UPPER DEVONIAN STRATIGRAPHY AND SEDIMENTOLOGY IN THE BINGHAMTON AREA

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INTRODUCTION

The purpose of this half-day field trip is to illustrate the prominent stratigraphic and sedimentologic features of the Upper Devonian rocks of the Binghamton area. The trip will introduce the participants to the stratigraphic units and some of the stratigraphic problems of the Upper Devonian strata of south-central New York, thus enabling them to appreciate more fully the longer field trip conducted by Woodrow and Nugent.

This report contains a summary of the stratigraphic nomenclature applied to the rock sequence in the Binghamton area and a brief discussion of some sedimentary features of these rocks. The location of each stop is shown on the index map (Fig.1), and the rock sequence at each stop is summarized in a generalized stratigraphic section (Fig. 2,3,and 4).

STRATIGRAPHY

The Upper Devonian sequence is composed of alternating very fine-grained sandstones, siltstones, and blocky shales. Interbeded with these units are beds of dark, fissile shale representing tongues extending eastward from a predominantly shale sequence in western New York. The presence of the dark shale tongues provides marker beds in an otherwise monotonous series of deltaic sediments, the Chemung facies.

A system of stratigraphic nomenclature based on the recognition of these marker beds has been developed by stratigraphers at the University of Rochester under the leadership of R. G. Sutton. This group is actively engaged in field studies of the Upper Devonian rock units in south-central New York. As these studies represent the most recent work on these strata, terminology proposed by the group (Sutton, et.al., 1962, Sutton, 1963) is used in this report. For further discussion of stratigraphic nomenclature, and of problems that have arisen during study of this rock sequence, see the article by Woodrow and Nugent.

Rock strata belonging to several formations are present around Binghamton. The oldest exposed rocks are in the Sonyea Formation (Colton and deWitt, 1958). The Sonyea beds occur in the lower parts of the Susquehanna River valley near the city of Binghamton, and in the Chenango River valley north of Binghamton. The Sonyea Formation will not be observed on this field trip. Stop A-1 at Twist Run (north of Endicott, N.Y.) and stop A-2 at the Binghamton Brick Company quarry will provide opportunities to examine exposures of several members of the Rhinestreet Formation (Sutton, et.al., 1962) which overlies the the Sonyea Formation. Stop A-3 is in the Corbisello Quarry, just south of the city of Binghamton, where beds younger than Rhinestreet are exposed. These are classified as the Gardeau Formation and the overlying New Milford Formation (Sutton, 1963), and are the youngest Devonian strata exposed in the area.

For purposes of small-scale mapping, it is useful to employ the procedure illustrated on the State Geologic Map of New York (1962). On this map strata above the Sonyea are not subdivided, but are included in the lower West Falls Group.

Acknowledgments: J. Harrison and D. Patchen assisted in preparation of the illustrations.

SEDIMENTARY FEATURES

A casual inspection of the Upper Devonian rocks in the Binghamton area may lead one to the conclusion that the lithologic sequence is devoid of significant or interesing sedimentary features. However, more detailed examination reveals several features and sedimentary structures worthy of discussion and investigation.

A striking characteristic of this rock sequence is a cyclicity of sedimentation that appears to be generally present, although in varying degrees. At two stops (A-1 and A-2), a cyclic pattern may be observed in the shale and siltstone alternations.

At stops A-1 and A-2, sedimentary features will be seen that have been named "flow rolls" by Pepper, de Witt, and Demarest (1954) to describe bulbous, somewhat nodular, lens-shaped siltstone or sandstone masses that frequently occur in the Devonian rocks of this area. The flow rolls generally rest upon shale and give the appearance of having been rolled or curled. Dunbar and Rogers (1957, p. 192) state that early in this century such phenomena were interpreted as the result of violent storms that churned the bottom of the sea floor and rolled up masses of the surface sandy layers. This is not a likely explanation because storm waves sublevate the sand on a sandy sea floor, moving the grains individually. It is not reasonable to conclude that the sand (or silt) would have had sufficient cohesion to permit rolling in this fashion. Thus the structures represent small landslides formed where the bottom had been aggraded to an instable slope. In such an environment, soft mud layers would have formed a lubricant over which thick sand layers could slide.

Preliminary radiographic studies of thin slices of flow roll matrix, employing the technique described by Hamblin (1962, p. 201), have been conducted at Harpur College, and the results have been somewhat surprising. Some laminations within these flow rolls are quite regular and, for the most part, little disturbed. There are some minor flowage features at the periphery of the masses, but not within the central portion.

There is little evidence that flow rolls formed on the surface of the sea floor, and in fact, where shales immediately underlie and overlie the flow rolls, the shale layers appear to "wrap around" these lens-shaped masses from above and below. Observations suggest that some, if not most, of these masses formed as a result of differential compaction and are more closely related to load casts.

Cross-stratification commonly occurs in the siltstones and sandstones. The sets of cross-strata range in thickness from a fraction of an inch to several feet. The sets of cross-strata in the siltstones are usually tabular and the individual cross-laminae are only fractions of an inch thick. Lenticular cross-stratification may be present in thick or massive sandstone beds. Tabular cross-stratification can be observed in siltstone beds at stops A-1 and A-2. Lenticular cross-stratification is seen in the sandstones of the Catskill facies at stop A-3.

Ripple marks have been preserved on the bedding surfaces of many sandstones and siltstones in the Upper Devonian strata. They are generally small-scale symmetrical features; thus they are thought to be oscillation ripples. Ripple marks will be seen at stop A-3.

At various levels within the alternating siltstone, shale, and very fine-grained sandstone sequence of the Chemung facies, thin beds of coquina or coquinoid siltstone are noted. These beds have a matrix of calcareous siltstone and weather to prominent pitted surfaces on the outcrop as a result of leaching of the calcareous material of the fossil shells. Some of the beds appear to be fairly persistent at a given outcrop, but it has not been established that they are persistent enough to be of any use as stratigraphic marker beds, even within a very limited area.

At stop A-1 of this trip, in Twist Run, typical coquinas will be seen. They contain an abundance of crinoid columnals, a majority are small (less than 1/10" in diameter), but with sizes ranging to ½" in diameter. The proportions of the various sizes of debris vary from place to place within a single bed. Associated with the columnals are many rhynchonellid and spiriferid brachiopods and pelecypods, all of relatively small size. There does not seem to be any size sorting of the fossil material which could be taken as an indication of current action on the debris.

A different type of coquina will be seen at stop A-2, at the Binghamton Brick Co. quarry. This coquina contains disarticulated valves of *Platyrachella mesastrialis* in profusion, with many crinoid columnals forming the bulk of the rock matrix.

FIELD TRIP STOPS

Stop A-1, Twist Run (Lat. 42° 08' 45" N., Long. 76° 03' W.)

The road cuts in Twist Run (Fig.2), expose beds of the Rhinestreet Formation. Near the top of the hill is a 7-foot interval of dark gray, fissile shale, the Dunn Hill Member of the Rhinestreet Formation. Above the Dunn Hill shales are the basal beds of the overlying Beers Hill Member of the Rhinestreet. Approximately 12 to 15 feet of strata of the Beers Hill Member are composed of siltstones, generally quite massive where fresh, but weather into thin and irregular units. The basal 4-foot unit exhibits minute cross-lamination.

Below the Dunn Hill Member is the Millport Member of the Rhinestreet, comprising the largest amount of the exposed beds. It is composed of a series of units which are somewhat cyclic in nature. Ideally the unit grades from massive, very fine-grained sandstone at the base, through massive siltstones into siltstones progressively thinner bedded and more argillaceous upwards, with a thin bed of dark shale at the top. At the base of each massive unit are flow rolls. Few if any of the units show the complete range of lithologies listed above, and each unit is extremely lenticular. Thus the measured thicknesses of each bed shown on Figure 2 must be regarded as true only for the exact place of measurement. Several of the massive beds of very fine-grained sandstone can be seen pinching out laterally within the confines of the outcrop.

