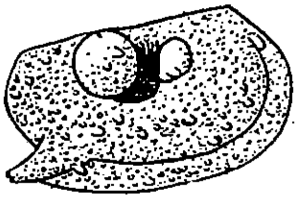
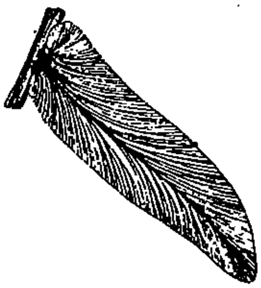


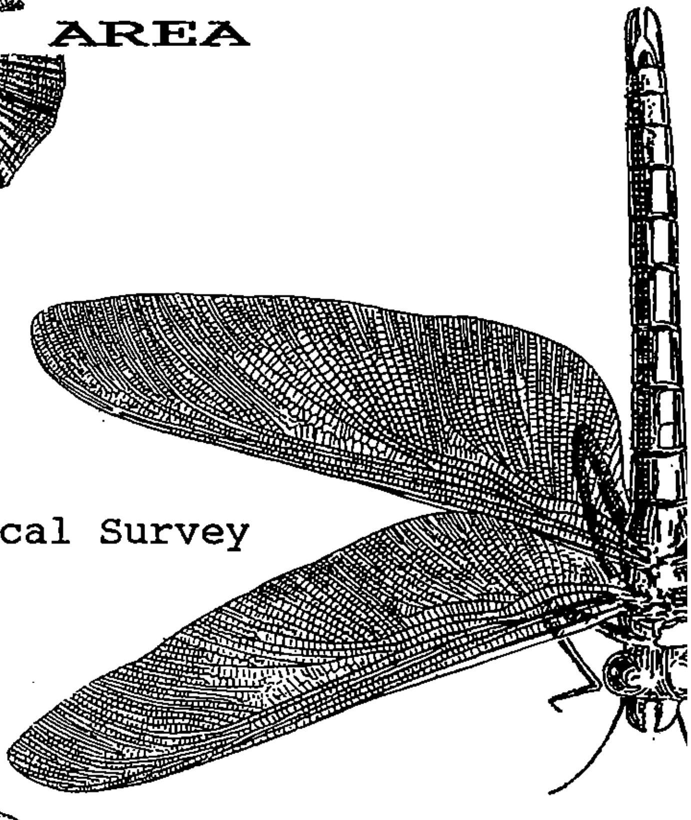
Guidebook for the

Pittsburgh Geological Society
Field Trip

July 29, 1990



FOSSIL COLLECTING IN THE PITTSBURGH AREA



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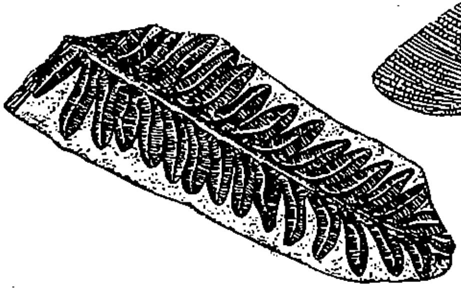
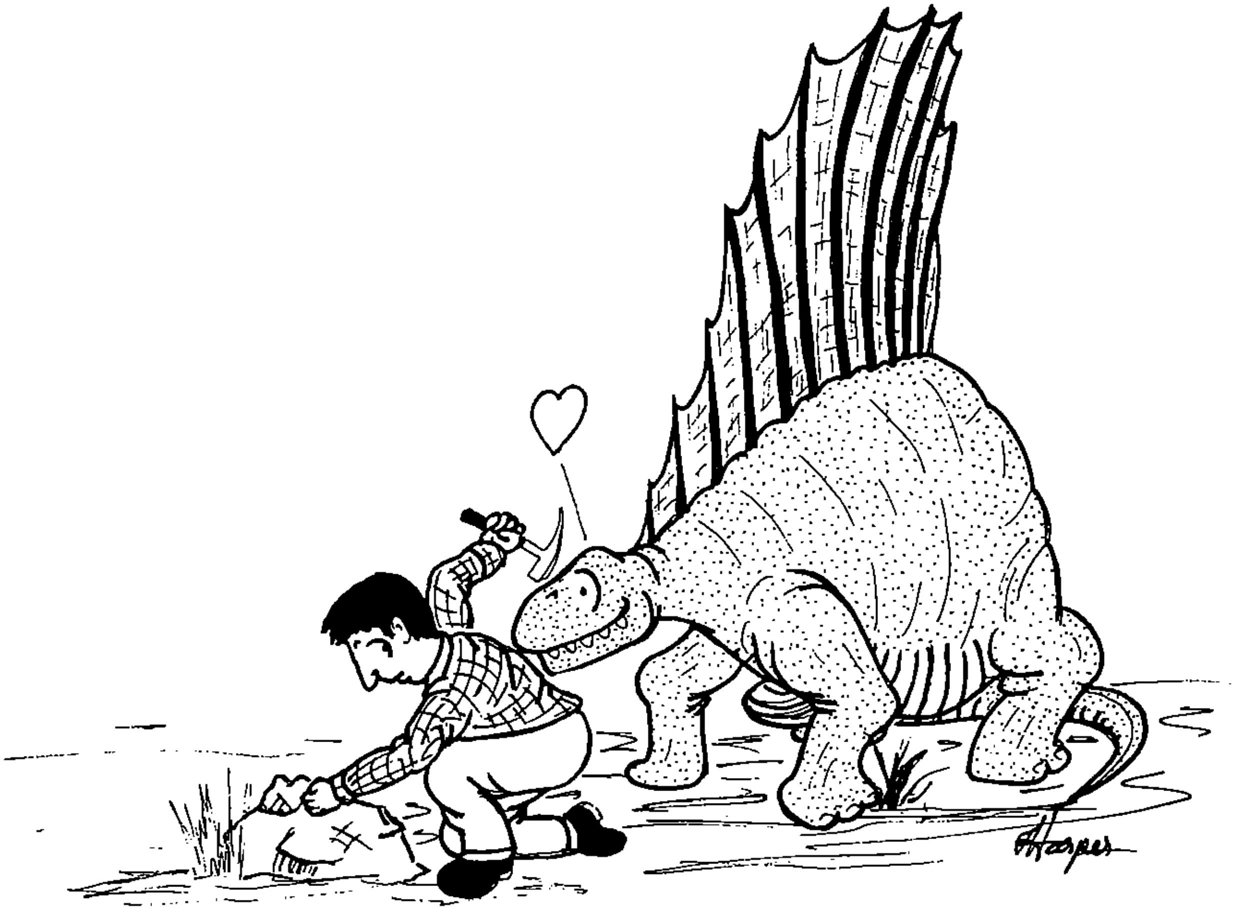
Pennsylvania Geological Survey



FOSSIL COLLECTING IN THE PITTSBURGH AREA



Leader: John A. Harper
Pennsylvania Geological Survey

July 29, 1990

Hosted by: **The Pittsburgh Geological Society**

For additional copies of this fieldtrip guidebook, contact:

The Pittsburgh Geological Society
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FOSSIL COLLECTING IN THE PITTSBURGH AREA

INTRODUCTION

Welcome to the Pittsburgh Geological Society's fossil collecting field trip. This trip is designed to allow the non-professional the opportunity to search for, collect, and identify specimens of the Pennsylvanian-age (290 million years old) fossils that can be found in abundance in the rocks of western Pennsylvania. Those of you who signed up for this trip with the expectation of finding a dinosaur, or at least a Pennsylvanian-age amphibian, will be sorely disappointed. Sorry, folks, no dinosaurs. The amphibian, however...well, who knows how lucky you might be.

On this field trip we will be visiting three sites. The first site is a sandstone quarry in Collier Township where excellent plant fossils can be found in the Connellsville sandstone. Most of these are preserved as carbonized (black) impressions that stand out on the gray rock. The second site is along I-279 near Camp Horne Road in the North Hills, an exposure of rocks that includes the Ames Limestone, perhaps the most fossiliferous rock in the tri-state area. The third site is a spoil pile near New Stanton in Westmoreland County where the Brush Creek shales contain an unusually abundant collection of nearshore marine clams and snails.

In this guidebook I have included some general discussion on the geology of the Pittsburgh area for those unfamiliar (but interested) in the subject. I have also included some general remarks on the kinds of fossils that can be found in western Pennsylvania rocks. This discussion is illustrated with line drawings of those fossils that can be found by the average collector. These drawings should help you identify whatever you find on the trip. I have also included a road log so that you can get back to any of these localities on your own.

Have fun, and good luck. Who knows - you just might find that amphibian you've been looking for.

ACKNOWLEDGEMENTS

This field trip would not have been possible were it not for the assistance and cooperation of a number of people within and outside of the Pittsburgh Geological Society. Mary Ann Gross took care of the logistics of this trip and also helped edit the guidebook. Lee Golden looked into some of the legal problems associated with a trip of this sort. Christopher Laughrey provided much needed critique of the guidebook text. I would especially like to thank Mr. Bill Duchess of the Collier Stone Company who provided access to their quarry during off hours. Credit for the fossil illustrations in this guidebook belongs to the following publications, listed in the references: Collinson and Skartvedt, 1960; Edmunds and Koppe, 1968; Hantzschel, 1975; Hoskins and others, 1983; Lesquereux, 1884; Lund, 1973; Moore and others, 1952; Morris and others, 1973; Romer, 1966; Scudder, 1895; Shimer and Shrock, 1944; Stewart, 1983; Wagner and others, 1970; and Weller, 1969.

GENERAL GEOLOGY OF THE PITTSBURGH AREA

Geologic History

Earth history is divided into large divisions of time called eras, periods, and epochs. The rocks that we can see in the Pittsburgh area were deposited during a portion of the Paleozoic Era called the Pennsylvanian and Permian Periods (Figure 1). The rocks that are deposited during a period of time are referred to as a system. Thus, the rocks of the Permian Period constitute the Permian System, and those of the Pennsylvanian Period comprise the Pennsylvanian System. Approximately 1,100 to 1,200 feet of Pennsylvanian- and Permian-age rocks crop out at the surface in the Pittsburgh area.

It is a rare phenomenon when the rocks representing all of the time elapsed in all of the periods are found piled upon each other in true succession in one place; under normal circumstances there are gaps and distortions in the rock record. A gap may be due either to non-deposition of sediments during a portion of time, or to subsequent erosion of the sediments that were deposited previously. In western Pennsylvania, there are many gaps in the rock record. Some of them represent a hiatus of tens of millions of years. Others represent only a few thousand years. The largest hiatus is the one you are standing on. Because the rocks under your feet were deposited about 290 million years ago, the earth's surface in western Pennsylvania represents a hiatus that spans 290 million years.

A Brief Geologic History of the Pittsburgh Area

At the end of the Precambrian (Figure 1, left hand column), about 600 million years ago, what is now Pennsylvania was part of a great "supercontinent". Break-up of this supercontinent began at that time (Figure 2A), separating the earth's crust into a series of rigid plates that were forced apart by molten rock upwelling at the breaks (mid-ocean rifts). During the next 160 million years the plates carrying present-day North America and Africa continued to separate.

Then about 440 million years ago the oceanic crust between North America and the mid-ocean rift cracked and the North American plate began riding up over the oceanic crust, back in the direction of Africa. As the ocean floor slipped under the North American plate, it pushed up a vast mountain range called Appalachia (Figure 2B). An elongate shallow seaway called the Appalachian Basin stretched from the present area of Alabama to Nova Scotia between Appalachia and inland North America. As the mountain range was being eroded large quantities of sediment were carried into the shallow sea. Over the next 200 million years this basin was the primary site of deposition in eastern North America as Appalachia shed tens of thousands of cubic miles of sediment.

Eventually the basin became clogged with sediment (Figure 2C) and the sea withdrew westward. During the Pennsylvanian and Permian Periods, when the rocks of the Pittsburgh area were being deposited as sediments, North America was in a very different setting than it is today. Figure 3 illustrates

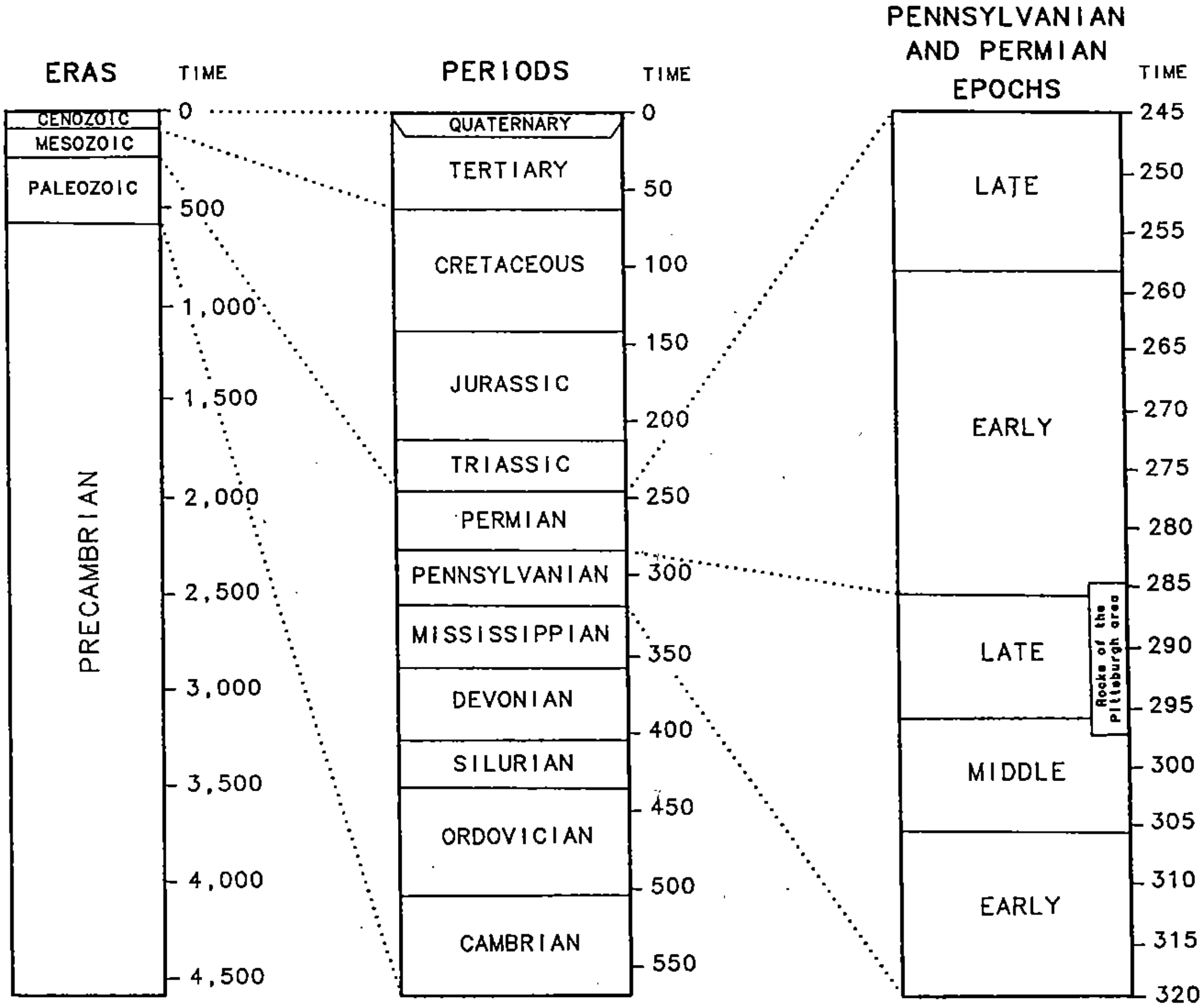


Figure 1. Simplified geologic time scales, showing the relationships between eras, periods, and epochs. The rocks of the Pittsburgh area were deposited mainly during the Late Pennsylvanian. Time is shown in millions of years.

Pennsylvania during the Pennsylvanian Period, approximately 290 million years ago. The modern political boundary of the state is also shown for orientation. Pennsylvania was situated about 5° south of the equator at that time, approximately where the Amazon basin of South America now lies, so that the climatic conditions in the Pittsburgh area were probably similar to those of the present Amazon. The landscape of western Pennsylvania was much different from today's deeply dissected plateau. At that time the area lay very close to sea level. As sea level fluctuated (see below), the Pittsburgh region was sometimes slightly above water and at other times slightly under water. Figure 3 is just one possible interpretation of the geography of Pennsylvania during an episode of time in the Pennsylvanian Period. The figure does not represent the entire span of time when all of the exposed rocks of the Pittsburgh area were deposited.

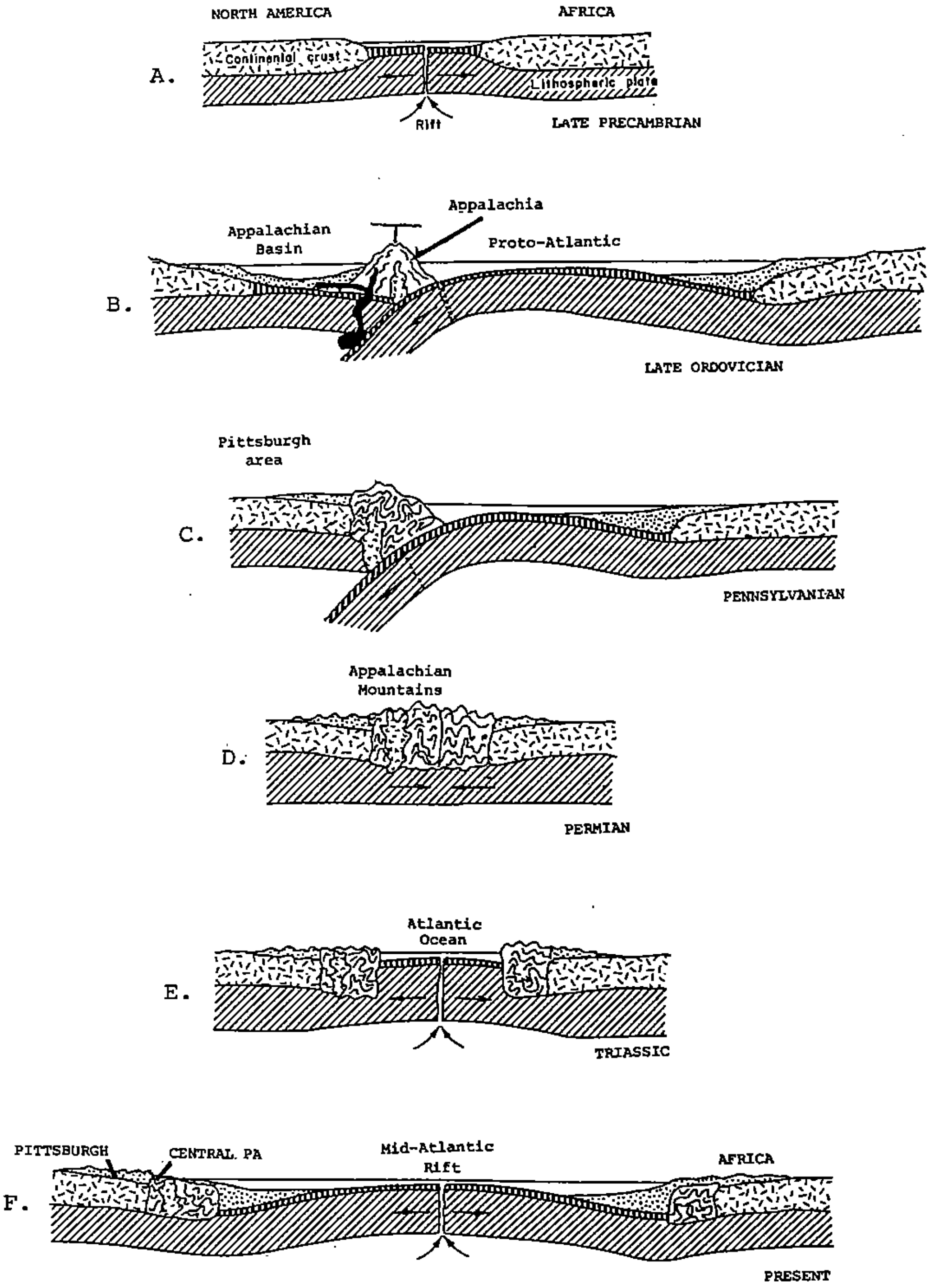


Figure 2. Diagramatic model of the plate tectonic history of eastern North America since the Late Precambrian, about 600 million years ago. Model modified from Dietz, 1972 and Sevon and Woodrow, 1981.

