KARST GEOMORPHOLOGY OF THE COBLESKILL AREA,

SCHOHARIE COUNTY, N.Y.

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INTRODUCTION

The term "karst" refers to a landscape that has evolved primarily by the solutional weathering of bedrock. Karst landscapes, dominated by features such as sinkholes, caves, and cave springs, are most commonly found where calcareous rocks, particularly limestone, comprise a large percentage of the surface.

The Cobleskill area of east-central New York State (Figure 1) is a portion of the Helderberg Plateau, the very northeastern tip of the Appalachian Plateaus geomorphic province. This area contains limestones of Helderbergian (Lower Devonian) age, dipping 1-2 degrees to the south-southwest. Northeast of the village of Cobleskill (Figure 2), tributaries of the north-flowing Schoharie Creek have entrenched through the limestones, providing paths for ground water flow suffiecint for caves and other karst features to have developed to an extent seen nowhere else in the Northeast. Recent works by Kastning (1975), Baker (1976), M. V. Palmer (1976) and Mylroie (1977) have provided a detailed geomorphic and hydrologic examination of the karst in this area. To the layman, the area is known chiefly as the location of Howe Caverns, which is part of the largest underground drainage system in the state.

The stratigraphy of the region is shown in Table 1. A thick sequence of Ordovician clastic rocks are overlain by a thin Upper Silurian section consisting of the Brayman Shale, Cobleskill Limestone, and the lower beds of the Rondout Dolomite. The Silurian-Devonian boundary is transitional within the Rondout Dolomite in this locality (Rickard, 1975). The Helderberg Group of early Devonian age consists of the upper beds of the Rondout Dolomite and the Manlius, Coeymans, Kalkberg, New Scotland and Becraft Limestones. All the limestones except the New Scotland are rather pure, with the Coeymans, Kalkberg and Becraft being exceptionally good scarp and bench formers. Overlying the Helderberg Group is the Tristates Group, a section of Lower Devonian clastic rocks grading upward to the Middle Devonian Onondaga Limestone. The Onondaga is a cherty, resistant limestone that also forms benches and scarps. It is overlain by the Middle Devonian Hamilton Group, composed primarily of clastic rocks which include the youngest bedrock units of the Cobleskill area.

Karst features are well developed on the Helderberg limestones, particularly the Manlius, Coeymans, and Becraft. Although karst features are common in the Onondaga Limestone farther east, this rock unit is not exposed over a broad enough surface in the field-trip area to possess significant karst features.

A variety of Pleistocene glacial sediments overlie the bedrock in discontinuous and irregular patches, primarily in the form of till sheets and drumlins. Glacio-alluvial sands and gravels are common in the valleys, as are lacustrine clays related to glacial Lake Schoharie (LaFleur, 1969). Holocene sediments consist mostly of reworked glacial material and colluvial material derived from the Paleozoic rocks.

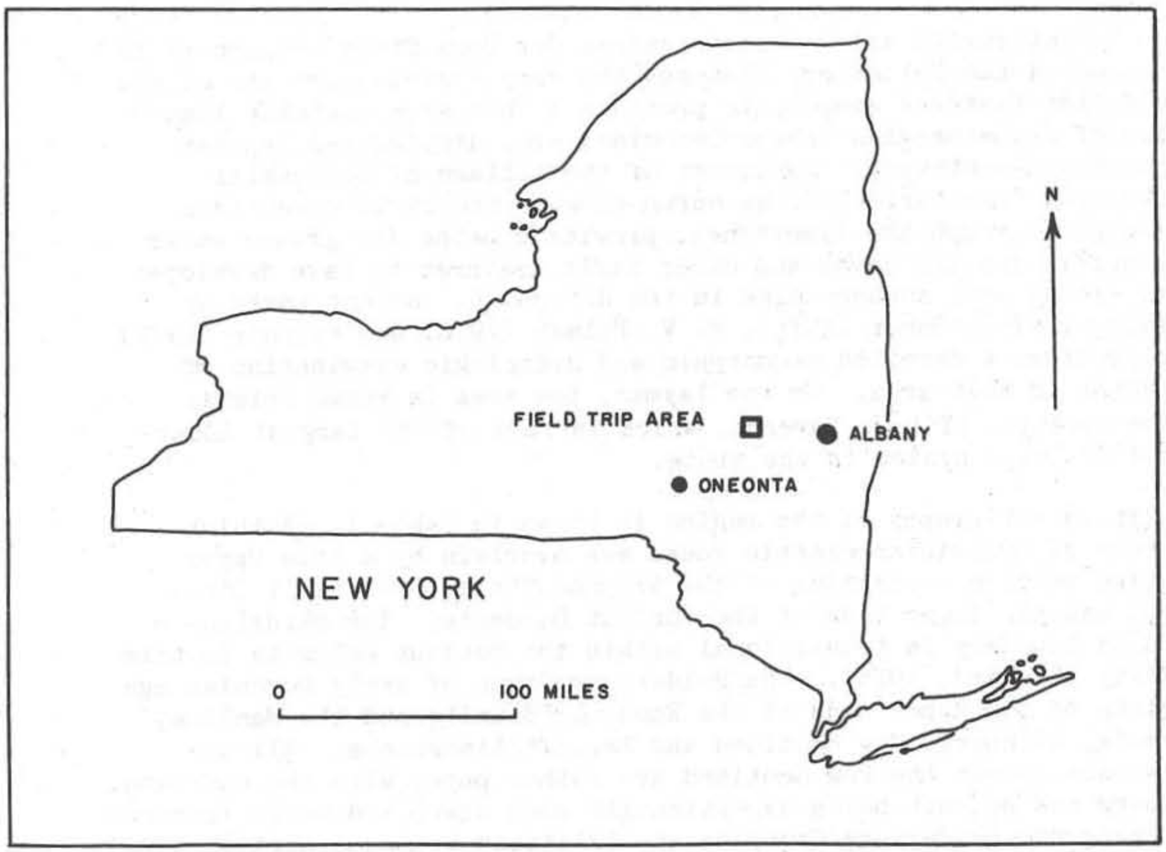


Figure 1 - Location map of the Cobleskill area, Schoharie County, New York.

System	Group	Rock Unit	Thickness at Howe Cave (feet)
Quaternary		alluvium	20 +/-
		sand and gravel (outwash)	0-20
		lacustrine sediments	0-100
		till and tillite	0-100+
Devonian	Hamilton	mainly sandstones and shales	340
		Onondaga Ls.	100
	Tristates	Schoharie Fm.(limy ss.)	8
		Carlisle Center Sh.	40
		Esopus Sh.	50
		Oriskany Sandstone	6
	Helderberg	Alsen Ls.	8
		Becraft Ls.	20
		New Scotland Fm. (shaly ls.)	-
		Kalkberg Ls.	104
		Coeymans Ls.	54
		Manlius Ls.	36
		Rondout Dol.	37
Silurian	Salina	Cobleskill Ls.	9
		Brayman Sh.	40
Ordovician		Indian Ladder Fm. (sandstone and shales)	100
		Schenectady Fm. (sandstone, graywackes, and shales)	1800-2000
Data compiled from Gregg (1973), Kastning (1975), Rickard (1975), Baker (1976) and Mylroie (1977).			

Table 1 - Stratigraphic section in the Cobleskill area.