Faunal elements are present within the sequence, either interspersed along bedding planes within the siltstone layers, or in definite beds of coquina. Both brachiopods (orthids, productids, and spiriferids) and pelecypods are abundant at several levels. At least three thin beds of coquina are present within this sequence. At this locality, each bed is very thin; the thickest observed being less than 6 inches.

The lowest outcrops in Twist Run are still within the Millport Member, which is underlain by the basal or Moreland Member of the Rhinestreet Formation. The Moreland is a dark shale unit similar in lithology and thickness to the Dunn Hill Member seen at this locality.

Stop A-2, Binghamton Brick Co. Quarry (Lat. 42° 07' 30" N., Long. 75° 54' W.)

The quarry of the Binghamton Brick Company is developed in the Millport Member of the Rhinestreet Formation. The Moreland Member is exposed at the entrance to the quarry below the level of the main floor. The quarry floor and walls, developed as a series of steps carved from the hill, are composed of beds of the Millport Member.

As in Figure 3, the Millport Member in this locality consists of a series of alternating gray to green siltstone and shale. The shale units range from 10 to 15 feet in thickness, and are generally thin-bedded and fissile, especially where weathering has occurred. Medium-bedded siltstones occur in a somewhat cyclic pattern throughout the section. In the upper part of the sequence, the siltstones are more thickly bedded, and correspondingly the cyclical pattern is not as regular.

Smooth, continuous bedding planes between shale beds and also between shale and siltstone beds predominate; there appears to be little lensing. Small-scale cross-laminations may be observed in the siltstones.

Two prominent flow roll zones may be observed. The first occurs about 100 feet above the floor of the quarry, and the next about 20 feet higher. The flow rolls of the latter unit are numerous, and range greatly in size, shape, and degree of development. Beds of coquina are seen in place and in slump in the upper part of the section.

Stop A-3, Corbisello Quarry (Lat. 42° 03' 45" N., Long. 75° 57' W.)
The Corning Member of the Gardeau Formation and the overlying New Milford Formation are exposed in this quarry. The Corning Member at this localtiy is a gray, fissile shale, of which approximately 5 feet are exposed.

The New Milford Formation contains a tongue of the Catskill facies at the base. This tongue is composed of massive, interbedded, thick lenses of sandstone. Lenticular cross-lamination is present in the thick lenses. There is a thin disrupted coal seam in the middle part of this sandstone unit. Ripple marking has been preserved on the upper surface of this sandstone tongue. This is probably a fluviatile deposit deposited near the strand line of the Upper Devonian sea.

Overlying the massive sandstone is a thick sequence of shale and interbedded siltstone. These fine-grained rocks are thought to be near-shore deposits, possibly lagoonal muds. Above the unit of shale and interbedded siltstone is another sequence of massive lenses of sandstone with interbedded siltstone and shale. These beds are similar to the basal sandstone in lithology, but are extremely lenticular.

This is the only stop on this trip, or on the trip led by Woodrow and Nugent, where the Catskill non-marine facies may be observed. Several miles to the south the New Milford is entirely composed of beds belonging to the Catskill facies.

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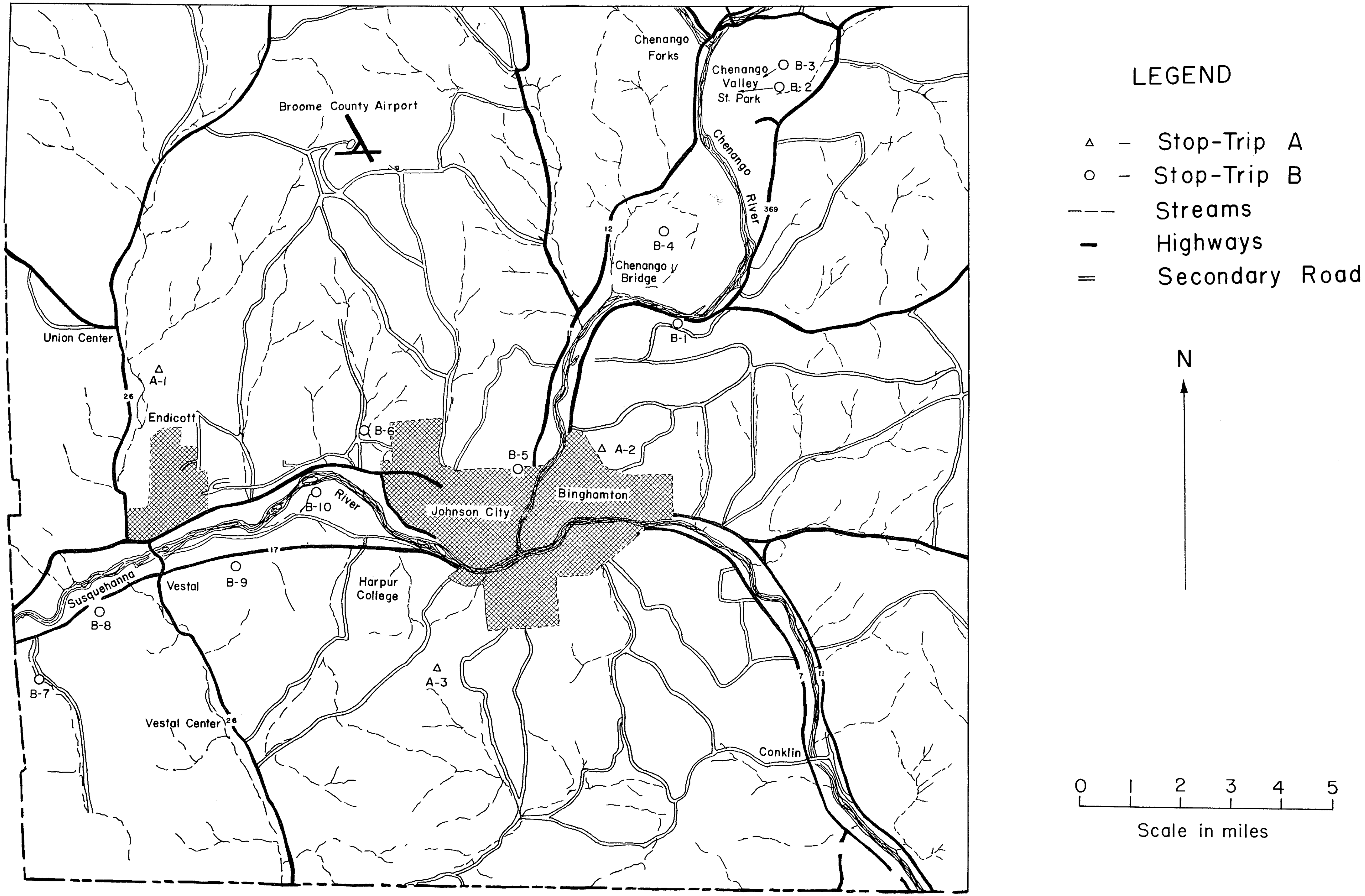