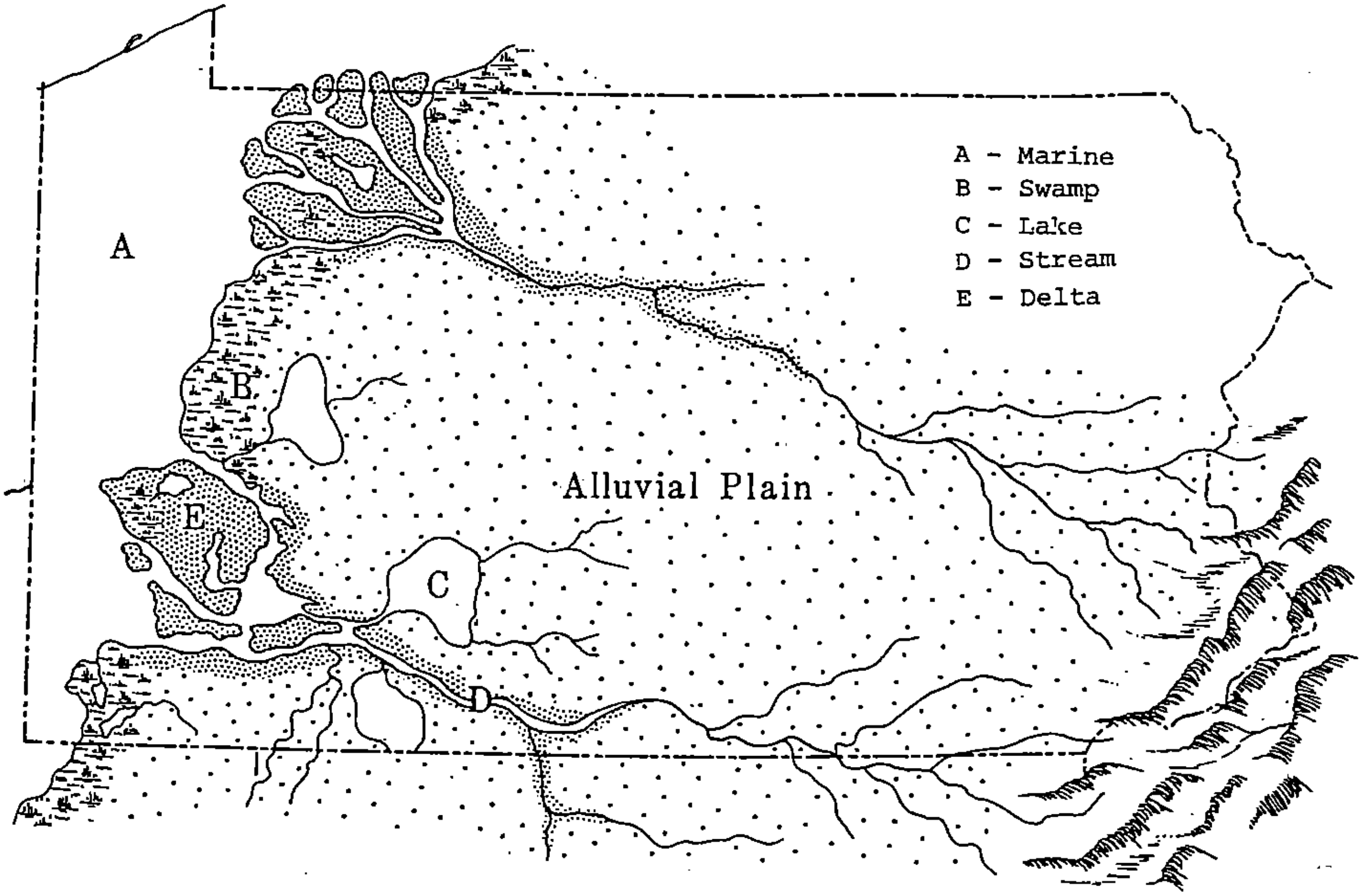


Figure 3. Inferred paleogeography of Pennsylvania during a portion of the Late Pennsylvanian when the rocks of the Pittsburgh area were being deposited. See text for explanation. Modified slightly from Wagner and others, 1970.

Rivers carried sand, silt, and clay eroded from Appalachia across a vast plain of deposition to the shoreline in western Pennsylvania. In the western half of the state the land was a low coastal plain that sloped very gently westward to the sea, similar to the present eastward-sloping surface of the middle Atlantic coastal plain. Within the coastal area, where Allegheny County is now located, five general environments of deposition were present. Offshore, in the ocean environment (A in Figure 3), marine rocks such as the Ames Limestone formed. An extensive swamp environment full of tall trees, ferns, and lush vegetation (B) stretched along the shore; it was here that the Pittsburgh coal seam began its long history. The lake environment (C), located on the coastal plain behind the swamps, was the site of nonmarine carbonate deposition. Sediments deposited in the two remaining environments were the result of various processes of stream action. Environment D represents: 1) the sand and silt deposited within the stream channel during normal flow, and 2) the silt and clay dumped on the adjacent flood plain during times of flooding. When a stream flows into a standing body of water, such as a lake or ocean, it loses velocity and the sediments being carried by the stream are deposited at its mouth. Unless the water currents in the lake or ocean are strong enough to remove the sediments as they are deposited, the stream sediments will gradually build outward to form a delta (E).

During the Permian Period North America and Africa collided, and the sedimentary rocks of the Appalachian Basin underwent extensive folding and faulting as the Appalachian Mountains were created (Figure 2D). This was just a small part of a worldwide event in which all of the continents came together in another supercontinent similar to the one at the end of the Precambrian.

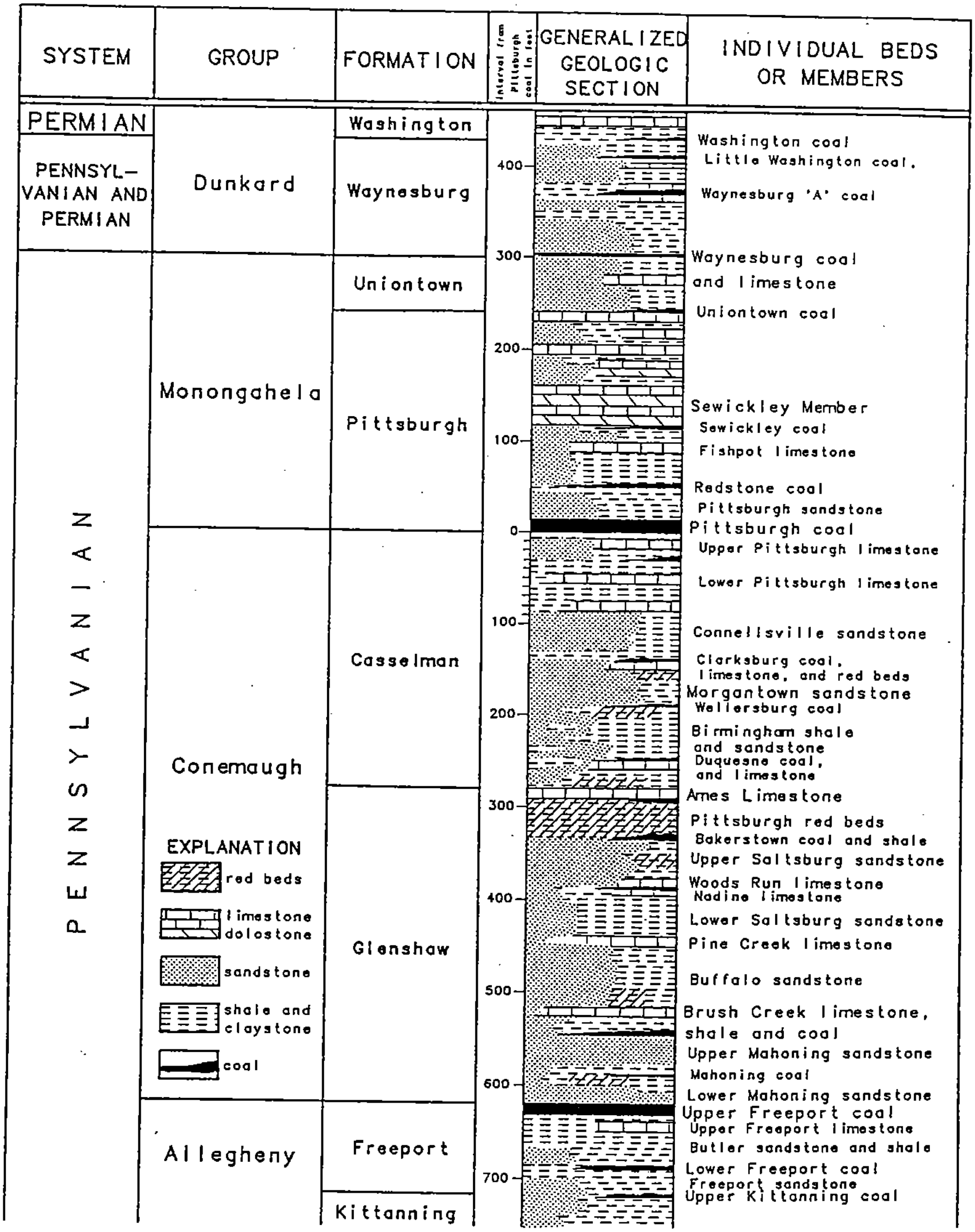
Most of geologic history in the Pittsburgh area following the creation of the Appalachian Mountains is shrouded in speculation. About 240 million years ago the continents once again began breaking apart as they did in the Late Precambrian. The North American and African plates began moving away from each other (Figure 2E), a trend that continues today (Figure 2F). Western Pennsylvania, and probably the entire Appalachian region, was apparently above sea level, and therefore subject to erosion during the last 270 million years of geologic time. This was a time apparently dominated by erosional processes that removed large amounts of sedimentary rock from the Appalachian Mountains, producing the topography we see today. The advance of the glaciers into Pennsylvania during the Ice Age began more than 500,000 years ago and ended as recently as about 11,000 years ago.

Surface Rocks of the Pittsburgh Area

Figure 4 represents a generalized columnar section of the rocks exposed in Allegheny County. You can see that most of the surface rocks in the Pittsburgh area belong to the Conemaugh Group. The lower boundary of the group is the top of the Upper Freeport coal, and the upper boundary is the bottom of the Pittsburgh coal. Figure 4 is highly generalized. Each rock unit within the section is shown as an average, both in thickness and in vertical distance from each other. Real changes in thickness and interval are too variable to be shown in one illustration.

The geologic column shows the rocks of the area as if they were all present in a single exposure 1,100-1,200 feet high. Such an exposure does not exist; we would have to dig a trench 1,200 feet deep along the top of a hill on the boundary between Allegheny and Washington Counties in order to provide such an exposure, and even then the record would not be complete. The rock record in the Pittsburgh area has many gaps owing to erosion or non-deposition that took place in the myriad depositional environments present 290 million years ago. Because of these gaps we cannot find a continuous rock sequence in any single locality; instead, we must fit many areas together to obtain the total sequence. The column, therefore, represents a composite prepared by piecing together much shorter sections that are exposed at different localities around the area. For example, the large roadcut along Route 28 at Harmarville exposes only the portion of the column from just below the Pine Creek limestone to the Connellsville sandstone at the top. A similar roadcut along Route 51 near Coraopolis exposes the rocks from the Mahoning sandstone

Figure 4. Generalized columnar section of the exposed rocks in the Pittsburgh area. -------->


SYSTEM
GROUP
FORMATION
Interval from Pittsburgh coal in feet
GENERALIZED GEOLOGIC SECTION
INDIVIDUAL BEDS OR MEMBERS
PERMIAN
PENNSYLVANIAN AND PERMIAN
PENNSYLVANIAN
Dunkard
Monongahela
Conemaugh
Allegheny
Washington
Waynesburg
Uniontown
Pittsburgh
Casselman
Glenshaw
Freeport
Kittanning
400
300
200
100
0
100
200
300
400
500
600
700
Washington coal
Little Washington coal,
Waynesburg 'A' coal
Waynesburg coal
and limestone
Uniontown coal
Sewickley Member
Sewickley coal
Fishpot limestone
Redstone coal
Pittsburgh sandstone
Pittsburgh coal
Upper Pittsburgh limestone
Lower Pittsburgh limestone
Connellsville sandstone
Clarksburg coal,
limestone, and red beds
Morgantown sandstone
Wellersburg coal
Birmingham shale
and sandstone
Duquesne coal,
and limestone
Ames Limestone
Pittsburgh red beds
Bakerstown coal and shale
Upper Saltsburg sandstone
Woods Run limestone
Nadine limestone
Lower Saltsburg sandstone
Pine Creek limestone
Buffalo sandstone
Brush Creek limestone,
shale and coal
Upper Mahoning sandstone
Mahoning coal
Lower Mahoning sandstone
Upper Freeport coal
Upper Freeport limestone
Butler sandstone and shale
Lower Freeport coal
Freeport sandstone
Upper Kittanning coal
EXPLANATION
red beds
limestone
dolostone
sandstone
shale and claystone
coal

to just above the Morgantown sandstone. The outcrop on Mt. Washington includes rocks ranging from the Ames Limestone to the Pittsburgh sandstone above the Pittsburgh coal. None of these exposures shows the whole Conemaugh Group; but by combining them, matching correlative units like the Ames Limestone and the Morgantown sandstone, we can obtain a fairly accurate portrait of the geologic column in Allegheny county.

Some geologic sequences show a consistent repetition of two or more kinds of rock, more or less alternating throughout the sequence. There may be differences in bed thickness, fossils, coloration, and other physical and chemical characteristics, but the repeated alternation of the various layers is unmistakable. In some cases this repetition is related to repeated, but not periodic, local changes in the environment. Streams, for example, often change course during floods, and swamps may dry up during droughts. In other cases the repetition is due to regional events such as episodes of mountain building that cause repeated pulses of erosion and deposition. Such changes commonly affect only limited areas.

Many of the repetitive segments in the rock record, however, are due to long term changes in the earth's climate, or to change in the configuration of ocean basins. Changing global temperatures, for example, profoundly affects the entire global ecosystem. Increasing global temperatures may cause glaciers to melt and sea level to rise, and a transgression occurs as the sea crosses the lowlands. What was once dry land is covered in water, and marine sedimentation occurs where once only streams, lakes, and swamps existed (Figure 5). Lowering global temperatures has the opposite effect. A drop in worldwide temperatures may lead to glaciation that causes sea level to fall by locking up water in ice sheets. Falling sea level results in regression, the act of the sea retreating from the land. This in turn causes increased erosion by exposing more land (the former shallow areas near the shoreline) and by lowering base level, requiring streams to cut down into the now relatively higher landscape. Erosion creates hiatuses in some areas, and the eroded rock is redeposited in other areas, often out onto the now exposed lowland where the sea used to be. If the climatic changes are cyclical, and recur over a long period of time, then sea level rises and falls accordingly and the changes are recorded in the rock record all over the world at the same time.

Geologists have been aware of the existence of cyclical patterns in the rock record for a long time. At certain times during geologic history certain sequences of rock types formed repeatedly in a vague, yet systematic vertical succession, representative of the repetition of changing depositional environments due in large measure to sea level fluctuation. You will have the opportunity to see this on this field trip. Coal seams and limestone beds occur at almost predictable intervals throughout the entire stratigraphic section; red siltstones, shales, and claystones, commonly called "red beds", occur intermittently in the lower half; and sandstones and shales are commonly interspersed everywhere with other rock types.

