracts that developed shortly after the deposition of the Mad River Outwash.

Pleistocene Flora and Fauna

Just before the Wisconsinan Glaciation, the area was likely covered in mature spruce and hemlock forests growing in deposits from older glacial episodes. The Wisconsinan ice demolished this ecosystem, and once this ice retreated, several successive plant communities were established. Sedges and coniferous forests likely dominated initially, with intervals of wet prairie grasslands and more deciduous forest growth during warming periods. Modern plant associations include a mixture of bog and marl meadows, swamp and hardwood forests, cedars, and shrubs. Many of the boreal species migrated north with the glaciers or went regionally extinct as the climate warmed. However, the consistent cool and wet microclimate at Cedar Bog allowed unique plant species, such as the northern white cedar, showy lady slipper, and round-leaf sundew to survive in isolation for thousands of years.

Several modern, familiar animals, such as beavers, white-tailed deer, salamanders, and turtles, lived in and around Cedar Bog during the late Pleistocene time. Additionally, large animals known as *megafauna* shared this habitat with well-known modern animals for thousands of years at the end of the Ice Age. These giant mammals include the mastodon, woolly mammoth, giant beaver (fig. 4), giant ground sloth, stag moose, and musk-ox. But unlike many of their smaller modern relatives, all of these North American megafauna went extinct in Ohio about 10,000 years ago as a result of a combination of factors relating to a dramatic shift to a warmer climate, habitat loss, and potentially overhunting by native humans.

Modern Cedar Bog

Though it might appear to be a relatively large fen, Cedar Bog is only a fraction of the size it was thousands of years ago. Significant land-use changes, including the human-made drainage modification of the Mad River during the early 1900s, eliminated thousands of acres of what was once part of this natural fen environment. Today, this delicate ecosystem survives because of passionate conservation efforts.

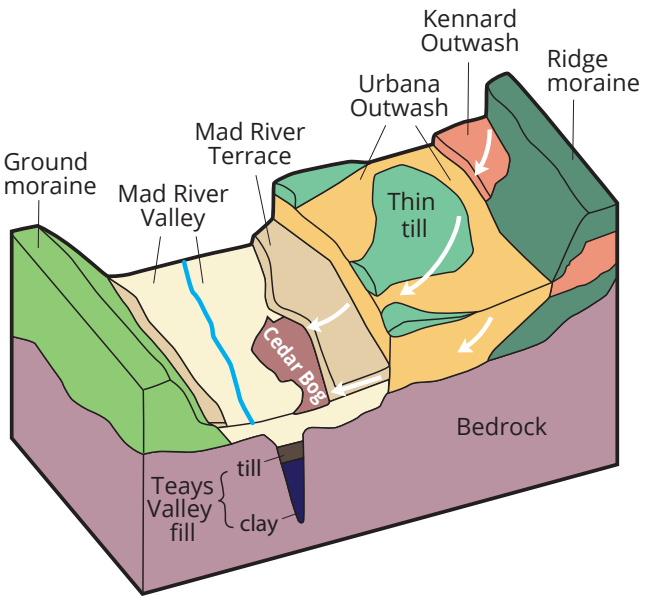


Figure 3. Conceptual model of Cedar Bog showing major terraces and generalized groundwater flow (arrows) that form the fen.