Location Map Showing Field Trip Routes, Binghamton, N.Y., Area.
FIGURE 1

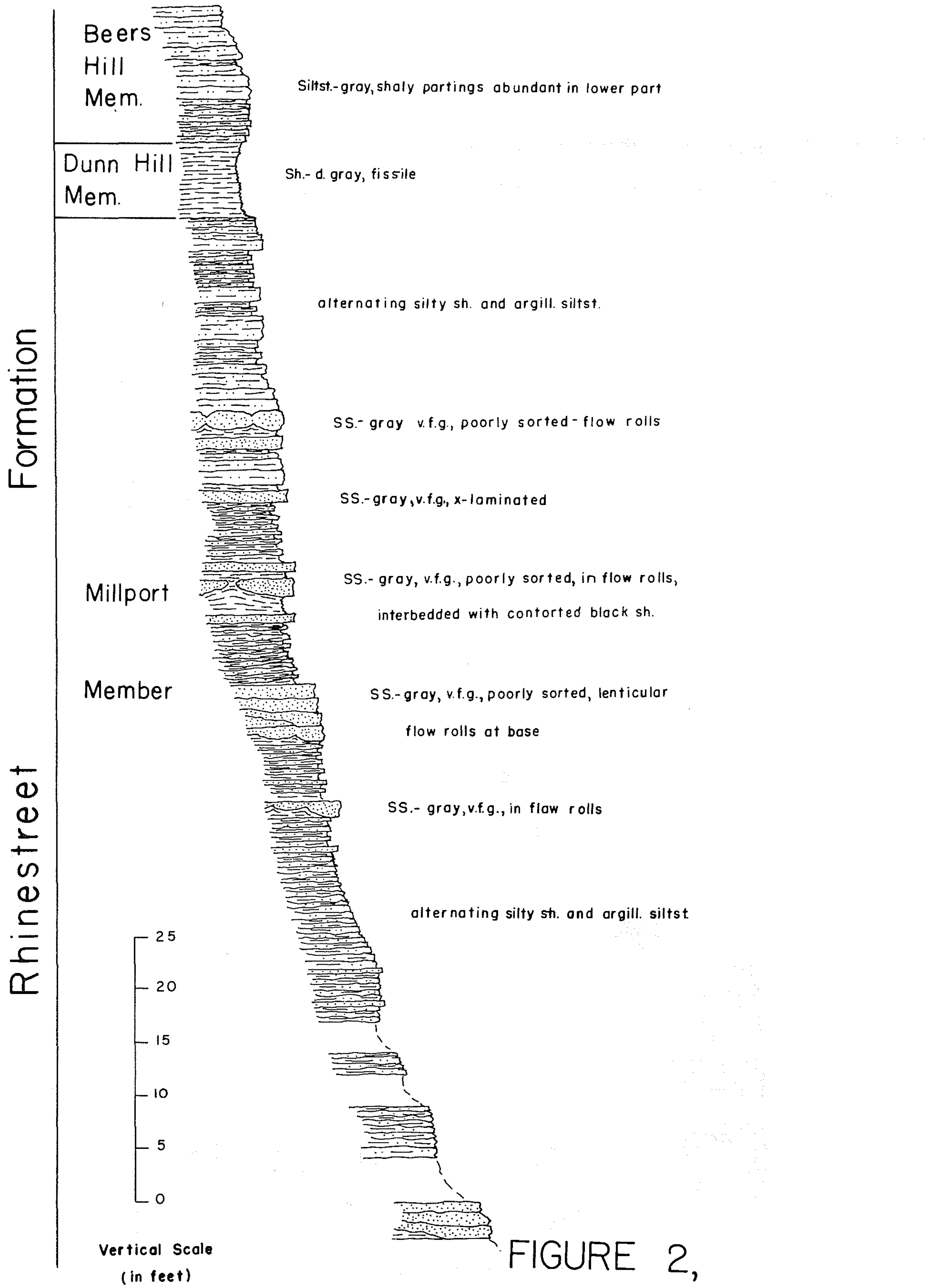
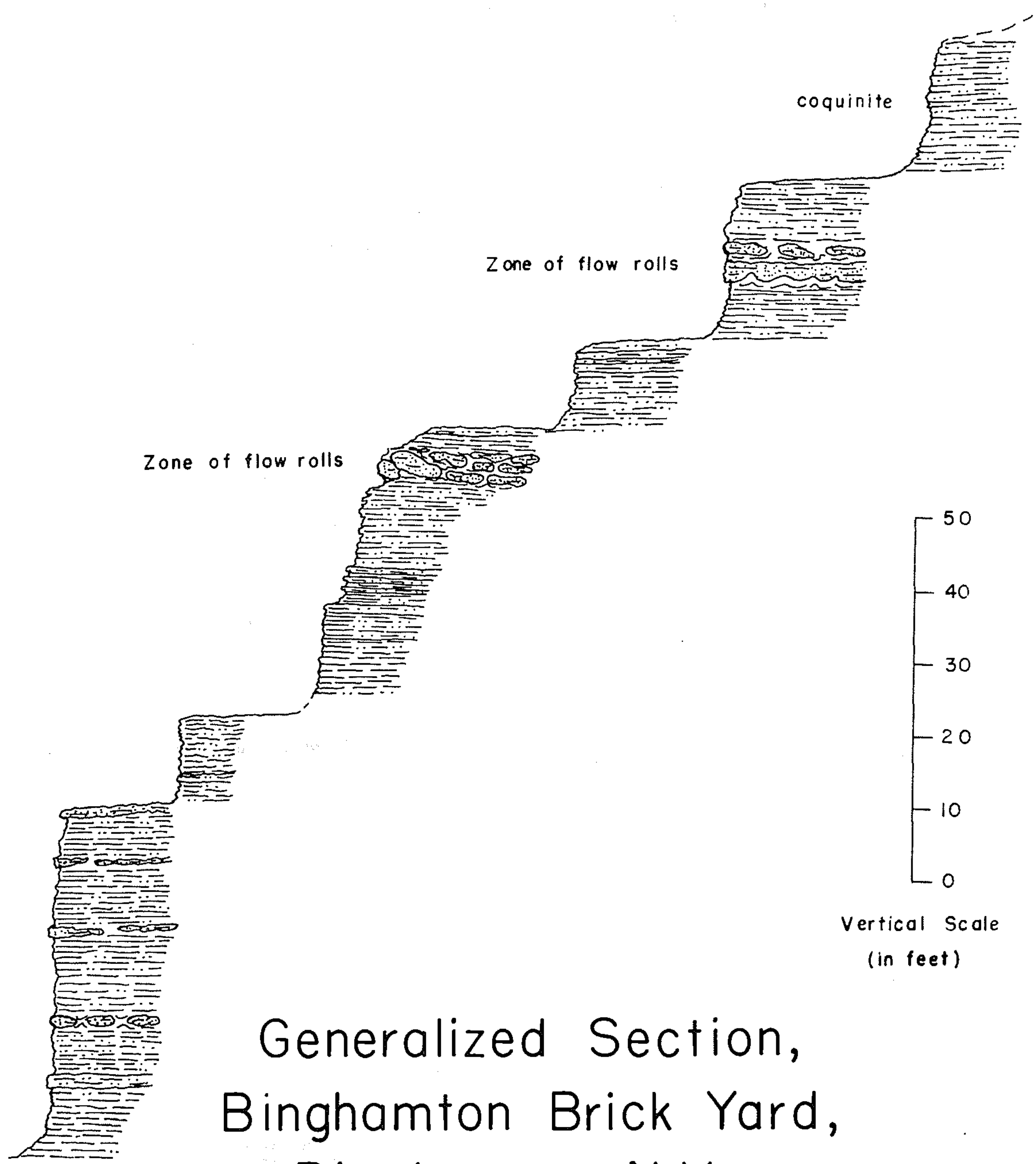


FIGURE 2,

Stratigraphic Section - Twist Run, Town of Union, N.Y.

note: rocks here described are part of
Millport Member of the Rhinestreet Formation



Generalized Section,
Binghamton Brick Yard,
Binghamton, N.Y.

