GEOLOGY OF THE ERIE CANAL, ROCHESTER GORGE, AND EASTERN MONROE COUNTY, NEW YORK STATE: IN THE FOOTSTEPS OF AMOS EATON AND JAMES HALL

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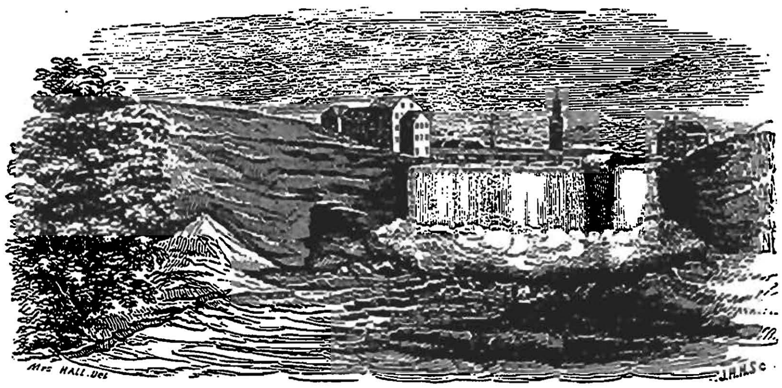

The Upper Falls at Rochester drawn by Mrs. James Hall (Hall, 1843, p. 82).

INTRODUCTION

The Phelps and Gorham Purchase, from the Seneca Nation in 1788, opened the lands west of Seneca Lake for settlement. Westward migration began as a trickle, but with the coming of the Erie Canal to the Genesee Country in 1822-23, a flood of immigration occurred that transformed western New York from dense forest to farmland, villages, and cities. For example, Rochester's first permanent settler did not arrive until 1812 while real growth blossomed in the 1820's. From the colonial period to the opening of the canal the west began at Schenectady.

The growth of geologic thought followed a similar pattern. A few random notices and sketches were made early on, primarily by army officers serving during the colonial wars and the Revolution. The Erie Canal changed all that. The surveys for the proposed project required organized, detailed, observations of the terrain and its underlying geology. Enter now DeWitt Clinton whose 1810 chronicle of a journey across the state, along with other writings, records numerous observations and interpretations of the geology from Albany to Buffalo. However, it wasn't until the seminal work of Amos Eaton (Father of New York Geology) in

1824 (*A Geological and Agricultural Survey of the District Adjoining the Erie Canal in the State of New York*) that a comprehensive and amplified attempt was made to unravel the superposition of western New York's strata. The foundation he laid ultimately led to the founding of the State Geological Survey in 1836. The following year James Hall came to the Genesee Country and examined its fossiliferous strata. Hall's work from 1837 to 1843 finally unraveled the stratigraphic column of western New York as we know it today, save for some modern refinements.

This paper attempts to show the evolution of geological investigations in Eastern Monroe County and Rochester as revealed in the writings and quotations of Amos Eaton and James Hall. The Erie Canal, its history and geology, and the geology of the Rochester Gorge are equally main themes as they provided the framework for the development of geologic thought.

In 1826 Amos Eaton led an expedition by canal boat across New York State. The surviving journals of two of the participants, George W. Clinton and Asa Fitch, provide unique insights into the state of geological knowledge, the nature of the landscape, and human development in the region at that time. These are quoted throughout the text but more liberally so in the roadlog. The writings of James Hall and to a lesser extent Sir Charles Lyell, are included to illustrate the degree of scientific advancement in the score or so years following Eaton's labors.

The paper is divided into five major subdivisions including the roadlog. The life, geological thoughts, and contributions of Amos Eaton is followed by a section on James Hall which contains a brief description of the rise of the New York State Geological Survey. The middle portion is devoted to the history and geology of the Erie Canal and its impact on New York State. With all of the historical perspectives in place the paper proceeds to the site specific, fourth, section - a discussion of Rochester and the Rochester Gorge. Finally the roadlog and boat trip is devoted principally to retracing the route of Amos Eaton's 1826 tour to the Rochester Gorge. The journal entries of the participants illuminate what travel was like at that time as well as highlighting Eaton's personality and ideas. Here Eaton's geology is contrasted with that of James Hall along with today's interpretation of the stratigraphic sequence and glacial topography. Hall's ideas are revealed in his 1837 field notebooks housed in the New York State Library in Albany and of course his monumental 1843 *Survey of the Fourth Geological District.*

AMOS EATON

Amos Eaton (Figure 1) was born in 1776 at New Concord, New York in the Taconic Mountains of Columbia County and died at Troy in 1842. He attended Williams College in western Massachusetts and graduated in 1799. Eaton eventually moved to New York City in 1800 to study law, where he became acquainted with and studied under two of the scientific leaders of the day, David Hosack and Samuel L. Mitchell. Under these men Amos Eaton's fervor for natural science was first nurtured. Details of Amos Eaton's life and his labors on New York geology may be found in McAllister's (1941) comprehensive biography, Wells'

FIGURE 1 Portrait of Amos Eaton (N.Y. State Library)

(1963) treatise on early geological investigations in New York State, and Fisher's (1978) synopsis of early New York geologists.

In 1802 Eaton was admitted to the bar and began working as a land agent for John Livingston, a wealthy land owner of Schoharie and surrounding counties. In 1804 Eaton quit his post with Livingston and moved to Catskill, New York to manage the 5,071 acres he purchased with his father the previous year and to establish his personal land agency. Eaton prospered in Catskill for several years when in September, 1809 he was falsely accused and indicted for forgery. Eaton was then 33 years old. The case against him eventually led to another more damaging suit in 1811 that resulted in bankruptcy that year and a trial on 26 August 1811 in Catskill. The jury returned a guilty verdict and Amos Eaton was sentenced to the state prison at hard labor for the rest of his life.

The state prison at that time was located in what is now Greenwich Village in New York City, on the banks of the Hudson at, ironically, Amos Street (McAllister, 1941 p. 142). While in prison Eaton continued his pursuit of scientific knowledge by studying botany and geology. In addition he met many influential people, not the least among them being DeWitt Clinton the mayor of New York and John Torrey the future eminent botanist. John Torrey, then a teenager, was the son of William Torrey the state prison agent. From his lengthy visits with

Amos Eaton, John Torrey received his early instruction in botany. The younger Torrey, in time, convinced his father to help seek Eaton's release from prison.

After Eaton had languished in prison for four years, his friends finally succeeded in securing his release when Governor Daniel Tompkins granted a pardon on 17 November 1815 on the condition that Eaton leave the state within three months, never to return. Eaton was finally vindicated on 15 September 1817 when Governor DeWitt Clinton granted an unconditional pardon. Amos Eaton persevered through an economic and personal storm that would have crushed a lesser person and at the age of 40 life began anew. In the Spring of 1816 Eaton moved to New Haven, Connecticut and studied at Yale, under Benjamin Silliman. In 1817 he returned to Williams College where he lectured on mineralogy and was conferred a Masters of Arts degree on 3 September 1817. Twelve days later DeWitt Clinton issued his pardon. From 1817 to 1824 Eaton wandered through eastern New York and western New England as an itinerant lecturer, although from 30 April 1819 he made Troy, New York his lifetime residence when he settled on Second Street near Ferry Street (McAllister 1941 p. 193). He soon met and came under the patronage of Steven Van Rensselaer, the last of the great Dutch Patroons. With the Patroon's financial support Eaton began his New York geological studies in earnest and eventually, in 1824, founded the Rensselaer School, now Rensselaer Polytechnic Institute in Troy.

EATON'S GEOLOGY

Before Eaton, not much was known of New York geology. As Wells notes (1963, p. 25):

> "Geologic work in the Northeastern States might soon have reached a dead center of vague generalization and haphazard observation and remained there for years, had it not been for the impact in 1818 of the forceful and, to many, irritating character of Amos Eaton."

Up to this time only William Maclure and Samuel Latham Mitchell had made attempts at unraveling New York's stratigraphic sequence on a grand scale. Maclure introduced the Wernerian classifications to American geology, thereby hindering its progress for many years (Wells, 1963). Maclure, to a lesser degree Mitchell, and others had failed to realize the significance and importance of fossils in establishing chronology. Amos Eaton was no exception. Beginning with his earliest geological publication in 1818 on the geology of the northern states, and culminating in his two monumental works, the 1824 canal survey and 1830 textbook, Eaton never unraveled the regional superposition of New York's formations (Figure 2). This was due to his adherence to Wernerian doctrine and his failure to recognize the general southerly dip of strata striking east-west across central New York State.

James Hall (1843, pp. 5-7) summarized Eaton's labors on the geology of New York as follows:

"The name of the late Stephen Van Rensselaer will always be remembered with reverence by the American student of geology.....Through his munificence, Professor Eaton was enabled to make a very extended and systematic survey of the rocks of New York; [Geological and Agricultural Survey of the District Adjoining the Erie Canal 1824].....if.....somethings are not.....in accordance with recent discoveries.....at that period.....he was in fact describing rocks.....not understood in Europe...... Had he evinced still more independence of European classifications.....pursued the investigation.....to a more thorough detail; published sections illustrating the order of superposition....with their fossils so numerous and characteristic, he would have left an undying fame to himself and his noble patron. We can only regret that this was not done in the most extended and perfect manner.....

"In that work (Survey of the Canal Rocks),.....it is evident that the author was fully aware of the great extent of our undisturbed strata as compared with those of Europe. He remarks, that:

> "Our secondary rocks along the line are several hundred miles in extent, and remarkably uniform in their leading characters.
>
> "After examining our rocks with as much care and accuracy as I am capable of doing, I venture to say, that we have at least five distinct and continuous strata, neither of which can with propriety take any name hitherto given and defined in any European treatise which has reached this country. The late work of Phillips and Conybeare describes many of the beds, and some of the varieties found among the rocks referred to; but the nomenclature of these very able geologists cannot be adopted to our district, without mangling and distorting the unprecedented simplicity of our rock strata (Canal Rocks, pages 7-9).

"I quote this, to show that Mr. Eaton was aware that the names and arrangement adopted in the systems of European authors did not apply to the rocks of New York; and yet, most fatally he attempted to apply that arrangement as far as possible, all the time supposing himself to be investigating rocks of the same age, while in truth they were much older than any described by the authors quoted. This attempt.....arose from the general belief that the older or Transition strata were in a highly disturbed and altered condition.....thus when so great a range of undisturbed strata, abounding with organic remains, was presented, as along the line of the Erie Canal, it was quite natural to refer them to the secondary deposits; ....

> "Having been a pupil of Prof. Eaton in the Rensselaer Institute, and receiving there my first instruction in Geology, it was natural to speak of him and his labors, as a tribute of respect as well to himself as to Mr. Van Rensselaer....."

Amos Eaton's canal survey of 1824 was his major achievement up to that time. The Erie Canal provided ease of travel, new exposures, and ready access to distant localities which were paramount in Eaton's construction of a framework and foundation for his geologic interpretations. In short, the Erie Canal resulted in the first geological survey of the state. This survey produced Eaton's (1824) cross section along the canal route from Boston to Lake Erie, but culminated in his 1830 textbook containing the first geologic map of New York State as a unit. In the 1820's and 1830's, the Erie Canal was a focus for geological work in New York, before the beginning of the New York Natural History Survey in 1836.

Eaton's theory of New York geology gradually emerged to embrace a concept of alternating episodes of non-marine and marine deposits (Figure 2). He divided the New York column into five series, each one bearing a cyclic sedimentary package of isochronous transgressions and regressions, beginning with a carboniferous unit, succeeded by a quartzose, and terminating in a calcareous deposit. According to Eaton, as the seas withdrew, land plants would occupy the emerged terrain. The ocean, when it returned, buried the plants to form his carboniferous formations, usually dark to black shales or perhaps even coal measures, at the base of each series. These units were generally his argillites or slates. The suprajacent deposit of the transgressing ocean would be coarse clastics or his quartzose formations, usually conglomerates and sandstones including red beds. He called most of these sequences graywackes. The continued flooding of the land culminated in the deposition of his calcareous formations such as dolostones and limestones. The seas would withdraw and the cycle would then repeat itself in the next series. Figure 2 clearly reveals Eaton's ignorance of the true superposition, yet he was one of the first to recognize local facies changes when, in 1828, he thought that the Catskill redbeds passed westward into the gray shales and sandstones of central and western New York (Wells, 1963).

Eaton's contributions to New York geologic investigations, although primitive and often erroneous were none-the-less significant. He made basic stratigraphic errors, but we must remember that New York geology at that time was like a cryptogram yet to be translated. Amos Eaton made the initial attempts, and in so doing laid the foundation for the more refined stratigraphic studies which were to follow. His students, such as James Hall, would invest the strata with new meaning and interpretations, carrying on where he left off.

