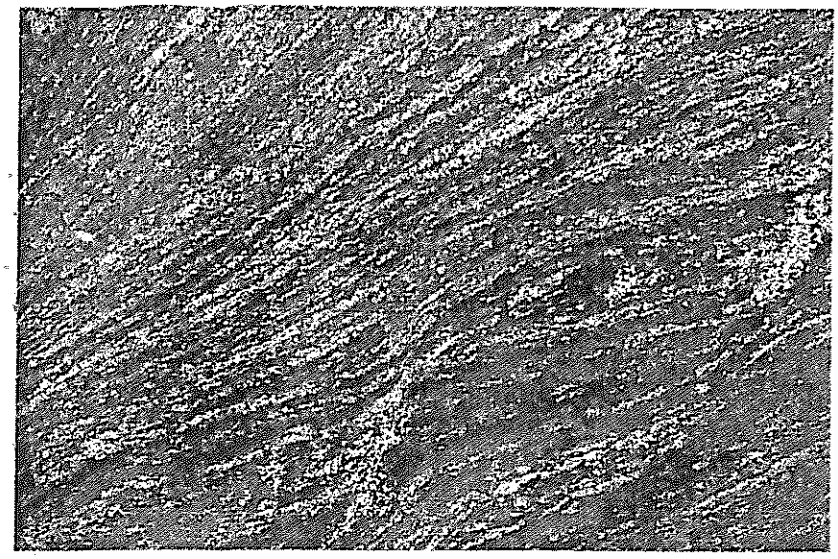
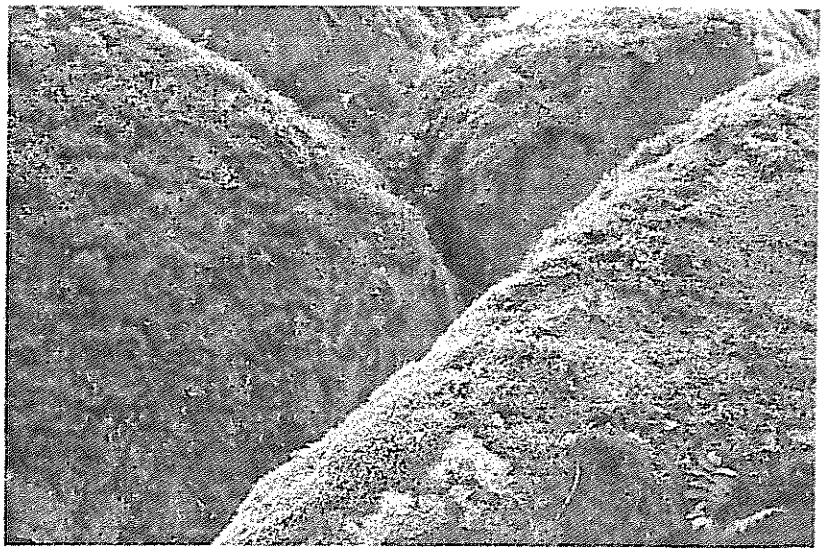


JERI JONES
1997

GEOLOGIC GUIDE TO THE PIGEON HILLS



INTRODUCTION

This field trip is specifically designed to grasp a general understanding of the geology of the Pigeon Hills, York County, Pennsylvania. By no means is this guide expected to provide all of the information known geologically about the area. It will introduce the reader to the area from the eyes of an Earth Scientist and, hopefully, answer some questions the reader may have.