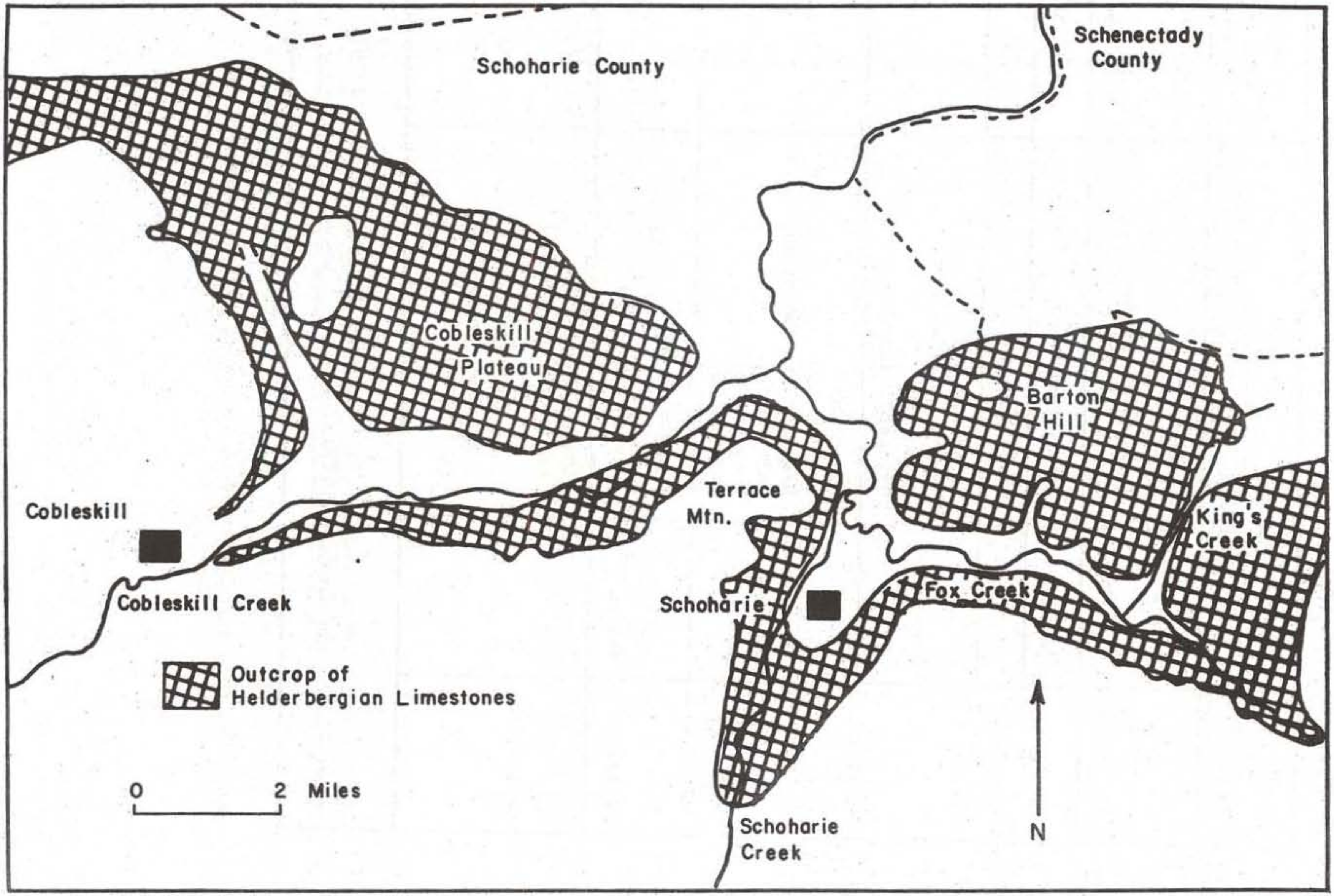


Figure 2 - Outcrop pattern of Helderbergian limestones in the Schoharie valley (modified from Berdan [1950]).

KARST FEATURES

A karst landscape consists of two environments, the surficial and the subsurface. Karst features of each environment can be classified according to their geomorphic relationships and hydrologic functions (Mylroie, 1977). This classification is outlined below, both to serve as a description of typical karst features to be found in the Cobleskill area, and to provide a convenient terminology for use in the remainder of the text. Details of this outline are explained in the paragraphs that follow.

- I. Surficial Karst Features
  - A. Exposed bedrock surfaces
  - B. Mantled bedrock surfaces
- II. Interface Features (connections between surface and subsurface environments)
  - A. Insurgences (zones of groundwater recharge)
    - 1. Diffuse
    - 2. Confluent
  - B. Resurgences (ground water emerges at the surface)
    - 1. gravity spring
    - 2. artesian spring
    - 3. overflow spring
  - C. Intersection features (fortuitous intersection of subsurface features by unrelated surface processes)
    - 1. Vertical
    - 2. Lateral
- III. Subsurface Features
  - A. Active cave passages (contain perennial streams)
    - 1. Tributary passage
    - 2. Master cave passage
    - 3. Diversion passage
    - 4. Tapoff passage
    - 5. Abduction passage
  - B. Abandoned cave passage (no longer contains perennial flow)

Surficial karst features form by the solutional etching of bedrock surfaces, both exposed and mantled with soil or sediment. These features form entirely within the surficial environment, without regard to the ultimate destination of the water that forms them. Such karst features as solution rills and solution pockets in the bedrock surface are examples of surficial karst features.

Interface features are the genetic connections between the surficial and subsurface environments. These include funnel-shaped depressions known as sinkholes, pits formed by ground water descending along fractures, sinking streams, and springs. Interface features can be divided into three main types depending on their hydrologic function: insurgences, or point of water input into the subsurface environment; resurgences or points of water output from the subsurface environment; and intersection features, or points of contact between the surficial and subsurface environments caused by predominantly non-solutional processes (such as collapse and scarp retreat) without substantial water exchange between the two environments.

Insurgences are basically of two types, diffuse and confluent. A diffuse input is the flow of water into the subsurface more or less uniformly over a large area, via primary porosity or fractures in bedrock. A confluent insurgence is the point where water enters the subsurface environment as perennial or intermittent streams.

Resurgences have three basic morphologies in terms of their hydrologic character: gravity springs, where water leaves the subsurface environment under free-surface flow; artesian springs, where water exits under hydrostatic pressure; and overflow springs, which can be either artesian or gravity springs, but which flow only in flood times, when the normal resurgences for a cave system cannot handle the entire groundwater discharge.

Intersection features comprise two basic categories; vertical intersection features, such as those formed by mechanical collapse of the roof of a solutional chamber, producing a collapse sinkhole; and lateral intersection features, where a retreating scarp or hillside breaches a pre-existing cave.

The subsurface environment forms the underground link between insurgences and resurgences. Solutional conduits, or caves, are classified by the hydrologic function they perform in completing this link. A "cave system" consists of those interface and subsurface features that are hydrologically integrated. Active cave passages are solution conduits that presently carry water, either perennially or seasonally. Abandoned cave passages no longer carry water, except perhaps during large floods, but they are preserved within the limestone as evidence of former paths of groundwater flow. Cave passages can be further subdivided as follows: tributary passages collect water from insurgences and carry it to the master cave passage, which is the main route connecting the insurgences to the resurgence(s). Diversion passages carry water around obstructions in the master cave. Tapoff passages convey water from master cave passages to relatively new springs as a result of local adjustments in base level, or other changes in the surface environment. Abduction passages represent connecting links between competing cave systems, where water flows from one cave system to another, as with surface stream priacy.

KARST OF THE COBLESKILL PLATEAU

The field trip described in this paper is limited to the area designated here, for convenience, as the "Cobleskill Plateau". It is bounded on the east by Schoharie Creek, on the south by Cobleskill Creek, on the north by the truncated up-dip edge of the Helderbergian limestones, and on the west by the line of disappearance of these limestones beneath the clastic Tristates Group (see Figure 2). This area is somewhat unique among the karst areas of the United States. The karst is highly developed, especially in the subsurface, and cave systems of several miles in length are known. However, because the area has been heavily glaciated, the impact of continental glaciation on karst topography and hydrology can be determined. Unlike the glaciated karst in alpine terranes, the Cobleskill Plateau is almost undeformed structurally. The lack of structural deformation allows a clear understanding of the effects of glaciation.