The rock section in the local area is further complicated because one sandstone, shale, limestone, or coal may look very much like any other. Because a few specific rock types of similar appearance may occur at any given

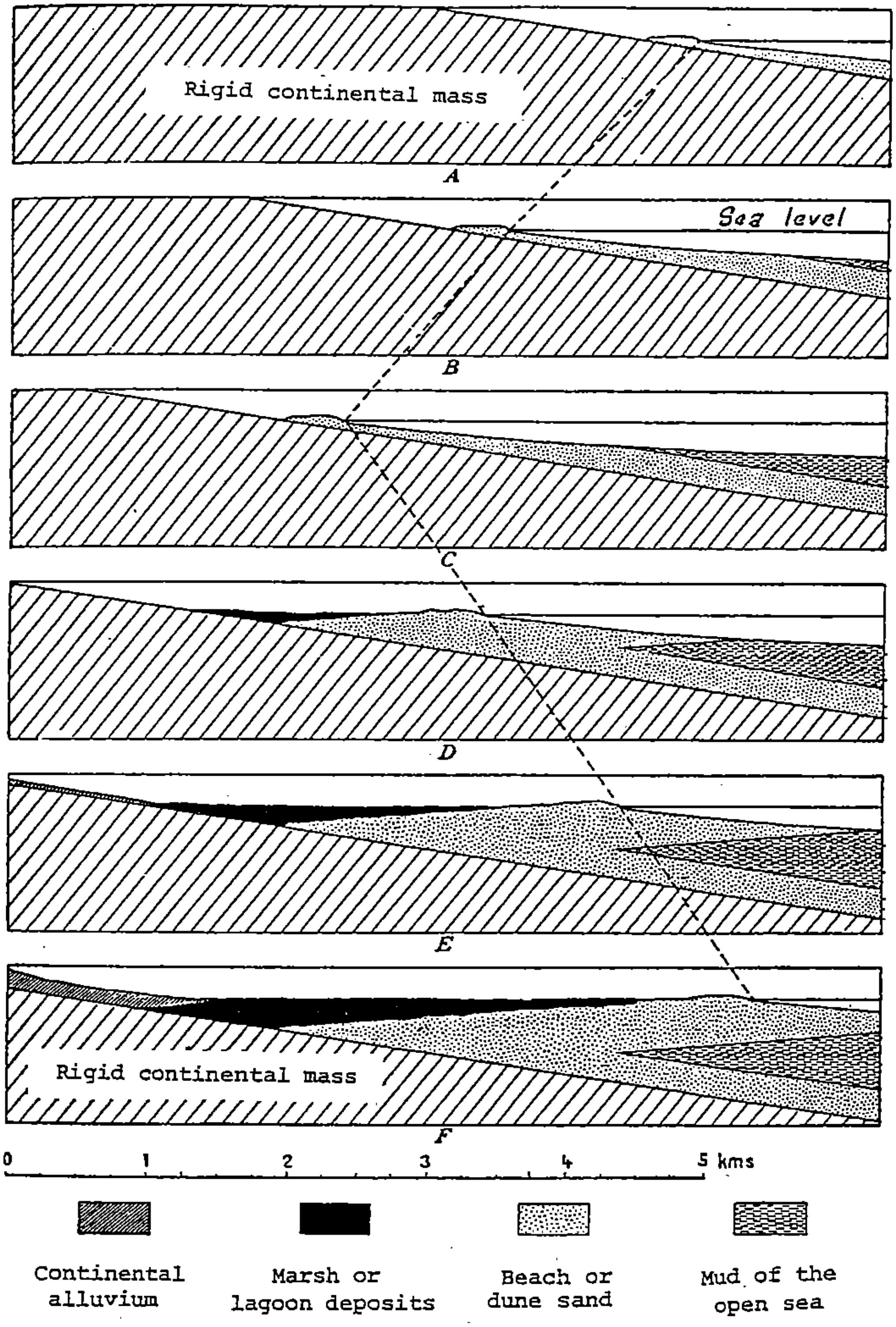


Figure 5. Diagrammatic profiles showing the effects of transgression and regression on the sedimentary deposits of an area. The sea transgresses to the left in A through C, then regresses to the right in D through F. Modified from Gignoux, 1955.

stratigraphic position, even a geologist who has worked with the local section finds it difficult to immediately identify the rocks in an unfamiliar outcrop. One way to determine the identity of an unknown rock unit in outcrop is to correlate it with a known section. This can be done by determining how far above or below a particular marker bed the rock unit occurs. A marker bed is a distinctive or readily identifiable rock layer of wide geographic extent that can serve as a reference for other layers. Marker beds are commonly thin beds representing a geologic "instant" within a thicker sequence. Layers that may serve as marker beds include extensive coals and thin limestones in the midst of thick sequences of sandstone and shale. In the Pittsburgh area, the best marker beds are the Pittsburgh coal, the Ames Limestone, and the Upper Freeport coal (see Figure 4). The Pittsburgh and Upper Freeport coals are thicker and more persistent than any other coal seams in the Pittsburgh area, and the Ames Limestone is the thickest and most fossiliferous rock layer in the county. Although they may be missing at certain localities due to erosion or a local change in the environment of deposition, these marker beds generally occur throughout the county. Because of their distinctive natures they can be more easily recognized than other units.

The Conemaugh Group

The Conemaugh Group is the thickest sequence of rocks in the Pennsylvanian System of western Pennsylvania, commonly containing more than 600 feet of sandstone, siltstone, claystone, limestone, and coal. The coals consist of a few thin seams that are mined only in limited areas. The group is bounded by the top of the Upper Freeport coal and the base of the Pittsburgh coal. The Conemaugh Group is divided into two formations, the lower Glenshaw Formation and upper Casselman Formation. Each of these formations is about 300 feet thick, dividing the group into two approximately equal subdivisions. The boundary between the two formations is the top of the Ames Limestone Member.

The Conemaugh Group underlies almost all of the northern half of the county, and in the southern half it crops out in the valleys of the Monongahela and Youghiogheny Rivers and Chartiers and Peters Creeks. Because the strata of southwestern Pennsylvania dip toward the southwest, the lower subdivision of the Conemaugh, the Glenshaw Formation, is well exposed north of the Allegheny and Ohio Rivers whereas the Casselman Formation, the upper half of the Conemaugh, is best seen south of the two rivers.

All of the rocks we will be seeing in outcrop at the fossil collecting sites belong to the Conemaugh Group. The first site we will be visiting is a sandstone quarry in the middle part of the Casselman Formation (the Morgantown and Connellsville sandstones) near Rennerdale in Collier Township. The other two sites are in the Glenshaw Formation. The second site is in the upper Glenshaw (Ames Limestone) along I-279 near the Camp Horne Road exit. The third site is in the lower Glenshaw (Brush Creek shale) in Youngwood, Westmoreland County. These sites will be discussed in more detail in the Road Log at the end of this guidebook (pages 40 to 50).

Environments of Deposition

A depositional environment is a geological setting where sediments accumulate. Depositional environments are characterized by specific physical, chemical, and biological conditions inherent in the depositional setting. An in-depth study of the environments in which the rocks of the Pittsburgh area accumulated as sediments would include analyses of the geology, climate, and flora and fauna of western Pennsylvania at the time of deposition. In addition, for those rocks that were deposited in a water environment, the analysis would include information on water depth, temperature, salinity (if appropriate), and the dynamics of water movement.

Each rock type in the Pittsburgh area represents the accumulation of sediment under the influence of certain conditions. The sediment may consist of sand- or silt-size grains that become sandstone or siltstone. An influx of clay may result in a deposit that becomes a shale or claystone, calcium carbonate crystals may become limestone, and peat may become coal. The place of accumulation may be a stream channel, the flood plain of a river, the bottom of a lake, a swamp, somewhere within a delta, a sand dune, an offshore sand bar, or the deep sea floor. By examining modern sedimentation in existing environments, geologists learn which sediments customarily accumulate in which environments, and what features characterize them. This knowledge can then be applied to rocks to determine the ancient depositional environments.

Rocks of Marine Environments

Marine rocks are rocks derived from sediments deposited in ocean environments. Some of these environments are illustrated in Figure 6.

The main rock types derived from marine sediments are shales and limestones, with lesser amounts of siltstone and sandstone. Limestone is the dominant rock type in those areas that did not receive much silt and clay. The marine limestones formed by a combination of precipitation of calcium carbonate through the actions of algae and other organisms, and accumulation and cementation of calcareous materials such as shell fragments and limestone pebbles. Marine shales commonly occur above and below the marine limestones in western Pennsylvania. These shales may be light gray or black, depending on the amount of organic carbon contained in the rock, and range from a few inches to over ten feet thick. Most of them contain abundant marine fossils. These shales typically represent deposition close to shore, such as a bay or lagoon, where carbonate precipitation was inhibited or overwhelmed by influx of mud and silt.

Fossils provide the best evidence for distinguishing marine environments in the rock record. The Ames Limestone and the Brush Creek limestone and shale contain numerous marine fossils; they are the best examples of marine rocks in the Pittsburgh area. The Ames represents deposition on the open ocean floor relatively far from shore. We will be visiting the Ames Limestone along I-279 near the Camp Horne Road Exit on this field trip and you will have the opportunity to collect the marine fossils it contains. The Brush Creek

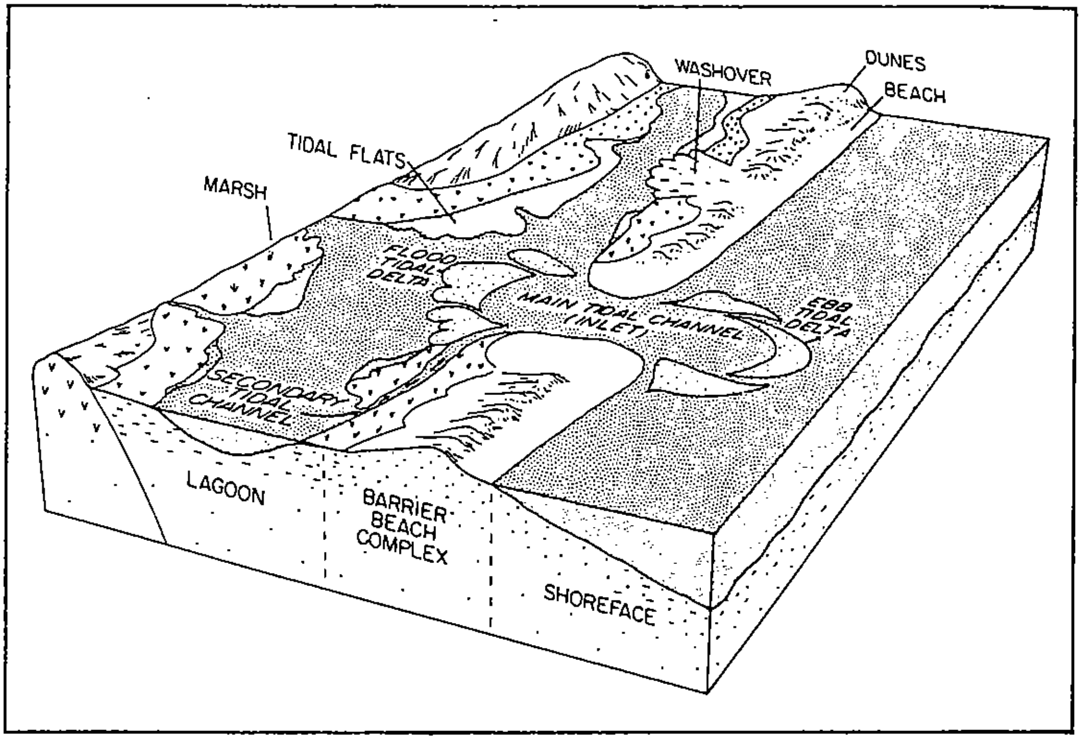


Figure 6. Block diagram illustrating some typical marine environments. From Reinson, 1984, p. 120.

shale at our last stop represents deposition in a quiet, poorly oxygenated area close to shore, probably a lagoon sheltered behind an offshore barrier island system. Once you have had the opportunity to collect fossils from both marine units you will be able to notice the striking differences in both the physical aspects of the rock and in the types of fossils present. The Ames contains a more normal marine (open ocean) fauna dominated by corals, crinoids, and brachiopods, whereas the Brush Creek contains a shallow-water, nearshore fauna dominated by clams and snails.

Rocks of Swamp Environments

Both small and large swamps, like that illustrated in Figure 7, occurred intermittently in the Pittsburgh area during the Pennsylvanian and Permian periods, and this is reflected in the rocks now exposed at the surface. The plant material of these swamps consisted of tall trees and shrubs with names such as *Lepidodendron*, *Calamites*, and *Psaronius* that were related to modern club mosses, scouring rushes, and ferns (see illustrations of plant fossils in this guidebook). The branches and leaves of these plants fell to the swamp floor, and accumulated over thousands of years. The mats of vegetation were converted to peat, and eventually became coal. Extensive coal seams such as the Pittsburgh and Upper Freeport seams probably represent enormous coastal swamps or islands, like the Everglades, or in Indonesia, whereas the thin restricted coal seams may have originated in much smaller bogs located between the distributary channels of deltas.

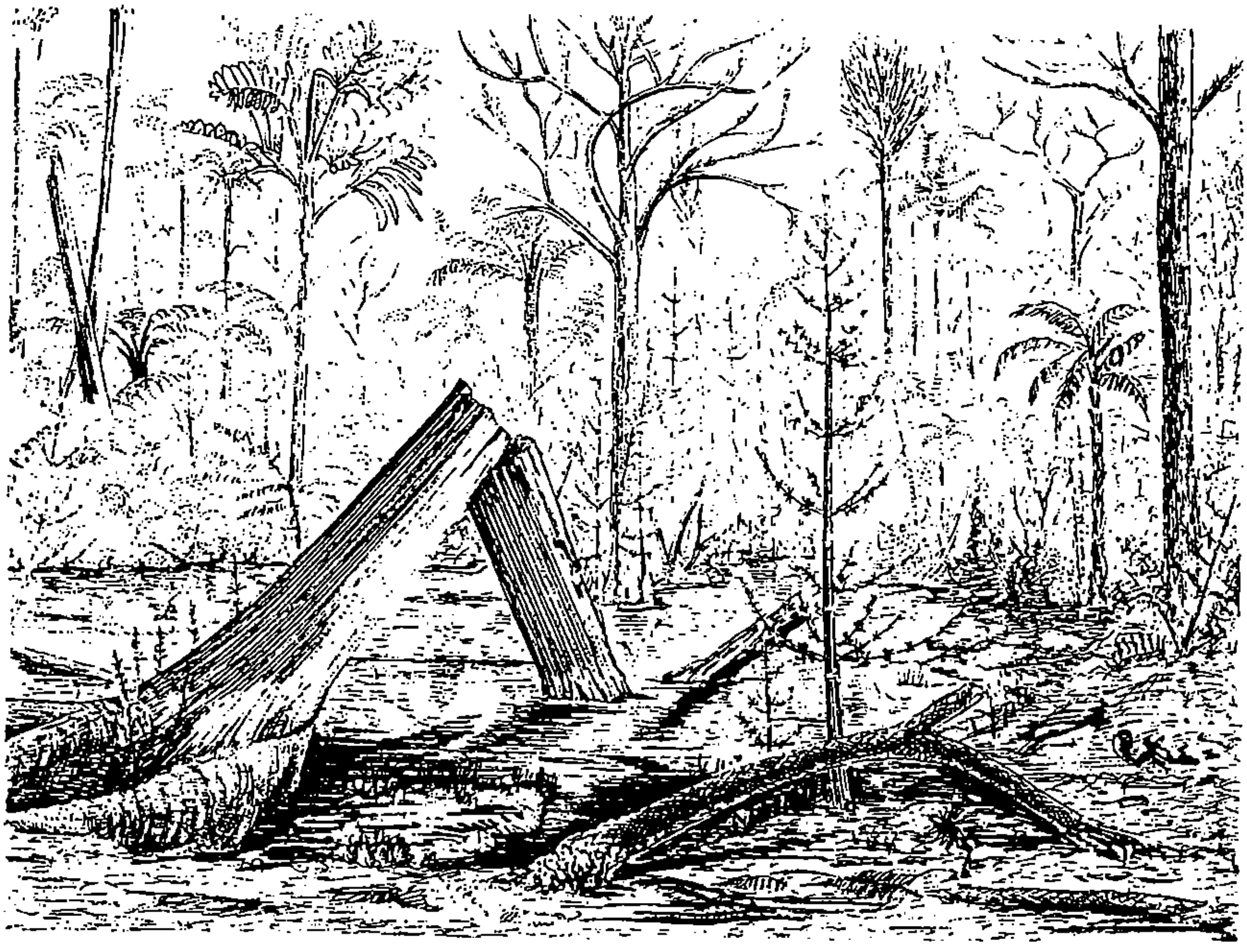


Figure 7. A typical coal swamp of the Pennsylvanian Period. From Edmunds and Koppe, 1968.

Behind the coastal swamps, and extending for many miles inland, was a flat lowland with numerous large and small water-filled depressions. In order to picture this setting, imagine the Louisiana coastal plain, with its inland lakes a few feet above sea level, located 20 or 25 miles from the shore. Now replace the sand found on Louisiana's coastal plain with mud and clay, and increase the size of the lakes. Turn this setting around so that the sea is to the west and you will have an idea of what the Pittsburgh area looked like 300 million years ago.

Rocks of Lake Environments

The rocks of the lake environment are mostly fresh-water limestones, shales, and claystones, fine-grained rocks derived from sediment deposited in quiet or slowly moving water. The size of the ancient lakes influenced the types and characteristics of the sediments. Deposition in small lakes involves primarily clays and silt; there may be a transition to swamp conditions. Therefore, the resultant rocks are shale and claystone, possibly with some thin coals. Deposition in large lakes, however, consisted mostly of carbonate precipitation by algae or other organisms. The influx of silt and

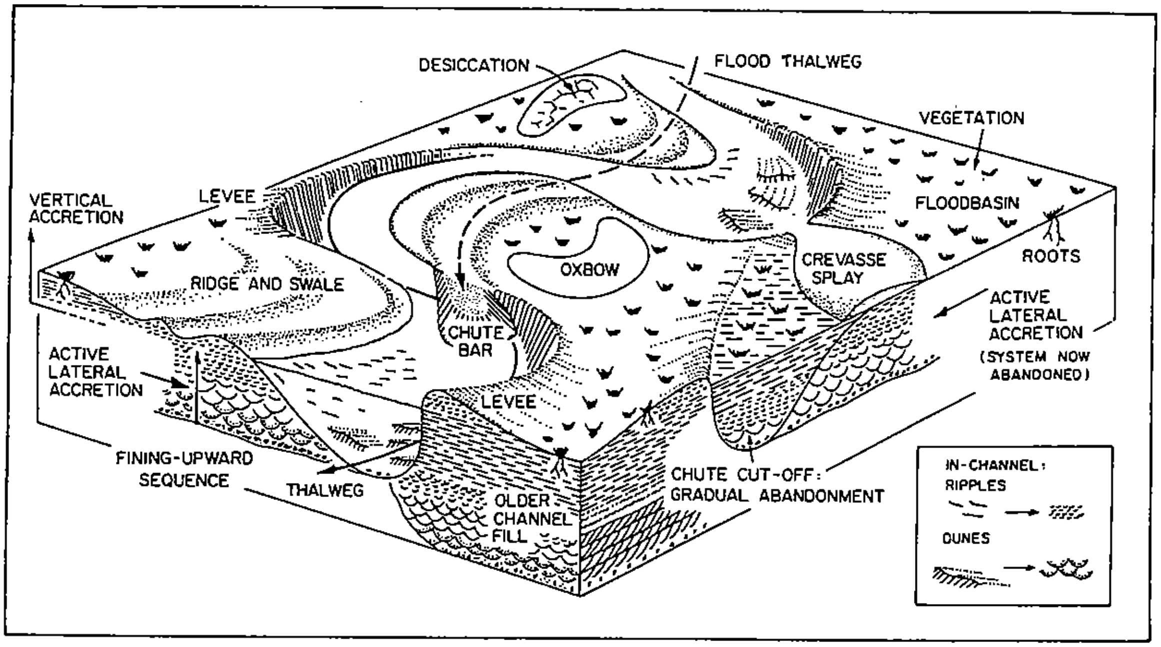


Figure 8. Block diagram illustrating some of the subenvironments common to a meandering stream environment. From Walker and Cant, 1984, p. 72.

clay that did occur resulted in alternation of thicker carbonate and thinner non-carbonate muds that lithified to the limestones and shales that can be seen at many outcrops. The alternating limestones and shales exposed in the hillside behind the Ground Round restaurant at the intersection of Route 19 and Gilkeson Road in Mt. Lebanon nicely illustrate large-lake deposition. We will not be visiting this locality, but at least two of the three localities we will be visiting on this field trip have exposures of lake-deposited limestones.

Rocks of Stream Environments

Stream environments include a variety of depositional sites within a valley (Figure 8). They can be divided into two broad categories, those areas within the active stream channel, and those areas on the adjacent flood plain. The flood plain receives sediments only when it is covered with water during a flood.

In the Pittsburgh area, the flat areas just above water level in the three rivers, where most of the area's heavy industry is concentrated, are the flood plains. Some towns, such as Aspinwall and Sharpsburg, lie on the Allegheny River flood plain; parts of McKeesport are situated on the Monongahela and Youghiogheny River flood plains. Sewickley and Coraopolis are on the Ohio River flood plain.