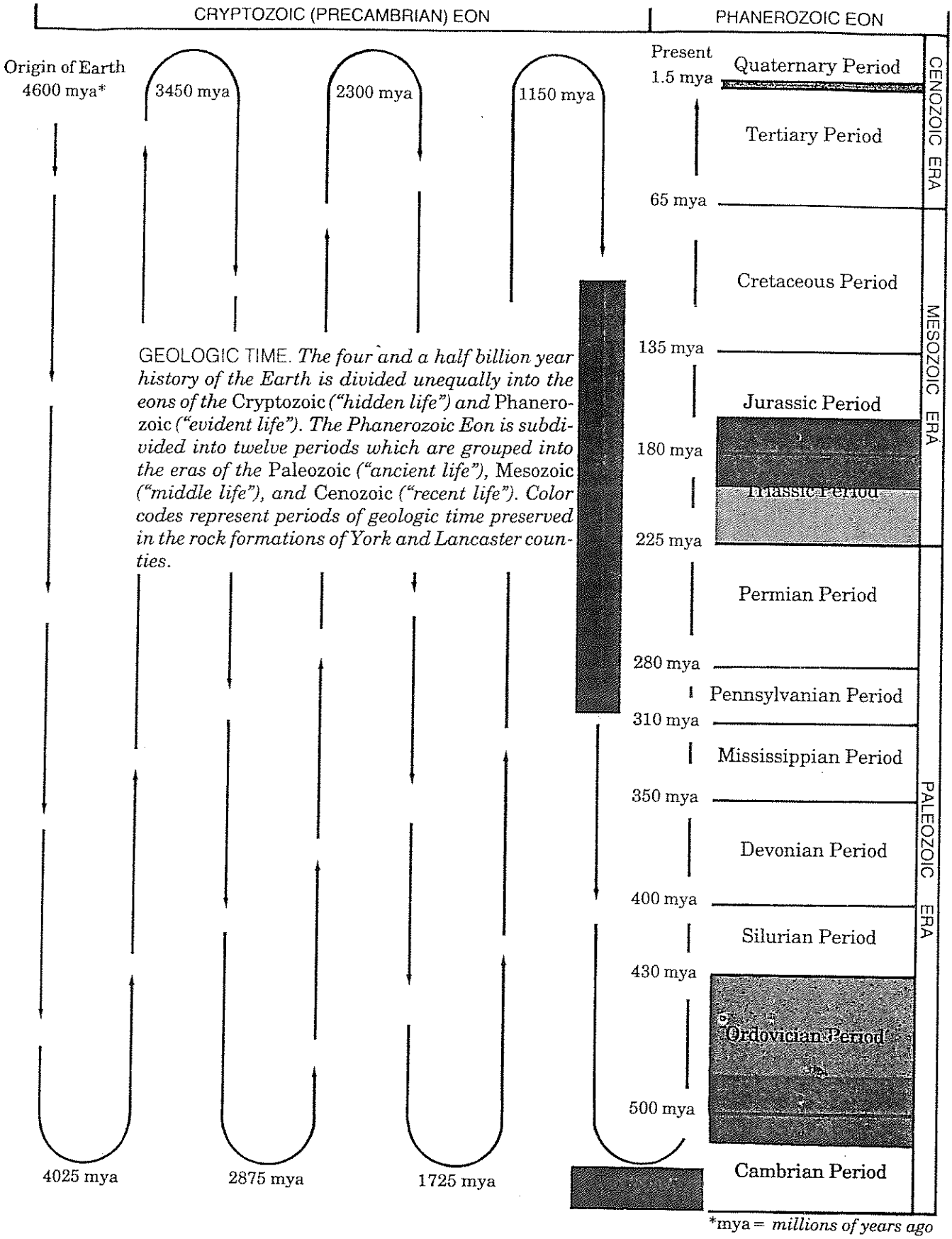
REGIONAL SETTING

The Pigeon Hills is only a small part of the total picture of the regional geology. Depending upon what scale the reader is using, the Pigeon Hills are just a piece of a puzzle of the geology of York County, Pennsylvania, United States or the world. Any geologist trying to place all of the pieces of the puzzle together must consider each piece carefully.

The Pigeon Hills is one of two **highland** areas in York County, lying within the **Conestoga Valley Section** of the **Piedmont physiographic province**. The other similar highlands areas are the Hellam Hills located east of York. To the south of this section is the Upland section composed of **metamorphic** rocks. To the north, the Pigeon Hills are butted against the **Triassic Lowlands Section**, a part of which will be examined at the end of this tour.

Most of the Conestoga Valley section is underlain by **sedimentary** rocks such as **shale, limestone** and **dolomite**. Of course these **carbonate** rocks are quarried throughout the county for a wide array of purposes. These rocks are generally **550 - 450 million** years old.

Rocks found in the Pigeon Hills are composed of mostly **metamorphic** rocks. **Metabasalt** is not only the oldest rock in the Pigeon Hills, but in York County as well. This rock which was once volcanic lava is **820 million** years old. Yes, indeed, we had volcanoes in the area during **Precambrian** times. Overlying the **basalts** are the **Chickies Formation (quartzite), Harpers Formation (phyllites** and **shales),** and the **Anteitam Foundation (quartzites** and **sandstone).** These three formations are approximately **600 - 550 million** years old.



GEOLOGIC TIME. *The four and a half billion year history of the Earth is divided unequally into the eons of the* Cryptozoic *("hidden life") and* Phanerozoic *("evident life"). The Phanerozoic Eon is subdivided into twelve periods which are grouped into the eras of the* Paleozoic *("ancient life"),* Mesozoic *("middle life"), and* Cenozoic *("recent life"). Color codes represent periods of geologic time preserved in the rock formations of York and Lancaster counties.*

