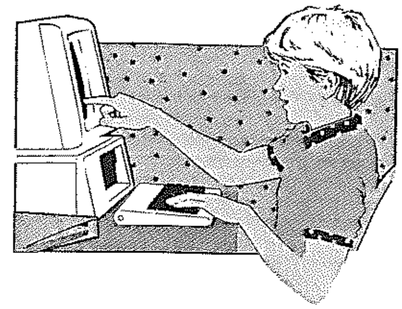
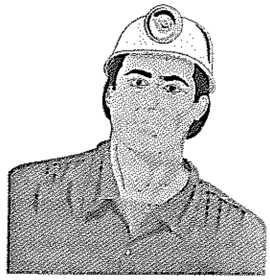
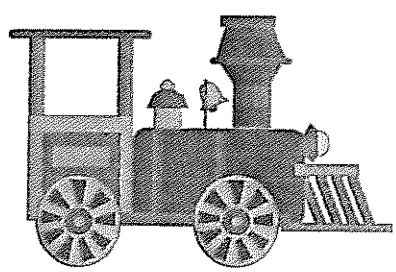
Mineral Resources of Adams County, Pennsylvania



Fieldtrip for Harrisburg Area Community College - Gettysburg Campus

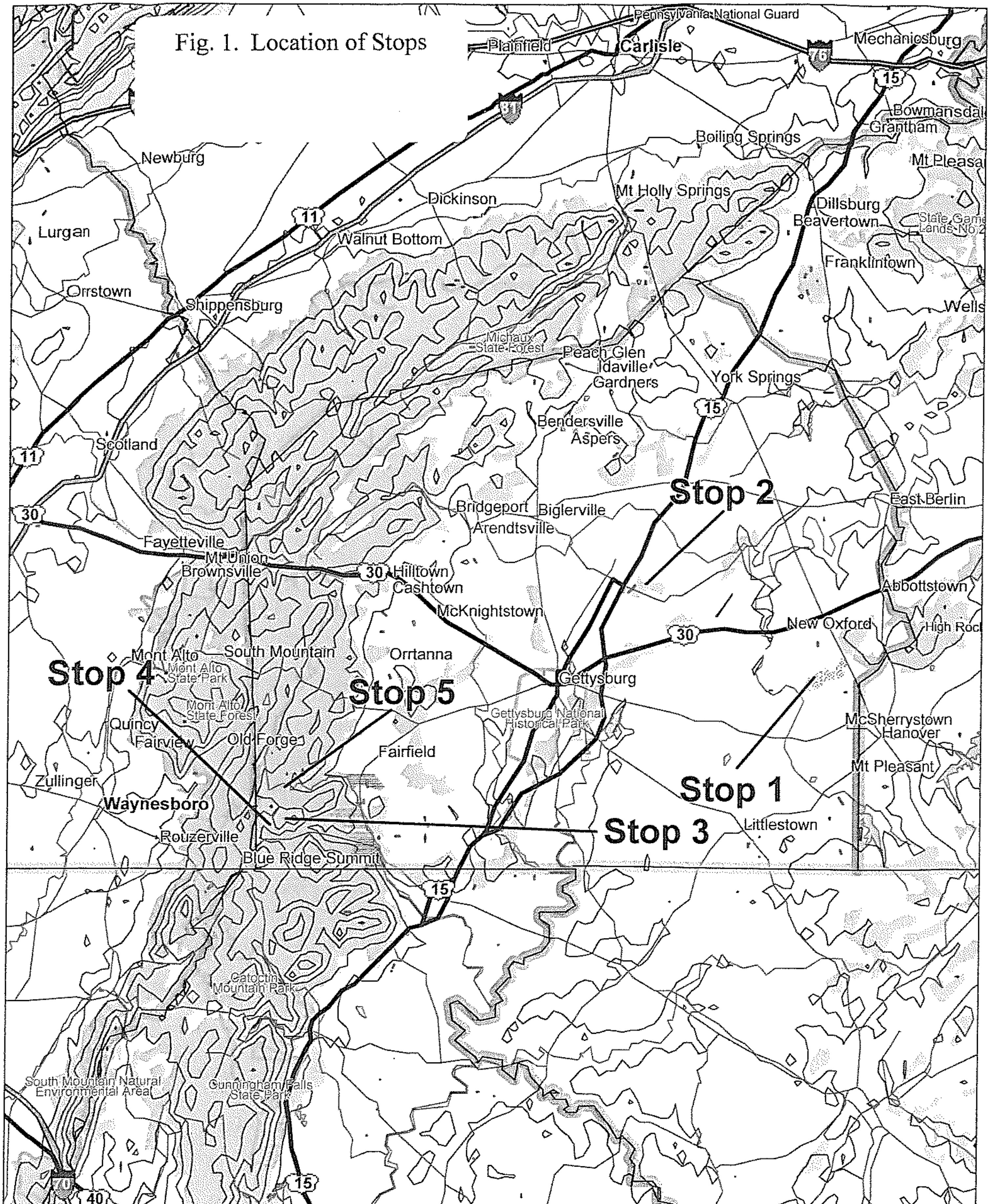
Continuing Education Program





by Jeri L. Jones, Jones Geological Services and G. Patrick Bowling, P.G.

April 20, 2002



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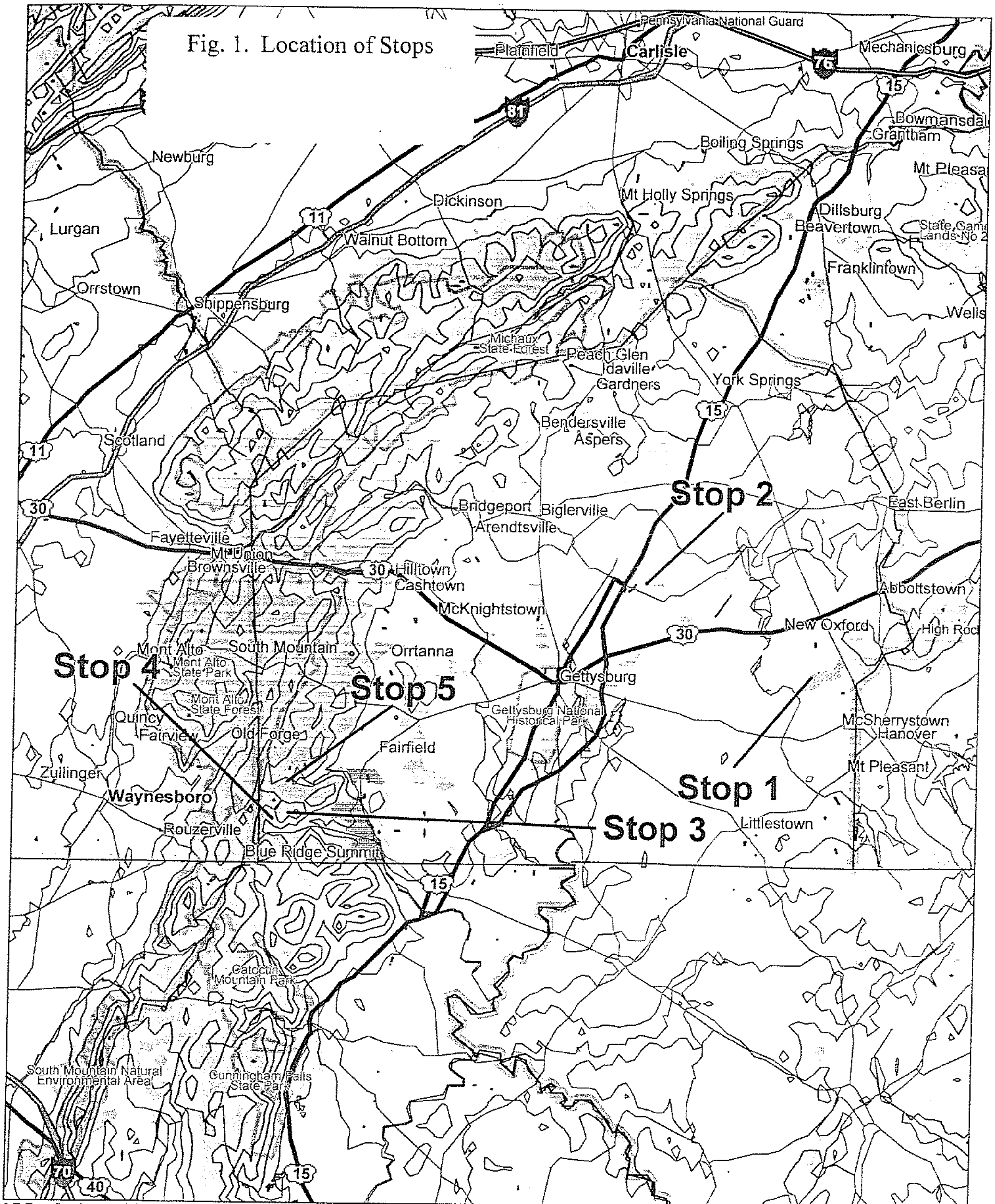

Fig. 1. Location of Stops

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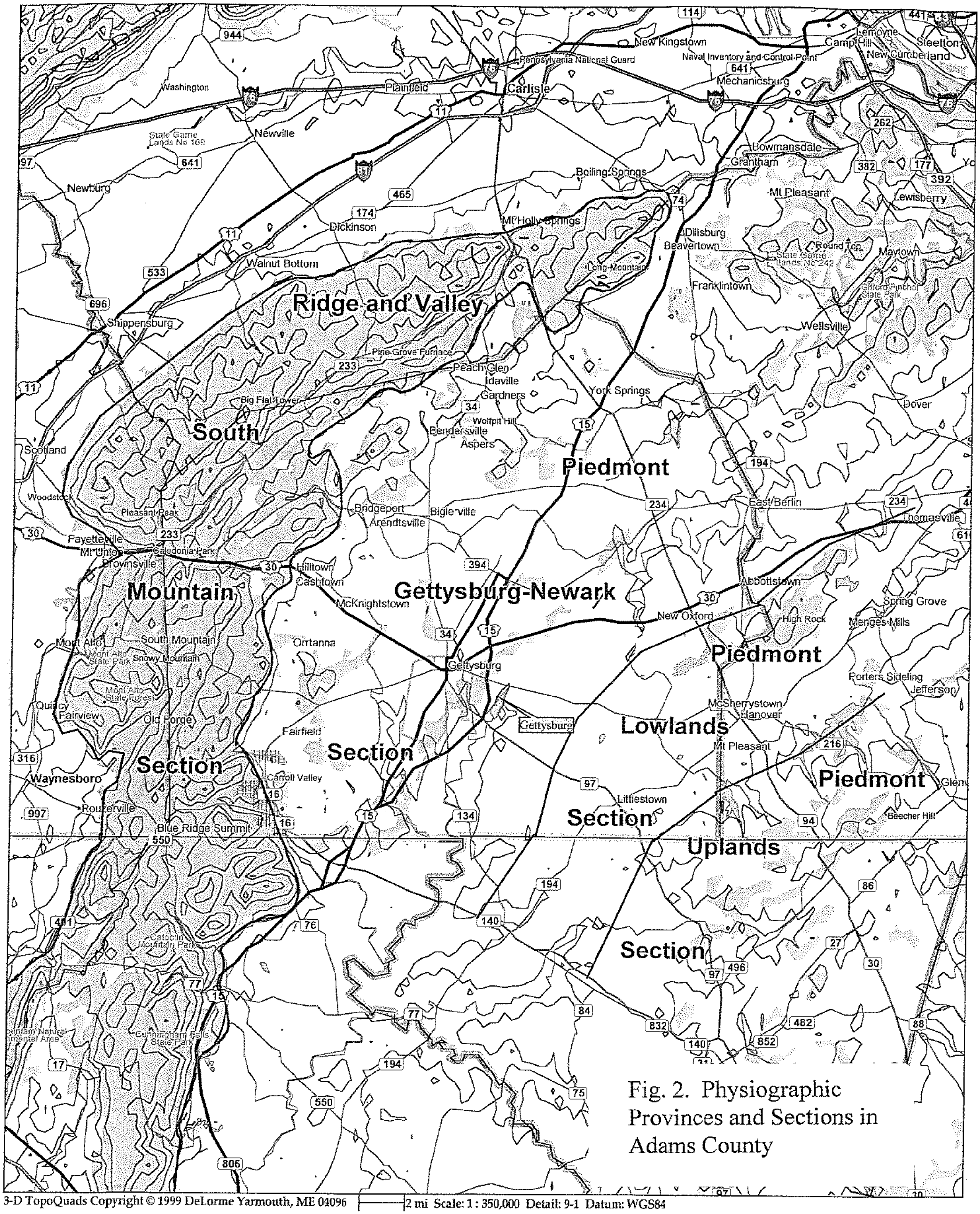

Fig. 2. Physiographic Provinces and Sections in Adams County

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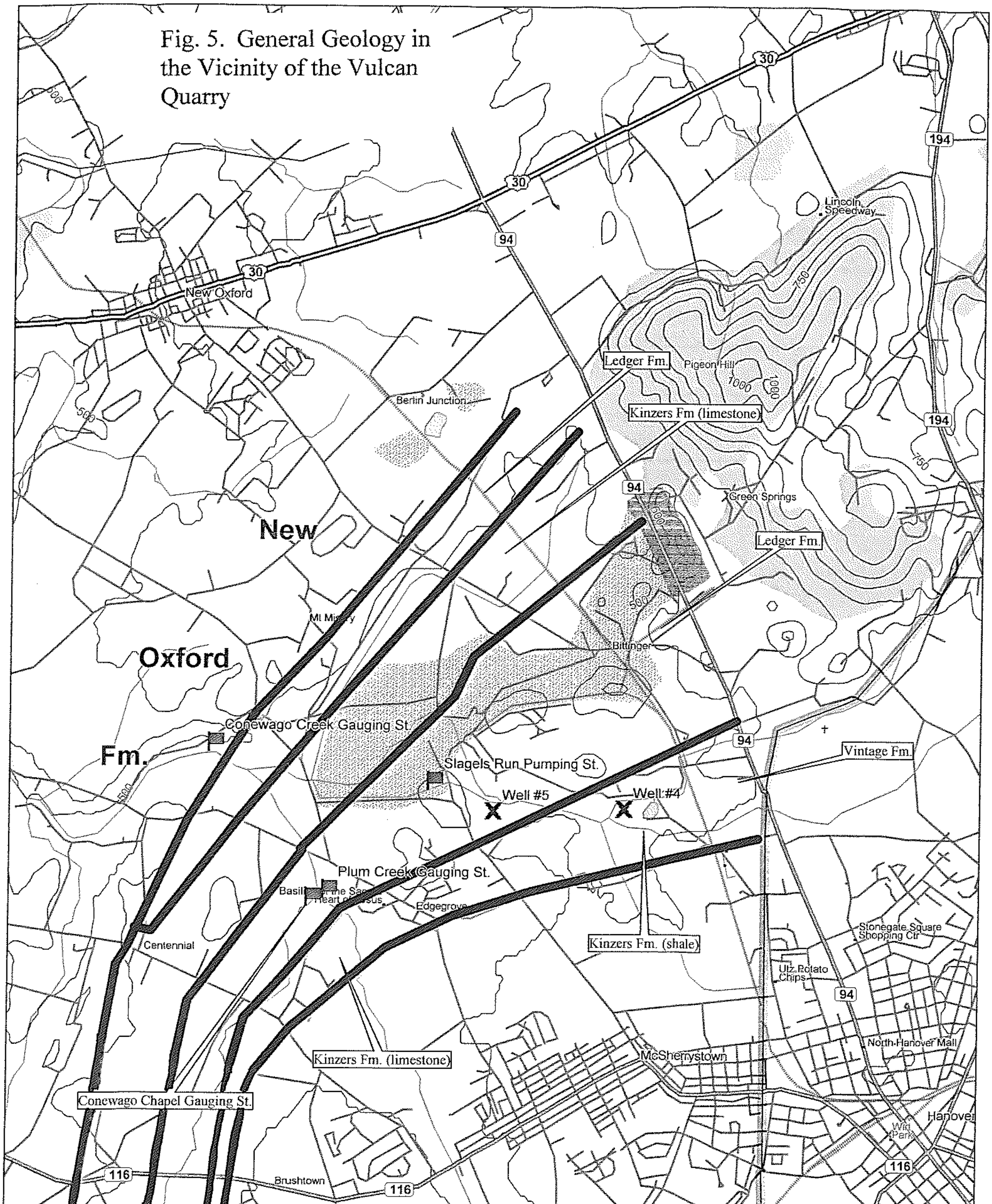

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Fig. 8. Sinkholes ("x") in the area of the Vulcan Quarry.

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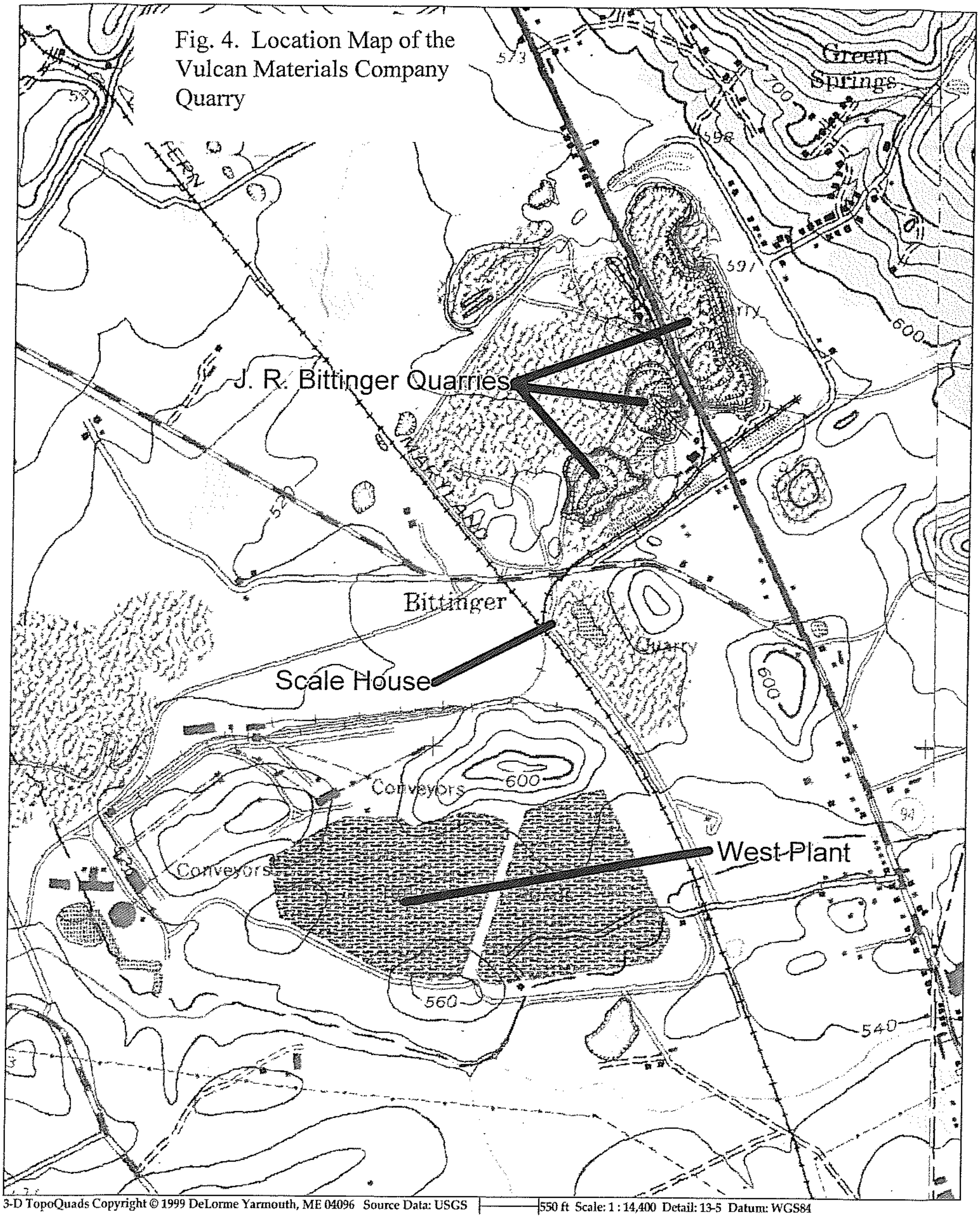
Fig. 4. Location Map of the
Vulcan Materials Company
Quarry
Green
Springs
J. R. Bittinger Quarries
Bittinger
Scale House
Conveyors
Conveyors
West Plant
600
600
560
540
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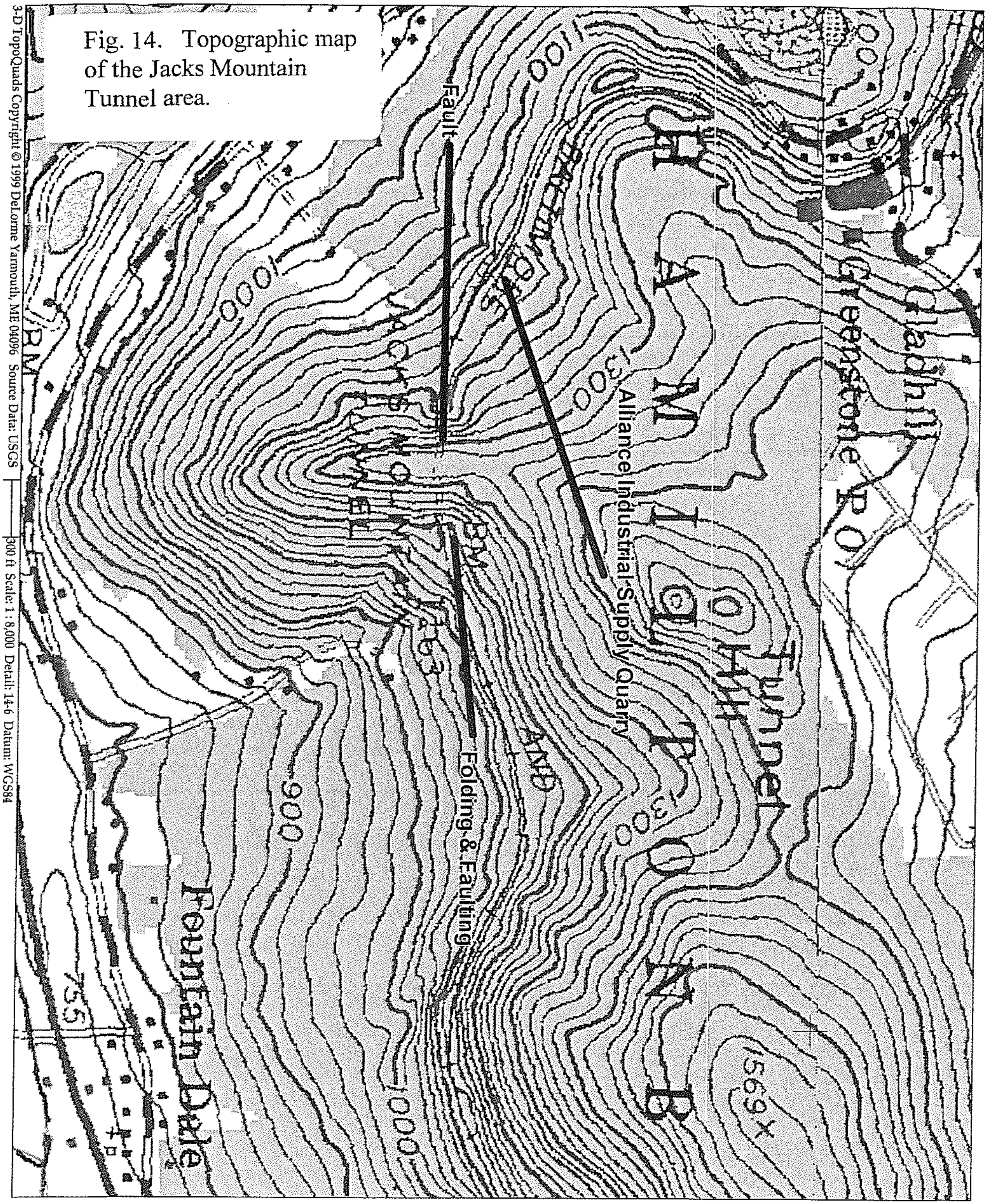

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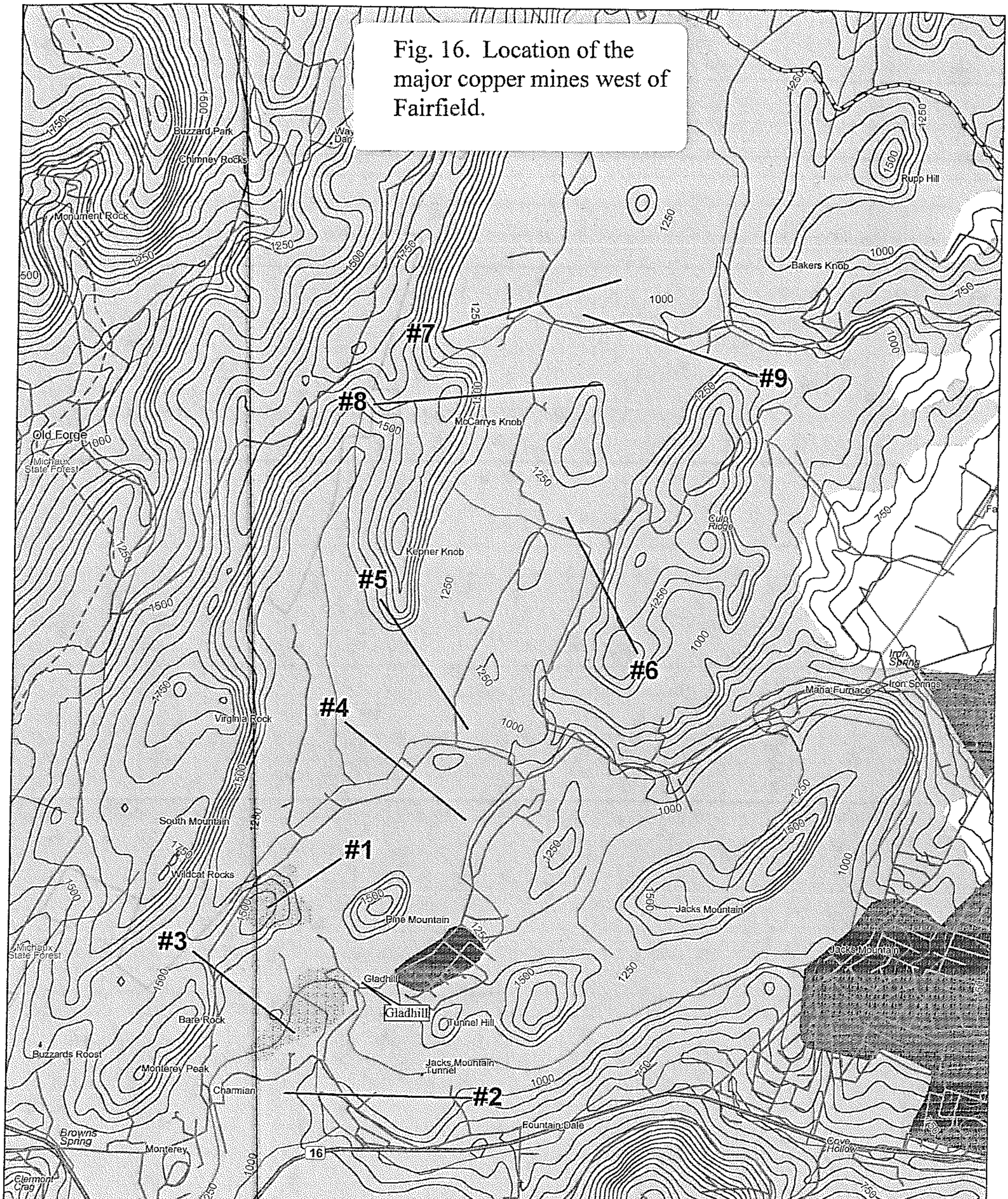

Fig. 16. Location of the major copper mines west of Fairfield.