JAMES HALL

James Hall, the "patriarch of American Paleontology, geological organizations, and state surveys" (Fisher, 1978) was born in 1811 at Hingham, Massachusetts, on the South Shore of Boston Bay. This setting influenced his love for natural history as he became very interested in

Series	Formations		Approx. Present Equivalents	Age
Anamolous	Analluvion, Diluvion		Glacial drift	Pleistocene
Tertiary (Fifth Series)	5th calcareous 5th quartzose 5th carboniferous	Shell marl Marine sand marly clay, plastic clay	Coastal Plain Long Island	Cretaceous
Upper Secondary (Fourth Series)	4th calcareous	oolitic oolitic rocks - Ohio	Glacial erratics in Catskills	
	4th quartzose	Third graywacke	Olean Conglomerate Marine Catskill Beds "Chemung" (Canadaway-Conewago Grps.)	Pennsylvanian L. Devonian
	4th carboniferous	Pyritiferous slate	Tioga Coal Genesee to West Falls Grp. U. Hamilton (W.N.Y.S.)	Pennsylvanian L. Devonian M. Devonian
Lower Secondary (Third Series)	3rd quartzose calcareous	Corniferous limerock Geodiferous limerock	Lower Hamilton Grp. Onondaga Ls. Salina Grp. (W.N.Y.) Lockport Grp. Helderberg Grp. (E.N.Y.S.)	M. Devonian M. Devonian L. Silurian L. Silurian E. Devonian
	3rd quartzose subordinates	Lias Ferriferous rock	Salina Grp. (C.-E. N.Y.) Clinton Grp.	L. Silurian E.-L. Silurian
	3rd quartzose	Saliferous rock	Newark Series Catskill Redbeds Oneida Cgl.- Herkimer Ss. Medina Grp. (Grimsby) Queenston Oswego Ss. Upper Lorraine Grp.	L. Triassic- E. Jurassic L. Devonian E.-Silurian- L. Silurian E. Silurian L. Ordovician L. Ordovician L. Ordovician
	3rd carboniferous	Second graywacke	Anthracite- Carbondale Pa. Lower Hamiton-Catskill Front Lower Lorraine Grp. Utica	Pennsylvanian M. Devonian L. Ordovician M. Ordovician
Transition (Second Series)	2nd calcareous	Metalliferous limerock Claciferous sandrock Sparry limerock	Helderberg Grp. Trenton Grp. Black River Grp. Tribes Hill Little Falls Chazy Grp. Beekmantown Grp.	E. Devonian M. Ordovician M. Ordovician E. Ordovician L. Cambrian M. Ordovician E. Ordovician & L.M. & E. Cambrian
	2nd quartzose	First graywacke	Shawanqunk Cgl. Schenectady Snake Hill Taconic sequence	E.-L. Silurian M. Ordovician M. Ordovician
	2nd carboniferous	Argillite	Normanskill Taconic sequence	M. Ordovician Ordovician & Cambrian
Primitive (First Series)	1st calcareous 1st quartzose 1st carboniferous		Green Mts. Manhattan Schist High Taconics Berkshires Adirondacks Highlands of the Hudson	Ordovician Ordoiviian Cambrian Cambrian Precambrian

FIGURE 2 Amos Eaton's Synopsis of New York Rocks, 1830 with approximate present equivalents.

[T.X. Grasso Drafted by: Richard D. Hamell, July 21, 1994]

During his tenure as State Geologist and as State Paleontologist, which lasted until his death in 1898, Hall continued to work on the stratigraphy of Western New York State. Much of this work was done in the "Genesee Country", as the area west of Seneca Lake was known, particularly in Monroe County. Hall named the Lockport Limestone, Rochester Shale, and Medina Sandstone with illustrations to clarify the stratigraphy, including the first vertical section showing relative thickness of formations drawn for the New York State Survey (Aldrich and Leviton, 1987). Another illustration was a map of the Genesee River with formations marked along its banks. This stratigraphy, with formational boundaries clearly marked, became incorporated into the New York System, the North American equivalent to the Silurian and Devonian Systems of Europe. The other State geologists eventually followed Hall's idea of using geographic localities for formation names, rather than the more colorful, lithologic terms of Eaton and others, although the New York System was dropped as correlations with the Silurian and Devonian of Europe became clearer.

Charles Lyell visited New York in 1841. He and Hall traveled the Erie Canal, examining outcrops along the way. Although Hall had little to do with the development of the Erie Canal, he was very critical of the financial waste in construction caused by choosing low quality rocks for building its locks, aqueducts and culverts. They also toured the Genesee River Valley, but little information exists of any impact Lyell had on Hall in this region. However Lyell, became much enamored with Niagara Falls, thereby leading Hall to devote considerable space to them in his final report. Hall also supported Lyell's idea that the surficial deposits of the region were the result of materials dropped in the sea by icebergs and swirling ocean currents. Early New York State geologists did not adopt a glacial theory for these drift deposits although Louis Agassiz had proposed the notion of glaciation (1837) in Europe (Aldrich and Leviton, 1987).

During his tenure as State Geologist and State Paleontologist, James Hall did much to promote the paleontology and stratigraphy of Western New York and laid the groundwork for future research in this region. For a more complete look at the life and contributions of James Hall see J. M. Clarke's biography of his mentor (1921).

ERIE CANAL HISTORY AND GEOLOGY

INTRODUCTION

The old Erie Canal (Figure 5) was not the first canal constructed in North America or even New York State, but it was by far the most successful. This is evidenced by the simple fact that one can still go by canal from Buffalo to Albany, across the state, albeit in a different location for much of the distance. The Erie Canal is still operating. This cannot be said of the Pennsylvania, New Jersey, Virginia and other state canals that attempted to link the interior of the continent with the eastern seaboard. The Erie Canal pierced the wilderness of nineteenth century New York State, transforming a sparsely populated hinterland of impenetrable forests into a line of burgeoning metropolitan complexes. As an alternative to the tortuous overland journey west, it opened the mid-continent of North America to a flood of migration and settlement.

Yankee, not Irish laborers, constructed the original canal, using teams of horses drawing scrapers and scoops, shovels, wheelbarrows and certain makeshift tools invented as the need arose. One such elegant device was a contraption to pull tree stumps out of the ground, as shown in Figure 6. Workers completed the 363 mile long canal in eight years. Syracuse, Buffalo, and many smaller communities either grew dramatically or came into existence as a result of the canal.

The original Erie Canal cost $7,143,789.86, well above the engineers' estimate of $4,881,738 (Whitford, 1906). However, in 10 years, from the tolls generated, it repaid all construction costs, including principal and interest on the loan, paid all maintenance and repair costs, and showed a profit. The State has apparently never surpassed this remarkable undertaking. Shipping costs were cut 80-90 percent, and the trip from New York City to Buffalo was reduced from a month to about two weeks. It was these economic incentives which inspired the novel idea, but also underlie its success.

FIRST CANALS IN NEW YORK STATE

In March 1792, an act of the legislature established two private canal companies -the Western Inland Lock Navigation Company (W.I.L.N.) and the Northern Inland Lock and Navigation Company (N.I.L.N.) - apparently brought to fruition by Elkanah Watson, a former assistant to Benjamin Franklin (Whitford, 1906). Watson was a friend of George Washington, from whom he probably acquired his passion for canals. General Philip Schuyler, a prominent member of the Senate, was instrumental in obtaining the law that created the two lock-navigation companies.

Although both companies were private stock ventures, each was linked with the state through monetary gifts, loans and purchases of stock. The Northern Company, incorporated to facilitate a water communication between the Hudson River and Lake Champlain, accomplished nothing beneficial while somehow expending $200,000. The Western Company, as shown on Figure 7, succeeded in making modest improvements in the Mohawk River Valley by constructing a mile-long canal with five locks around the falls at Little Falls (1795) and another two-lock canal connecting the Mohawk River with Wood Creek at Rome (1797). It also built a short canal around two rapids in the Mohawk River east of Herkimer (1798) and made minor improvements in Wood Creek (1793, 1803). After the year 1800, however, the canals fell into general disuse and after 1803 the company faded into oblivion.

The demise of the private navigation companies stemmed from high tolls, wasteful management, lack of experience and a host of other factors, one of the most significant being that short canals offered only a partial solution to the problems of inland water navigation. In fact, the failures of the lock navigation companies set the canal movement back 15 years as opponents of the Erie pointed out the futility of building a canal 363 miles long through

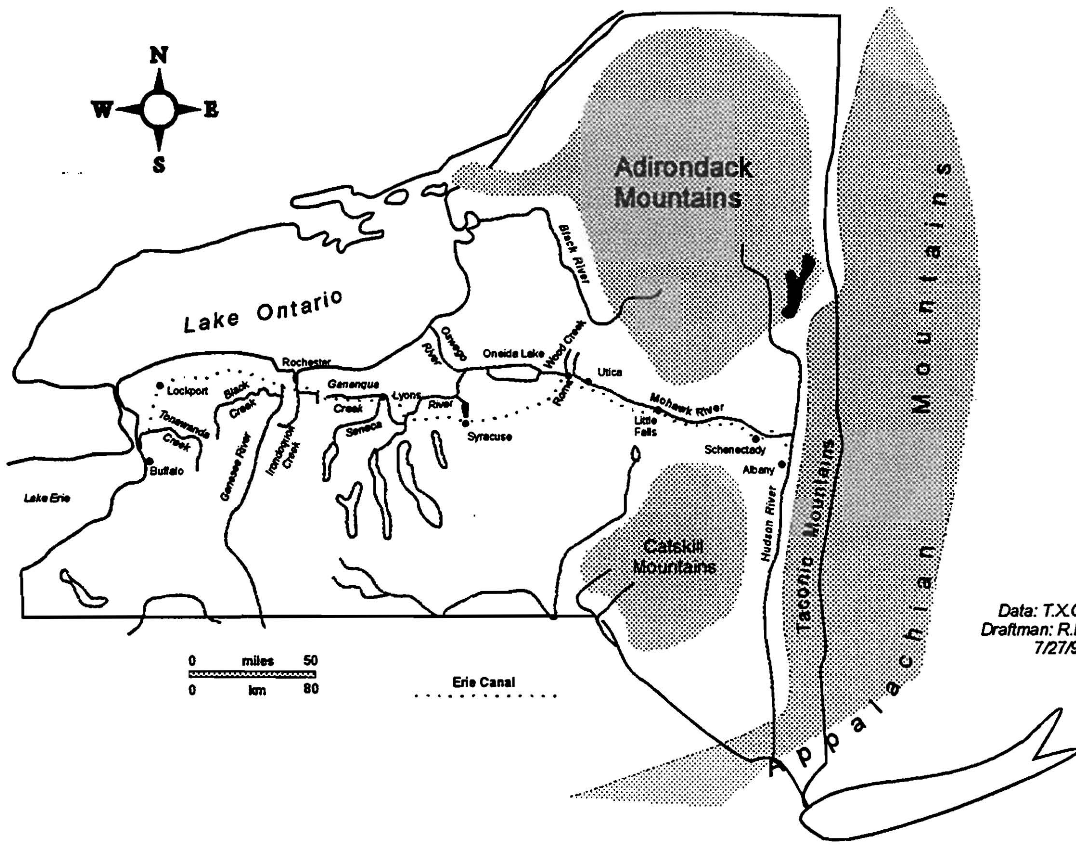

Figure 5 Location map of Erie Canal (dotted line) and neighboring highlands.

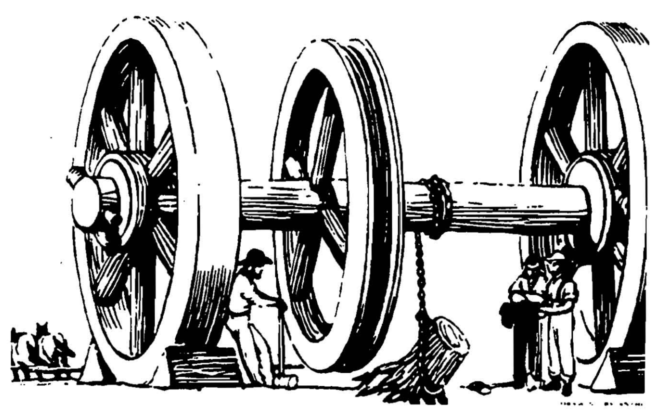

Figure 6 Device to grub stumps (from Andrist, 1964, p. 453; drawing by Anthony Ravielli)