In looking at Pittsburgh's river as they presently exist, the river valleys tend to emphasize the erosional aspects of streams. But streams also have a significant depositional nature. The bottoms of the Allegheny and Ohio River valleys contain about 35 feet of sand and gravel that was deposited during the last part of the Ice Ace. It is the debris that was washed out of the glaciers of northwestern Pennsylvania over 10,000 years ago. The Monongahela and Youghiogheny Rivers would have similar deposits except for the fact that they have always drained an area well south of the extent of glaciation.

Stream-channel deposits are typically sandstones and siltstones with the coarsest material at the base of the channel. The bottom of the stream deposit often contains a medium- to coarse-grained sandstone containing thin, discontinuous coal seams, pebbles composed of shale and claystone fragments, and plant fossils. The shale and claystone pebbles form a basal conglomerate within the sandstone. Above the conglomerate the sandstone becomes finer grained and the shale fragments and plant debris diminish upward ("fining-upward sequence" of Figure 8).

Flood-plain deposits are typically finer grained and more evenly layered than channel deposits. They include thinly layered clays and silts that slowly settle out of a body of water overflowing the stream banks. The resulting shales and siltstones are commonly much thinner than the channel sandstones and siltstones.

Over many thousands of years a stream shifts its channel back and forth across its valley, eroding previously deposited sediment and adding new sediment in its place to form a floodplain. Sand and gravel accumulate in the channel only to be removed at a later time when the stream builds a new channel on this plain.

Rocks of Delta Environments

The delta, lying between land and sea, is the most complex depositional setting because it contains a very large variety of nonmarine and transitional-to-marine environments, including many of those already mentioned (Figure 9). Deltas are formed where streams build low, flat plains out into the sea. A constant battle ensues between the sea attempting to erode the plain and the stream fighting to enlarge it. When sea level rises, the delta erodes; when sea level falls, the delta is built outward into the sea.

The sizes of the ancient deltas varied considerably during the millions of years needed to deposit the sediments now exposed in western Pennsylvania. When a marine limestone, such as the Ames or the Brush Creek, was accumulating, most of western Pennsylvania was completely covered by sea water. Deltas did not play an important role in deposition at that time in the Pittsburgh area. During times of extensive peat formation and the deposition of nonmarine carbonates, most of the area was covered with swamps and lakes, and deltas probably played only a minor part in deposition in the area at that time as well. But at other times deltas became very large and dominated the area, covering extensive areas at the expense of the lake, swamp, and open ocean environments.

The most easily recognized rocks representing deposition in the delta environment in Allegheny County are "red-beds", a series of interbedded

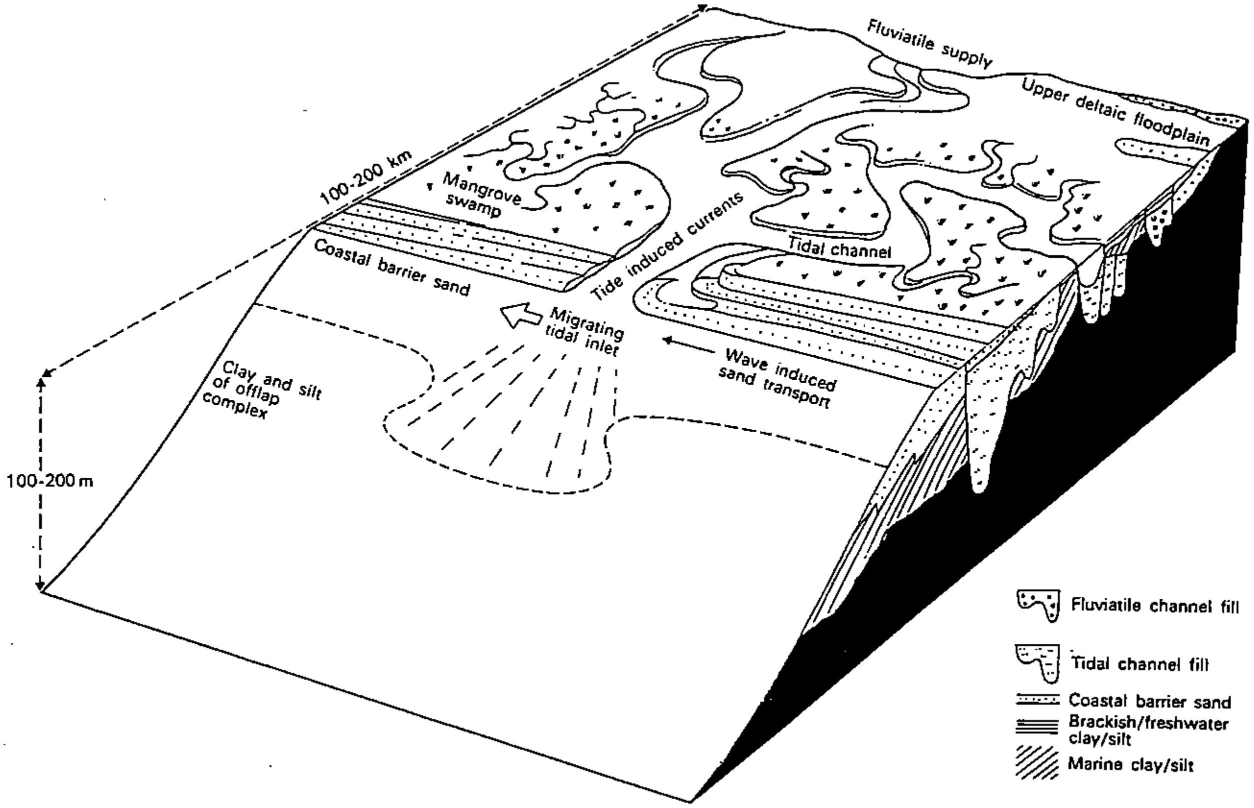


Figure 9. Block diagram illustrating the various environments common to a Pennsylvanian delta. From Elliott, 1978, p. 119.

reddish and greenish claystones and shales lying beneath the Ames Limestone. Although they recur throughout the Conemaugh Group, "red beds" tend to be concentrated in the upper part of the Glenshaw Formation and the lower half of the Casselman Formation. The most famous of these, the "Pittsburgh red beds", crop out in the hillsides around the Pittsburgh area, creating landslide hazards in many areas. The red and green coloration in these rocks is due, respectively, to the oxidation and reduction of iron minerals in the clays. The claystones and shales of the "Pittsburgh red-beds" contain carbonate cement and scattered carbonate nodules with marine fossils, indicating that the delta was at times flooded by marine waters of the ocean environment. At other times the shales and claystones were above water and exposed to the atmosphere, as indicated by the presence of leaf and stem impressions, footprints of amphibians and reptiles, impressions of rain drops, and mudcracks.

Siltstones, shales, and claystones with a gray or brown color are also common rocks of the delta environment. These rocks also occur in great abundance in marine, lake, and flood plain environments, however, so they are not as diagnostic of any one particular environment as some other types of rocks. Determining the specific environment of these rocks is often difficult, even for a geologist.

FOSSILS OF THE PITTSBURGH AREA

Introduction

Life during the Pennsylvanian Period was abundant and diverse. The seas, which spread across western Pennsylvania at least 6 times during the approximately 5 million years it took to deposit the rocks of the Glenshaw Formation, teemed with myriad forms of invertebrates, vertebrates, plants, and single-celled organisms such as algae and protozoans. Many new varieties of spore-bearing trees and shrubs occupied the land in broad swamps, some of which extended for thousands of square miles. Fresh-water fish and amphibians also occupied the swamps, lakes, and streams. Numerous insects, many surprisingly similar in appearance to modern forms, evolved at that time, and successfully conquered the numerous terrestrial environments that began to open up. Some of these insects grew to very large size; for example, some dragonflies had wingspans greater than two feet. The late Pennsylvanian Period also saw the first appearance of the reptiles, a group of animals which became very diverse and specialized during the Permian Period and eventually dominated the earth during the Mesozoic Era.

The rocks of western Pennsylvania, including the Pittsburgh area, contain a variety of invertebrate, vertebrate, plant, and trace fossils. Collectors may find an abundance of the shells of marine invertebrates that lived in the area at the time it was dominated by marine environments, such as at Stops 2 and 3. A careful search of non-marine limestones will also reveal many fresh-water invertebrates, and the shales associated with coal may yield insect fossils. Numerous carbonized plant fragments, preserved in the stream and delta environments, such as at Stop 1, may also be collected. Less common are vertebrate remains, such as fish teeth and scales, and amphibian and reptile bones that occur in strata deposited in open-water, lake, and delta environments. Trace fossils, the tracks, trails, feeding and resting traces, and borings made by animals, are also quite common in many of the rocks of the Pittsburgh area. These may not be recognized by the uninitiated collector, but can be quite useful and interesting when studied in conjunction with the rocks that contain them.

It is obvious that large fossil specimens are easier to find than tiny ones because they are easier to see. Fossil collectors who have a strong magnifying lens or access to a powerful microscope, however, may have the additional advantage of finding specimens of the plentiful microscopic fossils that occurs in many of the rocks in the Pittsburgh area. Microscopic animal fossils such as ostracodes (Figure 10) can be found in both the marine and nonmarine limestones; microscopic plant fossils such as spores will be found mostly in nonmarine rocks, however. Although microscopic invertebrates such as the single-celled *Tolypammina* (Figure 10) will be present, cemented to some of the shells in the marine rocks we will be visiting today, you probably will not see them unless you have at least an adequate magnifying glass.

The three localities we will be visiting on this trip are not the only good fossil-collecting localities in the Pittsburgh area. There really are numerous localities, but most are not suitable for large groups such as this.

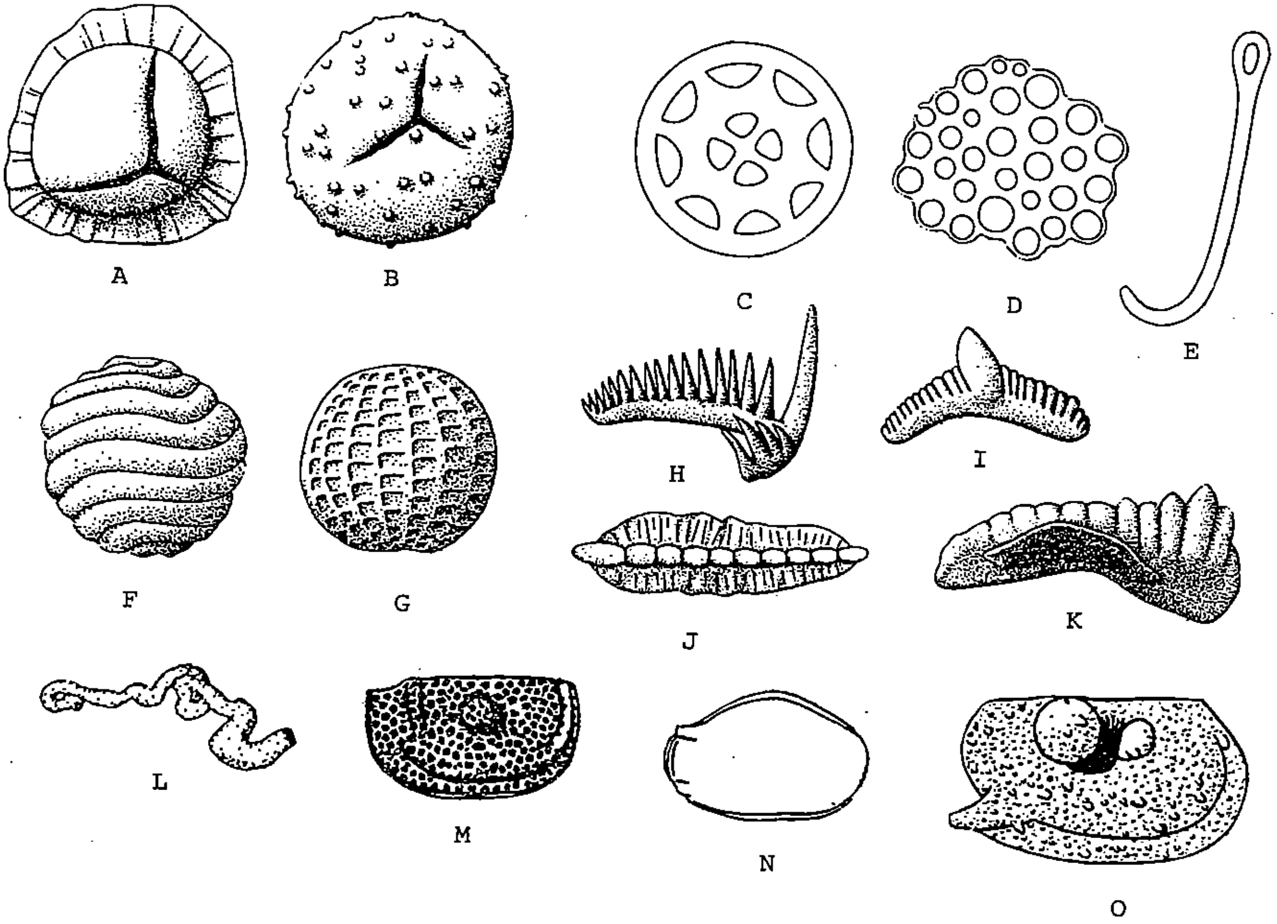


Figure 10. Some representative microscopic fossils. Plant fossils include spores of tree-like ferns (A and B) and algae (F and G). Animal fossils include single-celled protozoans such as *Tolypammina* (L), bivalved crustaceans called ostracodes (M to O), plates from sea cucumbers (C to E), and a variety of strange tooth-like forms called conodonts (H to K).

Care should be exercised in collecting fossils as there is a variety of fossil-like, non-organic, rock and mineral formations that can easily confuse even a veteran fossil hunter. You will most likely encounter some of these on this trip. The most common pseudofossils include concretions, dendrites, and sole markings. Concretions, which are hard, subcircular or irregular lumps or nodules in the rock, occur profusely in the marine shales above and below the Brush Creek and Ames limestones. Although most bear no resemblance to fossil shells, many are quite similar in size and appearance and may be, therefore, too tempting to discard. Dendrites, which are formed by manganese minerals crystallizing in a branching pattern, typically occur on bedding planes near joint edges in the rock, especially in thin bedded sandstones. They resemble finely detailed leaves of tiny ferns, and often occur in fine-grained sandstones at plant-fossil localities. Sole marks are sedimentary structures created either by the weight of a sand body on the underlying mud, or by current-carried debris gouging small potholes or grooves in the surface of the sediment on the bottom of the stream. These pseudofossils tend to look very much like trace fossils that are all oriented in one direction.

By comparison with other areas of the United States, very little scientific work has been done on the fossils of the Pittsburgh area. Most of the known forms were originally described from Illinois, Texas, and other states west of Pennsylvania. Therefore, the collector interested in identifying the fossils found in the Pittsburgh area may want to consult a good library for publications printed by the geological surveys of those states.

In the search for fossils, a sharp eye, a good hand lens, and a great deal of patience are necessities. Great care should be used to insure that rocks collected from different layers, even at the same locality, be kept carefully labelled, as each layer represents a specific interval of time. Accurate labels should accompany each specimen. For more information on collecting, preparing, and identifying fossils, refer to "Fossil Collecting in Pennsylvania" published by the Pennsylvania Geological Survey (Hoskins and others, 1983).

Illustrations of the more common fossils that can be found in the Pittsburgh area, as well as the not so common forms that are discussed in this chapter, are provided in the figures included with each major fossil type, and in the plates on pages 30 to 34 at the end of this section on fossils. The symbol **X** at each fossil in the plates indicates the size of the illustration with respect to an actual specimen. For example, **X** 1 means that the illustrations is approximately the same size as the fossil, whereas **X 0.7** means that the illustration is only 7/10 as large. These illustrations should help in the identification of most of the fossils that you will be able to find on this field trip.

Invertebrate Fossils

Invertebrate fossils are fossils of animals without backbones. These include fossils of a large variety of organisms, from microscopic one-celled animals to the shells of snails and clams, starfish and sea lilies, and crabs and insects. Marine invertebrate fossils will be found in marine rocks. These are among the most common fossils that can be found in the Pittsburgh area. Nonmarine invertebrates are harder to find and difficult to identify if you're not an expert. These can be found in the nonmarine rocks of the Pittsburgh area, particularly in lake limestones and black shales associated with coals. Many of the more common invertebrate fossils from the Pittsburgh area are illustrated in Plates 1 to 3, as well as in Figure 11.

Outcrops of the marine limestones and shales commonly contain a multitude of marine invertebrate fossils. There are exceptions; for example, the Ames Limestone that crops out along the Glassport-Elizabeth Road across the Monongahela River from Clairton contains few fossils. This is not characteristic of the Ames at most of the localities in the Pittsburgh area, however. In most places where the Ames crops out, the collecting is almost unparalleled in western Pennsylvania. The best collecting occurs in the calcareous shales above and below the limestones where the calcite shells, which are more resistant than the clay-rich matrix, weather out of the outcrop. In the limestones the rock and shells are equally resistant, and the

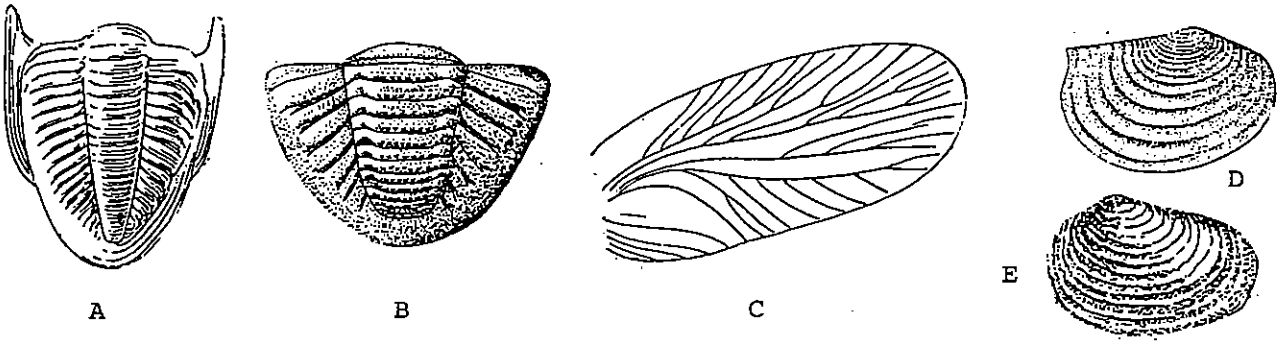


Figure 11. Some arthropods that can be found in Pittsburgh area rocks include trilobites (A and B), insect wings (C), and conchostrachans (D and E). A - *Ameura*, X1. B - *Ditomopyge*, X4. C - *Spiloblattina*, X2. D - *Palaeolimnadopsis*, X1.5. E - *Euestheria*, X5.

shells commonly break during attempts to remove them. Invertebrate shell fragments are commonly easy to find; more diligent searching is required to locate whole or almost complete specimens

The most abundant marine invertebrate fossils in the limestones are species of the horn coral, *Stereostylus*, numerous kinds of brachiopods (especially *Crurithyris*), and the plates and columnals of crinoids. Bryozoans (moss animals) are plentiful in the Pine Creek limestone (we will not see this unit on this trip). Less common but also present in the limestones are trilobites (extinct relatives of crabs, spiders, and insects), cephalopods (shelled relatives of octopuses and squids), snails, and clams. These latter fossil forms are more common, and easier to collect, in the fossiliferous shales above and below the limestones.