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INTRODUCTION

Welcome to the fieldtrip "Mineral Resources of Adams County" presented by the Continuing Education Department of Harrisburg Area Community College - Gettysburg Campus. We will examine historic and present operations where raw material is being removed from the Earth. We hope your day with us will be both an educational and recreational experience as we travel throughout the county. We will be visiting three different regions in the County today: 1) Piedmont Lowlands Section (PLS) where we will examine one of the largest limestone/dolomite active quarries in the area; 2) Gettysburg-Newark Section of the Piedmont (GNS) to step back into time and see what was once a copper-gold producing mine, and; 3) South Mountain Section (SMS) of the Valley and Ridge province to examine the complexity of the area's geology, an active producer of roofing granules and now abandoned copper deposits. Please ask questions anytime since this is "your" trip. The co-leaders are here to supply you with information to satisfy your interests.

So, you want to study mineral resources and how they are extracted from the Earth and used in Adams County? Well, before we can go down the road any further, one has to know what we mean by a mineral resource.

Such deposits are quite valuable for our existence as you will come to learn. A mineral resource is best described as "valuable mineral deposits of an area that are presently recoverable and may be so in the future; including known ore bodies and potential ore" (Parker, 1997). This also includes past operations which once removed valuable rocks and/or minerals out of the ground. The evidence of such an operation has long disappeared due to the lack of upkeep and development. Examples of mineral resources span literally hundreds of types of rocks, minerals and petroleum products. Think about it for a moment, if it can not be grown in the soil, where does that product come from - out of the Earth. Nearly 90% of our materials we need to survive originate from the Earth. Construction materials for buildings and roads, raw materials to build items such as planes, trains and automobiles (yes, that was a movie), agricultural supplies, filler material for pet foods and artificial building products, glass, plastics, televisions, computer, jewelry, oil, gas, and coal are just some examples of what these mineral resources produce. Quickly, you see that we can not live without mineral resources.

Think about the ways that mineral resources are extracted from the Earth. Yep, the first way that comes to mind are quarries, sometimes referred to as open pits; Oh yes, how about underground workings, where miners work in very dirty environment in sometimes rather unstable conditions? An inclined or vertical tunnel is referred to as a shaft while a horizontal tunnel is an adit (or sometimes referred to as a drift).

We aren't quite finished; think about oil and gas. How are those products extracted? WELL, did you get it? Yes, the answer are wells where those agents are pumped very similar to ground water. OOPS, there is another resources we need to address - ground water. This topic will come up in our conversation today numerous times since we are all affected by ground water.

OK, so you got the idea. It is now time to roll and explore what resources were, are and might be extracted from the soils and rocks of Adams County. You might be amazed on what you learn today!

ABOUT THE LEADERS

JERI JONES - A native of York, Pennsylvania, Jeri received his B.S. in Geoarchaeology from Catawba College in Salisbury, North Carolina. He has been employed by the York County Parks for 23 years where he conducts a number of geologic programs. His interest in local geology has led to many research projects. His favorite topics include the Dillsburg Iron Mines, gold prospecting, iron mining history and earthquakes. Today he represents his other profession, Jones Geological Services, where he conducts research projects, educational programs or civic and scout groups or anyone else that will listen. He has also written numerous articles on local geology; the book "Whispering Hills" in 1989 and the recently released "Gold in Southeastern Pennsylvania" book. He has also narrated a three-part video series known as "TimeWalk" which has been distributed to area schools and shown on cable television. Jeri is married to the Rev. Lou Ann Jones, who is the minister at Bethel United Church of Christ near Hanover.

G. PATRICK BOWLING, P.G. - Having grown up in Gettysburg with a father who was keenly interested in the history of the battle, Pat was fascinated by Devil's Den and stories of dinosaur footprints on a battlefield bridge. As a result, he was drawn to the study of geology and received his B.S. from the University of Pittsburgh in 1981. In 1987, he received an M.S. in geology from the New Mexico Institute of Mining and Technology in Socorro, New Mexico where he focused on geochemistry and crustal evolution. Since 1988, he has been employed by the Pennsylvania Department of Environmental Protection as a ground-water geologist where he currently works on drinking water source protection efforts including public education and outreach activities. He is a licensed professional geologist in Pennsylvania and is a member of the Geological Society of America. After stints in suburban Philadelphia, Fairfield and East Berlin, PA, Pat resides again in historic Gettysburg with his wife, Eileen and her two sons, Michael and Noah.

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ITINERARY

(see Fig. 1)

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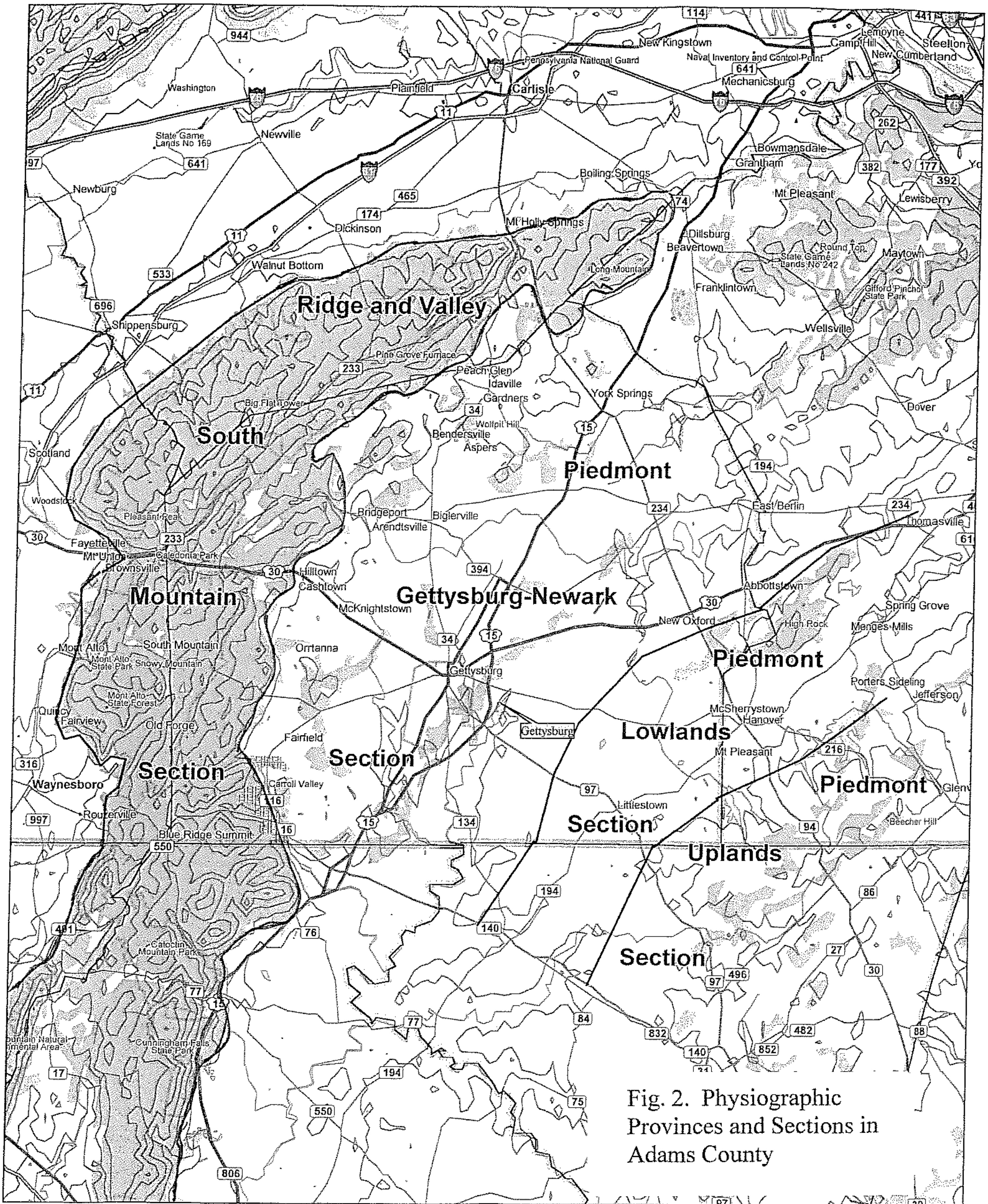

Fig. 2. Physiographic Provinces and Sections in Adams County

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Sample Punch
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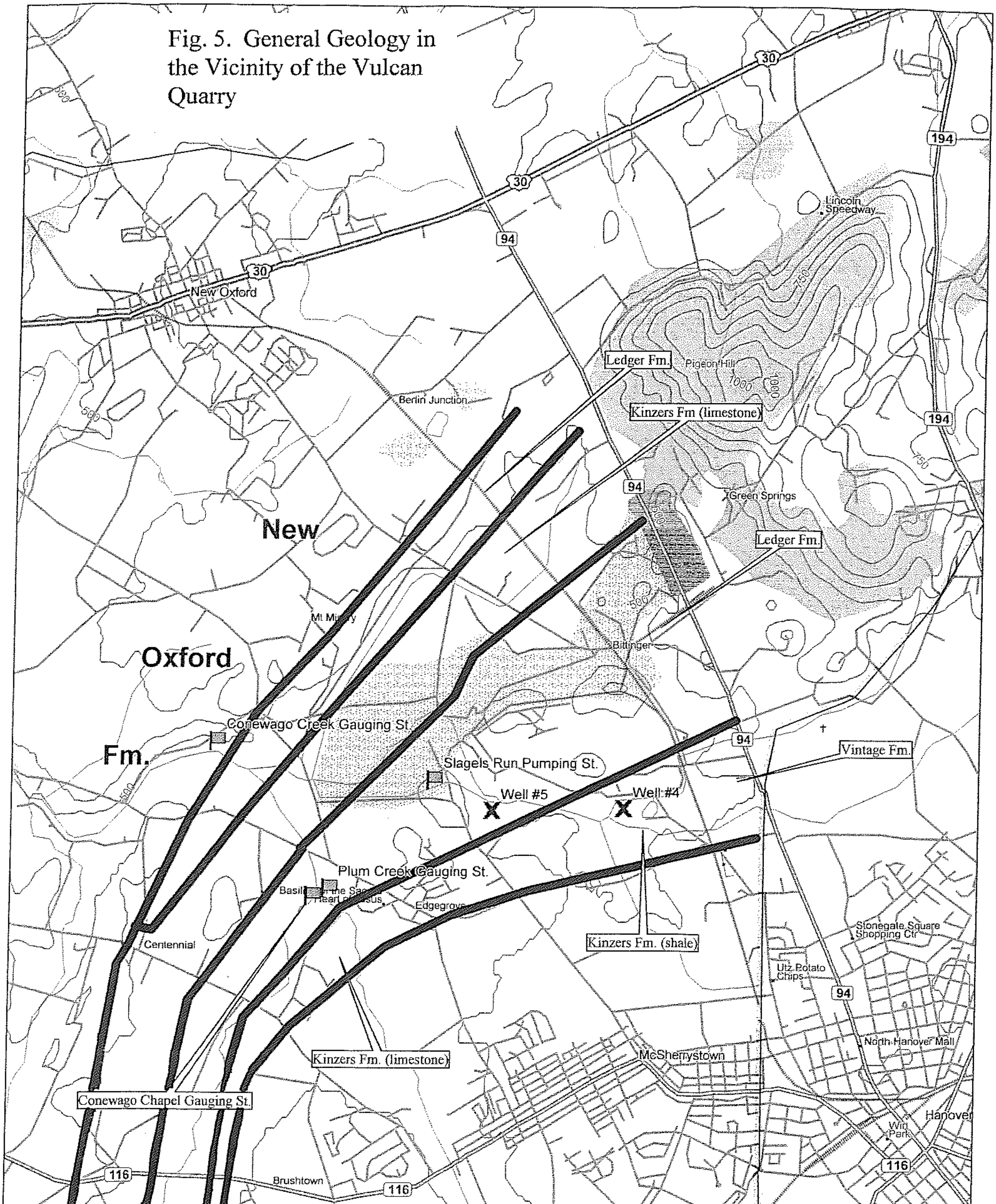

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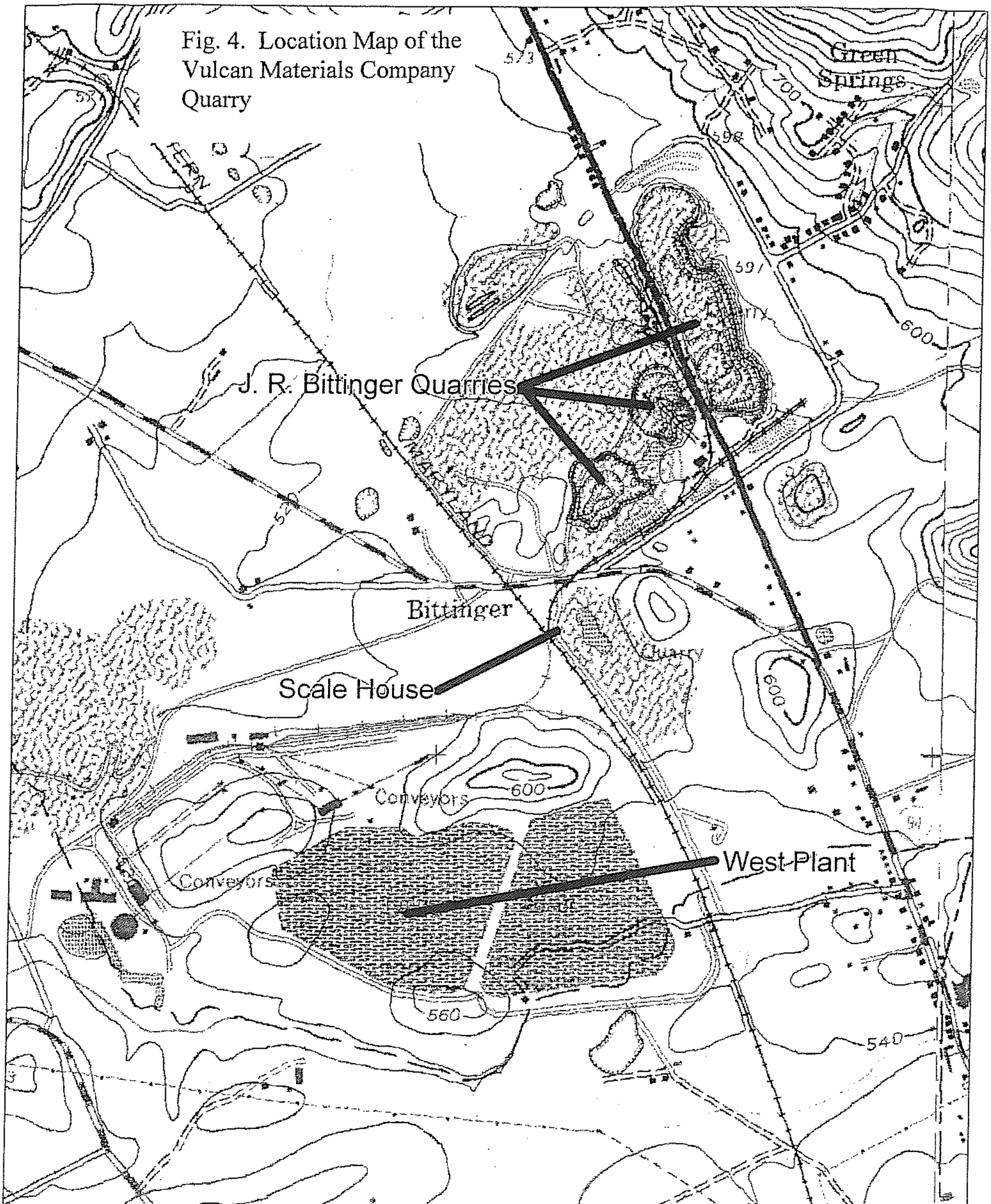

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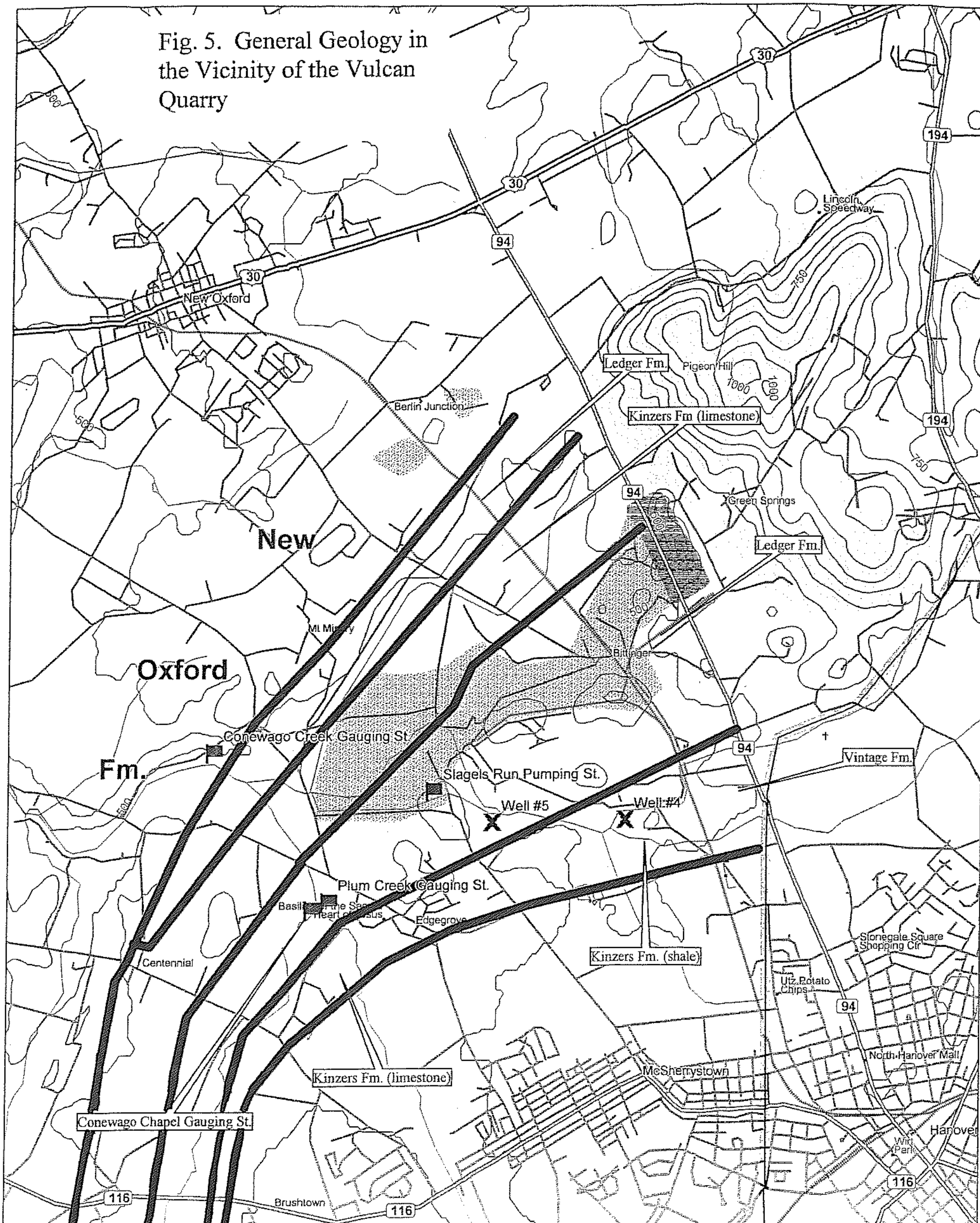

