Bedrock Geology of the Central Mohawk Valley, New York

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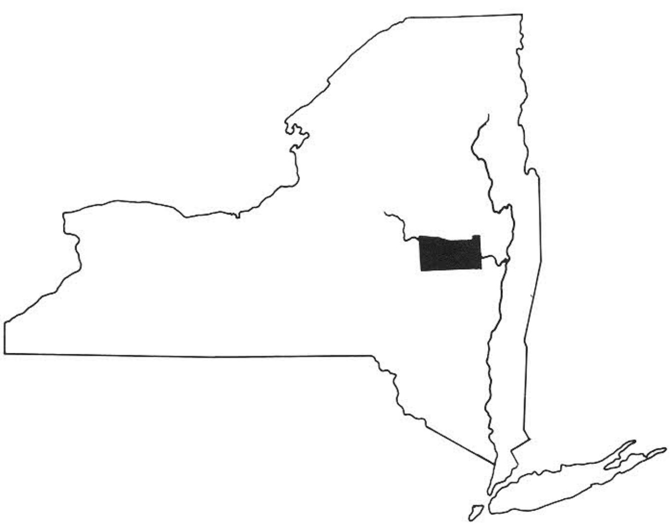

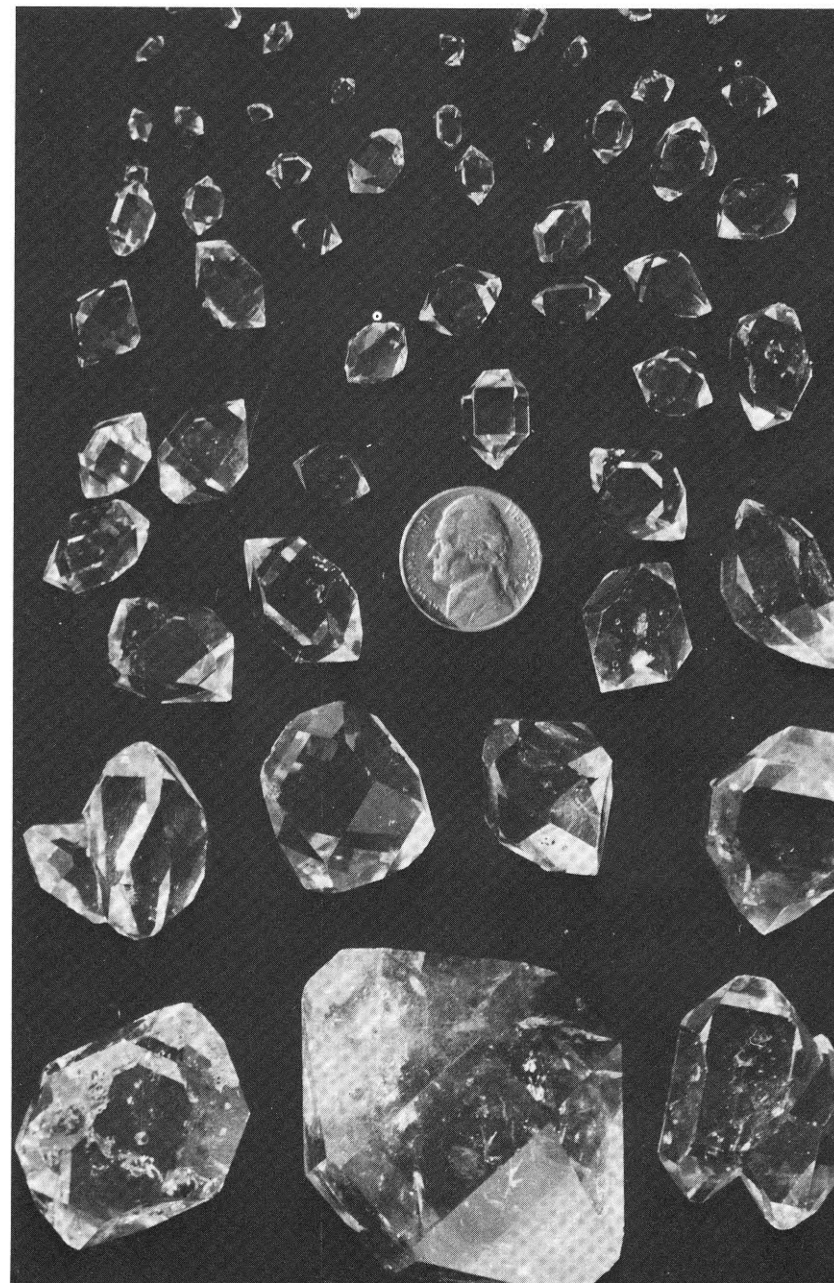

Figure 2
Herkimer "Diamonds"
(doubly terminated Quartz crystals) x 1.
Mohawk Valley, New York

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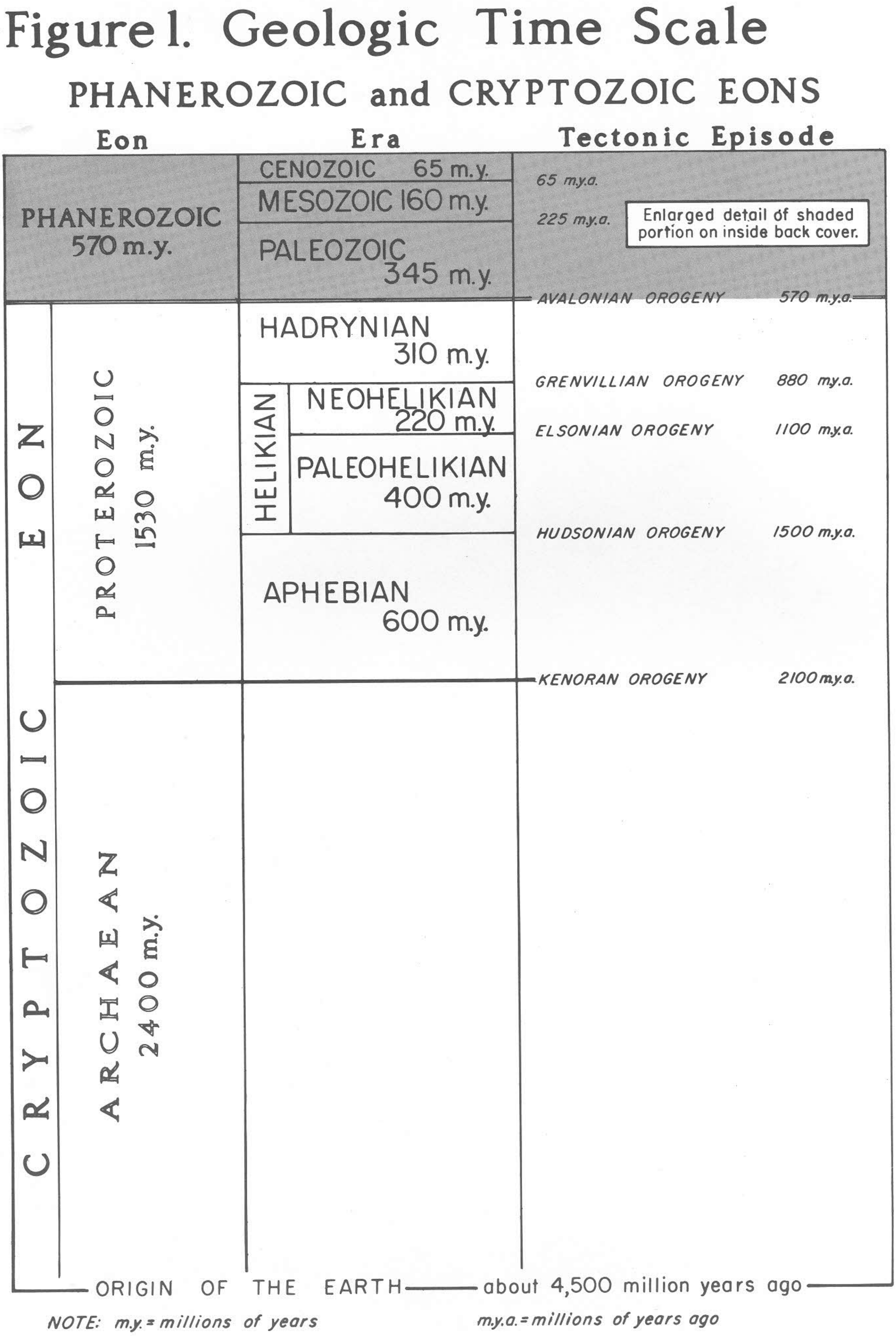

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Figure 3. *Lardner Vanuxem.*

LARDNER VANUXEM

(b. Philadelphia, PA 7/23/1792; d. Bristol, PA 1/25/1848)

——only picture known, a daguerreotype taken in 1846——

Upon the establishment of the Geological and Natural History Surveys of New York on April 15, 1836, Lardner Vanuxem was appointed one of four principal geologists commissioned to conduct a comprehensive survey of the minerals, rocks, and fossils of the Empire State. His area of investigation encompassed 15 counties in central New York, including Oneida, Herkimer, Fulton, and Montgomery in the Mohawk Valley and Otsego County. The results of his zealous and extraordinarily competent work are embodied in the succinct *Geology of New York, Part III, comprising the survey of the Third Geological District* (1842). Vanuxem was a charter member of the American Association for the Advancement of Science (1847). At the time of his death, his private collection of minerals was regarded as the largest, best arranged, and most valuable one in this country.

Lardner Vanuxem is best remembered in geologic circles for his formalized sequential system of nomenclature for Appalachian Province sedimentary rocks, hence his appropriate epitaph—"Father of American Stratigraphy."

Bedrock Geology of the Central Mohawk Valley, New York[1]

by Donald W. Fisher[2]

ABSTRACT

Stratigraphically, the rock record of the Mohawk Valley embraces metamorphic rocks of Medial Proterozoic (Helikian) age—greater than 1,200 million years old—to sedimentary rocks of Medial Devonian age—about 365 million years old. Except for the intensely deformed Proterozoic rocks, the overlying Cambrian, Ordovician, Silurian, and Devonian strata are essentially flatlying,—broken only by generally northeast-southwest trending normal faults. These block faults are step-like, with increasing vertical displacements toward the northeast, and with the largest faults having western upthrown sides.

Forty-four mapping units are portrayed by 33 color patterns on a map (scale 1:48,000) of the central Mohawk Valley. The mapped area is a mosaic of twelve 1:24,000 standard U.S. Geological Survey topographic quadrangles and portions of four others. The map legend describes the physical, organic, environmental, and economic characteristics of the rocks. The region covered extends from a point midway between Amsterdam and Schenectady on the east to St. Johnsville on the west; its north-south extent forms a belt bordered, approximately, by N.Y. route 29 on the north and U.S. route 20 on the south.

Geologic history, paleoenvironments, and locations of rock exposures exceptional for detailed study and class field trips are discussed. Many photographs illustrate fossils, minerals, and characteristics and locations of rock units. A selected bibliography to Mohawk Valley geology completes the work.

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[1] Submitted for publication, September 1979

[2] *State Paleontologist*, N.Y. Geological Survey, N.Y. State Museum, Cultural Education Center, Albany, N.Y. 12230.

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Robert H. Fickies, N.Y. State Geological Survey Environmental Geologist, and Department of Transportation Geologists, George Toung and Frank Irving, critically read and made significant additions to the "Environmental and Economic Characteristics" of the rock formations described in the map legend.

Professor James McLelland, Colgate University, provided information on the description and distribution of Proterozoic rocks within the mapped area. Professor John Riva, Laval University, graciously furnished the line drawings and photographs of graptolites. All other photographs were taken by the author, who is indebted to the photographic staff of the State Museum for their skills in processing and preparing film and prints. John B. Skiba, Geological Survey Cartographer, supplied drafting expertise. This graphic enhancement has made this publication more understandable and more usable to the reader.

From 1947 through 1951, the fieldwork was financially supported by the New York State Museum via Graduate Student Honoraria while working as a Temporary Field Geologist. The 1952 field season was conducted while I was Provisional Senior Paleontologist with the State Museum. A host of Mohawk Valley residents kindly permitted access to their properties and willingly called attention to secluded bedrock exposures. Without this cheerful attitude, the mapping program could not have been as complete or effective.

INTRODUCTION

Previous geologic investigations of Mohawk Valley rocks date back to Amos Eaton (1824) and his survey of the Erie Canal and Lardner Vanuxem's (1842) classic report on the geology of the Third Geological District, one of four comprehensive areal studies of the 1836–41 Geological Survey of New York. Darton (1894, 1895,), Cumings and Prosser (1900), Cushing (1905), Miller (1909, 1911), Ruedemann (1912, 1925), Kay (1937), and Fisher (1954) have made especially significant studies of Mohawk Valley geology. As for detailed quadrangle mapping on the west, Cushing (1905) and Dunn (1953–54) covered the Little Falls quadrangle, Kay (1953) the Utica quadrangle, and Rickard and Zenger (1964) the Richfield Springs and Cooperstown quadrangles. On the east, Ruedemann (1930) covered the Schenectady and Cohoes quadrangles. Except for Prosser, Cumings, and W. J. Fisher's Amsterdam quadrangle (the first New York State 15-minute geologic map to be published in color), the intervening Mohawk Valley rocks remained unmapped on a quadrangle basis until the present effort.

My acquaintance with the Mohawk Valley extends back over half a century for I was born in Schenectady, N.Y. and spent much of my early years in the Valley. In 1947, I began geologic studies by mapping the Fonda 15-minute quadrangle for a master's degree. A doctoral dissertation resulted in 1952 as an outgrowth of specialized paleontologic and stratigraphic studies of the Lower Ordovician rocks of the Mohawk Valley. Since 1952, I have, intermittently, conducted fieldwork in the Mohawk Valley while in the employ of the N.Y. State Geological Survey, N.Y. State Museum.

SETTING

The Mohawk Valley is the only natural gap across the Appalachian Mountain chain. It, thus, afforded easy access to westward migration by the French, Dutch, Palatine, British, and Americans both preceding and during the formative years of our country. The Valley was the site of many confrontations between the invading white settlers and the invaded Iroquois Indians. During the American Revolution, the area was the scene of skirmishes between American patriots and British soldiers with their Indian allies. British strategy was to conduct a three-pronged pincers attack on Albany, through the Champlain, Hudson, and Mohawk Valleys. The Champlain invasion was stopped at the Battle of Saratoga; the Hudson invasion stalled in the West Point area; the Mohawk invasion was effectively halted at the Battle of Oriskany in the Upper Mohawk

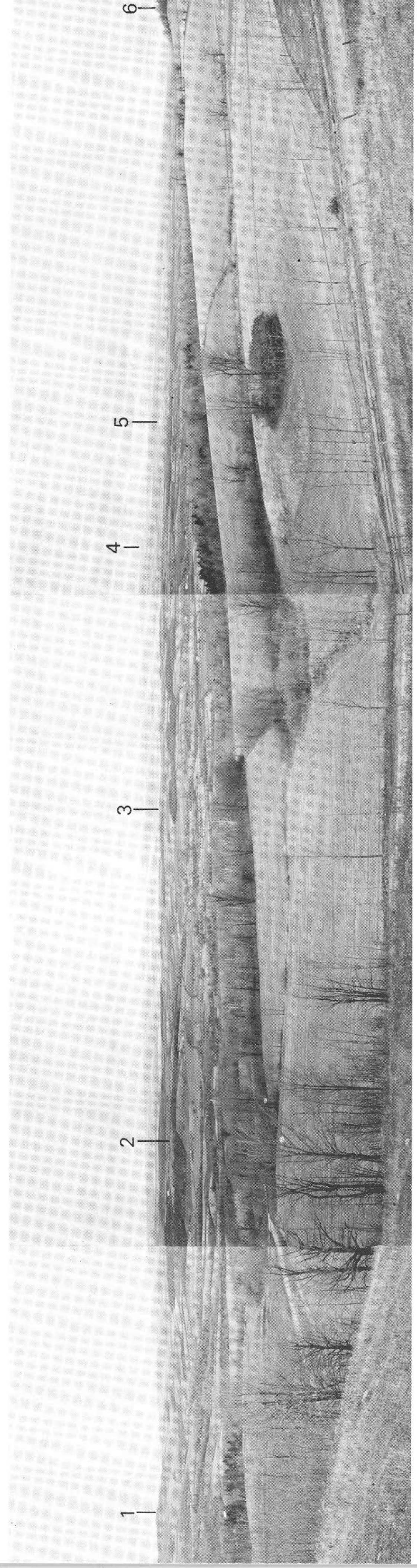


Figure 4. Panorama of Mohawk Valley; northward vista along U.S. 20 (Cherry Valley Turnpike), 5.5 km (≈3.4 mi) west of Sharon Springs. (1) Devonian (Helderberg) limestone terrace, (2) west-east-trending drumlin, (3) Mohawk River, (4) Proterozoic Adirondack Mountains, (5) Noses fault scarp, (6) Devonian (Onondaga) limestone terrace.

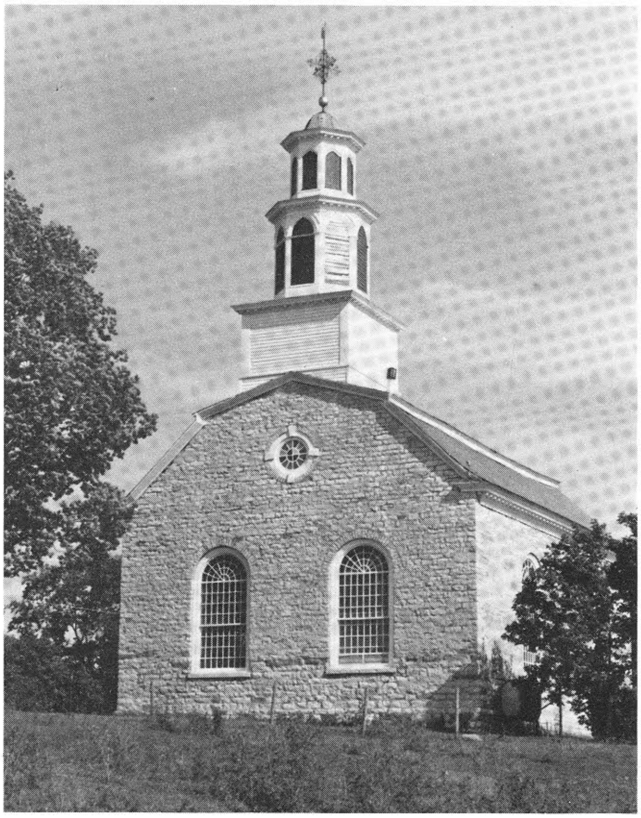


Figure 5. *Palatine Church; built in 1770, primarily of blocks of Middle Ordovician worm-riddled Lowville Limestone; west of Caroga Creek between relocated N.Y. 5 on south and old N.Y. 5 on north, 4.4 km (≈2.7 mi) north of Fort Plain and 5.4 km (≈3.3 mi) southeast of St. Johnsville.*

Valley. Names like British Governor Sir William Johnson, American General Nicholas Herkimer, and Indian Chief Joseph Brant are deeply indented in Mohawk Valley history. Walter Edmond's book, "Drums Along the Mohawk," is a semidocumentary on life in the Mohawk Valley during America's struggle for independence.

Paralleling the Mohawk River is a railroad (named over the years New York Central, Penn-Central, and Conrail) over which millions of tons of raw materials and finished merchandise have been hauled and, prior to the advent of frequent air travel, by which passengers usually traveled. In its heyday, the interurban trolley (Fonda, Johnstown & Gloversville Railway) also furnished much public transportation. Today, the region is serviced by many excellent roads, chief among which are N.Y. 29 at the north edge of the mapped area and U.S. 20 near the south edge, with N.Y. routes 5 and 5-S paralleling the Mohawk River on its north and south shores, respectively; I-90, the N.Y.

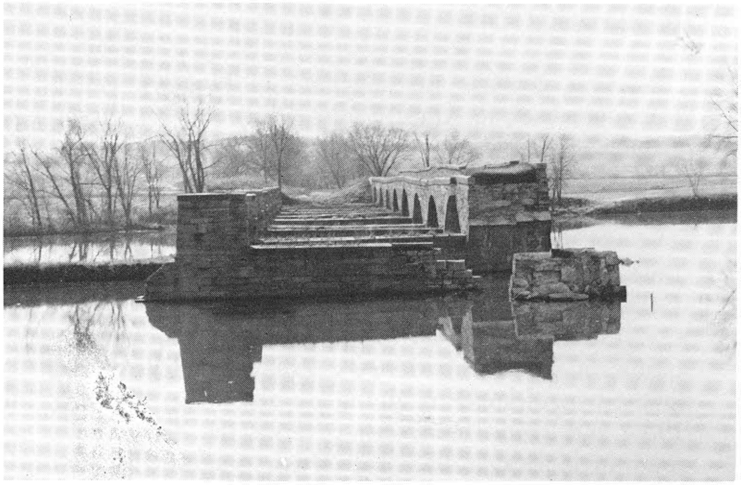


Figure 6. *Remains of limestone viaduct for old Erie Canal over Schoharie Creek, looking west from Fort Hunter.*

State Thruway (toll road) occupies the Valley to the south of the river as far west as Herkimer where it crosses to the north side. Crisscrossing the region from south to north are N.Y. routes 163, 10, 162, 30A, 30, and 67.

The east-southeast flowing Mohawk River occupies a lowland varying from 22.5–55 km (14–34 miles) wide, reaching north into the Adirondack Mountains and

Figure 7. *Viaduct for old Erie Canal over Schoharie Creek, looking east toward Fort Hunter; note towpath on left.*

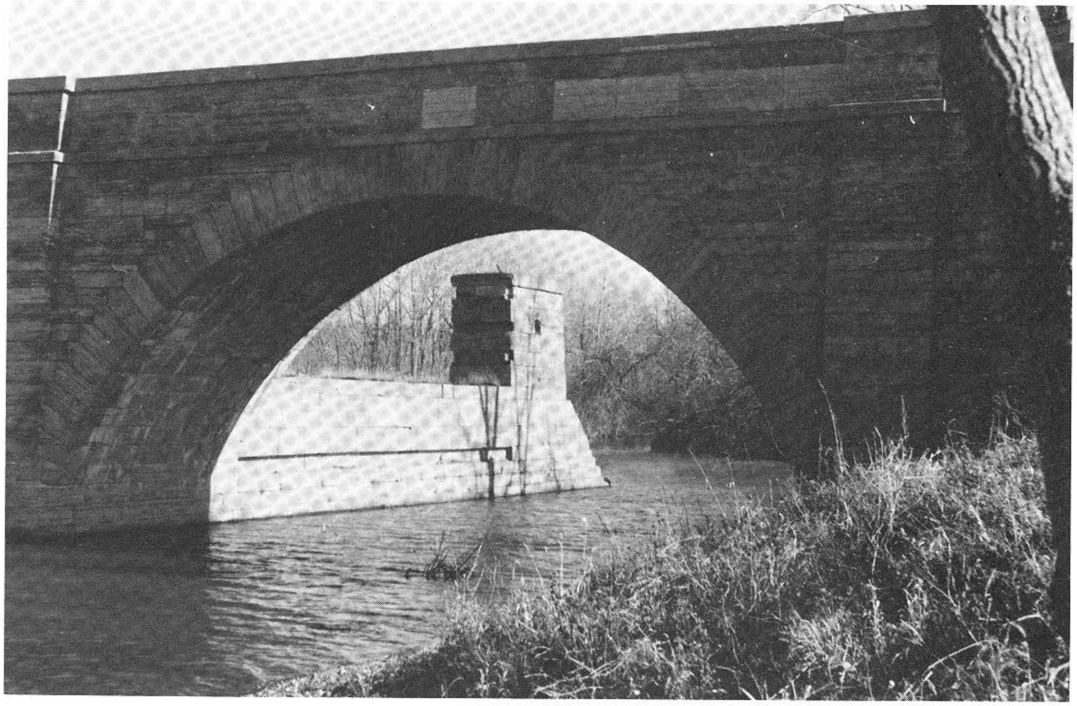
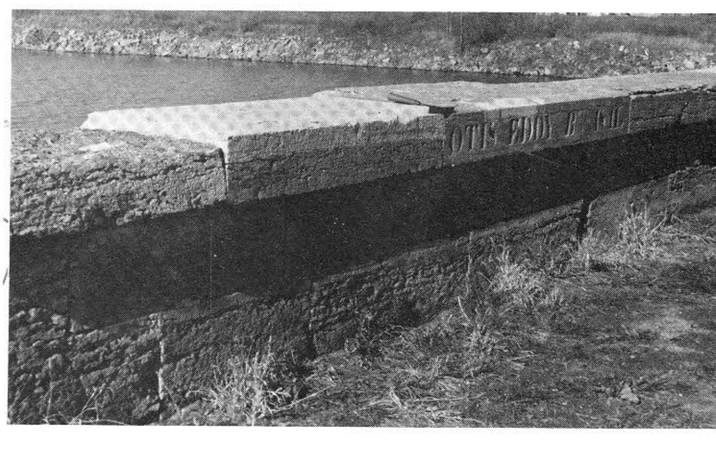


Figure 8. *Close-up of vaulted archway of Erie Canal viaduct over Schoharie Creek.*

south into the Helderberg Escarpment and Catskill foothills. The Mohawk's headwaters are about 5 km (3 miles) north of West Leyden, Lewis County while the mouth is at Cohoes, Albany County at the Hudson River; the entire course is 195 km (≃ 120 miles) long. Throughout its course, the Mohawk River drops about 500 m (1,650 feet) from a high of 512 m (1,680 feet). For much of its length, the river acts as the water avenue for the N.Y. State Barge Canal; the original course of the Erie Canal parallels the river on the south. In the mapped area, the highest elevation is 703 m (2,306 feet) at the unnamed hill 4 km (2.5 mi) east-southeast of Cherry Valley while the lowest elevation is 68 m (224 feet) where the Mohawk River leaves the map at the eastern edge; the relief is, therefore, 635 m (2,082 feet). Within the mapped region, the Mohawk's chief tributaries are East Canada, Timmerman, Caroga, Cayadutta, and North Chuctanunda Creeks on the north and Otsquago, Canajoharie, Flat, Yatesville, Auries, Schoharie (116 km = 72 miles long), and South Chuctanunda Creeks on the south.

The surface of the Middle Proterozoic (Helikian) metamorphic rocks of the Adirondack Mountains dips southward beneath Lower Paleozoic Cambrian and Ordovician sedimentary rocks (which comprise the Mohawk Lowland). These, in turn, dip southward beneath Middle Paleozoic Silurian and Devonian sedimentary rocks bordering the Mohawk Valley on the south and which form the Allegheny Upland.

Figure 9. *Comparison of erosion on dimension stone along towpath of Erie Canal viaduct over Schoharie Creek; Amsterdam Limestone on extreme left, Wolf Hollow Limestone to left of center, Larrabee (Trenton) Limestone to right of center.*



GEOLOGIC HISTORY AND PALEOENVIRONMENTS

Mohawk Valley geologic history begins with the establishment of a basement of Middle Proterozoic (Helikian) rocks which were metamorphosed by intense heat and high pressure some 1,100 million years ago during the mountain building event known as the Grenville Orogeny. Later, some 700 million years ago, these gneisses were intruded by mafic igneous dikes of Late Proterozoic (Hadrynian) age. But, for over 500 million years, there was no preserved sedimentary rock record; presumably the region was a tableland carpeted with a patchy veneer of thin soil. The earliest Paleozoic Era seas to flood the old base-levelled metamorphic terrain were exceedingly shallow ones (up to 20 m deep) in which quartz sands and carbonate mud (Potsdam Sandstone, Galway Formation, Little Falls Dolostone) were deposited. These laterally transitional Late Cambrian sediments accumulated on a continental shelf that fringed a large northern land now occupied by Canada and termed the Canadian Shield; the continental slope and deeper oceanic plain lay to the east in the area of eastern and central New England. Repeated land exposures (emergences) and water floodings (submergences) occurred during Late Cambrian and Early Ordovician times (515–470 million years ago), during which extensive and voluminous carbonate deposition (Beekmantown Group) took place. Locally, stromatolite (sediment trapped in algal mats and mounds) reefs, termed *Cryptozoon*, formed to the northeast of the mapped area.