Outcrops of nonmarine limestones may yield a rich assortment of small lake-dwelling invertebrates. These include spiral worm tubes, bivalved crustaceans called ostracodes (Figure 10) and conchostracans (Figure 11), and snails and clams. Outcrops of the Duquesne limestone (lower Casselman Formation) around the Pittsburgh area are particularly fossiliferous, containing large quantities of the worm tube, *Spirorbis*, ostracodes, and conchostracans. A good locality for this limestone, and the associated shales, can be found along the Conrail railroad tracks above the West End Circle. The carbonates and shales of the Sewickley Member of the Pittsburgh Formation at the Ground Round restaurant on the corner of Route 19 and Gilkeson Road in Upper St. Clair have yielded the nonmarine gastropod, *Anthracopupa*, and the nonmarine bivalve, *Anthraconaia*.

Nonmarine shales, particularly the roof shales of coal seams, may contain fragments of insects. Cockroaches are the most common fossil insects found in Pennsylvanian rocks; however, the forewings of these insects are typically the only parts preserved. In the Glenshaw Formation, *Spiloblattina* (Figure 11) has been found in the roof shales of a thin coal seam below the Brush Creek marine unit at Bryant in Shaler Township, and near Glade Mills in Butler County. The shales associated with the Bakerstown coal have yielded fossil cockroaches at Thompson Run and Murrysville. Several species of others have been recovered from the Casselman Formation from the shales above the Duquesne limestone at several localities around the Pittsburgh area. Perhaps the most famous fossil insect-bearing stratum in the tri-state area is the Cassville shale, the roof rock of the Waynesburg coal, at Cassville, Monongalia County, West Virginia. Multiple species of cockroaches representing 10 genera have been documented from this locality.

Vertebrate Fossils

The fossil remains of vertebrate animals are relatively common in the Pittsburgh area, but tend to be overlooked by the uninitiated. Vertebrate fossils are rarely found as whole skeletons, but more typically as disarticulated parts which have become separated from each other by agents of decay and by water currents prior to burial and fossilization. Some of the more easily found and recognized vertebrate fossil remains are illustrated in Figure 12.

The most common vertebrate fossils are the teeth, scales, and spines of fish, teeth of amphibians and reptiles, then bones. Scales and teeth are found most commonly in fine-grained black shales, fresh-water limestones, and other sediments typical of quiet-water deposition. Shales and thinly bedded limestones often must be split with a chisel-type (mason's) hammer to reveal the enclosed fossils. Fossil bones, however, may project from the weathered surfaces of limestones and sandstones. Where a shale has yielded many isolated fish scales, patient searching may uncover an occasional nearly complete specimen, perhaps a scientifically important find, that was the source of the scales.

Well-preserved, whole, small bony fish, as well as many isolated scales, were found in an Allegheny Group coal near Cannelton, Beaver County in the 1800's. Similar preservation in a coal beneath the Upper Freeport coal in nearby Ohio yielded a tremendous variety of small bony fish, shark teeth and spines, and bones of lungfish, coelacanths, amphibians, and reptiles. These animals had lived in or near a lake and were buried in plant debris shortly after death. Neither of these localities is now accessible, as the mines associated with them closed at the beginning of this century.

Scales of bony fish may be found in several coals and carbonaceous shales still exposed in Beaver County, as well as at the horizon of the fresh-water shales below the Brush Creek marine beds in western Allegheny County. Coelacanth scales may be found in black, iron-stained shales in a railroad cut in Jeannette, Westmoreland County, only a few feet above the Upper Freeport coal.

Outcrops of Glenshaw Formation rocks are good places to begin searching for vertebrate fossils in the Pittsburgh area. The fresh-water shales below the Brush Creek and Woods Run marine beds have both produced fish remains. The dedicated fossil hunter may find scales and teeth of small fish, such as the two-pronged teeth of the pleuracanth shark, *Diplodus*, and several kinds of small shark spines, such as those of *Acanthodes*. The fossils are typically concentrated in the finest-grained, blackest shales, and may be distinguished

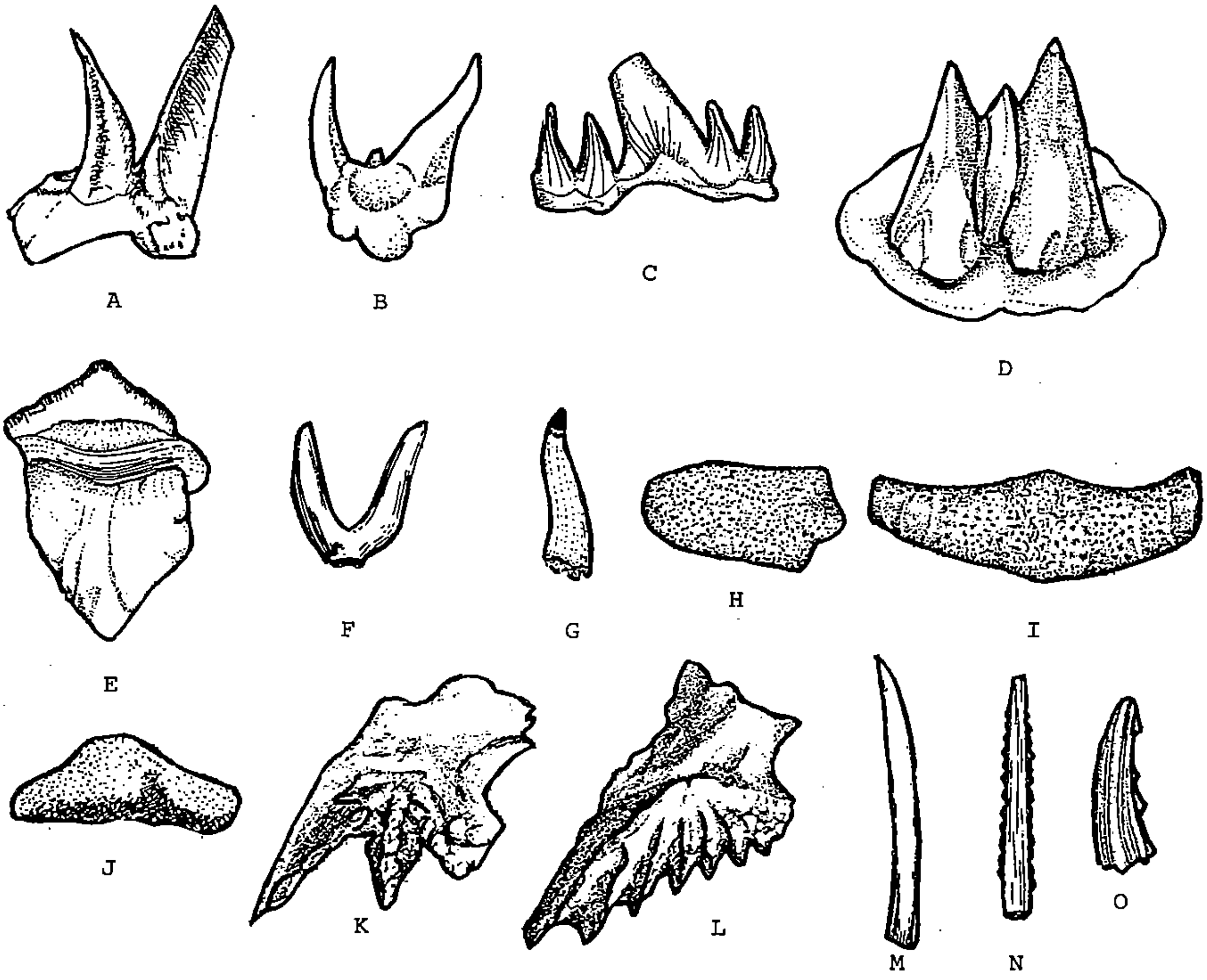


Figure 12. Some relatively common vertebrate remains that can be found in the rocks of the Pittsburgh area include the teeth (A to J), jaws (K and L), and spines (M to O) of various types of fish. A - *Orthacanthus*, X1. B - *Xenacanthus*, X1. C - *Cladodus*, X1. D - *Hybodus*, X2. E - *Petalodus*, X1. F - *Diplodus*, X14. G - *Paleoniscus*, X7. H - *Deltodus*, X1. I - *Campodus*, X1. J - *Helodus*, X1. K - *Sagenodus*, X8.5. L - *Monongahela*, X17. M - *Acanthodes*, X.5. N - *Orthacanthus*, X1. O - *Hybodus*, X1.

from plant fragments by the presence of a glossy enamel coating which has been blackened by mineral staining. The enamel coating gives the fossils a shiny appearance against the dull black background of the rock surface.

All of the marine limestones in the Glenshaw Formation have yielded fossil fish material. Fossils of some fish, including scales and teeth of minnow-sized bony fish, may only be found by dissolving blocks of the fossiliferous rock in acid. Reconstructions of some representative Pennsylvanian fish are illustrated in Figure 13.

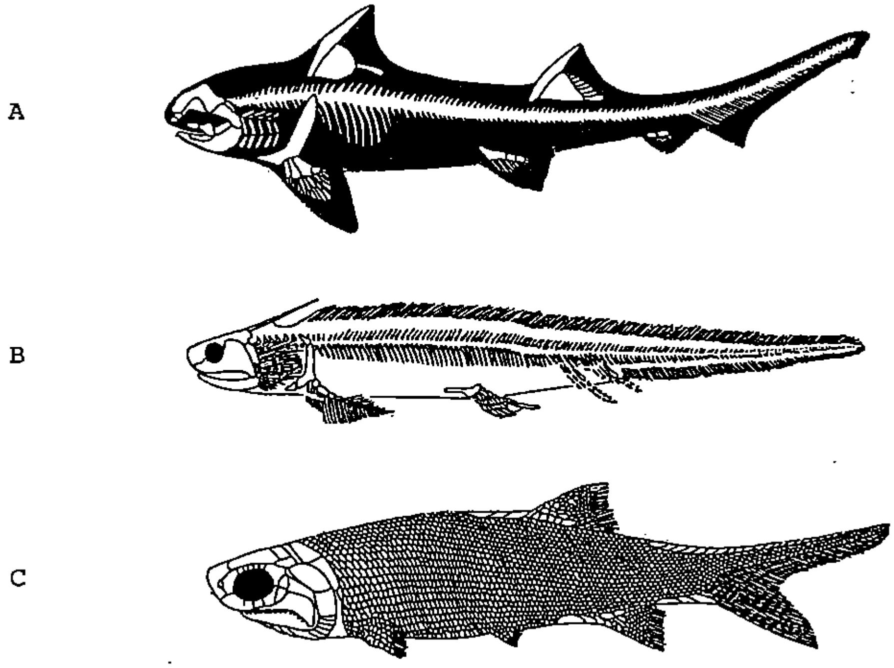


Figure 13. Reconstructions of some typical Pennsylvanian fish. A - *Xenacanthus*, a pleuracanth shark about 2.5 feet long. B - *Hybodus*, a pavement-tooth shark. C - *Elonicthys*, a small bony fish about 5 inches long.

The teeth of the fish-eating shark, *Cladodus*, have one tall central cusp, flanked on either side by two or three progressively shorter cusps which form a line upon a bony base. Gently curved plates with finely pitted surfaces are *Deltodus* teeth, designed for crushing hard-shelled invertebrates such as brachiopods and snails. Teeth of this type lay like a pavement in the jaw of a shark-like fish, giving these fish their common name "pavement-tooth sharks." *Helodus* and *Campodus* had similar dietary preferences; therefore the teeth are similar in general appearance. *Petalodus*, a relatively common fossil found in the marine limestones, had several rows of chisel-like teeth in the front of its mouth, and presumably flatter, crushing teeth in the back of its mouth. Most of the large fish found in the marine limestones fed on a plentiful supply of shelled invertebrates similar to those we still see today.

The Duquesne limestone, a sequence of fresh-water limestones nearly thirty feet above the Ames Limestone, contains an extremely rich vertebrate fauna. Among the larger bones likely to be visible without a hand lens are the spines of *Acanthodes*, the teeth and spines of the fresh-water sharks, *Orthocanthus*, *Xenacanthus*, and *Hybodus*, and the bones of the lungfish, *Sagenodus* and *Monongahela*. Many forms of fish and amphibians that were preserved in this limestone can only be found by dissolving the rock in acid and sifting the residue under a microscope.

The jet black shale lying above the Duquesne limestone also contains the remains of many fish. By carefully splitting the shale a collector may find

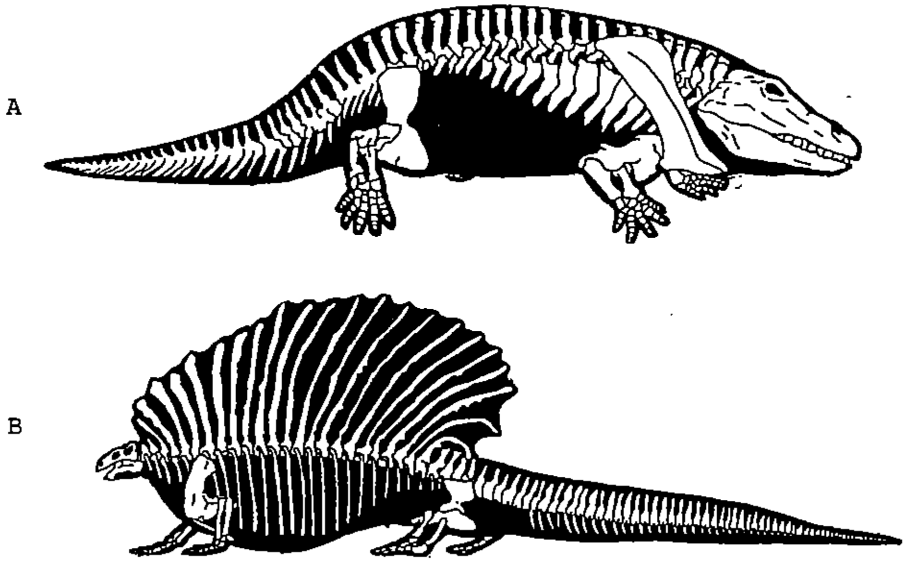


Figure 14. Reconstructions of an amphibian and a reptile that were common residents of the Pittsburgh area swamps during the Pennsylvanian Period. A - *Eryops*, a large amphibian about 6 feet long. B - *Edaphosaurus*, a plant-eating fin-backed reptile about 16 feet long.

hundreds of small, rhomboidal scales of the bony fish *Elonichthys*, as well as the bones of this and other fish. It is possible at times to find patches of scales, indicating that the remainder of the fish may be present within the rock. It is only possible to recover these fish by using an air abrasive unit, a type of microsandblasting machine used by professional paleontologists.

The bones of several large amphibians and reptiles were found in the Turtle Creek valley near Pitcairn around 1910 in the Pittsburgh red beds. The bones found included parts of a reptile-like amphibian, the finback mammal-like reptile *Edaphosaurus*, and the large amphibian *Eryops* (Figure 14). It is possible that diligent exploration may result in the rediscovery of this important locality, or one nearby.

The gray shales immediately below the Pittsburgh coal commonly contain relatively large, ornamented bony fish scales. Beneath these shales are thin-bedded fresh-water limestones which normally contain only the tiniest of fish scales and teeth. However, an old quarry in these limestones on Herron Hill yielded the skulls of several types of very grotesque amphibians, pieces of reptile skeleton, and bones and teeth of *Sagenodus* and *Orthocanthus*. Like the Turtle Creek valley vertebrate fossils discussed previously, these bones were concentrated in one spot. They were found by Carnegie Museum field workers in the 1930's. The quarry has since been covered by a housing project, so that further knowledge of these and other animals must await a new discovery.

Vertebrate fossils can also be found in Monongahela and Dunkard Group rocks, particularly, but not exclusively, in the fresh-water limestones and dolostones. Teeth and scales, and even the impression of the scaly skin of a fish, have been found in the Sewickley Member at the big roadcut on Route I79 at the Carnegie exit. Also, a thin sandstone lens in the Dunkard Group of Washington County yielded the jaws of the lungfish, *Monongahela* (Figure 12L).

Plant Fossils

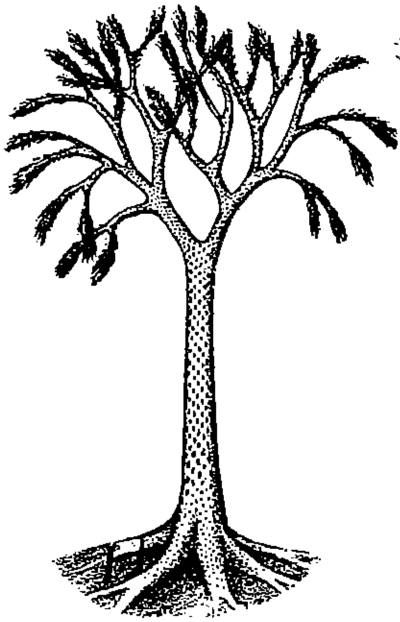
Because of the history of coal mining in western Pennsylvania, the typical Pittsburgh area resident is probably more familiar with plant fossils than any other kind. Strip mining operations in the county and adjacent areas during the last 200 years unearthed large numbers of carbonized leaf fragments and tree stems cast in sandstone. Many people could literally walk into their back yards and collect well-preserved plant fossils. With the inception of strip mining reclamation in 1966, however, the number of abandoned strip mines available for collecting fossils has decreased dramatically. Roadcuts, outcrops, and working mines are now the most practical locations for looking for plant fossils. Some of the more common plant fossils of the Pittsburgh area are illustrated in Figure 15 and Plates 4 and 5.

The fossil plants of the Pittsburgh area include trunks and stems, branches, leaves, fruit or cones, seeds, and roots of many varieties. The most common trees and shrubs that inhabited the coal swamps of the Pittsburgh area during the Pennsylvanian Period are illustrated in Figure 15. In searching for, and eventually trying to identify, fossil plant fragments, the collector should keep in mind that the fossils found may represent different parts of the same plant species. For example, the scale tree, *Lepidodendron*, is clearly recognizable by the diamond-shaped pattern of its surface, formed where the branch-like leaf bracts attached to the trunk. However, this represents only the stem of the tree. Other parts associated with *Lepidodendron* include: the leaves, *Lepidophylloides*; the roots, *Stigmaria*; the spore-bearing cone, *Lepidostrobus*; and the scales of the cone, *Lepidostrobophyllum*.

Other plants that can be found throughout western Pennsylvania include: the scale tree, *Sigillaria*, and its component parts (including *Stigmaria*, a name used for the roots of scale trees of all types); the early conifer, *Pennsylvanioxylon* (the tree that bore the leaves called *Cordaites*); the scouring rush, *Calamites*, with its leaves, *Annularia* and *Asterophyllites*; the small herbaceous relative of the scouring rushes, *Sphenophyllum*; the early true fern, *Psaronius*, and its leaves, *Pecopteris*; and the seed fern, *Medullosa*, and its leaves, *Neuropteris*, *Alethopteris*, and many others.