STOPS ON TOUR

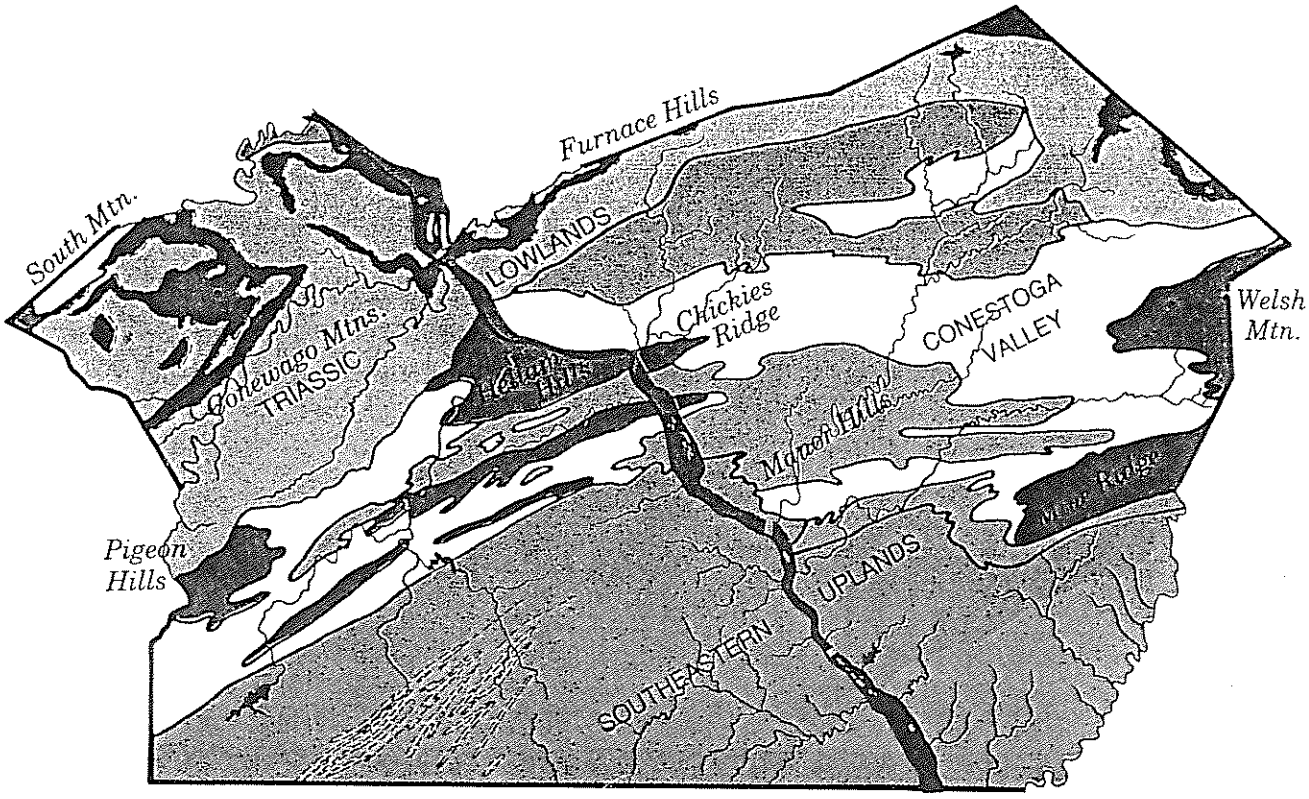
The surrounding **limestone valley** has a general elevation of 400 to 600 feet above sea level. General elevations in the Pigeon Hills are 1000 - 1100 feet, while the highest point, located at **PULPIT ROCK** is 1240 feet above sea level. Sounding high, this is the second highest elevation in the county -- the highest point of 1320 feet is found at **Stone Head** in the South Mountains (also known as the northern limb of the Blue Ridge Mountains) northwest of Dillsburg.

Due to the role of **plate tectonics** in this area over the past **1 billion** years, most of the rocks in the area have been heated and placed under pressure **(metamorphism)**, broken **(faulted)**, and bent either up or down **(folded)**. The rocks in the Pigeon Hills have been heavily **metamorphosed**, **faulted**, and **folded.** Because of the lack of continuous rock exposures, folding is difficult to detect by the untrained eye. The fact that these rocks have clearly changed their mineral content and/or texture, tells us that a high degree of heat and pressure affected these rocks. Again because of poor exposures, faulting can be detected more from **topographic** expression. Because faulted rocks have become **fragmented**, they are weathered and eroded away faster than a "normal" rock. This pressure often allows for long, narrows valleys and stream channels to develop and mark faults.

FIELD STOPS

Stop #1 -- *GLATCO LAKE -- Glatco Road (E. Haldeman & CO. bank)*

Imagine being here **120 years** ago when this lake was a striving iron mine. Chances were good if you lived in the area back then, you were either personally connected or somehow related to a **mine, furnace** or **foundry.** At its peak around **1874**, York county had **170 iron mines, six furnaces** (which were drawing to a close) and **numerous foundries.** The Pigeon Hills contained approximately **20** iron mines, all of which were located on the southern slope of the ridge. Most of the mining operation took place between **1850** and **1880.** All of the deposits mined **Limonite** (an iron-oxide mineral). Most of the ore was mined out of the ground, lying loose, not requiring "hard rock" mining, but **washing**. The ore was either hauled by a narrow gauge railroad or cart to Smith's Station or Kauffman's siding, near Jacob's Mill.



Precambrian

Anorthosite, Granite Gneiss, Conglomerate, Shale, Quartzite, Phyllite.

Cambrian

Quartzite, Sandstone, Shale, Limestone, Dolomite.

Cambrian/Ordovician

Schist, Marble.

Ordovician

Schist, Slate, Limestone, Dolomite.

