THE GEOLOGY OF SCHENLEY PARK

A Record of Climate and Sea Level Change 300 Million Years in the Making

David K. Brezinski and Albert D. Kollar
Section of Invertebrate Paleontology
Carnegie Museum of Hatural History

(interpreted Monongahela River water level in Schenley Park during creation of Lake Monongahela)

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Introduction

The rocks of Schenley Park record important events in Earth's history. The bedrock deposits that underlie the region are 290 to 300 million years old, and give testimony to changes in sea level and climate that occurred near the equator while the polar regions were gripped in one of Earth's greatest ice ages. Similarly, the landscape topography was sculpted by abrupt changes in river courses resulting from dramatic climate changes dating back less than 2 million years.

Approximately 300 million years ago western Pennsylvania was located near the equator in a warm and tropical climate. To the east (south at that time) the Appalachian Mountains were being formed. River systems flowed out of the mountains into western Pennsylvania, which was at that time a low-lying plain that bordered a large continental seaway (Figure 1). At this same time immense glaciers existed in the Earth's polar regions. These glaciers grew and melted time and again as the Earth's climate changed. When the global climate grew warm, the polar glaciers melted and the meltwater filled

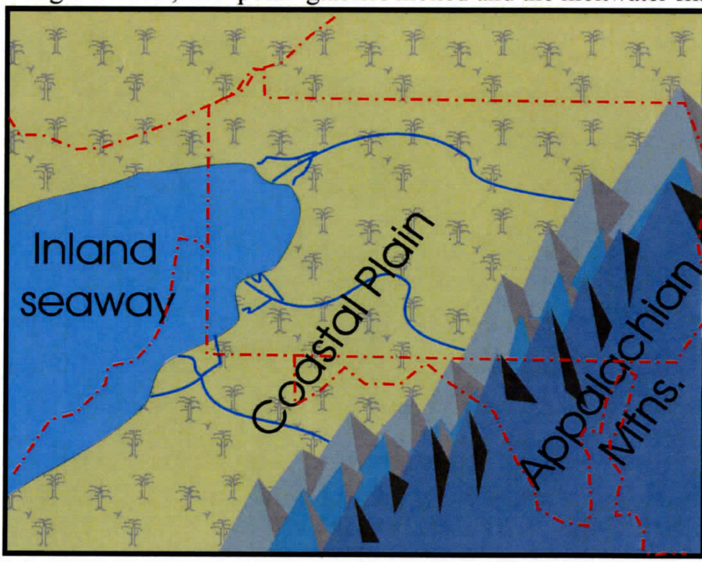

Figure 1.– Paleogeographic map of western Pennsylvania during a warm period between glacial episodes of the Late Paleozoic Ice Age, approximately 300 million years ago.

the ocean basins that overflowed on to and submerged large areas of the continents. During these flooding events fossiliferous limestone and shale were formed in vast shallow seas that submerged much of the continental areas. Along the margins of these shallow seas, tropical coastal swamps produced abundant decaying plant material that formed coal layers. When Earth's climate cooled, the polar glaciers expanded and migrated into lower latitudes. The result was that much of the water in the ocean basins became caught up in glacial ice. This produced a global sea level drop, and vast areas of the continental shelves were exposed to erosion. During these times, large rivers flowed across the continental shelf. In these river channels silt and sand were deposited which later would form sandstone.

This pattern of repeatedly changing climate and subsequent rapid sea level fluctuations persisted for many millions of years. This cycle of events produced repetitions in vertical accumulations of rocks called "cyclothems." Throughout the world cyclothem-type rocks characterize the geologic age called the Pennsylvanian Period, but nowhere are they better developed than in western Pennsylvania, where the geologic period gets its name. The evidence of these important changes in Earth's climate and sea level is recorded in every rock exposure throughout western Pennsylvania. In low-lying areas such as Kansas and Missouri the repetitions are characterized by alternations of marine limestone and nonmarine shale and sandstone. However, western Pennsylvania was higher in elevation and closer to the mountains; consequently, not every warming period produced enough melting of the glaciers to flood the continental shelves as far inland as western Pennsylvania. Even so, these periods of warm climate are recorded by the development of regional coal beds that formed in the coastal areas along the margins of these seas.

Panther Hollow Bedrock

Rocks exposed in Panther Hollow are assignable to a rock unit that geologists call the Casselman Formation of the Conemaugh Group. While the Conemaugh Group gets its name from exposures along the Conemaugh River, Panther Hollow exposes only a short sliver of the youngest part of that geologic unit. The Conemaugh Group was formed some 300 million years ago by complex changes in climate and global sea level; the Panther Hollow section of rock demonstrates just how complex these events were.