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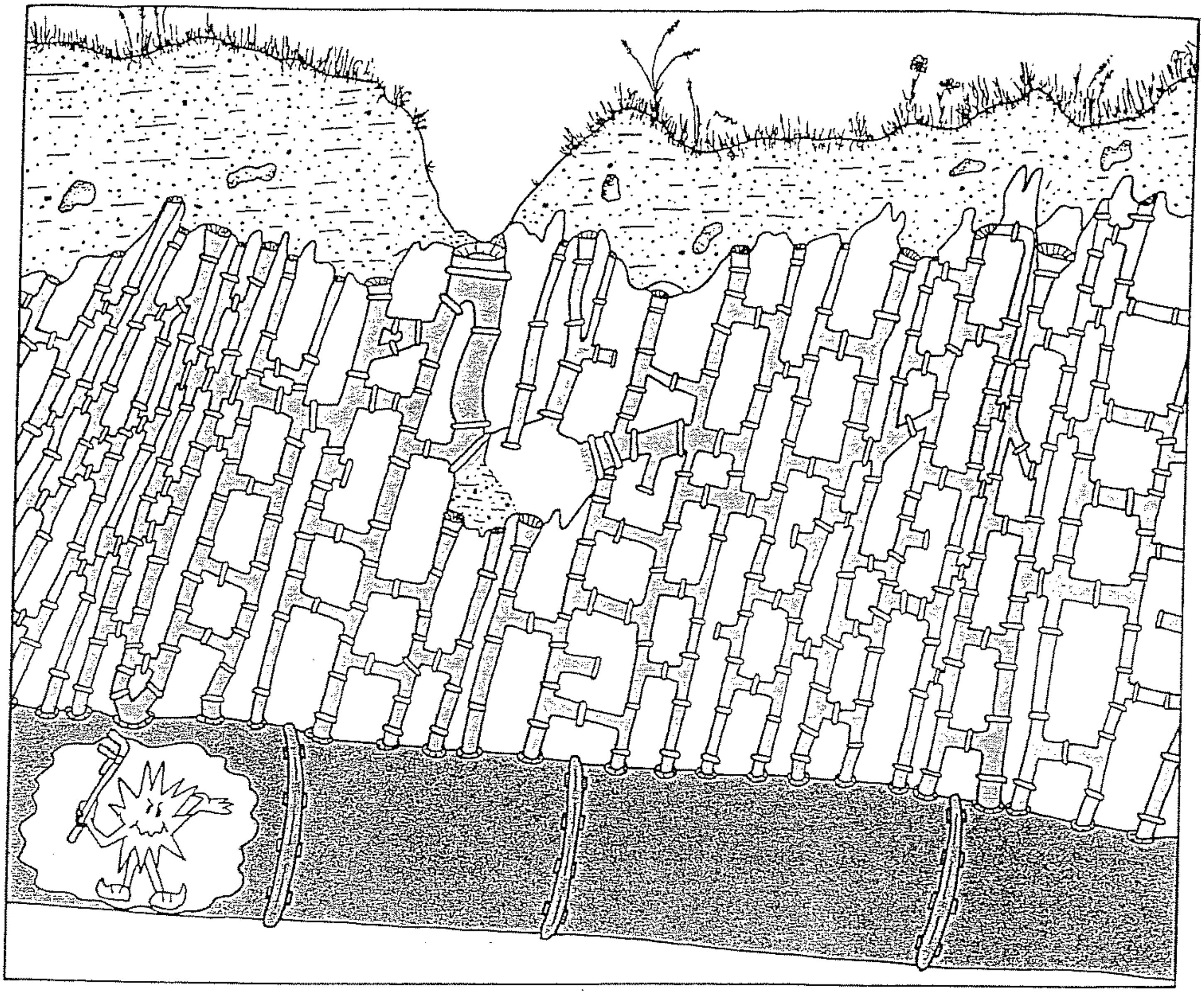
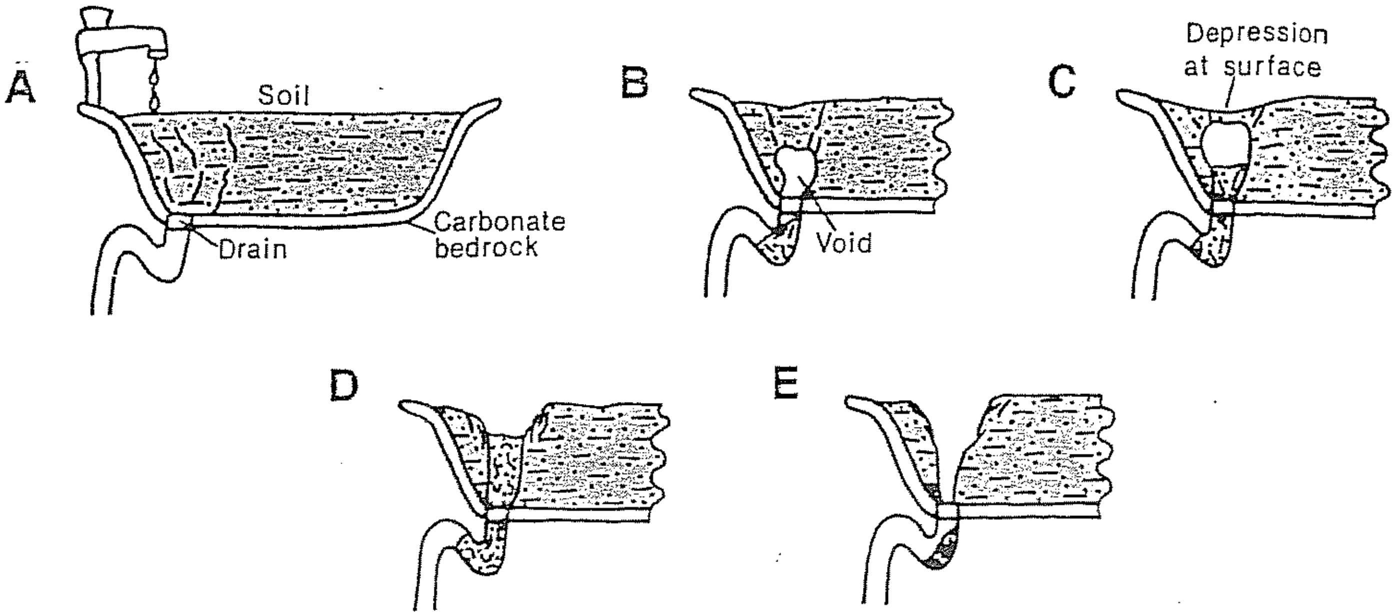


Mr. Carbonic Acid shows off his plumbing network in the limestone bedrock. Groundwater flows through the pipes to get to the water table (the large pipe at the bottom).

Fig. 6. How does ground water move through limestone bedrock?

Fig. 7. How does a sinkhole develop?



The bathtub model. A. Water infiltrates through the soil. B. As soil enters the drain, a void is left behind. C. Over time, the soil moves into the void and the void "migrates" toward the surface. D. Support is removed and collapse occurs. E. If enough water is supplied, an open connection to the drain results.

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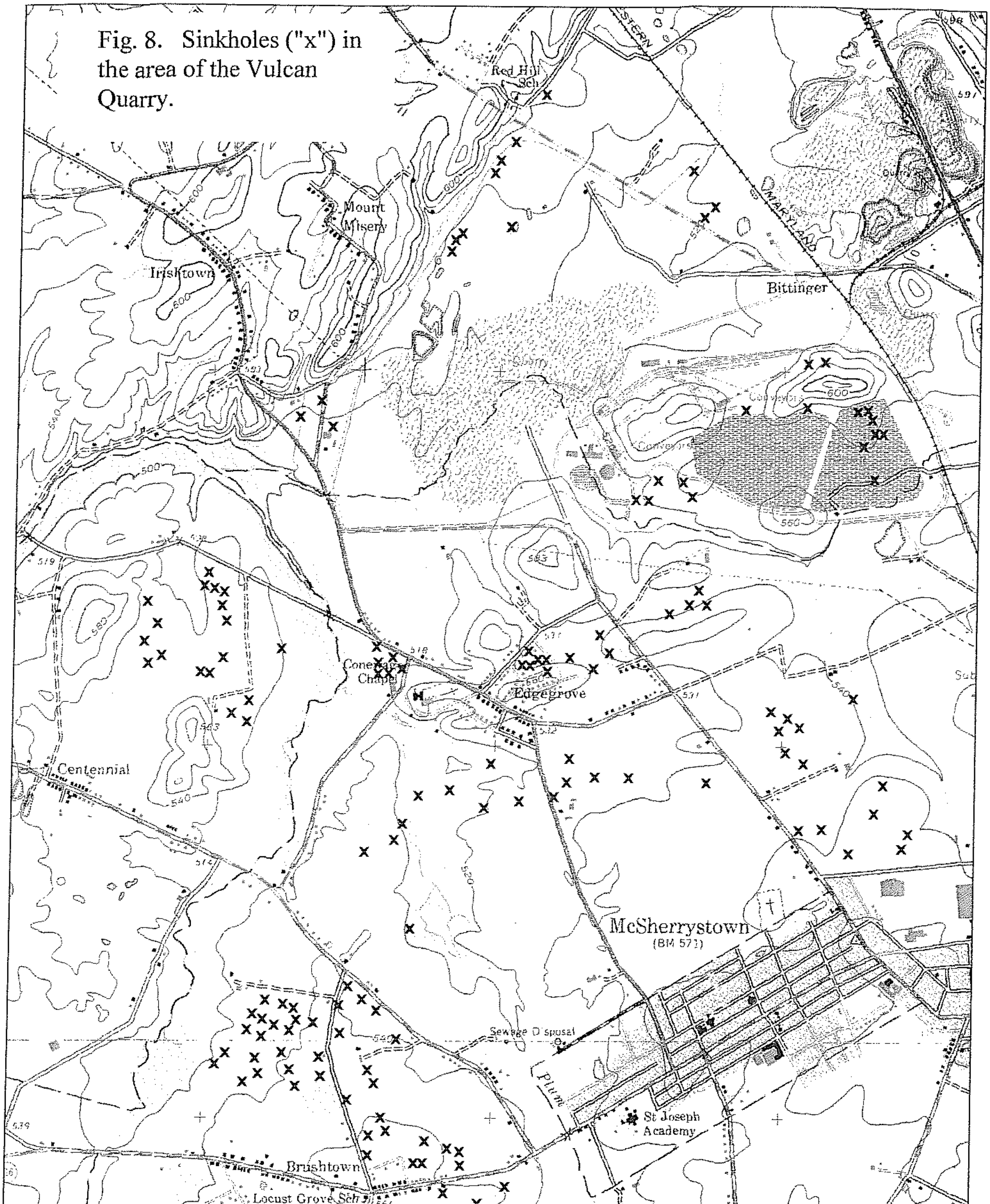

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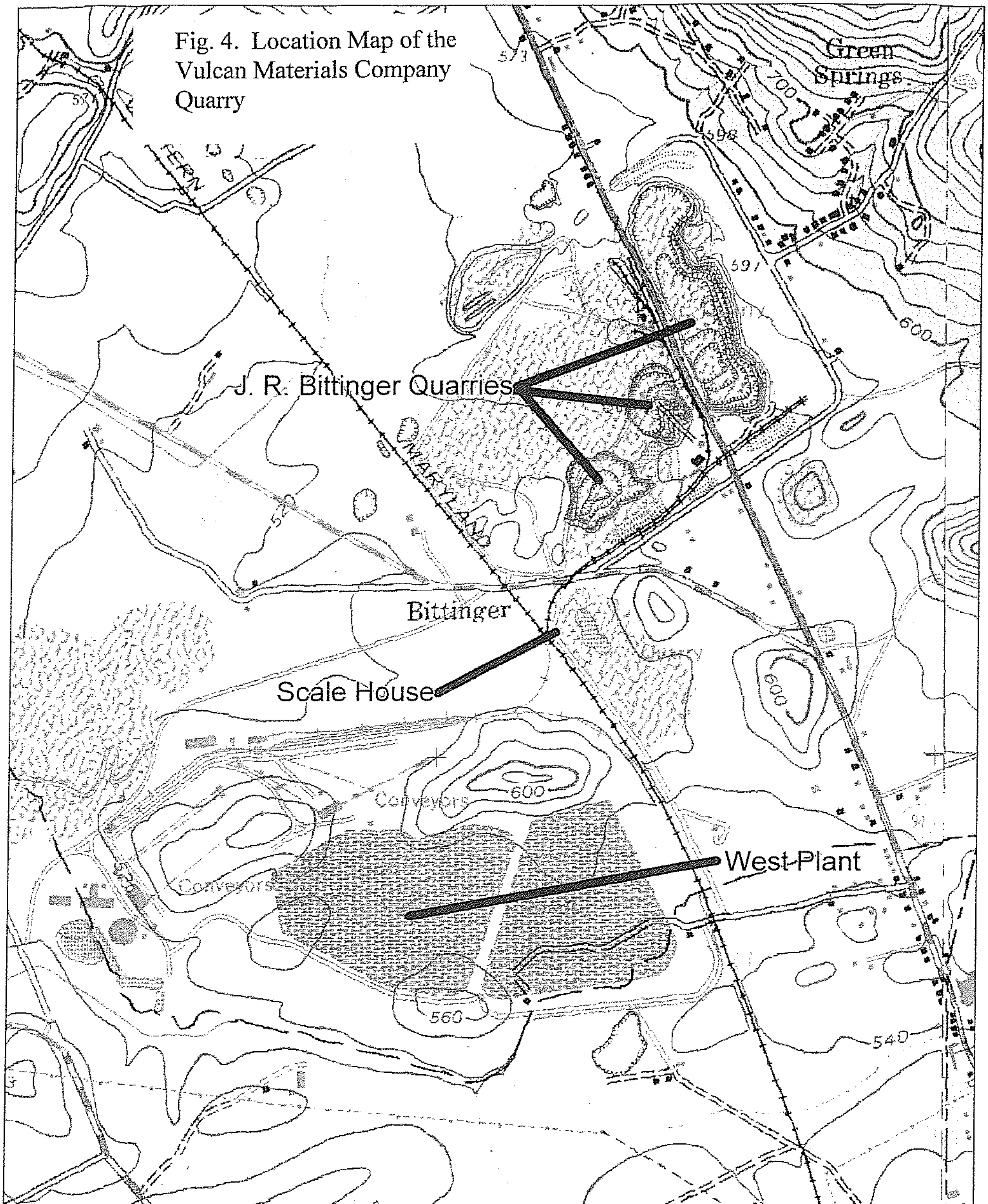

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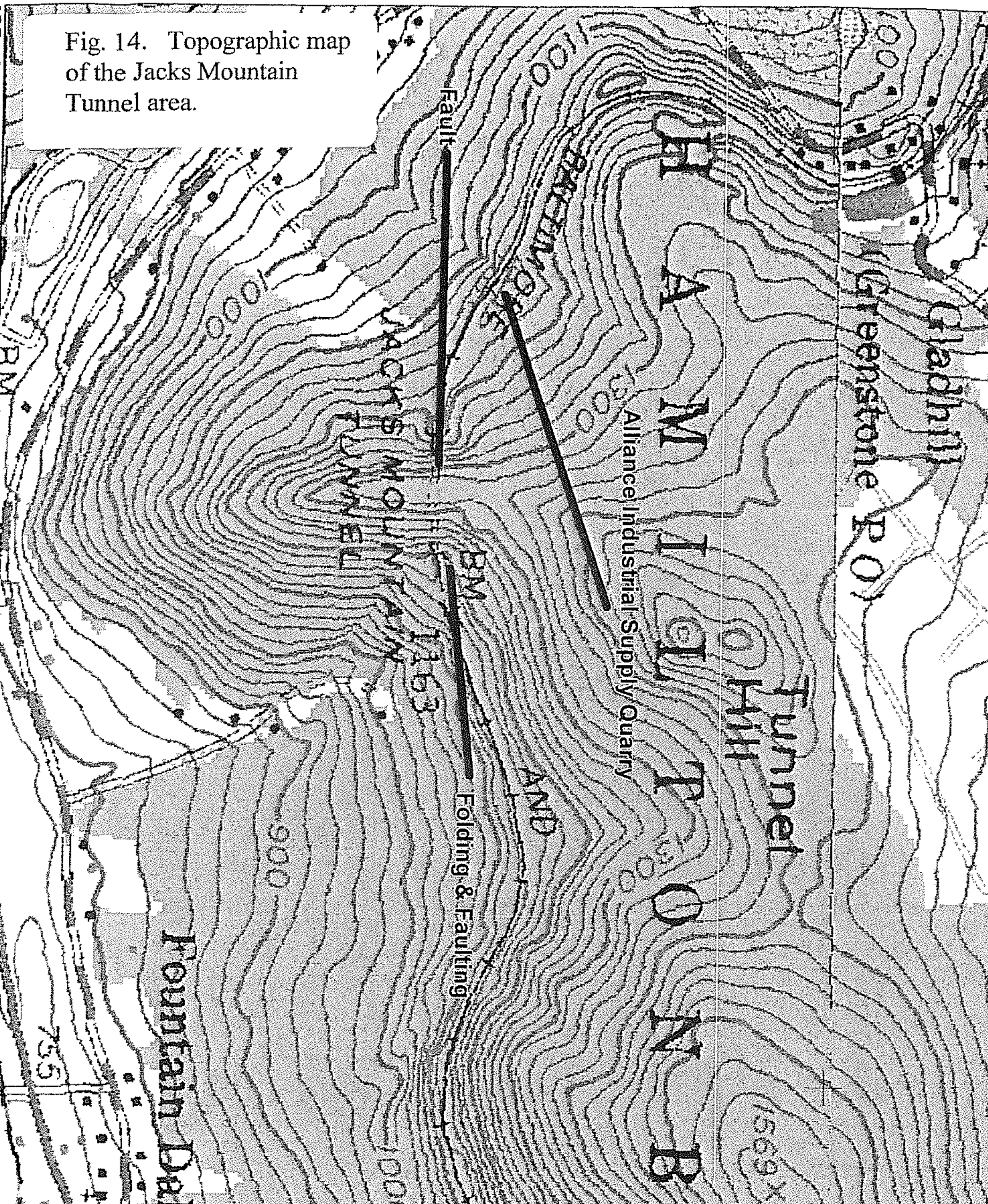

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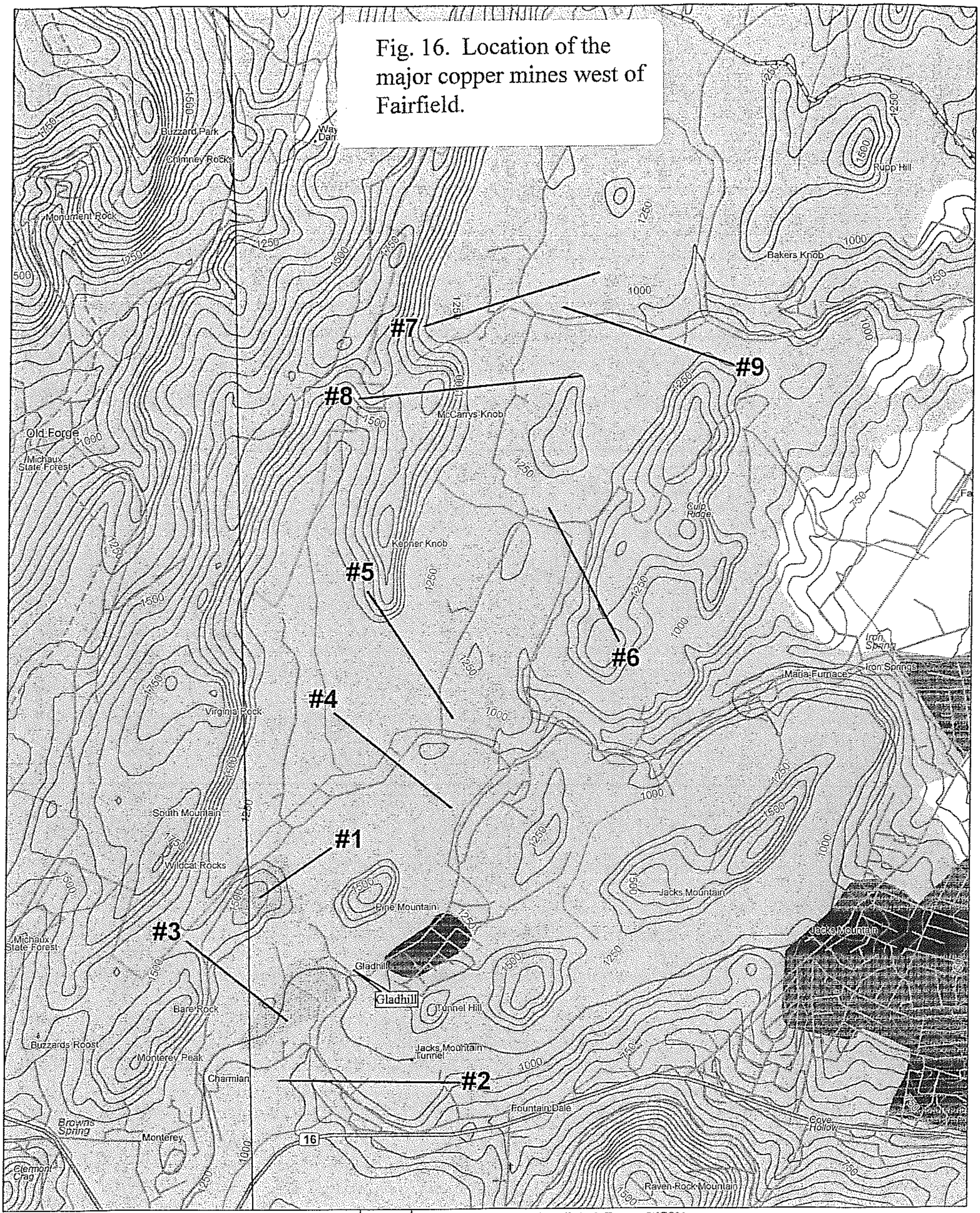

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TOPOGRAPHY AND GENERAL GEOLOGY

One doesn't have to look very far around the landscape to see a change in elevation. Geographers and geologists have divided regions into what are called physiographic provinces. The characteristics that separate these provinces include type of terrain (valley, mountainous, hilly, etc.), rock types, vegetation and drainage. Adams County lies within two physiographic provinces as described below (Fig. 2):

1. **Ridge and Valley Province:** Better known as the Appalachian Mountains, the terrain here is represented by alternating ridges and valleys. The South Mountain Section (SMS) lies along the northern and western edge of Adams County and is locally known as "South Mountain." Popular recreational areas within this section include Caledonia State Park and Michaux State Forest. Elevations range from 800-1,000 feet in the valleys and 1,400 - 2,100 feet on the ridges.

2. **Piedmont Province:** Occupies the remaining portion of Adams County and is composed of rolling terrain with scattered valleys. The Piedmont can be subdivided into three sections within Adams County:

   a. **Gettysburg-Newark Lowland Section (GNLS):** Occupies the area between South Mountain and the southeastern corner of the county. Elevation averages about 600 feet above sea level and in some areas, streams have cut downward into valleys 100-150 feet. Scattered hills ranging in elevation from 900 to 1,100 feet can be found, including foothills to South Mountain in the northwestern section of the county.

   b. **Lowland Section (PLS):** Elevations generally 400-600 feet above sea level characterized by a broad valley with isolated rolling and small rounded hills. Pigeon Hills marks the northern boundary of the PLS in this area with a maximum of elevation of 1024 feet above sea level.

   c. **Upland Section (PUS):** Characterized by terrain averaging in elevation of about 700-800 feet. The terrain is composed of rolling hills.

Adams County also spans two major drainage basins. The northern portion and most of the eastern part of the county ultimately drain to the Susquehanna River primarily as the Conewago Creek and its tributaries. The south-central and southwestern parts of the county, including the area around Gettysburg, are drained by tributaries (primarily Rock, Marsh, Middle and Toms Creeks) of the Monocacy River which empties into the Potomac River.

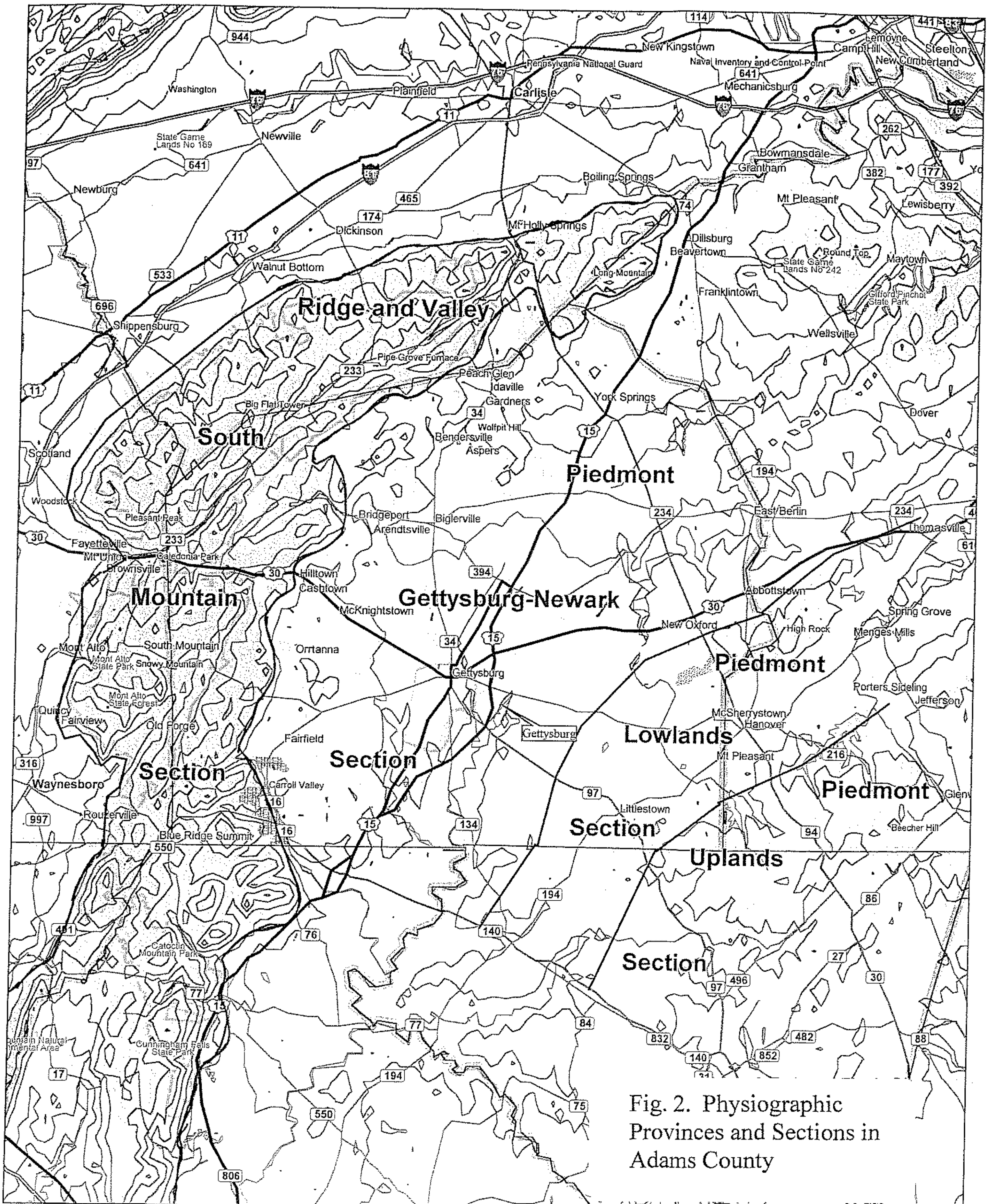

Fig. 2. Physiographic Provinces and Sections in Adams County

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Rocks found in Adams County range in age from 700 million years old to about 170 million years . Rock types include sedimentary, igneous and metamorphic. The oldest rocks (Precambrian) are located within the SMS. The last rock-forming episode in the area occurred within the GNLS, some 200 million years ago.