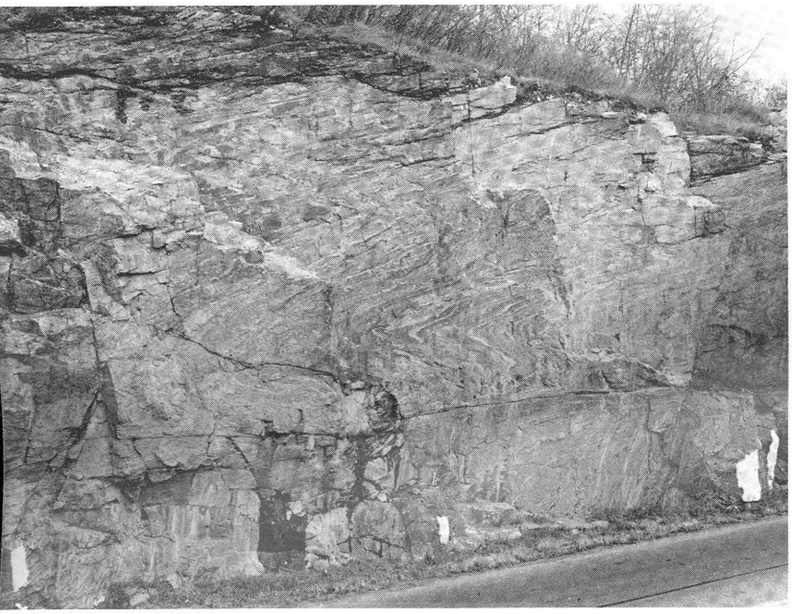
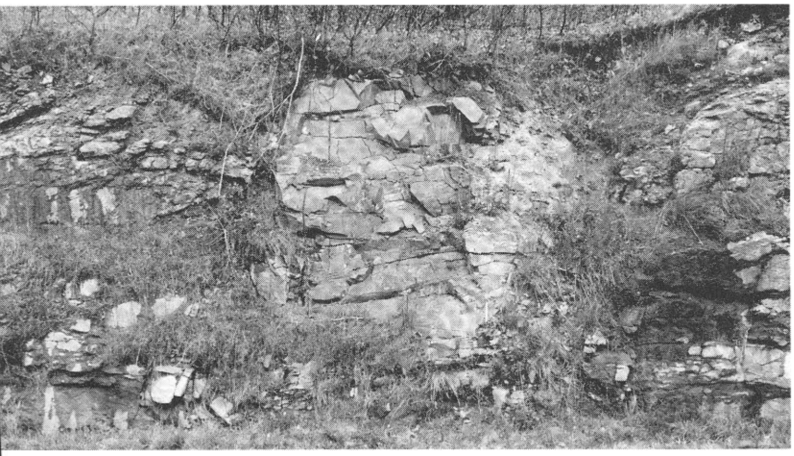


Figure 10. *Folded foliation in Middle Proterozoic (Helikian) garnet-gneiss (Peck Lake Formation); north side of N.Y. 5 at the "Big Nose," 10.2 km (≈6.3 mi) southwest of Fonda.*

Figure 11. *Late Proterozoic (Hadrynian) diabase dike, about 2.5 m (≈8 ft) wide, cutting Peck Lake Formation near west end of roadcut mentioned in Figure 10.*



Following Early Ordovician (Canadian Series) sedimentation, a widespread uplift of the American tectonic plate occurred, forcing shallow marine seas to withdraw from the land for about 5 million years. At this point, the large predecessor to the Atlantic Ocean, termed the Iapetus Ocean, reached its maximum width and the American and Afro-Eurasian tectonic plates, which had initially separated during Hadrynian times, began moving toward one another. Marine water again flooded the American plate in the New York area during Early Medial Ordovician time (465–460 million years ago) with the deposition of a complex array of reef, off-reef, and interreef carbonates (Chazy Group, Champlainian Series) in the Champlain Valley. These Chazy limestones are absent in the Mohawk Valley; if they were present they were erased by erosion prior to the deposition of the next intertidal shelf carbonate—the distinctive worm-burrowed early Mohawkian Lowville Limestone (Black River Group, Early Mohawkian Series). Instability of the crust increased in tempo, reflecting the approaching collision of the American and Afro-Eurasian plates. Another brief shelf emergence allowed the Lowville to be differentially eroded, leaving only isolated thin patches in the Mohawk Valley. Readvance of marine waters permitted a cycle of thin lumpy subtidal marine lime-

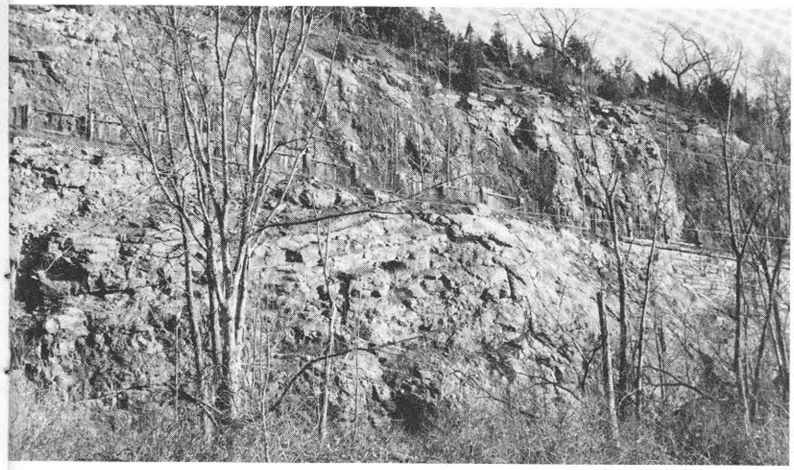


Figure 12. *Little Falls Dolostone (Late Cambrian) along south side of railroad and old Erie Canal bed at the "Little Nose," 8.5 km (≃5.3 mi) southwest of Fonda.*

Figure 13. *Low upwarp (anticline) in Fort Johnson Member of the Tribes Hill Formation (Early Ordovician); north side of N.Y. 5-S, 2.5 km (≃1.6 mi) northwest of Pattersonville.*

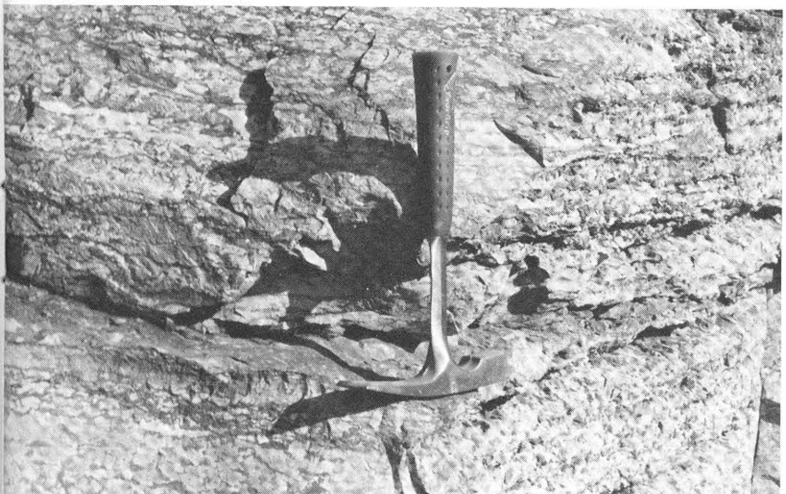


Figure 14. *Close-up of dolomitic limestone of the Fort Johnson Member displaying ubiquitous fretwork weathering with mineral dolomite weathering in relief; same locality as Figure 13.*

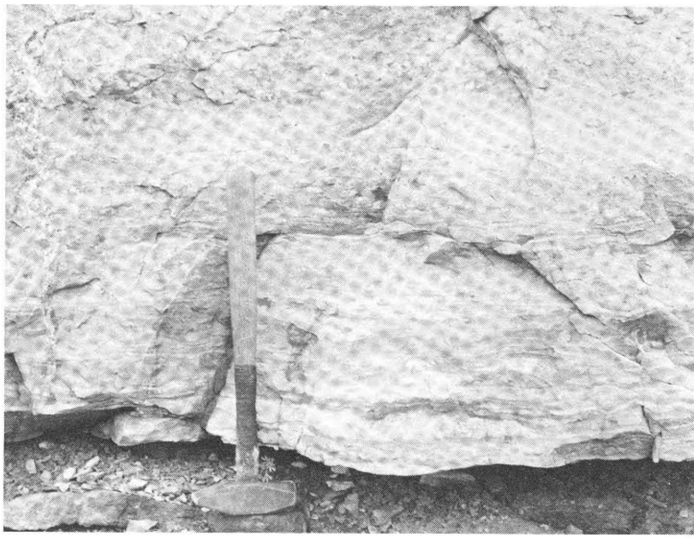


Figure 15. *Dolostone in Fonda Member of the Tribes Hill Formation (Early Ordovician); south side of I-90, 3.6 km (≃2.2 mi) southwest of Fonda.*

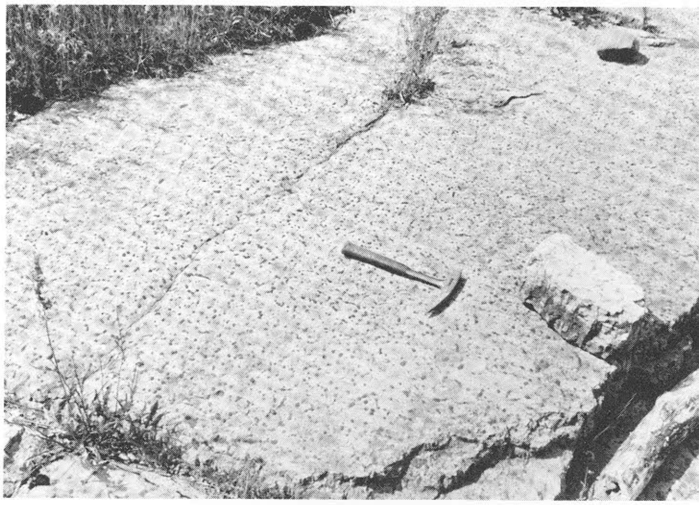


Figure 16. *Worm-riddled (*Phytopsis tubulosum*) Lowville Limestone (Medial Ordovician); Crum Creek, south of N.Y. 5, 4.2 km (≃2.6 mi) west-northwest of St. Johnsville.*

stones (Amsterdam) to form. The Amsterdam contains an abundant and cosmopolitan fauna of trilobites, ostracodes, gastropods (high- and low-spired), straight nautiloid cephalopods, brachiopods, bryozoans, and corals. The corals (some inverted) attest to an environment of rough, warm, clear, shallow marine water of normal salinity with a firm substrate (seafloor) for animal attachment. Next followed the accumulation of coarse lime sands (Larrabee Member of the Glens Falls Limestone), followed by clay-rich lime muds (Sugar River Member of the Glens Falls Limestone). Both of these Trenton Group (late Mohawkian Series) limestones possess abundant and varied bottom dwelling faunas. Their distinctions are due to depth differences, turbidity, and degree of water agitation; the Larrabee environment was shallower, less turbid, and more agitated. West of St. Johnsville there is a unit, called the Dolgeville, which represents a lateral transition from limestones (Poland, Russia, Rust) on the west to black muds (Utica) on the east. This Dolgeville

Figure 17. *Conglomerate phase of Amsterdam Limestone (Medial Ordovician) unconformably on Fonda Member of Tribes Hill Formation (Early Ordovician); south side of I-90, 3.6 km (≈2.6 mi) southwest of Fonda.*

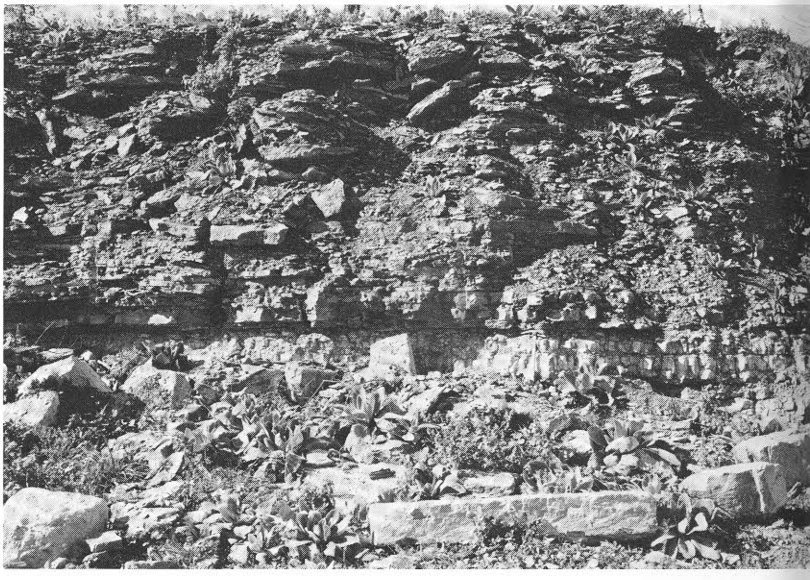


Figure 18. *Trenton (Kings Falls) Limestone on Black River (Lowville) Limestone; abandoned small quarry along north side of Mother Creek Fault, 2.6 km (≈1.6 mi) southeast of St. Johnsville.*

Figure 19. *Folded strata in upper 2 meters (≈6.5 ft) of Dolgeville facies (Medial Ordovician) along north side of I-90, west of the Little Falls Fault; note undisturbed Utica Shale above and undisturbed Dolgeville strata below.*

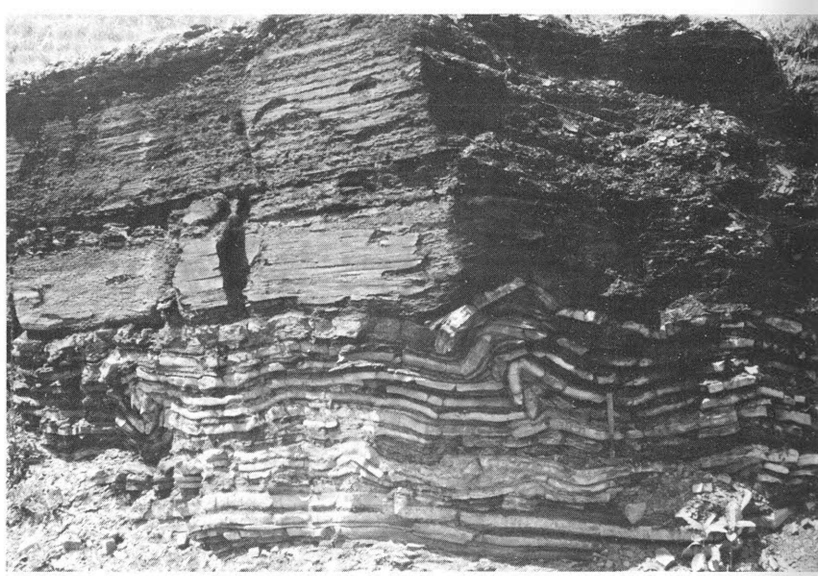


Figure 20. *Lower Utica Shale along south side of N.Y. 5-S, 0.8 km (≈0.5 mi) west of Fultonville.*

facies (Fisher, 1979) consists of interbedded limestones with a diminutive bottom fauna interlayered with black shales with a floating fauna of graptolites. The Dolgeville environment was just beyond the outer edge of the shelf on the uppermost western flank of a newly formed basin (Snake Hill Basin or Magog Trough).

Limestone deposition ceased with the continued, relatively abrupt, deepening of this north-south linear basin in the eastern Mohawk, Champlain, and Hudson Valleys. Thick, black, pyritic muds (Utica Shale) piled up; this oxygen-poor, murky environment was characterized by floating and swimming organisms, chief of which were the curious extinct "coping-saw blade" graptolites; bottom dwellers were scarce, represented by a few scavengers such as the trilobites *Triarthrus* and *Flexicalymene*. Meanwhile, the effects of the oncoming Taconic Orogeny were being felt from Newfoundland to Virginia. In western New England, a large landmass (Vermontia) was uplifted east of the aforementioned basin. Large masses of rock spalled-off this alpine upland and slid, via gravity, into the adjacent western basin of accumulating black mud. These transported rocks ranged in size from pebbles to immense blocks, many kilometers long. As the larger blocks moved, they ripped up carbonate rocks from the old continental shelf, bulldozing them beneath and in front of the moving masses while at the same time becoming incorporated into the unbedded or poorly bedded mud. A chaotic arrangement of many types and sizes of rocks resulted in the deformed sediment; this unique tectono-sedimentary unit is termed a mélange or wildflysch and is a common unit in the Hudson Valley. Continued erosion of the eastern, now dormant, upland produced thick coarse clastics (Schenectady Formation) which filled the Snake Hill Basin. About 440 million years ago, the next, and more intense, pulse of the Taconic Orogeny (Hudson Valley Phase) consisted of westward overthrusting of large rock slices, multiple folding, and metamorphism (in eastern Washington, Rensselaer, Columbia, Dutchess, and all of Westchester Counties) of existing rocks. This tectonic upheaval brought about vigorous erosion and reduction of Vermontia. The erosional debris settled in the shallow sea to the west as the Queenston Delta, a large clastic wedge that extended from Anticosti Island in the Gulf of St. Lawrence to Virginia on the south and west to Lake Huron and central Ohio. Within the Mohawk Valley, the Queenston Delta strata were erosively stripped away prior to the deposition of the next overlying Silurian strata.

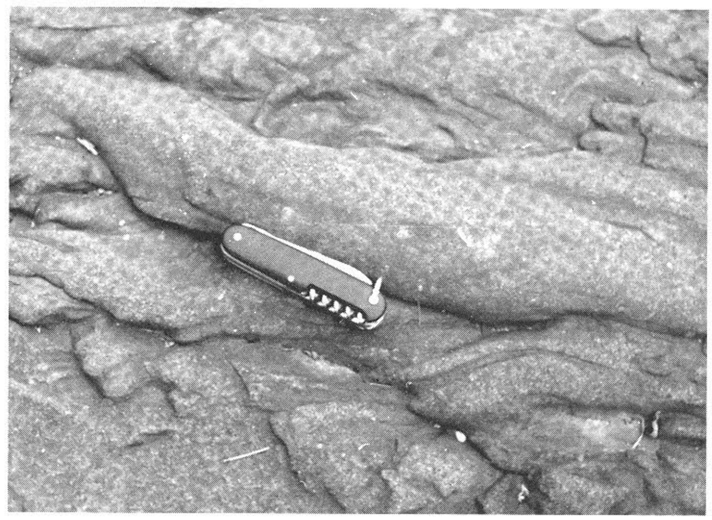


Figure 21. *Sedimentary flow rolls in medium-grained Schenectady sandstone (Medial Ordovician); in Schoharie Creek, 0.5 km (≈0.3 mi) south of Burtonsville.*

Following the compressional stresses of the Taconic Orogeny, a period of relaxation or tension ensued. Vertical, and perhaps strike-slip (as in the San Andreas Fault), movements occurred along old fracture lines in the Proterozoic basement. The Mohawk and Champlain Valleys were crosscut by almost vertical, normal faults. Some of these are upthrown on the east but most are upthrown on the west. All increase in displacement to the northeast and may curve southwestward to westward where their throw diminishes to

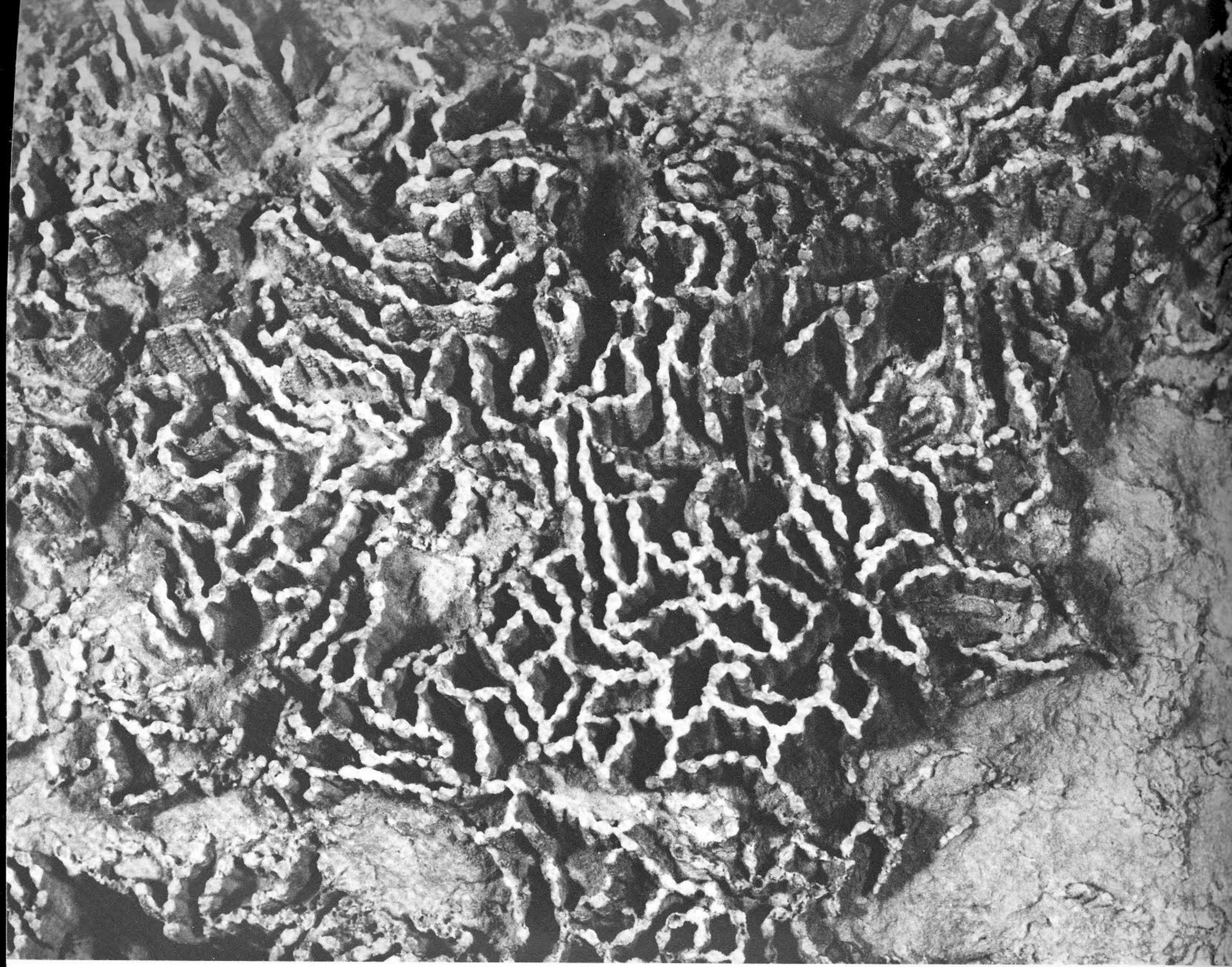


Figure 22. *Close-up of Late Silurian chain-coral* Cystihalysites; *Cobleskill Limestone, 2.8 km (≈1.7 mi) east of Sharon.*

zero. The resultant block topography is referred to as graben (downdropped blocks) and horst (upthrown blocks) structure. The youngest strata cut by the faults are in the Frankfort Shale. Whether this signifies that the minimum age of faulting is Frankfort time or whether the faults merely hinge out to zero displacement southwesterly within the Frankfort Shale, is unknown. I believe that the period of tension lasted from latest Ordovician through Early Silurian Wenlock age (time of deposition of the Lockport Dolostone, the capstone of Niagara Falls). The Late Silurian Brayman and Rondout Formations are not known to be cut by the Mohawk Valley faults.

Small, tight folds are a local curiosity in the Mohawk Valley. Several types of these are superbly exposed along N.Y. State Thruway (I-90), west of exit 29A and 4 km (2.2 miles) south of Little Falls. I (Fisher, 1979) have attributed this tight and vertically limited folding to isostatic readjustment of the central Mohawk Valley due to crustal overload by emplacement of large gravity slides during the Vermontian Phase of the Taconic Orogeny. Temporary westward reversal of dip of the seafloor could cause the yet unconsolidated thin lime beds to "creep" westward downslope and produce an erratic distribution of abrupt small folds with eastward dipping axial planes. Small isolated folds, seemingly

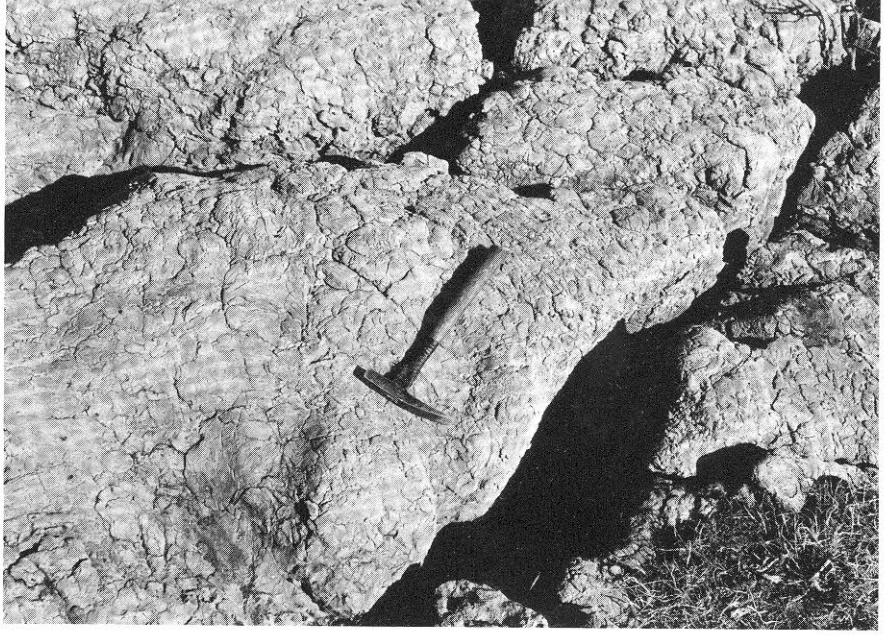


Figure 23. *Blanket reef of coral-like stromatoporoid; uppermost Manlius (Thacher) Limestone (Early Devonian), 1.7 km (≃1.1 mi) northeast of Sharon Center.*

without any regular trend or size pattern, exist within the Little Falls Dolostone and Tribes Hill Formation. These are thought to be caused by local stresses within the carbonates associated with collapse-and-fill phenomena.

Large, open folds with an amplitude to wave length ratio exceeding 1:50 are ubiquitous in the Mohawk Valley. The age of this folding is uncertain but Devonian strata as young as the Onondaga Limestone are involved. At some distance south of the mapped area, Late Devonian strata display large, open folds. Therefore, the age of the folding may be coincident, and is in the style, with the major folding which affected the entire Appalachian Mountain system during the Late Paleozoic Alleghenyan Orogeny.

The 35 million years of Silurian history is poorly documented in eastern New York; only the very latest Silurian (Pridolian) segment of time is represented by the sparsely fossil-bearing Brayman and sun-cracked Rondout Formations; the latter possesses sedimentary environments from supratidal to intertidal to subtidal. The Late Silurian Brayman Shale is unconformable upon older Ordovician rocks indicating lengthy erosion during most of Silurian time in eastern New York. While eastern New York was land for most of Silurian time, salt and gypsum beds (Salina Group) were forming, simultaneously, in central and western New York within super-salty seas. These "Dead Seas" followed a complex of many types of normal marine environments which were conducive to prolific invertebrate life (Lockport and Clinton Groups). New York's earliest Silurian time was characterized by a closing "gasp" of Queenston Delta-type sediments (Medina Group). For a more complete record of Silurian history, the splendid rock sequences along the Genesee and Niagara Gorges should be studied.