Pleistocene glaciation had a great effect on the surficial and interface karst features but a relatively minor effect on subsurface karst features. Glacial ice crushed, buried or quarried many of the surficial and interface features. Most surficial karst seen in the area today is post-glacial in origin. The greatest impact of glaciation has been in the deposition of till of varied thickness atop the pre-glacial topography. Where glacial till is thick (roughly more than 5 feet) it forms an impervious layer that allows surface runoff to collect and sink as large, confluent insurgences where the streams encounter exposed limestone. In areas where till is thin or absent, water tends to enter the limestone in a diffuse manner through solutionally enlarged joints. East of the Cobleskill Plateau, on Barton Hill (Figure 2), glacial till is generally thin or absent, and confluent insurgences are rare (Mylroie, 1977). In the vicinity of Cobleskill, however, till thicknesses vary greatly, and numerous drumlins are present. The greater abundance of till results in many confluent insurgences on the Cobleskill Plateau. The amount of glacial sediment thickens considerably toward the west on the plateau, having completely buried a northern pre-glacial tributary valley of Cobleskill Creek (Figure 2). Many of the largest closed depressions in this area are caused at least in part by glacial deposits. These depressions, instead of forming lakes, as in non-carbonate terranes, are kept fairly dry by the drainage of incoming water through solution conduits in the limestone exposed in their floors or walls. Although of glacial origin, these large depressions owe their continued topographic expression to solutional processes.

The valley of Cobleskill Creek has been filled with glacial drift to thicknesses as great as 100 feet, displacing the present stream from its original bed onto the limestone benches that once formed its south bank. The resistant limestone benches have prevented rapid downcutting of the creek into the less resistant glacial material. The glacially buried north bank of the valley contains a large artesian spring, known as Doc Shaul's Spring (Figure 3), which was originally a gravity spring in the valley wall during pre-glacial times. Piping by ground water under pressure has created a conduit from the bedrock upward through the overlying glacial sediment to the surface, forming an artesian karst spring.

Numerous sinkholes exist on the Cobleskill Plateau, formed by the subsidence of glacial material into solutional voids beneath. Many of these sinkholes feed vertical pits that extend through the Coeymans Limestone to caves in the underlying limestone. In this area, the size of a sinkhole tends to be proportional to the thickness of the glacial overburden and the capacity of the underlying solutional cavity to receive this material. Most sinkholes overlie active cave passages whose streams are able to remove material that subsides into them.

Glacial erosion and deposition has deranged much of the surface drainage on the plateau, resulting in the abandonment of some insurgences and the reactivation of others. In addition, many resurgences have been partly or completely occluded by glacial sediment. Despite these surficial changes, the subsurface conduits have not been significantly altered by glaciation. Many abandoned cave passages were filled with fine-grained silts and clays because of stagnant water conditions beneath the ice sheets. However, active cave passages flushed themselves clean of the finer sediments during and after ice withdrawal, with much of the coarser material remaining behind as lag deposits.

The major cave systems of the Cobleskill Plateau are apparently of pre-glacial origin, so their morphology and orientation have been determined by factors other than glaciation. The most important factor influencing the orientation and flow direction of the major cave systems in the Cobleskill Plateay and other nearby areas is the relationship between the regional dip and the altitudes of the master surface streams of the area (Fox, Schoharie, and Cobleskill Creeks). Groundwater in the limestones generally flows concordant to the strata, down the dip along favorable beds and bedding-plane partings, until it reaches the irregular and discontinuous top of the phreatic zone, roughly at the elevation of the local base level, where the water flows nearly parallel to the strike to the nearest available surface outlet.

The pattern of the major subsurface flow paths in the Fox, Schoharie, and Cobleskill valleys has been interpreted from cave exploration and from dye tracing of ground water. This pattern is shown diagrammatically in Figure 3.

In addition to the strike and dip of the beds and the interaction of the regional master surface streams with this structural geometry, there are several other geologic features of importance to the origin of caves in the Cobleskill Plateau. Joints, faults, and lithologic vatiations are of local importance in a cave system, even though the overall cave orientation is controlled by more regional factors. The main joint trends are sub-parallel to the dip and strike at roughly N20°E and N85°W respectively. The joints are therefore oriented parallel to the favorable flow paths and are often utilized by groundwater flow, which enlarges them solutionally into fissure-like passages.

Their influence is greatest upon interface features and tributary passages, which convey water underground from the surface, and which therefore must cut across the strata. Joints, because of their discordance to

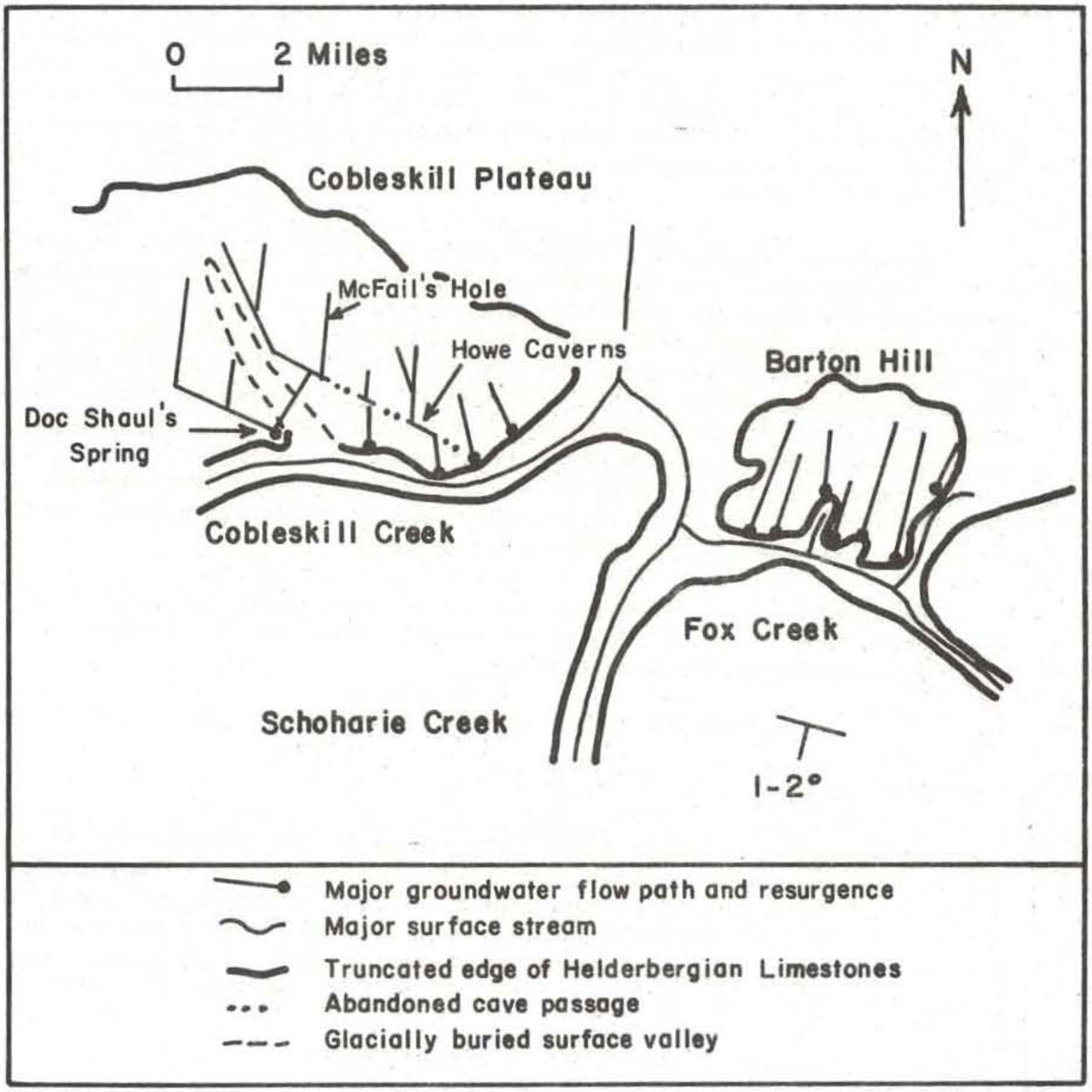


Figure 3 - Major paths of karst groundwater flow in the Cobleskill area.

the beds, are ideal for this function. Some single joints and joint swarms form cave passages that are almost perfectly linear for distances as great as 2000 feet. Joints seem to have less influence upon the low-gradient strike-oriented passages. Faults are occasionally utilized by ground water, in one case for nearly 2000 feet of cave passage. Faults are utilized as paths of groundwater flow for great distances only where they are oriented sub-parallel with otherwise favorable flow directions such as the dip or strike. Bedding-plane partings between contrasting rock types or textures are particularly favorable for groundwater flow and commonly form the initial zone of development of a cave passage. The contact between the massive Coeymans Limestone and the thin-bedded Manlius Limestone is of particular importance in this regard.