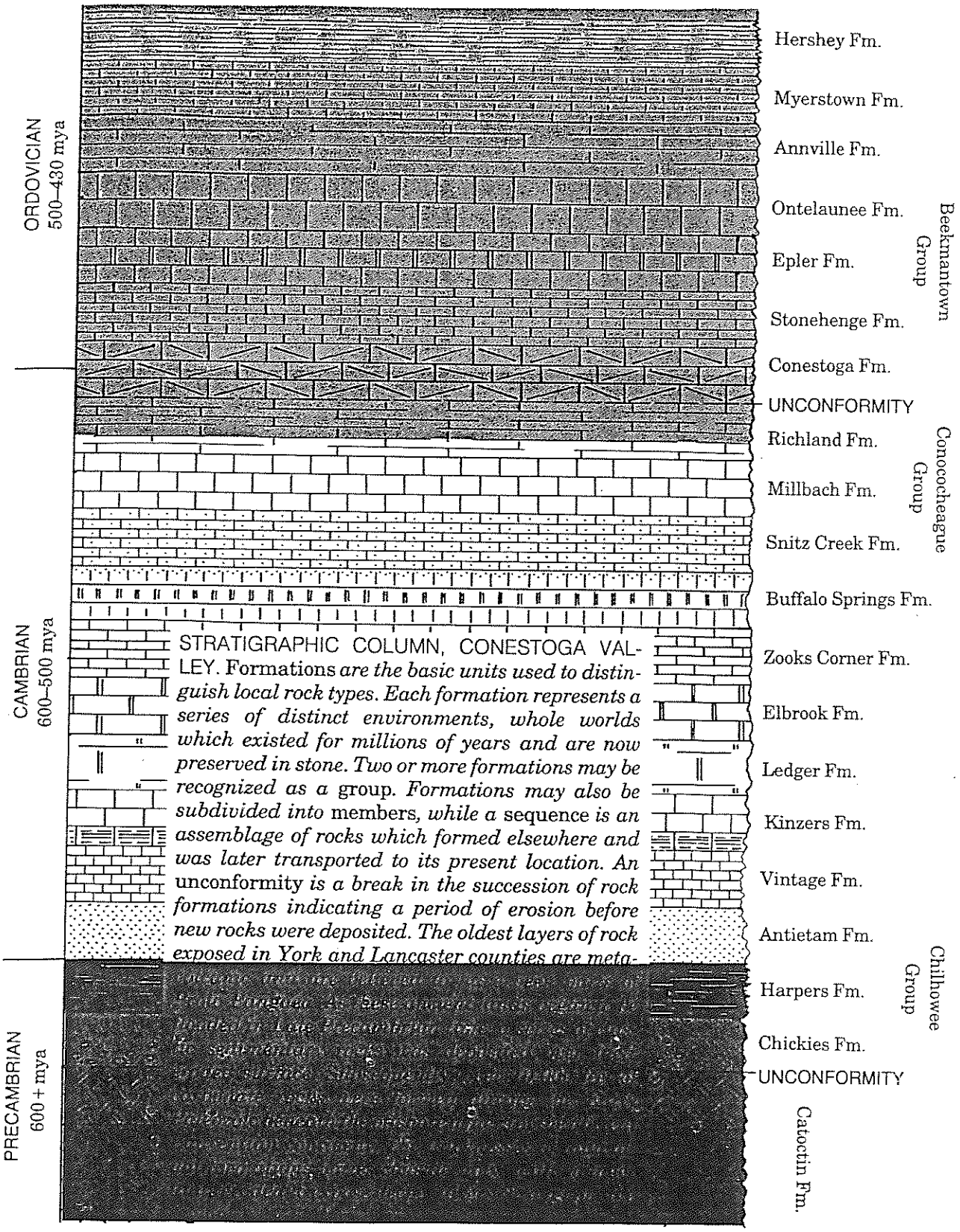
Triassic

Shale, Sandstone, Conglomerate, Diabase, Hornfels

Triassic/Jurassic

Diabase, Hornfels.

GEOLOGIC MAP OF YORK AND LANCASTER COUNTIES.