Black, filmy carbonized impressions of leaves may commonly be found in the platy shales above coal seams and in the dark shales of floodplain and lake deposits where the leaves fell into water and were buried in mud. Trunks, branches, and roots can be found in stream and channel sandstones.

Many highly fossiliferous gray shales occur in the Glenshaw Formation of western Pennsylvania. The nonmarine shales below the Brush Creek marine rocks



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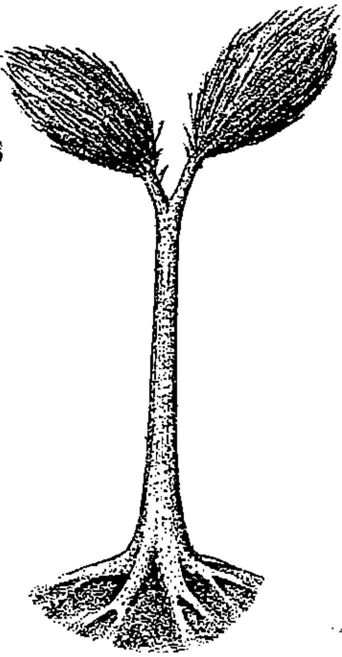

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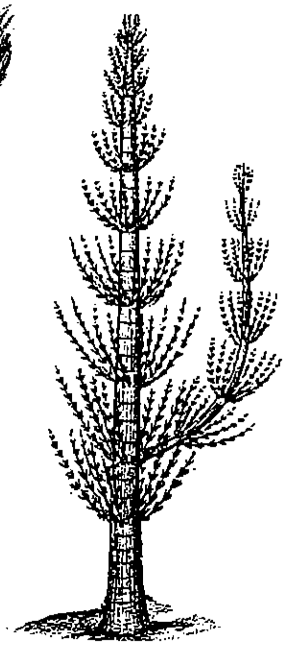

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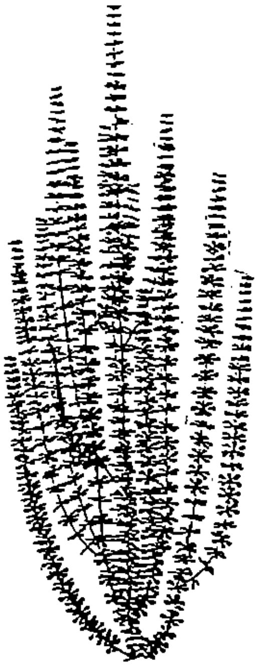

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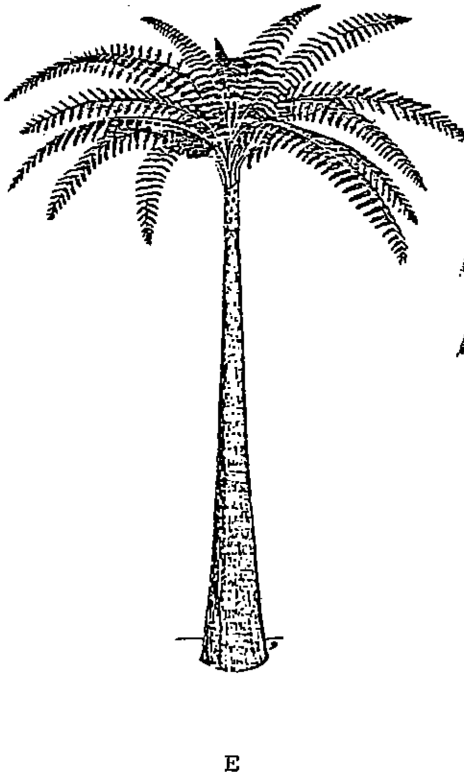

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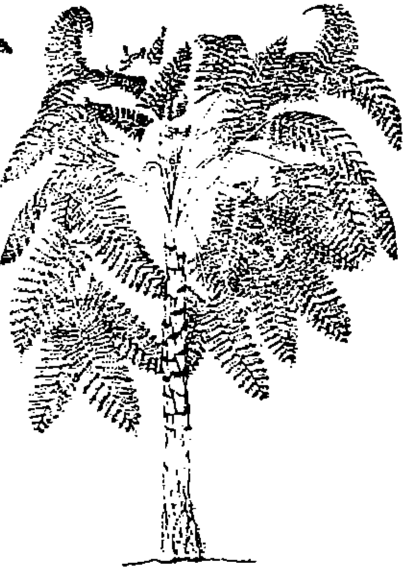

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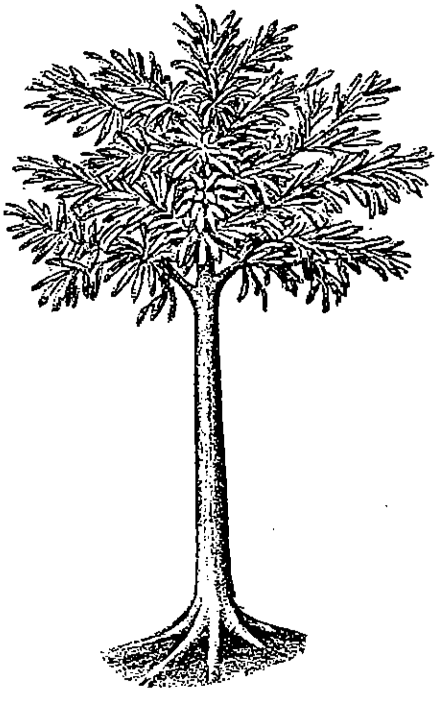

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exposed near Fair Oaks in Leet Township are representative. These shales yielded large numbers of specimens of *Neuropteris*, *Alethopteris*, and other seed ferns, *Pecopteris*, *Sphenophyllum*, and *Annularia*. Smaller numbers occur in the shales at Wildwood in Hampton Township and at Coraopolis.

In the Casselman Formation the Morgantown and Connellsville sandstones at Stop 1 contain an abundant and diverse fossil flora, including, but not limited to, species of *Pecopteris*, *Alethopteris*, *Odontopteris*, *Neuropteris*, *Sphenophyllum*, and *Cordaites*.

The shales associated with the Monongahela Group coals, particularly the Pittsburgh coal, also contain a large fossil flora. Where the rock is coarse grained, sandy, and full of mica, however, the abundance and diversity of plant fossils decreases dramatically.

A particularly fossiliferous locality in the shales overlying the Pittsburgh coal near Burgettstown in Washington County was found to contain at least 80 species of ferns, seed ferns, and scouring rushes. The abundance of *Sphenophyllum* is particularly noteworthy, and is also characteristic of other localities near Imperial and in Westmoreland County.

Lower Dunkard Group rocks also contain many plant fossils. The Cassville shale overlying the Waynesburg coal at Cassville, West Virginia has one of the most impressive floras described from the Appalachian Basin. In the Pittsburgh area, however, the Waynesburg Formation is dominated by sandstones and siltstones, and is rarely exposed because of increasing suburban development in the areas where it crops out. Identifiable plant fossils may occur, but are not as numerous or diverse as at the West Virginia locality.

Trace Fossils

Trace fossils come in a variety of shapes and sizes (Figure 16). For example, *Planolites* is a long, linear burrow. *Conostichus* is roughly conical. *Zoophycus* typically occurs as dark-colored semicircular or semielliptical swatches on the surfaces of siltstones, shales, and limestones. Each of these represents the activities of aquatic animals.

Ichnology, the study of trace fossils, can be fascinating even to someone not particularly interested in the fossils of the animals themselves. Studying trace fossils is like studying footprints in a detective case - one never quite knows who or what created the print, and attempting to solve the mystery

<----Figure 15. Reconstructions of some representative trees and shrubs found in Pittsburgh area rocks. A - *Lepidodendron*, and B - *Sigillaria*, both about 100 feet tall. C - *Calamites*, a 20-foot tall scouring rush. D - *Sphenophyllum*, a scrambling shrub about 10 to 15 feet tall. E - *Psaronius*, an early relative of the ferns that grew 40 feet tall. F - *Medullosa*, a seed fern about 12 feet tall. G - *Pennsylvanioxylon*, an early 100-foot tall conifer that carried the leaves called *Cordaites*.

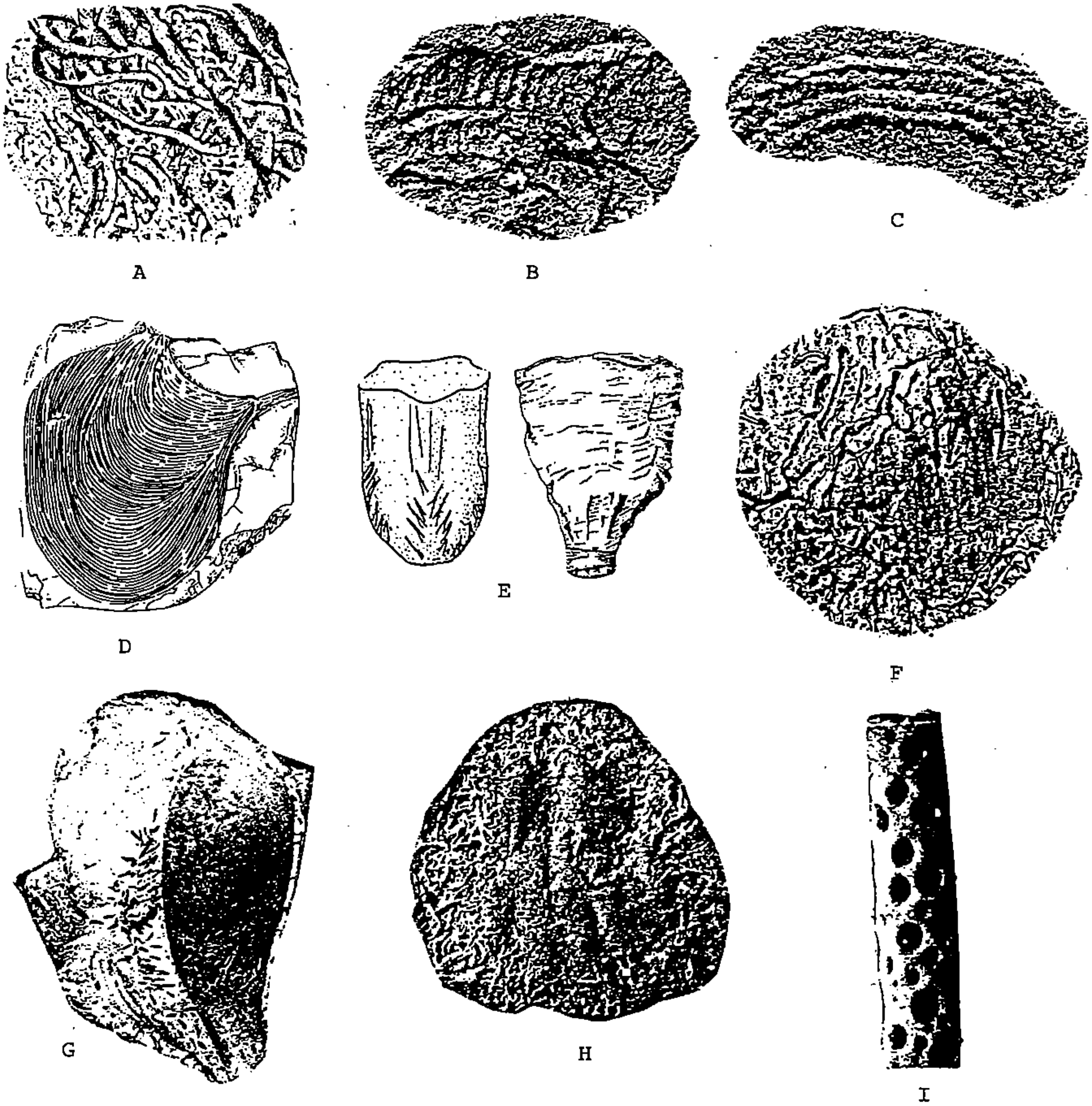


Figure 16. Some of the more common trace fossils of the Pittsburgh area include trails (A to C), feeding traces (D), resting traces (E), and borings (F to I). A - *Planolites*, X1. B - *Olivelites*, X1. C - *Palaeobullia*, X1. D - *Zoophycus*, X.5. E - *Conostichus*, X.8. F - *Conchotrema* on a brachiopod shell, X2. G - *Zapfella* on a snail shell, X1. H - *Clionolithes* on the interior of a brachiopod shell, X.5. I - *Tremichnus* on a crinoid stem, X1.

may be more satisfying than knowing the answer. Trace fossils have practical as well as esthetic applications, however. They can help geologists unravel questions of depositional environment, stratigraphy, fossil ecology, and evolutionary trends.

The trace fossils that can be found in the Pittsburgh area are astoundingly varied, yet few people outside of some experts in fossils or depositional environments even recognize them when they see them. If trace fossils are even noticed by the typical collector, they are often dismissed as strange markings on the rock that have little or no significance. In fact, trace fossils may have more significance than normal fossils because they indicate that a wider variety of animals lived in the area than can be recognized from preserved shells and bones.

All of the marine, and many of the non-marine, rocks of the Pittsburgh area contain trace fossils. *Zoophycus*, the feeding trace of a worm which swept the sea floor in a semicircular pattern, is common at the base of the Brush Creek Limestone along Route 51 near Coraopolis. The dark-colored pattern is easily distinguished against the buff-colored background of the rock. *Conostichus*, which has been interpreted as the resting trace of a jellyfish or sea anemone, occurs in all of the marine limestones and calcareous shales of the Glenshaw Formation. *Tremichnus* fossils, swollen pits in the surface of crinoid stems and plates, can be found almost anywhere crinoid debris is common, and in the Ames Limestone Member in particular. *Clionolithes*, *Conchotrema*, and *Zapfella* are tiny borings found in fossils sea shells. They were apparently made by boring organisms such as sponges, worms, or barnacles. *Planolites* is probably the most commonly encountered trace fossil in Pittsburgh area rocks, occurring in both marine and non-marine rocks. These trace fossils have been interpreted as burrows filled with sand or mud which had passed through the gut of a worm-like creature. *Olivellites* and *Palaeobullia*, however, are interpreted as trails made by gastropods.

Some burrows have no specific name. The Ames Limestone along Route 28 near Creighton (Harper, 1989) contains large horizontal and vertical burrows filled with a fossil hash of shell fragments. Large conical mounds in the Brush Creek limestone near Coraopolis and in the Pine Creek limestone near New Kensington also contain large, often bifurcating vertical burrows.

PLATE I

CORAL

Stereostylus
X1

BRYOZOANS

Rhombopora
X8

Septopora
X4

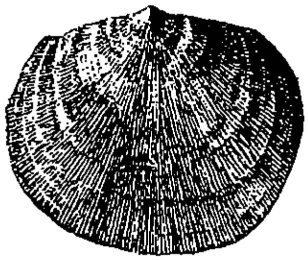
WORM TUBES

Spirorbis X15

BRACHIOPODS

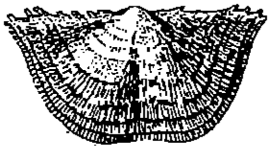
Lingula X3

Rhipidomella X1



Orthotetes X1

Derbyia X1



Chonetinella X5

Neochonetes
X2

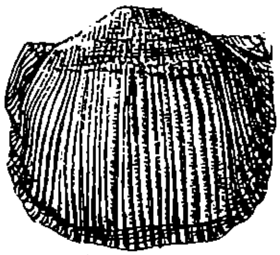
Kozlowskia
X1

Juresania X.3

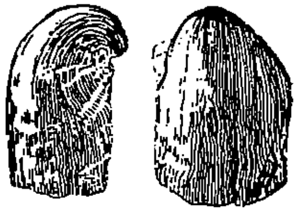
Hystriculina X2

Cancrinella
X1

Antiquatonia X1



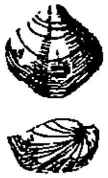
Reticulatia X1



Linoproductus X.3

Wellerella
X1

Hustedia
X2



Composita X.5

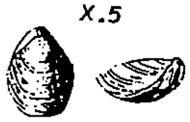
Phricodothyris
X.5

Crurithyris
X1

Neospirifer X1

Anthracospirifer
X1

Punctospirifer
X.5



Beecheria X.5

PLATE 2

GASTROPODS


Euphemites X1.5


Retispira X1.5

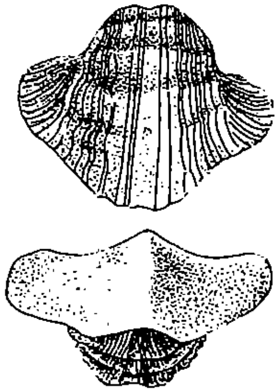

Pharkidonotus X1


Amphiscapha X1


Raphistomella X3

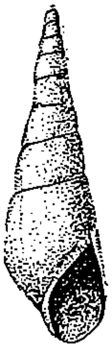

Shansiella X.5


Worthenia X.5

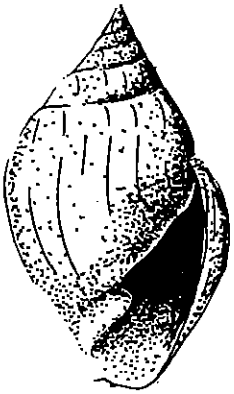

Knightites
(Cymatospira)
X2


Phymatopleura
X4


Pseudozygopleura
X2


Meekospira X2

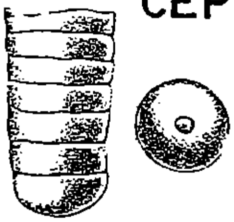

Soleniscus X2

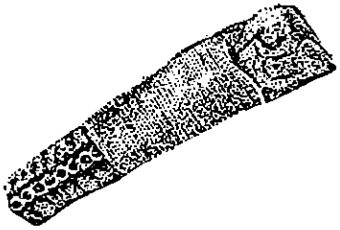

Strobeus X2

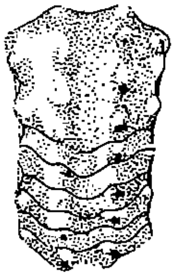

Anthacopupa X10

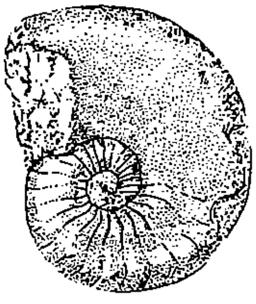
CEPHALOPODS

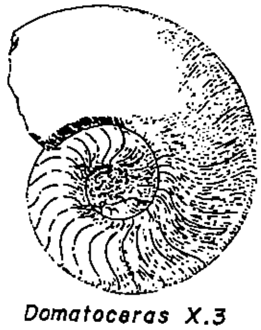

Brachycycloceras
X.3

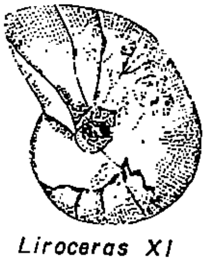

Mooreoceras X2


Pseudorthoceras X1


Tainoceras X.5


Metacoceras X.5


Domatoceras X.3


Liroceras X1

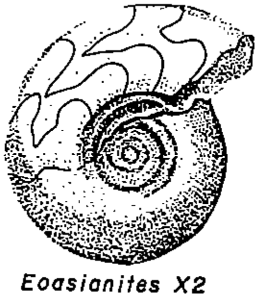
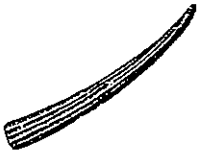