Lithologic variations between formations are important in controlling karst development. For instance, surface exposure of the nearly impermeable New Scotland Formation determines where water can sink into the underlying limestones and therefore helps to control the pattern of cave passages. The stratigraphic position of the various rock units is also of considerable importance. For instance, the impure, shaly Rondout Dolomite, which would otherwise be a poor cave former, contains extensive cave passages because of its position near the base of the pure limestones that are so favorable to cave development. Ground water in the pure limestones commonly forms entrenched canyons or tapoff passages in the underlying Rondout.

The features and processes described briefly in the preceding paragraphs are examined in greater detail, with specific examples, in the description of field trip stops.

DESCRIPTION OF STOPS ON KARST FIELD TRIP

Introduction

As with any geologic field trip, many of the features to be viewed are on private lands. It is important, therefore, to follow instructions exactly and to exercise a high degree of consideration and conservation at each locality. Detailed instructions are given here and in the road log as to where to go and where not to go at each stop; please obey them. The road log appears at the end of this report. See also Figure 4.

<u>STOP 1</u> -- Physiography of the Cobleskill area.

From this location, the general physiography of the Cobleskill Plateau can be seen. Cobleskill Creek, the major surface stream of the area, flows eastward immediately below (north of) Stop 1. Further to the north lies the gently rolling Cobleskill Plateau, comprised mainly of Helderbergian limestones, its landscape morphology controlled both by glacial and by karst processes. The regional dip is 1-2 degrees SSW. South of Stop 1, the limestones disappear beneath Middle Devonian rocks, mainly of clastic lithology. To the northwest is a prominent flat-topped hill, Barrack Zourie, which is an outlier of the Middle Devonian rocks. North of the Cobleskill Plateau lies the Mohawk lowland, developed on pre-Silurian rocks. Looking eastward along Route 7, three major

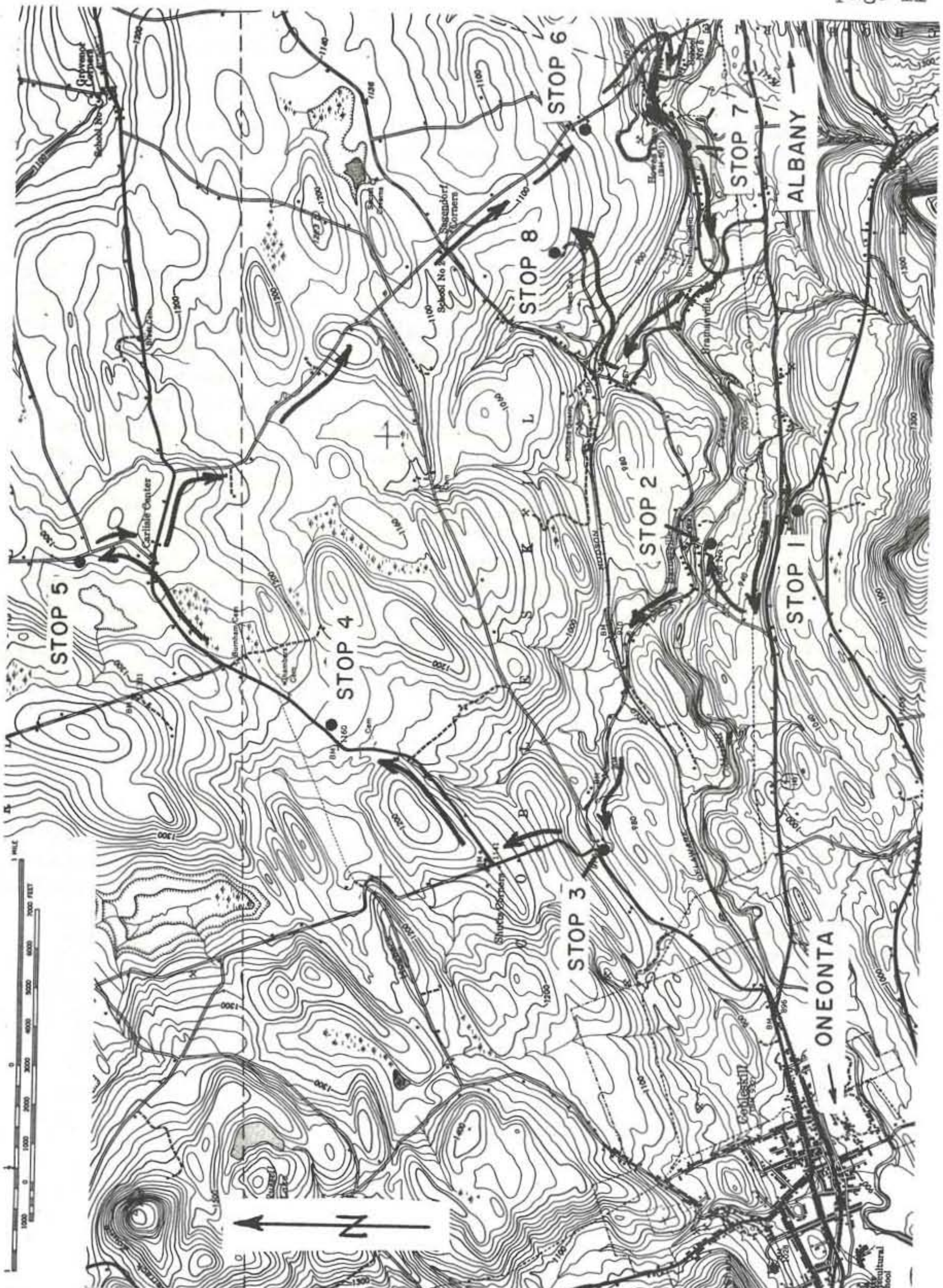


Figure 4 - Map of the western part of the Cobleskill Plateau, showing plan of karst field trip (from Cobleskill 7½-minute topographic quadrangle).

structural benches can be seen on the right (south). These benches are formed on resistant limestones and are not erosional terraces. The lowest one is formed on the Coeymans Limestone, the middle one on the Becraft Limestone, and the upper one on the Onondaga Limestone. The corresponding benches to the north of Route 7, across Cobleskill Creek, are for the most part obscured by thick deposits of glacial drift.