Figure 3 is a stratigraphic column showing the formations found in Adams County. The youngest rocks are found at the top (diabase) while the oldest are at the bottom (Catoctin Formation).

Figure 3. Geologic Formations in Adams County
(highlighted formations are those involved in today's tour)

Formation Name	Rock Type(s)	Thickness-Feet
Diabase	Dark-gray igneous rock	1800
Gettysburg	Shale, sandstone, congl.	16000
New Oxford	Shale, sandstone, congl.	6900
Beekmantown Group	Limestone, marble	300+
Conestoga	Limestone	1000+
Ledger	Dolomite, marble	2000
Kinzers	Limestone, marble	50?
Tomstown	Dolomite, limestone	1000+
Vintage	Limestone	500
Antietam	Sandstone, quartzite,	800
Harpers	Siltstone, graywacke	2,500-3,100
Weverton	Quartztie, phyllite,	800-1,000
Chickies	Quartzite, phyllite, congl.	800
Loudoun	Phyllite, graywacke	100-150
Catoctin metabasalt	Greenish volcanic rock	1000+
Catoctin metarhyolite	Reddish/purplish volcanic	2,200-2,900
Catoctin Schist	schist	100-150

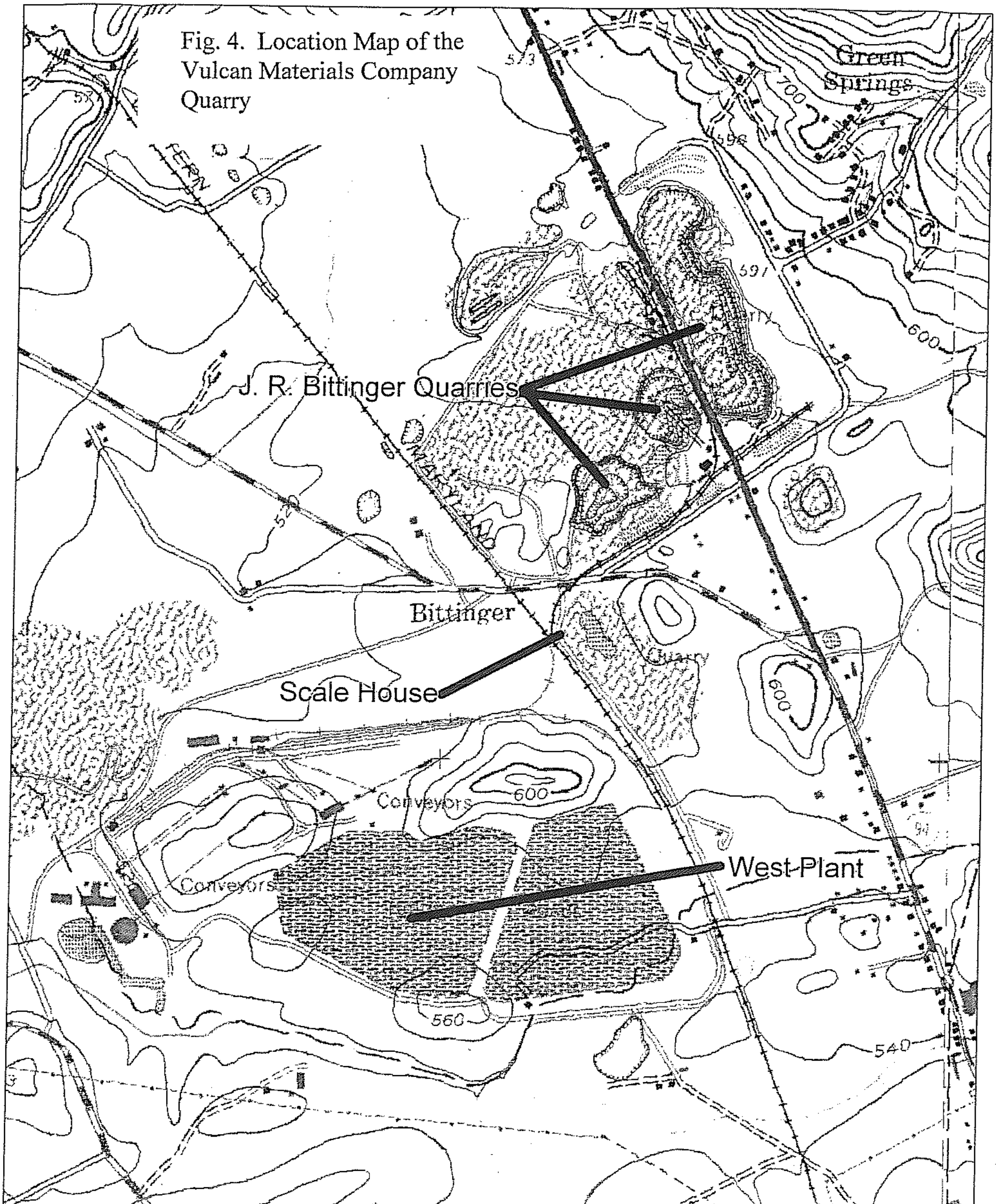
Thickness from Stose (1932) and Taylor and Royer (1981)

Containing most of the oldest rocks in the county, the SMS has undergone several "mountain building" episodes. Mountain building is the collision of continents as the larger tectonic plates covering Earth gradually move in response to convection currents deep within the warmer interior of the planet. As a result, the rocks have been intensely folded and faulted. Geologists feel that the SMS has been folded into a arch shape with the arch leaning toward the northwest. Although not able to be seen by a passer-by, a major fault, the Carbaugh-Marsh Creek Fault, is located where U.S. Route 30 passes through South Mountain. From a satellite photograph, it is obvious that South Mountain north of U.S. Route 30 has been pushed about 4 miles to the west relative to the highlands to the south of U.S. Route 30.

The PLS and PUS have again been pushed and shoved due to at least one continental collision. Although continuous rock exposures do not exist to see examples of the folding and faulting, geologists carefully studying the strata can measure these structures.

The GNLS contains the youngest rocks in Adams County. These rocks were deposited after several episodes of "mountain building," thus the rocks have not been deformed. The rocks uniformly dip toward the northwest 20-30 degrees. Minor faulting occurs within this area. A major fault borders the western edge of the GNLS where it intersects with the SMS.

NOTES



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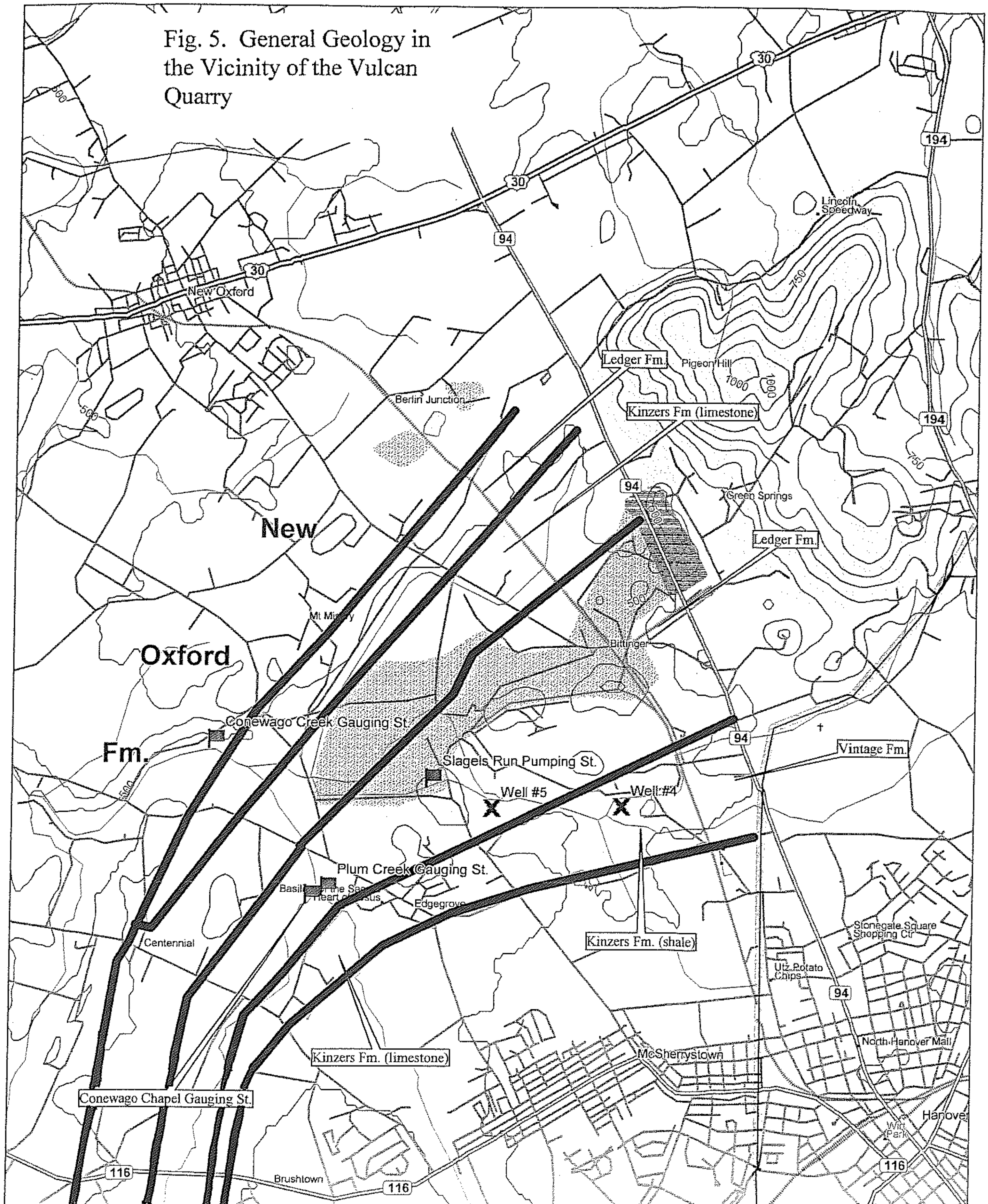

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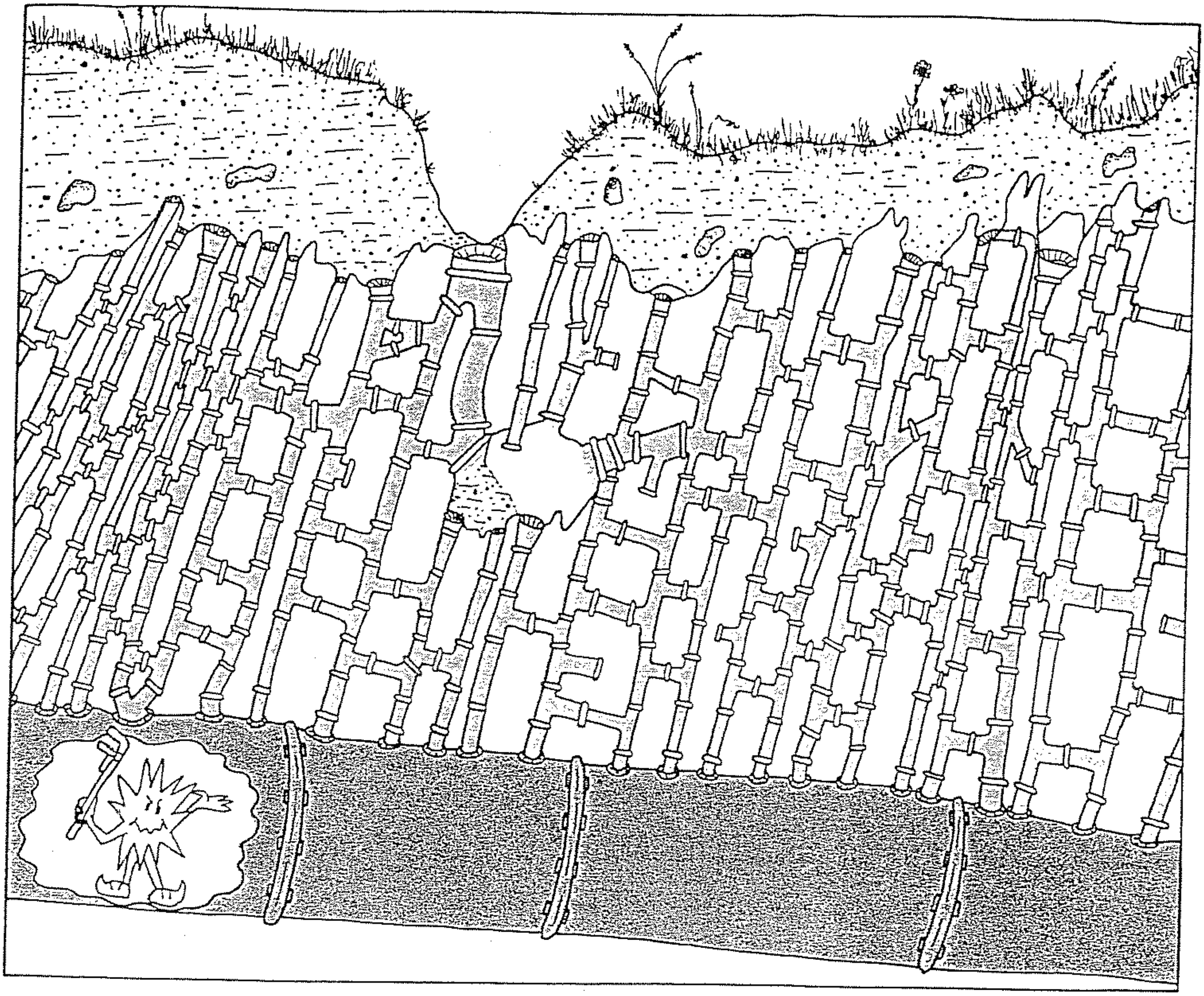
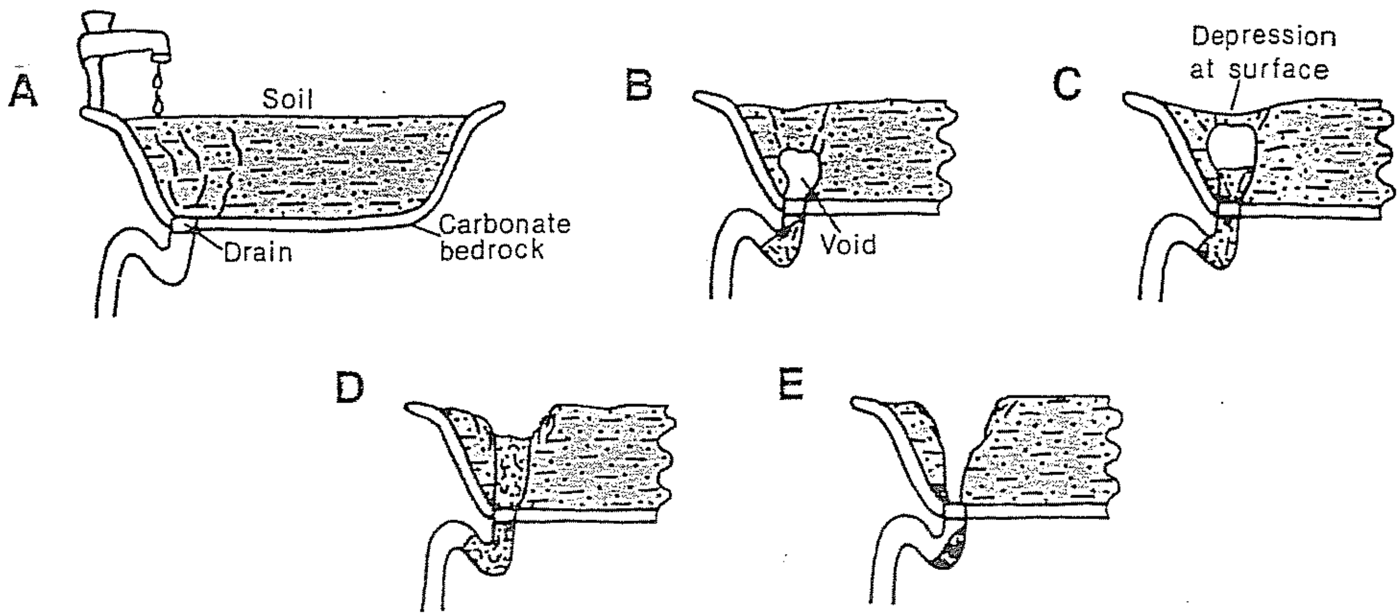


Mr. Carbonic Acid shows off his plumbing network in the limestone bedrock. Groundwater flows through the pipes to get to the water table (the large pipe at the bottom).

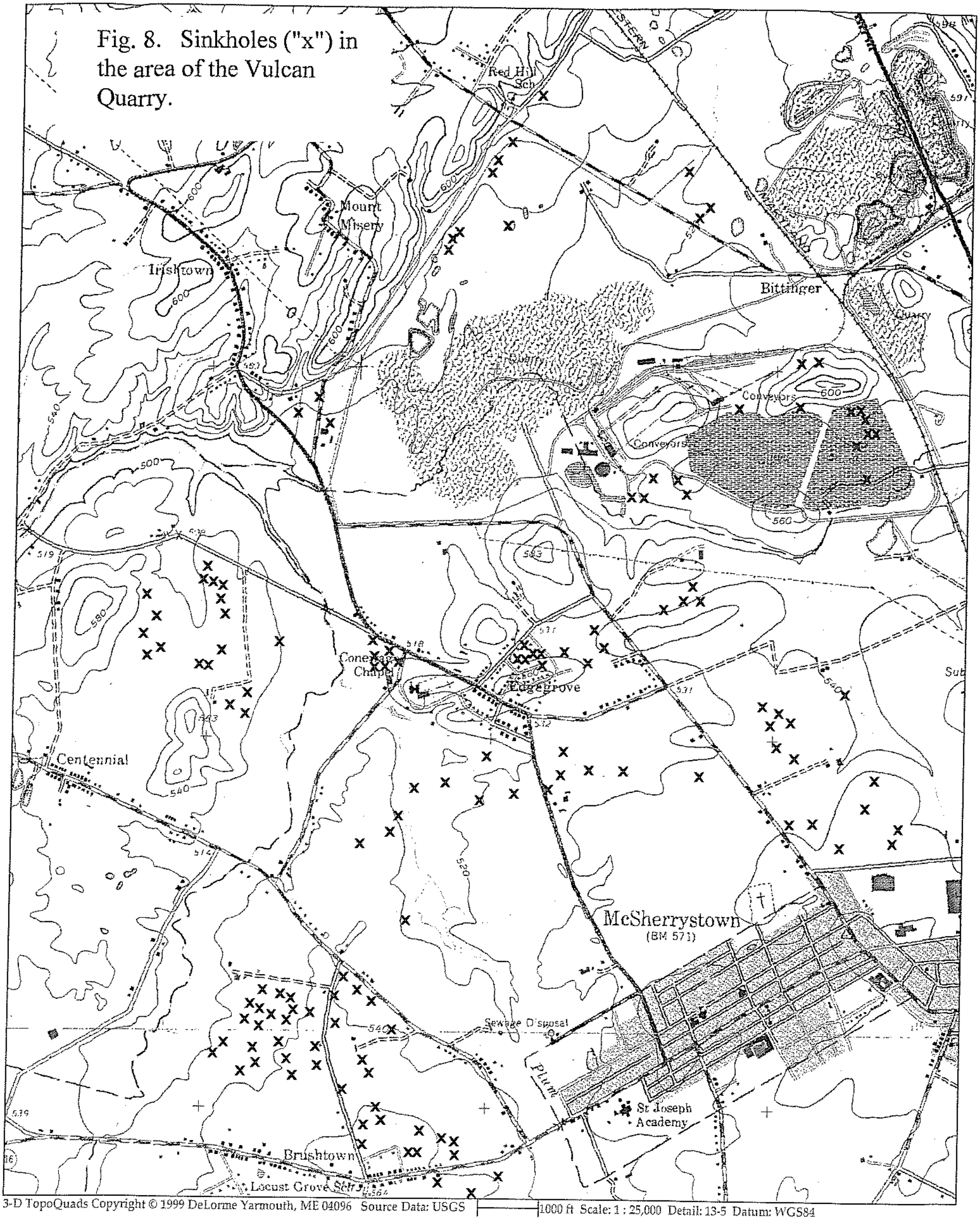
Fig. 6. How does ground water move through limestone bedrock?

Fig. 7. How does a sinkhole develop?



The bathtub model. A. Water infiltrates through the soil. B. As soil enters the drain, a void is left behind. C. Over time, the soil moves into the void and the void "migrates" toward the surface. D. Support is removed and collapse occurs. E. If enough water is supplied, an open connection to the drain results.

Fig. 8. Sinkholes ("x") in the area of the Vulcan Quarry.



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STOP 1. VULCAN MATERIALS COMPANY HANOVER QUARRY (Carbonate Operation)

Introduction: Just how far back into history does quarry to in Adams County? At first, you may have some difficulty coming up with an answer, but if we supply the clue "prehistoric man", that may help. Prehistoric man made his own tools and implements, some found locally dating back some 7,000 - 8,000 years ago. The raw material supplied to produce these tools came from the Catoctin Formation metarhyolite in the SMS. With the rock being fine-grained and silica rich, the rock broke rather easily and predictably. When broken, the rock also produces a rather sharp edge. Prehistoric man can be credited for producing the first quarries in Adams County. No, these quarries were not like those we know of today, but locations where the best metarhyolite was found and then broken into pieces that could be handled by man. Archaeologists call these "quarry sites", where thousands of man-made flakes lie on the ground, evidence of ancient human activity. Some of the sites found within the SMS occupy several acres and one could spend a life-time collecting all of the artifacts. The Carbaugh Run Rhyolite Site (36Ad30), near Cashtown. has been placed on the National Register of Historic Sites. The quarry has been dated from nearly 9000 BC to 1500 AD. Of course, since that time, more modern mining and quarrying has been done in the area, including extraction of copper, iron, sand, clay, and stone.

Our first stop is an active quarry, one that is usually off limits to visitors because of the risks involved in "quarry-stomping." So, consider yourself lucky and please obey all rules set forth by the quarry guide or tour leaders.

The PLS is a wealth of what geologist call carbonate rocks, mainly referring to the sedimentary rocks limestone and dolomite. Over historic times, humans have found uses for these two rocks, and this physiographic section has seen numerous quarries extracting these rocks. One of the first uses was as agricultural lime, used by most farmers to improve the chemistry of soils in their fields. During the 1800's, a small limestone quarry was a part of almost every farming operation. Over time, farmers began to recognize that certain limestones or dolomites were better for their needs. The quarries containing the better-grade rock began to sell their stone to neighboring farmers and suddenly, they found their profit more in the selling of the raw material than what they earned on raising crops. Again as technology improved, more and more uses of the carbonate rocks were found and today, as you will learn, these rocks are used for multiple products. In York County, there are still six active quarries working, but only one in Adams County, which is our first stop.