Eoasianites X2

PLATE 3

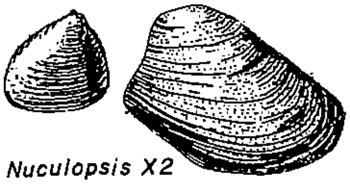
SCAPHOPODS


Dentalium X1


Plagioglypta X2

BIVALVES

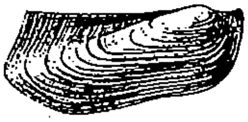

Clinopistha X2

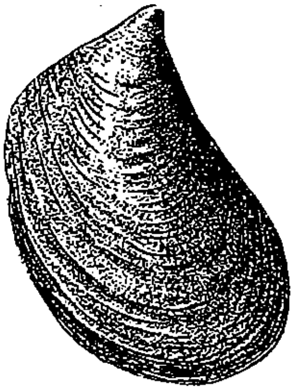

Nuculopsis X2


Palaeoneilo X1


Phestia X1


Solemya X.5


Parallelodon X1

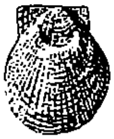

Orthomyalina X.5

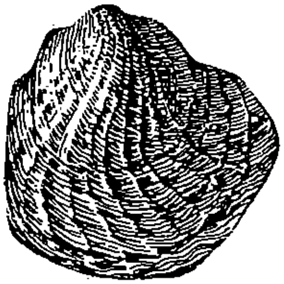

Septimyalina X.5


Dunbarella X2


Aviculopecten X1


Acanthopecten X1.5


Streblochondria X1

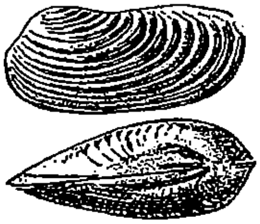

Pseudomonotis X2.5


Palaeolima X2


Schizodus X1


Astartella X1


Edmondia X.5

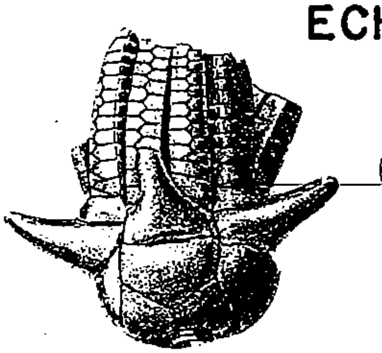

Wilkingia X1

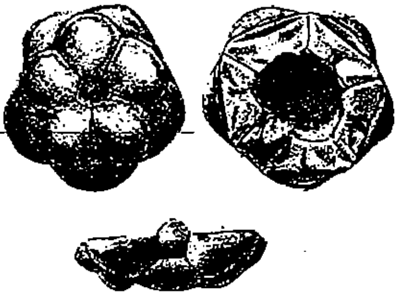

Chaenomya X.5


Anthroconaia X2

ECHINODERMS


Crinoid columnals X1


Delocrinus X1


Endelocrinus X2

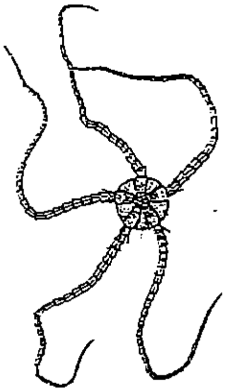
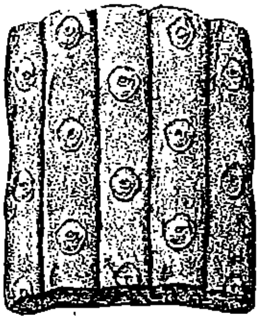
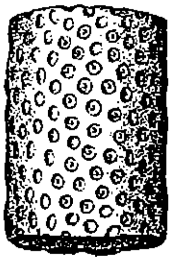

Syntomospina X5

PLATE 4

STEMS, LEAVES, AND FRUITS

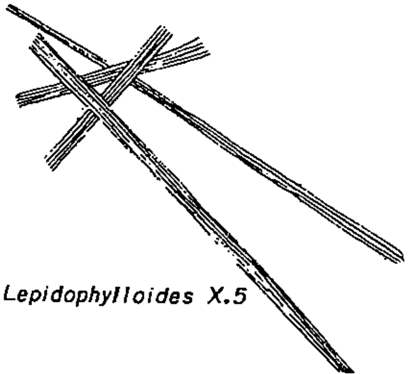

Lepidodendron X.5

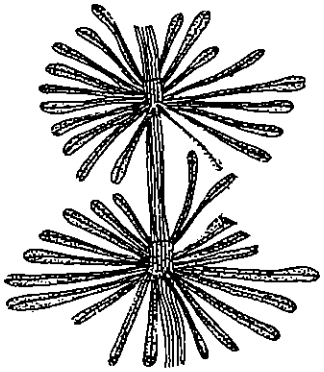

Sigillaria X.5

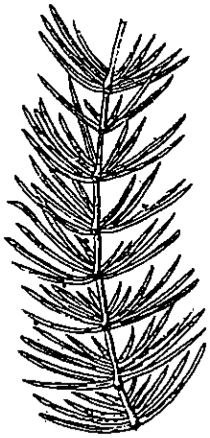

Stigmaria X.5


Calamites X.3


Pennsylvanioxylon X.1

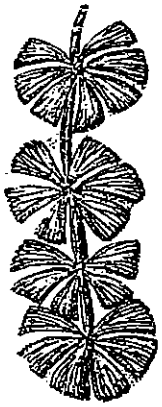

Lepidophylloides X.5


Annularia X1


Asterophyllites X1

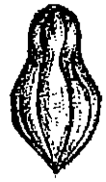

Cordaites X.5


Lepidostrobus X.5

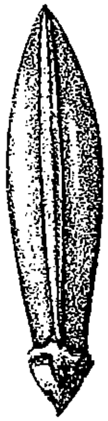

Sphenophyllum X1


Calamostachys X1


Codonotheca X.5


Codonospermum X.5

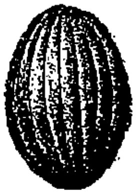

Trigonocarpus X.2


Lepidostrobophyllum X.5


Neuropterocarpus X.5


Carpolithes X.5

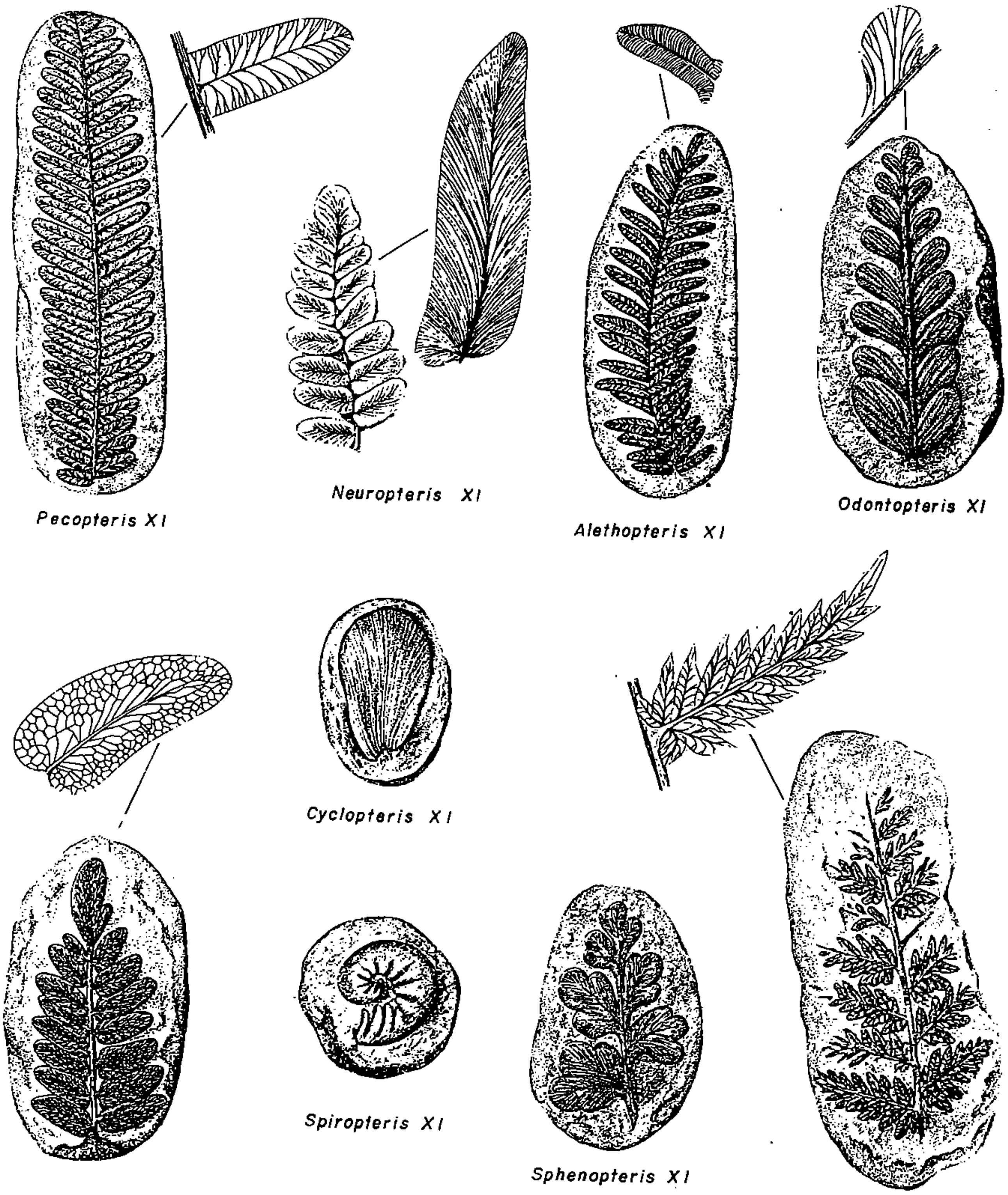

Pachytesta X.5


Holcospermum X.5


Whittleseya X1

PLATE 5

LEAVES



Pecopteris X1

Neuropteris X1

Alethopteris X1

Odontopteris X1

Cyclopteris X1

Linopteris X1

Spiropteris X1

Sphenopteris X1

Mariopteris X1

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The references listed below consist of those books and professional articles that were used to put this guidebook together. In addition, the list contains numerous selected references that can be consulted for the purposes of learning more about the fossils of the Pittsburgh area. These references should also help you identify the fossils you found on this trip, as well as other fossils you may find in the future.

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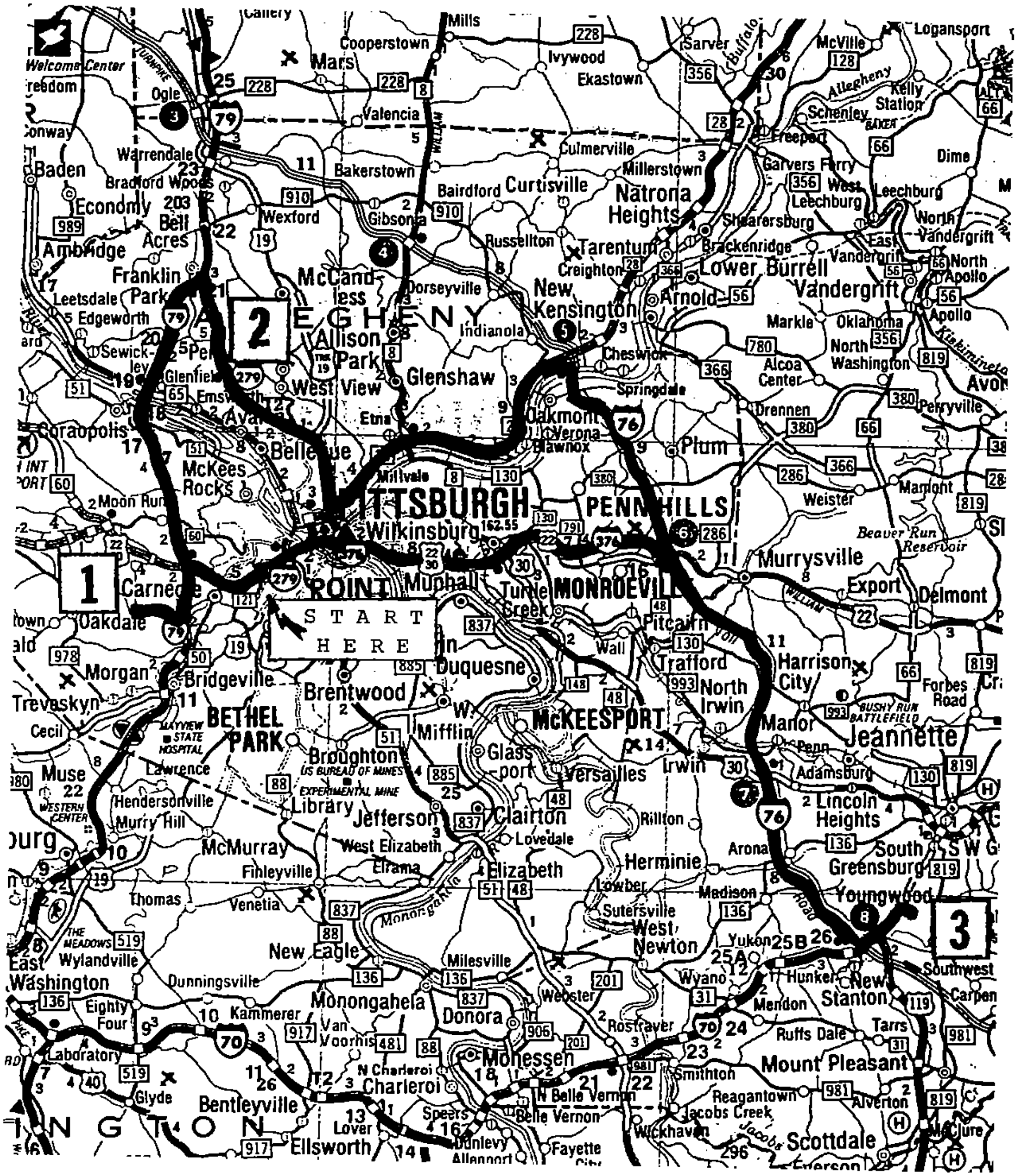

Figure 17. Location of field trip route and stops.

ROAD LOG

MILEAGE Int.	 Cum.	TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
0.00	0.00	**START:** Parkway Center Mall, near Chi Chi's restaurant.
0.05	0.05	Exit the parking lot and turn right onto mall access road.
0.05	0.10	Turn right onto Parkway Center Drive.
0.20	0.30	Turn left onto Greentree Road.
0.30	0.60	Turn right onto Mansfield Avenue.
0.20	0.80	Turn left onto Poplar Street.
0.05	0.85	Turn right onto westbound entrance ramp to Parkway West and merge with traffic.
1.65	2.50	Exit 3 to Carnegie and Heidelberg. Continue west on Parkway.
0.90	3.40	Exit 4 to Rosslyn Farms. The concrete embankment on the right hides some abandoned mines in the Pittsburgh coal as well as the scars of mine subsidence. Continue west on Parkway.
0.30	3.70	Bear right onto exit ramp to I-79 and then bear left to southbound ramp. Rocks exposed in the walls of this roadcut are part of the Pittsburgh Formation, above the Pittsburgh coal.
2.20	5.90	Bear right onto exit ramp at Exit 13 to Carnegie and Oakdale.
0.30	6.20	Turn right onto Noblestown Road.
1.00	7.20	Morgantown sandstone and other Casselman Formation rocks crop out on right side of road from here to Rennerdale. The Morgantown exhibits excellent cross bedding, typical of a stream channel sandstone.
0.30	7.50	Enter Rennerdale.
0.20	7.70	Turn right into Collier Stone Co. quarry.

STOP 1: PLANT FOSSILS FROM THE CASSELMAN FORMATION

This quarry, as well as an abandoned one on the other side of Noblestown Road, about 0.05 mi. west, produces principally from the Morgantown sandstone. The abandoned quarry reportedly provided building stone for the Allegheny County Courthouse in Pittsburgh. The active quarry provides road aggregate and building stone, examples of which can be seen near the office. Note that not all of the examples come from this quarry. Collier Stone Co. imports a lot of its stone from other areas of Pennsylvania, as well as from out of state.

This quarry is an excellent place for collecting plant fossils. I had the opportunity to collect many different specimens of stems, roots, and leaves of *Calamites*, *Stigmaria*, and numerous fern and seed-fern plants this past winter, and I barely scratched the surface of the good collecting area.

The quarry exposes most of the Casselman Formation and part of the Pittsburgh Formation, from just below the Morgantown sandstone (the lowest part of the active quarry face) to just above some abandoned mines in the Pittsburgh coal at the top of the hill. The plant fossils come from near the top of the active quarry, from dark-colored siltstones and silty shales that probably represent the Connellsville sandstone in one of its fine-grained forms. These rocks may represent either a floodplain or an abandoned meander channel of a stream that flowed through the area about 290 million years ago. A thin coal bed occurs at the top of this sequence, and the rock immediately adjacent to the coal boasts some of the most wonderful plant fossils I have seen in the Pittsburgh area, including whole fronds of ferns. A thin nonmarine limestone, probably the Pittsburgh limestone, occurs about 30 feet above this zone. The intrepid collector may wish to investigate this limestone for nonmarine fossils.

It should be noted that access to the quarry is by permission only. Those wishing to return to the quarry at another date need to contact Mr. Bill Duchess of the Collier Stone Co. who provided access for this trip.

MILEAGE		**TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY**
Int.	**Cum.**	
0.30	8.00	Leave Stop 1. Turn left onto Noblestown Road and retrace course back to I-79.
1.75	9.75	Bear right onto northbound ramp to I-79 and merge with traffic. A complete exposure of the Pittsburgh Formation of the Monongahela Group, probably the only such exposure in the Pittsburgh area, occurs in the large roadcut to the left as the bus enters I-79. The Pittsburgh coal is exposed on the terrace above Noblestown Road. The Uniontown coal is exposed as a "coal blossom" above the thick, well-developed light-colored limestones and dolostones of the Sewickley Member. This locality has provided some nonmarine invertebrate and vertebrate material in the limestones and dolostones, as well as some interesting trace fossils and some sedimentary structures such as fossil mud cracks. Plant fossils and nonmarine invertebrate fossils, such as insects and concostrachans, may occur in the black shales above and below the Pittsburgh coal, but I have not seen them myself.