STOP 2 -- Cobleskill Creek

Cobleskill Creek, seen here, is the master surface stream of the area. Glacial deposits of Wisconsinan (and possibly earlier) age have displaced the creek from its pre-glacially entrenched valley onto the bedrock benches that form the south bank of the buried bedrock valley. Glacial till now forms the north bank and attains thicknesses of more than 100 feet in the pre-glacial valley. Looking downstream, the post-glacial superposition of Cobleskill Creek on the Helderbergian limestones can be seen. The south-southwesterly dip of the beds may have counteracted the tendency of the creek to shift back into its original sediment-filled valley. Part of the flow of Cobleskill Creek sinks into solutional openings in the south bank, at the point where the Cobleskill Creek first crosses onto the limestones, just west of the bridge. The water resurges 6000 feet downstream where the creek swings north and leaves the limestones. During low flow, this underground diversion route is capable of accepting the entire flow of the creek, so that the channel is left dry for the next 6000 feet. This subsurface diversion of a surface river is one of the longest in the Northeastern United States.

STOP 3 -- Doc Shaul's Spring

To the south of the intersection is Doc Shaul's Spring, a large artesian karst spring (Figure 5). This spring is located directly above the glacially buried northern bedrock bank of the pre-glacial Cobleskill valley and drains solution conduits in the Rondout, Manlius, and Coeymans Formations. When the bedrock valley was filled with glacial sediment, a resurgence located in the valley wall at this locality was buried. In response, the underground water piped a conduit upward through the glacial sediment to the surface following the retreat of the east glacial ice sheet. This artesian spring, with a peak discharge of more than 40 cfs, is one of the largest karst springs in the Northeast. It drains several square miles of the Cobleskill Plateau to the north, including the areas seen at stops 4 and 5 (see Figure 4). The elongate hill south of the spring is a drumlin lying along the axis of the buried pre-glacial valley of Cobleskill Creek. To the north of the spring is a steep hillside formed by the till-covered Becraft and Onondaga structural benches. No bedrock outcrop is known within a radius of more than 1500 feet in any direction from the spring.

STOP 4 -- Limestone pavements.

Along the east and west side of the road at this location are exposed bedrock surfaces developed along bedding planes in the Becraft

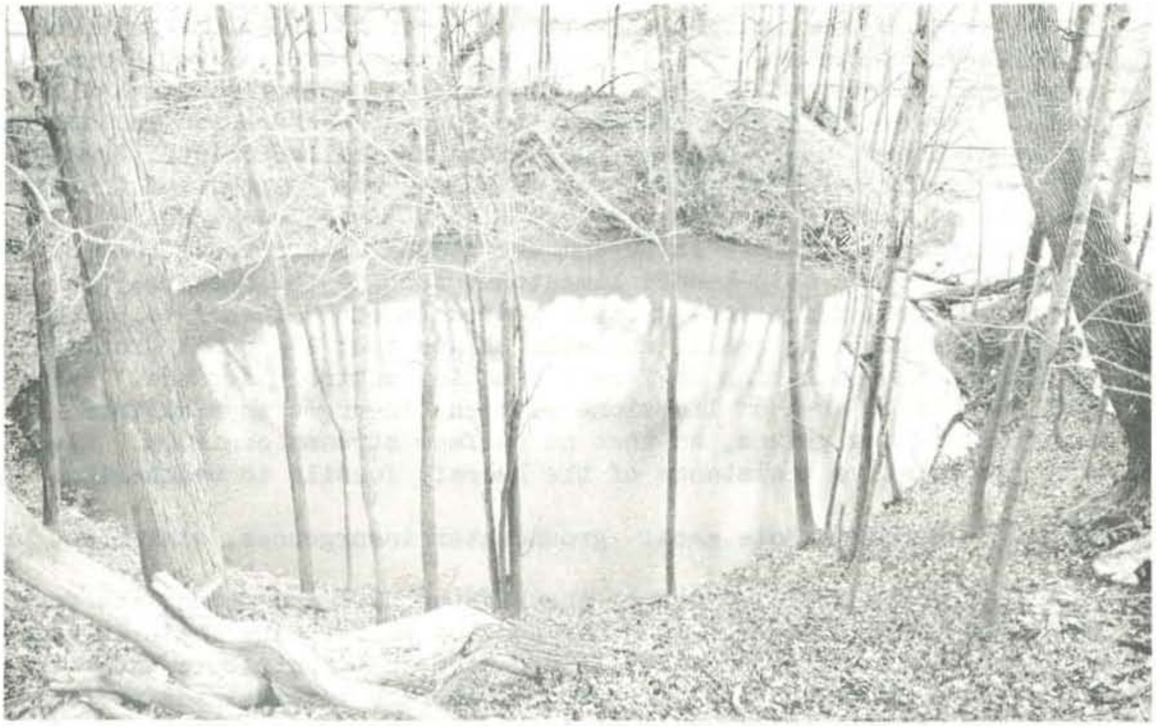


Figure 5 - Doc Shaul's Spring (Stop 3). Artesian conditions have resulted from the blockage of subsurface drainage by glacial deposits.

Figure 6 - McFail's Hole (Stop 5), a joint-controlled solutional pit in the Kalkberg and Coeymans Limestones.

Limestone. Bare surfaces of this type are called limestone pavements. In jointed limestones, such as those seen here, the joints become solutionally enlarged by infiltrating water to form fissures called grikes. Where the grikes intersect to form a checkerboard pattern, the blocks of limestone bounded by the grikes are called clints (Sweeting, 1973). In thick-bedded rocks such as these, the joints (and therefore the grikes) tend to be widely spaced (about 3 to 30 feet apart), and the resulting clints are large and are stable with respect to mechanical weathering. In a thin-bedded limestone, such as the Manlius, the joints and grikes are very closely spaced (about 3 inches to 3 feet apart), resulting in small, unstable clints that are easily rotated by mechanical weathering to form a chaotic, unstable surface. Rainfall on a large area of limestone pavement insurges in a diffuse manner along the grikes, so that no surface streams can form. Also note the relative resistance of the Becraft fossils to weathering.

STOP 5 -- McFail's Hole area: groundwater insurgences, sinkholes, pits.

Follow the field road from the highway down and around the farmer's field and follow the path into the woodlot below. The features seen here are confluent groundwater insurgences that contribute water to Doc Shaul's Spring (Stop 3). Most of them are vertical shafts formed by the solutional enlargement of joints in the upper formations of the Helderberg Group (Figure 6). They are named for some of the original explorers who descended the pits in search of caves.

A large number of insurgences are closely clustered in this area. This clustering is caused by two phenomena:

a) The area is a window of limestone in the surrounding clastic and glacial cover. Limestone is exposed to solutional processes from water draining off the surrounding impermeable uplands. The streams flow radially into the area and sink in a number of separate insurgences that all unite in the subsurface along a single drainage path.

b) The large amount of recharge available from the impermeable catchment area, plus the large sediment load carried in from that area, has blocked many of the insurgences, causing the formation of overflow routes to secondary insurgences, which further increases the complexity of the insurgence pattern.

Note: Permission to enter this property must be obtained from the National Speleological Society, 1 Cave Avenue, Huntsville, Alabama 35810. Visitors must be accompanied by a local member of the N.S.S.

Referring to Figure 7, locate and examine each of the features discussed below.

1. Wick's Hole - a large, occluded insurgence receiving the combined flow of three intermittent streams that unite here. The bedrock exposed in the walls of the sinkhole is the Kalkberg Limestone. Note the washed-in vegetal matter and sediment, and the overflow route to the south.