FIGURE 3

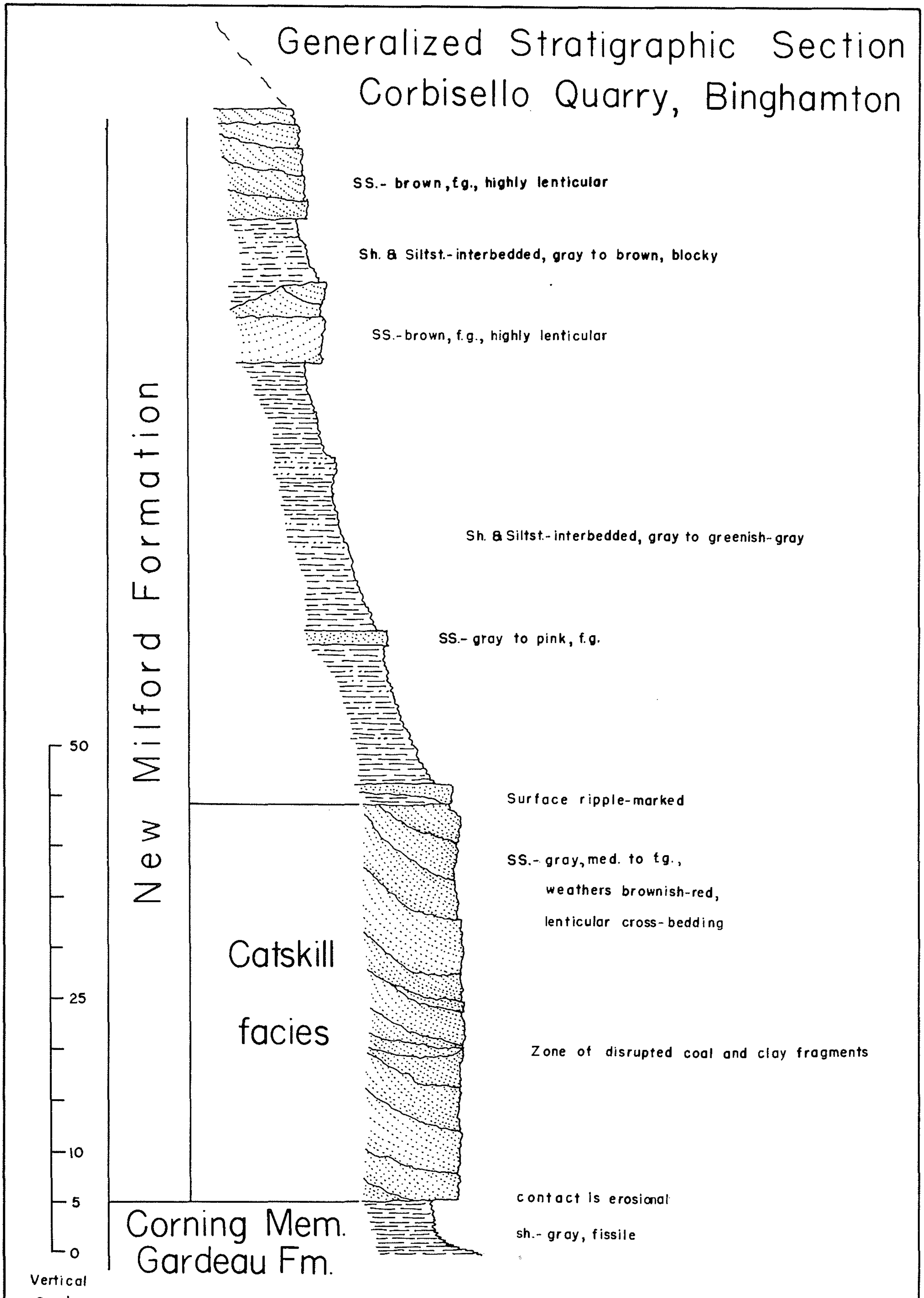

Generalized Stratigraphic Section
Corbisello Quarry, Binghamton
SS.- brown, f.g., highly lenticular
Sh. & Siltst.- interbedded, gray to brown, blocky
SS.- brown, f.g., highly lenticular
Sh. & Siltst.- interbedded, gray to greenish-gray
SS.- gray to pink, f.g.
Surface ripple-marked
SS.- gray, med. to f.g.,
weathers brownish-red,
lenticular cross-bedding
Zone of disrupted coal and clay fragments
contact is erosional
sh.- gray, fissile
New Milford Formation
Catskill
facies
Corning Mem.
Gardeau Fm.
50
25
10
5
0
Vertical
Scale
(in feet)

FIGURE 4

GEOMORPHOLOGY OF THE BINGHAMTON AREA

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The Binghamton area, also known as "The Triple Cities", is located in Broome County, immediately north of the Pennsylvania State line. The 200,000 population of the metropolitan area is largely confined to the flood plain-terrace area, often two miles wide, of the Chenango and Susquehanna Rivers. Until recent years the Endicott-Johnson Corporation was the only important large industry of the area. Attracted by excellent water recources, and other factors, however, there are now more than 100 industries in the area the largest being: International Business Machines, Inc., Ansco-Ozalid, Link Division of General Precision, Inc., and General Electric Co. Such a setting provides an ideal environment for Harpur College and Broome Technical Community College.

The purpose of this report is to focus attention on the specific topographic, hydrologic, and glacial features that typify the area. The general geologic setting is discussed in other articles of this volume. Additional information may be found in the text of the Description for Field Trip B. The route of the trip (Fig. 1) was designed to cover the maximum area in the time provided. The trip stops are at convenient and accessible localities but are representative of the geomorphology of the Triple Cities.

TOPOGRAPHY

The flavor of any topography is largely the result of the intensity and nature of the interaction of internal earth foces and the external degradational processes. The Binghamton landscape has been sculptured from shale and siltstone of Upper Devonian age by the action of running water and gravity. These processes continued for millions of years until molested and interrupted by the challenge of Pleistocene glaciation.

The topography of the area ranges from 810' in the Susquehanna River to 1877' south of Ingraham Hill (Fig. 2). The total relief is less today than it was during preglacial time, owing to aggradation of till on upland and valley sides and deposition of outwash and alluvial materials in river channels. The valley bedrock floors of the major drainages were 200' deeper and hill summits were probably 10'-20' higher. Glacial ice was not an important erosional factor in the area.

Three important slope elements compose the topography, namely those slopes produced by, (1) Sheet wash and gravity - "equilibrium-type slopes", (2) direct river incisement and oversteepening by lateral corrasion, and (3) aggradational processes. Some of the quantitative slope and drainage relations are presented in Tables 1 and 2. Slopes of the first category usually range from 13-15 percent grade, whereas second category slopes may be vertical and third category slopes horizontal. Less than one-fourth of the slopes are more than 15 percent. The wide flood plain-terrace areas reduce the overall ruggedness of the region.

At least three interesting aspects of slopes and drainage are worthy of special mention: (1) With the exception of direct stream corrasion the, steepest topography occurs on north-facing slopes; (2) Many stream junctions in the southern part of the

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Acknowledgments: W. Bothner and W. Cook aided in drafting the illustrations. W. Cook, J. Conners, and R. Teifke aided in assembling some of the statistical data.

DRAINAGE BASIN	BASIN AREA (Sq. mi.)	TOPOGRAPHIC SLOPE				SOILS					
		More than 15%		Less than 15%		Pervious		Partly Pervious		Impervious	
		Sq. mi.	% at basin	Sq. mi.	% at basin	Sq. mi.	%	Sq. mi.	%	Sq. mi.	%
North of Susquehanna River including Patterson Creek Finch Hollow Creek	52.1 12.1	7.8	15	44.2	85	12.9	25	2.9	5	36.2	70
South of Susquehanna River	37.6	9.0	24	28.6	76	8.6	23	2.6	7	26.4	70
Chenango River Valley (including Castle and Thomas Creeks)	41.3	8.8	21	32.6	79	10.3	25	1.7	4	29.5	71
TOTAL	131.0	25.6	20	105.4	80	31.8	24	7.2	6	92.1	70
Nanticoke Creek	29.3	4.6	16	24.7	84	4.7	16	1.5	5	23.1	79
Little Choconut Creek	11.7	2.4	20	9.3	80	.4	3	.1	2	11.3	95
Tracy Creek	10.0	1.1	11	8.9	89	.6	5	.1	2	9.3	93
Big Choconut Creek	19.0	5.3	28	13.7	72	1.9	10	.3	2	18.7	88
Pierce Creek	5.5	1.1	20	4.4	80	0	0	0	0	5.5	100
Little Snake Creek	22.8	7.2	32	15.6	68	1.3	6	0	0	21.4	94
TOTAL	98.3	21.7	22	76.5	78	8.9	9	2.0	2	89.3	89
Potato Creek Brooks Creek	6.9	1.4	20	5.5	80	0		0		6.8	100
Page Brook Ballyhack Brook Osborne Creek	23.1	4.7	20	18.3	80	1.7	7	.2	1	21.2	92
Bradley Creek	7.4	.8	11	6.6	89	.7	9	.1	1	6.7	90
Stratton Mill Creek Stanley Hollow Creek Sherwood Hollow Creek Trim Street Creek Doubleday Creek Unnamed Creek	19.2	6.9	35	12.3	65	.6	3	0	0	18.5	97
Sugar Creek	6.4	1.9	30	4.5	70	.3	5	0	0	6.1	95
TOTAL	63.0	15.7	25	47.2	75	3.3	5	.3	0	59.3	95
GRAND TOTAL All Drainage Areas	292.0	62.5	22	229.0	78	43.9	15	9.5	3	238.8	82