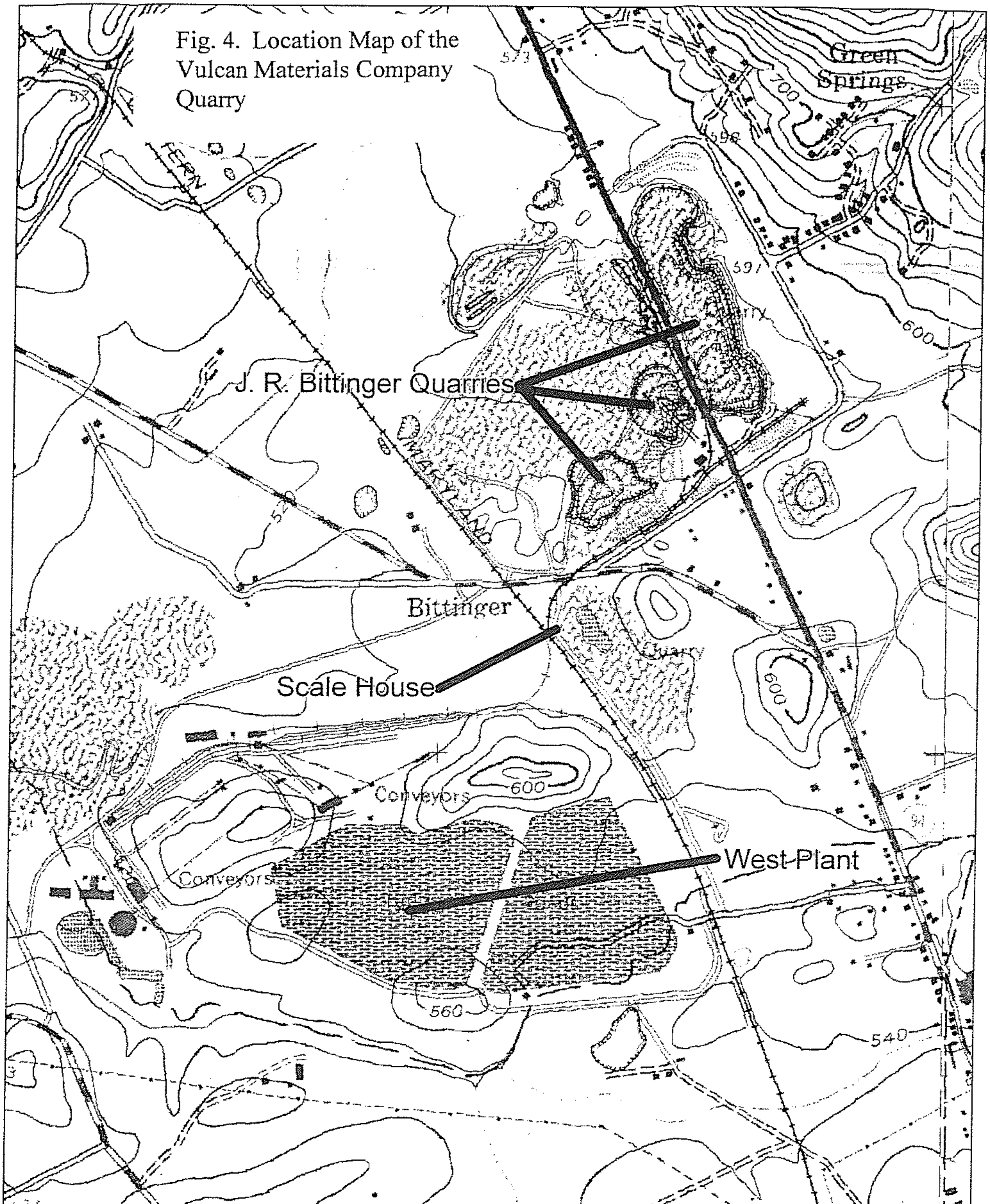
History of the Property: Quarrying on the Vulcan Materials Company property was started in the late 1800's as a small quarry extracting stone to be burned into agricultural lime by John R. Bittinger (Fig. 4). Mr. Bittinger also burned the high-calcium limestone to lime and shipped to eastern cities for use in paper manufacturing and for building purposes. Eight kilns were used. The original quarry was located on the west side of Pa. Route 94 near the location of Hanover Toyota. Miller (1934) best describes the early workings:

"The quarry formerly owned and operated by John R. Bittinger of Hanover but now owned and operated by the Bethlehem Mines Corporation of Bethlehem, Pennsylvania, is the largest quarry in the area. The quarry is at the end of a railroad spur northeast of Bittinger station on the Baltimore & Harrisburg division of the Western Maryland Railroad. The large quarry west of the Hanover pike is connected by a tunnel with another east of the road. To the north, several large holes about 50 feet deep that were formerly worked are now filled with water. The large quarry opening is about 800 to 1,000 feet in diameter and about 50 feet deep. The newer quarry is about 1,600 feet long, 700 feet wide and 60 feet deep. The stripping is done by steam shovel and dragline excavator and the dirt is carried by train to a distant dump. The rock is drilled by a churn drill and is blasted to the floor of the quarry where it is handled by an electric shovel. Tram cars carry the rock up inclines to the crushers, an Allis-Chalmers gyratory of huge size. A tram car load of 15 to 20 tons does not half fill it. The rock is broken to 5-inch size."

Both limestone and dolomite were quarried here, some more crystalline than others (Fig. 5) Bethlehem Mines Corporation abandoned the kilns, sending the rock to its own kilns in Bethlehem, where it was used for flux. The limestone and dolomite was crushed, screened and sized for road material, railroad ballast, and top dressing for roads. The Bethlehem Company also erected large elevated bins where the rock was loaded into the railroad freight cars by gravity. Still visible today around the buildings are well kept flower beds and lawn, first developed here by Bethlehem Mines.

In 1934, the annual capacity was 450,000 tons of fluxing stone and 125,000 tons of commercial stone. From 1917, when Bethlehem Mines purchased the property to 1930, the quarry produced 5,770,000 tons of fluxing stone and 522,000 tons of commercial stone (Miller, 1934).

Recent Development: In 1962, Bethlehem Mines opened the active quarry which is referred to as the "West" plant. Here, limestone and dolomite belonging to both the Ledger and Kinzers Formations are being extracted. The Antietam Formation is found on the property, usually occupying small, rounded knolls.



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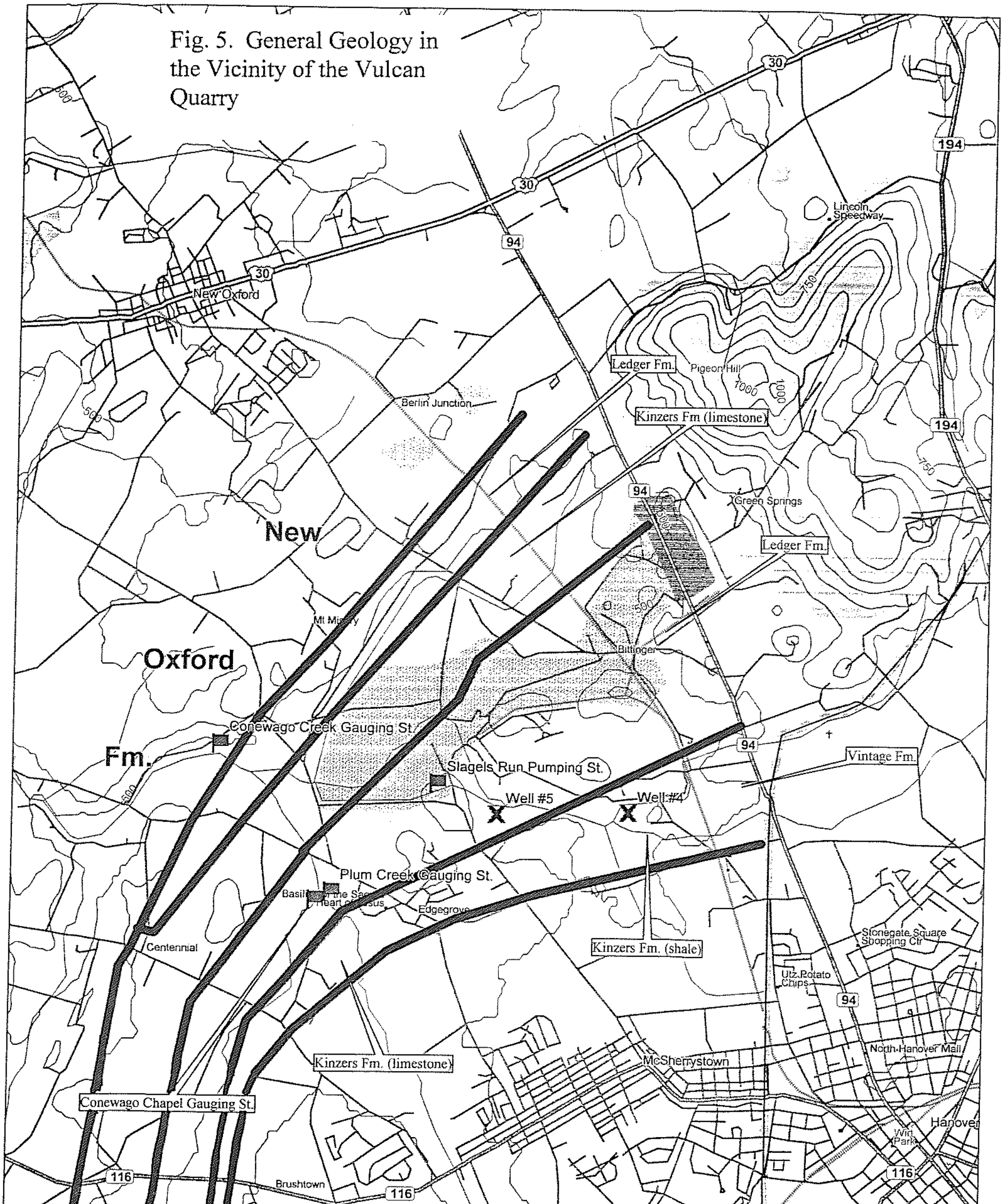

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O'Neill, Jr. (1964) reported the following uses for the stone: Agricultural purposes, concrete, aggregate, road metal, flux, paint, filler, riprap, railroad ballast and stone sand.

Hole (1968) reported that the major use of stone was for metallurgical purposes, mainly blast furnace flux stone which was shipped to Bethlehem's Steel plant at Sparrow's Point, Maryland. Other products being produced here include:

Sinter Flux	Open Hearth Flux
Rice Flux	Sinter Feed
Limestone for Quicklime	Sand
Screenings	Ag-Lime

Hole continues by stating:

"Total production in 1967 was slightly over 4,000,000 tons from the West Plant quarry. Since the main quarry opened in 1962, 19,800,000 tons of stone have been processed, and during the same time span about 1,200,000 tons of shale and mud have been removed. This gives some idea of the difficulties of quarrying this highly-faulted, cavernous ground. As lower levels are developed, the problems of mud and caverns will diminish, but not disappear."

The operation has gone through several ownership changes since Bethlehem Steel. Below is a summary of ownerships in the 14 years:

1917-1988	Bethlehem Steel Company operated the plant
1988	Broyhill bought out Bethlehem and operated facility
1989	Whimpey Minerals purchased the property
1996	Tarmac bought out the operation
2000	Vulcan Materials Company took over the operation

Today, the property consists of 1300 acres with about 33% of that acreage consisting of the "West" quarry. With the improvements of mining engineering and equipment, the quarry today produces about 4 million tons of rock annually. A wide variety of products are now produced from the raw material including, chemical grade limestone and dolomite shipped to Bethlehem Steel for assisting in the manufacturing of steel; incinerators, scrubbers, coal sulfurization; aggregate for cement blocks, cinder blocks, cement, and lime.

Factors including property limitations, permitted depth, and the geology affect the life span of all mineral resource producers. It is estimated here that Vulcan Materials Company has about 20 years of removing the *known* resources for specialized stone. It is estimated that the quarry can extract the carbonate rock for aggregate resources for up to 100 years. Just how deep can the quarry go? Presently the quarry is 250 feet below the original surface, but the operation is permitted to go to a depth of an additional 350 feet.

During this excursion, we will be taking a riding tour of the quarry that will provide you with a good understanding of how a quarry functions, problems that the operation may incur, the complexity of the local geology involving the PLS, ground water movement through the carbonate rocks, and how the rock is produced into the variety of products sold by Vulcan Materials Company. Please follow the directions stated by the plant host or co-leaders.

Stop 1 - Notice the pretty light green water in the bottom of the lowest level. Ground water is one problem which quarries or mines have to contend with, particularly in the limestone/dolomite region. How does this operation deal with the problem, what is the water used for and just how much of a problem is it?"

As quarries and mines work their way downward, ground water is usually encountered at varying depths depending on the geology, hydrology and climate of an area. In limestone quarries in Pennsylvania, dewatering is almost always necessary for safe and efficient operation. The pool of water is a sump used to collect ground water which is then pumped out of the quarry to control how wet and muddy the pit is. This quarry pumps out ground water at a rate of around 6 to 7 million gallons per day (mgd). That's a lot of water but don't worry, it's not wasted! We'll talk about what else the water is used for in a little while.

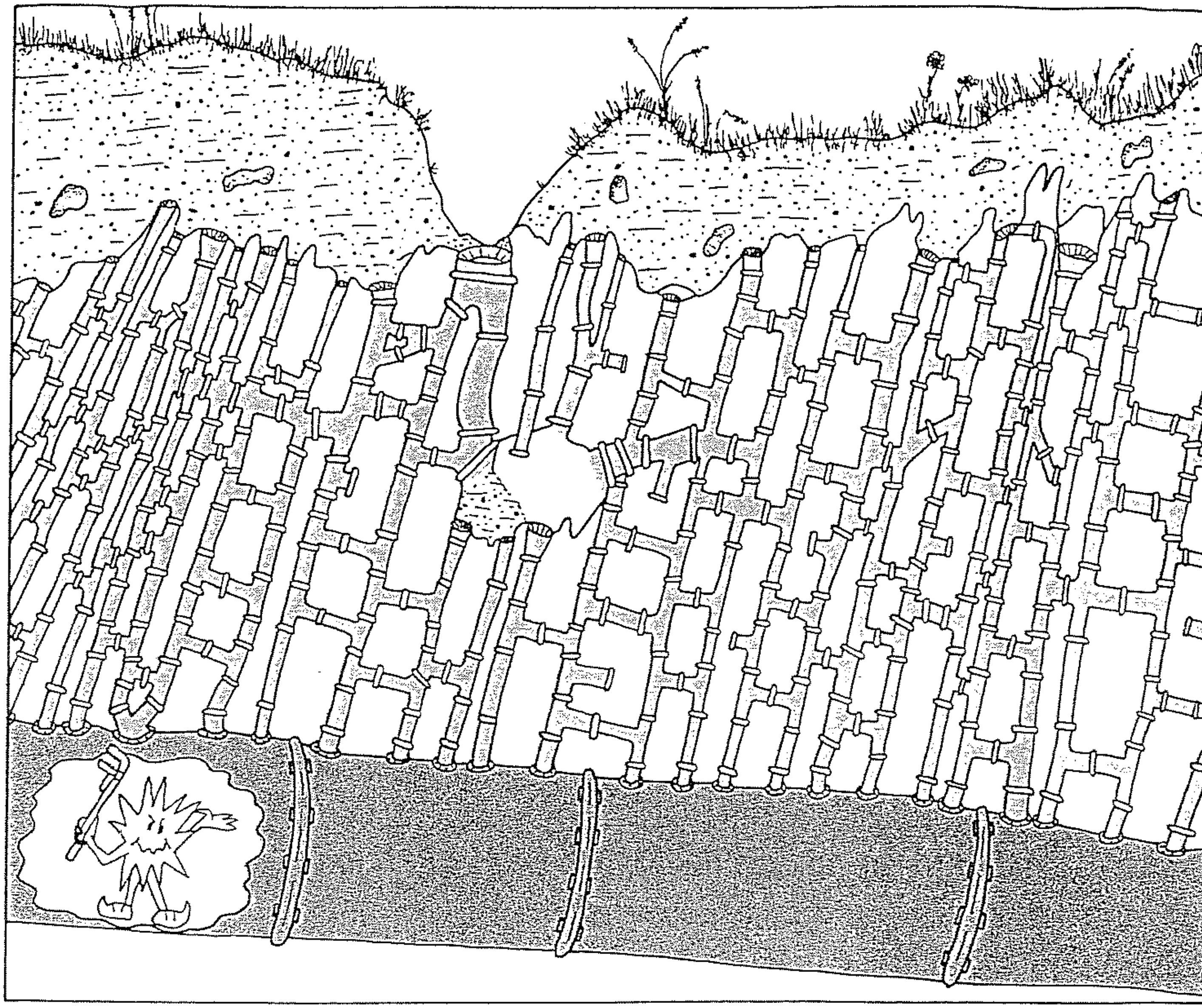
Carbonate rocks typically lack intergranular spaces (pores) since they are commonly well-cemented or crystallized, so there is not much original or primary (formed at the time of deposition) porosity in the rock. So, where is all the water coming from then? At a few places in the quarry, you may be able to see ground water seeping out along fractures and individual rock layers or you may see water cascading out of larger fractures or voids. Ground water in the carbonate rocks here (and also in most of the other rocks throughout Adams County) occurs in "secondary" features (formed after deposition of the rock) such as fractures and openings between interbedded rocks. So, while the limestone has little to no primary porosity, it has appreciable secondary porosity which makes it a good aquifer since it can transmit and store large amounts of water.

The secondary porosity of the limestone and dolomite is even more pronounced because of the unique tendency of carbonate rocks to dissolve in humid climates. In arid climates such as the southwestern U.S., limestone and dolomite are hard, resistant rocks that typically make up ridges. In areas with abundant rainfall, rainwater interacts with carbon dioxide, a natural minor component of the atmosphere, to form carbonic acid which is a weak acid that dissolves carbonate rocks. Additionally, carbon dioxide gas in soil may react with percolating water to form carbonic acid.

The action of the acidic water widens existing fractures into conduits and creates openings such as caves and sinkholes in the carbonate rock. Solution of carbonate rocks over a large area produces a distinct landscape known as karst topography that is characterized by closed depressions, sinkholes, caves and underground drainage. A karst terrane may have a complex "plumbing" system where a convoluted network of various openings connect surface water to ground water through "disappearing" or sinking streams, sinkholes, conduits, caves and springs (Fig. 6). The only place that an "underground stream" can actually occur in would be a karst area.

A sinkhole is a subsidence feature found in karst areas. It is commonly a drain for surface water and is thought to form primarily from water flushing down soil or other surficial materials into voids in either the carbonate bedrock or the overlying soil (Kochanov, 1999). The bathtub model for sinkhole development is presented in Figure 7. Sinkholes are dangerous as they can damage structures, roads and utility lines. Many of the roads near the quarry have been impacted by sinkholes (Fig. 8). Red Hill Road has signs that warn "Sinkholes, Travel at Your Own Risk". Hanover Street has been closed at times due to sinkholes and some are visible in the farm fields adjacent to the road Jones, 1997). The quarry must be especially careful in how the extracted water is discharged. The receiving stream is concrete-lined to convey the water away and not allow it to spread out and erode soil that may be plugging the throats of sinkholes. It is also of interest to note that Ice Age fossils such as mastodon bones have been found at the quarry in voids that were apparently connected to old sinkholes (Joe Hurtack, personal communication).

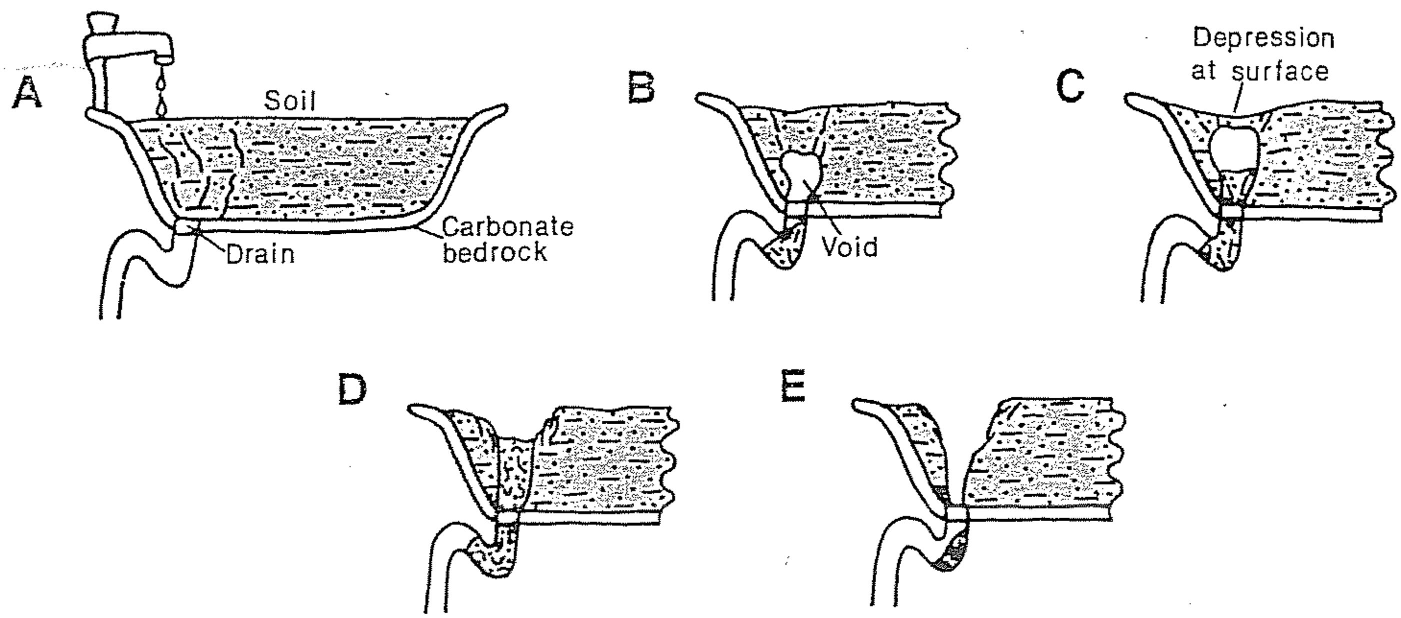
Stop 2 - You may notice some of the equipment sitting idle today (they don't operate on Saturdays). By today's standards, this equipment can remove and transport many tons of rock daily. Here, you will be able to leave the bus and follow the guide over to a dumping bin where the large trucks dump the rock, which is then transported underground up the hill to the crushers, screeners and separators, which we will see a bit later.



Mr. Carbonic Acid shows off his plumbing network in the limestone bedrock. Groundwater flows through the pipes to get to the water table (the large pipe at the bottom).

Fig. 6. How does ground water move through limestone bedrock?

Fig. 7. How does a sinkhole develop?



The bathtub model. A. Water infiltrates through the soil. B. As soil enters the drain, a void is left behind. C. Over time, the soil moves into the void and the void "migrates" toward the surface. D. Support is removed and collapse occurs. E. If enough water is supplied, an open connection to the drain results.

Fig. 8. Sinkholes ("x") in the area of the Vulcan Quarry.

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Stop 3 - Note the east wall on this level. There is some fairly good examples of folding and faulting present here. Attempt to follow a certain colored layer across the entire face - it turns out to be somewhat difficult. Think of the pressures involved within the Earth's crust to have caused this movement. Remember, you are looking at just a very small part of the PLS, so magnify this problem by about 50. Also, some quarries only remove the chemically purest rock to make specific products. By encountering these types of folds and faults, think about the headaches that the mining engineers may have to follow those layers.

Berkheiser and others (1985) best describe the geology here:

"Selectively mines a geologically complex setting."

Stop 4 - We are driving past the extensive system of conveyor belts and buildings, making the crushers, screeners and separaters. Here the rock arrives from the bottom of the quarry and is crushed. Then the rock is sent to various belts based on size and chemistry, screened into various sizes, followed by being deposited on their respective piles, ready for distribution.

Stop 5 - From this vantage point, you can get a good overall view of the entire "West Plant" operation. You can also see a good representation of the PLS as it appears as a valley. Just to our northeast is the termination of the Pigeon Hills, a highland area marking the northern edge of PLS, running eastward about 5 miles to near the York Airport. The oldest rocks within this region are volcanic rocks belonging to the Catoctin Formation, dated at 720-800 million years old. Harder, more resistant rocks such as quartzites and metavolcanic rocks underlay the Pigeon Hills, while softer, less resistant rocks like the carbonates, sandstone and shale lay under the lower elevations surrounding this area.