2. McFail's Hole - a large pit insurgence formed by solutionally enlarged joints (Figure 6). It overlies directly the cave passage that drains this area. Formerly 90 feet deep, its lower 30 feet has become

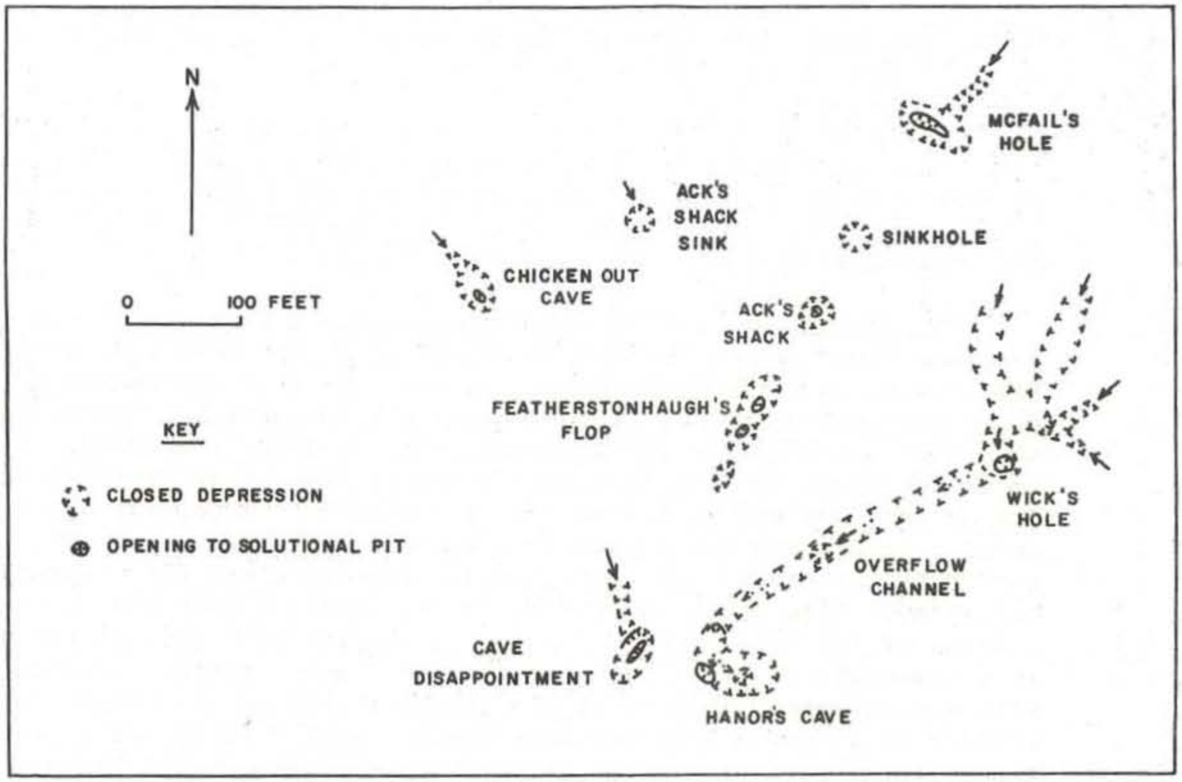


Figure 7 - Map of confluent insurgence points in the McFail's Hole area (Stop 5).

blocked in recent years by collapse material. The upper lip of the pit is in the Kalkberg Limestone, and the main part of the shaft is in the Coeymans Limestone.

3. Ack's Shaft - a pit insurgence 80 feet deep. It is narrower than nearby McFail's Hole, although it receives about the same flow of water. The water that utilizes this pit enters a small insurgence 200 feet to the northwest and flows to Ack's Shack through a shallow solution conduit about 10 feet below the surface. The water enters the wall of the pit near the top and descends to a narrow cave passage below. The top of the pit is an intersection feature, caused by the collapse of the 10 feet of rock directly over the pit. The upper part of the pit is formed in the Kalkberg Limestone, the lower part in the Coeymans and upper Manlius Limestones.

4. Cave Disappointment - a pit insurgence similar to McFail's Hole, fed by a perennial surface stream. This pit leads to a series of adjacent shafts, fissures, and low cave passages. The pit connects by way of these tributary routes to nearby Hanor's Cave. The pit is formed in the Kalkberg and Coeymans Limestones.

5. Hanor's Cave - an overflow pit insurgence for floodwater overflowing from Wick's Hole. Hanor's Cave transmits this water to Cave Disappoint-

ment. The cave, developed in the Kalkberg and Coeymans Limestones, fills to the ceiling with water during floods.

6. Walking north up the stream bed that feeds Hanor's Cave, note the solutional enlargement of joints in the exposed bedrock. Continue north to Wick's Hole, then follow the path around the field to the vehicles.

STOP 6 -- Howe Cave Quarry.

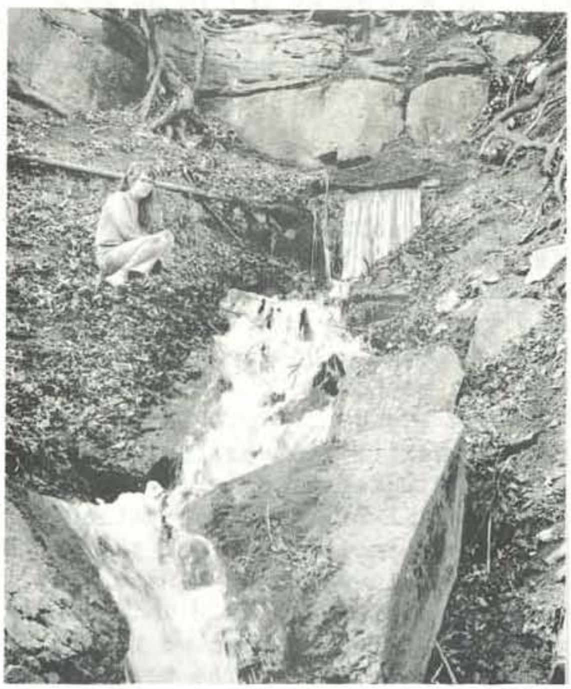
Stop along the road at the northeastern edge of the quarry. The Coeymans Limestone is exposed in the ditch on the west side of the road. Glacial striae can be seen on the rock surface, presently undergoing destruction by solution. Solutional denudation rates as much as a foot per 1000 years are common in karst areas (Sweeting, 1973). Cross the ditch (to the west) and climb to the top of the dirt ridge but no farther, and look down into the quarry. The quarry floor is located within the lower Manlius Limestone, and the quarry walls are formed by the middle and upper Manlius Limestone and the Coeymans Limestone. Note the thin bedding of the Manlius, compared to the thick bedding of the overlying Coeymans. On the far west wall of the quarry is a low-angle reverse fault (dipping 14 degrees south, striking N75°W) with approximately 1½ feet of displacement (Figure 8). It is subsidiary to a larger bedding-plane thrust located below the quarry floors, best seen within the natural-cement mine located beneath the quarry, which contains large gash veins of strontium and barium minerals (40 feet long, 3 feet wide, and 8 feet high) associated with the faulting.

Many of the joints near the top of the quarry wall are solutionally enlarged but become narrower with depth. The Howe Caverns master cave once crossed the area now occupied by the quarry, from west-northwest to east-southeast, but has been truncated by the quarrying operations. The western section of the cave extends through the salient of limestone that juts into the quarry from the west wall. The actual cave opening, located along the northeast wall of this salient, is obscured by quarry debris, as is the corresponding opening in the eastern wall of the quarry. A drainage tunnel has been dug into the cave from the south side of the salient, draining the cave water across the quarry floor to an artificial shaft in the middle of the quarry, which carries the water into the cement mine below.

STOP 7 -- Gravity springs and openings to cement mine.

Park just west of the small bridge over the stream. At the bridge, look upstream at two grated openings, one rectangular and the other rounded in cross section. (Do not attempt to enter any of the features described in this stop; view from shoulder of road only.) This is the resurgence point for the water in Howe Caverns that was seen to flow across the quarry floor at Stop 6. These openings apparently represent the original, natural solutional resurgence for Howe Caverns, now altered by mining. The bedrock ledges exposed are the Rondout Dolomite, which has been mined as a "natural cement" (Cook, 1906). The Rondout

Figure 8 - West wall of the Howe Cave Quarry (Stop 6), showing thin-bedded Manlius Limestone in the lower third, overlain by thicker bedded Coeymans Limestone. A low-angle thrust fault can be seen dipping to the left (south-southwest), with a displacement of slightly more than a foot.