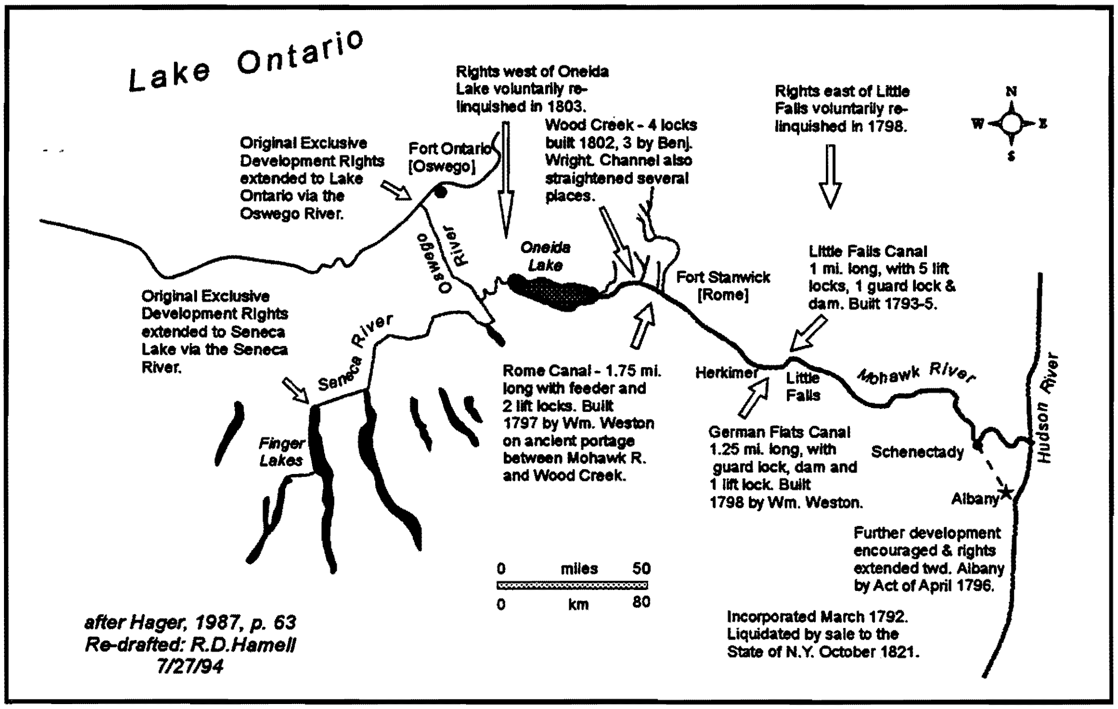

Figure 7 Map showing developments of the Western Inland Lock Navigation Company

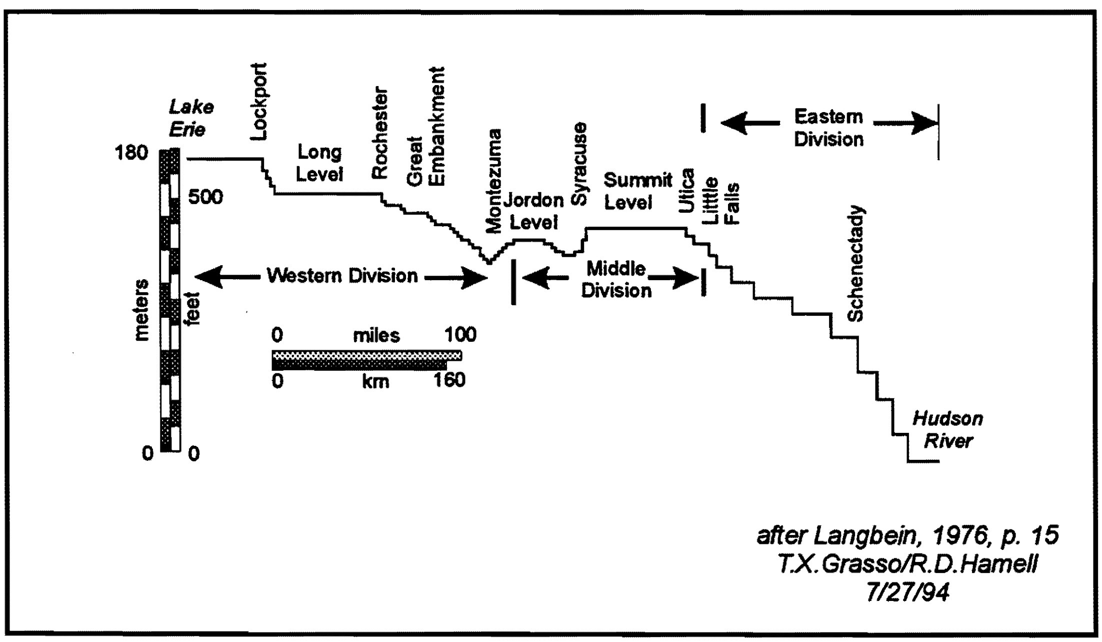

Figure 8 Profile of the Erie Canal

unquestionable authority, that the reports that had been so industriously circulated, respecting the sickness and death of many of the workmen on the Montezuma Marshes are entirely unfounded."

Clinton's Ditch crossed the Seneca River on grade, the towpath being carried across the river on a bridge supported by 130 bents (frames). To obviate the difficult grade crossing in the first enlargement, Van R. Richmond designed and built the great Montezuma Aqueduct. Work began in 1849 and it was brought into use in the spring of 1856. The stone aqueduct rests on a wood foundation floor, covering an area of approximately two acres, supported by 4,464 bearing piles from 15 to 30 feet long (4.5 to 9 m). The aqueduct had 31 towpath arches and was 841 feet long, the second longest aqueduct on the Erie Canal. The central portion was dismantled in the winter of 1917-1918 to free the Seneca River for Barge Canal traffic.

Genesee-Irondequoit Valleys

The route of the canal west from Montezuma lay up the valley of the Clyde River to Lyons. From here it ascended the tributary Ganarqua (Mud) Creek, the shallow draft navigable headwaters of which are found at Palmyra. These are misfit streams that occupy a plexus of abandoned meltwater channels collectively known as the Fairport Channels. The Fairport Channels drained proglacial Lake Dawson in the Rochester region, carrying its waters and all the Great Lakes drainage east to Lyons where it emptied into an early Lake Iroquois. These channels cut a swath through the drumlin belt, permitting a low gradient path for the canal.

The preglacial course of the Genesee River led east from Rush then north through what is now the Irondequoit Valley. Near Rochester, Lake Dawson ranged from 483 feet (147 m) elevation to 462 feet (141 m). Details of the glacial lakes succession in the Genesee Valley region may be found in Muller, et. al (1988). Lake Scottsville occupied the Genesee Valley south to Avon at the same time as Lake Dawson's waters existed over the northern part of Rochester. Lake Scottsville at an elevation of 540 feet (165 m) was dammed at its northern margin by the Pinnacle Hills moraine along the southern margin of Rochester. Lake Scottsville waters drained north across the Pinnacle Hills moraine because the eastward leading leg of the old channel was plugged with glacial deposits. However the north-south portion of the preglacial valley was scoured into a deep U-shaped trough. The Genesee River, now flowing northward in a new postglacial course, began carving the Rochester Gorge when it encountered the Niagara Escarpment. Withdrawal of the ice margin farther north just over 12,000 B.P. permitted Lake Iroquois to expand westward to completely occupy the Lake Ontario basin. Lake Scottsville drained away and Lake Dawson rapidly lowered a total of 120 feet (37 m) to an elevation of 425 feet, the level of Lake Iroquois, the southern beach ridge of which is Ridge Road (NY 104).

The deep U-shaped trough of the preglacial Genesee, the Irondequoit Valley, was to be a dire hurdle. The canal commissioners wanted to maintain a profile that was downhill from Lake Erie to the Genesee River and as far east as Montezuma (Figure 8). Luckily, east of Pittsford near Bushnell's Basin (Figures 10, 29), the valley was occupied by a kame and esker

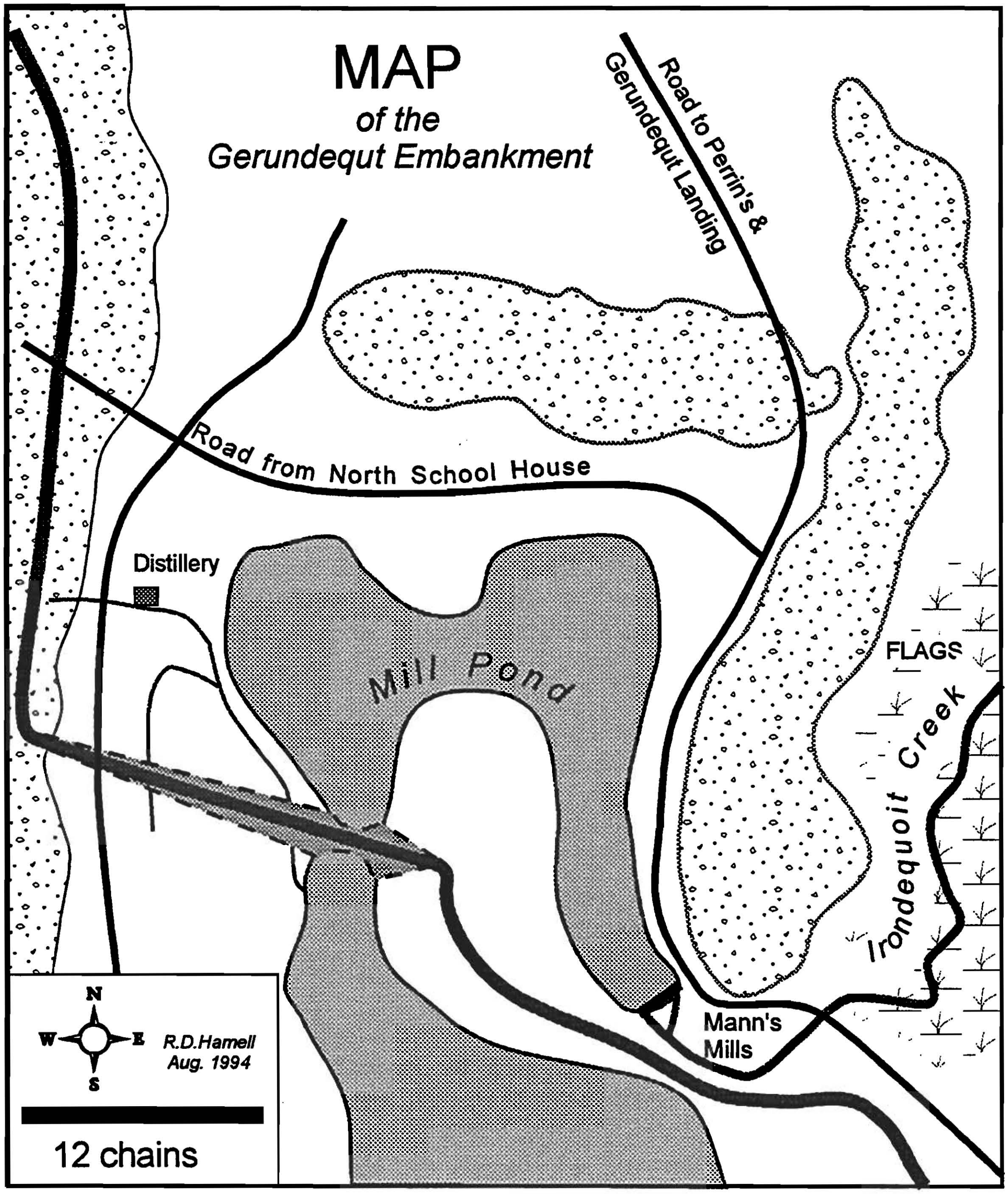

Figure 10

James Geddes' 1808 map of the Irondequoit Valley showing the proposed Great Embankment. The stippled patterns are the "ridges" of Geddes. The ones north of Mann's Mills and the loop in Irondequoit Creek show the Cartersville Esker. The canal eventually crossed the esker north of Mann's Mills.

(Map modified by R. D. Hamell)

complex the crests of which were all at the same elevation. The commissioners approved a scheme to connect the natural deposits with an artificial embankment which would carry the Erie Canal some 60 feet (18 m) over Irondequoit Creek. A culvert 240 feet (72 m) long and 17 feet (5 m) high was constructed to carry Irondequoit Creek beneath the embankment. The structure, which came to be known as the Great Embankment, was completed in 1822 and was heralded far and wide as one of the great engineering marvels of the Erie Canal (Figure 11).

James Geddes in his 1808 survey discovered the esker ("ridges" as he called them) when he wrote (Canal Laws, 1825, p.43):

> "...The passage of the Irondequoit Valley is on a surface not surpassed, perhaps in the world, for singularity. . . Those ridges along the top of which the canal is carried, are in many places of just sufficient height and width for its support, and for 75 chains the canal is held up, in part by them, and in part by artificial ridges, between 40 and 50 feet above the general surface of the earth; the sides of them are in most places remarkably steep, so that when the work is finished, the appearance to a stranger will be that nearly all those natural embankments were artificial works."

At Rochester the canal crossed the Genesee River on a large aqueduct 810 feet (247 m) long (Figure 12), making it the third longest aqueduct on the entire line of the Enlarged Erie. Further, it was the only all stone aqueduct as the others carried the canal in a wooden trunk, supported by stone piers, with towpath arches on one side only. The commissioners went to the added expense, not for the sake of architectural beauty, but because of the severe flooding that long plagued the Genesee River and which was arrested only by the completion of the Mount Morris Dam at Letchworth State Park completed in 1953.

Lockport and the Niagara Escarpment

Canal construction through Lockport proved to be extremely difficult and this was the last section completed in 1825. Two prominent escarpments exist on the Lake Ontario plain in Western New York - the Niagara on the north (once known as the Mountain Ridge) and the Onondaga on the south. Of the two, the Niagara Escarpment is more pronounced. The Lockport Dolostone which crowns it is famous for its crystals of calcite, dolomite, fluorite, gypsum and other sulfates, as well as sulfides.