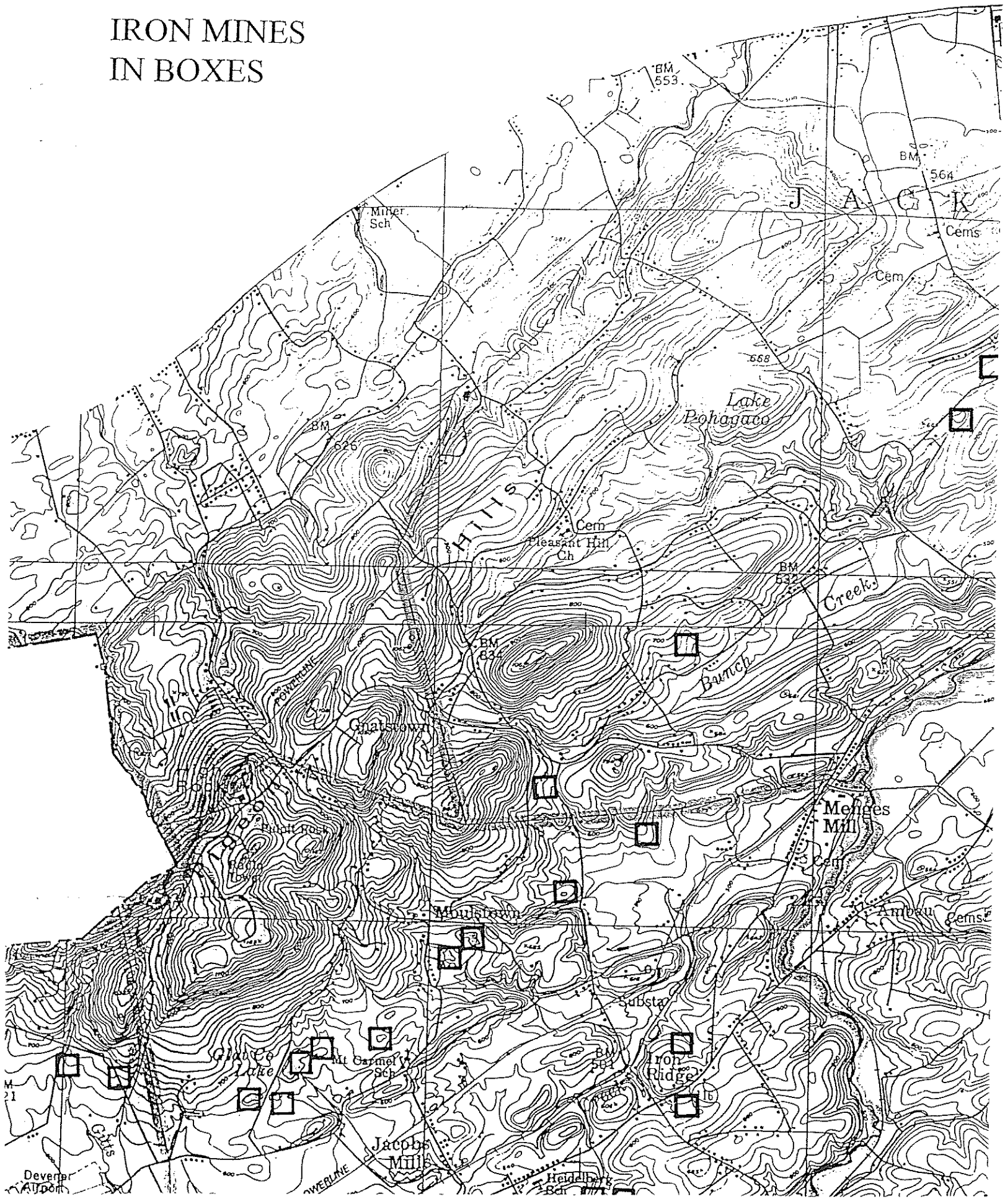


STRATIGRAPHIC COLUMN, CONESTOGA VALLEY. Formations *are the basic units used to distinguish local rock types. Each formation represents a series of distinct environments, whole worlds which existed for millions of years and are now preserved in stone. Two or more formations may be recognized as a* group. *Formations may also be subdivided into* members, *while a* sequence *is an assemblage of rocks which formed elsewhere and was later transported to its present location. An* unconformity *is a break in the succession of rock formations indicating a period of erosion before new rocks were deposited. The oldest layers of rock exposed in York and Lancaster counties are meta-*

APPENDIX A: ROCK FORMATIONS OF YORK AND LANCASTER COUNTIES

NAME	ROCK TYPE	AGE	REFERENCE LOCALITY	APPROXIMATE THICKNESS
Annville Fm.	Limestone	Ord	Annville, Lebanon Co.	250′
Antietam Fm.	Quartzite	C	Antietam Creek, Md.	300′
Beekmantown Grp.	Limestone, Dolomite	Ord	Berks Co.	2,300′
Buffalo Springs Fm.	Limestone, Dolomite	C	Buffalo Springs, Lebanon Co.	1,000′
Cardiff Fm.	Conglomerate, Quartzite	Ord	Peach Bottom, Lancaster Co.	200′
Catoctin Fm.	Metarhyolite, Metabasalt, Greenstone	PC	South Mtn. York-Adams Co.'s	?
Chickies Fm.				
Hellam Mem.	Conglomerate	PC	Hellam Hills, York Co.	600′
Chickies Quartzite	Quartzite	PC	Chickies Rock, Lancaster Co.	400′
Cocalico Fm.	Sandstone, Shale	Ord	Cocalico Creek, Lancaster Co.	2,000′
Conestoga Fm.	Limestone	Ord	Conestoga River, Lancaster Co.	300′
Elbrook Fm.	Limestone, Dolomite	C	Elbrook, Franklin Co.	3,000′
Epler Fm.	Limestone, Dolomite	Ord	Richland, Lebanon Co.	1,000′
Gettysburg Fm.	Shale, Sandstone, Diabase	Tri	Gettysburg, Adams Co.	16,000′
Gettysburg Fm.				
Congl. Mem.	Conglomerate	Tri	Conewago Mountain, York Co.	7,300′
Heidlersburg Mem.	Sandstone, Shale	Tri	Heidlersburg, Adams Co.	4,800′
Hammer Creek Fm.	Sandstone, Shale	Tri	Hammer Creek, Lebanon Co.	9,360′
Harpers Fm.	Phyllite	PC	New Providence, Lancaster Co.	1,500′
Hershey Fm.	Limestone	Ord	Stouchsburg, Berks Co.	1,000′
Kinzers Fm.	Shale, Limestone	C	Kinzers, Lancaster Co.	150′
Ledger Fm.	Dolomite	C	Ledger, Lancaster Co.	2,000′
Myerstown Fm.	Limestone	Ord	Millardsville, Lebanon Co.	220′
New Oxford Fm.	Conglomerate, Shale, Sandstone	Tri	New Oxford, Adams Co.	4,000′
Peach Bottom Fm.	Slate, Schist	Ord	Delta, York Co.	1,000′
Peters Creek Fm.	Schist	Ord	Peters Creek, Lancaster Co.	2,000′
Schaefferstown Fm.	Limestone	C	Schaefferstown, Lebanon Co.	300′
Tomstown Fm.	Dolomite	C	Tomstown, Franklin Co.	1,000′
Vintage Fm.	Dolomite	C	Vintage, Lancaster Co.	650′
Wissahickon Fm.	Schist, Metabasalt	C-Ord	Southern York-Lancaster Co.'s Wissahickon Creek, Philadelphia	10,000′
Zooks Corner Fm.	Limestone, Dolomite	C	Zooks Corner, Lancaster Co.	1,600′
Zullinger Fm.	Limestone, Dolomite	C	Waynesboro, Franklin Co.	2,500′