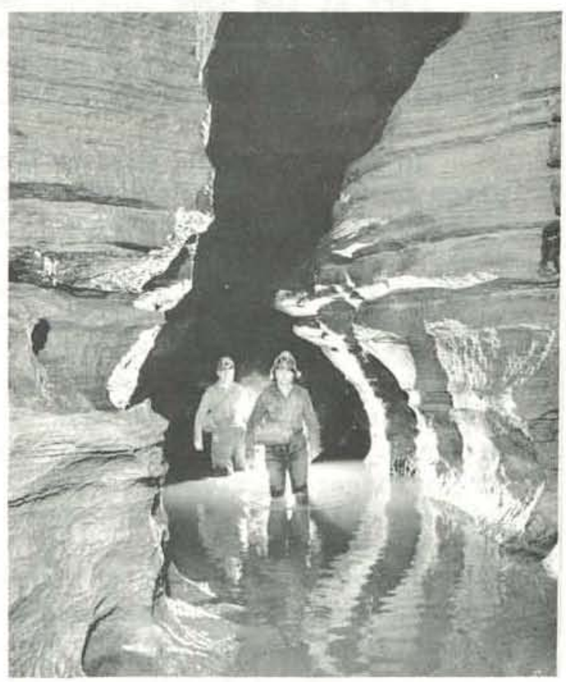


Figure 9 - Nameless Spring, a partly dammed gravity spring in the northern wall of the Cobleskill valley (Stop 7).

Figure 10- Typical cave passage (non-commercial variety) in the Howe Caverns area, developed within the thin-bedded Manlius Limestone. This is a typical canyon passage formed by a free-surface cave stream that has incised below the original solution conduit.

contains the Silurian-Devonian boundary in this part of New York State (Rickard, 1975). Proceding downhill (west), two more rectangular openings are seen. These also are openings to a cement mine in the Rondout. Farther downhill, the small ledge of thick-bedded rock is the type section of the Cobleskill Limestone. About 9 feet of Cobleskill Limestone occurs here, overlain by the Rondout Dolomite and underlain by the Brayman Shale.

Farther down the road on the north side is a small resurgence, Nameless Spring, a gravity spring in the Cobleskill Limestone (Figure 9). This spring has been dammed as a water supply. The small erosional re-entrant in the valley wall where the spring emerges is called a spring alcove. Immediately west of Nameless Spring is Nameless Spring Cave, an overflow spring for Nameless Spring. This cave is developed at the Rondout/Cobleskill contact and carries water only in flood times. Because of the larger spring alcove at the cave, it is possible that Nameless Spring is a fairly recent tapoff from Nameless Spring Cave.

STOP 8 -- Howe Caverns.

Park at the Howe Caverns parking lot and enter the lodge as a group. If the party is sufficiently large, it is possible to be admitted to the cave at the half-price group rate. (Advance notice must be given in order to receive group rates.)

In the following discussion, refer to Figure 11 for locations and place names in Howe Caverns. The elevators into Howe Caverns occupy an artificial shaft to the cave. The original entrance is located immediately southeast of the quarry seen at Stop 6. The elevators descend roughly 160 feet to the cave. Howe Caverns consists of a large master cave passage flowing southeast nearly parallel to the regional strike, with water contributed by dip-oriented tributary passages that enter from the north. Leaving the elevator, an abandoned passage (the West Passage) is seen to the left through the concrete portal. Although it once drained much of the Cobleskill Plateau farther west, it no longer carries a stream. It is terminated after a few hundred feet by collapse where it approaches the wall of a surface valley. This passage apparently formed prior to the incision of the valley that now truncates it. Straight ahead from the elevators is a natural chamber with an artificial tunnel heading north from it. This tunnel connects to the rear of the Winding Way and was constructed to provide a loop passage for smoother flow of tourist traffic. The tour follows the natural cave passage to a major junction. To the left, in the floor, a stream enters and follows the main cave to the southeast. Ahead and to the left is the entrance to a long tributary passage, the Winding Way, which will be discussed in detail later. The tour follows the main passage to the right. This passage is a large conduit composed of two basic parts: a large oval tube, 20 to 30 feet wide and 15 to 20 feet high, with a deep canyon cut in its floor, 6 to 12 feet wide and 10 to 15 feet deep, formed by entrenchment of the cave stream beneath the tube level (see Figure 10). The solutional ceiling is

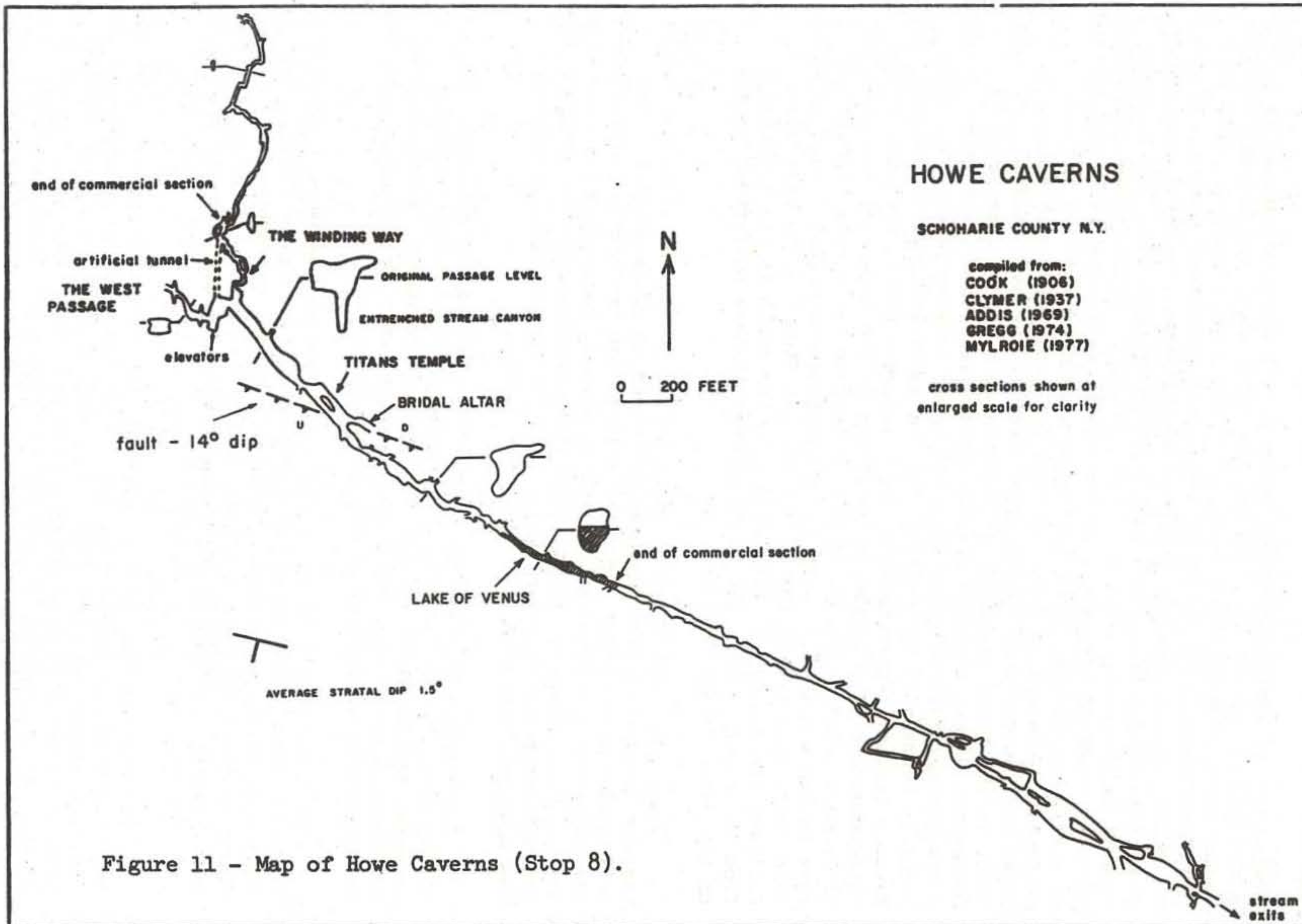


Figure 11 - Map of Howe Caverns (Stop 8).