Devonian time (400–350 million years ago) in eastern New York began with a clearing of marine waters and a return to normal salinities with proliferation of bottom-dwelling invertebrate animals—dominantly brachiopods. The remarkably quartz-free Lower Devonian Helderberg Group limestones are noted for their abundant and varied invertebrates, chief of which were gypidulid, uncinulid, and strophomenid brachiopods, bryozoans, and stalked echinoderms (cystoids, crinoids); mollusks are notably rare. Localized reefs of corals and stromatoporoids signify that the waters were shallow, warm, agitated, and clear and that crustal stability was maintained for almost 10 million years. Some 385 million years ago, crustal unrest (early phase of Acadian Orogeny) in New England and the Canadian Maritime Provinces had its effect in eastern New York. Uplift and an erosional surface atop the Helderberg limestones were followed by the superjacent Oriskany, Esopus, and Carlisle Center Formations—the quartz and clay detritus from the eastern (and northern?) uplifted land. The sedimentary environment of the Carlisle Center Formation was especially strange as this unit contains about equal amounts of lime, clay, and quartz-silt. Furthermore, the sole fossil is a prolific occurrence of "rooster-tail" markings (*Zoophycus*=*Taonurus*) believed to be feeding trails of marine worms.

A brief return to stable conditions followed, some

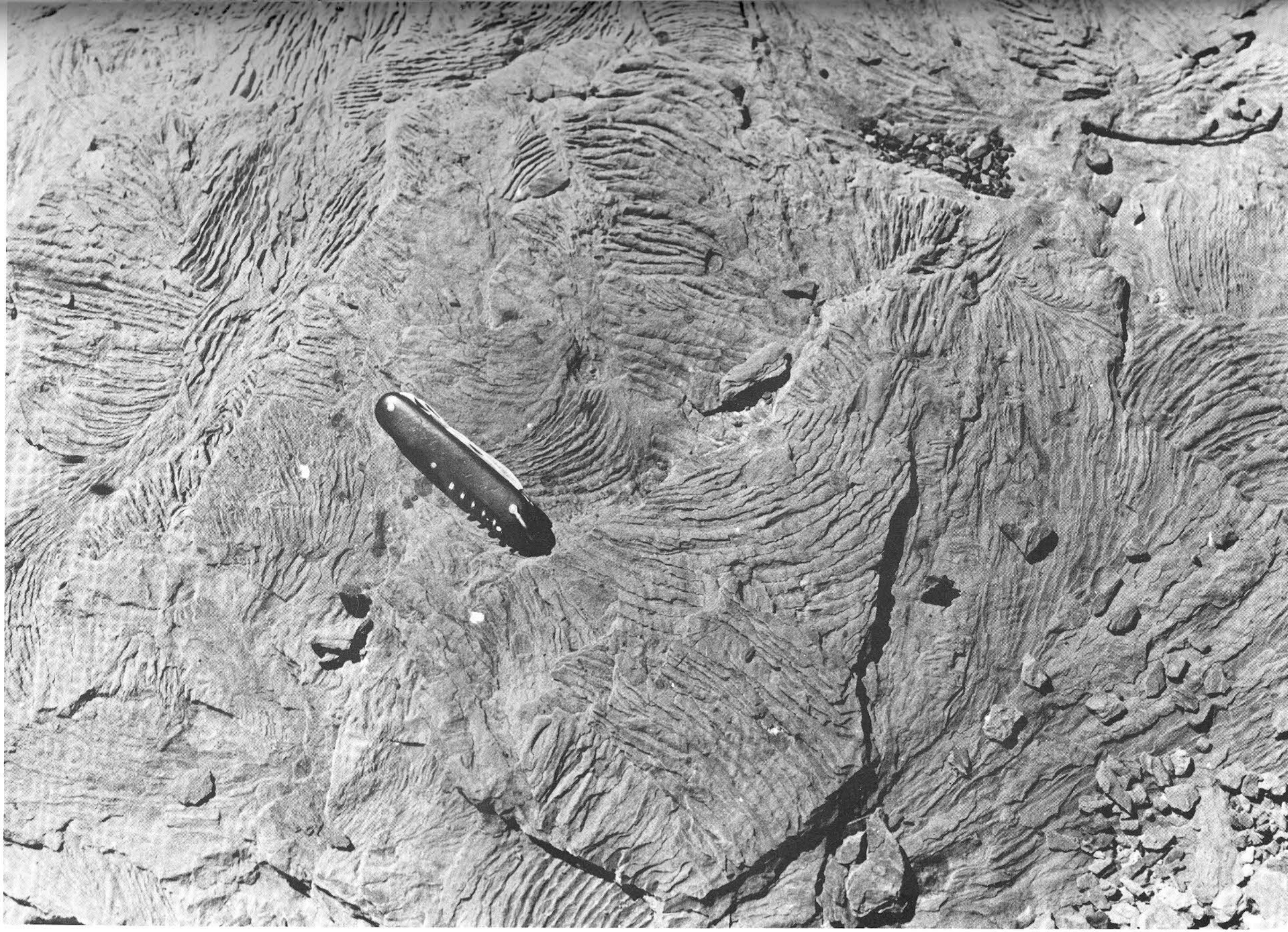


Figure 24. *Close-up of bedding plane surface of Carlisle Center Formation (Early Devonian) showing feeding trails of the marine worm* Zoophycos (=Taonurus) cauda-galli; *east side of N.Y. 166, 2.8 km (≈1.7 mi) north-northeast of Cherry Valley.*

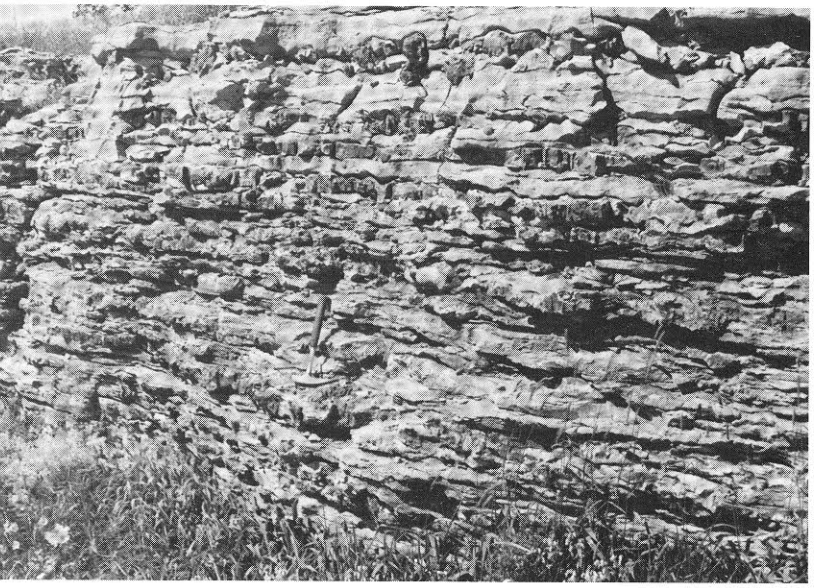


Figure 25. *Moorehouse Member of Onondaga Limestone (Medial Devonian), showing layers of knobby dark gray chert; north side of U.S. 20, 3.7 km (≈2.3 mi) northeast of Cherry Valley.*

Figure 26. *Cherry Valley Limestone on Union Springs Shale, both members of the Marcellus Formation (Medial Devonian); unnamed stream, 1.2 km (≈0.75 mi) south-southeast of Cherry Valley.*

370 million years ago, with the deposition of the chert-rich Onondaga Limestone with its abundant and varied bottom fauna; fish remains are seldom encountered. Immense numbers of corals and frequent coral reefs mark the resumption of warm, shallow, clear marine waters. But quiesence was short-lived. Within the upper few feet of the Onondaga is a 5–10 cm (2–4 in) layer of bentonite (volcanic ash) denoting that crustal instability was returning. As the sea deepened, black mud (Union Springs) accumulation abruptly followed the Onondaga Limestone. Pelagic (swimmers, floaters) animals replaced the dominant bottom dwellers during early Hamilton Group—Marcellus Formation—time (Cherry Valley, Chittenango) with coiled and straight cephalopod-mollusks becoming numerous. Younger Hamilton Group—Marcellus Formation—(Otsego, Solsville) strata reveal an increase in quartz and mica content and a return of marine organisms to primarily a bottom-dwelling habitat. Pure carbonate sedimentation never returned to eastern New York. Exceedingly thick land plant-bearing sandstones and shales of the Medial and Late Devonian Catskill Delta attest to the tremendous amount of debris that was washed from the rejuvenated eastern land source during the second and more intense pulse of the Acadian Orogeny, some 365–355 million years ago.

The next 250 million years (Late Paleozoic and Mesozoic Eras) are unrecorded in the Mohawk Valley. Whether strata of this interval were deposited here cannot be proven. If sediments of this time (including the age of the dinosaurs) were laid down, they were erased by erosion. One must turn elsewhere in North America to fill these pages of geologic history. Only a very fragmentary record of Mesozoic Era history is known from the Mohawk Valley in the form of narrow igneous dikes of an ultramafic (olivine-bearing) volcanic rock (peridotite) which cut the Little Falls Dolostone along East Canada Creek near the Manheim Fault. The dikes have been radiometrically dated (Rubidium-Strontium) as 130 million years old (Early Cretaceous time).

Likewise, New York's record in the succeeding 65 million years of Cenozoic Era history (the great rise and diversification of mammals) is scanty; only that of the last few thousands of years (Pleistocene Period) is reasonably well shown in the sediments left by the continental ice blanket of the last Ice Age. Several advances and retreats of continental glaciers modified the drainage which had been impressed on the landscape during earlier Cenozoic times. Relatively thick gravels, sands, silts, and muds in the form of till, moraine, drumlins, kames, and outwash occur in the Mohawk Valley; these glacial deposits are presently under investigation. A few mammalian fossils (caribou,

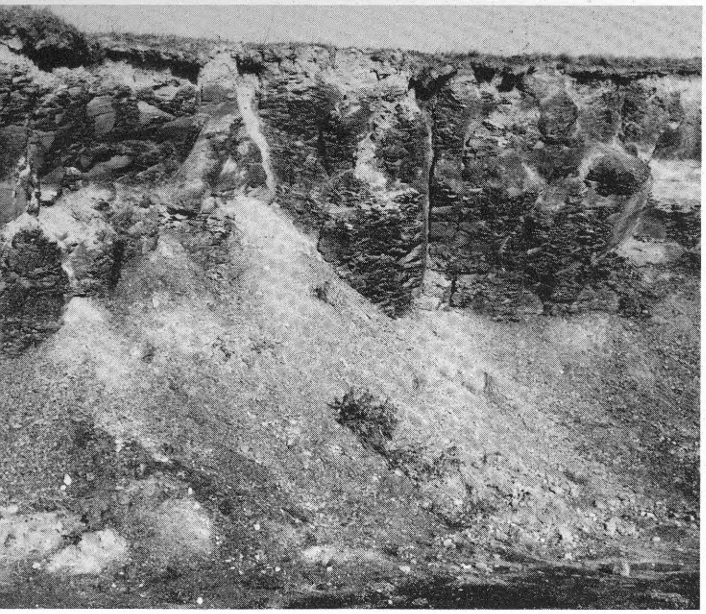
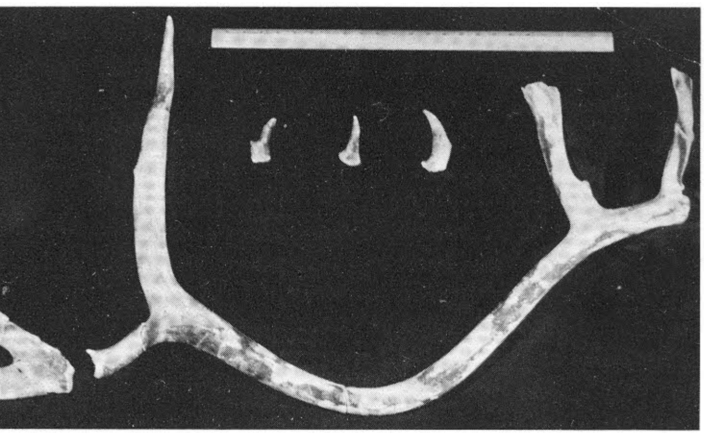


Figure 27. *Chittenango Shale Member of the Marcellus Formation; west side of Slate Hill Cemetery Road, 3 km (≈1.9 mi) southwest of Sharon.*

mastodon, mammoth) have been reported. Presumably, the story of glacial advances and withdrawals, temporary lakes, and glacial deposits will enable the local Ice Age history to be more firmly established, permitting correlations with other areas where glacial history has been authenticated. It has been demonstrated by glacial geologists that the Mohawk Valley was the site for a much enlarged river (termed the Iromohawk) which functioned as an outlet for all of the Great Lakes. Because the St. Lawrence Valley outlet and the Lake Ontario basin were still blocked by continental ice, the Great Lakes were forced to drain through the Mohawk into the Hudson River and then to the Atlantic Ocean. As such, the Iromohawk possessed the ability to move more and larger rock due to its increased volume and velocity and, thus, to immensely increase its erosive and depositional capabilities. It was at this time, some 13,000 years ago, that most of the glacial deposits were formed in the Mohawk Valley and that the exceptional potholes, such as those on Moss Island at Little Falls and along Canajoharie Creek at Canajoharie, were scoured into the bedrock. Interestingly, the extensive Pleistocene glacial action both exposed (by erosion) and concealed (by deposition) bedrock. Mohawk Valley glacial history is a complex and fascinating one, but that is another story.

A closing note. Research, now underway, suggests that the Adirondack Mountains are geologically quite young, that the doming (and renewed faulting) has occurred within the past few million years—and is continuing even today at the rate of 3 mm uplift per year! Minor earthquakes are an annual occurrence and these are being carefully monitored. Geological processes are continually modifying the face of the Earth; exposures that past investigators studied have been altered and/or buried. Likewise, exposures studied and described now will be altered and/or concealed for future investigators.

Figure 28. *Right antler of barren ground caribou,* Rangifer arcticus; *Pleistocene sand and gravel pit, 0.8 km (≈0.5 mi) northwest of the Schenectady County Airport. Specimen described by Fisher and Ostrom (1952) and now in the N.Y. State Museum.*



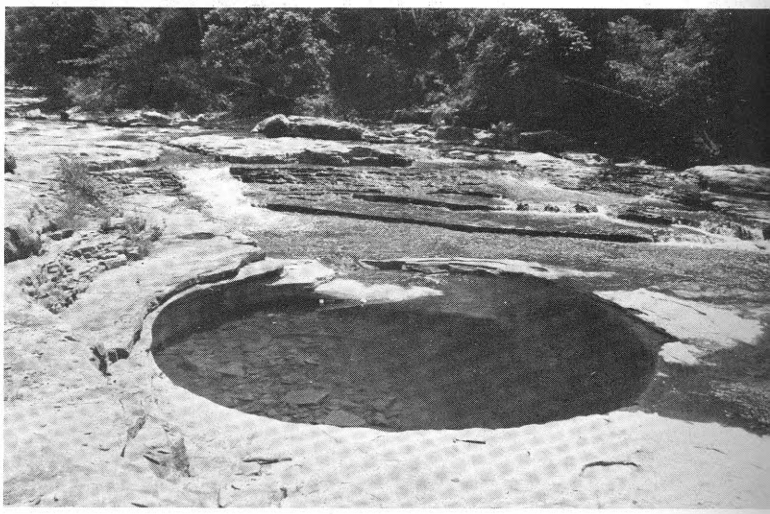


Figure 29. *Excellent example of a glacial pothole; in Chuctanunda Creek Dolostone Member of the Tribes Hill Formation (Early Ordovician), Canajoharie Creek, south edge of the village of Canajoharie, which derives its name from the Indian word meaning, "The pot that washes itself."*

Miscellaneous Notes

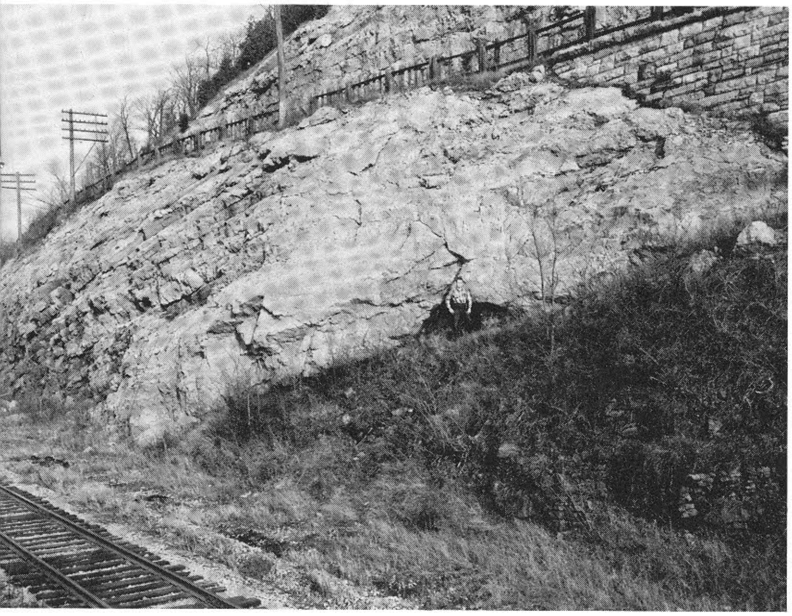


Figure 30. *Proterozoic-Paleozoic contact; south side of railroad at the "Little Nose," 8.5 km (≈5.3 mi) southwest of Fonda. Brecciated Upper Cambrian Little Falls Dolostone rests unconformably on Helikian Peck Lake garnet-gneiss.*

Figure 31. *Close-up of above contact, showing 15–30 cm (≈6–12 in) of unconsolidated mica-rich clay along the unconformity, producing a re-entrant between the dolostone above and the gneiss below.*

Figures 32, 33. *Close-up of local breccia, consisting of dolostone clasts in a quartz-sand and dolomite matrix; south side of railroad at the "Little Nose," 8.5 km (≈5.3 mi) southwest of Fonda.*

A. **FOR THE GEOLOGIST**

1. The **origin of the breccia at the Little Nose**, along the south side of the railroad, at the base of the Little Falls Dolostone, is mystifying. All of the clasts are dolostone, quartzose dolostone, or, rarely, chert; the latter is white to light gray or cream. Clasts range from a few millimeters up to slightly over one meter in diameter. The cement is dolomite enclosing relatively large, well-rounded quartz grains. This "Little Nose" breccia grades northeastward into regular bedded Little Falls Dolostone; the breccia's extension in other directions is unknown owing to concealment by glacial deposits or younger bedrock. It has not been determined whether the breccia is a talus deposit along the eastern flank of a Proterozoic gneiss ridge or whether it is tectonic in origin, reflecting rock fracturing along the Noses Fault or constituting a Late Cambrian breakup of dolostone beds due to slippage along the Paleozoic-Proterozoic unconformity. Along this unconformity there is a 5 to 20 cm (≃2 to 8 in.) thick clay zone, rich in muscovite, which may be fault gouge or a relict residual soil.

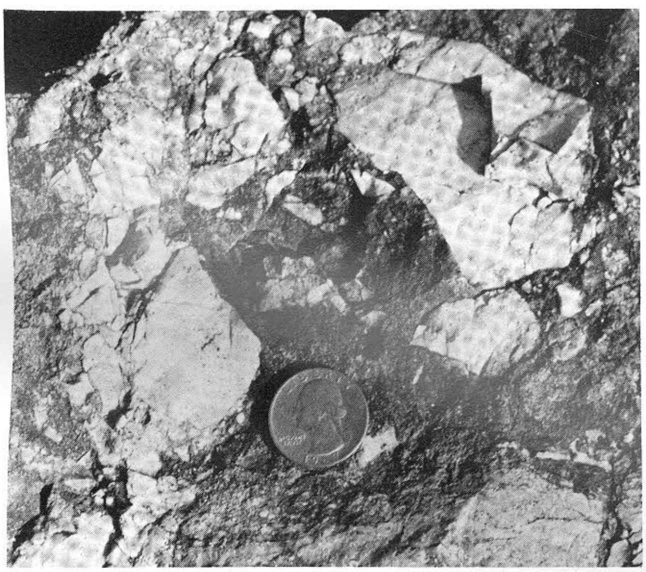


Figure 34. *Brecciated white to very light gray chert in upper part of Little Falls Dolostone; same locality as above.*

2. The **Cranesville Dolostone** (Fisher, 1954, p. 92) was separated as the youngest Lower Ordovician (Canadian) in the Mohawk Valley. This was based on identification, by Josiah Bridge, of *Eccyliopterus* similar to those in the Ogdensburg Dolostone of the St. Lawrence Valley. Now, I have been able to demonstrate that the Cranesville Dolostone is a lateral dolomitic facies of the Fonda and Wolf Hollow Members of the Tribes Hill Formation. The gastropod identified by Bridge is probably *Ecculiomphalus*, a common genus in the Wolf Hollow and Fonda Members. The Cranesville is excellently displayed in the Cushing Stone quarry (south of Cranesville), in numerous field exposures north of Cranesville, along North Chuctanunda Creek at Hagaman, and in the abandoned quarry south of St. Johnsville on the upthrown side of the Sanders Road Fault.

3. The **surface of relief (unconformity) atop the Lower Ordovician strata** (Canadian age) was a major one in geologic history. In the Mohawk Valley, erosion progressed so that some rock units were completely stripped away prior to the subsequent flooding by Medial Ordovician (Mohawkian age) seas. But much of the rock record of this time may never have existed in this region. The time gap (hiatus) represented by this erosion surface probably consumed from 35 to 45 million years, between 490 and 445 million years ago. In the Champlain Valley, the Chazy Group of limestones and the upper Beekmantown Group of carbonate rocks record this sedimentary gap in the Mohawk Valley. Proof of this unconformity is seen in that differing Middle Ordovician rocks rest on differing Lower Ordovician rocks of the Tribes Hill Formation. Examples are: along East Canada Creek, Lowville Limestone rests on the Palatine Bridge Member; in the St. Johnsville area, Lowville Limestone rests on Cranesville Dolostone or its equivalent, the Wolf-Hollow Fonda limestones; along Canajoharie Creek, the Glens Falls Limestone rests on Chuctanunda Creek Dolostone; along a tributary to Flat Creek, Utica Shale rests on Cranesville Dolostone; along Borden Road at Stone Ridge, patches of Lowville occur between Glens Falls Limestone above and Fonda Limestone below; along I-90 west of Fultonville, Amsterdam Limestone rests on Fonda Limestone; at Manny Corners, Lowville Limestone rests on Cranesville Dolostone; on the Patterson Farm west of Pattersonville, Lowville or Amsterdam Limestone rests on Chuctanunda Creek Dolostone.

4. The **Galway Horse** is a composite fault block, caught along the Hoffmans #1 Fault, north of N.Y. 67 and straddling the Pattersonville-Galway quadrangle boundary. Lowville, Amsterdam, lower Glens Falls (Larrabee), and upper Glens Falls Limestone units are exposed. When Kania Road was widened and paved in the early 1960's, superb exposures were available along the north side.

5. Whether the **Amsterdam Limestone** belongs to the Black River Group or Trenton Group is uncertain. Ross (1964), using bryozoan evidence, favored a Black River assignment and, accordingly, termed the Amsterdam "Chaumont." Kay (1937) assigned the Amsterdam to the lower Trenton as has been the practice with most modern stratigraphers who have dealt with

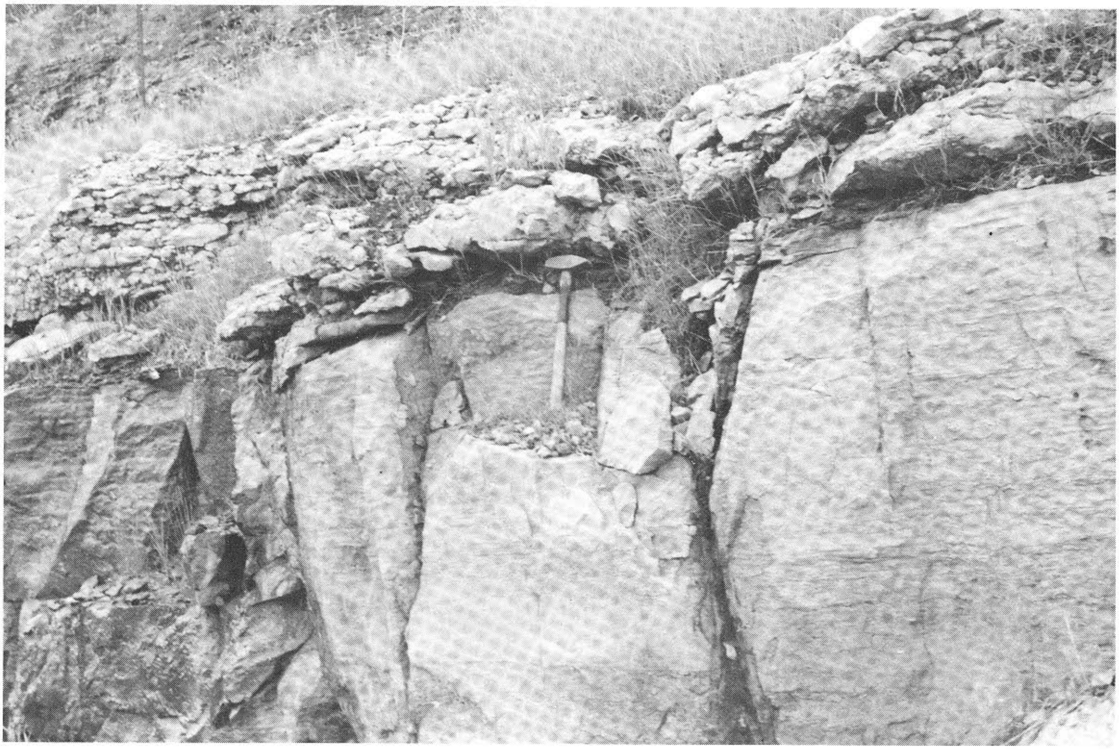
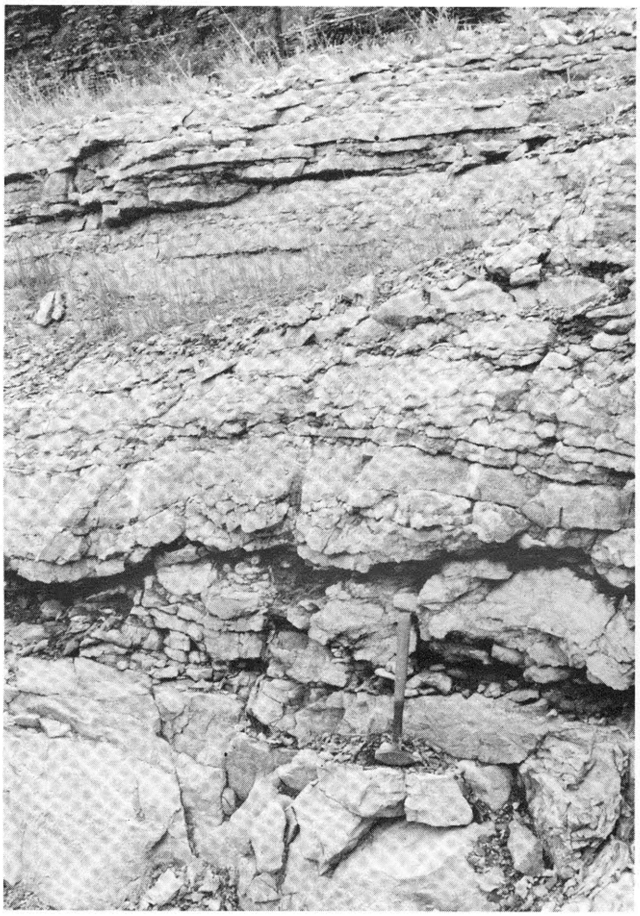