Beginning in Lake Dawson time and continuing into Lake Iroquois time, a lake was impounded between the Niagara and Onondaga Escarpments which was named Lake Tonawanda by Kindle and Taylor (1913). This lake extended east to near Holley and debauched north across the Niagara Escarpment through several spillways. Of these the spillway at Lockport gained ascendancy over the others, probably due to greater isostatic rebound to the east. This spillway carved a northeastward trending notch in the Niagara

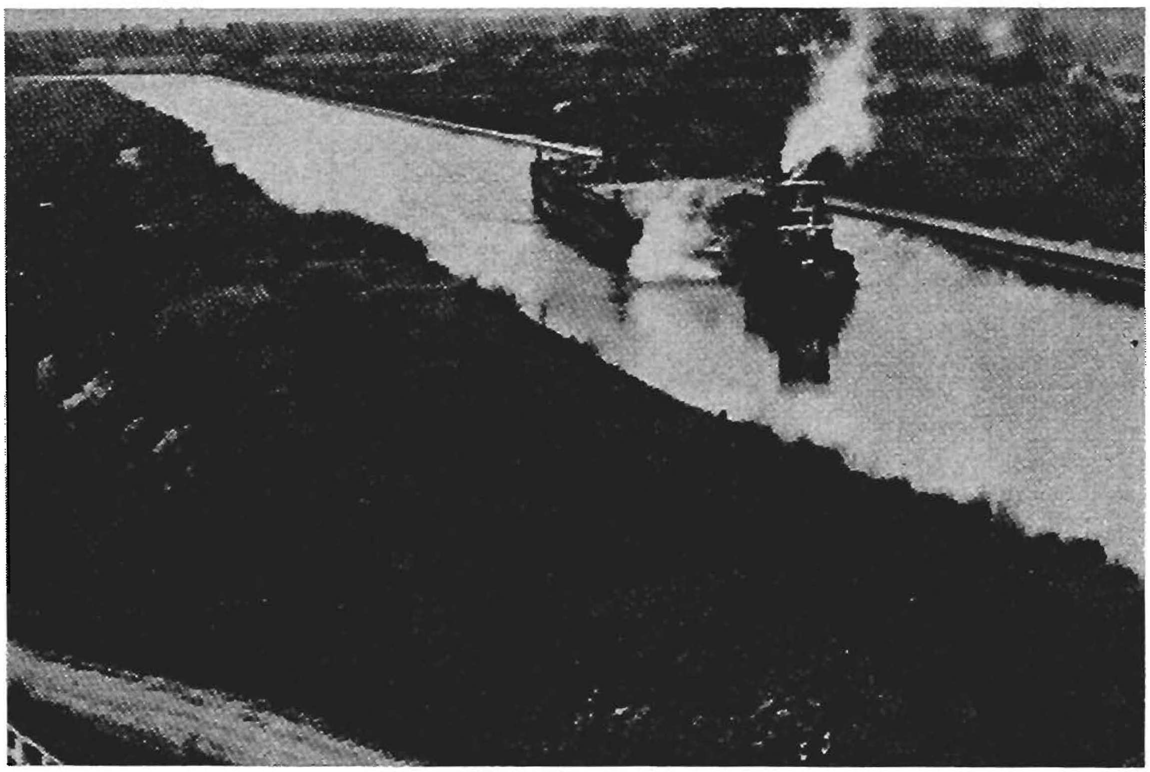

Figure 11 The Great Embankment circa 1921 looking west from Bushnell's Basin. Jefferson Road (NY96) in lower left foreground.

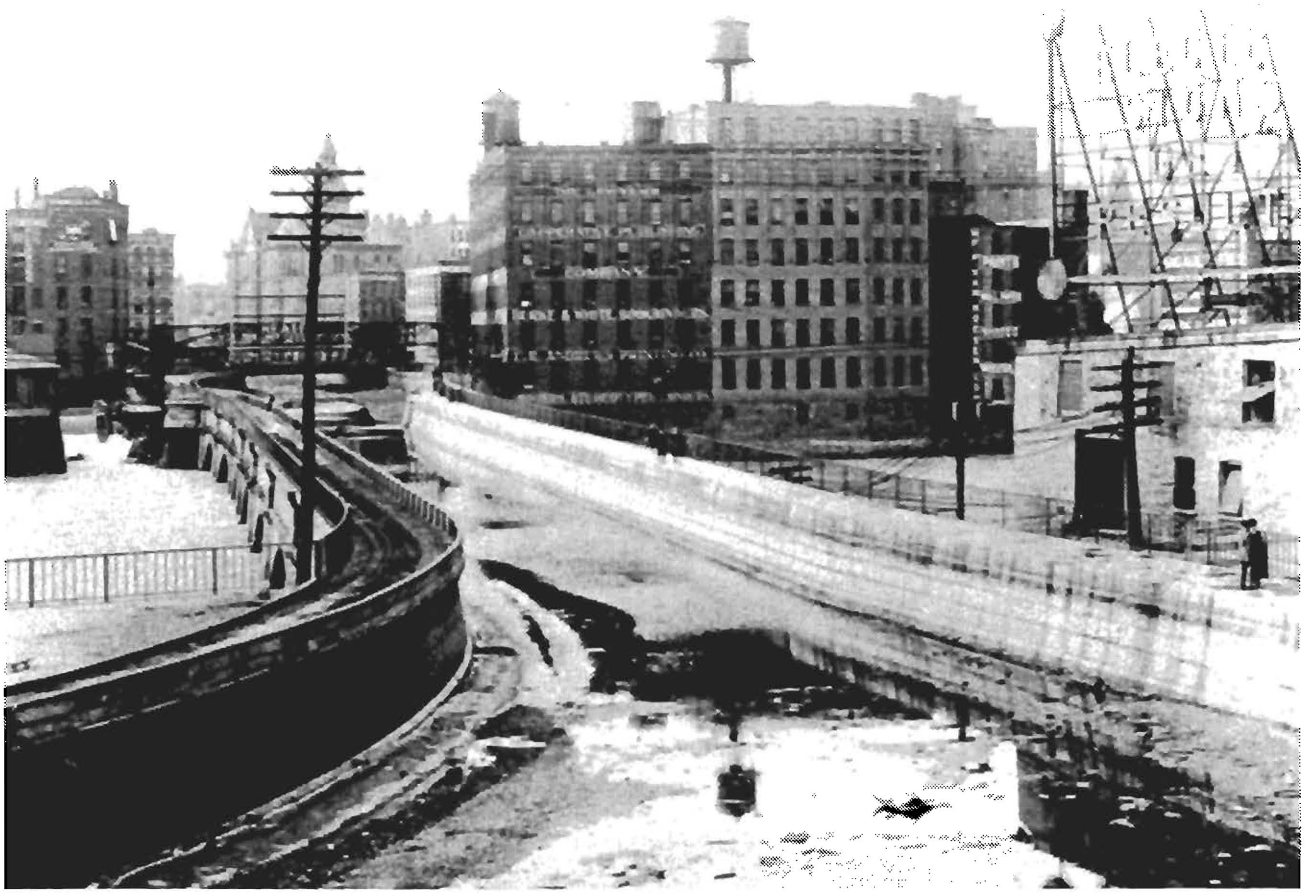

Figure 12 Downtown Rochester Aqueduct looking west, circa 1913 (Stone Collection, Roch. Mus. and Sci. Center)

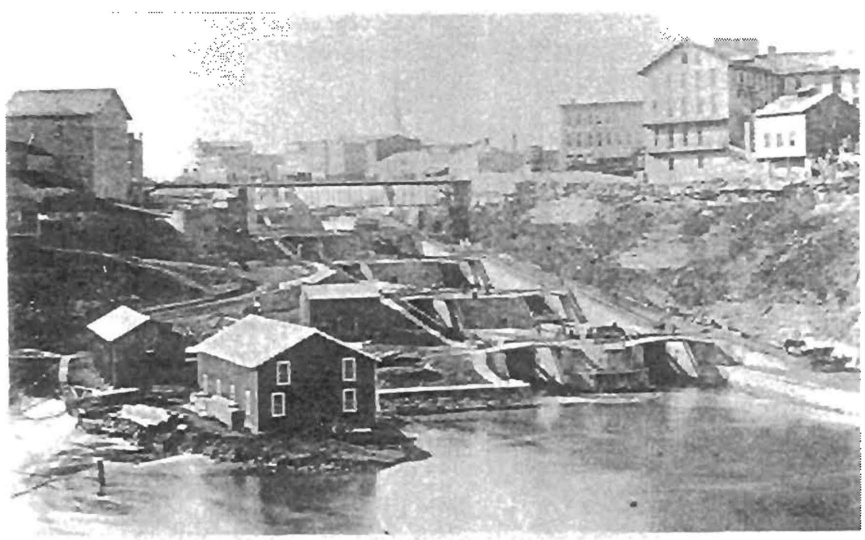

Figure 13 Lockport flight of combined locks, circa 1880. Note canal boats in lowest and uppermost chambers of the west flight. Rochester Shale capped by Decew Dolostone on right (west) bank.

Escarpment that, before the canal, carried a misfit tributary to Eighteen Mile Creek (not the classic Eighteen Mile Creek of Grabau famous for its fossils - which is south of Buffalo).

In this defile Nathan Roberts completed, in 1825, the famous Lockport flight of five double combined locks that raised or lowered boats fifty-five feet across the face of the escarpment (Figure 13). Furthermore, to maintain a gentle gradient eastward for the flow of Lake Erie water, Roberts' crews had to blast through the dip side of the cuesta, thereby creating a "deep cut" from Pendelton at Tonawanda Creek to Lockport with a maximum depth of forty feet (12 m). The commissioners had once contemplated a route going directly east from Tonawanda Creek, running south of the escarpment instead of turning north at Pendelton. This plan had the advantage of being shorter and cheaper as it would have negated the cost of blasting the deep cut and constructing five combines. However, this would have meant going uphill from Lake Erie, not down, and the water supply from Lake Erie would have been lost. This early plan was therefore abandoned. From the mouth of Tonawanda Creek the canal paralleled the east side of the Niagara River, terminating in the Erie Basin in downtown Buffalo.

GEOLOGY OF ROCHESTER AND THE ROCHESTER GORGE

INTRODUCTION

The Erie Canal came to Rochester in 1822-1823, and the "Young Lion of the West" was born. The appellation was accurate enough as evidenced by the economic explosion and unparalleled physical growth, fostered by the canal, that was this city's hallmark in the first quarter of the 19^{th} century. The original Erie Canal was only 40 feet wide at water surface and just 4 feet deep. Yet this narrow ribbon of water made New York the Empire State, and made Rochester the first "boom town" in America. The canal lowered transportation costs by more than 90% and the rapid growth that resulted is clearly revealed by the fact that 3,130 souls resided in the Village of Rochesterville in 1822, more than double the population only two years before. Further affirmation is found in the 1827 village directory, which boasted:

> "...not one adult person is a native of the village. The oldest person living in the village that was born here is not yet 17 years old."

It is difficult to imagine that in 1810, when DeWitt Clinton and the canal commissioners came here on an exploratory trip for the proposed Erie Canal, there wasn't a single person residing in what would become the Village of Rochesterville - today's downtown Rochester. Later, in 1827, Clinton (found in O'Reilly, 1838, p. 416), wrote to Everard Peck recalling his visit:

> "When I saw your place here in 1810 without a house who would have thought that in 1826 it would be the source of such a work? This is the most striking illustration that can be

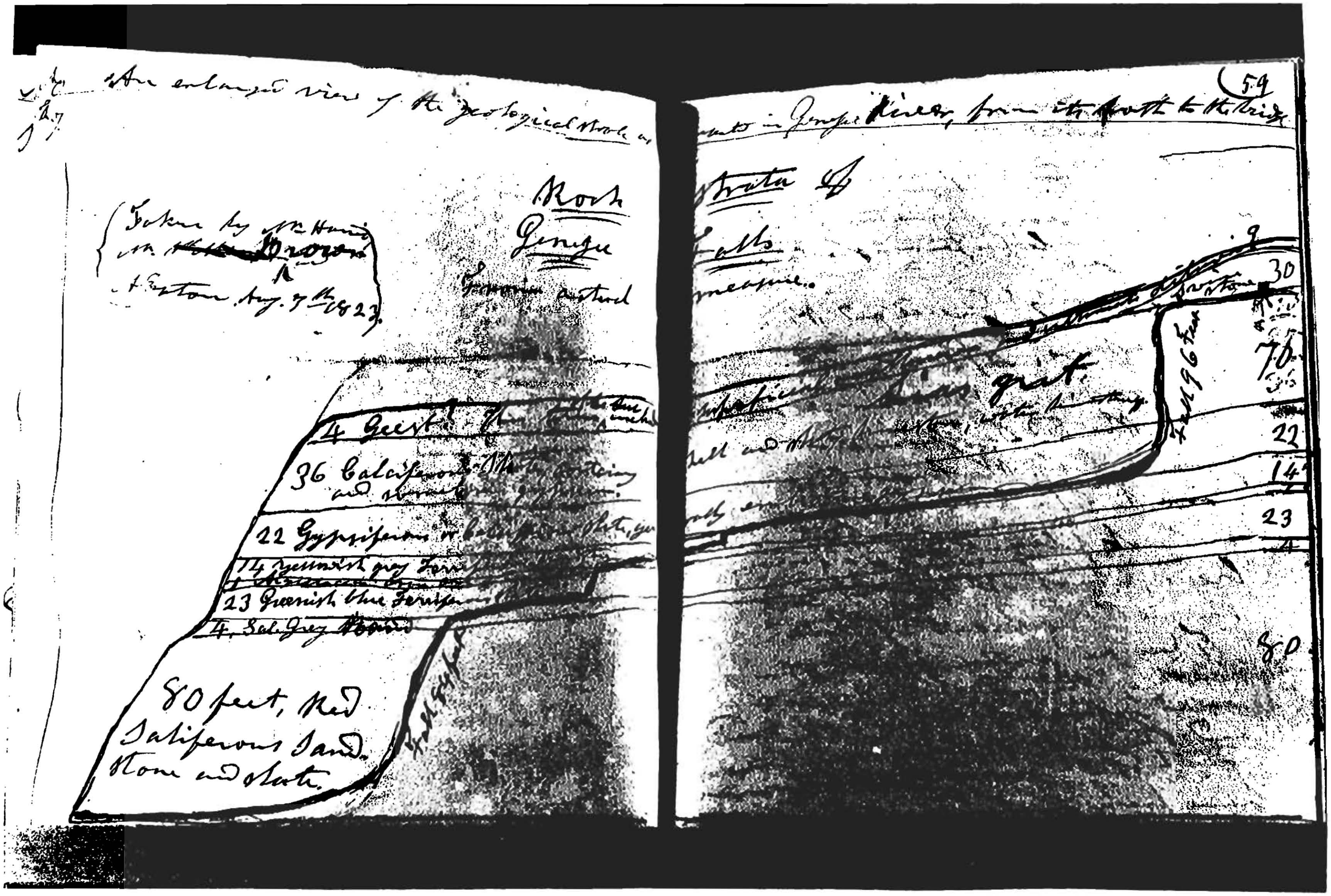

Figure 14 Eaton's 1823 drawing of the stratigraphy and falls in the Rochester Gorge. Note the northerly dip of the strata. (Journal C, Aug. 1823, N.Y. State Library)

> furnished of the extraordinary progress of your region in the career of prosperity."