IRON MINES IN BOXES



The following is taken from "**IRON ORE BELTS OF ADAMS AND YORK COUNTIES**" by **Persifor Frazer** written in **1876** concerning the E. Haldeman & Co. bank:

> "It was opened in 1870 by J. Drittenhafer of Hanover and is now worked by E. Haldeman & Co. There are eight feet of stripping before reaching the ore. There are three cars at work, which are intended to put out thirty tons of ore per day. The bank covers perhaps one-half acre. Eighteen men are employed eleven hours per day at $1.10, or nine to ten cents per car load of dirt and ore. Sixty-six per cent is wash ore. He can work 600 tons per month of 25 working days."
>
> "It *(the iron ore)* is used at Chickies Furnace in Lancaster County in small quantities as admixture with Cornwall and Chestnut Hill ore, for foundry iron."
>
> "Twenty-five tons of ore per day are shipped at Smith's Station, Hanover Branch railroad. The bank is now 45 feet deep and the only trouble is from the scarcity of water."

An analysis of the ore compiled by one Mr. M'Creath is as follows:

metallic iron	**43.000%**
metallic manganese	**3.878%**
sulphur	**0.094%**
phosphorus	**0.672%**

Located immediately to the east and actually connecting with this bank was Bechtel's;'s Bank. When operating in the 1860's, this bank covered four acres. In 1876 this bank was not operating.

These two banks, as most in the Pigeon Hills, are found to be in the **Antietam Foundation.**