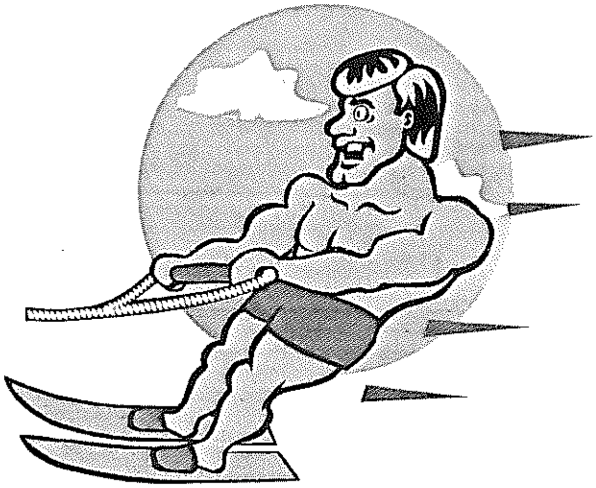
So, what happens to all the millions and millions of gallons of ground water from the dewatering operation? It is discharged into Slagle Run which, as noted previously, has a concrete channel to prevent erosion and minimize sinkhole development. The water is then withdrawn from the stream at an intake just downstream from the discharge for use as one of the drinking water sources for Hanover's public water system.

The Hanover Municipal Water Works serves over 36,000 people in the Borough of Hanover and Penn Township in York County along with McSherrystown Borough and Conewago Township in Adams County. The system also sells water to a consecutive public water system in West Manheim Township, York County. The typical demand on the Hanover Water Works is over 5 million gallons pre day (mgd) and a 11.5 mgd (design capacity) water treatment plant is used to produce drinking water from several surface-water sources.

The use of surface water requires the treatment process to include rapid sand filtration to remove microbes (such as giardia cysts) that are resistant to disinfection. In addition to the intake on Slagle Run, other primary sources for Hanover's system are impoundments on the South Branch of the Little Conewago Creek and a tributary, Long Arm Creek (Fig. 9). It's worth noting that most of the streamflow in Slagle's Run near the water intake is ground-water discharge from the quarry. At certain times, the quarry contribution accounts for as much as 75% of the water used by the Hanover Municipal Waterworks (Ronald Orndorff, Hanover Borough Engineer, personal communication).

While the Hanover system also includes a reserve well for drought purposes, the recent drought conditions in Pennsylvania has raised concern about the adequacy of Hanover's reservoirs. The carbonate rocks in this area have great potential for ground-water development due to their good secondary porosity and Hanover is already developing some water wells to supplement their system. Two wells, both with test yields of about 2,000 gallons per minute, have been installed in Conewago Township and are being prepared for service pending approval from the Pennsylvania Department of Environmental Protection (Fig. 10). Although karst aquifers generally yield significant quantities of water, they are also easily susceptible to contamination because their plumbing system allows for direct connection to the surface and rapid transport of contaminants. Ground water from limestone and dolomite aquifers is also generally hard due to the dissolution of calcium and magnesium from the rocks.

NEWS FLASH: In the early 1970's, some bone material was discovered within a sinkhole that was encountered during the quarrying. The bones were studied by Carnegie Institute of Pittsburgh, Pennsylvania, who identified the bones as belonging to a Mastodont (Fig. 11). Mastodonts roamed through Pennsylvania during the Cenozoic Era starting during the late Miocene Period, some 10 million years ago (Sullivan and Randall, 1996). The exact age of these bones is not known, but it shows that the sinkhole was active millions and thousands of years ago. The Mastodont got too close and fell into the openings, but could not get out due to the steep sides. Additional bone material are occasionally discovered in similar sinkholes. Thanks to the observant employees, the bones are not destroyed by the crushing process.



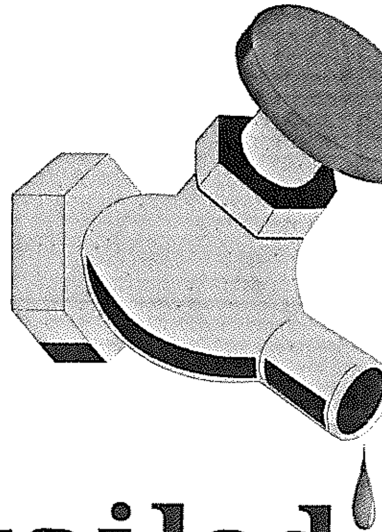
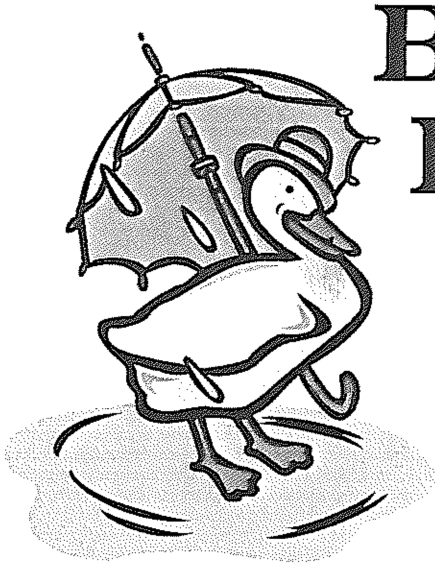


Fig. 9. Detailed illustration showing the Borough of Hanover Water System. Map courtesy of the Borough of Hanover.



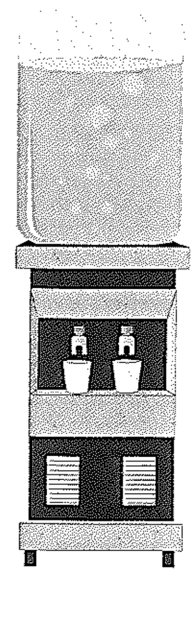
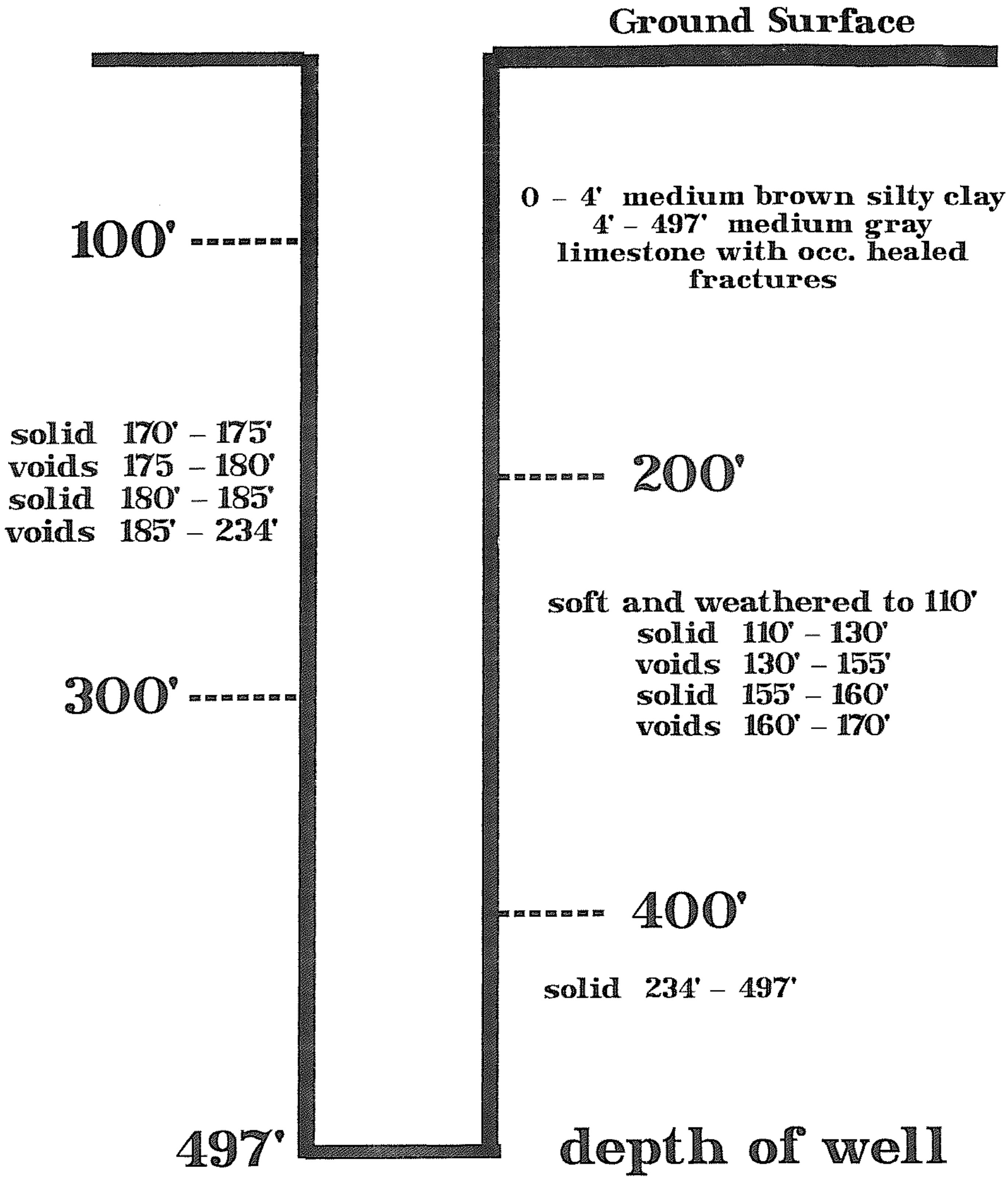


Fig. 10. Water Well Log for Hanover Borough's well #4.

Kinzers Formation limestone



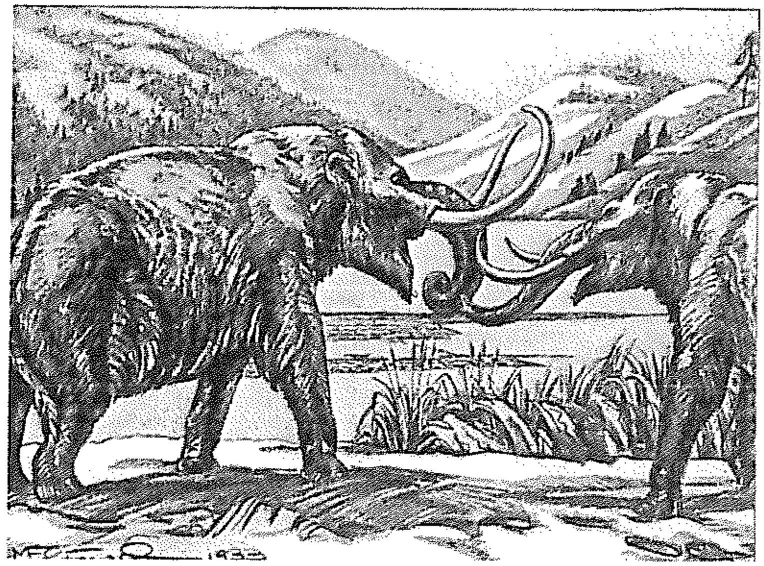


Fig. 11. Illustration of the American Mastodont by Margaret Flinsch in 1933 under the direction of Henry Fairfield Osborn from his classic two volume work titled Proboscidea. Courtesy of the American Museum of Natural History (Sullivan and Randall, 1996) Male on the left and female on right..

NOTES

STOP 2. RELIANCE MINING AND MILLING COMPANY (ABANDONED COPPER-GOLD MINE)

"The Mine that Never Mines"

We will now travel back into history, not as far back as the first mining interests in Adams County in the early 1800's, but around the turn of the 20th century. The following was taken from a 1954 issue of the Gettysburg Times which was used to locate the first modern-day gold find in southeastern Pennsylvania (Jones and Schmerling, 2002).

"Hunterstown, which almost became the Adams County seat when the county was founded 154 years ago, also enjoys the distinction of being the only town in the county with streets "paved with gold."

Martin Harman, Lincoln Square, can give the details. He was foreman and one of the owners of the mine that produced the "gold" and the copper for which the Reliance Mining and Milling Co., Inc., was digging.

The gold and copper mine was started about 1905 and was in existence about two years, during which tons of rock were removed. Most of the rock was crushed by huge machines installed in a large building near the face of the mine (Fig. 12). The mine was 245 feet in depth, running into the earth on a 35 degree angle.

But despite the money that was poured into the corporation and the tons of rock that came out of the hole near Hunterstown, nothing was ever shipped from the site.

So when the company failed the rock remained piled around the mill and eventually, Mr. Harman relates, the township supervisors used the "gold-bearing" rock for the roads and streets in and near Hunterstown.

Mineral value of the mine assayed $90 per ton, the 81-year old local resident recalls, but there was a squabble between the general manager, Parris Erb, and other officials of the company. There was a matter of midnight relaxation over a few quarts of whiskey by Erb and the workers and eventually Erb left and the work stopped.

The company failed twice. Harman recalls that Erb, a mining engineer, first opened the mine, about a half mile north of Hunterstown on the John Little property, about 1885. Some quantities of rock were removed and sent to a firm near Dillsburg to be processed. But the Dillsburg firm failed about that time and so nothing further was done about the Hunterstown mine.

Twenty years later Erb returned to Hunterstown, this time to form the Reliance C. About $75,000 in stock was sold. Mr Harman, as foreman of the mine, purchased some of the stock. He still retains the beautifully engraved certificate.

The Reliance Co. was incorporated under the laws of the Territory of Arizona on November 28, 1905, with $250,000 worth of capital stock. M.L. Davis, of Lancaster, was the president. When the mine resumed operations, about 1905, a force of some 20 men was engaged and work progressed around the clock.

First sought was copper. One day Allen Harman, W. Middle St., then eight years old and one of the foreman, happened to discover some interesting defects in the copper rock. The golden strains through the rock turned out to be "actual gold." Then work at the mine progressed faster. Mercury baths were set up to pick the gold out of the rock. Harman tells of wiping his hand across the top of the mercury and pulling off a pound of gold at one time. Erb used the pound as a pocket piece.

But the mine was doomed for failure. Nothing was ever shipped from it, and the company eventually went out of business. A short time after that an engineer from Boston looked over the site for another concern. He was enthused with what he found. But nothing ever came of that enthusiasm.

And so the mine deteriorated. The buildings slowly rotted away. Later, the machinery was sold at sheriff's sale to the Bittinger quarries near Cross Keys. Now all that remains is the hole in the ground, full of water, the entrance clogged with tin cans and other rubbish dumped there over the years. The mine was a failure. But it did pave the streets of Hunterstown with "gold" - until the state highway department put blacktop on the highways."

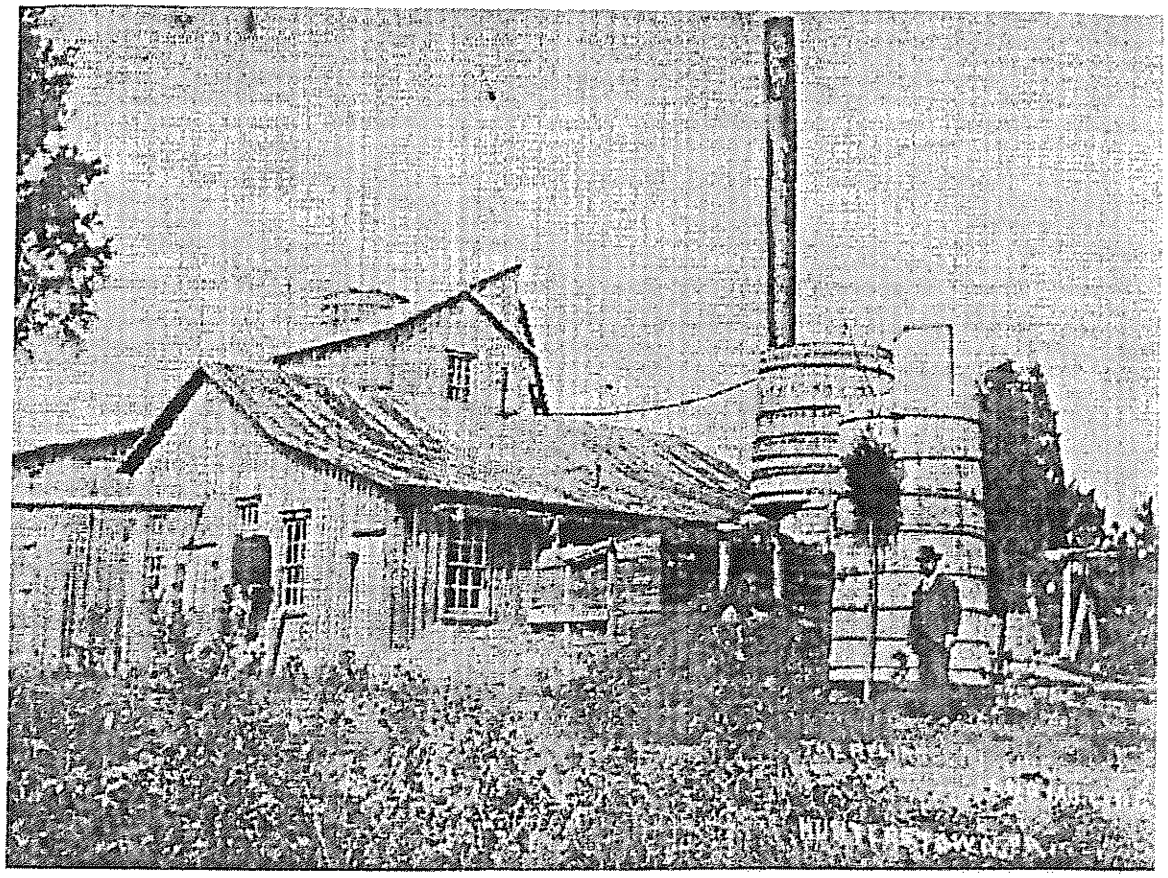


Fig. 12. A view of the Reliance Mining and Milling Company taken in 1905. Parris Erb, mine manager poses in front of the ore washing tank. Photo from Jay Lininger, Matrix Publishing Company of Dillsburg, PA.

Mrs. Allen Harman, reported in 1984 that she can remember the Hunterstown mine buildings in 1909 and that children entered the mill sheds and found bottles of mercury which they poured onto their hands to watch the heavy liquid roll around on their palms (Hoff and Smith, 1985). Donald Hoff and Robert Smith, II, also reported through a communications, with Edith Criswell that a mine-roof collapse occurred about 1910 when her father, Robert Englebert, was working in the mine with Hayden Camper, and that some of the mill concentrations may have been shipped from Granite Hill Station. She also stated that the mine buildings were still present prior to its final closing in 1916, when her husband-to-be, Vernie Criswell, and William Matthews were the last two men to work the mine. According to Mrs. Criswell, activity at the Hunterstown mine ceased and resumed several times during the 1905-1916 period.

George W. Stose, a geologist who conducted research for both the U. S. Geological Survey and the Pennsylvania Geologic Survey visited the site and noted his findings in his Adams County report in 1932:

"An incline descends 200 feet westward at an angle of 60 degrees, and at the time of visit the prospect was equipped with hoist, crusher, and other machinery. The incline however, was not open to inspection."

Donald Hoff, Curator of the Earth Sciences at the State Museum of Pennsylvania entered the mine in 1955 and reported the following:

"Observed that the upper section of the mine was developed as a pair of inclines connected by a cross-cut. The southerly incline has two short, side drifts. Both inclines follow relic sedimentary bedding that dips approximately 30 degrees to the west-northwest."

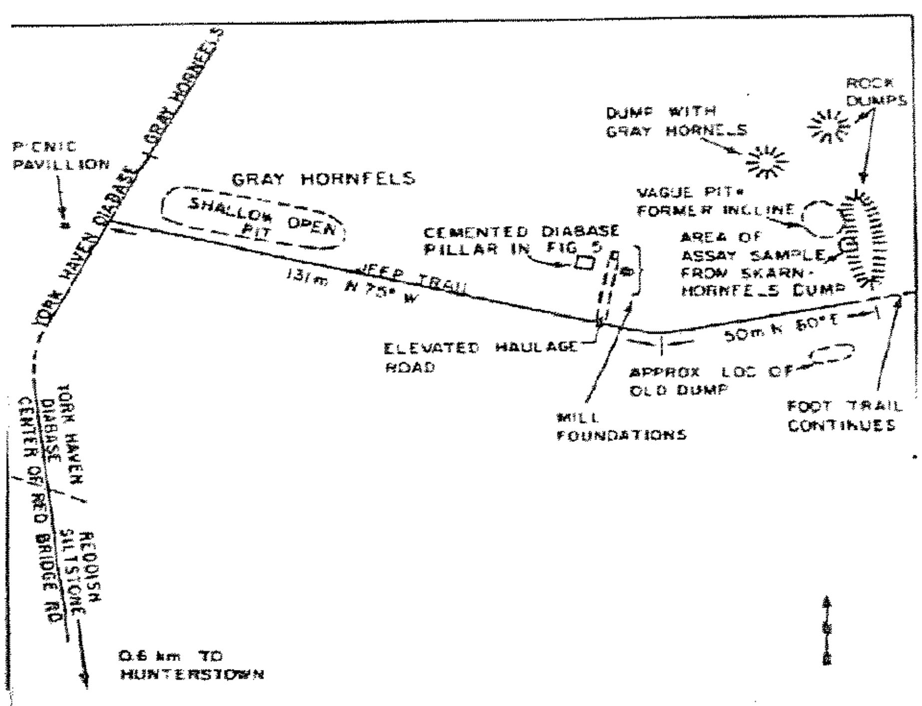


Fig. 13. Site map of the Reliance Mining and Milling Company Mine
(from Hoff and Smith, 1985)

Geology in the vicinity of the Mine

This deposit is located within the GNLS of the Piedmont and the Gettysburg Formation, composed of sandstone, shale and minor amounts of limestone of Triassic age. It was the interaction of an intruding magma body with these sedimentary rocks that created the Hunterstown copper-gold deposit. Today, the magma has cooled and is the rock called diabase (iron stone). Such deposits formed in this method are termed as "Cornwall-type deposits, since the world-famous Cornwall Mine in Lebanon County was formed in a similar fashion (Spencer, 1908). Such occurrences are somewhat common within this physiographic section throughout southeastern Pennsylvania. Many of these deposits have been worked for iron, copper and stone. Mineral collectors for many years have collected on the dumps in the mines of these deposits as they traditionally show a variety of mineral species. Other Cornwall-type locations within Adams County and neighboring York County include: Valley Quarry - Gettysburg plant, Stone Jug Hollow, and the Dillsburg-Grantham-Welsville district (Jones and Bowling, 2001; Jones and Eisenberger, 2002; Hoff, 1978; Smith and Hoff, 1977; Jones and Goodman, 1980; Spencer, 1908).

The occurrence of gold with some of the Cornwall-type deposits has been noted, found within some of the ore and also from the diabase (Jones and Schmerling, 2002).

Various elements determined what minerals would form and how much the rock would be altered during contact metamorphism. Elements would include:

1. Composition of the Gettysburg Formation sedimentary rocks
2. Composition of the magma
3. Chemical reaction created between the sedimentary rocks and magma
4. Depth of burial that reaction occurred
5. Temperature of the magma
6. Distance from the actual contact between the sedimentary rock and magma

Taylor and Royer (1981) show the Hunterstown mine located within an northern-extended off-shoot of what geologists call the Gettysburg Sheet. This is a large intrusion of diabase within the Gettysburg Formation that transverses Adams County southwest-to northeast.

Inspection of the three small dumps remaining on the property shows very little mineralization (Fig. 13). This would support why no or very little ore was transported from here. The copper mineralization occurs in update-rich light-colored (lime-bearing) rocks. Minor amounts of green to bluish-green chrysocolla and rare malachite were observed. Hoff and Smith (1985) reported the following analyses of a high-grade sample taken from the dumps:

Copper - 0.54% Gold/ton - 0.012 oz. Silver/ton - 0.01 oz.

Small, localized copper occurrences are not unheard of within the Triassic section. One of the today's leaders (JLJ) knows of such occurrences showing malachite on the property of the East Berlin Fish & Game Club near Lake Mead, Adams County; on a farm off of Davidsburg Road in Dover Township; along Fox Run, east of Bull Road, in Conewago Township; and at LeCron's copper prospect near Foulstown, all in York County. The Fox Run and LeCron's localities were sites of previous copper exploration (Jandorf, 1913).

Side Note: The following article was found in the archives of the Adams County Historical Society while researching information for this trip. The article is by Sickles (1966):

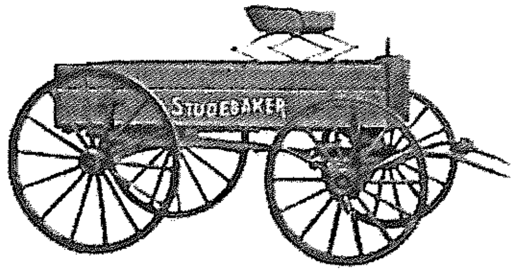
"In 1737, the first settler to build his house in this part of the Old Marsh Creek settlement region of the "highlands" of Lancaster, then the fourth county of the province of Pennsylvania was one of John McCreary. His house stood for many years after the establishment of Gettysburg by Samuel Gettys in 1769, in the area of the present Gettysburg now referred to as "Long Lane" or the Recreational Park. Jacob Moritz erected the second house in "Sleepy Hollow" near the present Gettysburg High School area, in 1742."