The study of the rock sequence in Panther Hollow allows the identification of the dramatic global changes that occurred in Earth's distant past. At the base of the exposure a significant period of global warming is suggested by the presence of the red shales of the Pittsburgh Red Beds and the overlying Ames Limestone [1, 2] (Figure 2). These red shales suggest that the climate in western Pennsylvania was very warm and dry during the interval of time during which these shales were deposited. Furthermore, the Ames Limestone represents the submergence of the region by a warm sea in which tropical creatures lived. The Ames marine layer extended over all of southwestern Pennsylvania, eastern Ohio, and northern West Virginia. The extent of the Ames submergence suggests that the melting of the glaciers in the polar regions must have been considerable, and therefore, the climatic warming must have likewise been substantial.

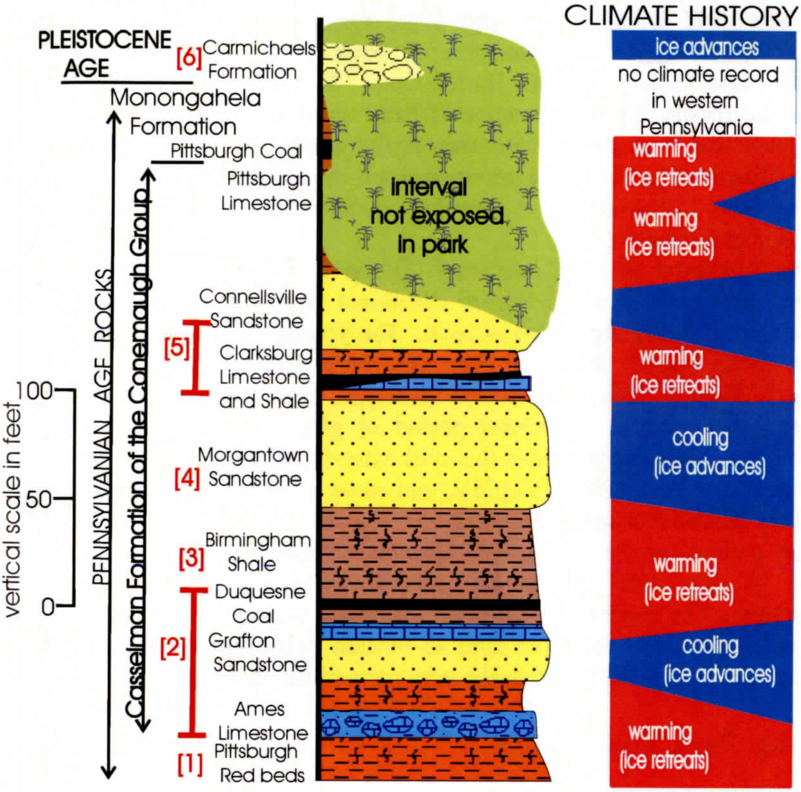

Figure 2.– Section of rock and associated geological names for units exposed in Panther Hollow and Schenley Park.

Overlying the Ames Limestone is the Grafton Sandstone. This sandstone represents ancient river channel deposits that were formed when rivers flowed across the region as the Ames sea withdrew. The reason for the withdrawal of marine waters from the area was global sea level drop produced by climatic cooling and the growth of polar glaciers. The sea level drop allowed these rivers to flow from east to west across the nearly flat, previously submerged, coastal plain. Above the Grafton Sandstone are the Duquesne Coal [2] and Birmingham Shale [3]. These rocks indicate that following the Grafton cooling episode the climate again warmed so that tropical coastal swamps once again developed across western Pennsylvania (Duquesne Coal). The very near shore marine fossils that are sometimes found in the Birmingham Shale indicate that full- fledged marine waters lay not too far to the west in southeastern Ohio. The fact that full marine conditions were not experienced in the Pittsburgh area suggests that the submergence of the continental areas during this time interval was not quite as extensive as during the Ames deposition. Situated above and chronologically following the formation of the Birmingham Shale is the Morgantown Sandstone [4]. This sandstone, like the Grafton below, is the result of a cooling episode, where sea level dropped and large river systems criss-crossed the region. The Morgantown Sandstone is covered by the Clarksville Limestone and Shale [5] and the Barton Coal. These beds do not have any marine fossils, but the presence of fresh water limestone and red shales indicates that the climate was again warm during this time period. However, just as in the previous cases, the Clarksburg warming episode was followed by a cooling event that produced the Connellsville Sandstone [5].

The remainder of the Conemaugh Group is not exposed in the park, but if it were it would record additional warming and cooling episodes preserved in the cycles of rock. The youngest, and therefore, highest rocks known from the Schenley Park area belong to the Pittsburgh Coal. This coal, which averages eight to ten feet in thickness, represents a significant period of global warming. The remarkable swamp that produced this coal extended over all of western Pennsylvania, northern West Virginia, and eastern Ohio and may have existed for tens of thousands of years.