TOPOGRAPHIC SLOPE AND SOIL CHARACTERISTICS OF DRAINAGE BASINS IN THE BINGHAMTON AREA

TABLE 1

TABLE 2

Morphometric Summary of Third-Order Basins in the Binghamton Area

		50 basins north of Susquehanna River (mean)	50 basins south of Susquehanna River (mean)
Basin area (sq. mi.)		0.573	0.482
Basin perimeter (mi.)		3.179	2.780
Stream length total (mi.)	First order	3.16	2.32
	Second order	0.79	0.81
	Third order	0.80	0.56
	Total all orders	4.75	3.69
Stream length mean (mi.)	First order	0.167	0.151
	Second order	0.250	0.236
	Third order	0.722	0.506
	Mean all orders	0.291	0.253
Overland flow (mi.)		0.062	0.058
Stream Gradient (percent)	First order	10.9	10.7
	Second order	8.4	8.6
	Third order	4.6	6.4
	Mean all orders	9.3	9.5
Topographic slope (percent)		13.1	15.2
Basin relief (ft.)		428	506
Drainage density		8.38	8.90
Circularity index		0.563	0.621

All data obtained from U.S.G.S. 1:24,000 scale Topographic Maps.

area are "barbed", and; (3) The presence of youthful-type valleys superimposed upon the "maturely-dissected" land forms.

The author believes that by use of such data as found in Tables 1 and 2 important deductions can be made and theories for erosional history can be tested. For example some geologists believe the area south of the Susquehanna has had a somewhat different history than the area to the north. An interpretation of the data shows, however, that in general the erosion is of similar magnitude. The statistical level of significant differences are attributed to the slightly higher sandstone ratio and circularity index of the southern basins.

HYDROLOGY

Drainage Considerations

The major streams in the area are the Susquehanna, Chenango, and Tioughnioga Rivers. As the combined discharge of these rivers entering the Binghamton area is 6,106 cfs. and is 6,451 cfs. when it leaves the area, the 228 square miles of the region have added 345 cfs., a yield of 1.51 cfs/sq/mi.

There are many unusual drainage relations in this area, such as the Susquehanna River entering the area from the south and then making a right angle bend and flowing west out of the area. The relic channels and erosional history of these rivers is discussed elsewhere in this volume.

Water Resources

Water is a basic ingredient of the economy of the Binghamton area. Table 3 itemizes water use for the year 1962. The reader should study the publication by Brown and Ferris (1946) for a complete analysis of ground-water characteristics in the area. In 25 years, ground water use has increased 170 percent, from 5.3 billion gallons in 1937, to 7.6 bg. in 1944, to 8.9 bg in 1962. Brown and Ferris (p. 40) gave this note of caution:

> "Thus, under the present localization of ground-water development in the southwestern part of Broome County, it is possible that appreciably more than 50 percent of the total available supply is being utilized".

Some water users, such as Ansco, have major programs of water reversal in which they have developed some wells that are periodically used as recharge wells.

Rock wells in the area are generally more than 100' deep and yield only small amounts of water that is of poor quality owing to hardness and occasional chlorine, iron, sulfur etc. All public and industrial wells are developed in the outwash sand and gravel. The water is of excellent quality and may produce yields considerably more than 1,000 gpm with transmissibility of 70,000 gallons per day per foot of drawdown. Several wells and test borings have encountered large thicknesses of lacustrine clays, one reported as much as 200'.

GLACIAL GEOLOGY

The Wisconsin ice sheet covered the Binghamton area and spread 40 miles south into Pennsylvania. As it covered hills in Pennsylvania as high as 2,800' and by an interpretation of modern ice sheet slopes, it is probable that the total thickness of ice over Binghamton may have approached 3,000'. The part of the sheet confined to the major

TABLE 3

Water Use in 1962 by Major Districts in the Triple Cities

District Location	Water use 1962 (gal.)[1]	Water Source
Binghamton	3,700,000,000	Susquehanna River
Endicott	3,600,000,000	Ground water wells
Johnson City	4,500,000,000	Ground water wells
Vestal	310,000,000	Ground water wells
Chenango Bridge	73,000,000	Ground water wells
Fenton	146,000,000	Ground water wells
Others	250,000,000	Ground water wells
Total	12,579,000,000	

[1] Data obtained from official records and by personal interviews of major facilities.

valleys would be 1,000' thicker than ice over the uplands. The amount of ice erosion of bedrock features would be dependent on orientation. For example north and south-trending valleys probably were over-steepened owing to parallel direction with major alignment of ice transport. The Finger Lake district is a perfect example of what happened when a newer ice sheet invaded that area slicing 1000' of bedrock in the troughs. In the Binghamton area drainages that were athwart glacial movement received little erosion except on the north-facing upper slopes, and instead were largely filled with a great assemblage of glacial debris. The burial of such pre-glacial channels has attributed to many of the V-shaped post-glacial gorges in the Triple Cities area. Glacial deposits and outwash along with drainage modifications is discussed in separate sections.

Number of Wisconsin Glaciations

According to MacClintock and Apfel this area is the type locality for the Binghamton till sheet, a later glacial stage than the Olean till sheet. It would be good propaganda and serve local pride if this could be verified. There is serious doubt, however, concerning a two-cycle advance and retreat of major scope in this part of south-central New York (Denny, Muller, Moss and Ritter etc.). The author has found a few additional nails to hammer in the coffin of a "Binghamton till sheet" (Table 4). The Binghamton till lithology is always found below 950' elevation, it has been found with Olean separated by a transitional phase, both vertically and laterally, and only one weathering profile is developed in the till. Geomorphometry studies of small drainage systems (Table 2, Fig. 3) indicate the two areas, one south and one north of the Susquehanna River, have had a similar drainage history. This would not be the case if there had been a separate Binghamton till sheet, because the area south of the river would have had a longer and different type of erosion history. Thus the idea of a separate ice advance during Binghamton time should be abandoned and instead the term should be retained only as the valley facies of the Olean drift. It is only found in the through-valleys or in regions in communication with such valley systems. Its somewhat characteristic lithology of a high limestone content often enriched with igneous-metamorphic erratics, is attributed to transport by basal ice in the through-valleys as they incorporated formerly reworked stream gravels.

Table 4 contains data analysis of till samples compiled at Harpur College and at Franklin and Marshall College. The author is very surprised that all Olean samples of Moss and Ritter show coated heavy minerals greater than 74 percent. In their article no mention is made of a possible transitional lithology. Studies in the Binghamton area for this report indicate there are morainic hybrids and that there was mixture of the two end-members of the series. This can also be noted in the sand-silt-clay ratios. The nature of ice flow in this region and the wastage of ice blocks contribute to this heterogeneity. Furthermore, whereas significant exposures of Binghamton facies are unknown higher than 950' in this area, Olean facies can occur at all elevations, viz. Oakdale area (Samples #12,13, 14, taken at elevations from 850'-875'). Much work remains to be done on the intertonguing of the till lithologies.