located at the Coeymans/Manlius contact, and the cave passage is located in the Manlius Limestone. The ceiling rises above the Coeymans/Manlius contact only in areas where ceiling collapse has occurred. Note the difference between the smoothly sculptured solutional ceilings and the rough, planar ceilings produced by collapse. The cave continues downstream over a bridge and past a large collapse area to the largest chamber in the cave, known as Titan's Temple. In this chamber, evidence for each stage of the cave's origin can be seen. The passage originated as a solution conduit along the Coeymans/Manlius contact and was eventually enlarged by solution into the large tube with elliptical cross section now seen as the upper half of the main passage. At some point in the past, probably in response to a drop in the level of Cobleskill Creek, the cave stream cut downward to a lower level, forming a new passage that diverged from the upper tubular level. The upper level is terminated by sediment fill a short distance to the east of Titan's Temple. Upstream from the divergence point, the cave stream entrenched the deep canyon in the floor of the tube. At the point of divergence between the two levels, a reverse fault cuts through the cave having a dip of 14 degrees to the south-southwest. This is the same fault observed in the quarry wall at Stop 6. The cave water followed the dip of the fault plane to the south in its divergence from the upper level. The fault appears to have no further impact on the cave (Gregg, 1974).

Downstream from Titan's Temple in the lower, active level, the cave passage is generally rectangular or arched in cross-section. The rectangular areas occur where the thin-bedded and highly jointed Manlius Limestone has collapsed along bedding planes, destroying the curvilinear shape of the passage. Joints contribute small amounts of infiltrating water through the ceiling in this part of the passage, forming many stalactites aligned in rows along the joints.

A few small side passages enter this section of the cave. They are of two basic types: abandoned upper levels or loops of the main passage, and abandoned or active tributary passages. Nearly all the tributaries enter from the north, feeding water to the master cave from insurgence areas located in the up-dip direction.

The cave stream is ponded midway in the main passage, forming the "Lake of Venus" and causing alluviation of the bedrock floor. The boat ride on the lake demonstrates some of the explorational difficulties found in caves that are partially flooded. The Lake of Venus has been artificially deepened by the construction of a small dam at the end of the tourist route.

Returning along the main passage, the tour then enters the Winding Way. Although it is normally dry, water pours out of this passage into the main stream during floods. The Winding Way is a classic example of what is called a canyon passage, high and narrow with many twists and turns. As the passage is followed up-dip, the ceiling gradually ascends. The upper part meanders back and forth over the lower level of the canyon. The ceiling of the Winding Way cuts discordantly downward across the strata to merge in a graded manner with the solutional ceiling of the master cave. The discordant ceiling results from the transmission of water to the master conduit from stratigraphically higher insurgences.

The artificial tunnel branching from the Winding Way leads the tour back to the elevators. Notice the obvious difference between the solutional walls of the Winding Way and the blasted walls of the tunnel. Near its southern end, the tunnel intersects a large natural chamber. Along the east (left) wall of this room are some interesting calcite deposits (informally called "lilypads"). They mark the former water surface of a stagnant pool of water that was supersaturated with respect to calcite. Several different pool levels can be discerned, and some dogtooth spar is visible in places below the levels of the former water surfaces. Also along the east wall of this room is a solutionally enlarged fissure, 40 feet high, that extends nearly to the surface. This fissure is a source for the mud, water, collapse material, and glacial debris seen at this location. Cross the bridge, enter the elevator, and return to the surface.

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ROAD LOG FOR KARST FIELD TRIP

Miles from last point	Cumulative Miles	
0.0	0.0	STOP 1 - intersection of Routes 7, 145 and Mineral Springs Road; view of Cobleskill Plateau. From here, head west on Route 7 to
0.7	0.7	Barnerville Road; turn right on Barnerville Road. Note drumlins to the west, resistant limestone benches to the east. Continue on Barnerville road past Cobleskill Creek on the left (north) to
0.6	1.3	STOP 2 - Barnerville Methodist Church; view of Cobleskill Creek valley. From here, cross over Cobleskill Creek, heading north. Bear left at intersection immediately beyond Cobleskill Creek, and continue to
1.0	2.3	Railroad tracks. (Notice drumlins ahead and to left). Cross tracks and continue to
0.6	2.9	Intersection with Meyers road, which enters from the right (east). Bear left, continue to
0.2	3.1	STOP 3 - Doc Shaul's Spring (at road intersection). Observe spring from the south side of the road, but don't leave the road. From here, follow side road north (uphill) to
0.6	3.7	Intersection. Turn right (east) and continue to
0.6	4.3	Intersection. Bear left, following main road; continue to
0.5	4.8	STOP 4 - Bare limestone pavements on either side of road. Do not stray too far into the fields. From here continue north
0.6	5.4	Pass road on left; continue northeast.
0.2	5.6	Pass Runkle Cave (its resurgence can be seen across the field to the left (west), continue northeast.
0.6	6.2	Pass dirt road on left, turn left onto paved road at next intersection. Continue north to
0.4	6.6	STOP 5 - McFail's Hole area (confluent insurgences). Park cars along road, follow

Miles from last point	Cumulative Miles	
		the field road on foot from the paved road down and around the farmer's field, and follow the path into the wood lot beyond. Note: permission to enter this property must be obtained from the National Speleological Society, 1 Cave Avenue, Huntsville, Alabama 35810. Visitors must be accompanied by a local member of the N.S.S.
0.4	7.0	T-intersection. Bear left (east), continue east to
0.3	7.3	Intersection. Bear right (south), continue to
1.3	8.6	Myers Road on right; continue past this road to
0.2	8.8	Lawton Road on the left; continue past this road to
0.5	9.3	Crossroads (Sagendorf Corners). Continue straight through this intersection to the south, to
0.9	10.2	Robinson Road on the left. Continue past this road to
0.2	10.4	STOP 6 - Howe Cave Quarry on right (west). On foot, cross ditch to west and climb to top of dirt ridge to view quarry, but no farther. Return to cars, continue south to
0.3	10.7	Crossroads. Proceed straight (south) to
0.1	10.8	Railroad tracks. Cross tracks and turn sharp right to the west, past the small town of Howes Cave to
0.4	11.2	STOP 7 - (Gravity springs and cement mine) at "Fallen Rock" sign and small bridge over stream, just past large building on the north side of the road. From here continue west on road to
0.7	11.9	Bridge over Cobleskill Creek. Continue to
0.1	12.0	T-intersection. Turn right (north), following the Howe Caverns signs.
0.4	12.4	Re-cross Cobleskill Creek. Continue to
0.4	12.8	T-intersection. Turn right (north), and continue to

Miles from last point	Cumulative Miles	
0.1	12.9	Railroad overpass. Make an immediate right turn beyond the overpass onto the Howe Caverns Estate, STOP 8 - Take tour of Howe Caverns. Because of the large parking area, mileages back and forth along the Howe Caverns driveway will vary. Return mileages are calculated from the end of the Howe Caverns driveway at the railroad overpass. Return under the railroad overpass to the southwest and on to
0.2	0.2	Intersection. Bear right (southwest), and continue to
1.0	1.2	Intersection with Barnerville Road. Turn left (south) onto Barnerville Road, re-cross Cobleskill Creek, and continue on to
0.7	1.9	Route 7. From here parties may return to Oneonta by taking Route 7 southwest (to the right), or may go their own way. Albany is to the left (northeast).