Not everyone shared the governor's enthusiasm for Rochester. In 1826, Amos Eaton led a geological expedition across the state aboard the canal boat LAFAYETTE. Earlier, in 1823, Eaton made the first detailed geologic study of the Rochester Gorge where he depicted the sequence of formations in a sketch contained in his field notebook (Figure 14). Eaton's understanding of the geology of the gorge was further advanced by the Reverend Chester Dewey. Eaton's work formed the basis for the illustration entitled "Section of Rocks on the Genesee River etc." on page 77 of Henry O'Reilly's 1838 *Sketches of Rochester*, and redrawn here (Figure 15) with annotations.

Returning to Eaton's 1826 field excursion, the group included Rensselaerian School students, faculty, and several dignitaries such as George W. Clinton, the governor's son, Asa Fitch the future state entomologist; and Joseph Henry, the brilliant young physicist who performed some of the seminal experiments on magnetism in this country and thereafter helped found the Smithsonian Institution. The party arrived in Rochester on Sunday, May 14, and Asa Fitch recorded Eaton's impressions of Rochester:

> "This place Prof. Eaton says is a mere mushroom springing upon a moment and is destined to decay and fall away to nothing. He predicts that there will not be a third of the present number of buildings in the lapse of a few years - that he does not believe there is a place on earth so remarkable for its splendor and poverty."

Fifteen years later (August, 1841) Rochester was visited by the eminent Scottish geologist Sir Charles Lyell (1845, p. 23) who recorded in his diary:

> "We explored the picturesque ravine through which the Genesee flows at Rochester, the river descending by a succession of cataracts over the same rocks which are exposed farther westward on the Niagara...The contemplation of so much prosperity, such entire absence of want and poverty, so many school-houses and churches rising everywhere in the woods...fills the traveler with cheering thoughts and sanguine hopes..."

One can only wonder if Eaton and Lyell visited the same municipality. (*All Lyell quotes here and elsewhere in this paper were graciously provided and authored by Gerald M. Friedman Ph.D., D.Sc., Rensselaer Center of Applied Geology, affiliated with Brooklyn College, City University of New York*).

Rochester was preordained for greatness, not so much by its location on the canal--a major east-west artery of commerce--but by its location at the waterfalls and gorge carved by the muddy waters of the Genesee in its head-long dash north to Lake Ontario. The water power, derived from the river's drop, churned water wheels that in turn drove gears, shafts and leather

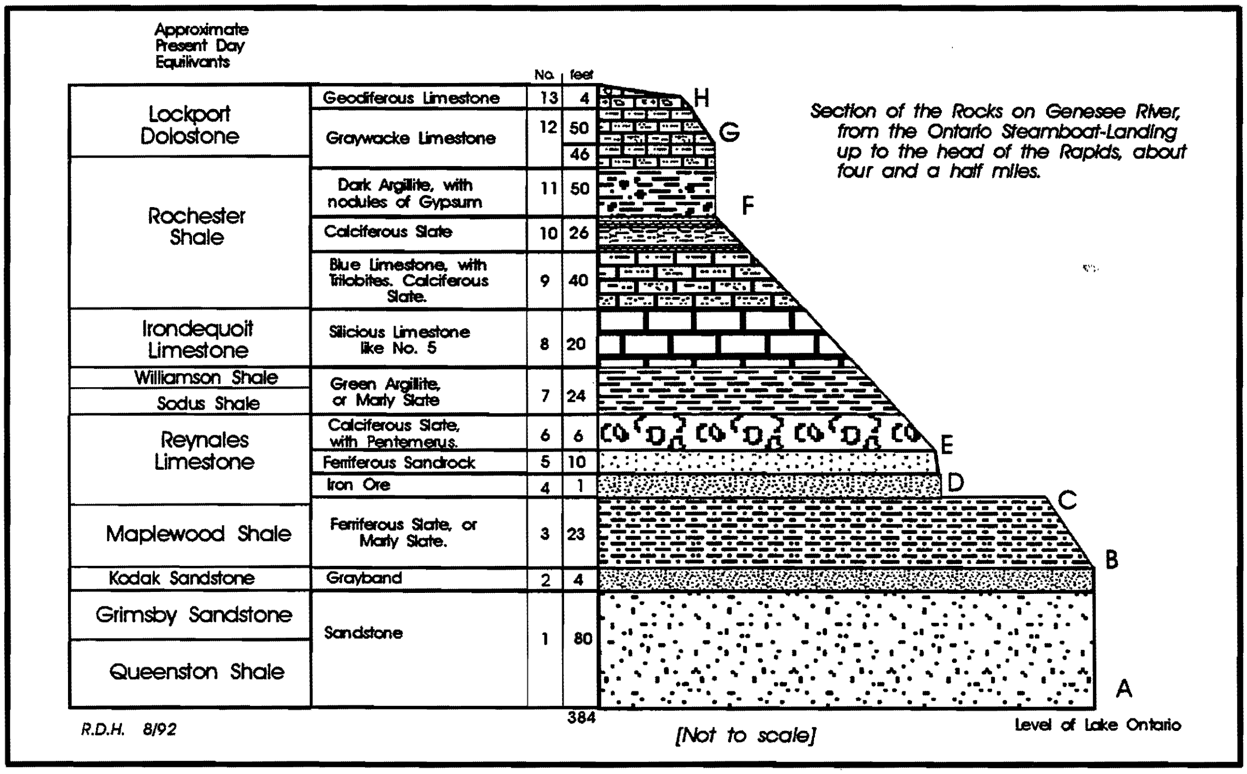

FIGURE 15 Geology of the Rochester Gorge, contrasting authors' rock units with those in use 1823-1838.

A to B - height of the last step (84 feet) of Lower Falls [Lower Falls]*
B to C - ascent to the upper step of those falls [Middle Falls]
D to E - height of upper step of the Lower Falls, about 25 feet [Middle Falls]
E to F - ascent up the river
F to G - height of the Middle Falls, 96 feet [High Falls]
G to H - ascent to the Rapids [old Upper Falls-base of Court Street Dam]

*Brackets are author's for current terminology belts that provided smokeless industrial power. A spectrum of products for domestic, agricultural and industrial use, such as flour, furniture, edge tools, farm machinery, beer, barrels, canal boats, and fire engines were but a few of the products directly or indirectly, turned out by Rochester's many water powered mills.

The primacy of the waterfalls and river gorge in the historical settlement and industrial development of Rochester cannot be understated and therefore geologic and human history are intertwined. Geologic events of the near and distant past laid the foundation that guided the course of human events resulting in the founding and growth of Rochester. In broad strokes, the geological-historical interrelationship can be explained by the gorge's attraction of the early settlers because of the ample water power. The mills that located at the falls produced goods that could not be inexpensively transported to New York City markets. The attraction of great reductions in shipping costs provided the incentive for locating a canal across the Genesee River at Rochester, giving Rochester millers and their products a ready access to eastern markets. This suddenly transformed what before the canal was a struggling enclave at the small Upper Falls of the Genesee, into a thriving, vibrant community after the ditch's completion. Had the Rochester gorge not formed and if it did not contain the rock types necessary for the formation of waterfalls, the canal may have crossed the Genesee River elsewhere--perhaps farther south--and maybe Canandaigua, Avon, or Batavia would have attained Rochester's status as the major city in the region.

THE NIAGARA ESCARPMENT

A prominent rock ridge, approximately 200 feet high, rises abruptly from the lake plain that borders the southern shore of Lake Ontario. This topographic feature was called the Mountain Ridge by the early white settlers, and later the Niagara Escarpment by mid 19th century geologists. Although ill-defined east of Rochester, the escarpment becomes more pronounced westward forming a sharp angular feature in the Niagara River region (Figure 16).

Downtown Rochester and I-490 West, from downtown to the Spencerport exit, lie at or near the crest of the escarpment; numerous rock cuts along the way proclaim its presence. Further evidence of the escarpment's existence in the Rochester area is revealed by the sharp drop in the lay of the land north of Ridgeway Avenue and the view of Lake Ontario that northbound motorists can observe from NY390 just north of Lexington Avenue.

In the Rochester region the Niagara Escarpment and Ridge Road (the southern beach of Lake Iroquois - see Fig. 31, p. 59) were two prominent topographic features that did not escape the keenly watchful eye of DeWitt Clinton during his canal tour of 1810 (Campbell, 1849, p. 114). In his journal entry for Sunday July 29th, he wrote:

> "Shortly after leaving the Genesee River, we entered a remarkable road called the Ridge Road, extending from that river to Lewiston, seventy-

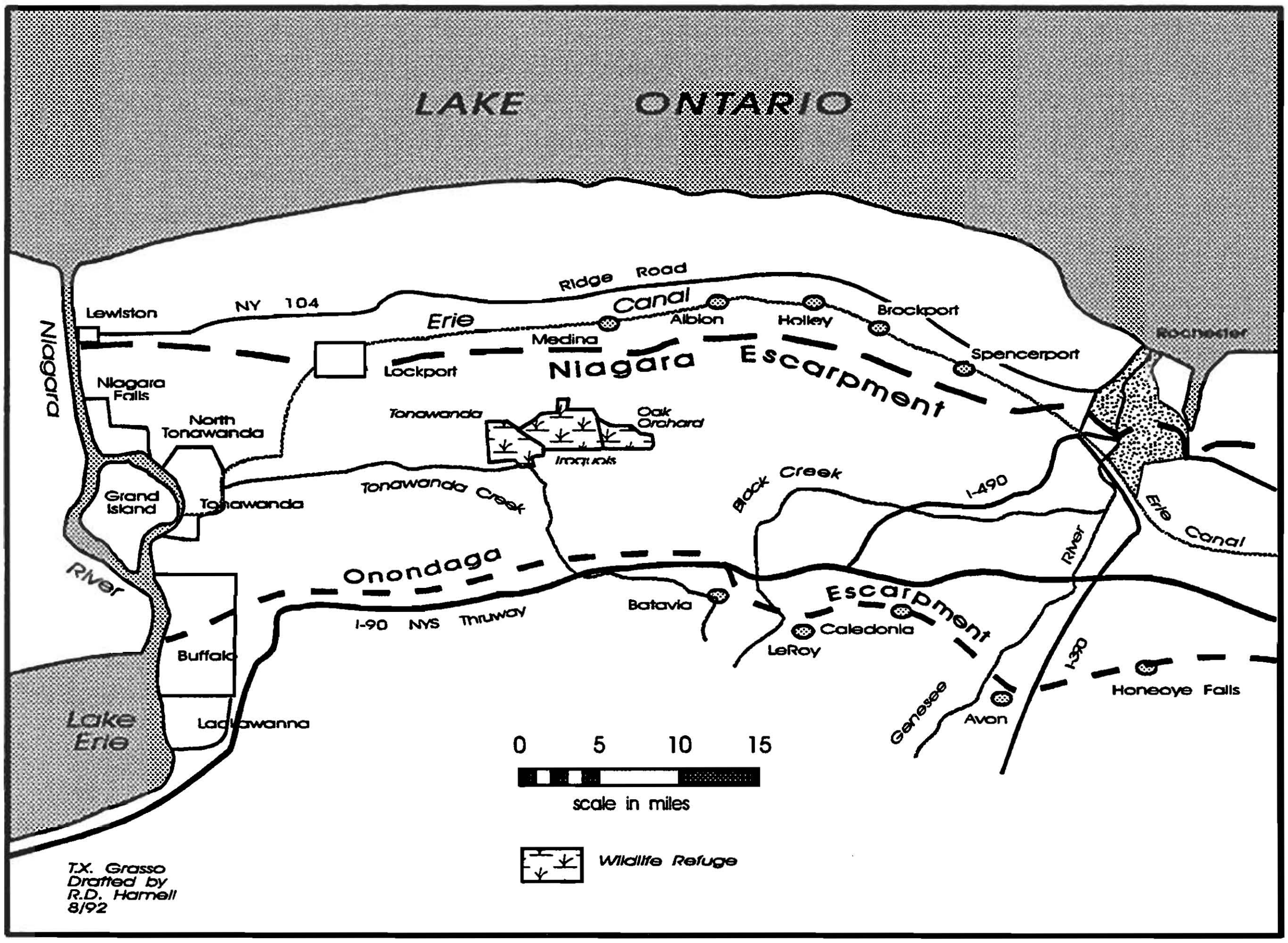

FIGURE 16 Map of the Niagara and Onondaga Escarpments in Western New York.