"Word was passed around for many years in early Gettysburg that John McCreary and Jacob Moritz mined copper in the area where the mine has always been believed to have existed. Gettysburg's late well-known barber, Joseph Hoffman, whose grandfather sold the land on High Street in 1850, on which the second Catholic Church was built in 1852, told me that difficulty was encountered in the excavation for the new church, when the ground "fell in" and revealed the tunnel below, in which water was running. The same was found when George Arnold erected his building on the Square in 1846, the building in which the Adams County Farmers and Merchants Savings Institution, the forerunner of the present bank, was started in 1859. Gus Tawney, many years the borough's Superintendent of Streets, "also found the tunnel" while digging beneath the Square in 1911. But, to this day, there is no record available anywhere to verify that copper was ever found beneath Gettysburg, so-called "mine" was but a natural subterranean water course."

Old mines, quarries and sinkholes were once attractive places to dump almost anything as it was a matter of "out of sight, out of mind". While this mindset still exists, it is hopefully disappearing as littering laws, environmental regulations, recycling programs and educational campaigns strive to raise awareness and get people thinking about their actions. As you might expect, these efforts are designed to address more than just the aesthetics of litter. There can be significant threats to the environment and human health from improper waste disposal. It's much easier for the likelihood of ground-water contamination when material is introduced into the subsurface via mines, pits and sinkholes. Consider that a gallon of used oil can render millions of gallons of water unfit for use. Ultimately, that polluted ground water will discharge into a stream if its not extracted from a well at some point. A nearby example of the ramifications of dumping is the Hunterstown Road Superfund Site (towards Gettysburg). During the 1970s, waste containing chlorinated solvents was just dumped on the ground at the three acre site. In the early 1980s, it was discovered that significant soil and ground-water contamination had occurred and several residential water wells were impacted. Although the U.S. Environmental Protection Agency (EPA) considers the soil cleanup complete after the removal of over 9000 tons of contaminated soil and sediment and 80 buried drums, the ground-water remediation program is still being designed. Significant costs have been borne by all parties (including taxpayers) in addressing the site. So, the legacy of dumping can involve much more than it seems.

DID YOU KNOW THAT? John Clement Studebaker built a house and work shop where he worked as a blacksmith and wagon maker on Studebaker Road, about 2.4 miles north of here. Today, a monument has been placed on the property in honor of Mr. Studebaker. So who was Mr. Studebaker? Have you heard of the Studebaker cars, later headquarted out of South Bend, Indiana?

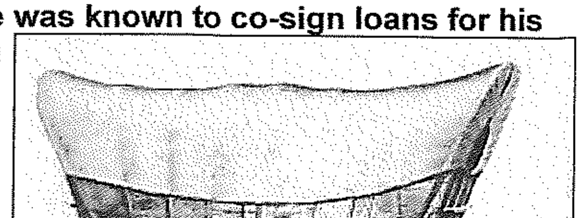
NOTES



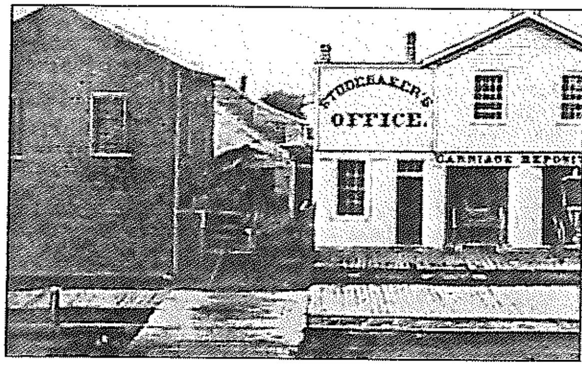
The Wagon Business

The Studebakers trace their origins to the Ruhr Valley of Germany in the town of Solingen. Located southeast of Düsseldorf, on the western reaches of Germany, this locale has been renown, since the middle ages, for it's iron work and blade making. Throughout the late 1600's the people of that region had been subjected to war, heavy taxation and religious strife and by the early 1700's life for many had turned unbearable. Peder and Clemens Studenbecker[1], working as blade maker's then, decided to forsake these harsh conditions and immigrate to The New World. Departing Germany in those days though, was frought with obstacles, the most daunting of which were the guilds. Skilled workers, such as the Studenbeckers, belonged to trade guilds. These organizations, formed to uphold trade standards and protect members, were loath export their professional secrets. The brothers were told that in order to quit the guild, they had to relocate to another city and work at a different trade for five years. They complied by moving to Hagen[2], to the northeast of Solingen, and having satisfied their obligations, journeyed down the Rhine with their cousin Heinrich [3] to Rotterdam. Sailing on the *Harle* for Philadelphia, they arrived in the American colonies September 1, 1736 and eventually moved to Germantown to take up farming.

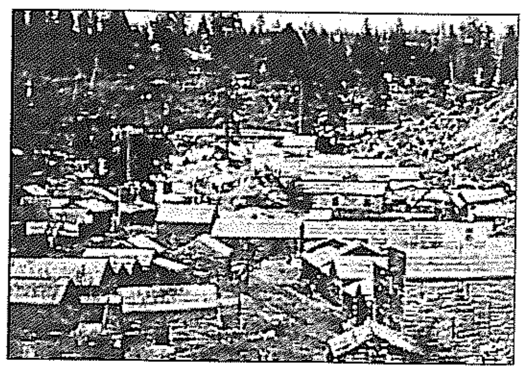
John Clement Studebaker was born on February 8, 1799 in Adams County, Pennsylvania, sixty-two years after the first Studebakers landed in America. He was married at age 21, in Ephrata, Pennsylvania, to Rebecca Mohler, an 18 year old from Lancaster. Purchasing some land in 1830 near Getty's Town (now Gettysburg), he built a house and work shop where he worked as a blacksmith and wagon maker. Industrious and devoutly religious, he ran his business on the philosophy "always give more than you promise". Times were hard though and his efforts at raising a family were not very successful. Not only was the country in an economic slump, but John C. had a charitable spirit towards those in need. He frequently undercharged people, accepted farm goods for payment or did work on credit for which he didn't collect. Additionally, he was known to co-sign loans for his church brethern, some of which defaulted. Within five years he found himself deeply in debt and was forced to sell his holdings. Captivated by the possibilities that lay further west, John Clement built a covered wagon and moved his family to



Ohio where he felt life would be easier. Arriving in Ashland, Ohio in 1836, he purchased a small farm and mill with the intent of taking up milling. Ill-fortune, it seemed, followed him to Ohio and when persistent creditors tracked him down, he was forced to sell the mill and return to blacksmithing and wagon making. Life in Ashland was no better than before as the nations economy worsened and his familier mode of doing business pushed him deeper into debt. Ultimately he was forced to mortgage his land to pay creditors. Confident he could still find a place where he might prosper, he headed further west, leaving his eldest son Henry to run the business in his absense. Venturing into Indiana he came accross a town called Southhold, later to become South Bend. Located next to the St. Joseph river he felt that it had possibilities and returned to Ohio to prepare his family for yet another move. Clement, his second son, went ahead a year before the family[4] and late in 1851 John C. Studebaker and family departed Ohio in that same covered wagon bound for South Bend.
(Click Image to Enlarge)



As the Studebakers settled in, Clement was teaching and Henry was blacksmithing for hire. Neither was happy with their arrangement and they endeavoured to go into business. With the passion of youth, $68 and two sets of smithy tools, they established *H & C Studebaker* on February 16, 1852. The first day of business grossed 25 cents for shoeing a horse. A few weeks later they received their first wagon order from a Mr. Earl. The wagon was constructed and sold for $175. Business was slow though and they did whatever they could to make ends meet. The end of the first year would bring just one more wagon order[5]. At this time the third son, John Mohler, had come of age. He, like his brothers, had learned smithing and wagon making but his immediate desires lay west in the gold fields of California. When a wagon train passed through South Bend early in 1853, he proposed an arrangement wherein he would give them a new wagon in exchange for passage and board. It was agreed and his brothers helped him build the wagon in ten days.
(Click Image to Enlarge)



J. M. (as his family called him) arrived in Hangtown, California on August 31, 1853 with but 50 cents in his pocket [6] . The anxious party of gold seekers had barely stretched their legs when a request went out from the crowd of towns folk for a wagon maker. The blacksmith was in need of help. J. M. acknowledged his experience in that trade but declined the request saying he was eager to begin prospecting. A stranger standing nearby[7] cautioned him that prospecting was risky and that the job just offered him was a fine opportunity. Impressed by his candor J. M. took the strangers advise but, the smithy, Joe Hinds, was not building wagons. He was in immediate need of 25 wheel barrows. J. M. was to receive $10 for each wheelbarrow he completed. Accustomed to oak and hickory he did his best with the pitch pine at hand and finished the first one in two days. Upon hearing Joe's critisism of his first effort, J. M. replied he "was a wagon maker, not a wheel barrow maker" and assured him the next one would be better. He would work for Hinds [8] for the next five years becoming known

STOP 3. CSX RAILROAD TUNNEL - JACKS MOUNTAIN (Tapeworm Railroad)

Historical Sketch: Thaddeus Stevens is credited with many accomplishments in his life, particularly when he was a member of the Pennsylvania legislature body. Thaddeus was involved in two major areas: 1) education for young men, and 2) iron furnace interests. You see, Thaddeus owned both the Maria Furnace near Faifield and the Caledonia Furnace, along U. S. Route 30 in Caledonia State Park. He had a dream of connecting by rail, the area near Hagerstown, Maryland with Baltimore and Philadelphia. Beginning in 1836, Taddeus designed a railroad that would transverse South Mountain in southern Adams County. Although no proper name was never known for this project, it became known as the "Tapeworm" since it weaved its way across the mountain in a rather conspicuous route.

The roadbeds were limited to a rise of just one percent, one foot per 100 feet. In the days of the "Tapeworm", the engines were wood-fired, and it was impossible to create steam pressures high enough to recover much energy from the old prime movers. Today, some of the old bed can still be seen, including the custom-crafted viaducts constructed of granite. The Irish who worked on this construction were highly skilled, exactly fitting each piece of stone without using cement to support the weight of the trains. A draw back was that Thaddeus did not have necessary equipment to cut through the rocky slopes of Jacks Mountain and do the necessary grading. Although more than $500,000 was spent on this project, a political upheaval in the State House in 1838-39 was the beginning of the end of the "Tapeworm" project. After an investigation, it was determined that the "Tapeworm" was to benefit only Thaddeus with his iron interests in the area and not good for the county, state or nation. The story of this investigation which led to the failure of the "Tapeworm" is included in the following pages.

The Western Maryland Railroad about a half of a century later bought some of the rights to the "Tapeworm" and completed this important link for rail between Hagerstown and points east. This included the construction of the Jacks Mountain tunnel.

Geology: Let's switch "tracks" somewhat and look at a different aspect of geology. With the trip coming into the SMS to look at the mineral resources (Stops 4 and 5), we could not refuse to include the "Tapeworm Railroad Tunnel" as part of the tour. Although it is about a 1.3 mile walk round trip, it is well worth the trip to see a small cross section of Jacks Mountain, one of the prominent peaks within this area in southern Pennsylvania (Fig. 14).

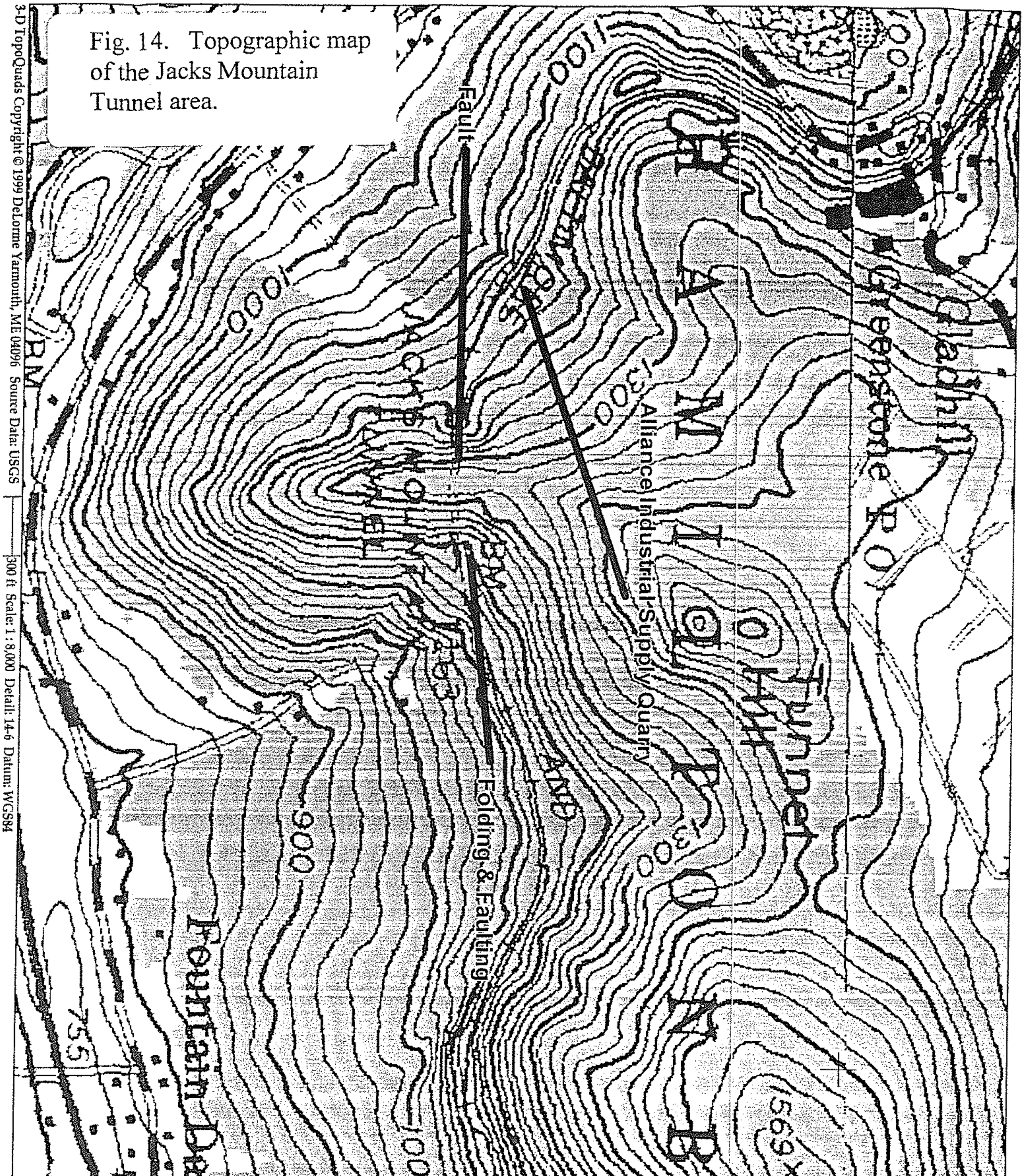


Fig. 14. Topographic map of the Jacks Mountain Tunnel area.

Geology is not an exact science, after all if we knew all of the answers about how rocks formed, the history of the Earth and where all the valuable minerals are, what kind of excitement can we add to the science. What makes geology interesting is that "when you think you know all of the answers, you find out that you don't."

OK, so this is the stop where we study how the rocks at the tunnel were pushed, shoved, and broken. We could write three pages about all of the features a structural geologist would see, but we think you, the reader might get lost in the reading when we use words such as axial cleavage, jointing, overturned beds, and crenulation folding. Instead this is a stop where you can admire the rock exposure and say "Wow, that's cool." We , however, will give you a bit of its history as far as we know it. You see, the structural geology of the SMS is still one of the most complex in the state and really not too well understood.

Today, we are using two different research papers to relay the information to you about the CSX Railroad tunnel geology. John Fauth conducted a comprehensive geologic survey of the area in 1978. He also conducted a similar survey in the Caledonia State Park to our northwest in 1968. Using this stop as a tour stop for geologists, David MacLachlan (1993) described a slightly revised interpretation of this railroad cut using some of Fauth's ideas. It is not our purpose here to base our opinion on what we think is accurate, but to show you the complexity of an area and methods of interpreting its geology. We share some of both authors ideas below, put in layman's terms.

As we start to walk northeastward from Gladhill (Greenstone), we will encounter several exposures of the Catoctin Formation metabasalt. This rock was actually volcanic lava some 720-800 million years ago, making it one of the oldest rocks visible on the surface in Pennsylvania. If you closely examine the rock as you pass by it, you may see features that are called amygdules which were once gas bubbles that after the lava cooled, the gas bubbles broke and later filled in with minerals. Minerals such as epidote (grass-green) and quartz (white) are the two most common inclusions. If you look carefully, you may also see scattered patches of another green-colored mineral, malachite, which is indicative of the copper content of some of the metabasalts (as you will learn at stop 5). Because the rock is a fine grained dark (mafic) igneous rock, it is termed a basalt. Later metamorphism (at least two different episodes of heat and pressure seen in these rocks) slightly changed the mineralogy, but left the texture of the rock very much the same as prior to metamorphism.

Of course, the highlight on this particular stop is the tunnel itself. As you enter the portal from the west, the rocks exposed here are still the metabasalt, but you are soon to see a change. As you enter the tunnel, look at the south wall (right side) and see if you, as an amateur geologist, can detect a change in rock type. If you are observant, you will see a change in color from a darker color of the metabasalts to a lighter color rock that we call the Weverton Formation.

The Weverton unit is composed here of quartzite (metamorphosed sandstone) and a small amount of phyllites (metamorphosed shale). This formation is younger in age, dating back into the Early Cambrian times based on fossils found in the area. The line that separates these two formations here is a fault, but there is a difference of opinion between Fauth (1978) and MacLachlan (1993) on what type of fault it is based on the relative movement along the fracture. If the Weverton Formation slid up and over the metabasalt, it would be classified a reverse (thrust) fault, but if the metabasalt moved upwards relative to the Weverton rocks, than it would be classified as a normal fault. So, what difference does it make? Reverse faults occur in areas where compression has taken place (thrusting). Normal faulting results in areas where tensional stress (pulling apart of) has occurred. What makes this decision so tough to interpret is that both reverse and normal faults exist in the SMS and neighboring GNLS.

As you continue through the tunnel, watch your step, but you will now stay within the Weverton Formation. Toward the eastern end of the tunnel, you will start to notice that the rock appears to be twisted, as the layers of quartzite and phyllite are going up and down (Fig. 15). Exit the tunnel and observe the rock outcrop , particularly on the north side. This is one of the classic examples of folding in southeastern Pennsylvania. If you attempt to follow individual beds, you may also detect that some of the beds are discontinuous, meaning that they have been broken by faults. If you think these rocks are a mess, you are right!!

Folding occurs when compressional stress is put onto bedrock. If the rock can give a little and bend, it will fold, before it breaks. If the composition of the rock is not "bendable", the rock will fracture and shift to counter the stress, thus forming faults. Folds that form an arch-shape are termed anticlines and those making a "U" shape are termed synclines. How many anticlines, synclines and faults can you locate within this railroad cut?

To put this exposure into a larger picture, the SMS is believed to be an overturned anticlinorium, which appears in cross section as an anticline, but has been pushed over the vertical, leaning in one direction. Within an anticlinorium are a series of synclines and anticlines, but overall the shape is that of an anticline. According to MacLachlan (1993), we are located near the axis (center) of this anticlinorium, with the axis of the fold plunging toward the southwest.

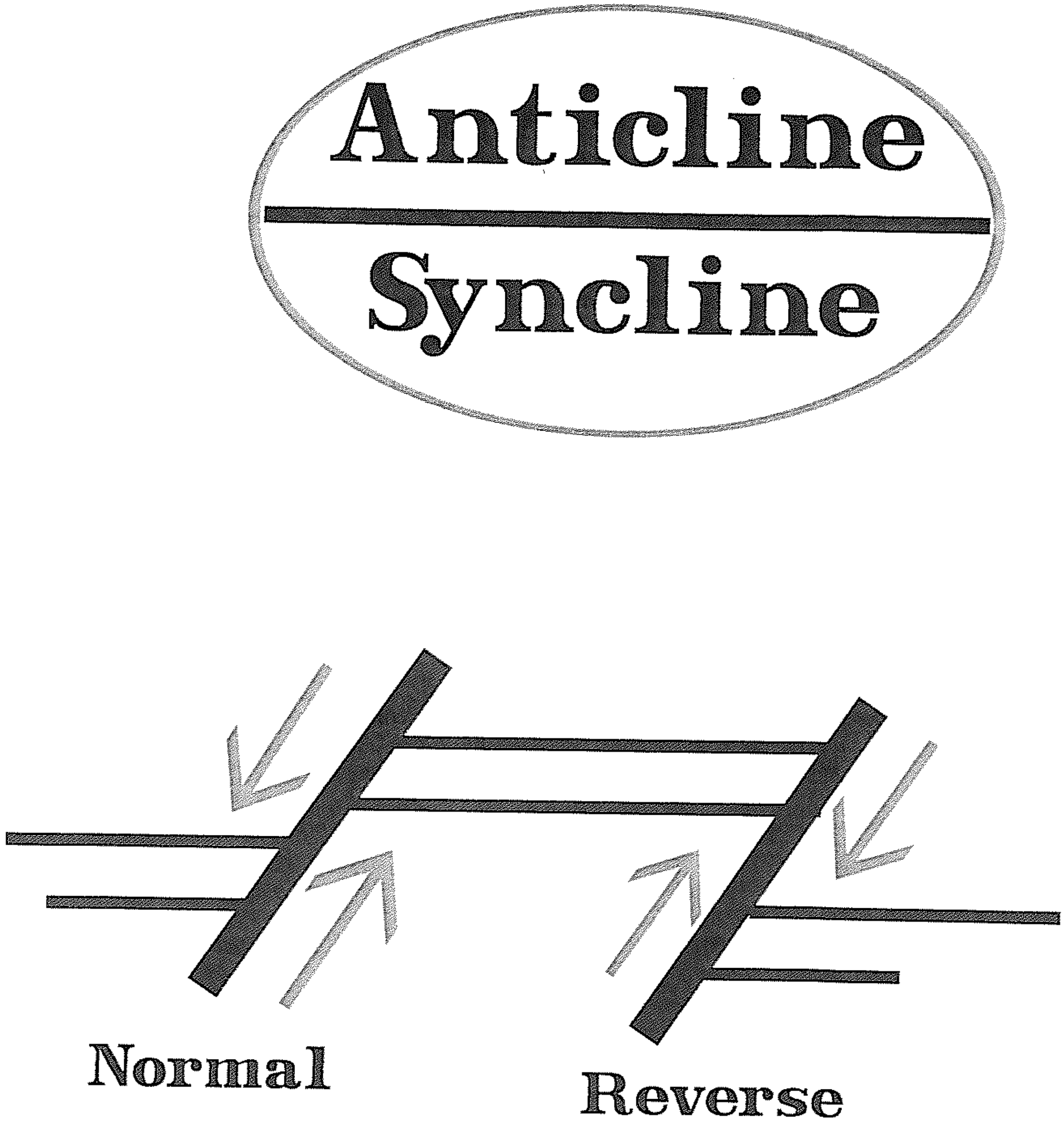


Fig. 15. Types of Folds (top) and Faults (bottom)

Thaddeus Stevens, The Great Commoner

By Ross Hetrick

He could be called the most famous unknown person in American history. In his time, his fame rivaled that of Abraham Lincoln and when he died in 1868, his body lain in the Capitol Rotunda-an honor previously bestowed only on Lincoln and Henry Clay. Yet today, if you ask who Thaddeus Stevens was, you get a quizzical look and a shrug of the shoulders. Even in Gettysburg, where he started his remarkable political career and has a street, building and creek named after him, he is practically a non-entity.

His memory was resurrected briefly in early 1999 because of the Clinton impeachment. That's because Stevens spearheaded the only other impeachment effort in 1868 against Andrew Johnson. Yet, that was only the capstone to a career that stretched from the ridiculous to the sublime and included achievements that helped change our nation dramatically.

Acknowledged as the most prominent-and the craftiest-attorney of his day in Pennsylvania, Stevens was dubbed the "Great Commoner" for his unfailing advocacy for the downtrodden and his opposition to slavery. His life reads like a great epic with the hero overcoming every obstacle, dying in the end in one last momentous struggle.