Landforms Resulting From Glaciation

1. Plains. The character of glacial deposits, with some exceptions, indicates that the end of the ice age was not marked by general recession of the ice margin. Instead, much of the ice withered in place without support of fresh increments from Canada. The thinner ice on the hills left a general ground moraine that ranges from a few feet to more than 75 feet thick, but averages about 10 feet. Table 2 provides data on soil that has developed from the till and other materials. In the valleys the ice blocks were thicker and the valley walls offered some protection from the sun. This resulted in a longer residence time for such stagnant masses: These relations are spectacularly displayed by the range of deposits and land forms in the Chenango Valley State Park area, and will be seen on Field Trip B. (see Figure 4 and 2 for orientation and interpretation of the vicinity) The pre-glacial channel of the Chenango River was located north and west of Chenango Bridge. Owing to the unique topographic configuration and protection in the area the ice margin remained static in this locale and even received moderate norishment from a tongue of ice that extended north to upper Chenango River area. The great flood of deposits that issued from this source are still visible in the valley train and terrace deposits that extend from this spot to west of Vestal and decline 100' in slope from Chenango Bridge (940') to Castle Gardens (840'), in Vestal. Thus, this huge aggradational plain compounded by the meltwaters in this natural sluiceway in addition to lacustrine clays covered the former bedrock channel to depths greater than 200' in places (Fig. 5).

2. Diversion channels. The ice blocks also forced drainage from its former channel, causing incisement in other areas. Many changes occurred in the Chenango Bridge vicinity, for example, as the Chenango had to abandon its old channel at Kattelville and east of the State Park and cut a new channel west of the Park and south of Chenango Bridge. Confirming evidence for these events are found in well logs, kame terraces at Hillcrest, and glacio-fluviatile gravels plastered 140' high on bedrock walls south of Route 7. Another sure sign of post-glacial channeling is the cutting of bedrock in the stream bed as occurs west of Lilly Lake.

The 950' elevation was local base level for much of the Binghamton area in the post-glacial cycle of erosion. This is the elevation at which, many features are truncated; many valley walls steepen (exclusive of under-cut bends), and; alluvial fans from tributaries spread their debris in the major valleys. Fairchild erroneously interpreted these forms as deltas thus giving him the picture that during Wisconsin time a huge lake was impounded behind a morainic barrier at Towanda, Pa, that extended upstream in the Susquehanna and tributaries to Great Bend, Pa., a distance of 75 miles. He named it "Glacial Lake Binghamton" and infers a 915' strand line at Towanda is equivalent to the 940' level at Binghamton, thus necessitating a 25' isostatic rise. Unfortunately, the author's work in the area does not substantiate this conclusion, so once again he performs a nomenclatural disservice to the name "Binghamton". It is true that outcrops of some deltaic clays and sands occur and that well logs indicate blue clays at many sites. Such exposures are not correlative, however, but instead emphasize that during the life cycle of the ice age there were many local blockages of impounded waters. The Field Trip will visit some of the lakebed outcrops and show their occurrence at many different elevations.

Location of Sample	Size Distribution			Heavy Mineral Characteristics			Limestone and Chert in Gravel %	Till Facies
	sand %	silt %	clay %	uncoated opaque	uncoated nonopaque	coated minerals		
1. Stream bank, Castle Creek, 0.8 mi. SSE of Glen Castle, 5 ft. above stream	20.8	59.4	19.8	18.2	33.4	48.4	10	B
2. Same locality as #1. 30 feet above stream level	13.6	58.7	27.7	10.0	21.6	68.4	6	O
3. Excavation, .2 mi. west of African Rd. on Rt.17 in Vestal	15.2	68.4	16.4	41.6	33.2	25.0	15	B
4. Excavation in Star-Victory shopping center, .6 mi. west Bunn Hill Rd., between Vestal Road and Rt. 17	18.2	58.3	23.5	29.9	38.6	31.5	22.5	B
5. Stream bank, Occanum Creek 1.2 mi. west of Windsor	18.2	72.9	8.9	13.3	1.6	85.1	2.5	O
6. Road cut; rerouted Hiway 10 south of Cannonsville	20.0	67.2	12.8	18.3	20.0	61.7	0	O
7. Excavation, just west of new bridge over R.R., west edge of Bainbridge, Rt. 7	24.8	64.2	11.0	23.2	8.3	68.5	5.0	O
8. Same locality as #7, 300 feet further south	17.2	73.7	9.1	18.3	10.1	71.6	2.5	O
9. Stream cut. Tioughnioga River, 1.4 mi. north of Rt. 12. Till on top of stratified sands.	31.8	45.6	22.6	28.2	20.0	51.8	0	OB
10. Stream cut, Tracy Creek, 1.3 mi. south of Rt. 17	35.4	44.2	20.2	28.3	18.3	53.4	0	OB
11. Excavation, .3 mi. east of Owego Rd. and Rt. 17 in borrow pit of Triple Cities Construction Company	26.8	42.3	30.9	41.8	20.0	38.2	12.5	B
12. Excavation, .1 mi. west of Calvary Cemetery, J.C. (Oakdale area). 8 ft. below land surface.	27.0	37.7	35.3	13.3	5.0	81.7	0	O
13. Same location as #12, 16 ft. below land surface								
14. same location as #12, 24 ft. below land surfa								
15. Hawleyton								
16. East Binghar								
17. 1/2 mi.								
18. Sid								
19.								

The Susquehanna River, like the Chenango, has also had its share of drainage diversions (Fig. 5). Good examples are at Rock Bottom Dam (located at point D in Fig. 4), at Roundtop Hill, (west of Harpur College), and at Roundtop (in Endicott). A slightly different pattern of diversions can be seen at the mouth of the Tioughnioga River and Tracy Creek, both streams were forced to cut through bedrock gorges in order to reach their local base level.

3. Cols. In addition to the low-level drainage diversions, there are many high-level saddles and cols that indicate drainage modifications in drainage divide areas. The region between Chenango Bridge and Greene (Fig. 4) probably has at least 10 of these overflow saddles and the position of several of the best ones are indicated on the map. In a modest way these are through-valleys but they had a different history than those along the Appalachian Plateau escarpment to the north. The notches show a wide range in perfection of development and size and a smaller range in elevation.

4. Kettle Holes. The kettle hole swarm in the Chenango Valley State Park vicinity is one of the finest displays of this ice stagnation feature in New York State. Many are more than 60' deep with side walls that show a wide range in steepness. The largest single kettle hole is immediately south of Roundtop Hill in Vestal.

5. Additional Forms and Deposits. There are additional glacial deposits in the region, some with form and some are formless. Morainic loops occur with imperfect hill and lobate form, and are largely restricted to the area south of the Susquehanna River. Varve clays are found in Tracy Creek, and several small hanging deltas are in the Binghamton area. Some hillside slopes near the State line appear to be of the form produced by congeliturbation processes. Although kame hills and eskers are unknown in the metropolitan region both forms are present to the west of the area near Apalachin.

SYNTHESIS

The Binghamton metropolitan area is located on a variety of fluvial planar features at the confluence of the Susquehanna and Chenango Rivers. The Upper Devonian marine shales and siltstone were sculptured by running water into rolling hills of about 13 per cent gradient. The original relief of more than 1000' had been somewhat modified and subdued by glaciation.

Water is an important commodity and is found in good abundance in the interstices of the sand and gravel outwash deposits. Small amounts are obtained in some bedrock wells provided the bore has intersected sufficient numbers of water-bearing fractures.

There was one major Wisconsin ice sheet that covered the area, and it left a rich geomorphic heritage. A partial chronology of glacial events would include the following:

1. Glacial erosion of a small degree on upland areas increasing in magnitude in north and south-trending valleys.

2. Ice stagnation and melting with development of ground moraine on uplands and hillsides, and valley moraines with "choker" deposits in the lowlands.

3. Impounding of water forming lakes between morainic masses with formation of lacustrine clays and deltaic deposits.

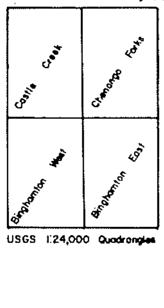
4. Diversion and breaching of the stagnation areas with formation of outwash areas, valley trains, and kame terraces.