> eight miles. The general elevation of the ridge is from ten to thirty feet, and its width varies........About from three to half a mile south, and parallel with this ridge, there is a slope or terrace, elevated 200 feet more than the ridge, with a limestone top [Lockport Dolostone], and the base freestone [Queenston Shale/Grimsby Sandstone]. The indications on the ridge show that it was originally the bank of the lake. The rotundity of the stones, the gravel, and c., all demonstrate the agitation of the waters........"

When rivers and streams eventually crossed the Niagara Escarpment and cascaded down its face, waterfalls and rapids formed. These, in time, receded or migrated upstream leaving behind deep bedrock gorges notched into the escarpment. Thus did the Rochester and Niagara Gorges come into being. But before all this could happen, the underlying bedrock units had to be deposited uplifted, tilted to the south $^1/_2$°, and beveled by erosion.

BEDROCK GEOLOGY

The strata exposed in the Rochester Gorge were deposited discontinuously over a span of 20 million years beginning in the Late Ordovician Period and ending in the Middle Silurian Period. The total sedimentary package of primarily shelf strata is about 450 feet (137 m) thick but was deposited in environmental settings ranging from marginally marine intertidal to fully marine, deep basin, anoxic, water. The stratigraphic column is subdivided into four major rock units (from older to younger): Queenston Formation, Medina Group, Clinton Group and Lockport Group. These units, save for the Queenston, can be further subdivided into finer scale units (Figure 17).

The Queenston Formation and Medina Group are well exposed in the lower gorge from the Stutson Street Bridge to the Lower Falls, just south of the Driving Park Bridge (**STOP 4**). The top of the 84 foot (25.6 m) high Lower Falls exposes the top of the Medina Group, namely the Kodak Sandstone, a prominent gray band exposed about half way up the side of the gorge just above the red Medina Group. Early in Rochester's history this falls was known as the Lower Step of the Lower Falls (Figures 18, 19).

At the Lower Falls, above the Kodak Sandstone, the gorge reveals nearly the entire Clinton Group terminating in the lower part of the Rochester Shale. The Reynales and Irondequoit Formations are relatively conspicuous as they jut out from the side of the gorge. They have a brownish color and are made up of thicker beds than the intervening thin bedded shale (Figure 20). The Reynales Formation is made even more prominent by the presence of a thin (1 foot thick) red iron ore bed, a few feet up from the base of the unit. This bed, formerly the Furnaceville Hematite, has recently been renamed the Seneca Park Hematite by LoDuca and Brett (1990). The upper part of the Reynales Limestone caps the Middle Falls which earlier was known as the Upper Step of the Lower Falls. Today RG&E operates a hydroelectric dam on top of the Middle Falls. The remainder of the Clinton Group is exposed more or less

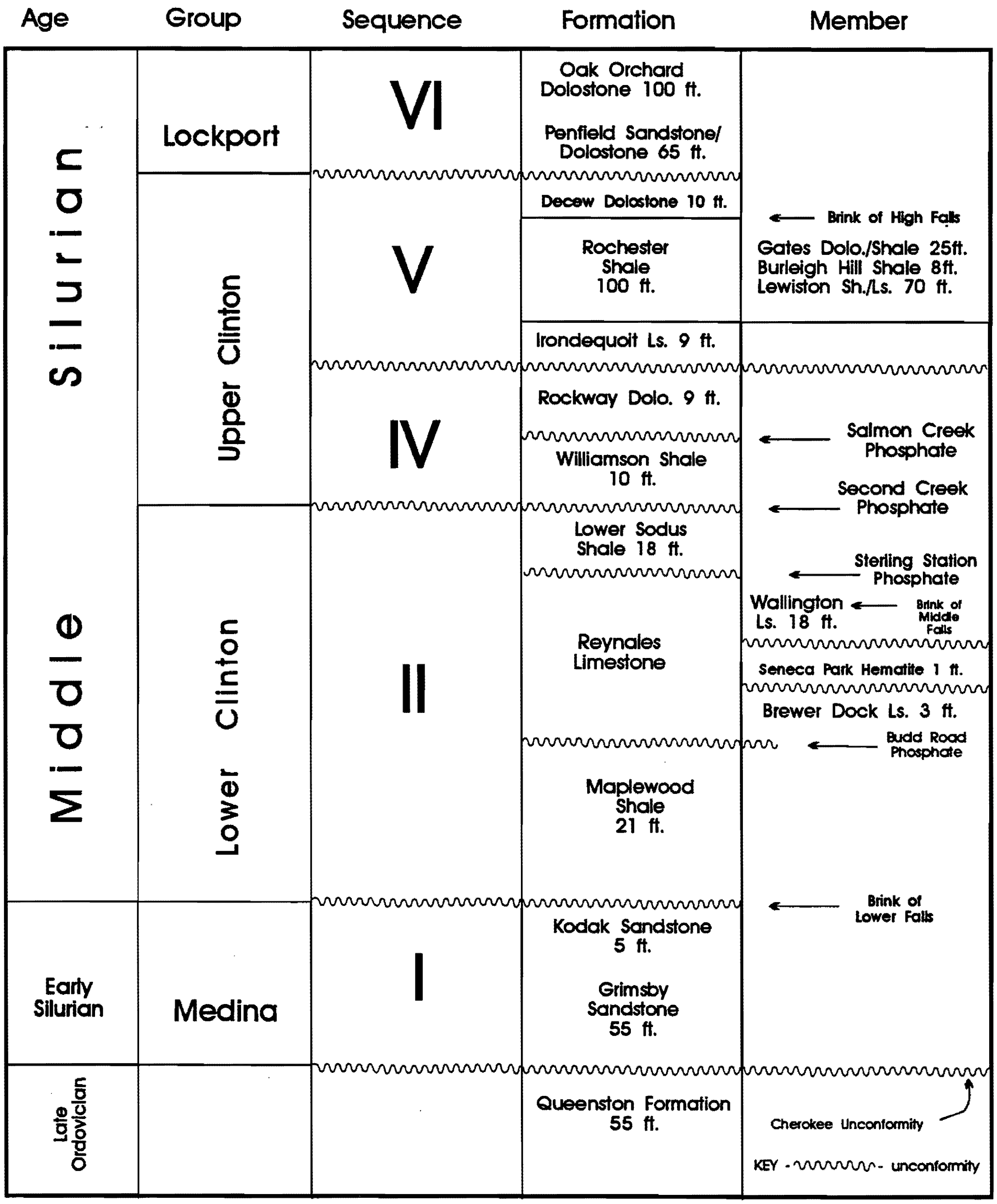

FIGURE 17 Stratigraphy of the Rochester Gorge

[After: C. E. Brett, W. M. Goodman and S. T. Lo Duca. 1990. Figure 4, p. C11. NYS Geol. Assoc. Guidebook, Fredonia State Univ., 62nd Ann. Mtg., modified by T.X. Grasso, drafted by R.D. Hamell, Oct. 1991]

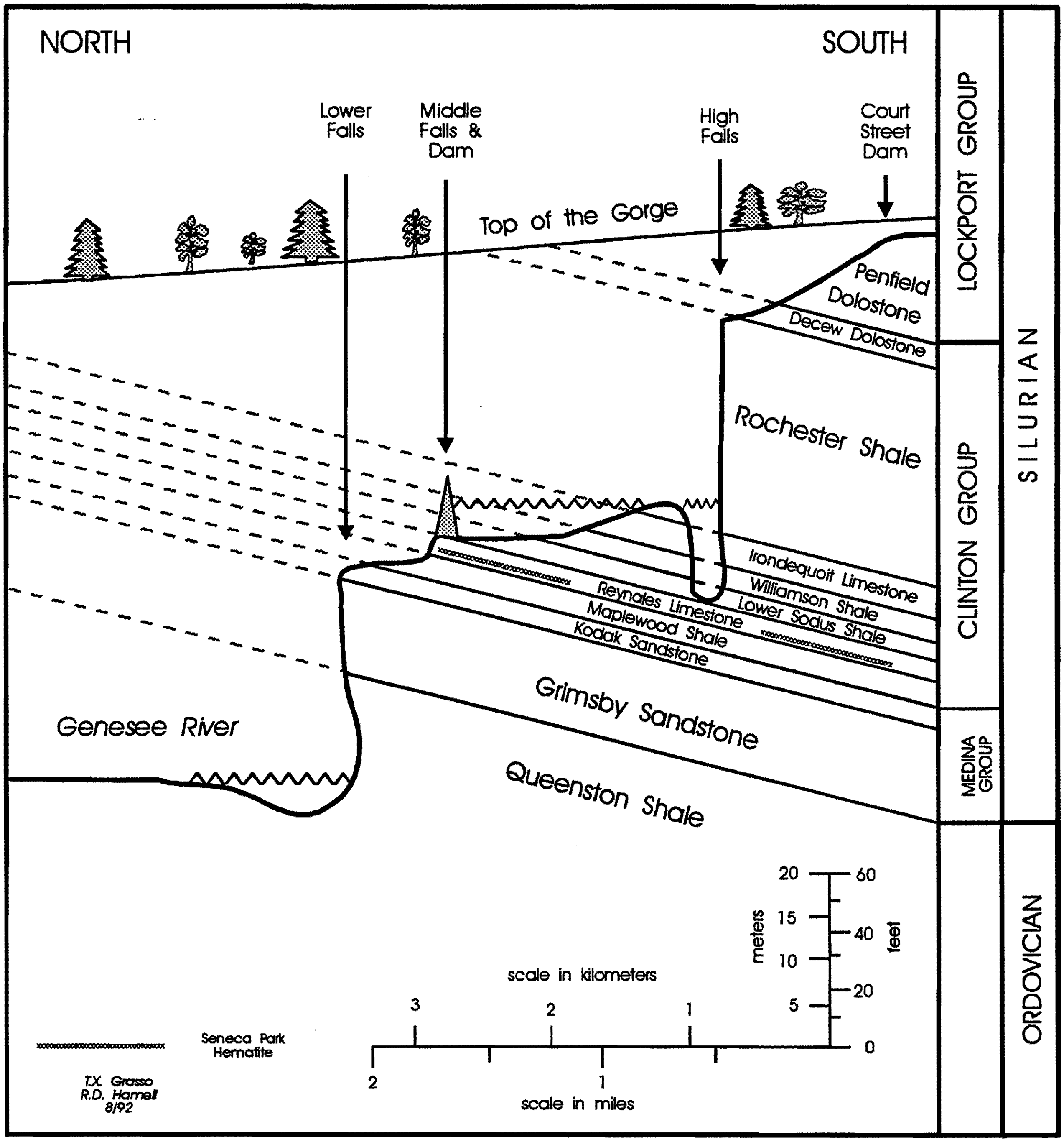

FIGURE 18 Stratigraphic Profile of the Rochester Gorge

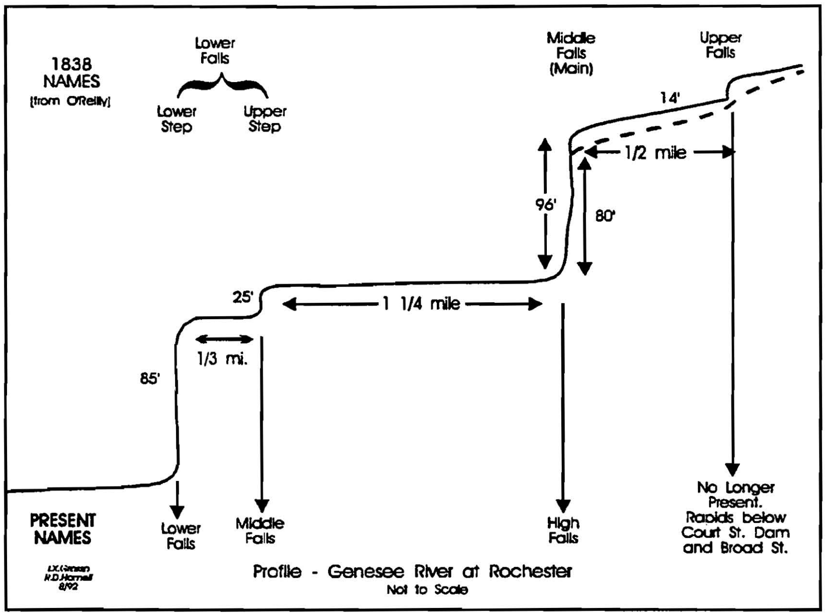

FIGURE 19 Old and current names for the waterfalls in the Rochester Gorge. Dashed line upstream from High Falls is approximate present day profile.