Stop #2 -- *GROUND WATER AND SPRINGS (Moulstown Road)*

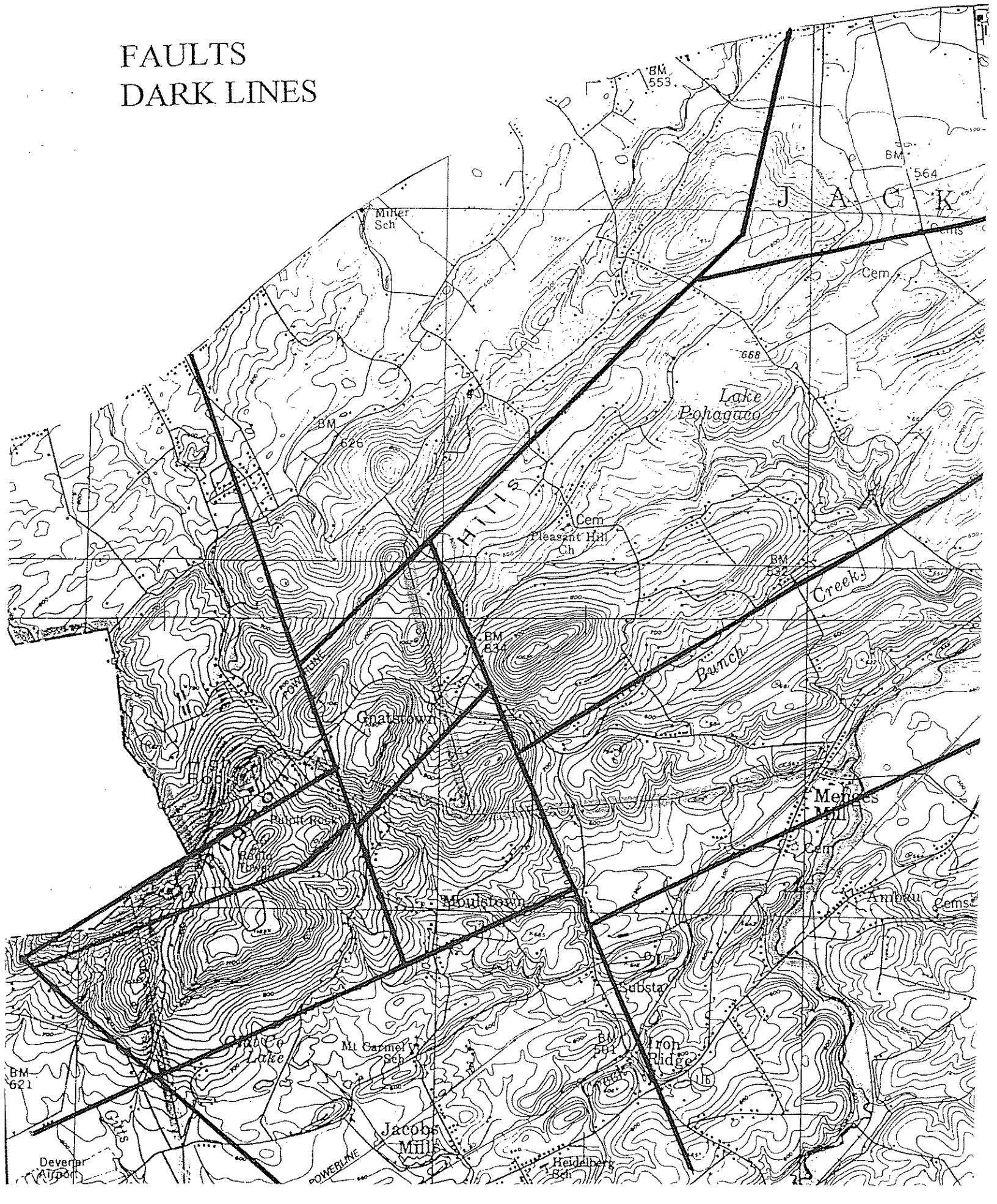
Ground water is found everywhere beneath the Earth's surface. In most cases, the ground water surface reflects the **topographic expression**. Several characteristics of bedrock depend on how ground water flows through the Earth's crust. **Porosity** is the percentage of pore space in a rock. This pore space allows water to flow through the rock. For example, **sandstone,** which has rounded **quartz grains** naturally cemented together, has better porosity than **granite.** Granite is composed mostly of **feldspar** and **quartz crystals** intergrown together.

The second characteristic is **permeability**, the ability for a rock to transmit fluid through itself. If a rock, like **sandstone**, has uniform grain size, this rock would most likely have a better permeability than say a rock like a **conglomerate**. A conglomerate contains various sized particles from anything above 2.5 inches to as small as sand-sized grains. In this case, the water will have to find its way through the pores instead of simply following a "tunnel" through the rock.

When ground water intersects the surface, we know this as a **"Spring".** In this case, this spring is located in the **Chickies Formation.** The rock is predominantly **quartzite (Metamorphosed sandstone).** The rock generally has good permeability and good porosity. Most springs found in the Pigeon Hills are actually found along **faults**, a natural crack in the rock which ground water follows.

For many years, people thought that since ground water was flowing directly out of the Earth, this is the purest water around. Recent generations however, have asked an important question -- "Where is this water coming from?". As far as we know (if one is not familiar with the area) there could be a landfill toward the top of the hill or perhaps an uranium deposit in the hill. *"PURE WATER?"* -- you make the decision! This is the reason why many of these "road side" springs are being capped off. Testing of the water from these springs by government officials are finding **nitrates** and **heavy mineral** content in the water.

FAULTS
DARK LINES



Stop #3 --*PULPIT ROCK AREA -- High Road*

This stop brings us close to the highest elevation in the Pigeon Hills. At an elevation of **1240** feet, we are at the second highest point in York county. From this point down to Stop #1 at Glatco Lake is a difference of **560** feet in elevation. The difference of elevation from one point to another is known as **relief**.

The rock exposed here is the **Chickies Formation**. Named from the famous Chickies Rock in Lancaster county, the age of this rock is **600 million** years old, one of the oldest **sedimentary** rocks in the state. Once **sandstone**, the **quartzite** here has been through several periods of **metamorphism.** With each period, the **quartz grains** in the original **sandstone** were melted and enlarged. For example, 4 quartz grains welded together will produce one large grain. This thermal process produces a coarse-grained rock which means you can easily see the grains with the naked eye.

Fossils found within this formation tell a geologist about the environment in which the rock was originally formed. **Scolithus tubes** are evidence of a **worm** that once lived in an ancient ocean in the **intra-tidal** area. (An area that experienced abundant wave action.) Although the actual organism has never been found, we see the burrow it made in the sand. Because the Scolithus had a short life span (**20 - 30 million years**), these fossils are known as an **index fossil** -- meaning any rock they are found in are **600 - 570 million years old.**

As one stands on the top of the mountain, try to understand what our landscape has gone through over the last **150 million years**. From the time of the last **tectonic** event (**mountain forming**), only two natural processes have affected our landscape -- **weathering** and **erosion**. It is true that the climate has changed considerably over the millions of years including the "Great Ice Age" during the **Pliocene** and **Pleistocene** periods.