Figure 35. *Middle Ordovician Amsterdam Limestone unconformably upon the Lower Ordovician Fonda Member of the Tribes Hill Formation; south side of I-90, 3.5 km (≈2.2 mi) southwest of Fonda.*

Figure 36. *Middle Ordovician Glens Falls Limestone unconformably upon the Lower Ordovician Chuctanunda Creek Dolostone Member of the Tribes Hill Formation; west side of Canajoharie Creek, south edge of village of Canajoharie.*

Figure 37. *Middle Ordovician Amsterdam and Glens Falls Limestones, the former resting unconformably upon the Lower Ordovician Fonda Member of the Tribes Hill Formation; along south side of I-90, 3.5 km (≃2.2 mi) southwest of Fonda.*

Figure 38. *Close-up of Amsterdam Limestone at above locality; note lumpy and irregular bedding.*



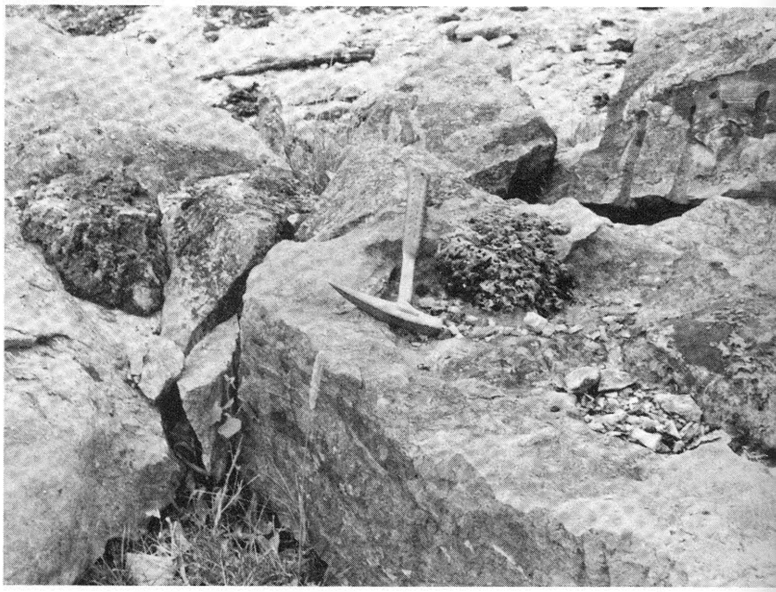


Figure 39. *Blocks of dolostone and chert of the Lower Ordovician Tribes Hill Formation in the Amsterdam Limestone; Roger Patterson Farm, 1 km (≃0.6 mi) west of Pattersonville.*

Figure 40. *Conglomerate base of the Middle Ordovician Larrabee Limestone Member of the Glens Falls Formation, showing clasts of Lower Ordovician Tribes Hill Dolostone and Middle Ordovician Lowville and Amsterdam Limestones; Roger Patterson Farm, 1 km (≃0.6 mi) west of Pattersonville.*

Middle Ordovician stratigraphy of New York. The older workers, however, were inclined more to a Black River designation. Over the years, I have made a large collection of fossils from the Amsterdam (chiefly from the abandoned quarry east of Manny Corners, on N.Y. 67). This fauna is a most cosmopolitan one and contains elements that are allegedly diagnostic of both Black River and Trenton Groups! Often, there are a few cm (few inches), sometimes up to 200 cm (≈6.5 ft), of carbonate breccia or conglomerate at the Amsterdam's base, in contact with the Lowville. Blocks of Lower Ordovician dolostone and chert and Lowville pebbles comprise the clasts. Similarly, the basal Larrabee Limestone has clasts of Amsterdam Limestone and Lowville. Thus, time gaps are suggested at both the base and summit of the Amsterdam and the unit is set off stratigraphically from accepted Black River Limestone below (Lowville) and accepted Trenton Limestone (Larrabee) above. The Amsterdam's assignment to either of these groups must, accordingly, remain unresolved.

6. The **Schenectady-Frankfort relations** are somewhat obscure owing to widespread cover of bedrock by glacial deposits and modern alluvium. Most efficient masking is accomplished by the west-east trending drumlins in the belt north of the Devonian Limestone Escarpment terrain. Thick Schenectady sandstones and quartzose shales in the Esperance quadrangle (Schoharie Valley) seemingly grade westward into silty gray shales with occasional siltstones of the Frankfort along the meridian of Sharon Springs. Arbitrarily, no Schenectady is mapped west of the southern trace of the Noses Fault on the Carlisle quadrangle and no Frankfort is mapped east of this Fault. However, the lower Schenectady along I-90 in the Rotterdam Junction quadrangle has all the characteristics of the Frankfort facies. This suggests that the Frankfort is, in part, a westwardly younger regressive facies intermediate between the Utica Shale below and the Schenectady sandstones above.

7. **Helderberg limestones** are stratigraphically striking, complex but patterned, and very fossiliferous in the Carlisle, Sharon Springs, and Sprout Brook quadrangles. The Manlius changes from a thin-bedded, tentaculitid-rich limestone, capped with a stromatoporoid reef in the Sharon Center area, to a thicker bedded, sparsely fossiliferous, nonreefoid limestone in the Cherry Valley region. The Coeymans thickens markedly from about 12 m (≈40 ft) near Sharon to a bipartite unit of 17 m (≈55 ft) (lower) and 9 m (≈30 ft) (upper) in the Cherry Valley region; an intervening Manlius tongue wedges between the two Coeymans divisions from the west. Both the New Scotland shaley limestone and the Becraft coarse fossil-fragmental limestone thin to the west; the former disappears just

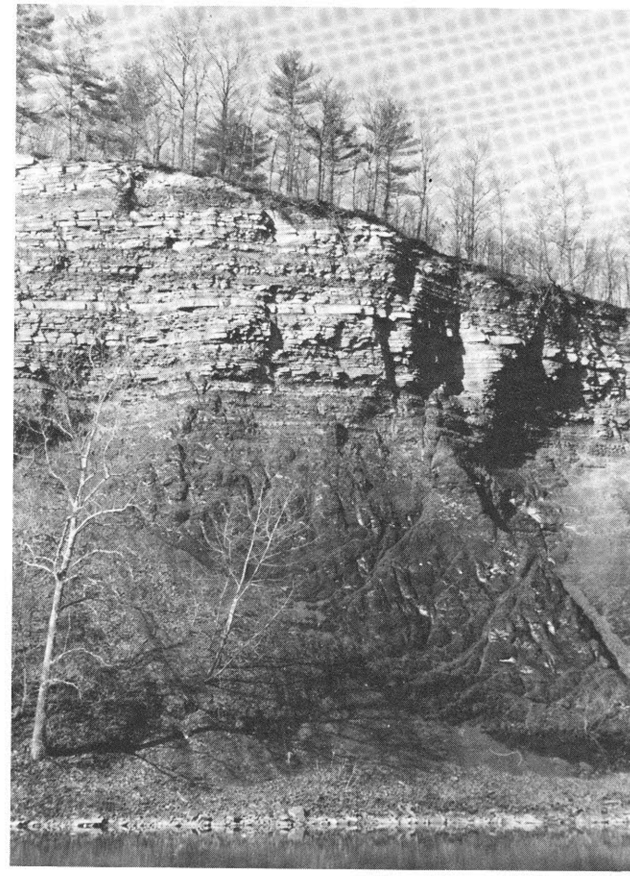
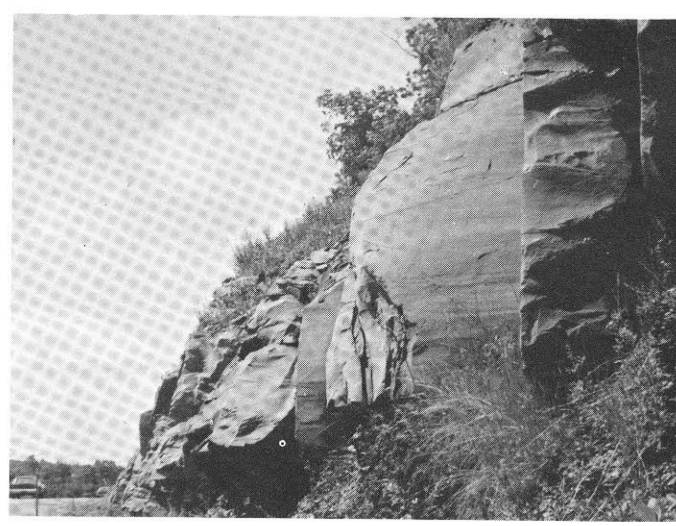


Figure 41. *Interbedded Middle Ordovician Schenectady sandstone and shale resting with abrupt, but conformable, contact on black Utica Shale; west side of Schoharie Creek, 4.8 km (≈3 mi) north-northwest of Burtonsville. This is "Bega's Cliff" of Cumings and Prosser (1900).*

Figure 42. *One of the thick-bedded sandstones within the Schenectady Formation; west side of I-90, 5.5 km (≈3.4 mi) southeast of Rotterdam Junction.*



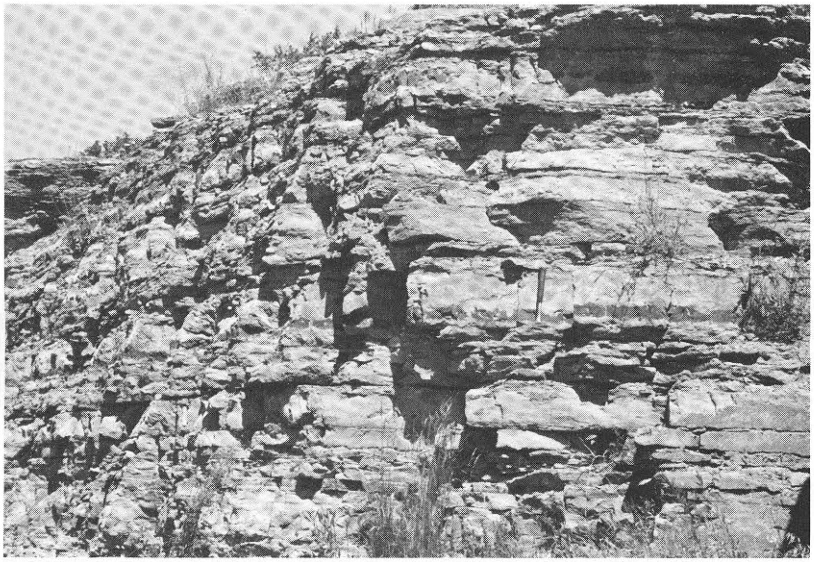


Figure 44. *Kalkberg Limestone (Early Devonian); note bedded dark gray chert and shale interbeds; north side of U.S. 20 at west edge of Sharon Springs.*

Figure 45. *Becraft Limestone (Early Devonian); ledge in field 2.7 km (≈1.6 mi) east-southeast of Sharon.*

⇦ Figure 43. *Rock section in north-facing cliff of Judd's (Tarakawara) Falls, showing lower Manlius (Thacher) Limestone at base (author at shaly zone in upper Thacher) succeeded by lower Coeymans (Dayville), upper Manlius (Elmwood), and upper Coeymans (Deansboro) Limestones; 3.1 km (≈1.9 mi) north-northeast of Cherry Valley, just north of U.S. 20.*

west of Sharon Springs where it is about 2 m (≈6.5 ft), and the latter has its most westerly observed road ditch exposure near Sharon Center. The terrace-forming Kalkberg is a persistent outcropping unit in the mapped area, averaging 14 m (≈45 ft).

8. The **Oriskany Formation** within the mapped area is a thin (up to 0.5 m ≈20 in.)' medium bluish-gray limestone, light brown weathering, with large (up to 2 mm) well-rounded, frosted, quartz sand grains "floating" in a calcium carbonate matrix. This atypical Oriskany rests on the Kalkberg division of the Helderberg Group along U.S. 20 north of Cherry Valley (Locality #23) and on the Becraft division of the Helderberg Group, southeast of Sharon.

Figure 46. *Oriskany "Sandstone" (Early Devonian); pasture exposure, west of N.Y. 166, 2.7 km (≈1.6 mi) north-northeast of Cherry Valley.*

But south of the mapped area, the Oriskany's physical makeup and thickness differs. In a new rock cut along I-88, 6.5 km (≈4 mi) east of Cobleskill and 11 km (≈7 mi) southeast of the southern juncture of the Sharon Springs and Carlisle quadrangles, 2.5 m (≈8 ft) of light bluish-gray, tan to light brown weathering, calcareous siltstone to a very fine-grained sandstone lie between the Esopus Shale above and the Becraft Limestone below. The uppermost Oriskany is a 15 cm (≈6 in) black quartzite locally packed with large brachiopods. The remainder of the Oriskany contains numerous large brachiopods (*Acrospirifer*, *Costispirifer*, *Hipparionyx*, *Rensselaeria*), large platyceratid snails, and rare trilobite fragments.

9. The Lower Devonian **Schoharie Formation** (in the restricted and original sense) has not been observed in the mapped area. However, just off the map's southern boundary, 4.5 km (6.75 miles) south of

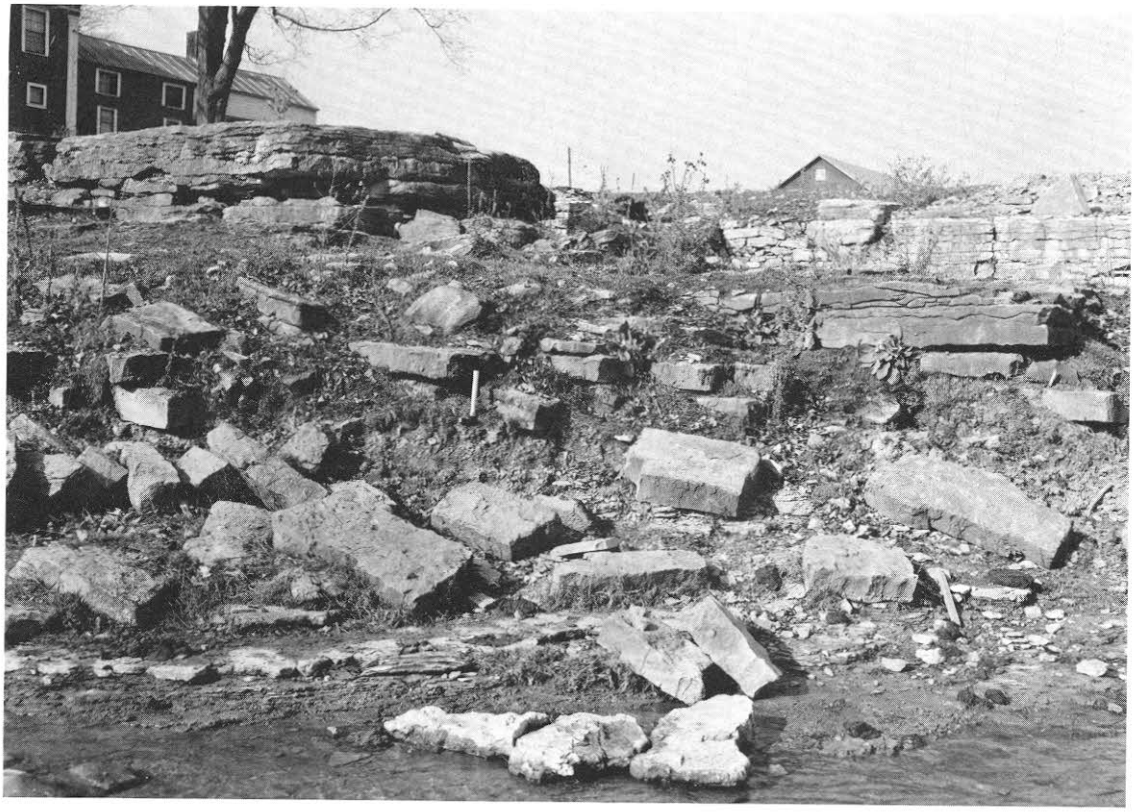


Figure 47. *Schoharie quartzose limestone (Early Devonian); abandoned quarry, 4.5 km (≃6.75 mi) south of Sharon Springs on north side of Hanson Crossing Road.*

Sharon Springs on the north side of Hanson Crossing Rd. is a small abandoned quarry along the west bank of West Creek west of the abandoned Delaware & Hudson R.R. Here, 60–76 cm (2–2.5 ft) of quartzose limestone and calcareous sandstone is assigned to the Schoharie. Over 3 m (≃10 ft) of Edgecliff Limestone overlies the Schoharie and over 3 m (≃10 ft) of Carlisle Center, with glauconite in the top, underlies the Schoharie. The Schoharie has its upper surface covered with black phosphate pebbles. Silicified corals, brachiopods, and cephalopods occur throughout.

The name Schoharie has undergone several nomenclatorial vicissitudes. Vanuxem (1840, p. 378) originally intended the name to apply to the abundantly fossiliferous limestone between the Fucoides Cauda-Galli (Esopus-Carlisle Center of modern usage) unit below and the Onondaga Limestone above. As such, it is the Rickard Hill Member of the Schoharie of Johnsen (1957, 1962); it is also the Rickard Hill Member of Rickard (1975) who regards the Schoharie as a formation consisting of the Rickard Hill, Saugerties, and Aquetuck Members. Goldring and Flower (1942) had demonstrated that the Schoharie of Vanuxem graded southward into argillaceous limestones and calcareous mudstones, which they named the Leeds facies of the Schoharie. They distinguished the underlying Carlisle Center Formation as an entity, separate from the Esopus and Schoharie. Johnsen (1957, 1962) chose not to use the name Leeds, but revived Chadwick's (1940) name, Saugerties (which Chadwick later abandoned, 1944), for upper Schoharie, introduced Aquetuck as a middle member, and added the Carlisle Center as a lower member. It seems that, in keeping with Vanuxem's intention, the Carlisle Center should be divorced from the expanded Schoharie and retained as a separate formation between the Esopus below and restricted Schoharie above.

10. The **disturbed zone within the Union Springs Shale** is an enigma. Northeast of Cherry Valley along the south side of Otsego County 54 (Locality #24) is an instructive and baffling exposure of the Union Springs Member of the Marcellus Formation. Within the *Styliolina fissurella*-rich black shale are thin rubbly argillaceous limestones with a profuse benthonic fauna of horn corals, trilobites, pelecypods, and brachiopods together with the pelagic goniatite nautiloid *Werneroceras plebeiforme*. Interbedded limestone concretions up to 60 m (≃2 ft) long display disturbed attitudes up to 40°. In addition, a 30 cm (≃1 ft) zone within the black shale reveals brittle fracture similar to cleavage (Figure 49) although the underlying and overlying strata are horizontal and do not show this highly in-

Figure 48. *Marcellus Formation: Cherry Valley Limestone resting, with abrupt lithologic contact, on disturbed Union Springs Shale; note inclined concretions near hammer (on left) and pseudocleavage near hat (on right). Roadcut along south side of Otsego County 54 (old U.S. 20), 4.3 km (≃2.7 mi) east-northeast of Cherry Valley.*

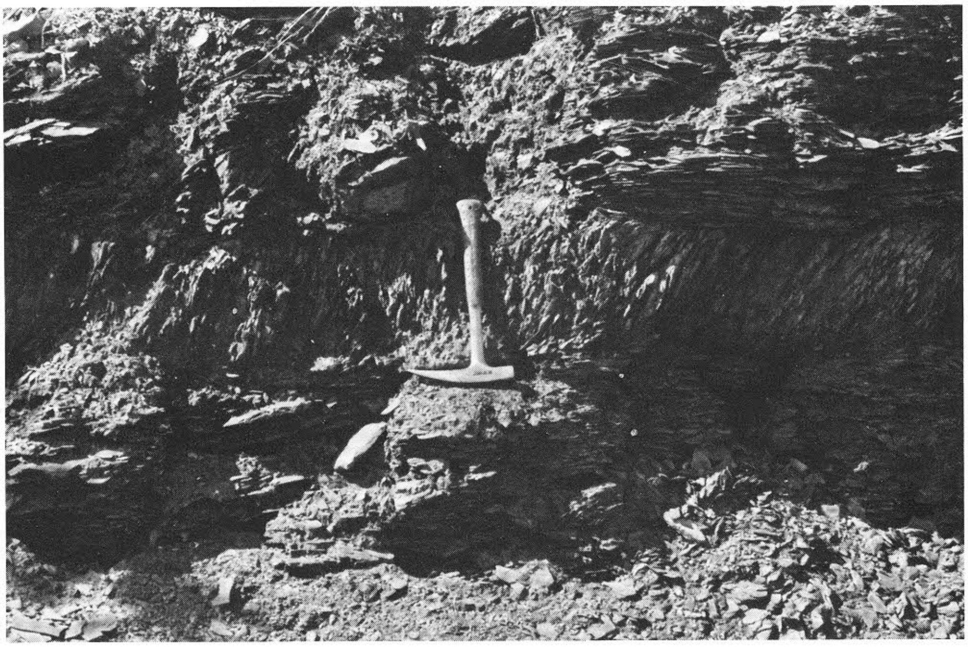


Figure 49. *Close-up of pseudocleavage zone in upper Union Springs Shale; same locality as above.*

clined fracturing (60–75° E). Conceivably, this "pseudocleavage" zone may represent either 1) a surface of décollement, that is, a gliding surface, lubricated by semiconsolidated wet clay, for a major westward thrust fault; or 2) a violent sediment disturbance created by an intense submarine earthquake. The disoriented concretions would represent a response to this deformation. This deformation would have occurred during the second pulse of the Acadian Orogeny.

B. **FOR THE QUARRYMAN—**

As of this writing (summer, 1979), the *active* quarries within the mapped area are:

1. General Crushed Stone Co. (formerly Kellam and Shaeffer)—in Tribes Hill Formation—south of N.Y. 5-S, 3.7 km (≃2.3 miles) west of Pattersonville.
2. Cushing Stone Co.—in Tribes Hill Formation—south of N.Y. 5-S, 4.8 km (≃3 miles) east of Amsterdam.
3. John Talarico Quarry—in Little Falls Dolostone—north side of N.Y. 5, 2.4 km (≃1.5 miles) west of St. Johnsville.
4. Montgomery County Stone Quarry—in Tribes Hill Formation (Wolf Hollow and Palatine Bridge Members)—south of N.Y. 5 at west edge of Palatine Bridge, 1.2 km (≃0.8 mile) west of N.Y. 10 bridge over Mohawk River.
5. Town of Carlisle shale pit—in Schenectady Formation—south side of U.S. 20, 1.6 km (≃1 mile) west of Sloansville.
6. Town of Cherry Valley quarry—in Solsville Member of Marcellus Formation—both sides of Countryman Mountain Road, 4 km (≃2.5 miles) east of Cherry Valley.
7. Town of Rotterdam shale pit—in Schenectady Formation—Putnam Road, 2.7 km (≃1.7 miles) west of I-90.
8. Town of Sharon shale pit—in Chittenango Shale Member of Marcellus Formation—northwest side of Slate Hill Road, 3.2 km (≃2 miles) southwest of Sharon.

Numerous abandoned stone quarries exist throughout the mapped area; these are denoted on the colored geologic map by inverted crossed hammers. Active quarries are denoted by upright crossed hammers.

C. **FOR THE FOSSIL COLLECTOR*—**

Abundant and varied invertebrate (backboneless) fossils may be gathered from most rock units (see map legend) in the area discussed. The rock units which most easily yield an interesting assortment of invertebrate fossils are: Fonda Member of the Tribes Hill Formation, Amsterdam Limestone, Glens Falls Limestone, Utica Shale, Helderberg Group limestones, Onondaga Limestone, Union Springs shale and limestone. The most abundant fossil groups are brachiopods (lamp shells), bryozoans (moss animals), and corals followed by cephalopods (*Nautilus* ancestors), gastropods (snails), ostracodes ("bean" animals), trilobites, and worm burrows and trails. Many fossils are extracted only with great difficulty.

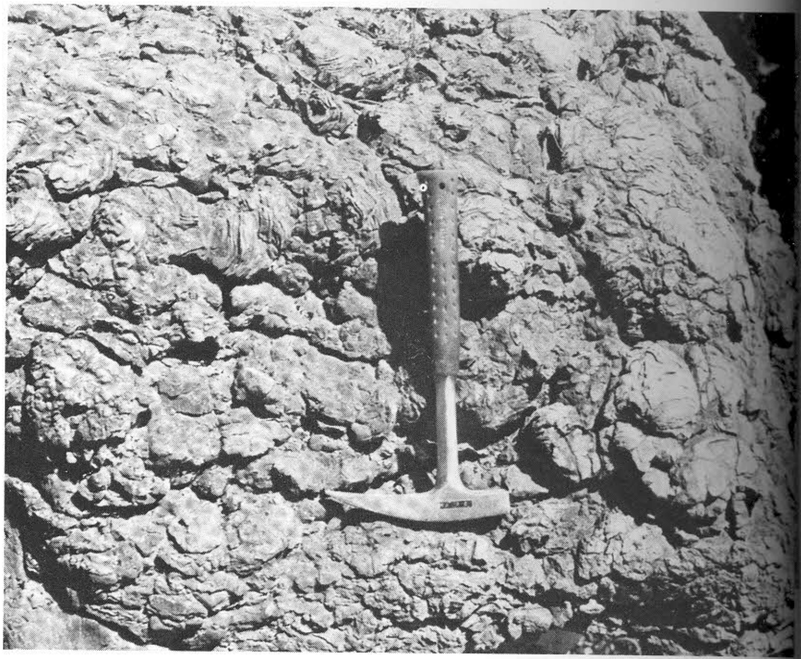
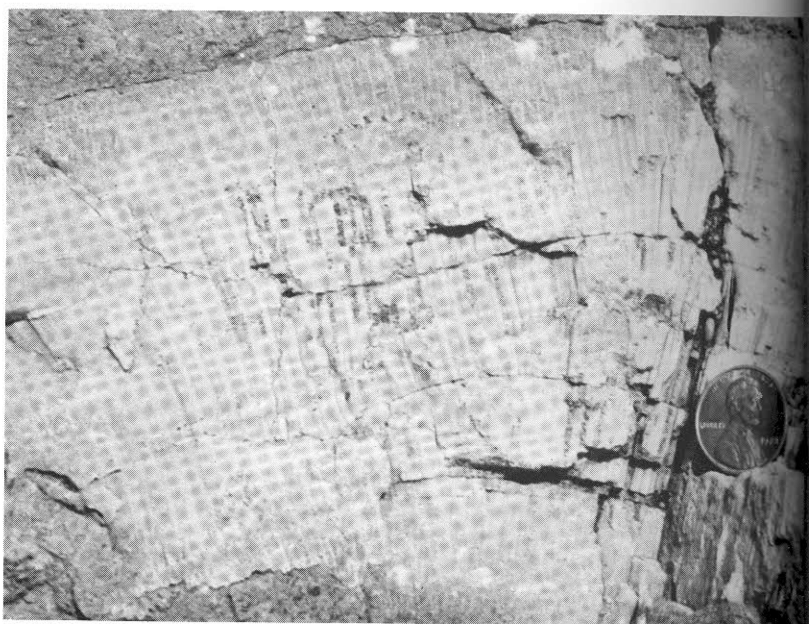


Figure 50. *Close-up of stromatoporoid reef in uppermost Thacher Member of Lower Devonian Manlius Limestone: note "cabbage-like" form and unbedded character; field exposure west of town road, 4.4 km (≃2.7 mi) northwest of Sharon.*

Figure 51. *Tabulate coral in Edgecliff Member of Middle Devonian Onondaga Limestone; east side of N.Y. 166, 2.7 km (≃1.6 mi) north-northeast of Cherry Valley.*



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* Permission to enter and collect on private land should always be obtained prior to collecting efforts. Proper etiquette should be exercised when on private and public property.