FIGURE 20 East side of gorge just downstream from the Lower Falls. Rock Units: 1=Queenston, 2=Grimbsy, 3=Kodak, 4=Maplewood, 5=Reynales, 6=Lower Sodus, 7=Williamson, 8=Irondequoit, 9=Rochester. (Bill Clar)

continuously to the lip of the High, Main, or Upper Falls just north of the Inner Loop and Conrail bridges and south of the Pont de Rennes Bridge over the river. At one time this falls was called the Middle Falls.

From the brink of the High Falls to the Court Street Dam the Lockport Group is exposed in banks and bed of the river and once formed a small cascade of about 14 feet that stood where the Broad Street Bridge (second Erie Canal aqueduct) is today. This small cataract was, before canal construction, the Upper Falls of the Genesee. Over the years the change in terminology for Rochester's three waterfalls (originally four) led to much confusion. Going downstream from downtown, the original Upper Falls no longer exists. The old Middle Falls is now the High (Main or Upper) Falls, while the Upper Step-Lower Falls is now the Middle Falls and the Lower Step-Lower Falls is currently known as the Lower Falls (Figure 19).

Depositional Models

From the time the strata in the gorge were first examined by Amos Eaton in 1823, numerous models have been advanced to explain how the rocks were deposited. A relatively recent one, is the concept of sequence stratigraphy (see Brett et al., 1990 for a comprehensive discussion). The basic tenet of this model is that the sedimentary rocks in the gorge can be grouped into genetically related packages (called sequences), bounded above and below by unconformities.

A typical sequence begins when sea level is low. Therefore a particular region at that time above sea level is subject to erosion forming an unconformity. Another possibility, at this time, is that nonmarine strata are laid down at the base of a sequence above a regional unconformity. Following this period of sea level lowstand, sea level begins to rise, flooding the region. As the shoreline parades inland, gradually flooding the previously exposed land, the transgressive sequence begins with shallow water (continental shelf) deposits that are subsequently overlain by more offshore deposits, generally limestones. At maximum flooding sediment starvation may result in phosphate nodule deposition above the offshore deposit. The upper part of each sequence typically begins with a deep water, outer shelf or, basin deposit, above the phosphate horizon, which is in turn overlain by successively shallower deposits (a shallowing upward or regressive sequence) as sea level falls. Eventually sea level may fall enough to expose the region to erosion, resulting in the formation of another unconformity. However, erosion may also remove portions of the underlying sequence thereby often resulting in only a partial sequence preserved in the rock record. In summation, sequence stratigraphy presumes to record a rise of sea level at the start of the sequence above an unconformity, or nonmarine strata, followed by a fall of sea level at the end of the sequence. The result is another unconformity at the top of the package followed by the next rise in sea level with its signatory sediments. Sequence stratigraphy is remarkably similar to Amos Eaton's five Series (see Figure 2, p. 7) although on a finer scale. (Geologists are apparently struck from time to time by a recurring illness of seeing regular cycles everywhere in the rock record).

Recent studies of the Silurian of Western and Central New York by Brett, et al. (1990), have revealed six major, unconformity bounded, sequences in the section exposed in the Rochester Gorge (Figure 17). That classification and nomenclature is followed here.

STRATIGRAPHY

Queenston Formation (Grabau, 1908)

During the Middle and Late Ordovician Period, the Taconic Orogeny occurred as eastern North America collided with an island arc (Bronson Hill) in the Atlantic. Eastern New York and western New England, were transformed into Alpine-like mountains as the Taconic Mountains of New York, the Green Mountains of Vermont and Berkshire Hills of Massachusetts were born. Rivers flowing off the newly formed upland eroded the landmass, depositing the sediment in a marine basin to the west. Over time, sediment began to fill the marine basin and a large deltaic complex prograded east to west across the state. The result was the Queenston Formation, 1,000 feet (328 m) of unfossiliferous, fine grained, red, shale, siltstone, and sandstone deposited at the seaward margin of the Queenston Delta. Many of the beds display mud cracks and current ripples, further evidence of its subaerial to intertidal depositional setting. Only the upper 50 to 55 feet (15 to 16.7 m) of the Queenston is exposed in the gorge, comprising the lowest strata below the Driving Park Bridge. Following deposition of the Queenston, an interval of emergence prevailed during which a major erosion surface developed. This erosion surface, widely traceable in eastern North America, was called the Cherokee Unconformity by Dennison and Head (1975).

Sequence I

Medina Group (Luther, 1899)

Grimsby Formation (Williams, 1919)

The Grimsby or Red Medina Sandstone represents the return of terrestrial, deltaic and intertidal deposition to the Rochester area following the erosion that formed the Cherokee Unconformity. This 50 to 55 foot-thick (15-16.7 m) red sandstone sharply overlies the Queenston, its lower portion made even more conspicuous by a 10 foot (3 m) thick bed of massive sandstone, which may equate with the Whirlpool Sandstone further west. The Queenston and Grimsby together make up most of the exposures in the Rochester Gorge north of the Lower Falls, their red color a striking contrast to the gray, green and buff colors of the overlying Clinton Group shales and limestones. The Grimsby, especially in the middle of the unit, contains numerous worm burrows and trails--one a U-shaped tube *(Daedalus)*, and the other a corrugated, criss-crossing, trail *(Arthrophycus)*. These fossils, along with sedimentary structures such as wave and current induced ripples and mud cracks on some bedding surfaces, indicate a deltaic origin for these strata.

The Grimsby Sandstone is famous as a fine building stone, and was quarried below the Lower Falls, early in the city's history. The stone for the first Erie Canal aqueduct over the Genesee River (1822-1823) came from the Grimsby quarried at Carthage (below the Lower Falls). Nearly all of the red sandstone buildings in Rochester are constructed of the Red Medina save for the present City Hall on Church Street (1885-1889) built of Newark Series sandstone from the Connecticut Valley.

Kodak Sandstone (Chadwick, 1935)

The Kodak Sandstone is currently placed at the top of the Medina Group by Brett, et al. (1990) although older nomenclature places the Kodak at the base of the Clinton Group. This stratum of gray sandstone is about 5 feet (1.6 m) thick, lies directly above the Grimsby, and forms a prominent stripe on the sides of the gorge downstream from the Lower Falls (Figure 21). In Amos Eaton's 1823 field book he names it the Gray Band (1824). The Kodak caps the Lower Falls and represents a near shore deposit, the initial but minor transgression of the late Sequence I sea. The remainder of Sequence I strata were removed by erosion that took place when sea level dropped at the end of Sequence I time.

Sequence II

Lower Clinton Group (Vanuxem, 1839)

Maplewood Shale (Chadwick, 1918)

Sequence II begins with marine sediments laid down in a shallow subtidal setting, now the 21 foot-thick (7 m) green Maplewood Shale. The Maplewood therefore represents the initial flooding of the Sequence II transgressing sea into the Rochester region. It is well exposed along the access road to the RG&E substation, off Seth Green Drive, just west of St. Paul and Norton Streets (**STOP 4**), and splendidly so on Densmore Creek down from Densmore Road north of Norton Street in the town of Irondequoit.

Reynales Limestone (Chadwick, 1918)

The Reynales Limestone earlier designated the "*Pentamerus* Limestone" by Hall (1843), is a slightly deeper, more offshore, deposit than the underlying Maplewood. Therefore the two units are interpreted as a deepening upward sequence that recorded the rise of sea level at the start of Sequence II. The Reynales is subdivided into three members. In ascending order, they are Brewer Dock Limestone (3 feet; 1 m), Seneca Park Hematite (Iron Ore, 1 foot; 0.3 m) and the Wallington Limestone (17 feet; 5 m). The Brewer Dock is characterized by thin beds of fossiliferous limestone alternating with thin, green, shale beds resembling the Maplewood Shale below. The Seneca Park Hematite, previously known as the Furnaceville from exposures in northwestern Wayne County, is at a stratigraphically higher level than the Furnaceville iron ore in Wayne County and therefore cannot be the same unit (Brett et al., 1990). The Seneca Park is found just below the crest of the 25 foot (8 m) high Middle Falls and along both sides of the gorge downstream from this point to near Kodak Park.

FIGURE 21 West side of gorge below Driving Park Bridge. Rock Units: 1=Queenston, 2=Grimbsy, 3=Kodak, 4=Maplewood, 5=Reynales. (Bill Clar)

The overlying Wallington Limestone was deposited in an open marine, shallow to moderate subtidal, clear, tropical ocean. The evidence for this interpretation is that the rock is coarse grained, some bedding surfaces are ripple marked, but more importantly the unit yields a rich and diverse assemblage of invertebrates, including corals. Some beds, especially in the upper 7 feet (2 m), are packed with masses of the large (2 to 3 inches long; 5 to 7.5 cm), smooth shelled, brachiopod, *Pentamerus* that when alive must have grown like "oyster beds" on the Silurian sea floor. The combination of certain dense strata packed with fossils, interbedded with some containing nodules and stringers of chert (flint) renders the Wallington Member especially resistant to weathering and erosion and, therefore, it forms the cap of the Middle Falls as well as the falls on Densmore Creek down from Densmore Road north of Norton Street (Figures 22, 23).

The area between the Middle and Lower Falls was the site of much industrial activity. At the Middle Falls mills sprouted on each side of the river on mill races beginning above the falls and terminating just below the Lower Falls. Flour, carpet manufacturing, paper and lumber, plus furniture manufacturing were some of the industries that occupied this site from 1817 to 1961.

Upstream from the Middle Falls, near the base of the Bausch Street bridge, several industries occupied the "flats" of the Genesee. Most, but not all, of this acreage was created by fill dumped at the site primarily in the early 20th century. On the east side of the river north of the Bausch Street Bridge, a coal gasification plant was constructed in the late 19th century. It greatly expanded in the early 20th century and eventually extended operations to the west side of the gorge south of Bausch Street. Coal gas was produced by the destructive distillation of bituminous coal for use in heating and perhaps some lighting. The plant ceased production in the 1950's. On the west side "flats" south (upstream) of the Bausch Street Bridge, but north of the gasification plant, the city's waste was incinerated and disposed of at the City Garbage Disposal Plant from the time of World War I to the 1960's. Each of these industries contributed a unique blend of toxic, hazardous, and other waste into the river, that over the years helped to "enrich" its banks not to mention Lake Ontario.

The buried waste from the coal gasification plant that once occupied the Bausch Street site is probably the source of the *creosote* now seeping from bedding planes in the Grimsby Sandstone exposed in the face of the Lower Falls.

Lower Sodus (Gillette, 1940)

Relative sea level dropped after Wallington deposition resulting in the deposition of shallow water, subtidal, green and purple shales of the Lower Sodus Formation. The Lower Sodus, approximately 20 feet (6 m) thick, is particularly distinguished by its "pearly layers", thin (1 to 3 inch thick; 2 to 7.5 cm) beds packed with the lustrous shells of the tiny brachiopod, *Eocoelia*.

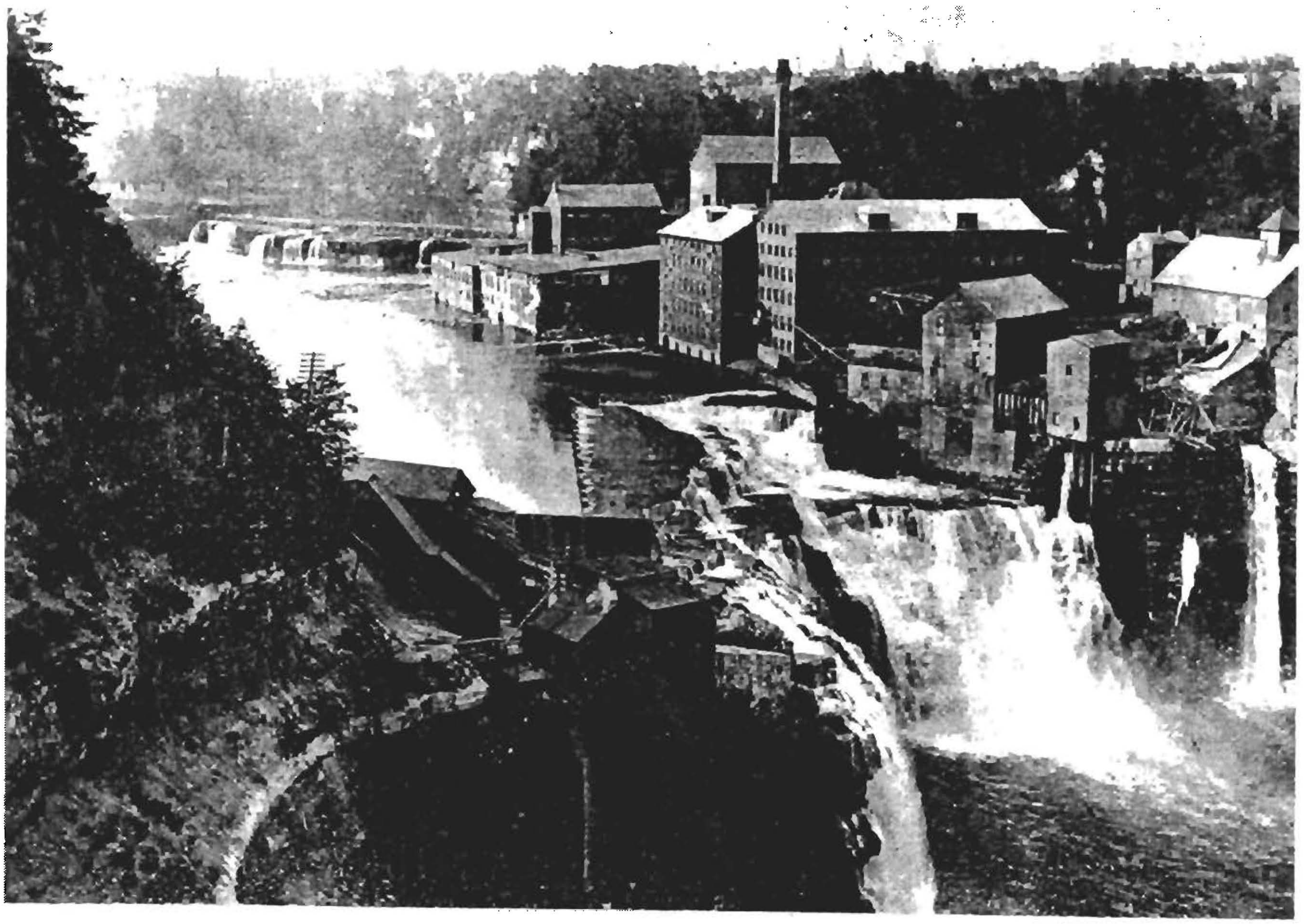

FIGURE 22 Industrial development on the west side of the gorge between the Lower and Middle Falls circa 1880. C.J. Hayden Furniture Co. in foreground, Rochester Paper Co. in middle distance, Middle Falls in distance (Local History Div., Roch. Public Lib.).