The rock exposure in Panther Hollow represents only a small sample of the total cyclothem record preserved in western Pennsylvania. The three to four million years that are represented here are a small portion of the more than 45 million years during which a great ice age gripped the world in the later parts of the Paleozoic Era.

Schenley Park Topography

While the bedrock that underlies Schenley Park owes its origin to important changes in global climate some 300 million years ago, the current topography or landscape of the area is the result of climatic factors that occurred less than two million years ago during what is popularly called the "Ice Age."

Following the deposition of the sediments that created the area's bedrock, the entire region was uplifted as, to the east, intense folding and faulting marked the final stages of formation of the Appalachian Mountains. The culmination of this mountain-building episode was completed approximately 245 million years ago. During the ensuing 245 million years much of Pennsylvania was slowly, but continuously eroded. The result was a river system similar to, but not exactly like what we see today. Approximately 1.5 million years ago the Monongahela River flowed through Schenley Park and Oakland. It did not flow to the Gulf of Mexico via the Ohio River as we know it today. Instead, the Monongahela continued northward, up the Beaver River to New Castle, and then to an ancestral confluence under what is today Lake Erie. The evidence for this ancient river course is gravel deposits that are known to occur throughout the immediate area [6] (Figure 3). These gravels mark the bottom of this old river course. Their distribution has been dissected by relatively recent erosion. The original Monongahela River course was modified more than

20 thousand years ago when large glaciers dammed the river's course near present-day Elwood City. This damming created a lake that geologists call Glacial Lake Monongahela. This lake stretched from New Castle to Clarksburg, West Virginia, and from Kittanning to Moundsville. Much of western Pennsylvania was under water including Pittsburgh, Washington, Uniontown, Latrobe, and Greensburg. At Schenley Park, Flagstaff Hill was a peninsula within this lake. The water level was so high that the Monongahela River eroded a new channel to the south and switched courses near Homestead. Rather than bending northward at Swissvale and then back south through Oakland, the river diverted to the south and carved a new course where the Glenwood Bridge is currently located. Thus, when Lake Monongahela was drained when the ice melted about 20 thousand years ago, the Schenley Park river bottom was left high and dry. The new river course was much lower than the old, and this triggered the rapid erosion of branch tributaries like Panther Hollow.

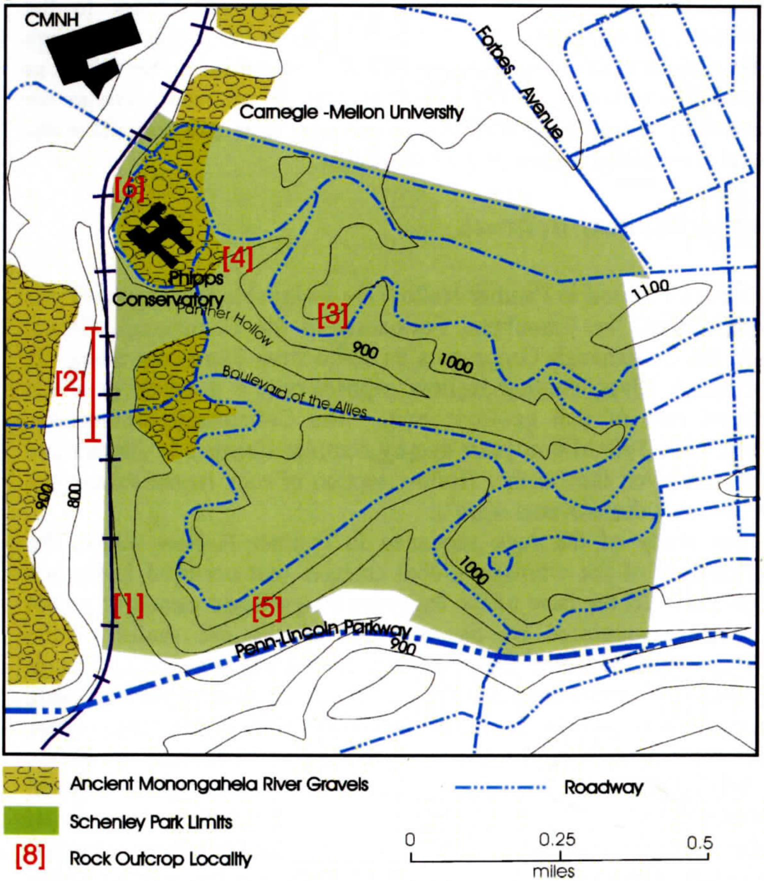

Figure 3.– Topographic map of Schenley Park illustrating the distribution of river gravel deposits that demarcate ancient Monongahela River course.