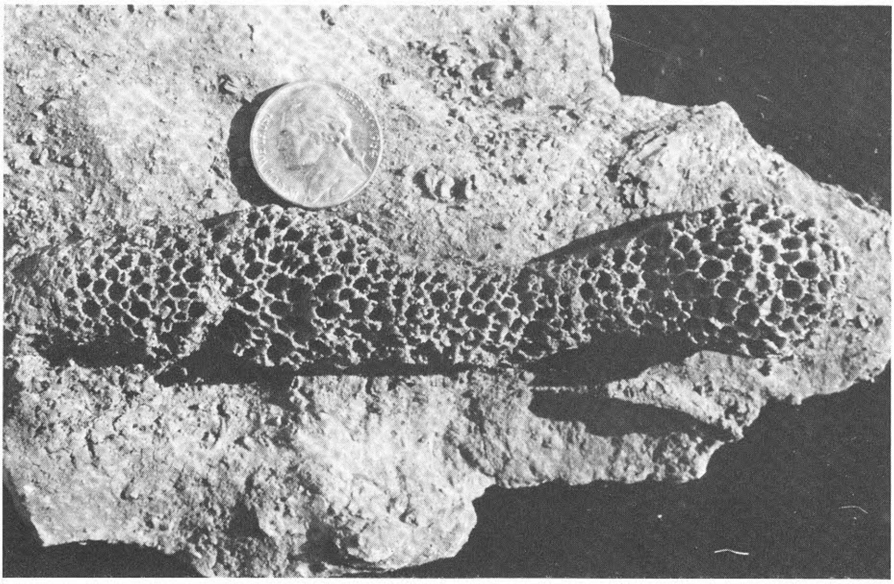


Figure 52. *Rugose coral in Edgecliff Member of Middle Devonian Onondaga Limestone; exposure in woods near waterfall, 4.2 km (≃2.6 mi) north of Cherry Valley, near west edge of geologic map.*

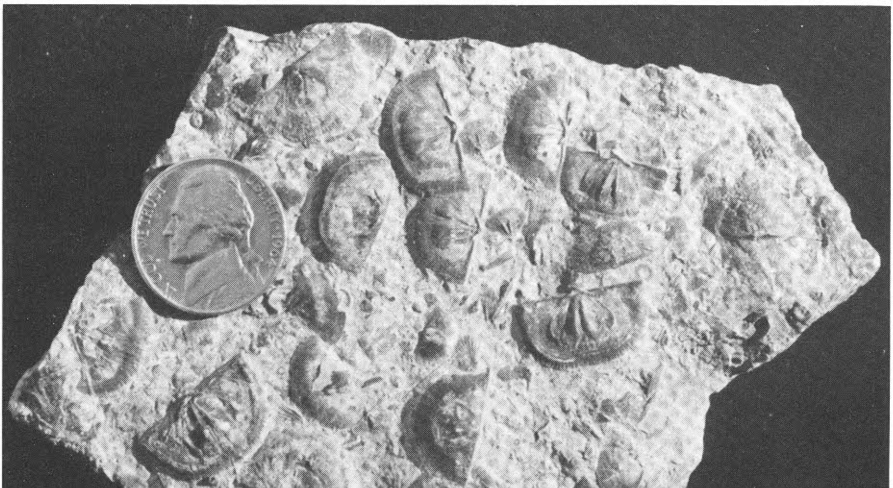


Figure 53. *Brachiopod* Sowerbyella *in upper Glens Falls Limestone; north side of N.Y. 67, 0.6 km (≃0.4 mi) east of Manny Corners.*

Figure 55. *Cricoconarid* Tentaculites gyracanthus, *an extinct group of mollusks, from the lower Thacher Member of the Manlius Limestone; bedding plane exposure, 4.5 km (≈2.8 mi) northwest of Sharon, south side of town road.*

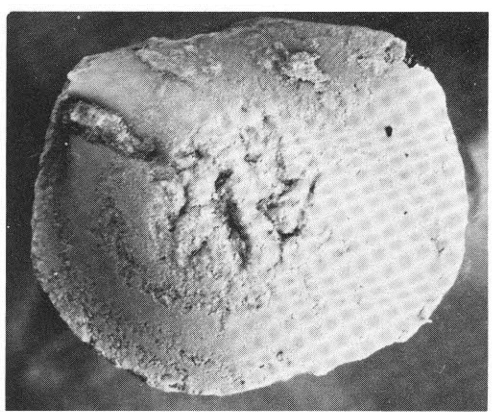


Figure 54. *Rostroconch* Ribeiria, *an extinct group of mollusks, from the Fonda Member of the Tribes Hill Formation; east side of Borden Road, at Stone Ridge, 5.2 km (≈3.2 mi) southwest of Fonda.*

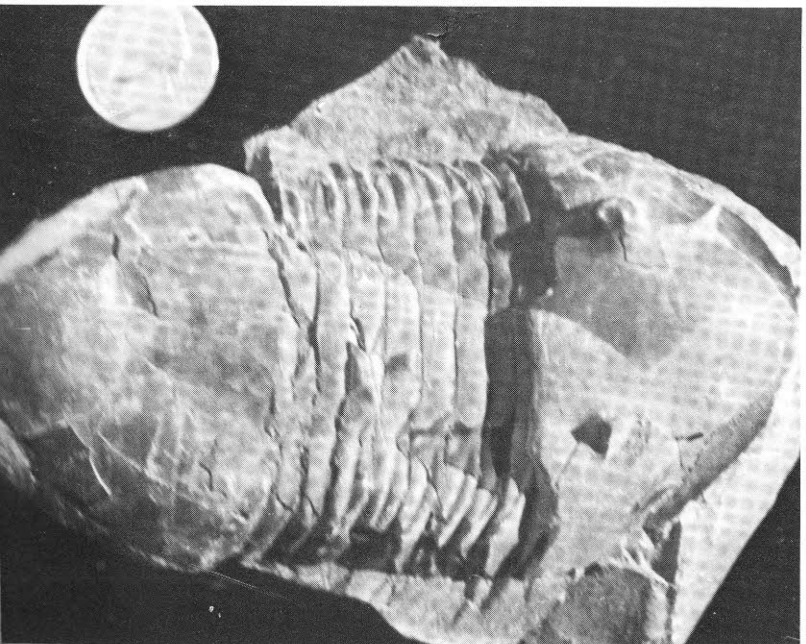


Figure 56. *Trilobite* Isotelus gigas, *an extinct group of arthropods, from the Amsterdam Limestone; abandoned quarry, south of N.Y. 67, 0.6 km (≃0.4 mi) east of Manny Corners.*

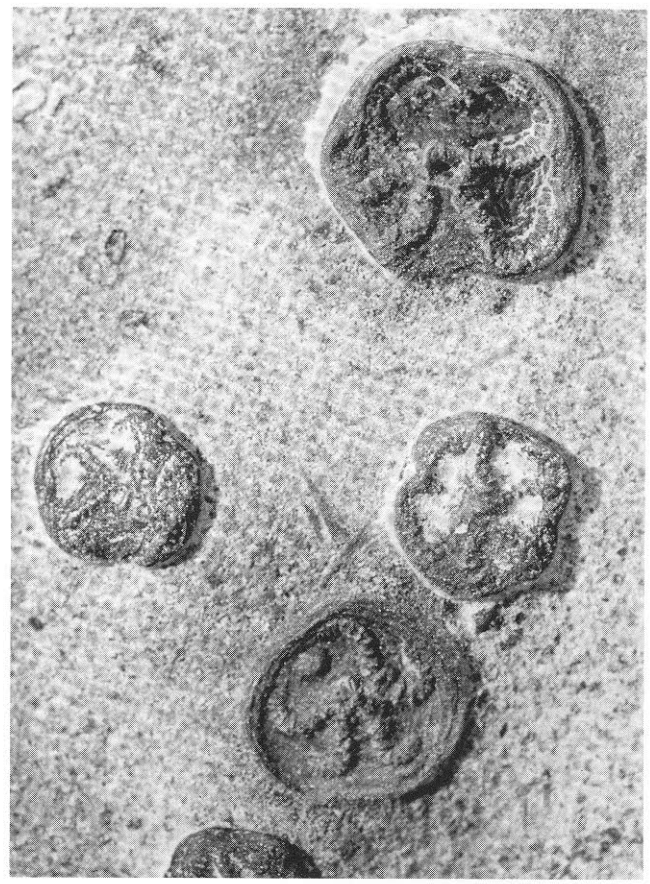


Figure 58. *Edrioasteroid* Postibula *n. sp., an extinct group of echinoderms, from the lower Thacher Member of the Manlius Limestone; bedding plane exposure, 4.5 km (≃2.8 mi) northwest of Sharon, south side of town road.*

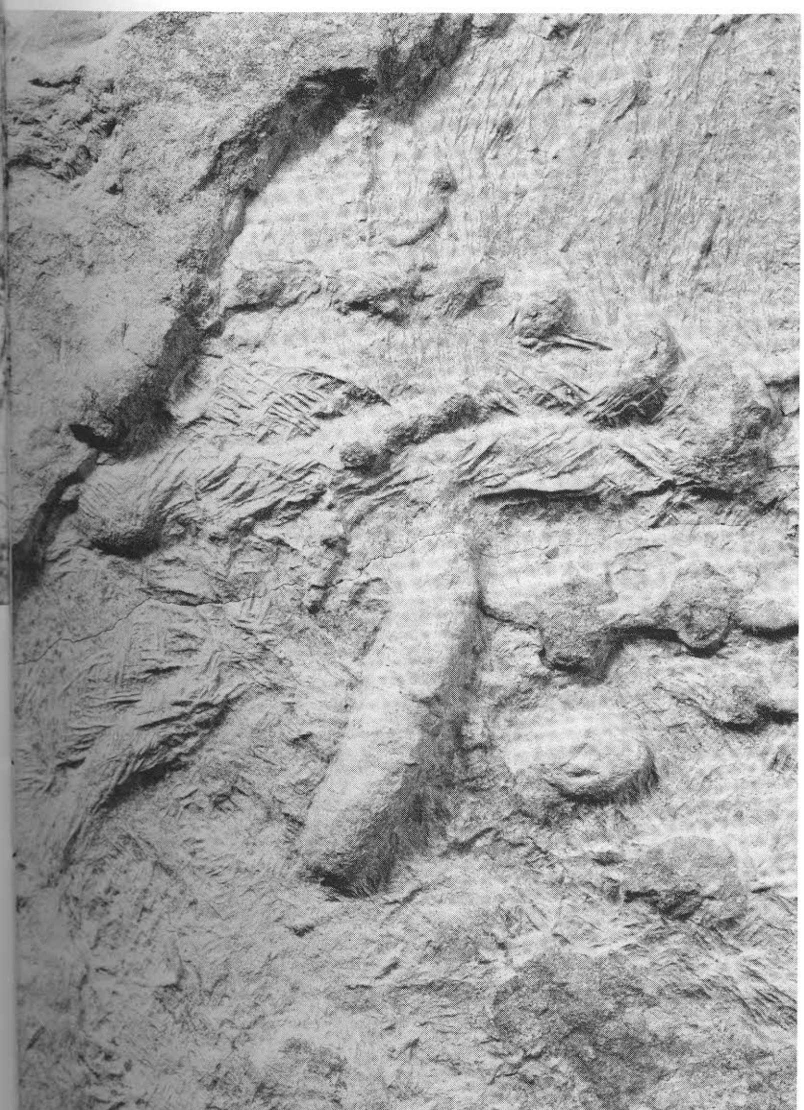


Figure 57. *Trace fossils, believed to be the walking markings of trilobites from the Carlisle Center Formation (Early Devonian); south side of U.S. 20, 3.3 km (≃2.2 mi) northeast of Cherry Valley.*

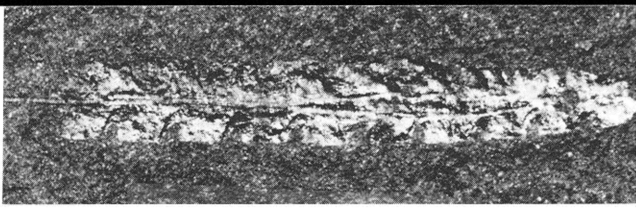
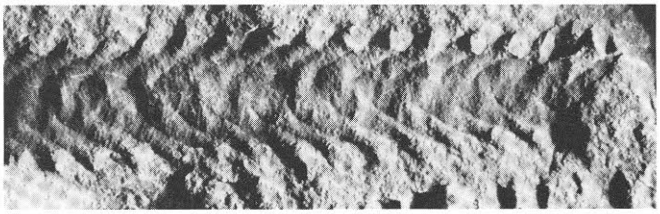


Figure 59. *Graptolite,* Climacograptus brevis strictus *Ruedemann, x 10; lowest Utica Shale* (Corynoides americanus *zone).*

Figure 60. *Graptolite,* Orthograptus amplexicaulis *(Hall), x 6; Russia Limestone and lower Utica Shale* (C. americanus *and* O. ruedemanni *zones).*



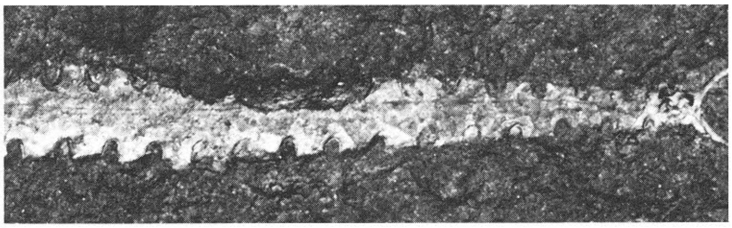
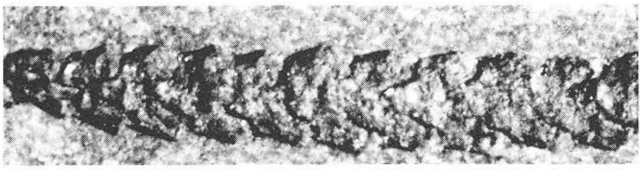


Figure 61. *Graptolite,* Climacograptus spiniferus *Ruedemann, x 6; upper Utica Shale* (C. spiniferus *zone).*

Figure 62. *Graptolite,* Climacograptus pygmaeus *Ruedemann, x 10; uppermost Utica Shale* (C. pygmaeus *zone).*



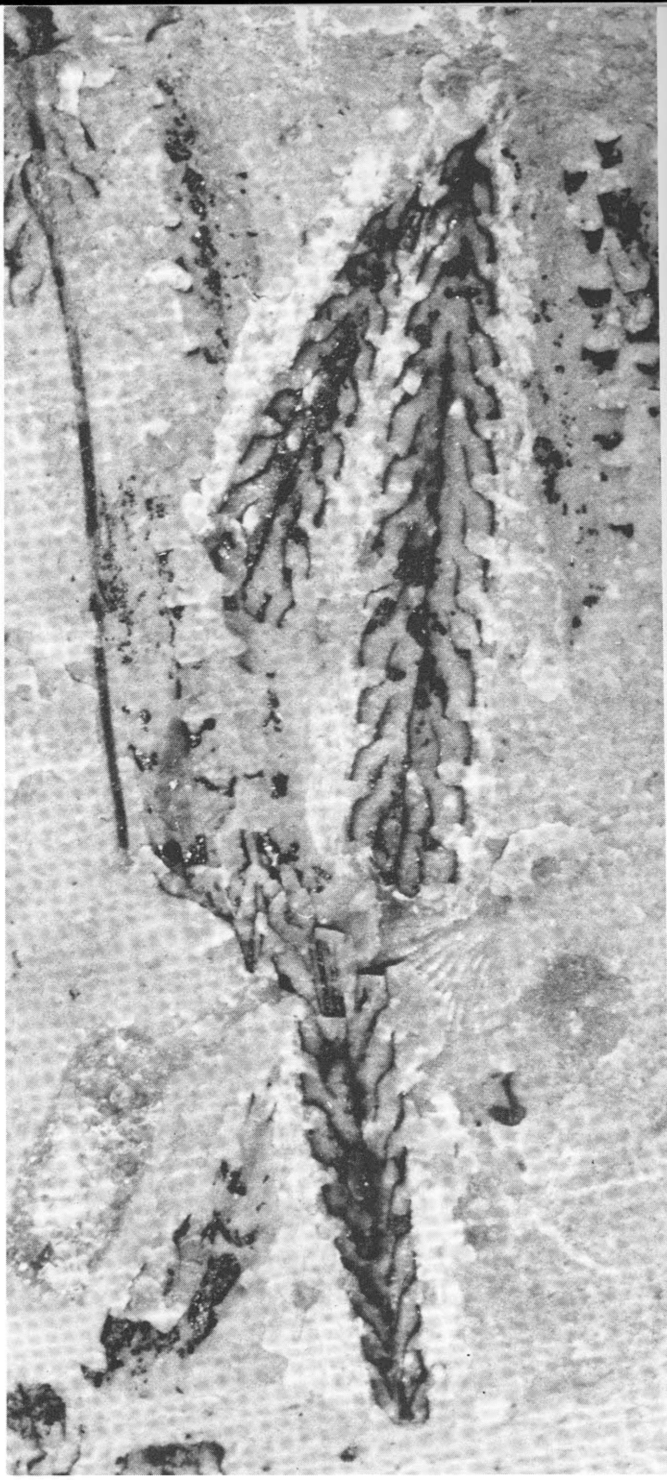


Figure 63. *Graptolite,* Climacograptus putillus *(Hall), x 10; upper Trenton Limestone and lower Utica Shale,* (Orthograptus ruedemanni *zone).*

Figures 59–64 are courtesy of Dr. John Riva, Laval University, Quebec, Canada.

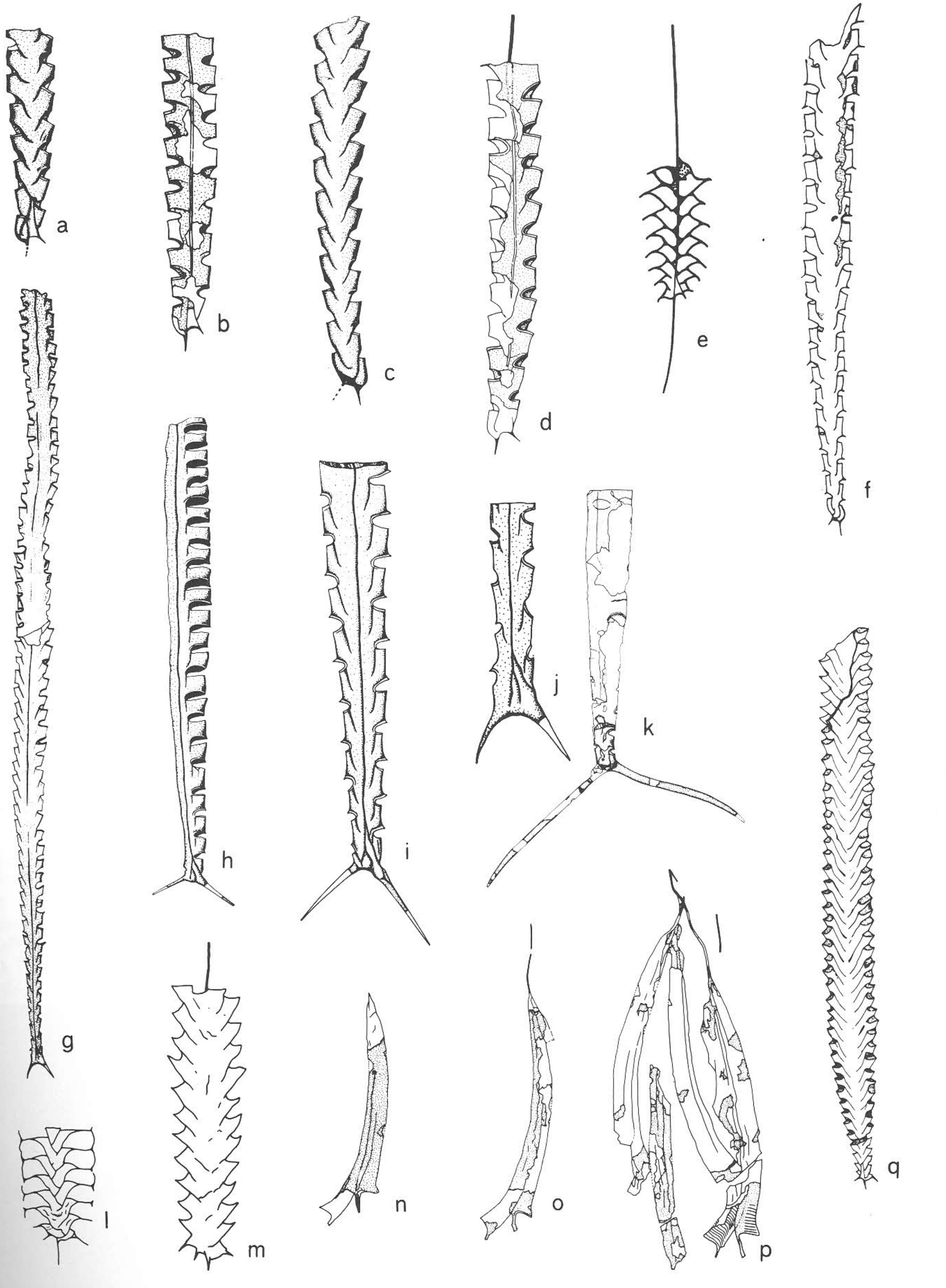
Figure 64. *Graptolites, Utica Shale*

a–d. Climacograptus pygmaeus *Ruedemann, x 10, uppermost Utica (Maysville),* C. pygmaeus *zone*

e. Orthoretiolites *sp. (new), x 10, upper Utica (Maysville, Nowadaga),* C. pygmaeus *and* C. spiniferus *zones*

f. Climacograptus typicalis *Hall, x 10, upper Utica (Maysville, Nowadaga),* C. pygmaeus *and* C. spiniferus *zones*

g–k. Climacograptus spiniferus *Ruedemann, g. x 3, h. x 5, i. x 10, j. x 8, k. x 5, upper Utica (Nowadaga),* C. spiniferus *zone*



l. Neurograptus margaritatus *Lapworth*, *x 6, lower Utica (Canajoharie)*, O. ruedemanni *zone*

m. Orthograptus ruedemanni *Riva*, *x 6, lower Utica (Canajoharie)*, O. ruedemanni *zone*

n–p. Corynoides americanus *Ruedemann*, *x 10, lower Utica (Canajoharie)*, C. americanus *zone*

q. Orthograptus amplexicaulis *(Hall)*, *x 3, lower Utica (Canajoharie)*, Orthograptus ruedemanni *and* Corynoides americanus *zones*

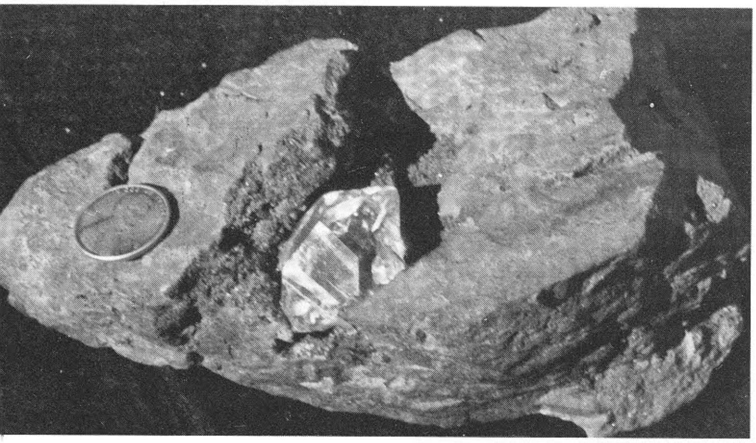


Figure 65. *Herkimer "Diamond" (doubly terminated quartz crystal), Mohawk Valley, New York, in solution cavity (vug) in the Upper Cambrian Little Falls Dolostone.*

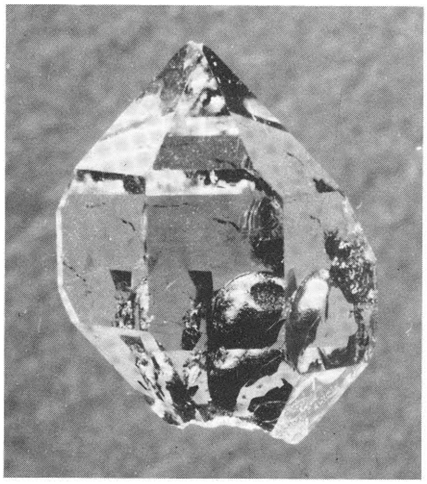


Figure 66. *Herkimer "Diamond" with enclosed bubble, Little Falls Dolostone.*

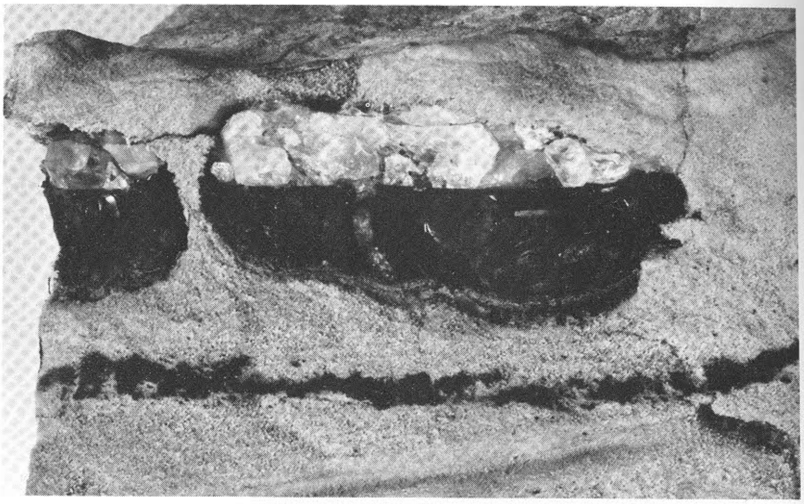
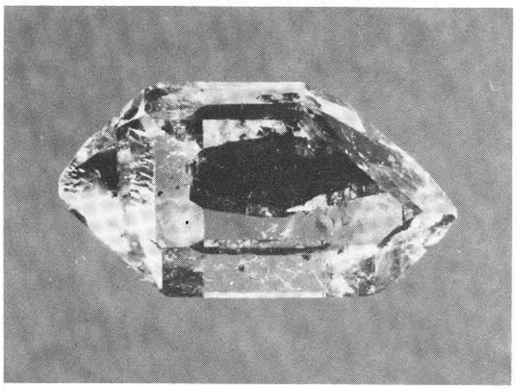


Figure 68. *Vug in Little Falls Dolostone filled with anthraxolite below and quartz above; Flat Creek, Mohawk Valley.*

Figure 69. *Exhumed quartz from vug showing shrinkage cracks along contact with anthraxolite; Flat Creek, Mohawk Valley.*

Figure 67. *Herkimer "Diamond" with phantom quartz crystal coated with black anthraxolite, Little Falls Dolostone.*