5. Alluvial fan development by tributary streams.

6. Present period of degradation of the valley fill materials.

REFERENCES

References are listed in the article <u>General Geology of South-Central New York</u>.



SCALE : MILES

.5 0 1 2 3

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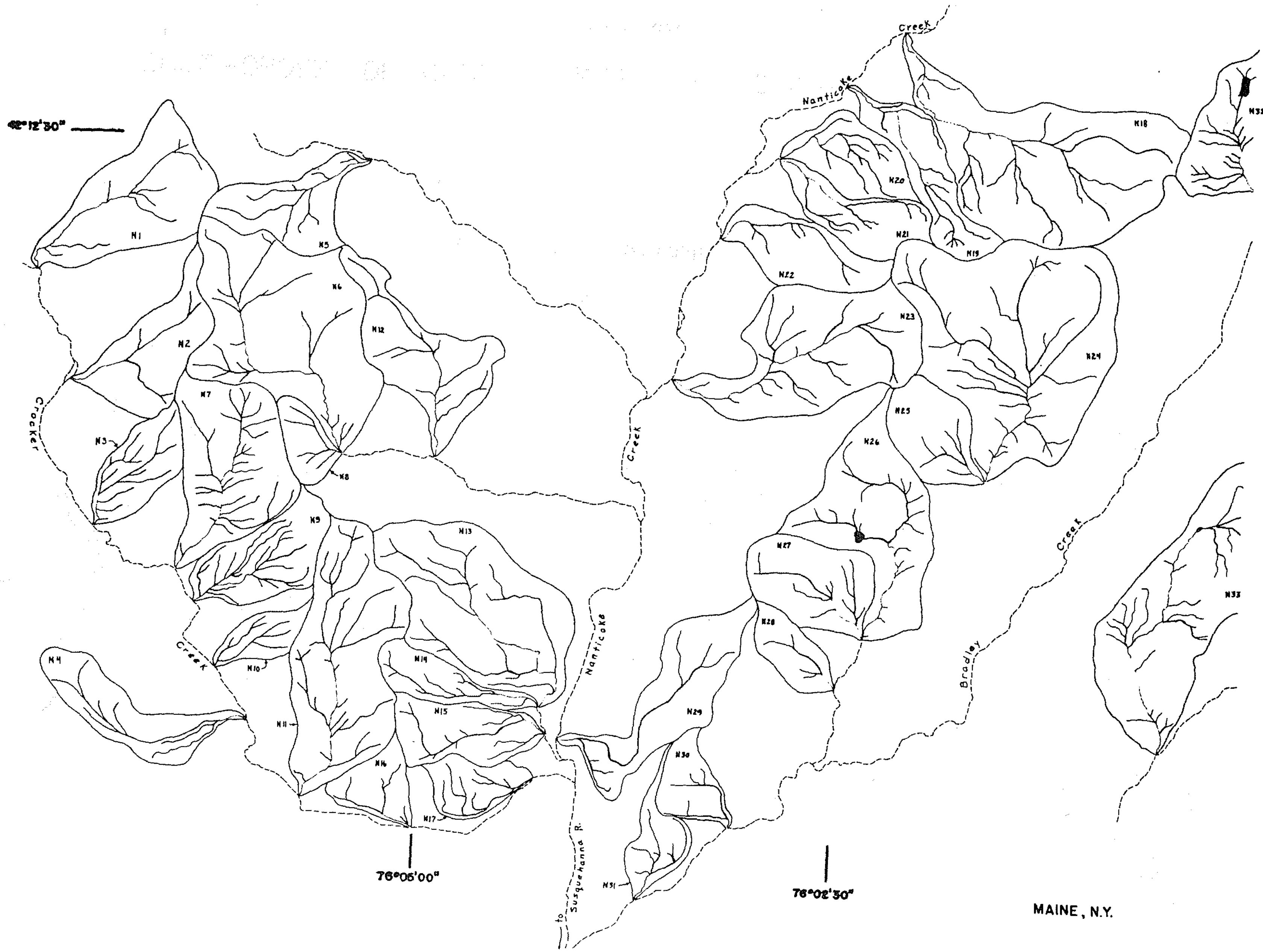
TOPOGRAPHIC MAP OF BINGHAMTON AREA

Figure 2


42°12'30"
N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
N12
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N14
N15
N16
N17
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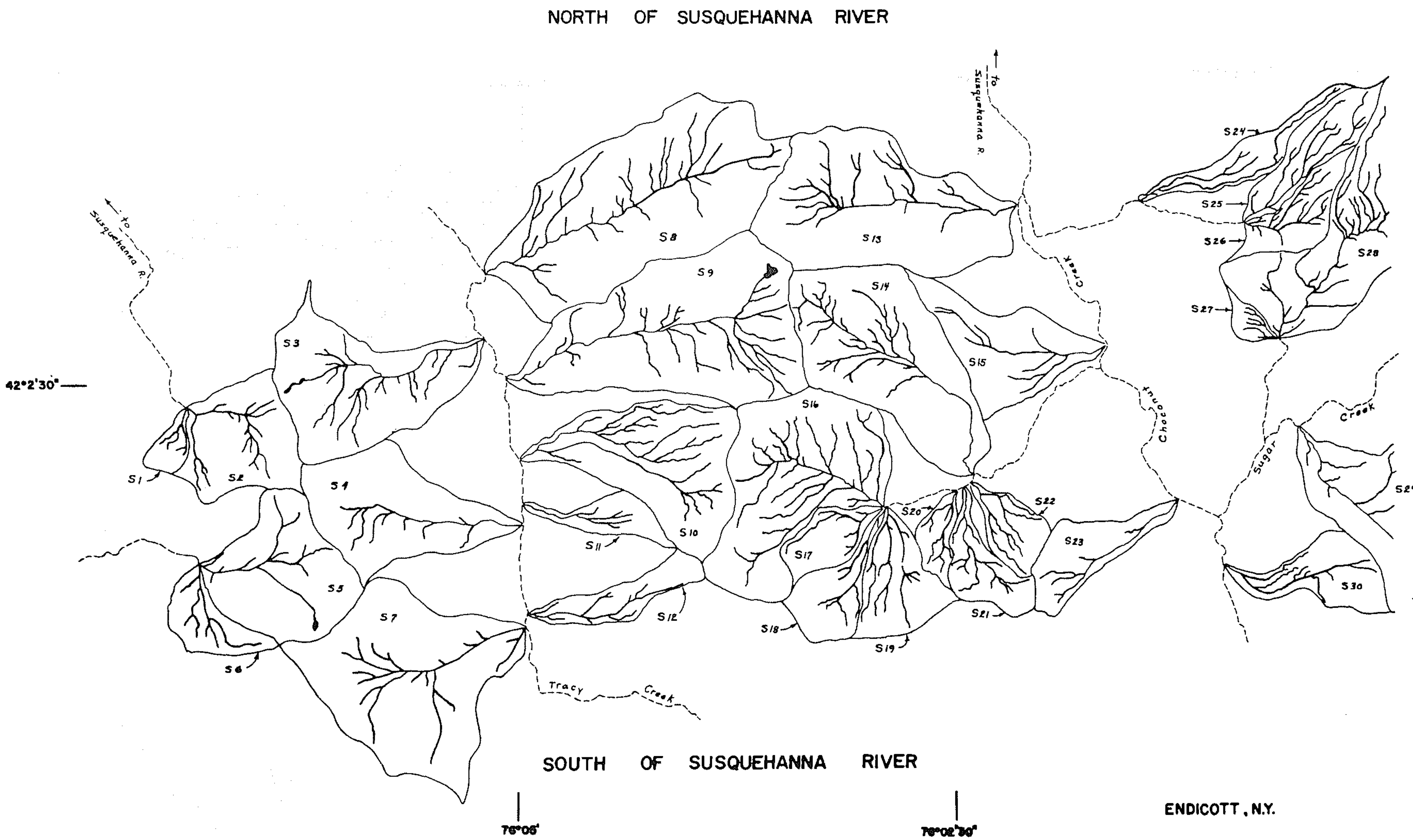
N27
N28
N29
N30
N31
N32
N33
Crocker
Creek
Nanticoke
Creek
Nanticoke
Creek
to Susquehanna R.
Bradley
Creek
76°05'00"
76°02'30"

MAINE, N.Y.