Anyway, the reason why we have ridges and valleys in this area is due to weathering and erosion. The rocks are broken down through weathering and transported by erosion. Softer rocks composing the valleys, weather and erode faster than rocks underlying the ridges. For example, the **quartzite** and

) high temperature and/or pressure, the composition and texture of the rock will be to produce a distinct new type of rock.

selves into light and dark bands, proc "layered" appearance known as *foliation*. ible layering, not to be mistaken for beddi

METAMORPHIC ROCKS.

Original Rock *Mineral Components*	Metamorphic Rock *Increasing Temperature and/or Pressure*			
Clays, Shales *(Mica, Quartz)*	Phyllite	Slate	Schist	Gneiss
Sandstones *(Quartz, Feldspar)*	Quartzite			
Basalts *(Plagioclase, Pyroxene)*	Greenschist	Amphibolite	Gneiss	
Limestones *(Calcite)*	Marble			

metabasalt underlie the Pigeon Hills while to the south in the valley, **sandstone, shale, phyllite** and **limestone** are found. Not only is this prominent in York county, but the famed Appalachian Mountains of central Pennsylvania are another classic example.

Stop #4 -- *METABASALT -- Beaver Creek Road*

Found here are the oldest rocks in the area. These **metabasalts** were at one time volcanic lava. Because of major shifting of the Earth's crust, weathering and other tectonic episodes, the actual **volcanic vent (cone)** cannot be found. These **basalts** have been dated by **uranium-strontium** at **820 million** years old and have been correlated with similar rocks in the Hellam Hills and the **Catoctin Formation** volcanic rocks found in the South Mountains west and south of here.

Today, these rocks are known as a **meta-basalt**. This means that like all of the rocks in the Pigeon Hills, these rocks have been changed with heat and pressure. In this case, the **mineral content** has been changed more than the **texture appearance**. The green color of the rock is mostly due to the mineral **chlorite.** Other minerals found in the rock include **epidote, hornblende, pyrozene** and minor **quartz**. Also, because of the **metamorphism** any signs of individual flow of lava have been destroyed. The layering appearance seen in this road cut is due to **metamorphism**. The minerals all aligned themselves on parallel planes giving the rock this appearance.

It is noteworthy that in the **metabasalts** of South Mountain, large **copper** deposits were mined from the late **1700's** into the early **1900's** near Fairfield, Adams County. Although small evidence of copper has been found in the rocks in the Hellam Hills, no such signs have been seen here.

Another interesting side note about the metabasalt. The writer of this guide has found **gold** washing out of the metabasalt not too far from this location. Seem strange, but approximately 15% of the streams in York County contain gold. The Pigeon Hills (northern slope only) is one of the newest additions to gold localities in the county. How large are the flakes? -- Try 1/8 - 3/16 of an inch. (Not enough to retire on!)

Stop #5 -- *NEW OXFORD CONGLOMERATE -- Route 194*

The final stop of the day is the youngest rock examined on our tour. We have now left the Pigeon Hills and actually are standing on the boundary between our "themes" region and the **Triassic Lowlands Section.** The word **Triassic** is a geologic period that lasted from **225 - 180 million years ago.** In Pennsylvania , the Triassic rocks formed at that time are found in a 10 - 20 mile wide section through southeastern Pennsylvania. Of course, the rocks don't terminate at the political borders but extend into surrounding states up and down the eastern seaboard.

As you stand here and face northwest, imagine being here 220 million years ago. The climate then was comparable to the Everglades Swamp in Florida. Picture a swamp environment with abundant vegetation, **(ferns, water plants, etc.)** and trees **(mostly palms and conifers)**. An occasional meandering stream and small tributaries are also seen. Also, with a little luck, you might see a reptilian-type "dinosaur" walking through the swamp. This is what the Triassic was like back then.

The Pigeon Hills were the highlands bordering the Triassic basin on the south while the Blue Ridge and Applachian Mountains bordered it to the north.. All of the drainage from torrent rainfall flowed off of these highlands into the basin.

That leads us into the rock located here. Known as a **conglomerate (sedimentary rock containing *rounded* pebbles),** this rock belongs to the **New Oxford Formation**, named after the Adams county borough. This **conglomerate** is the oldest rock within the Triassic Region. As one walks northwestward across the "basin", the rocks become younger in age. Upon close examination of the pebbles, many are composed of rocks found within the Pigeon Hills (**Chickies, Harpers** and **Antietam)**. Fragments of these rocks have been eroded into the basin by water and deposited in the sand. After at least several million years, this **sediment** with **pebbles lithified** (hardened) into the rock.

This particular exposure is one of the best for the New Oxford

Conglomerate in York County. **Layering** (also know as **bedding** or **stratification)** can be easily seen. Each layer has a particular story to tell about the environment that once existed here. For example, high water currents were able to transport larger sediment. A lesser water current could only carry fine-grained sediment.

If you were taking notice of the soil colors along this trip you have noticed a sudden change here at this stop. Triassic rocks produce a distinct greyish-brown sandy clay soil.