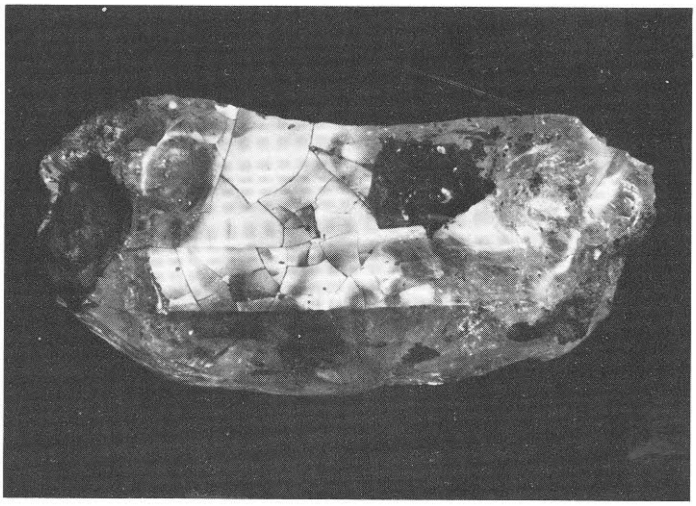
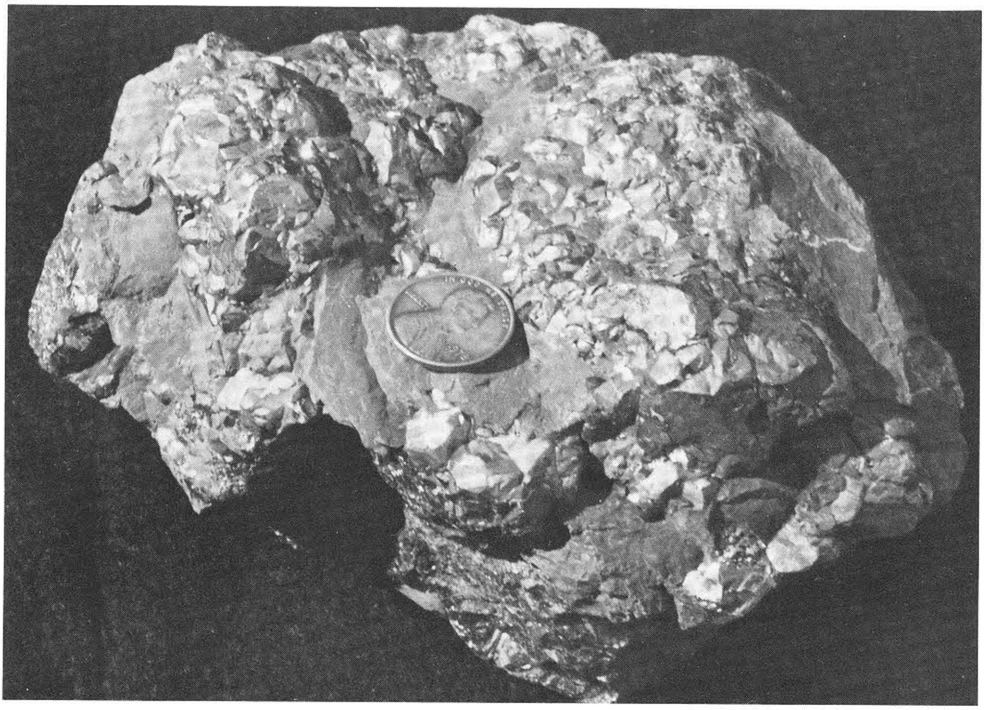


Figure 70. *Vug in Little Falls Dolostone filled with dolomite crystals; note curved surfaces on rhombs.*

D. FOR THE MINERAL COLLECTOR*—

Doubly terminated, clear-white quartz crystals (Herkimer "Diamonds") may be recovered from the Little Falls Dolostone and, less abundantly, from the Galway Formation. Private commercial diggings are available for collecting (for modest fees) in the area north of the Mohawk River between Fonda and Middleville. Occasionally, flecks of black bitumen (anthraxolite) occur within the quartz crystals or as lower fillings in cavities (vugs) within the upper 10 meters of the Little Falls Dolostone. Calcite (calcium carbonate) and dolomite (calcium-magnesium carbonate) rhombic crystals (those of dolomite possess curved faces), usually as clustered pockets, occur in the Little Falls Dolostone and, more rarely, in the Galway, Tribes Hill, Helderberg, and Onondaga units. Pyrite or "fool's gold" (iron sulfide) nodules are sometimes found in the Utica and Brayman shales. Strontianite (strontium carbonate) and celestite (strontium sulfate) have been found, rarely, in the Rondout Formation. Barite (barium sulfate) and siderite (iron carbonate) occur, sparingly, within concretions in the Union Springs Shale. Galena (lead sulfide) has been reported, rarely, from the Trenton Limestone and sphalerite (zinc sulfide) is found, occasionally, in the Little Falls Dolostone.

* Permission to enter and collect on private land should always be obtained prior to collecting efforts. Proper etiquette should be exercised when on private and public property.



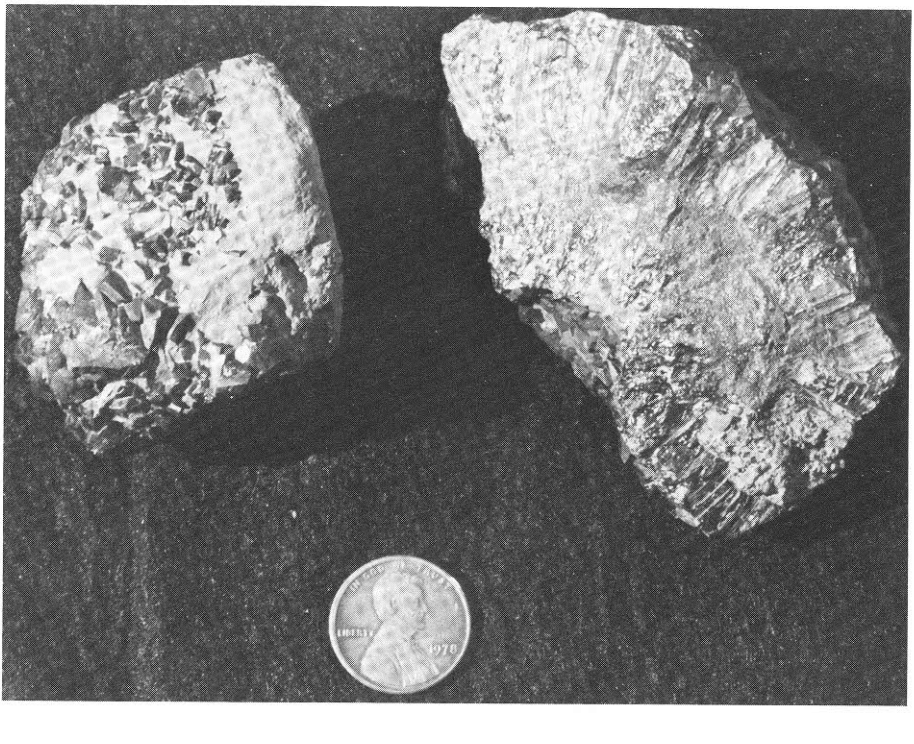


Figure 71. *Pyrite nodules in Upper Silurian Brayman Shale; quarry south of I-88 on north side of Barton Hill, 6.5 km (≈3.8 mi) north-northeast of Schoharie.*

E. FOR THE SPELUNKER*—

Cave exploration (spelunking) should always be carried out with the proper equipment and in company with experienced cavers; under no circumstances investigate a cave alone. For those who are interested in pursuing the investigation of caves, outing clubs at colleges or universities should be contacted. These people possess the "know-how" of cave exploration and often permission is denied access to property unless one is affiliated with such an outing club.

When carbonate-saturated and acid-bearing water migrate along bedding planes and micro-joints in carbonate rocks (limestones and dolostones), the enlargement of these cracks by solution may produce caves just below the water table. Within these natural excavations, mineral accumulations, of sometimes bizarre shapes, frequently occur. The most common are calcite growths of stalactites (extending downward from the ceiling) and stalagmites (extending upward from the floor).

The diameter of a cave for accessibility is primarily dependent upon the amount of water passing through it and the relative solubility of the rock. The volume of water is largely governed by the topography of the area drained by underground drainage, the changes brought about by surface erosion, and the type and thickness of overlying glacial deposits. A cave's "life" ceases when the roof collapses and the channel is open to daylight. "Dead" caverns have a pronounced effect upon topography as they create sinkholes (abundant west and east of Sharon Springs) or rock basins on the land surface.

There are many caves, particularly in the Devonian carbonates, to the south of the mapped area in the valleys of Schoharie and Cobleskill Creeks. The principal ones are Howe Caverns (commercial), Secret Caverns (commercial), Ball's, Clark's, Becker's, Knox, Mac Fail's (longest and deepest cave in New York), Patrick, Shelter, and Young's. Most of these are chiefly developed in the Manlius and Coeymans Limestones, but cave development is also extensive in the Rondout, Kalkberg, Becraft, and Onondaga Formations.

In the mapped area, the following caves are known:

Sprout Brook Quadrangle—

- Cherry Valley Cave (in Coeymans and Manlius Limestones)—4.5 km (≈2.8 miles) NNE of Cherry Valley, to the west of Van Berwwerker Road
- Route 20 Cave (in Seneca and Moorehouse Members of Onondaga Limestone)—4.2 km (≈2.6 miles) NE of Cherry Valley on S side of U.S. 20
- Collins Cow Cave (in Kalkberg and Coeymans Limestones)—4 km (≈2.5 miles) WNW of Sharon Springs on N side of a large sinkhole, N of U.S. 20
- Calf Cave (in Coeymans and Manlius Limestones)—near the SE corner of the sinkhole mentioned above (Kalkberg Ls.)
- Pendulum Well (in Coeymans and Manlius Limestones)—4.4 km (≈2.7 miles) NW of Sharon Springs to the W of Keller Rd. about 150 m (≈500 ft)
- Lynk Cave (in Coeymans Limestone)—2.3 km (≈1.4 miles) WNW of Sharon Springs west of Lynk Rd. on west side of sinkhole

Carlisle Quadrangle—

- New Carlisle Cave (at Coeymans-Manlius contact)—1.1 km (≈0.7 mile) NW of Carlisle road intersection (U.S. 20 and Schoharie County 7), W of Cemetery Rd.

Randall Quadrangle—

- Mitchell's Cave (in Little Falls Dolostone)—8 km (≈5 miles) E of Canajoharie, atop the Little Nose, S of N.Y. 5-S, about 1.6 km (1 mile) SE of house at end of Klemme Rd. This cave is, perhaps, thé most interesting one within the mapped area. It drops vertically about 46 m (≈150 ft), has a 61 m (≈200 ft) northeast passage, ending in a relatively large room 15 m (≈50 ft) long, 4.5 m (≈15 ft) wide, and 15 m (≈50 ft) high with two good flowstone cascades.

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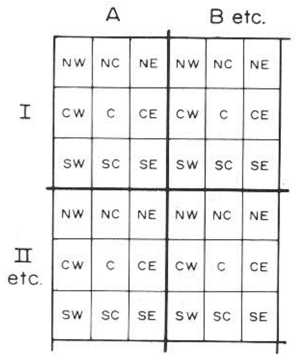
* Permission to enter and collect on private land should always be obtained prior to collecting efforts. Proper etiquette should be exercised when on private and public property.

ROCK EXPOSURES: EXCEPTIONAL FOR DETAILED STUDY AND CLASS FIELD TRIPS



Locality Code: Horizontal (letter) and vertical (Roman numeral) coordinates plus directional sector of individual quadrangle map; locality numeral cross-referenced to map legend and plotted on geologic map.

Locality #1: (private) IA-SW (Oppenheim Quadrangle). East Canada Creek, beginning south of power station and continuing upstream to dam impounding East Canada Lake. At power station is a normal fault (Manheim Fault), downdropped on east showing dragged Dolgeville limestone and shale against upthrown Little Falls Dolostone; Tribes Hill (Palatine Bridge Member), Lowville, and lower Trenton limestones exposed beyond Little Falls to the dam. On east bank of stream, note thin peridotite dikes within the dolostone, roughly paralleling fault.

Locality #2: (private) IA-SW (Oppenheim Quadrangle). Along west bank of Crum Creek on south side of NY 5; low fold and worm-riddled (*Phytopsis*) Lowville Limestone. Limited parking for class study.

Locality #3: (private) IA-CE (Oppenheim Quadrangle). On east side of town road, 6.5 km (4 miles) NE of St. Johnsville, Crystal Grove Campground; quartz-crystal collecting (for fee) in Galway dolostones.

Locality #4: IC-SW (Peck Lake Quadrangle). Along west side of Kecks Center Road, north of Kecks Center. Potsdam Sandstone on gneiss, demonstrating moderate relief on Proterozoic basement.

Locality #5: IF-SC (Galway Quadrangle). Along south side of West Galway Road, southwest of Cummings Pond. Mosherville Sandstone on uppermost lingulid-bearing Galway dolomitic shales. Conceiv-

Figure 72. *Manheim Fault, a normal fault showing dragged Dolgeville facies on relatively downdropped (right) side and Little Falls Dolostone on relatively upthrown (left) side; across from power plant on east side of East Canada Creek, 5.4 km (≈3.3 mi) west-northwest of St. Johnsville.*

Figure 73. *Lowville Limestone, illustrating low anticlinal fold; Crum Creek, south of N.Y. 5, 4.2 km (≈2.6 mi) west of St. Johnsville.*

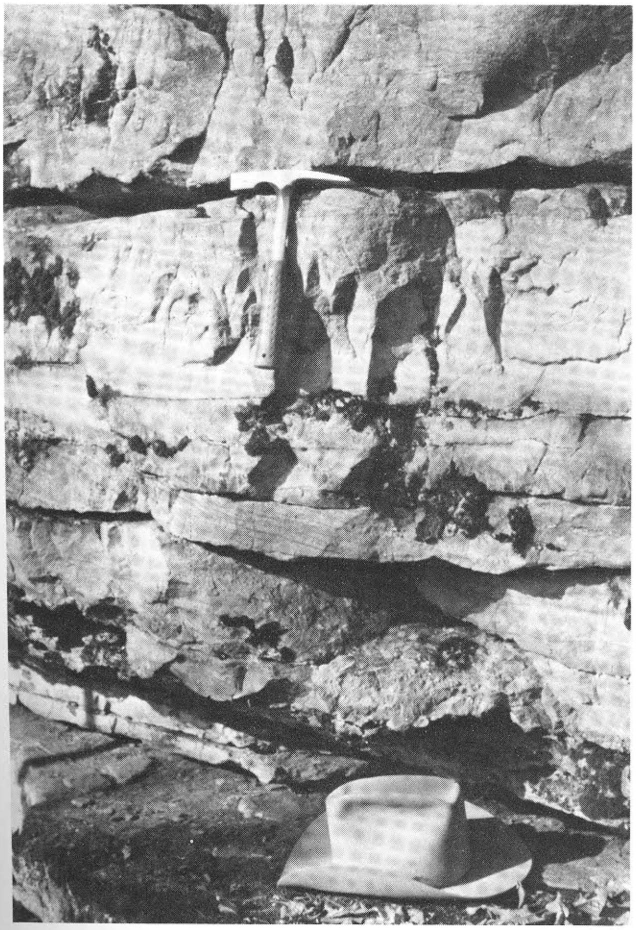


Figure 74. *Upper Cambrian Potsdam (Keeseville) Sandstone; ledge in woods, 0.5 km (≈0.3 mi) north of Kecks Center.*

Figure 75. *Kimball Corners quartz-cobble conglomerate; north side of N.Y. 29, 0.5 km (≈0.3 mi) east of Kimball Corners and 4.4 km (≈2.7 mi) north-northwest of Galway.*

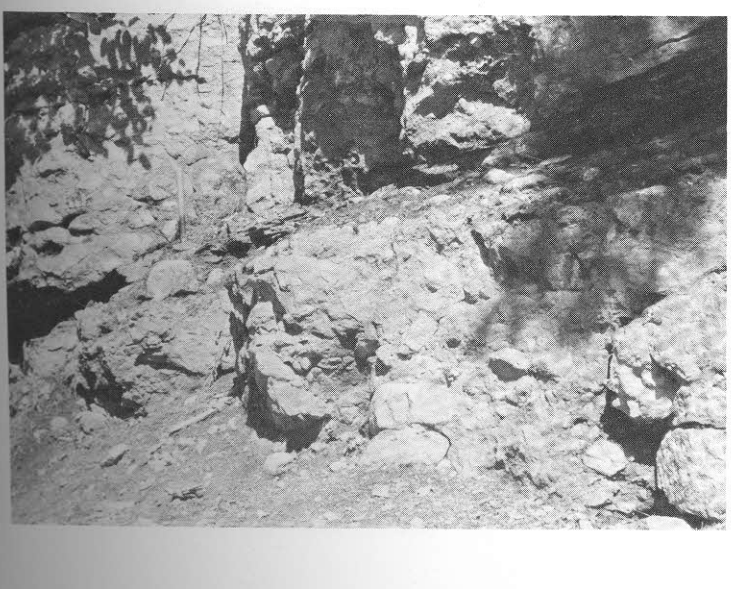


Figure 76. *Sanders Road Fault, a normal fault showing Palatine Bridge Member of the Tribes Hill Formation on western upthrown (right) side and black Utica Shale on eastern downthrown (left) side; temporary roadcut exposed during relocation of River Road, paralleling N.Y. State Thruway.*

Figure 77. *Palatine Bridge Member of Tribes Hill Formation; south side of River Road, south of I-90, south of St. Johnsville.*

ably, this shale interval may relate to one in the Hoyt Limestone at Lester Park, 5 km (≈3 miles) west of Saratoga Springs.

Locality #6: IF-C (Galway Quadrangle). Along north side of NY 29, east of Kimball Corners. Type locality of Kimball Corners Conglomerate, a basal quartz-cobble conglomerate on the Proterozoic basement. Danger: heavily traveled road.

Locality #7: (private) IIA-CW (Fort Plain Quadrangle). Loyal Creek, a tributary to Otsquago Creek. Splendid graptolite collecting in middle and upper Utica Shale.

Locality #8: IIA-NC (Fort Plain Quadrangle). Abandoned quarry (private) and exposure along south side of town road, south of I-90, south of St. Johnsville. Cranesville dolomitic facies of Wolf Hollow Member of Tribes Hill Formation overlain by veneer of Lowville Limestone, in turn overlain by basal coarse-grained Trenton Limestone; Palatine Bridge Member of Tribes Hill along road. Contact of Palatine Bridge on Little Falls Dolostone along Thruway (I-90) to the north but off limits to visitors.

Figure 78. *Chuctanunda Creek Dolostone member of the Lower Ordovician Tribes Hill Formation overlain by 4.5 m (≈15 ft) of Middle Ordovician Trenton (Glens Falls) limestone and several tens of meters of Utica black shale; Canajoharie Creek, at southern edge of village of Canajoharie.*

Locality #9: IIB-SC (Canajoharie Quadrangle). Canajoharie Creek. Section extends from uppermost Palatine Bridge Member, through Wolf Hollow, Fonda, and Chuctanunda Creek Members (this dolostone with large potholes and algal mounds) unconformably overlain by Trenton Limestone, in turn abruptly overlain by Utica black shale upstream through Wintergreen Park. Good fossil collecting in most units and many sedimentary features. Modest parking at end of Floral Avenue (village park).

Locality #10: IIB-SC (Canajoharie Quadrangle). Abandoned State-owned quarry at east end of Canajoharie south of NY 5-S. Contact of Fort Johnson Member of Tribes Hill Formation on reddish-stained uppermost Little Falls Dolostone. Upper part of quarry in Palatine Bridge Member. Quartz and anthraxolite formerly collected here in Little Falls unit.

Locality #11: IIB-SE (Canajoharie Quadrangle). Flat Creek. Section begins in north-south course with Little Falls Dolostone, unconformably overlain by Palatine Bridge Member of Tribes Hill Formation at "elbow" of stream course; Wolf Hollow Member forms caprock of falls

Figure 79. *Falls along Flat Creek, showing Fonda, Wolf Hollow, and Palatine Bridge Members of Tribes Hill Formation (Fort Johnson Member is absent in this section); 1.3 km (≈0.8 mi) south-southwest of Sprakers.*

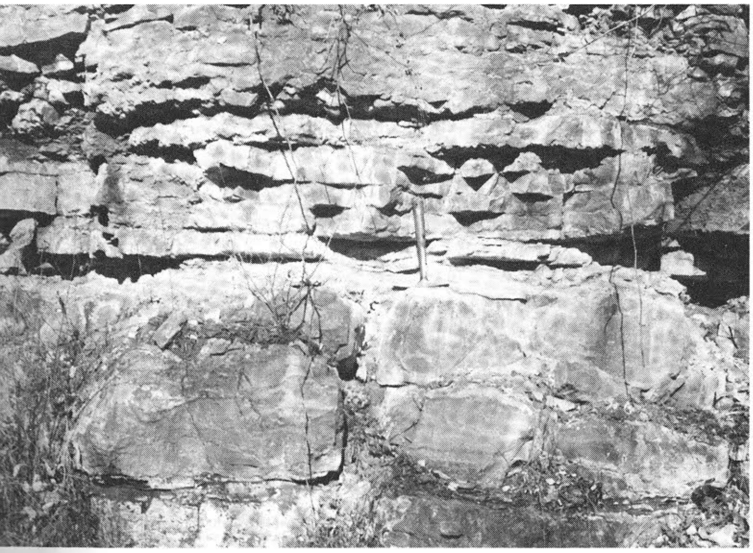


Figure 80. *Middle Ordovician Limestone (Larrabee?), with lenses of Lowville, unconformably on Lower Ordovician Fonda Member of Tribes Hill Formation; east side of Borden Road, 4.8 km (≃3 mi) southwest of Fonda.*

Figure 81. *Coarse grained, pebbly, glauconitic limestone in Fonda Member, replete with fossils, especially the rostroconch* Ribeiria.

with thin Fonda above. Trenton Limestone along mainstream, but absent along eastern tributary where Utica Shale rests on Tribes Hill (Cranesville) dolostone.

Locality #12: IIC-SW (Randall Quadrangle). Several exposures in the "Noses" area. At the "Big Nose" on north side of Mohawk River, mafic dike cuts Peck Lake garnet-gneiss on north side of NY 5 (unsuitable for large group, limited parking, narrow shoulder). At the "Little Nose" along old Erie Canal and railroad on south side of Mohawk River, breccia in basal Little Falls Dolostone rests on a few inches of unconsolidated clay above the gneiss. Dragged Utica Shale along N-S road east of Noses Fault.

Locality #13: (private, in part) IIC-C (Randall Quadrangle). Borden Road (east side) and Van Wie Creek. Uppermost Palatine Bridge Member and Wolf Hollow Member in Creek; fossiliferous Fonda Member in east ditch of road and in roadcut overlain unconformably by patches of Lowville Limestone, in turn overlain by fossiliferous Trenton Limestone. Good fossil collecting and varied lithologic types, including ribeirid-bearing glauconitic limestone in Fonda Member.

Locality #14: (private) IID-NE (Tribes Hill Quadrangle). Abandoned quarry, north of NY 67 on upthrown side of Tribes Hill Fault. Exposure of Palatine Bridge, Wolf Hollow, and Fonda Members of Tribes Hill Formation; good for sedimentological study, particularly fill of Fonda coarse-grained limestones in channeled Wolf Hollow fine-grained limestones.

Locality #15: (private) IID-CE (Tribes Hill Quadrangle). Abandoned quarries and field exposures north and south of railroad tracks east of Fort Hunter. Partly concealed section goes from Fort Johnson Member (type locality) through Trenton Limestone.

Locality #16: IIE-C (Amsterdam Quadrangle). Roadcut on north side of NY 5, east of Amsterdam, at railroad overpass. Wolf Hollow and Palatine Bridge Members of Tribes Hill Formation; good for sedimentology and fossils.

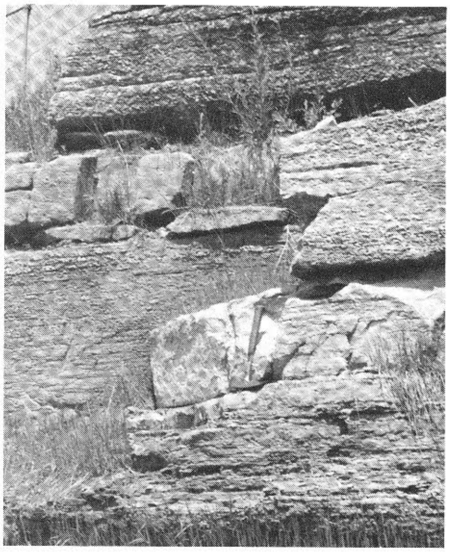


Figure 83. *Wolf Hollow Limestone on Palatine Bridge Limestone; note persistent 1 m dolostone bed, 1.3 m above base of Wolf Hollow Limestone; north side of N.Y. 5, 3 km (≈1.8 mi) southeast of Amsterdam.*

Locality #17: (private) IIE-CE (Amsterdam Quadrangle). Abandoned quarry, roadcut, and field exposures along NY 67 east of Manny Corners. Section ranges from Cranesville Dolostone (floor of quarry) overlain unconformably by Lowville, Amsterdam (type locality in quarry wall), Larrabee, and Sugar River Limestones. Especially good for fossil collecting and sedimentology.

Figure 82. *Fonda, Wolf Hollow, and Palatine Bridge Members of Tribes Hill Formation; abandoned quarry, north of N.Y. 67, 3.2 km (≈2 mi) northeast of Tribes Hill.*

Locality #18: (private) IIF-SW (Pattersonville Quadrangle). Roger Patterson Farm, abandoned old quarries and field exposures south of I-90 and county road (Florida Road); Amsterdam and Larrabee Limestones. Good display of blocks of Chuctanunda Creek Dolostone in Amsterdam and pebbles of Chuctanunda Creek and Lowville in Larrabee. Superb fossil collecting, especially colonial tabulate corals (some inverted) and horn corals in Amsterdam and brachiopods in Larrabee.

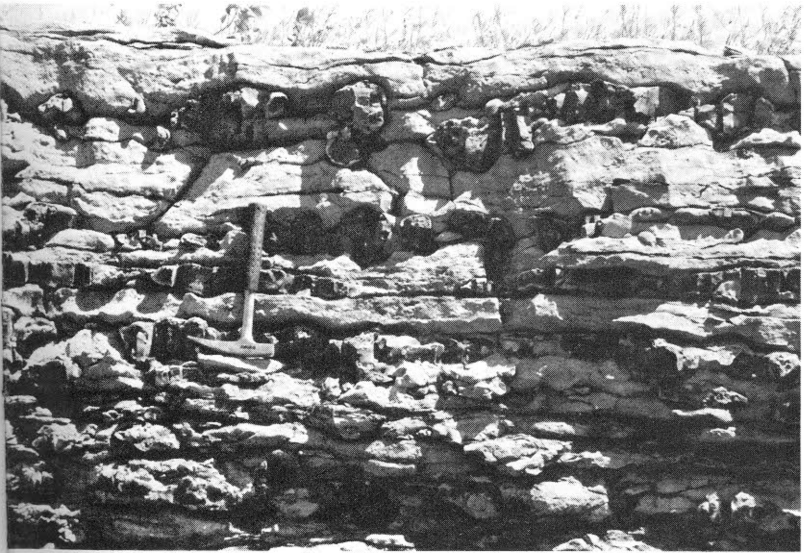
Locality #19: (private), in part) IIF-SC (Pattersonville Quadrangle). Field exposures west of, and roadcuts along, Wolf Hollow, a narrow north-south valley marking the trace of the Hoffmans Fault, north of the Mohawk River. Dragged Schenectady sandstone and shale on the east and Little Falls through Utica Formations on the west.

Locality #20: IIF-NC (Pattersonville Quadrangle). Roadcuts on both sides of NY 67 showing different types of dolostones and calcitic dolostones with collapse-and-fill structures and mineralization along fractures. Assumed to be Fort Johnson Member of the Tribes Hill Formation, but may be a wedge of a post-Little Falls unit coming in from the east.