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	Cum.	
1.35	11.10	Roadcut to the left in the Pittsburgh Formation displays siltstones and shales in channel configuration, probably due to deposition in an abandoned meander channel.
0.45	11.55	Exit 14 to Pittsburgh. Continue north on I-79.
0.35	11.90	Exit 15 to Airport. Continue north on I-79.
1.70	13.60	Exit 16 to Crafton and Moon Run. Continue north on I-79.
3.60	17.20	Red beds are exposed in the hillside on the left (southbound lanes).
1.10	18.30	Exit 17 to Coraopolis. Continue north on I-79.
0.65	18.95	Exit 18 to Neville Island. Continue north on I-79.
0.15	19.10	Cross back channel of Ohio River.
0.20	19.30	Cross Neville Island.
0.20	19.50	Cross main channel of Ohio River.
0.20	19.70	Exit 19 to Emsworth, Sewickley, and Glenfield. Continue north on I-79. The roadcut on the right exposes Glenshaw Formation strata from the Buffalo sandstone at the bottom to the Saltsburg sandstone at the top. The fossiliferous Pine Creek limestone and shale occur at about the level of the road in the northbound exit ramp.
0.50	20.20	Roadcuts on both sides of I-79 expose red beds of the upper Glenshaw Formation. These Pittsburgh red beds created considerable problems to the highway department at the time of construction. The highway crews dug into an ancient landslide mass that became reactivated. The mass had to be excavated before construction of the highway could resume. Continuation of landsliding due to instability of the red claystones is evident from the outcrop.
2.00	22.20	Exit 20 to Mt. Nebo Road. Continue north on I-79.
2.80	25.00	Roadcut on the left exposes Connellsville sandstone above Clarksburg limestone and claystone.
0.60	25.60	I-279 enters from right. Note that there is no entrance to I-279 from the northbound lanes of I-79. For this reason, we will travel up to the next exit and turn around.
1.70	27.30	Bear right on exit ramp at Exit 22 to Wexford.
0.40	27.70	Turn left onto Route 910 (Orange Belt).
0.10	27.80	Turn right onto southbound entrance ramp to I-79 and merge with traffic.
1.00	28.80	Connellsville sandstone outcrop on right.
0.85	29.65	Roadcut on right side of highway exposes a small, gentle anticline and syncline in the Clarksburg limestone & overlying Connellsville sandstone. The Clarksburg limestone here contains numerous nonmarine fossils, mostly ostracodes and worm tubes.

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	Cum.	
0.15	29.80	Bear left onto southbound entrance to I-279.
1.00	30.80	Roadcuts on the left over next 0.45 mi. expose thick sequences of lower and middle Casselman sandstones that probably consist of combined Morgantown and Birmingham sandstones.
0.70	31.50	Roadcut on the left extends approximately 0.3 mi., exposing a thick sequence of sandstone. The lower part of the outcrop consists of thick-bedded, massive, gray sandstone, highly fractured in a nearly circular pattern, with mineralization stains along the fractures. The upper part of the outcrop consists of massive yellowish sandstone, very different from the lower part. At 31.60 mi., a thin coal seam with underlying dark-colored shale splits the outcrop into two discrete sandstone units, corresponding to two parts described above. The Wellersburg coal & shale separate the overlying Morgantown sandstone from the underlying Birmingham sandstone. The coal & shale disappear abruptly to the north beneath the Morgantown channel cut & fill.
0.75	32.25	Roadcut on the left illustrates the highway department's use of different engineering approaches to different forms of bedrock. Thick sequence of Morgantown and Birmingham sandstone at the top of the roadcut are relatively competent, and the roadcut is nearly vertical. Pittsburgh red beds and associated strata (Ames Limestone is exposed near road level at the north end of the roadcut) are incompetent and susceptible to landsliding. Terraces or steps about 4 ft. high and 4 ft. wide cut into these rocks help prevent slope movement. Terraced roadcuts are common from here to Pittsburgh.
0.75	33.00	Small landslides in the unstable upper Glenshaw Formation occur on the right.
0.65	33.65	Turn right onto dirt access road leading to large roadcut on the right and park the bus on the flat area below the roadcut.

STOP 2: MARINE FOSSILS FROM THE AMES LIMESTONE (AND LUNCH STOP)

This roadcut exposes upper Glenshaw to lower Casselman strata, from the Upper Saltsburg sandstone at the base to the Morgantown sandstone at the top. Moving from the base of the cut to the top, one encounters: 1) gray sandstone at the level of the parking area; 2) seven terraces of red and gray claystones (red beds) containing very hard nodules; 3) five terraces of red and gray claystones, very weathered, with some speroidal weathering, greenish-blue zones of reduction, some root casts, manganese dendrites, and some questionable trace fossils; 4) the Ames Limestone terrace; 5) two terraces of red and gray claystone; 6) the top terrace, containing a small lense of gray sandstone (Grafton sandstone?) and a barrier of large sandstone boulders used to prevent rockfalls from reaching the highway; and 7) the steep flat face of sandstone at the top of the cut.

The Ames Limestone occurs about 2/3 of the way up the hillside. We will be climbing up to it on the vetch-covered side of the cut, not on the terraced face. You may climb the terrace if you wish, especially if you are interested in examining the various strata on the way up.

The Ames typically occurs in three basic layers, including about 1/2 to 3 inches of hard calcareous shale at the base, overlain by 18 to 36 inches of very hard, argillaceous limestone, which is then capped by about 10 inches of calcareous shale.

The lower calcareous shale commonly contains a hash of diverse faunal elements, many preserved as phosphatic replacements. These can be recognized by their black color. Many of the molluscan fossils, which had original calcium carbonate shell layers, have been completely replaced by phosphatic minerals. This replacement phenomenon has occurred with perfect duplication of the finest details of shell sculpture, at least in specimens that have not been crushed thoroughly. It may even be possible to find specimens that retain traces of the original markings.

The thick middle section of limestone, the Ames Limestone proper, contains a diverse fauna of brachiopods, corals, and crinoids. There are some corals scattered throughout the limestone, but for the most part they occur at discrete horizons, often in association with black nodules of phosphatic material. The buff colored rock, which is typical of the Ames in western Pennsylvania, is generally much harder than the associated shales. A small sledge hammer and a good chisel will be somewhat useful for the ambitious collector, and may prove to be necessary in order to remove anything of interest.

The upper shale section, which at this locality is highly weathered and not well exposed, is typically rich in brachiopods, particularly Crurithyris and Composita. Crurithyris often occurs in such abundance that the shells may be mistaken for small pebbles in the rock. The rock itself consists of easily broken, buff-colored, slightly calcareous shales or other mudrocks. The fossil content decreases upward.

Interested participants may wish to climb to the top of the terraced cut, to the boulder barrier. Many of the large sandstone blocks contain plant fossil impressions and pieces of coal, as well as large chips of shale and siltstone. The represent the basal conglomerate discussed under Rocks of Stream Environments on page 15. **CAUTION:** Do not cross the barrier.

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	Cum.	
0.15	33.80	Exit Stop 2. Return to I-279 and turn right onto southbound lane.
0.75	34.55	Exit 21 to Camp Horne Road. Continue south on I-279.
1.60	36.15	Exit 20 to Bellevue. Continue south on I-279.
1.55	37.70	Exit 19 to Perrysville Avenue. Continue south on I-279.
1.80	39.50	Exit 17 to Venture Street. Continue south on I-279.
2.05	41.55	Bear right on exit ramp at Exit 15 to Route 28.
0.50	42.05	Turn left onto East Ohio Street.
0.35	42.40	Merge with traffic on northbound lanes of Route 28 at the H. J. Heinz plant.
0.40	42.80	Troy Hill on the left is part of the old pre-Ice Age Allegheny River valley. During the Ice Age, the Allegheny, Monongahela, and Ohio Rivers cut down through the surrounding rock, forming the present landscape of Pittsburgh, and leaving the older valley floors high and dry. Similar portions of the old valley floors can be seen at Natrona Heights, the University of Pittsburgh Applied Research Center in Harmarville, on the North Side of Pittsburgh, in Bellevue, McKeesport, Oakland, Homestead, and many other places.
1.25	44.05	Exit 2 to 40th Street Bridge. Continue north on Route 28.
0.35	44.40	Exit 3 to Millvale. Continue north on Route 28.
0.20	44.60	Pittsburgh and Schenley red beds and Ames Limestone exposed in hillside on left side of highway for 0.8 mi. Colluvial soils, derived from red beds, have long history of earthflow-type landsliding. Exposure was being graded & concrete retaining walls were being built at time of writing (1990).
0.90	45.50	Shaler Water Works on left supplies ground water to the North Hills area from alluvial sand and gravel of the present Allegheny River valley.
0.90	46.40	Exit 5 to Etna and Sharpsburg. Continue north on Route 28. Exposure of upper Glenshaw to lower Casselman rocks in cliff at left, from Upper Saltsburg sandstone near road level to Connellsville sandstone at the top.
1.65	48.05	Exit 6 to Highland Park Bridge. Continue north on Route 28.
0.55	48.60	Famous Brilliant Cut locality at intersection of Allegheny River Boulevard and Washington Boulevard on the right across the Allegheny River. This used to be an excellent fossil collecting locality in the Ames Limestone. Some recent landslides have all but totally ruined the site for all but the intrepid collector.
0.40	49.00	Exit 7 to Delafield Avenue. Continue north on Route 28.

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	Cum.	
0.20	49.20	Water filtration plant for Pittsburgh Water Authority on right in Aspinwall. Surface water from Allegheny River is treated here before being piped for use in much of the city of Pittsburgh.
0.60	49.60	Exit 8 to Fox Chapel Road. Continue north on Route 28.
0.40	50.00	Exit 9 to Blawnox. Continue north on Route 28.
1.00	51.00	Exit 10 to R.I.D.C. Park. Continue north on Route 28.
1.30	52.30	Long, high roadcut extends 1.15 mi. along the left side of Route 28. Cyclothemic deposition is evident in the repeated layers of different types and colors of rock. 275 ft. of middle Glenshaw to middle Casselman strata are exposed, from the Woods Run limestone at the northern end of the cut to Connellsville sandstone at the southern end. A well-developed channel sandstone can be seen at the northern end of the roadcut.
1.30	53.60	Abandoned mine in Upper Freeport coal on left.
0.50	54.10	Bear right onto exit ramp at Exit 11 to Harmarville.
0.15	54.25	Bear right onto Route 910.
0.15	54.40	Turn left onto Old Freeport Road.
0.60	55.00	Bear right onto entrance ramp to Pennsylvania Turnpike.
0.30	55.30	Turnpike toll booth. Take ticket and proceed.
0.10	55.40	Bear right onto eastbound ramp toward Harrisburg and Philadelphia and merge with traffic.
0.40	55.80	Cross Allegheny River.
0.35	56.15	Strata of the middle Conemaugh Group exposed on both sides of the road.
0.95	57.10	Ramp to Allegheny Valley Service Plaza. Continue east on Turnpike.
7.60	64.70	Exit 6 to Pittsburgh. Continue east on Turnpike.
7.30	72.00	Former Pleasant Valley Service Plaza on left, now an auto auction facility.
3.95	75.95	Exit 7 to Irwin and Greensburg. Continue east on Turnpike.
7.45	83.40	Ramp to Hempfield Service Plaza. Continue east on Turnpike.
0.50	83.90	Bear right onto exit ramp to Exit 8.
0.50	84.40	Turnpike toll booth. Pay toll and proceed.
0.10	84.50	Bear left onto exit ramp to US 119.
0.25	84.75	Merge with traffic coming north from I-70. Roadcuts at this intersection expose the Brush Creek interval, including the coal and overlying marine shale.
0.25	85.00	Exit to US 119 southbound. Continue north and merge with northbound traffic on US 119.
0.85	85.85	Enter Youngwood.
0.85	86.70	Turn right onto Depot Street.

MILEAGE Int.	 Cum.	TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
0.10	86.80	Cross Conrail railroad tracks, then turn left onto access road to Conrail Industrial Park.
0.10	86.90	Turn left into dirt parking area and park.

STOP 3: MARINE FOSSILS IN THE BRUSH CREEK SHALES

The spoil piles on the side of the lot nearest the industrial park offices contain some very fossiliferous Pennsylvanian rocks of the Brush Creek interval. The Brush Creek is the oldest of six marine zones in the Glenshaw Formation, and second only to the Ames Limestone in diversity and abundance of invertebrate fossils. This locality is particularly interesting and important because of an unusual abundance of fossils, many preserved in life position. Clams, snails, and scaphopods, among other invertebrates, died suddenly while earning their daily living on the sea bottom at this locality, their shells encased in the organic-rich mudrocks for 290 million years. It will not be difficult to find the spoil piles; the Brush Creek has a noticeably salt-and-pepper aspect to it here, due to preservation of original shell material in the mollusc (clam and snail) shells.

Fossil enthusiasts will also be interested to note that numerous specimens of the tiny brittle-star, *Syntomospina*, have been found at this locality.

The clam Astartella, which measures less than 3/4 inch in the longest dimension, dominates the fauna at Youngwood. Thousands of specimens can be collected within the space of a half hour; needless to say, the discriminating collector tends to become very selective in a very short time. Whole and broken clam shells occur with other fossils in jumbled masses, apparently postmortem assemblages accumulated in sediment pockets during storms. Complete, uncrushed, and unbroken specimens of Astartella occur throughout the rock, however, standing in life position almost perpendicular to the bedding of the shale. Numerous specimens of complete snail shells can also be found in life position, their shells oriented upright in the rock. Although scaphopods are relatively rare at this locality, those specimens of Plagioglypta that were collected were also found in life position, with the shell oriented at a low angle to the rock layers.

Why are so many of the fossils at this locality found in life positions? This phenomenon was probably due to a combination of rapid death and lack of sediment disturbance, due to oxygen depletion in the water and bottom muds, and quick burial, due to rapid sediment influx. These are common occurrences even today in such coastal areas as Texas and Louisiana. The Brush Creek typically consists mostly of mudrocks having relatively high organic content. Aragonite, a form of calcium carbonate that most molluscs use to form their shells, is unstable under normal conditions; it tends either to recrystallize to the more stable mineral form, calcite, or dissolve completely after burial.

In unusual cases, however, such as in some Brush Creek localities where the rock has a high organic content, the aragonite may be preserved in its original form and structure. Then when the fossil shells are exposed to weathering, the aragonite turns chalky, producing the noticeable salt-and-pepper aspect of the rock.

The spoil piles are refuse from excavations made in the hillside on the other side of the buildings to the east. The outcrop itself is in the warehouse yard of Bell Telephone, and access is understandably restricted.

MILEAGE		**TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY**
Int.	**Cum.**	
0.05	86.95	Exit Stop 3 and return to Depot Street.
0.20	87.15	Cross Conrail railroad tracks and Third Street (US 119 northbound), then turn left onto Fourth Street (US 119 southbound).
0.85	88.00	Leave Youngwood.
0.25	88.25	Exit to US 119 southbound. Continue straight toward the Turnpike and I-70.
0.60	88.85	Bear right onto entrance ramp to Turnpike.
0.45	89.30	Turnpike toll booth. Take ticket and proceed.
0.00	89.30	Bear right onto westbound entrance ramp to Pittsburgh and Ohio, and merge with traffic.
8.00	97.30	Exit 7 to Irwin and East McKeesport. Continue west on Turnpike.
0.20	97.50	Roadcut on the right exposes strata of the upper Monongahela and lower Dunkard groups. The Waynesburg coal, the boundary bed, occurs in three benches.
1.40	98.90	Roadcut on both sides of the road expose shales, sandstones, and nonmarine limestones of the Monongahela Group.
5.70	104.60	Roadcut on right exposes Brush Creek shale and overlying sandstones.
4.00	108.60	Bear right onto exit ramp at Exit 6 to Pittsburgh.
0.50	109.10	Turnpike toll booth. Pay toll and proceed.
0.10	109.20	Bear left onto exit ramp to Monroeville and Parkway East.
0.25	109.45	Bear right onto westbound lane of Parkway East and merge with traffic.
3.15	112.60	Outcrop of Pittsburgh coal and adjacent strata on both sides of highway.
0.70	113.30	Exit 15 to Penn Hills. Continue west on Parkway.
0.90	114.20	Exit 13 to Churchill. Continue west on Parkway.
1.40	115.60	Exit 11 to Wilkinsburg. Continue west on Parkway East.
0.30	115.90	Pittsburgh sandstone of the Pittsburgh Formation exposed in roadcut on right. To the left, along the eastbound entrance ramp, you can see the Pittsburgh coal and some

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	Cum.	
		collapse structures in the overlying rocks due to mine subsidence.
1.30	117.20	Exit 9 to Swissvale and Edgewood. Continue west on Parkway.
0.20	117.40	Red beds exposed in hillside to the left. The Ames Limestone is also supposed to be here, but it apparently is covered by vegetation.
1.25	118.65	Eastern portal of the Squirrel Hill Tunnels. The hill to the left is a large slag dump.
0.85	119.50	Western portal of the Squirrel Hill Tunnels.
0.10	119.60	Exit Exit 8 to Squirrel Hill and Homestead. Continue west on the Parkway.
0.60	120.20	Birmingham shale, lower Casselman Formation exposed on the left and right.
0.65	120.85	Roadcuts along right side of the Parkway for the next 2.35 mi., from just beyond the Saline Street Bridge to the exit ramp at Second Avenue in downtown Pittsburgh, expose the middle Conemaugh Group strata, from the Pittsburgh red beds and Ames Limestone near road level to the Morgantown sandstone just below the Boulevard of the Allies at Duquesne University. Weathering of the red beds causes periodic rock falls of Ames Limestone in places. The Morgantown sandstone at the top of the cliff exhibits channel cut and fill features. These are best seen from the eastbound lanes of the Parkway and from Second Avenue.
0.40	121.25	Exit 7A to Oakland. Continue on west on Parkway.
0.20	121.45	Exit 7B to Glenwood. Continue west on Parkway.
0.55	122.00	Exit 6 to Boulevard of the Allies and Liberty Bridge. Continue west on the Parkway. Notice the flat area (part of South Side) across the Monongahela River to the left. This is the present-day floodplain of the river. Floodplains are not good places to build from the standpoint of geologic hazards (flooding). However, they are ideal for building because the foundation is easily excavated, the landscape is flat, and they are within easy reach of river transportation. Needless to say, socio-economics wins out over geology every time.
1.10	123.10	Exit 4 to Second Avenue. Continue west on Parkway.
0.40	123.50	Exit 3 to Grant Street. Continue west on Parkway.
0.55	124.05	Exit 2 to Stanwix Street. Continue west on Parkway.
0.25	124.30	Cross Monongahela River on Fort Pitt Bridge.
0.35	124.65	Northern portal of Fort Pitt Tunnels. The tunnels were excavated out of Casselman Formation strata, mostly Morgantown sandstone, on Mt. Washington. Were it not for

MILEAGE		TRIP ROUTE AND REMARKS ON ROADSIDE GEOLOGY
Int.	**Cum.**	
		the vegetation, you could see a complete section of the Casselman, and a portion of the overlying Pittsburgh Formation, exposed on the hillside. The Ames Limestone crops out about road level on Carson Street below the bridge. The mostly mined-out Pittsburgh coal crops out along the McCardle Roadway almost directly above the tunnels.
0.70	125.35	Southern portal of Fort Pitt Tunnels. Notice the Morgantown sandstone in the cliffs.
0.55	125.90	Exit 6 to Banksville Road. Continue west on Parkway.
0.60	126.50	Bear right onto exit ramp at Exit 5 to Parkway Center Drive.
0.35	126.85	Turn right onto mall access road.
0.10	126.95	Turn left into parking lot of Parkway Center Mall.
0.05	127.00	**FIELD TRIP ENDS**. Have a good day, and happy fossil hunting in the future.