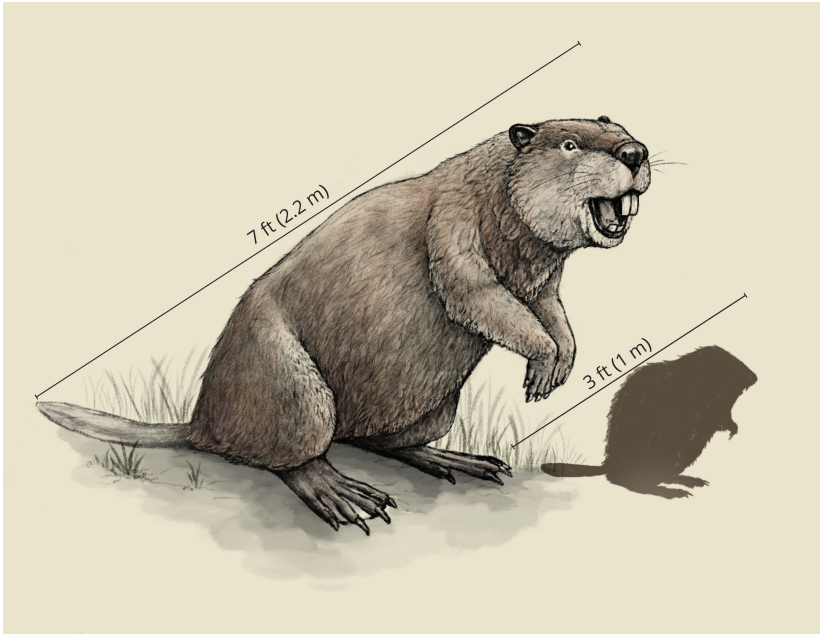
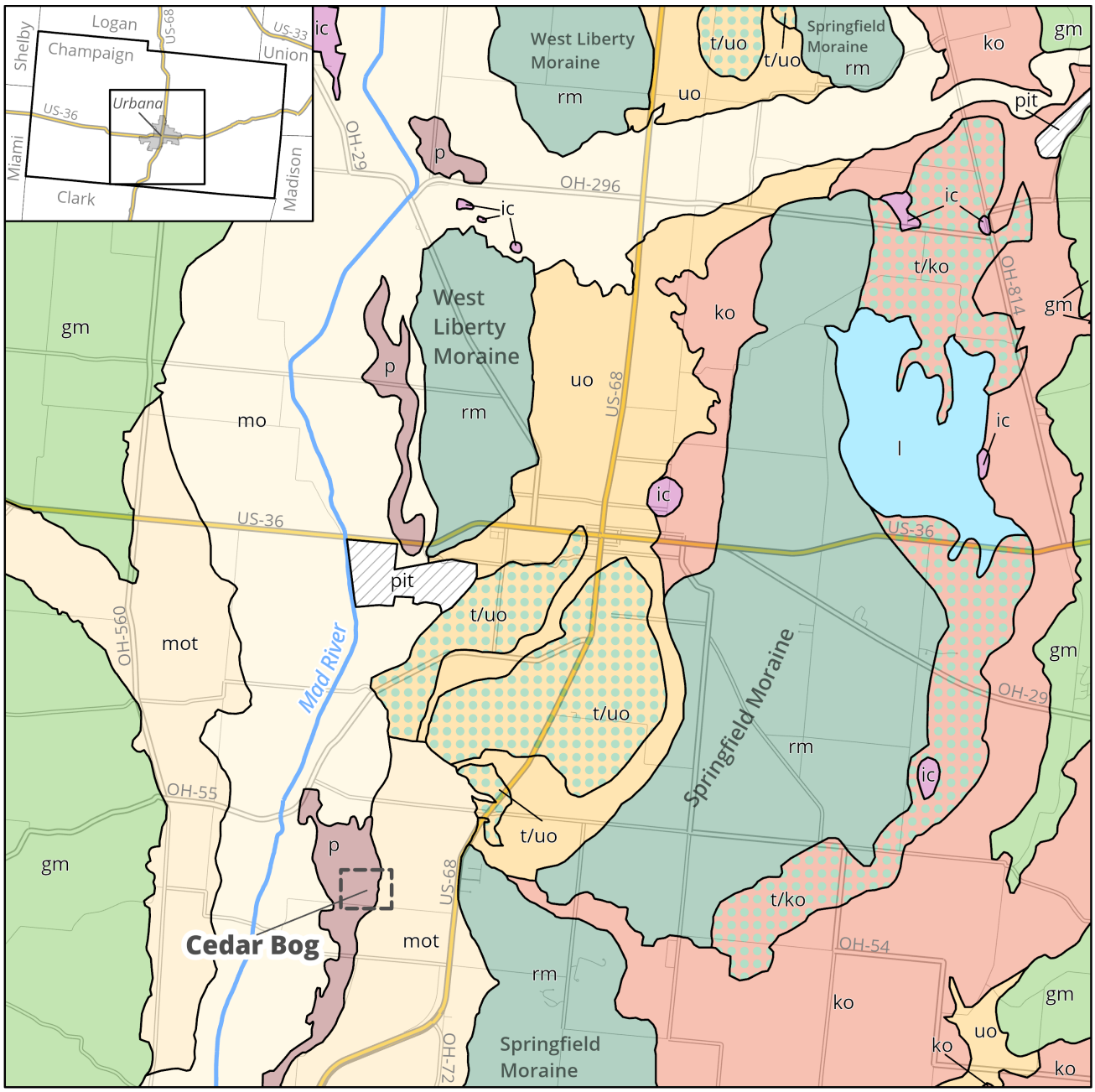
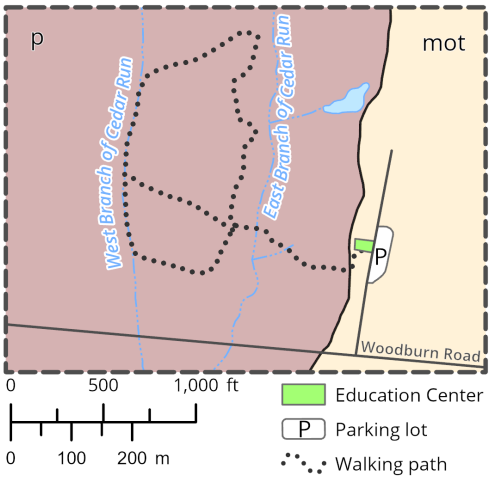


*Figure 4. Depiction of the extinct giant beaver (*Castroides ohioensis; *left) compared to the extant North American beaver (*Castor canadensis; *right). Modified from original illustration by Madison Perry.*

GEOLOGIC MAP OF CEDAR BOG & ADJACENT AREAS, CHAMPAIGN COUNTY, OHIO





Legend

Unit contact

N

0 1 2 mi

0 1 2 km

Map Units

ko	Kennard Outwash	gm	Ground moraine
t/ko	Thin till over Kennard Outwash	rm	Ridge moraine
uo	Urbana Outwash	ic	Ice contact
t/uo	Thin till over Urbana Outwash	l	Lacustrine
mot	Mad River Outwash terrace	p	Peatland
mo	Mad River Outwash	pit	Sand-and-gravel pit

Education Center

P Parking lot

Walking path

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