Locality #21: IIIA-CW (Sprout Brook Quadrangle). Roadcuts, primarily along east side of NY 166, south of US 20. Moorehouse, Nedrow, and Edgecliff Members of Onondaga Limestone. Carlisle Center Formation just north of abandoned railroad bed. Good for limestone and chert study and fossil collecting.

Locality #22: IIIA-CW Sprout Brook Quadrangle). Large roadcut on east side of OC 32 north of US 20. Full thickness of Manlius Limestone overlying Rondout Dolostone and underlying Coeymans Limestone. Good for study of varied limestones.

Locality #23: IIIA-W (Sprout Brook Quadrangle). Large roadcuts on both sides of US 20, northeast of Cherry Valley and east of NY 166. The largest (on the south side) shows Kalkberg Limestone, Oriskany "Sandstone," Esopus shale and chert,



Carlisle Center calcareous, argillaceous siltstones with the worm trail *Zoophycus,* and the basal cherty Onondaga (Edgecliff) Limestone. Splendid for lithologic types and fossils. A volcanic ash bed (bentonite) occurs midway in the Kalkberg at the overpass for the abandoned Cherry Valley Railroad.

Locality #24; IIIA-C (Sprout Brook Quadrangle). Roadcut on south side of county road (OC 54) paralleling US 20, northeast of Cherry Valley at point where there is a marvelous vista to the north across the Mohawk Valley to the Adirondack Mountains. Union Springs black shale with lime concretions overlain by Cherry Valley Limestone, in turn overlain by Chittenango Shale.

Figure 84. *Moorehouse Member of Onondaga Limestone, showing knobby dark gray to black chert in medium to dark gray limestone; east side of N.Y. 166, 2.2 km (≃1.4 mi) northeast of Cherry Valley.*

Figure 86. *Carlisle Center Formation resting, with abrupt contact, on Esopus Shale; east side of N.Y. 166, 2.8 km (≃1.7 mi) north-northeast of Cherry Valley.*

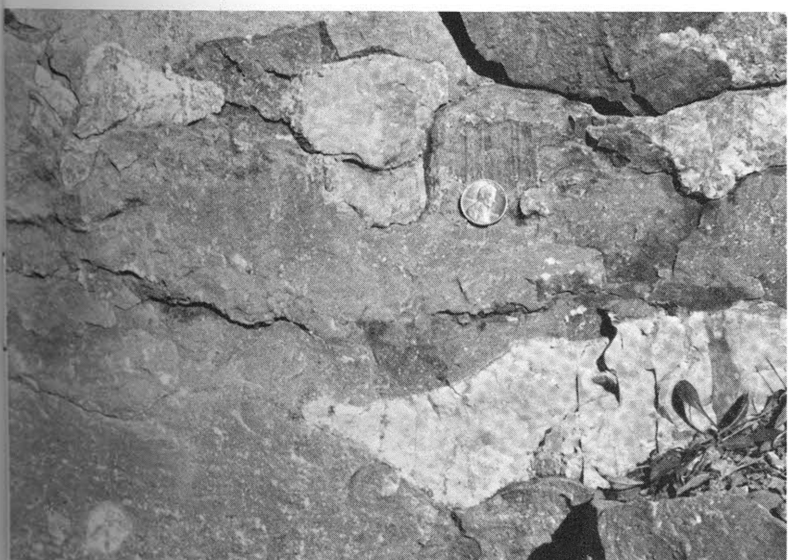


Figure 85. *Edgecliff Member of Onondaga Limestone (Medial Devonian), showing light gray to tan chert lenses in light gray coarse grained fossil-fragmental, coral-rich limestone; east side of N.Y. 166, 2.7 km (≃1.6 mi) north-northeast of Cherry Valley.*

Locality #25: (private, in part) IIIA-C (Sprout Brook Quadrangle). Active quarries and field ledges on both sides of county road leading east from Cherry Valley across summit region in vicinity of microwave tower. Sandstones and shales of the Solsville Formation.

Locality #26: IIIA-E (Sprout Brook Quadrangle). Similar roadcuts on both sides of US 20 just west of Leesville and just west of Sharon Springs. Kalkberg Limestone; good for fossil collecting and chert study.

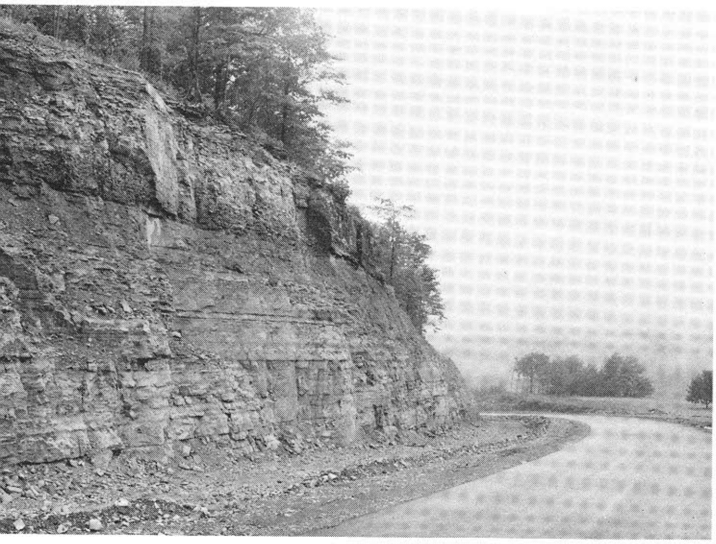


Figure 87. *Edgecliff Member of Onondaga Limestone with abrupt conformable contact on Carlisle Center Formation; south side of U.S. 20, 3.7 km (≈2.3 mi) northeast of Cherry Valley.*

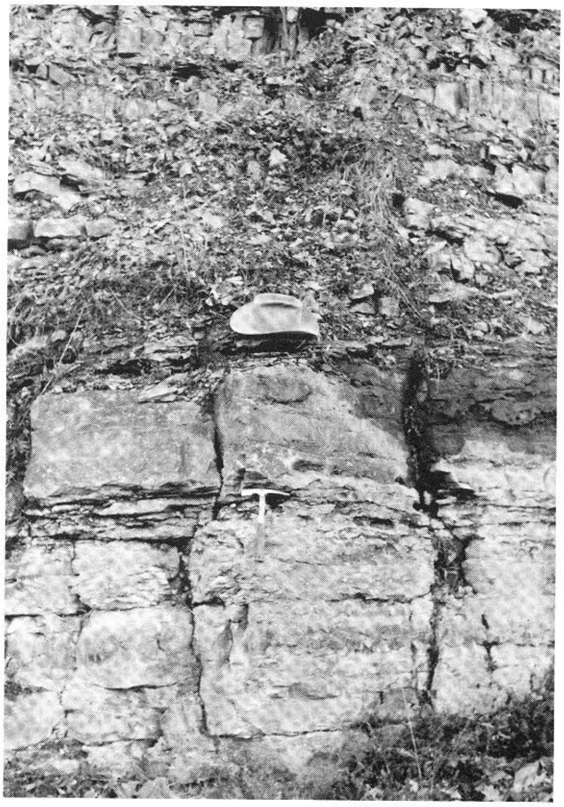


Figure 88. *Lower Devonian Esopus Shale, with blocky black chert (top of photo), resting on Oriskany "Sandstone" (hat at contact), in turn resting on Kalkberg Limestone of the Helderberg Group (hammer at contact); south side of U.S. 20, 3.7 km (≈2.3 mi) northeast of Cherry Valley.*

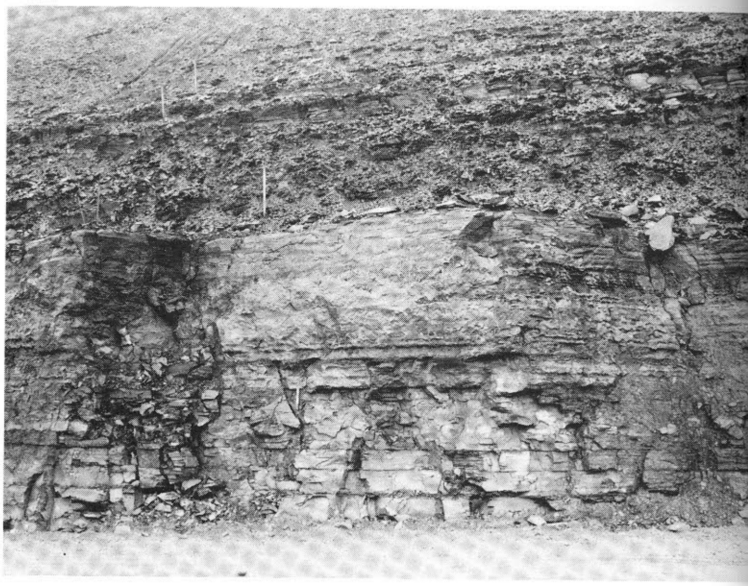
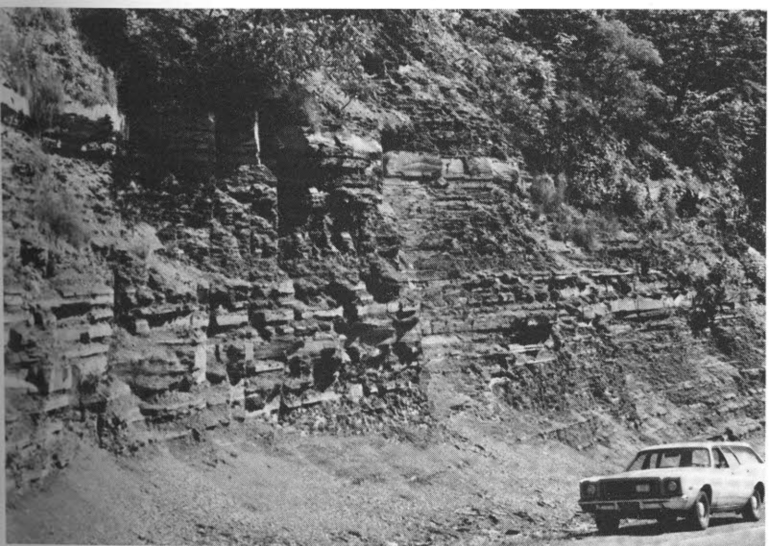


Figure 89. *Middle Devonian Chittenango Shale (top of photo), resting on Cherry Valley Limestone, in turn resting (see hammer) on Union Springs Shale; south side of OC 54, 4.3 km (≈2.7 mi) east-northeast of Cherry Valley.*

Figure 90. *Solsville Member of Middle Devonian Marcellus Formation: shows silty shales with some argillaceous siltstone; active quarry along Countryman Mountain Road, 4.5 km (≈2.8 mi) east of Cherry Valley atop the "Cherry Valley Hills."*

Figure 91. *Kalkberg cherty limestone: note terrace formed atop this unit; north side of U.S. 20, at west edge of Leesville.*

Figure 92. *Upper Ordovician Frankfort siltstone and shale; west side of N.Y. 10, at north edge of Sharon Springs.*



Locality #27: IIIB-CW (Sharon Springs Quadrangle). Roadcut on west side of NY 10 at northern edge of village of Sharon Springs. Ordovician Frankfort shale, with few siltstones, overlain (contact almost imperceptable) by Silurian Brayman Shale. Limited parking for class study.

Locality #28: (private, in part) IIIB-C (Sharon Springs Quadrangle). Roadcut on south side of town road and field exposures, one mile northeast of Sharon Center. Thacher Member of Manlius along road with thin beds covered with conical shells of *Tentaculites gyracanthus*, ostracode *Hermannina alta*, small brachiopods, small bryozoans, and rare edrioasteroids; mudcracked. Strata above are coarser-

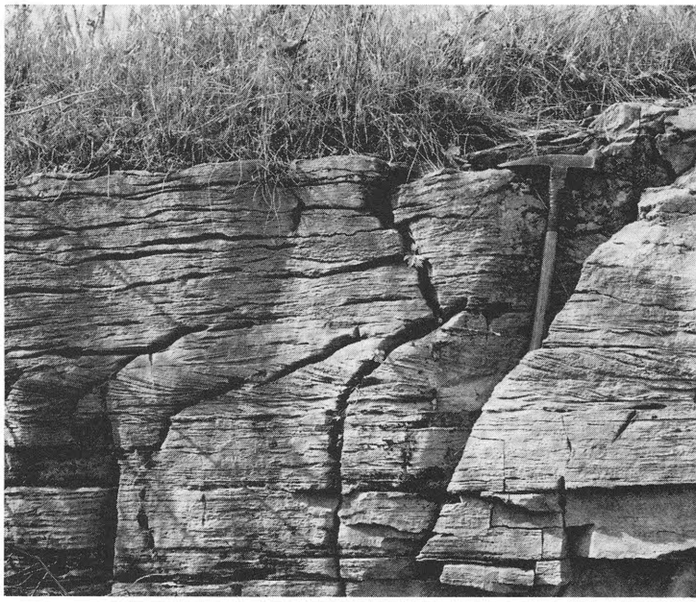


Figure 93. *Crossbedded coarse grained limestone in upper Thacher Member of Lower Devonian Manlius Formation; west side of town road, 4.4 km (≃2.7 mi) northwest of Sharon.*

Figure 94. *Unbedded stromatopora blanket reef resting on regular bedded fine grained limestone of Thacher Member of Manlius Formation; field exposure west of town road, 4.4 km (≃2.7 mi) northwest of Sharon.*

Figure 95. *Base of Middle Ordovician Schenectady sandstone and shale resting on black Utica Shale; Buttermilk Falls, Yatesville Creek, 2.4 km (≈1.5 mi) north-northwest of Rural Grove.*

grained and slightly crossbedded. Field exposures to the southwest display a superb stromatoporoid reef. Excellent area for varied types of limestones and fossils.

Locality #29: (private) IIIC-NC (Carlisle Quadrangle). Buttermilk Falls along Yatesville Creek. Schenectady sandstones resting abruptly on Utica black shale. Relatively long walk to closest parking facility.

Locality #30: (private) IIIF-NC (Rotterdam Junction Quadrangle). Gorge of the Plotter Kill. Continuous sequence of sandstones, siltstones, and shales of the Schenectady Formation. Good for sedimentological studies.

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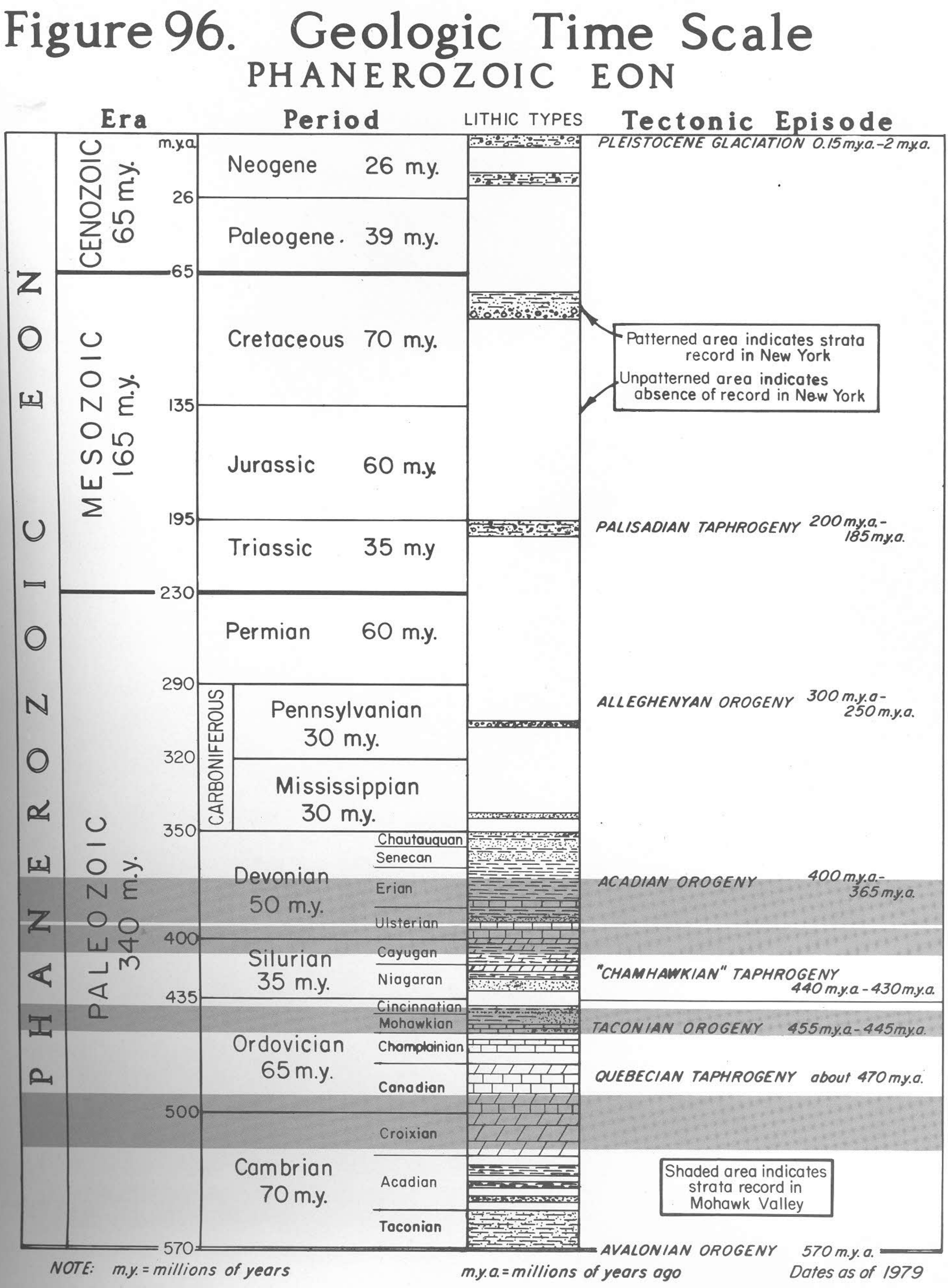

Figure 96. *Geologic Time Scale: Phanerozoic Eon*

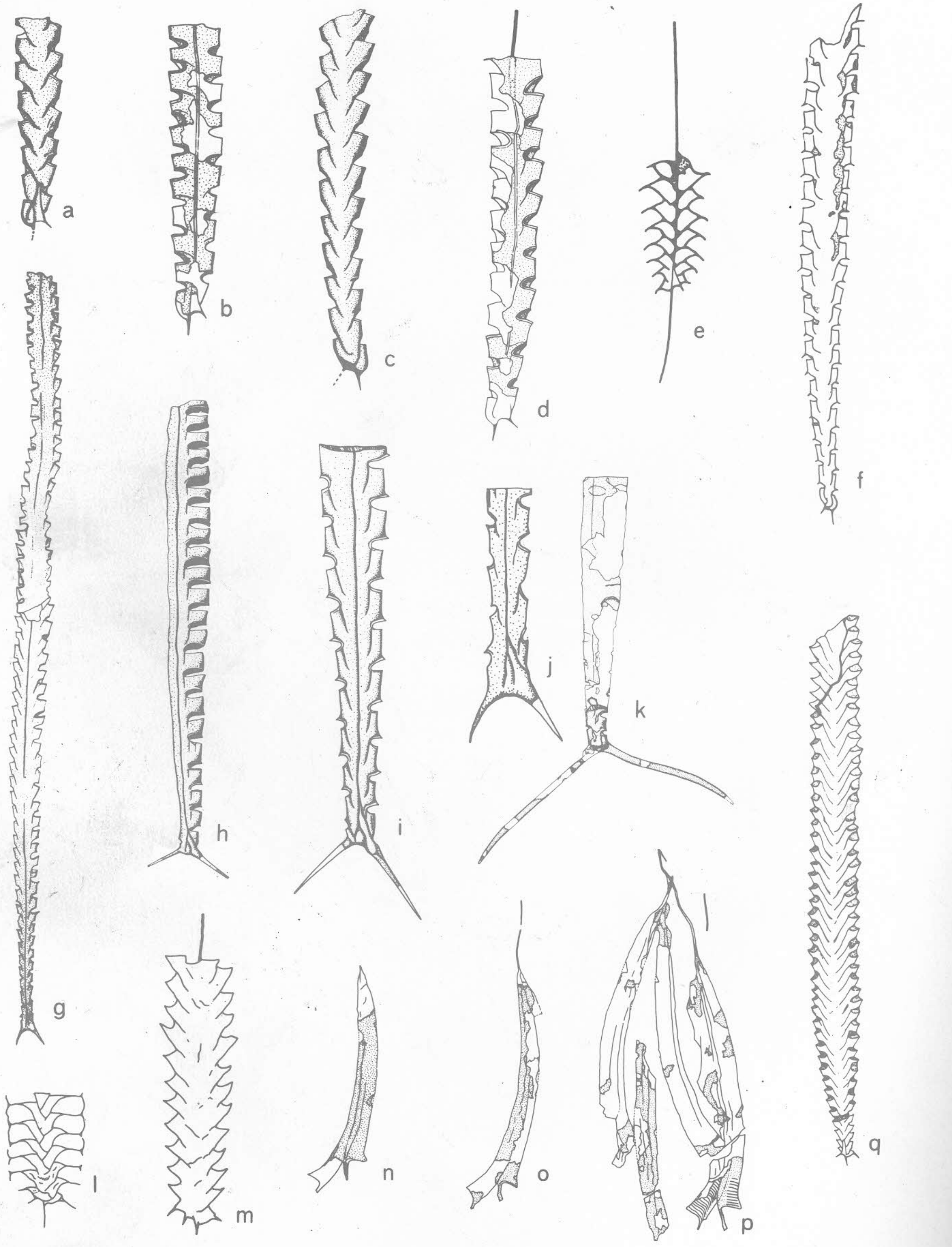

Figure 64. Graptolites, Utica Shale *(see pages 28—29)*

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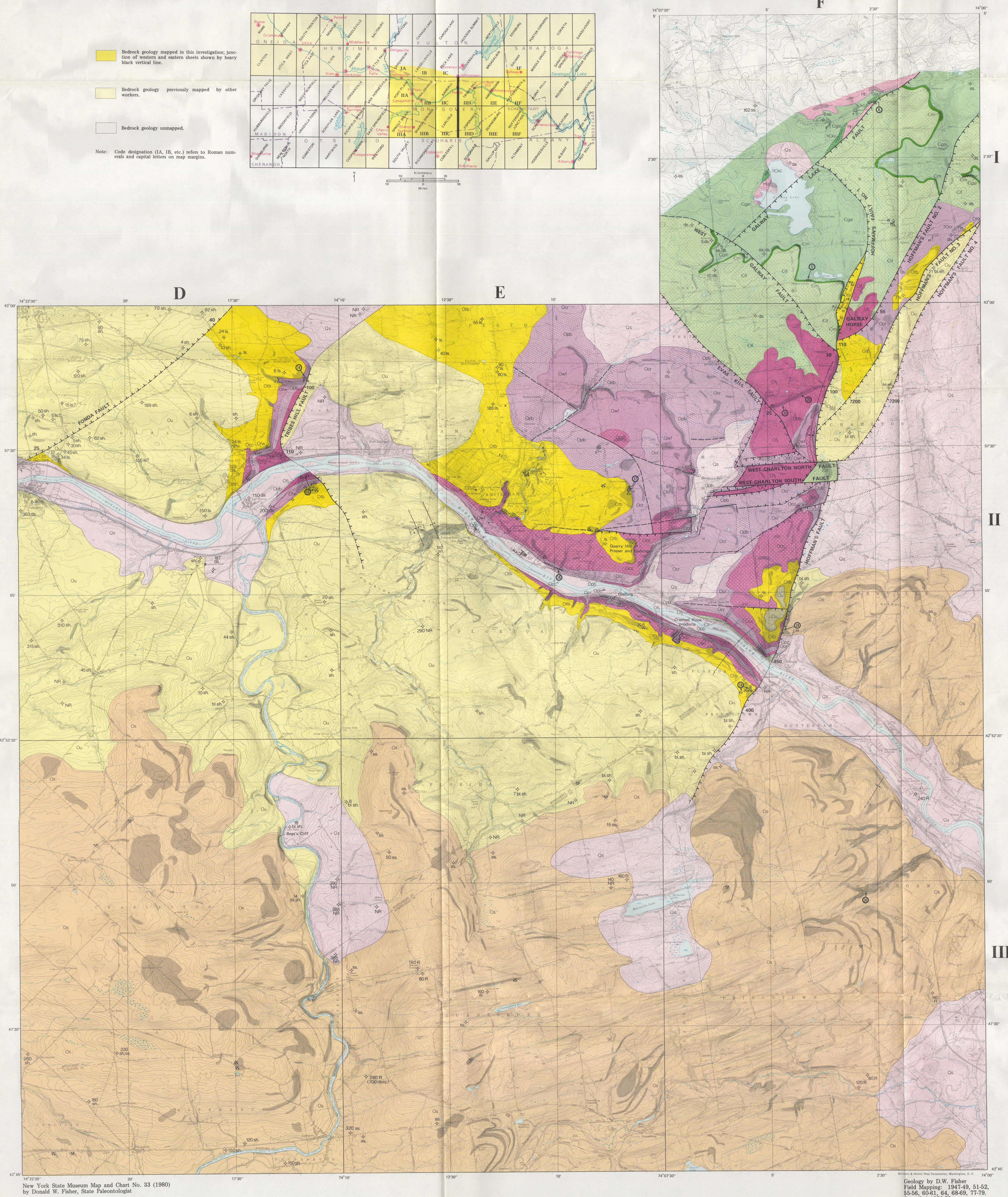
STATE GEOLOGIST



New York State Museum Map and Chart No. 33 (1980)
by Donald W. Fisher, State Paleontologist

Geology by D.W. Fisher
Field Mapping: 1947-49, 51-52, 55-56, 60-61, 64, 68-69, 77-79
Compiled 1978-79

BEDROCK GEOLOGY OF THE CENTRAL MOHAWK VALLEY, NEW YORK

(Eastern Sheet)

1980

Mapped area

EXPLANATION

NOTICE: Units indicated by uncolored boxes are not present on this sheet.

PHYSICAL AND ORGANIC CHARACTERISTICS (thickness of unit, in meters and feet, in parentheses)

ENVIRONMENTAL AND ECONOMIC CHARACTERISTICS* (red print = engineering aspects; blue print = water properties; gray print = economic uses)

PHANEROZOIC EON CENOZOIC ERA QUATERNARY (HOLOCENE AND PLEISTOCENE)

Qs **Sediments** (up to 125 m ≅ 410 ft.). Light brown, tan, and gray gravels, sands, silts, and clays; in form of drumlins, kames, moraines, outwash plains, terraces, and till all concealing various underlying bedrock units. Shown only where bedrock geology is uncertain.

0.2 my

Poor foundation for heavy structures; cut slope stability poor; drilling rate fast, slower where cobbles or boulders in till are encountered; machine tunneling generally fast although sticky clays may cause buildup on excavating equipment.

Gravels and sands are excellent to good aquifers; outwash deposits are the most productive. Tills are relatively impermeable and yield water slowly. Where till underlies permeable materials, perched water tables may be extensive as along the lower Schoharie Valley and Auries Creek, and locally along the Mohawk River. Where till or clay overlies more permeable sediments, artesian conditions are common.

Gravel and sand used for construction purposes and concrete manufacture. Boulder and cobble-gravel used for holding unstable slopes. Clays have a potential use for brick manufacture (east of the mapped area they were so used in the early 20th century).

unconformity

MESOZOIC ERA LOWER CRETACEOUS

Kd **Peridotite dikes** (1-5 cm wide ≅ 0.5-2 in). Dark green to black, fine grained peridotite dikes, striking N 20-30°E, transversing the Little Falls Dolostone along East Canada Creek just north of the Manheim Fault (Locality 1); radiometrically dated (Rb-Sr) as 130 ± 10 million years old.