Born in Danville, Vermont in 1792, he was abandoned by his father in his early childhood to be raised by a mother with a deep passion for education. After attending the University of Vermont and Dartmouth, he moved to Pennsylvania where he was a schoolteacher for a short time in York before passing the bar and putting out his shingle as a lawyer in Gettysburg in 1816. It was there that he made a name for himself as a politician. Yet, he latched on to the most improbable of political vehicles-the Anti-Mason party, a movement that attributed most of the problems of the young republic to the Masons, a very old fraternal organization. Yet, because of his political skills, Stevens was able to make the Anti-Masons into a powerful force in Pennsylvania politics and kept it alive in the state long after it was moribund in the rest of the country.

One of the most famous acts during these early years was his defense of Pennsylvania's public school act of 1834. His stirring speech on April 11, 1835 as a member of the state House of Representatives is credited with turning back the tide to repeal the legislation passed the previous year. He urged his fellow legislators to "build not your monuments of brass or marble, but to make them of everliving mind."

Also during his time in Gettysburg, he became the largest property owner and started various iron mills, including one in Caledonia, outside of Chambersburg. One of his most prominent achievements was Gettysburg College, for which he secured $18,000 from the state in 1834 for its initial buildings. He then went on to sell property to the college for its campus, served on the board of trustees for 34 years and helped prevent it from leaving Gettysburg in 1854.

But he had his share of fiascoes. One was the "Buckshot War" when he and his allies tried to steal an election in 1838. But the plan backfired when mobs from Philadelphia invaded the legislature, forcing Stevens and others to jump out a window and run across a field. Then there was the Tapeworm Railroad, so named because of its zigzag course through the mountains of Pennsylvania. After spending hundreds of thousands of dollars on the project, it was dropped by the state legislature with Steven's enemies charging it was a boondoggle to help his iron mills located on the proposed railway.

Moving from Gettysburg to Lancaster in 1842, Stevens again entered politics as a Whig and was elected to Congress from 1848 to 1852. He then helped form the Republican Party in Pennsylvania and returned to the House of Representatives in 1858 and stayed until his death in 1868. During these last 10 years of his life, which were plagued by health and financial problems, he played a crucial role in the Civil War and its aftermath.

As chairman of the House Ways and Means Committee, he guided through measures that were essential to finance the war. He was unrelenting in his pressure on Lincoln to use blacks as soldiers and to free the slaves. In fact, some historians suggest that Stevens deserves the title of the Great

Emancipator as much as Lincoln. As the undisputed master of the House of Representatives, he was also a key mover of the 13th and 14th amendments, which helped insure the freedom of the slaves. He even played a part in the Battle of Gettysburg. Confederate general Lee set up his headquarters in a house owned by Stevens and the unfinished railroad cut, where Confederate soldiers were slaughtered, was a remnant of the Tapeworm Railroad. Confederate general Jubal Early also warmed up for the battle by burning Stevens's Caledonia iron works on his way to Gettysburg.

Despite his dour demeanor, there were many jokes associated with Stevens. Asked by Lincoln about the honesty of his secretary of war, Simon Cameron, Stevens replied, "He wouldn't steal a red-hot stove." When Cameron demanded a retraction, Stevens complied, telling Lincoln that Cameron would steal a red-hot stove. Another time, a political enemy encountered Stevens on a narrow sidewalk and refused to step aside, saying, "I never get out of the way of a skunk," "I always do," Stevens said, stepping off the curb.

Some of his greatest-and most controversial-actions came after the war when he strived to protect the hard-won freedom for the former slaves and transform the south from a feudal society to a more egalitarian republic. It was a struggle that would make him the chief architect of Reconstruction and the leader of the effort to impeach and convict Andrew Johnson.

In a crucial, yet little known episode, Thaddeus Stevens and Edward McPherson, the clerk of the House, were able to prevent the takeover of the Congress by southern Democrats and their allies. It was at the end of 1865 and Andrew Johnson had issued pardons wholesale to Confederate leaders, who were then elected to Congress. On December 4, the unrepentant secessionists showed up ready to take up where they had left off before the war.

But Stevens had instructed McPherson, a former Gettysburg congressman and Stevens's protégé, not to call the names of the southerners. This was met by howls of protest from the southerners, but Stevens called for order until the roll call was finished. With the southerners unable to vote, the house passed a measure creating a committee to deal with the matter of southern representatives. This effectively barred the southern states from taking over the congress and allowed Stevens and the Republicans to pursue their Reconstruction policies.

Stevens has been widely condemned for this action, with some historians calling him the "dictator" of the House. But if he had not exercised this brilliant, yet simple, parliamentary maneuver, the history of the United States may have been very different. Slavery may have continued in another form for generations to come. Even though the 13th Amendment was passed, the southern states were using the incarceration loophole in the amendment to place blacks back into involuntary servitude. This was done through the notorious Black Codes, which jailed blacks for not having jobs and then turned them over to planters to be used as slaves again. To get jobs, blacks had to get work permits from local sheriffs, who were not disposed to issue them. This was only stopped with the stationing of federal troops in the south and the passage of the 14th Amendment, which extended the protections of the U.S. Constitution to the states.

If southern and northern Democrats had controlled Congress, the 15th Amendment giving blacks the vote would never have passed, thus denying them that important right. Even with that amendment in place, civil rights advocates had to fight mightily against the southern powers a hundred years later to insure the right to vote.

It is hard to say what ramifications there would have been if Stevens had been successful in his most ambitious plan-the confiscation of land from leading Confederates and the redistribution to freed slaves. Called the "forty acres and a mule" plan, Stevens hoped to break the back of the southern aristocracy and establish a society of yeoman farmers, such as existed in the Midwest. But it is doubtful the freed slaves would have been able to hold on to the land after Reconstruction ended in 1877, considering the violent crusade the white southerners mounted that disenfranchised the black population.

The impeachment of Andrew Johnson, which failed to convict him by one vote in the Senate, was also part of Stevens's struggle for equality. Johnson was the main obstacle to the Reconstruction plans and the president helped to stiffen southern resistance. Stevens and other Republicans saw the absolute need to remove Johnson if they were to be successful. And even after the effort failed, Stevens in the last three months of his life introduced another unsuccessful resolution of impeachment.

Stevens, once denounced, has in recent years been celebrated for the vital role he played in helping American realize the ideals set forth in the Declaration of Independence. In his final years, his considerable energies were focused on uplifting one of the most dispossessed people of America-the slaves. And while other politicians paid lip service to equality, Stevens believed it to the marrow of his bones. He carried this commitment to his grave, which was not in the big Lancaster graveyard where James Buchanan, the 15th president, is found. Rather, it is in a small cemetery downtown, appropriately located next to an elementary school. The inscription reads:

Thaddeus Stevens
1792-1868
I repose in this quiet and secluded spot,
not from any natural preference for
solitude, but finding other cemeteries
limited as to race by charter rules, I have
chosen this that I might illustrate in my
death the principles which I advocated
through a long life:
EQUALITY OF MAN BEFORE
HIS CREATOR

If you would like to join the Thaddeus Stevens Society, email us at: rhetrick@gettysbury.edu

home

The "Cornerstone Speech"
This is an example of the mentality of the South at the time of the Civil War

STOP 4. ISP MINERALS QUARRY - CHARMAIN

Here ISP Minerals, headquarted in Hagerstown, Maryland is extracting the Catoctin metabasalt for the use of the manufacture of artificially colored roofing granules at their nearby granule manufacturing plant. The stone has the physical characteristics necessary to meeting all of the specifications required for top-grade base granular material for artificial coloring. The rock must be nonporous, as uniform as possible in color and texture, resistant to weathering, and compatible with the coloring process (Nelson, 1968).

Mr. Tony Shepeck, geologist for ISP Minerals, has furinshed the accompanying insert with the most up-to-date information on their production here.

NOTES

STOP 5. COPPER MINES IN SOUTH MOUNTAIN

When one thinks of areas in the country that mine copper, states like Michigan, Arizona and Utah come to mind. Who would ever think of Pennsylvania and especially Adams County. Well, look surprised because we had numerous copper mines or prospects in operation within the Catoctin metabasalt between Fountain Dale and Mt. Hope (Fig. 16). The first record of native copper in Adams County was in 1787 (Wherry, 1911) with efforts to mine and smelt it as early as the 1830's (Frazer, 1880). Attempts to mine copper continued off and on until the 1920's when the last operation closed. Occasional rumors and actually potential investigations by mining companies were heard throughout the steep terrain of these lovely mountains; the last back in 1965 (Lininger, 1978). Dr. E. T. Wherry visited the area in 1911 and reported that 80 prospects and mines existed, but only about 20 are known in recent time (Lininger, 1978).

Interest in the Adams County native copper district was probably due to the fact that the larger and richer copper deposits in Michigan were just being discovered. Similar to the Adams County geology, the Michigan copper was also being found within metabasalt. According to Geyer and others, 1976:

The native copper was formed from chloride-bearing aqueous solutions released during the metamorphism of basalt at greater depth. Copper was leached from the deep, hot dry rocks and added into the cooler, near surface rocks which were undergoing hydration. Recent, near surface alteration of native copper has produced the brightly-colored secondary copper minerals.

The mines: According to documentation, no large copper deposits were ever found in Adams County. Although several prospects are located in Franklin County to the northwest and into Maryland to the south, the majority of the mines are located within a small area of southwestern Adams County. Listed below are the major mines including type of mine and additional comments:

1. Virgin Mine
   - Inclined shaft
   - Operating in 1909 (Stose, 1932)
   - Destroyed by the GAF/ISP Minerals quarrying
   - Rich ore reported at a depth of 308 feet
   - Machinery used included: head frame, iron skip cars, surface dump cars, 8-horsepower hoist, pump, 22-horsepower gasoline air compressor and tanks for compressed air hand drills.

Fig. 16. Location of the major copper mines west of Fairfield.

3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 1500 ft Scale: 1 : 43,750 Detail: 12-0 Datum: WGS84

2.	Eagle Metallic Copper Co.	Inclined shaft Operating in 1909 (Stose, 1932) No native copper reported (Stose, 1932) Machinery used included: tram carts, 20-horsepower hoist, blower, pump, drills, and assay house.
3.	Headlight Mine	Tunnel Assay reported as 10-20% copper (Stose, 1909)
4.	Bingham Mine (Copper Furnace Mine)	Open pit and shaft Operated by a Philadelphia company in 1840, which included a furnace on the property Operated for a time by the National Copper Company of Belvidere, N.J. No reported commercial grade of native copper Sample analyzed at 4% copper (Stose, 1909) Rock cut and polished is an outstanding decorative piece, possibly could be a ornamental stone.
5.	Reed Hill Mine	Operated by the Reed Hill Copper Co. Open pit and shafts Masses of cooper up to a pound were reported from here (Stose, 1932)
6.	Russell Mine	Operated by the Reed Hill Copper Co. Shaft and tunnel Equipped with an air compressor and engine. Mine was not open for inspection in 1909 (Stose, 1932) Mineralized zone 8-feet thick was reported
7.	Snively Mine (Old Musselman Mine)	Shafts and tunnel One specimen of copper weighing 27 pounds was reported from here Assay of 5.83% reported (Stose, 1909) Mineralized zone 8-feet thick
8.	Deshler Shaft (Culp Hill Mine)	Reportedly struck good ore
9.	Bechtel Mine	Shaft

Mineralogy: The native copper is accompanied by some other copper minerals, which gives the specimens a beautiful contrast in color. Other minerals identified associated with the copper are: malachite (green), azurite (blue), chryscolla (green), and cuprite (rusty-red). The native copper occurs as wires, grains, hackly masses and rarely crystalline masses often of large size. Lininger (1978) reports seeing several copper specimens weighing up to 30 pounds and has seen masses in place weighing hundreds of pounds. The copper occurs directly in the metabasalt or in white quartz veins or pockets and more rarely in white calcite.

Because all of the above mines are on private property, permission is needed to collect the old dumps. In many cases, the land is not open for collecting. In some cases, if the owner does grant you permission, it is a 2-mile round trip walk, carrying all of the equipment and specimens.

SIDENOTE: Along Pa. Route 16 to the south of Greenstone, native copper was encountered during the construction of the "Underground White House (UWH)." A copper mine across the road is now filled in with water, but the one co-author (JLJ) did some collecting here and on the dump piles of the material taken out for the UWH some 32 years ago.

NOTES

OTHER MINERAL RESOURCES IN ADAMS COUNTY

Of course, with our limited time on this trip, we aren't able to show you *all* of the mineral resources that have been or currently are being removed from Adams County. Below is a listing of the "active" operations not visited today. Number in parentheses behind name is corresponding map number in Fig. 17:

Name	Formation	Product(s)
Glen Gery Corp. - Alwine/Hamilton #1 (365)	New Oxford	Clay/Bricks
Glen Gery Corporation - Alwine- Mt. Pleasant (366)	New Oxford	Clay/Brick
Glen Gery Corporation - Oxford Pit (367)	New Oxford	Clay/Brick
Vulcan Materials Company (368)	See Stop 1	
Wilson Chapsaddle Sand Quarry (369)	Diabase	Sand, clay
Valley Quarries - Gettysburg plant (370) (also known as H.T. Campbell & Teeters	Gettysburg hornfels	Const. aggregate
Valley Quarries - Fairfield plant (371)	Gettysburg congl. Beekmantown	Const. aggregate
ISP Minerals (372)	See Stop 4	

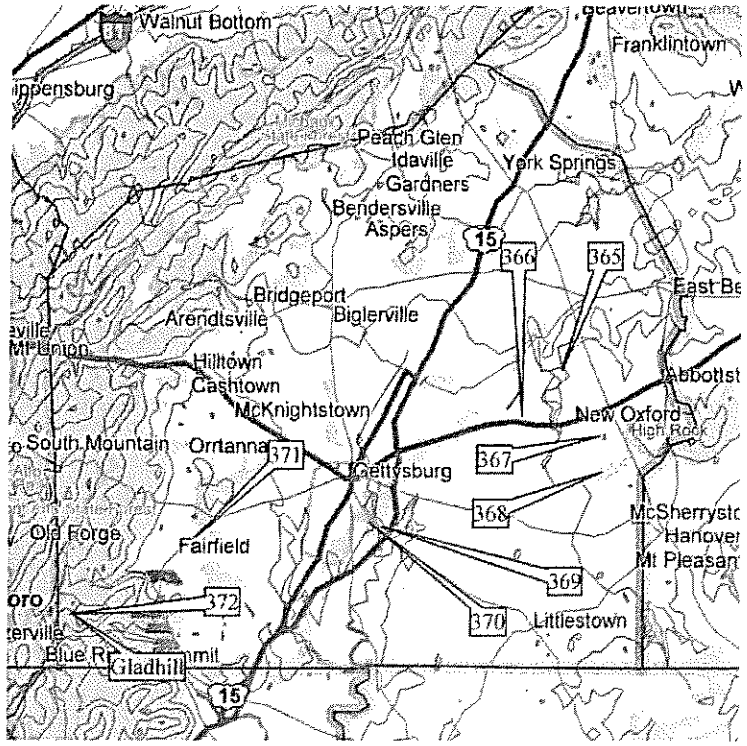


Fig. 17. Current non-fuel mineral producers in Adams County.
(Taken from Barnes, 1997)

In addition to the above, past resources have included numerous limestone and dolomite quarries used by the early farmers and agricultural business people. These quarries are numerous throughout the PLS in Adams County. One of the earliest mineral resources was that of iron, where limonite, hematite and magnetite (all iron minerals) provided a rich resource spanning the late 1700's into the early 1900's. A map of Persifor Frazer's study of the iron mines in 1876 is shown in Fig.18. Many of these mines have been destroyed either by the urban development or filled in by property owners to prevent any liability concerns.

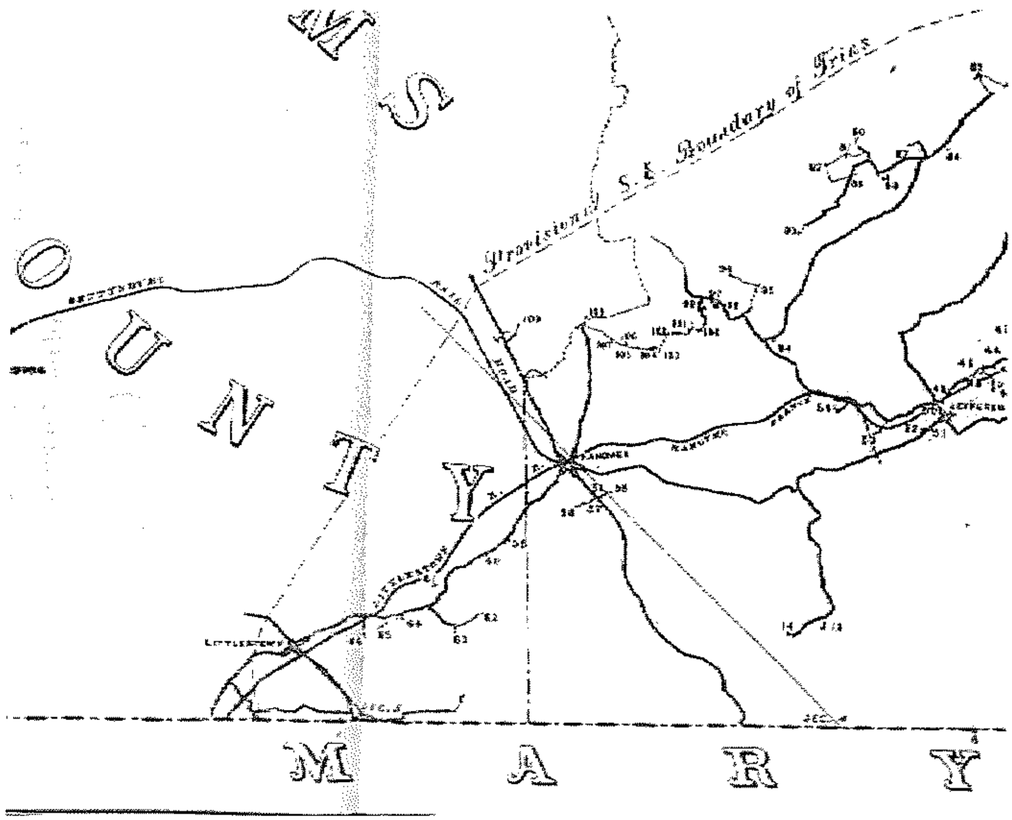


Fig. 18. Iron mines in the Hanover- Littlestown vicinity.
From Frazer, 1876

Other resources removed include the following (from Stose, 1932):

Rock Type	Product(s)
Diabase (nicknamed "Gettysburg Granite)	Decorative Stone
Triassic Sandstone	Decorative Stone
Metarhyolite	Decorative Stone
Quartzite	Decorative Stone
Slate	Roofing
Diabase	Crushed Stone
Limestone	Crushed Stone
Limestone	Lime/flux
Clay/Shale	Paper, bricks, tile clay
White Clay	Paper filler, paint, vitrified tile, chinaware
Vein Quartz	Silica for crockery and tile
Oil/Gas (drilled in several locations with no recovery or production)	

REFERENCES

Barnes, John H., 1997. Directory of Nonfuel Mineral Producers in Pennsylvania. Pa. Geol. Survey, 4th ser., Open File Report 97-04.

Berkheiser, Jr., Samuel W., Barnes John H., and Smith, II, Robert C., 1985. Directory of the nonfuel-mineral producers in Pennsylvania. Pa. Geol. Survey, 4th ser., Information Circular 54.

Brichter, Raymond W., editor, 1993. Guidebook for the 12th annual field trip of the Harrisburg Area Geological Society: South Mountain and the Triassic in Adams County, Harrisburg, PA.

Fauth, John L., 1968. Geology of the Caledonia Park quadrangle area, South Mountain, Pennsylvania. Pa. Geol. Survey, 4th ser., Atlas 129a.

Fauth, John L., 1978. Geology and mineral resources of the Iron Springs area, Adams and Franklin counties, Pennsylvania. Pa. Geol. Survey, 4th ser., Atlas 129c.

Frazer, P., Jr., 1880. The geology of Lancaster County, Pennsylvania. Pa. Geol. Survey, 2nd ser., Report CCC.

Frazer, Jr., P., 1876. Report of Progress in the District of York and Adams Counties showing the Iron Ore Belts and Individual Mines. Pa. Geol. Survey, 2nd ser., Rept. C.

Geyer, Alan R., Smith, Robert C., II, and Barnes, John H., 1976. Mineral collecting in Pennsylvania. Pa. Geol. Survey, 4th ser., General Geol. Rept 33.

Hoff, Donald T., 1978. Campbell's quarry, a complex mineral locality in Gettysburg, Pennsylvania. Rock and Minerals, v. 53, no. 6, p. 247-253.

Hoff, Donald T., and Smith, Robert C., II, 1985. An Adams County copper-gold mine doomed for failure. Pennsylvania Geology, v. 16, p.13-16.

Hole, Gilbert, L., 1968. Geology of the Hanover Quarry, Hanover, Pennsylvania *in* Guidebook for the 33rd annual Field Conference of Pennsylvania Geologists, The Geology of mineral deposits in south-central Pennsylvania. Harrisburg, PA.

Jandorf, Morton L., 1913. Copper in York County, Pennsylvania. Mining Science Press 106, p. 346-347.

Jones, Jeri L., 1997. Surface envirinomental geology of the Oxford Ave. and Edgegrove Road tracts, Conewago Township, Adams County, Pennsylvania. Conducted for Re/Max Quality Service, Inc. of Hanover, PA.

Jones, Jeri L., and Goodman, Jan. The Dillsburg Iron Mines, Rocks and Minerals, v. 55, no. 4, p. 153-157.

Jones, Jeri L., and Bowling, Patrick, 2001. Geology and mineral resources of the Gettysburg, Adams County Area, Pennsylvania. Field Guide for Harrisburg Area Community College- Gettysburg Campus.

Jones, Jeri L., and Schmerling, Donald W., 2002. Gold in southeastern Pennsylvania with collecting sites in Adams, Lancaster and York counties, Pennsylvania. Matrix Publishing, Dillsburg, PA

Jones, Jeri L., and Eisenberger, Larry, 2002. A tiny look at a large quarry - the minerals of Valley Quarry - Gettysburg plant. Rocks and Minerals, in preparation.

Kochanov, William E., 1999, Sinkholes in Pennsylvania: PA Geol. Survey, Educational Series 11, 33 p.

Lininger, Jay, 1978. The native copper and piedmontite localities of Adams County, Pennsylvania. Rock and Minerals, v. 53, no. 3, p. 140-143.

MacLachan, David B., 1993. Jacks Mountain Tunnel in South Mountain and the Triassic in Adams County, Guidebook for the 12th annual Field Trip of the Harrisburg Area Geological Society. Harrisburg, PA.

Miller, B. L., 1934. Limestone in Pennsylvania. Pa. Geol. Survey, 4th ser., Min. Res. Rept. 20.

Nelson, Arnold, 1968. GAF Corporation Quarries, Charmian, Pennsylvania *in* Guidebook for the 33rd annual Field Conference of Pennsylvania Geologists, The geology of mineral deposits in south-central Pennsylvania. Harrisburg, PA.

O'Neill, Jr., Bernard O., 1964. Atlas of Pennsylvania's mineral resources - Part 1. Limestones and dolomites of Pennsylvania. Pa. Geol. Survey, 4th ser., Mineral Resources Rept. 50.

Parker, Sybil P., 1997. Dictionary of Geology and Mineralogy. McGraw-Hill, New York.

Sickles, Eugene S., 1966. Gettysburg's copper mine. Adams County Historical Society manuscript.

Smith, Robert C., and Hoff, Donald T., 1977. Newly discovered minerals at Stone Jug copper prospect, Adams County, Pennsylvania. Pennsylvania Geology, v. 8, no. 5, p.14-16.

Spencer, Arthur A., 1908. Magnetite deposits of the Cornwall type in Pennsylvania. U.S. Geol. Survey Bull. 359.

Stose, George W., 1909. The copper deposits of South Mountain in southern Pennsylvania. U.S.G.S. Bull. 430.

Stose, George W., 1932. Geology and mineral resources of Adams County, Pennsylvania. Pa. Geol. Survey, 4th ser., County Report 1.

Sullivan, Robert M., and Randall, Kesler. A., 1996. Pennsylvania's prehistoric Pachyderms. Natural History Notes of the State Museum of Pennsylvania. Number 2, November.

Taylor, Larry E., and Royer, Denise W., 1981. Summary of groundwater resources of Adams County, Pennsylvania. Pa. Geol. Survey, 4th ser., Water Res. Rept. 52.

Wherry, E. T., 1911. Copper deposits of Franklin-Adams Counties, Pennsylvania. Journal of Franklin Institute, p. 151-163.

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