THIRD-ORDER DRAINAGE PATTERNS OF BINGHAMTON AREA

SCALE: MILES

1 0 1

Figure 3

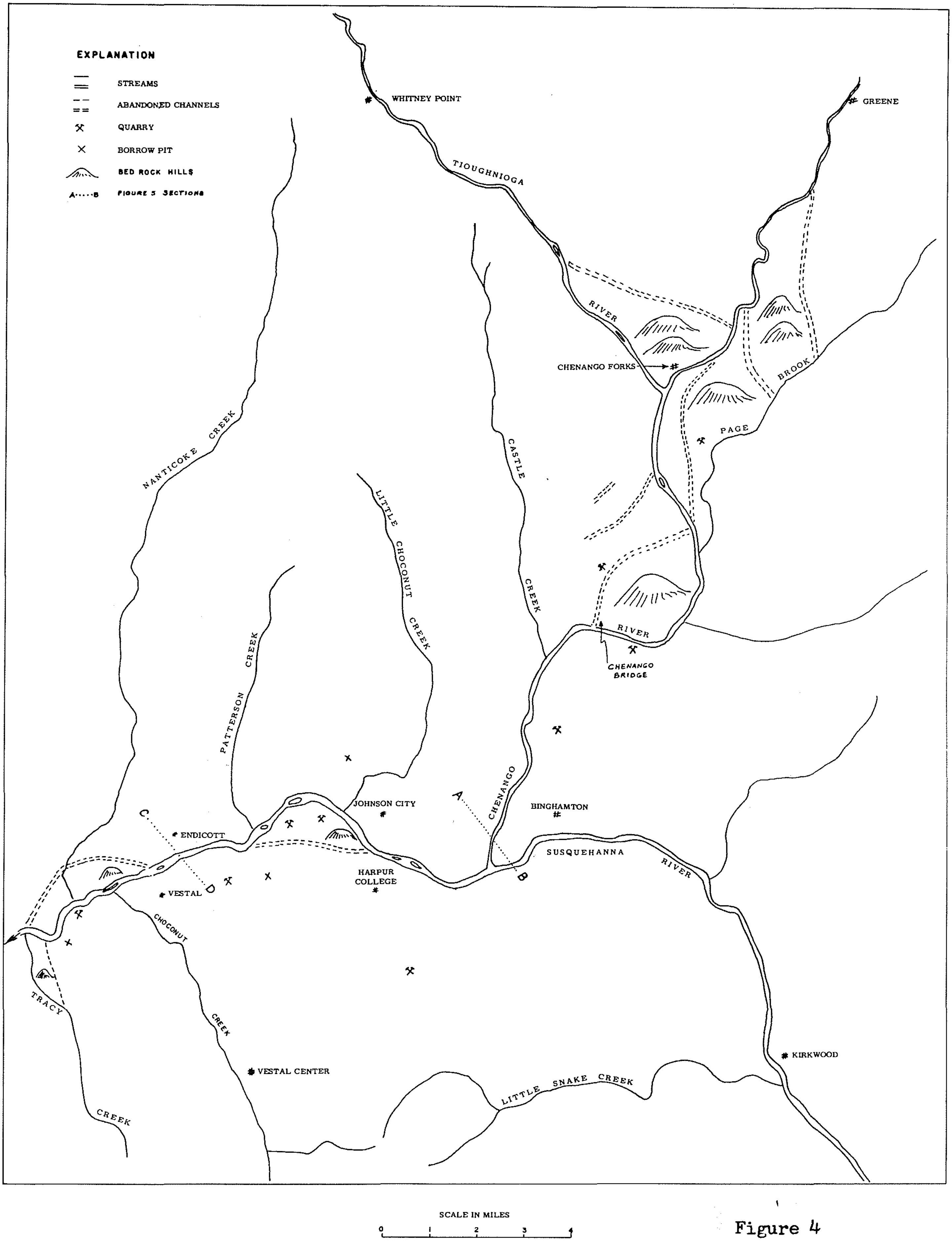
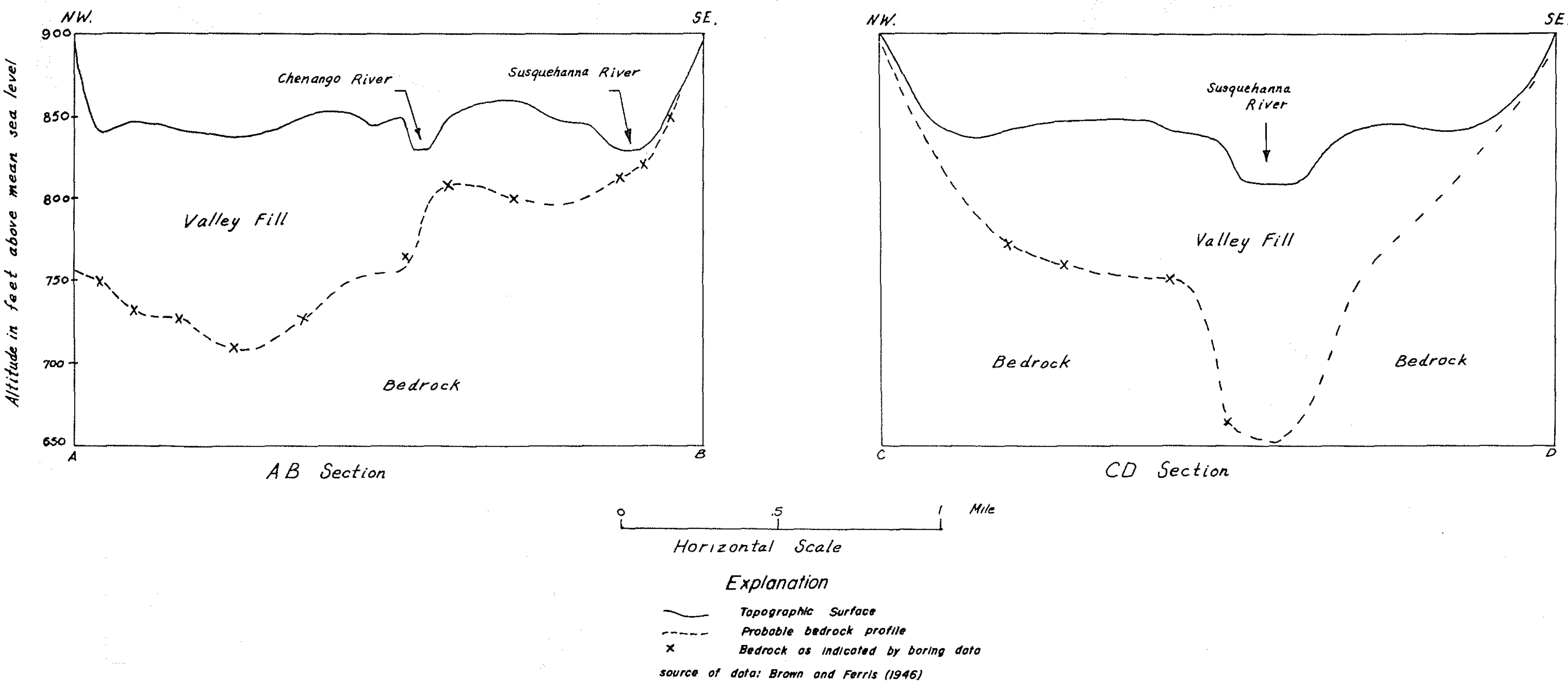


Figure 4

PART OF BROOME COUNTY SHOWING MAJOR DRAINAGES



CROSS SECTIONS TRANSVERSE TO VALLEY AXES

Figure 5