130 ± 10 my

Too localized to have economic significance.

unconformity

PALEOZOIC ERA MIDDLE DEVONIAN HAMILTON GROUP (Erian Series)

CAZENOVIA STAGE

Marcellus Formation (230 ± 15 m ≅ 755 ± 60 ft.) Divisible into following subunits:

Ds **Solsville Sandstone** (90 ± 5 m ≅ 300 ± 20 ft). Brown-weathering gray, fine to medium grained sandstones with interbedded argillaceous siltstones and silty shales; sandstones predominant in the upper one-third of the unit. Brownish-orange iron oxide staining is locally common. Scarce plant fossils and pelecypods. Locality 25.

365 my

Fair to good foundation for heavy structures; cut slope stability generally good; joints may require bolting; excavation requires blasting; drilling rates moderate; machine tunneling rates expected moderate.

Generally low yield aquifer; locally, some more porous beds provide adequate domestic supplies; water may have high iron content.

Used for road aggregate, rip-rap, and fill.

Dot **Otsego Shale** (75 ± 5 m ≅ 250 ± 20 ft). Light brown-weathering, light gray, slightly calcareous, silty mudstone and shale with a few argillaceous siltstones and sandstones near top of unit. Rare brachiopods and pelecypods. Gradational with Chittenango Shale below.

Dch **Chittenango Shale** (55 ± 5 m ≅ 180 ± 20 ft). Non-calcareous, light gray grading downward into black, fissile shale; locally slightly silty and micaceous. Diminutive pelagic fauna of tentaculitids and styliolinids; other fossils extremely rare. Abrupt contact with Cherry Valley Limestone below. Locality 24.

Dcu **Cherry Valley Limestone** (1-2 m ≅ 3.5-6 ft). Cream-weathering, black, fine-grained, bituminous, limestone; massive, compact. Locality 24. Diminutive fauna of brachiopods, pelecypods, ostracodes, and conodonts; characterized by coiled and straight cephalopods, chiefly *Agoniatites vanuxemi* and *Striacoceras*, and the trilobite *Proetus haldemani*. This unit may form terraces.

Union Springs Shale (7-8.5 m ≅ 23-28 ft). Slightly calcareous, black, fissile shale with a few thin beds of hackly, bituminous limestones that are fossiliferous; shows evidence of compressive stresses with disturbed shaley bedding and "pseudo-cleavage" as well as disoriented ellipsoidal calcareous concretions, often with barite or siderite centers; note exposure along county road, paralleling U.S. 20, northeast of Cherry Valley (Locality 24). Pelagic fauna of tentaculitids and styliolinids in shales and the ammonites *Cabrieroceras plebeiforme* and *Parodiceras discoideum* in limestones; benthonic fauna of corals, trilobites, pelecypods in limestones. Abrupt contact with Onondaga Limestone below.

Ds / Dot / Dch / Dcu

Fair to poor foundation for heavy structures; commonly rippable, although explosives needed for more competent limey or sandy beds; drilling rates usually fast, slower in relatively thin Cherry Valley Limestone; black shales may deteriorate when exposed to atmospheric moisture in excavation; cut slope stability fair to poor, rock may be abundantly jointed.

Poor aquifer, generally very low water yield; water may have high iron content.

Used for fill.

(no group name)

Onondaga Formation (35 m ≅ 115 ft). Divisible into following subunits (in descending order) with varying degrees of difficulty: (Localities 21, 23).

370 my

Donu **Seneca Limestone** (1.2-1.8 m ≅ 4-6 ft). Very light gray weathering, dark gray to black, massive, fine grained argillaceous limestone; characterized by brachiopods, chiefly *Atrypa*.

SOUTHWOOD STAGE

Tioga Bentonite (7.5-17.8 cm ≅ 3-7 in). Cream-colored, sticky clay; where exposed (rarely) produces a deep re-entrant (see exposure east-northeast of Cherry Valley along U.S. 20, 0.8 km ≅ 0.5 mile from the Cherry Valley Limestone cut mentioned previously). The Tioga is a volcanic ash.

Moorehouse Limestone (23-25 m ≅ 75-80 ft). Light to medium gray weathering, medium to dark gray, medium-bedded, fine to medium grained slightly argillaceous limestone characterized by nodules and nodular beds of dark gray to black chert. Fossils are chiefly brachiopods, gastropods, corals, trilobite fragments, and crinoid columnals.

Nedrow Limestone (2.5-4 m ≅ 8-13 ft). Medium to dark gray weathering, dark gray, argillaceous limestone; tends to be thinner bedded than overlying and underlying units with which it is gradational. Characterized by platyceratid gastropods and phacopid trilobites.

Donl **Edgecliff Limestone** (4.5-6.5 m ≅ 15-22 ft). Medium to dark gray weathering, light to medium gray, medium to coarse grained limestone characterized by nodules and nodular beds of light gray to cream-colored chert and profuse, often silicified, colonial and solitary rugose and tabulate corals; lower 0.3-1.8 m (1-6 ft) finer grained and non-cherty. The Edgecliff and Moorehouse Limestones may, collectively or separately, form terraces.

Donu / Donl

Generally very good foundation for heavy structures; site should be explored for sinks or cavities in rock; cut slope stability good, excavation requires blasting; drilling rate cyclic, moderate to slow in cherty members; machine tunneling rate expected to be slow to very slow in cherty units.

Generally poor aquifer with low water yields; locally, open fractures may provide adequate or large domestic supplies; water hard.

Selected members used for high-friction aggregate; used for road aggregate, rip-rap. Formerly used for building stone and railroad ballast.

unconformity

LOWER DEVONIAN TRISTATES GROUP (Ulsterian Series)

SAWKILL STAGE

Dceo **Carlisle Center Formation** (13 m ≅ 42 ft). Buff-weathering, light gray to tan, uniformly thin-bedded, calcareous, argillaceous, siltstone; green glauconite commonly present at upper contact. Bedding planes covered with "rooster-tail" markings, presumed to be feeding trails of the worm *Zoophycos (Taonurus) caudigalli.* Abrupt contacts with Onondaga Limestone above and Esopus Shale below. (Localities 21, 23)

Esopus Formation (5.2 m ≅ 17 ft; 15.5 m ≅ 50 ft along I-88 east of Cobleskill). Dark brown-weathering dark gray to black, medium to thin bedded, compact heavily chertified argillite with dark gray shale interbeds; the blocky argillite exhibits conchoidal fracturing and contains poorly preserved silicified brachiopods and gastropods. Locality 23.

Dceo

Fair to good foundation for heavy structures; cut slope stability fair, may require bolting; drilling rate moderate in upper unit, cyclic fast in shaley Esopus to slow in lower cherty Esopus; rock may be rippable in shallow excavations.

Poor aquifer with very low water yields.

Used for fill; Esopus has potential for light weight aggregate production.

DEERPARK STAGE

Oriskany "Sandstone" (0.4-0.6 m ≅ 1.5-2 ft; 2.5 m ≅ 8 ft along I-88 east of Cobleskill). Actually a medium gray weathering, light bluish-gray limestone with large spherical frosted quartz grains "floating" in the lime matrix. Contains the large brachiopods, *Acrospirifer*, *Costispirifer*, *Hipparionyx*, and *Rensselaeria*, as well as gastropods. Locality 23. A light brown weathering, very fossiliferous, calcareous siltstone along I-88, south of Howe Caverns.

385 my

Too thin and localized to have economic significance.

unconformity

LOWER DEVONIAN HELDERBERG GROUP

HELDERBERGIAN STAGE

Db **Becraft Limestone** (0-2 m ≅ 0-7 ft; 5.5 m ≅ 18 ft along I-88 east of Cobleskill). Medium gray-weathering, light gray to tan, medium to thick bedded, coarse grained, fossil-fragmental limestone. Replete with crinoid columnals and other parts as well as the unique crinoid base *Aspidocrinus scutelliformis;* uncinulid brachiopods are also a major element of the fauna. The Becraft is well exposed in the extreme southwestern corner of the Carlisle quadrangle and extreme southeastern corner of the Sharon Springs quadrangle; the unit is unknown west of Sharon Center.

Too thin within the mapped area to have economic significance.

New Scotland Limestone (0-9 m ≅ 0-30 ft). Thin bedded argillaceous limestones interbedded with calcareous shales; very fossiliferous. Poorly exposed in terrace face below Becraft Limestone, southeast of Sharon; better exposed to the southeast of the mapped area.

Dk **Kalkberg Limestone** (12-17 m ≅ 40-55 ft). Light to medium gray weathering, medium to dark gray, thin to medium bedded, siliceous limestones with calcareous shale interbeds; characterized by pods and beds of dark gray chert; a 2-3 cm bentonite (volcanic ash bed) occurs along the south side of U.S. 20 at the overpass for the abandoned Cherry Valley railroad. This has been radiometrically dated (Rb-Sr) as 395 million years old. The Kalkberg contains abundant and varied fossils, dominated by brachiopods, bryozoans, and crinoid columnals. Terraces are commonly produced by the relatively resistant Kalkberg. Localities 23, 26.

Fair to good foundation for heavy structures; cut slope stability good; excavation requires blasting; drilling rate fast in New Scotland, cyclic moderate in non-cherty beds to slow in cherty Kalkberg; machine tunneling expected to be slow in Kalkberg.

Non-porous rock, generally low to very low water yield, locally open joints may provide adequate domestic supply. Water hard.

Used for fill; possible use for high-friction aggregate.

W E — Db / Dk / Dm / Dc / Dm

Dc **Coeymans Limestone** (14-31 m ≅ 45-102 ft). Medium to dark gray weathering, light to medium gray, medium to thick irregular bedded, medium to coarse grained, locally fossil-fragmental, limestone; depressions (sink holes) caused by solution and collapse are frequent. The Coeymans is moderately fossiliferous characterized by the pentamerid brachiopod *Gypidula coeymanensis* and crinoidal debris. The thickened Coeymans (Ravena Member) splits along the Judd's Falls Valley into a lower (Dayville Member) and upper (Deansboro Member) Coeymans separated by an upper Manlius (Clarksville-Jamesville Members) westward to the Syracuse region. Locality 22.

Dm **Manlius Limestone** - Thacher Member (9-14 m ≅ 29.5-46 ft). Very light gray to white weathering, dark gray to black, thin to thick bedded, fine to medium grained limestone with rare calcareous shale interbeds and rare cross-bedding in the thicker, coarser beds; the thinner bedded (ribbon limestones) and blocky medium bedded layers break with a conchoidal fracture and "ringing" sound. Fossils are abundant but only a few species are represented; cabbage-like stromatoporoid blanket reefs and baffles are locally present at the top of the unit; the tentaculitid *Tentaculites gyracanthus* and the ostracode *Hermannina alta* are ubiquitous in the ribbon strata, together with rare edrioasteroids; small, spiriferid brachiopods *(Howellella vanuxemi)* are scattered throughout the unit. Localities 22, 28.

Very good foundation for heavy structures; sites must be explored for sinks or cavities in rock; depth of weathering, variable with pinnacled surface possible; cut slope stability good, excavation requires blasting; drilling rate moderate; potential for machine tunneling good.

Non-porous rock, however, open joints and cavities frequently provide moderate to high water yields; water hard.

Combined with other Helderberg units, used in production or Portland Cement; Coeymans suitable for road aggregate, rip-rap and building stone; Manlius and Coeymans used for agricultural lime. Formerly used for building stone and railroad ballast.

400 my

UPPER SILURIAN (Cayugan Series)

Sr **Rondout Formation** (12-13 m ≅ 40-43 ft). The type Rondout of the Hudson Valley is divisible into many units, all with reported Late Silurian fossils. In this area, and to the west, the Rondout is divisible into an upper Chrysler Member and a lower Cobleskill Member. The Cobleskill is unquestionably Late Silurian; the Chrysler has not yielded any diagnostic fossils, it may be latest Silurian or earliest Devonian; here, I choose to regard it as Late Silurian.

Sr / Sb

Fair to good foundation for heavy structures; cut slope stability good; excavation requires blasting; drilling rate moderate; potential good to fair for machine tunneling. Cobleskill Limestone may contain open cavities or sinks.

TURIN STAGE

Larrabee Limestone (0-4 m ≅ 0-15 ft). Medium to dark gray weathering, light to medium gray, coarse to very coarse grained, fossil fragmental limestone; locally crossbedded and conglomeratic with clasts of older Amsterdam, Lowville, or Tribes Hill Formation. Abundant nodules of the alga *Solenopora* exhibit a pseudo-conglomeratic appearance; remainder of fauna is principally a molluscan-brachiopod-crinoidal debris assemblage. Localities 17, 18.

445 my

Otb / gf / a / lo

Good foundation for heavy structures; depth of weathering variable; drilling rate moderate to slow, excavation requires blasting; cut slope stability good. except where shaley seams may dip into a cut.

Groundwater yields generally low to very low; water hard.

Used for road aggregate, rip-rap, and fill; Larrabee, Amsterdam, and Lowville formerly used for building stone and canal lock and viaduct construction. Because of purity, Lowville and Larrabee have potential for agricultural lime production.

a **Amsterdam Limestone** (0-3.5 m ≅ 0-11 ft). Light to medium gray weathering, dark gray to black, fine to medium grained, massive to irregular to lumpy bedded, conglomeratic limestone; locally contains blocks of Chuctanunda Creek Dolostone and small clasts of Lowville Limestone; has bentonite bed near top of abandoned quarry east of Manny Corners. Great abundance and variety of fossils: gastropods, brachiopods, trilobites, and horn corals are most profuse followed by ostracodes, colonial corals, bryozoans, and conodonts; occasional straight nautiloid cephalopods are found; the trilobite *Raymondites spiniger* and the corals *Lambeophyllum* and *Favistella* are characteristic. The Amsterdam is not certainly identified west of the I-90 roadcut near Fultonville. Localities 17, 18.

lo **Lowville Limestone** (0-1.8 m ≅ 0-6 ft). Chalk-white weathering, tan to light gray ("dove"), fine grained, conchoidal-fracturing, thin to thick bedded limestone with occasional mudcracks. Characterized by being riddled with vertical worm burrows *(Phytopsis tubulosum).* The early branch-like coral *Tetradium cellulosum* is locally abundant in the upper 30 cm (≅ 12 in) such as along Caroga Creek near the Palatine Church; other fossils extremely rare. Has a very patchy distribution beneath the Amsterdam or, in its absence, the Glens Falls. Localities 2, 8, 17.

450 my

unconformity

LOWER ORDOVICIAN BEEKMANTOWN GROUP (Canadian Series)

GASCONADE STAGE

Tribes Hill Formation (7-70 m ≅ 23-230 ft). Thins westward and northward; divisible into:

490 my

Occ **Chuctanunda Creek Dolostone** (0-20 m ≅ 0-65 ft). Buff to tan weathering, light bluish-gray, medium to thick bedded, fine to medium grained dolostone with erratic distribution of bluish-gray to white chert; locally very vuggy with crystals of dolomite, calcite, and, rarely, quartz and anthraxolite. Possesses dolomitized algal mounds or "hippopotami" backs and "ghosts" of loosely coiled gastropods (probably *Ecculiomphalus*). Has very irregular distribution, reflecting the relief surface atop the Tribes Hill Formation. Absent west of Nelliston-Fort Plain. Localities 9, 19.

W E — Occ / Ocr / Ofw / Opb / Ofj

Ofw **Fonda Limestone** (0-7 m ≅ 0-23 ft). Vari-colored weathering, light to dark gray colors; principally mottled calcitic dolostone with thin seams of coarse grained, light gray, glauconitic, pyritic, oolitic, pebbly limestones with much quartz sand. Most fossiliferous portion of Tribes Hill Formation with clam-like ribeirids exceedingly abundant, followed by gastropods *(Ophileta, Gasconadia, Ecculiomphalus, Raphistomina),* cephalopods *(Clarkeoceras, Ellesmereoceras, Walcottoceras),* trilobites *(Asaphellus, Clelandia parabola, Hystricurus ellipticus, Symphysurina),* and conodonts. Localities 9, 13, 14.

Wolf Hollow Limestone (0-8.5 m ≅ 0-28 ft). Mottled, fretwork-weathering (dolomite weathers, in relief, tan while calcite weathers white), massive, compact, dark gray to black, dolomitic limestone; exhibits conchoidal fracture; a single 4-foot bed of dolostone three feet above the base is traceable throughout most of the Mohawk Valley. Fauna scarce, mainly straight and slightly curved nautiloid cephalopods *(Ellesmereoceras, Ectenoceras, Clarkeoceras),* tight *(Ophileta)* and loosely *(Ecculiomphalus)* coiled gastropods, and worm burrows. The Wolf Hollow commonly forms the caprock of waterfalls. Gradational contact with overlying Fonda Member but sharp contact with underlying Palatine Bridge Member. Localities 9, 11, 13, 14, 16, 19.

Good foundation for heavy structures; footing sites should be explored for open joints or cavities; depth of weathering variable; drilling rate generally moderate, excavation requires blasting; cut slope stability generally good, joints may require some bolting.

Groundwater yields are generally good for domestic or small commercial supplies, but can vary locally, depending upon location of open joints and cavities; water is hard and may contain minor hydrogen sulfide.

The Wolf Hollow and Fort Johnson members have been used extensively in the past as a building stone and in canal lock and viaduct construction; except for the shaley Palatine Bridge Member, all members have been used for rip-rap; the Cranesville and Chuctanunda Creek Members are used for high-friction road-aggregate, railroad ballast, and fill.

Ocr **Cranesville Dolostone** (0-15 m ≅ 0-50 ft). Medium gray to tan weathering, light to dark gray, medium to thick bedded, medium to coarse grained, dolostone with locally abundant light to medium gray chert. Rare "ghosts" of gastropods. The Cranesville, formerly regarded as a younger unit, has been demonstrated to be a dolomitic facies of the Fonda and Wolf Hollow Members. Localities 8, 17, 19.

NEW YORK STATE SCIENCE SERVICE
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THE UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
NEW YORK STATE MUSEUM

NEW YORK STATE GEOLOGICAL SURVEY
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unconformity

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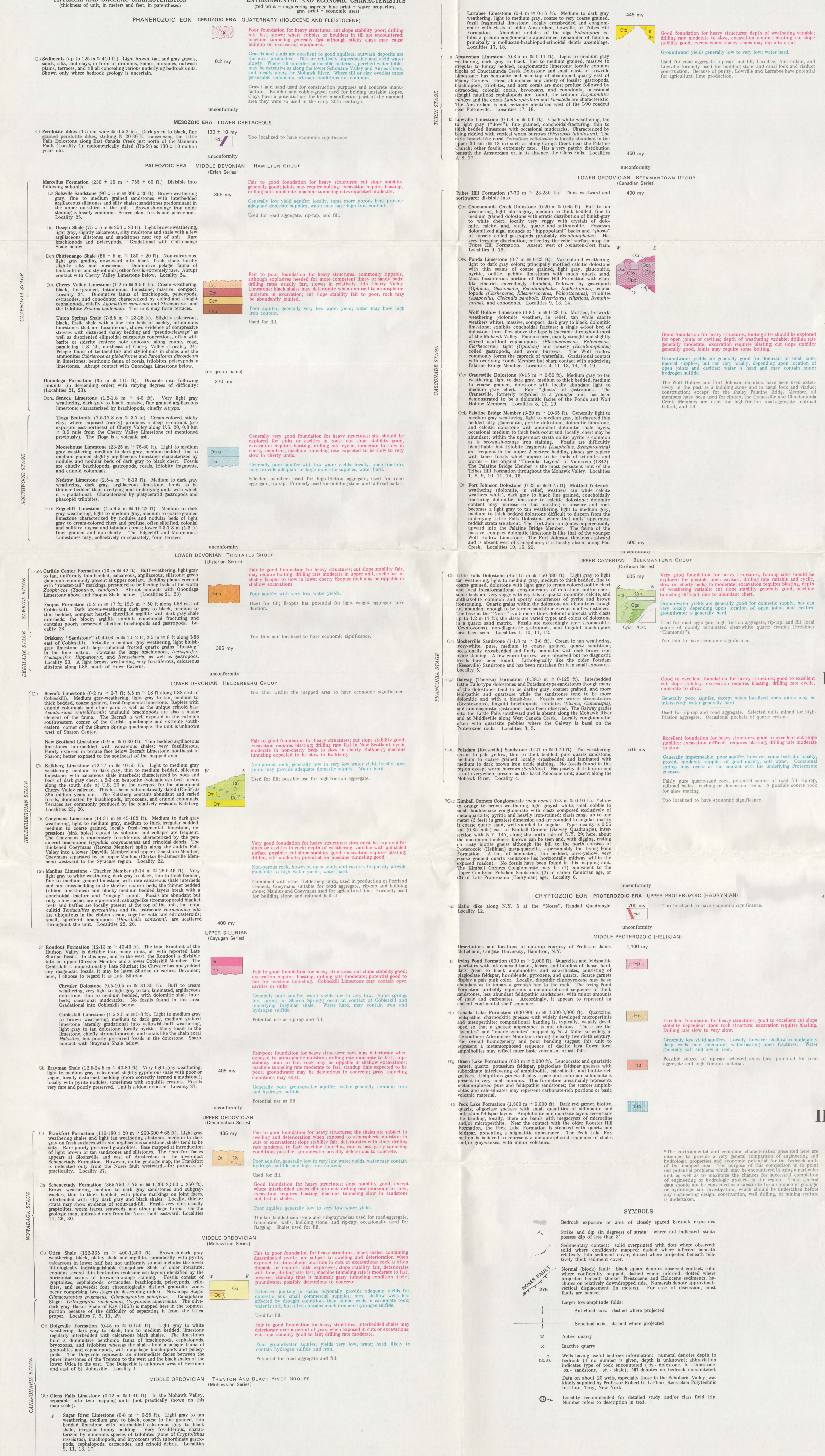
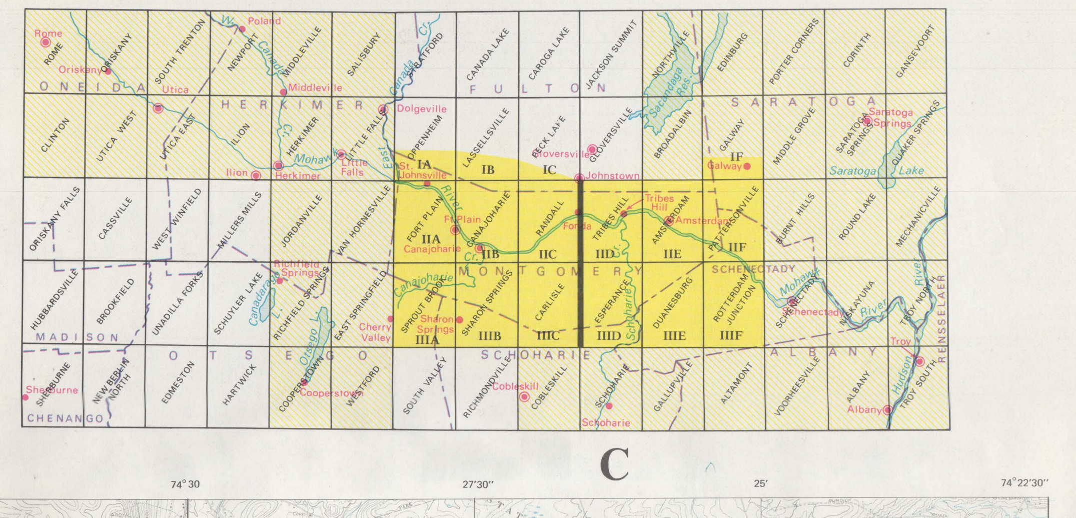


INDEX MAP



Bedrock geology mapped in this investigation; junction of western and eastern sheets shown by heavy black vertical line.

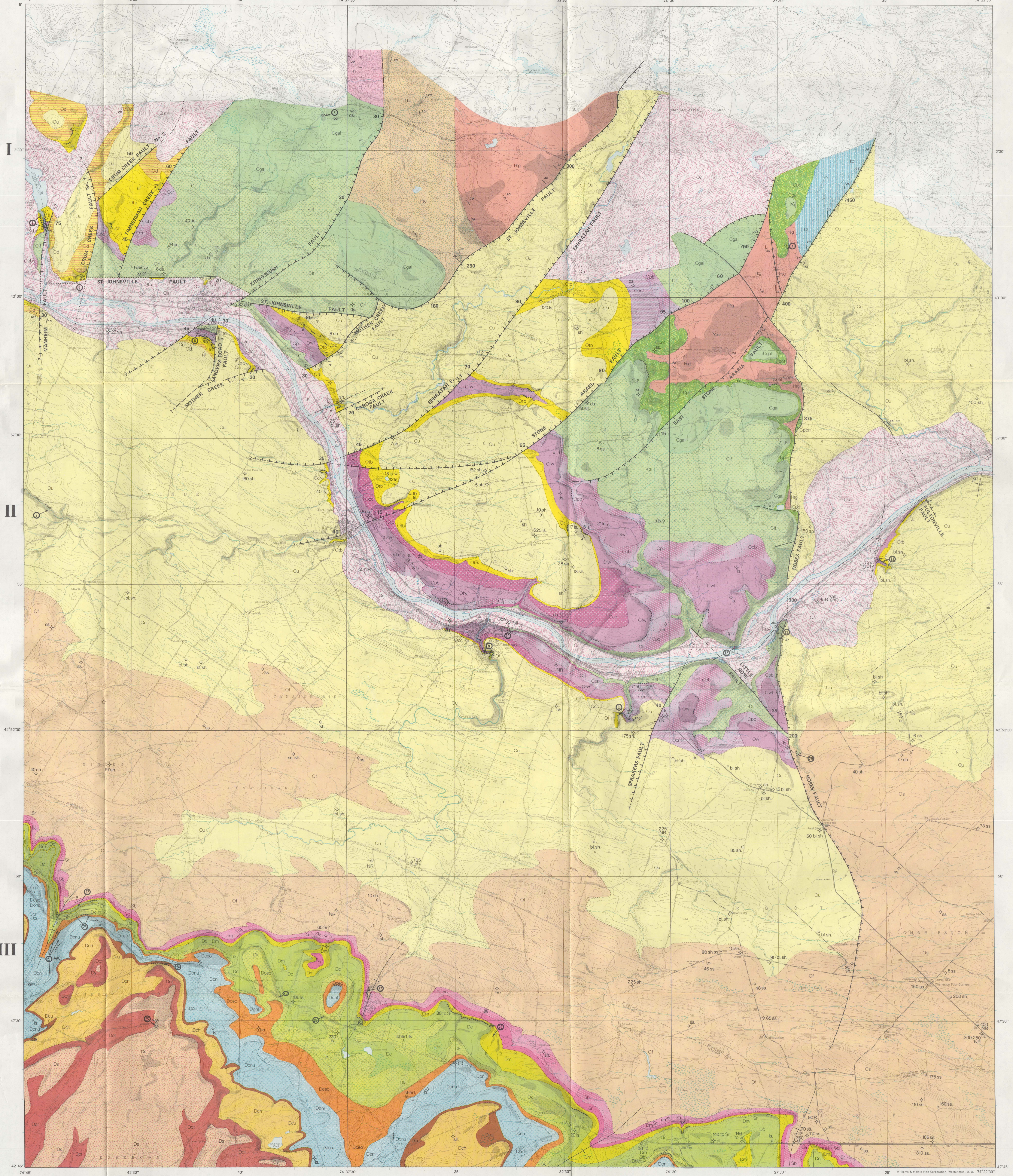
Bedrock geology previously mapped by other workers.

Bedrock geology unmapped.

Note: Code designation (IA, IB, etc.) refers to Roman numerals and capital letters on map margins.

SCALE 1:48000

CONTOUR INTERVAL 10 FEET



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Geology by D.W. Fisher
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Compiled 1978-79

BEDROCK GEOLOGY OF THE CENTRAL MOHAWK VALLEY, NEW YORK

(Western Sheet)

1980

Mapped area