FIGURE 23 West side of gorge today, between the Lower and Middle Falls. Compare with Figure 22 (Bill Clar)

Sea level then rose again to deposit other formations above the Lower Sodus Shale at Rochester. However, immediately afterward, a major drop of sea level took place resulting in widespread erosion across western New York thereby bringing Sequence II to an abrupt end. The formations above the Lower Sodus were stripped away at Rochester but are still present in the Sodus Bay region. Therefore the top of the Lower Sodus is marked by a widespread, conspicuous unconformity that not only terminates Sequence II but is a major gap in the rock record where hundreds of feet of strata present in central and eastern New York are absent in western New York.

Sequence III

Middle Clinton Group

The Middle Clinton Group is not present in western New York due to the unconformity mentioned above. However, a narrow seaway persisted in east central and eastern New York where strata of Sequence III were deposited. These rock units will not be described as they are not germane to this paper.

Sequence IV

Upper Clinton Group

Williamson Shale (Hartnagel, 1907)

Overlying the Lower Sodus Shale are 6 to 10 feet (2 to 3 m) of dark, organic rich, black to green, fissile, shales - the Williamson Formation. At the base of the unit is a very thin, phosphatic, pebble horizon named the Second Creek Phosphate Bed marking the regional unconformity. The lithological and biological evidence points to a deep water origin for the Williamson Shale. The Williamson Shale contains few fossils, an indication that environmental conditions were highly stressed Only a sparse bottom dwelling population, if any, could dwell in these deep anoxic waters. Higher in the water column oxygenated conditions prevailed and therefore a thriving community of pelagic organisms, mostly graptolites was able to flourish. When these individuals died they slowly slipped into the murky, black, bottom muds adding their organic matter to what was already there. Graptolite remains blanket some of the bedding plane surfaces in the Williamson Shale.

Therefore, the Williamson represents a rapid rise of sea level commencing with the Second Creek Phosphate Bed. The Williamson accumulated at a time when sea level was at its highest point in the Silurian Period of North America. Toward the end of Williamson time sea level began to fall resulting in a shallowing upward sequence at the top of the unit.

The Williamson and underlying Lower Sodus Shales are exposed on the east side of the gorge north of the Middle Falls and on the west side north of the Rose Garden in Maplewood Park.

Irondequoit Limestone (Hartnagel, 1907)

The Irondequoit Limestone as originally defined encompassed the 18 feet (6 m) of dense, fossiliferous, carbonates that directly overly the Williamson. The lower 9 feet (3 m), now recognized as a separate unit, the Rockway Dolostone (Carlton Brett, personal communication), are fine grained and were deposited in relatively deep water when sea level rose rapidly once again. After this event, sea level fell sharply terminating Sequence IV and producing another regional disconformity.

Sequence V

Sequence V commences with 9 feet (3 m) of Irondequoit Limestone. This unit which sharply overlies the Rockway, is a coarse grained limestone, and contains an abundant and diverse faunal assemblage. The coarse lithology and abundant fossils are consistent with the inference that the Irondequoit was deposited in an inner shelf shallow water environment. This conclusion is further strengthened by the presence of small mound-like reefs or bioherms near or at the top of the unit composed of algae as well as bryozoans. The Irondequoit records the early phase of sea level rise at the start of Sequence V.

The Irondequoit Limestone is exposed in the upper part of the gorge walls near the Lower Falls. In addition it is found on the west side of the gorge, just above the river, upstream from the RG&E Dam on the Middle Falls, and on the east side of the gorge north of the Middle Falls.

Rochester Shale (Hall, 1839)

The Rochester Shale is approximately 90 feet (30 m) thick and makes up nearly all of the gorge walls from the level of the river, above the Middle Falls, to the top of the High (Main) Falls. It comprises all of the rock visible in the gorge below Brown's Race at the newly established High Falls Historic District Park (**STOP 5**). On the gorge's east side the Rochester Shale is well exposed in the banks from river level to a few feet below Upper Falls Park. The brownish colored strata at the very top of the gorge belong to the overlying Decew Formation of the Lockport Group according to Zenger (1965) and Rickard (1975), but uppermost Clinton Group in Brett's (1990) usage (Figure 24).

The lower 20 or so feet (6 to 7m) of the Rochester Shale is highly fossiliferous containing a rich diversity of marine invertebrates including corals, brachiopods, bivalves, snails, cephalopods, trilobites, and echinoderms such as the crinoid *Eucalyptocrinites coelatus* and the rare cystoid *Caryocrinites ornatus*.

FIGURE 24 East side of gorge below Upper Falls. Genesee Brewery in center and left of photo. Rock Units: 1=Lewiston Mbr.-Rochester, 2=Gates Mbr.-Rochester, 3=Decew Fm. (Bill Clar)

The hundreds of invertebrate species found in the lower Rochester Shale combined with the fine grained shale and thin limestone beds in which they are found, indicate deposition in warm, well oxygenated, normal marine waters of intermediate depth. The lower Rochester is, therefore, transitional in bathymetry from the shallow water upper Irondequoit Limestone below to the deep water deposits of the middle Rochester Shale above.

In the past the classic locality for study of the lower Rochester Shale was along Densmore Creek, upstream from Norton Street, east of Culver Road. The unit was exposed above a small cascade over the Irondequoit Limestone. However, a concrete trough or flume was constructed on top of the Rochester Shale thereby rendering it inaccessible. Small exposures of the lower Rochester Shale may be seen along the south side of the Keeler Street Expressway (NY104), just west of the Portland Avenue bridge, and along NY390 at the Ridgeway Avenue bridge.

The succeeding 20 feet (6 m) of the Rochester Shale consists of dark, organic rich, mudstones and shales that are nearly devoid of fossils and suggest deposition in deep, outer shelf water, but not quite as deep as those that prevailed in Williamson time.

The ocean gradually shallowed again as the dark, low faunal diversity mudstone and shale discussed above, passes upward into lighter colored more fossiliferous shale and thin limestone beds of the top of the Lewiston Shale Member (Brett, 1983). These beds form a conspicuous bulge in the middle portion of the east wall of the gorge just downstream from the High Falls (Figure 24). A second deepening event is recorded by the uppermost 33 feet (10 m) of the Rochester Shale. This sedimentary package is characterized by uniform, thin (1 to 2 inch thick; 2.5-5 cm) beds of dolostone and shale of the Burleigh Hill Shale and Gates Members. The dolostone beds have an internal structure that suggests deposition from storm generated events such as hurricanes. The Gates is characteristically even bedded and almost banded. This feature is well displayed in the upper part of the gorge at the High Falls, and also in the rock cut for the entrance ramp to I-390 South from Lyell Avenue (NY31) westbound. The brink of the High Falls today is at the top of the Gates Member.

Decew Dolostone (Williams, 1914)

The Decew Dolostone, was probably deposited in shallow water, therefore, it represents the top of the shallowing upward sequence that began in the underlying upper Gates Dolostone Member. Sea level continued to fall after the Decew was deposited exposing the region once again to erosion. Thus an unconformity was produced on top of the Decew, terminating Sequence V. The Decew is characterized by a distinctive pattern of convoluted and contorted bedding that gives the unit a "ball and pillow" or rounded, concretionary appearance especially on well weathered, vertical surfaces. This distinctive bedding is called enterolithic structure and can be traced west to the Niagara Gorge and into Canada. This internal structure was probably caused by flowing and slumping of the still unlithified Decew sediment, perhaps triggered by a large earthquake that shook the area one day during the Middle Silurian Period 420 million years ago or a meteorite impact!

FIGURE 25 High Falls before upper ledges were removed by blasting. Looking west. Gorsline Building in distance. Nov. 1914. (Stone Collection, Roch. Mus. and Sci. Center)

FIGURE 26 High Falls showing rock debris from blasting. Looking west. Gorsline Building in distance. Nov. 1914. (Stone Collection, Roch. Mus. and Sci. Center)

The Decew weathers to a distinctive tan or buff color which can be seen in the uppermost 6 to 10 feet (2 to 3 m) of strata in the gorge above and just downstream from the Main Falls (Figure 24). It is also is well exposed in cuts on the Inner Loop, along I-490 west from downtown, and at the Lyell Avenue (NY31) interchange with I-390.

The Decew once formed the brink of the High Falls. However, between 1913 and 1919, under a P.W.A. (Public Works Administration) project for flood abatement and protection, the river bed was lowered from a point upstream near Broad Street to the present brink of the High Falls. The blasting lowered the High Falls approximately 10 feet (3 m) and removed the Decew Dolostone caprock from the lip of the falls (Figures 25, 26). A second P.W.A. project from 1936 to 1938 deepened the river once again in order to install a new dam at the Central Avenue Bridge which today can be seen at the upstream side of the Inner Loop Bridge over the river (Howe, 1936). Today the High Falls is approximately 80 feet (24 m) high according to direct measurement and according to elevation data supplied by RG&E, not 96 feet (29 m) as shown in Eaton's 1823 Journal C sketch (Figure 14) and stated by Henry O'Reilly in his 1838 *Sketches of Rochester* plus countless publications since. Compounding the confusion of the falls' height is the questionable accuracy of Eaton's and O'Reilly's original measurement.

Brown's Race was blasted through the Decew Dolostone and upper Gates Member of the Rochester Shale late in the Fall of 1817 by Francis and Matthew Brown. By 1818 several mills were in operation on Brown's Race, and with the opening of the Erie Canal to the west side of the Genesee River in 1823, Brown's Race enjoyed the fruits of the initial boom years. Many industries flourished here and by 1879 Brown's Race generated 3,760 H.P. Francis and Matthew Brown rebuilt, in 1818, the first and original Harford Mill which stood on the tract in 1807, renaming it the Phoenix Mill. One third of the building still stands, formerly the Lost and Found Tavern, later Whispers and now the Public House. For details of Brown's Race mills and industries see Rosenberg-Naparsteck (1988).

Sequence VI

LOCKPORT GROUP (Hall, 1839)

Penfield Dolostone (Zenger, 1962)

The initial deposit of Sequence VI, the Penfield Dolostone, was laid down, when the sea once again transgressed Western New York submerging the sequence bounding unconformity. This unit is a coarse, sandy dolostone containing wave induced ripples. Some beds within the Penfield display crossbedded laminae. The Penfield Formation was most likely a shallow water deposit as, in addition to its coarse grained sediment and sedimentary structures many of the fossils, mostly echinoderm stems, are broken and fragmented. The Penfield Dolostone is exposed in the bed and banks of the river upstream from the High (Main) Falls, to the Court Street Dam (**STOPS 2 and 3**), and in the Barge Canal cut on the west side of the city.

The upper part of the Penfield once formed a small cascade of 14 feet (4 m) between what are now the Court Street and Main Street bridges. This cascade, as described earlier on page 166 and Figure 19, was the original Upper Falls of the Genesee at Rochester. It was first blasted away to make room for the foundation of the first Erie Canal (Clinton's Ditch) Aqueduct over the river, completed in 1823, but was further altered by the two subsequent P.W.A. deepenings.

In 1789, at the original Upper Falls of the Genesee, Ebenezer (Indian) Allen, the first white settler in what is now downtown Rochester, established a saw and grist mill on the west side of the river. The site is now occupied by the Lawyer's Cooperative Publishing Company and Aqueduct Park (Figure 27). The mills of Allen had not prospered, probably because there weren't enough settlers in the region to support them. By 1807 little remained of the first mills at the Upper Falls. The Genesee crossing had not yet come of age. Eventually, in 1803, Nathaniel Rochester, William Fitzhugh, and Charles Carroll purchased Allen's 100 Acre Tract site, which had by now gone through several hands. In 1811, Rochester surveyed the tract and subdivided it into mill and residential lots which he then put up for sale.

Eventually two mill races were blasted out, one on each side of the river. The one on the west side came to be known as the Rochester, Fitzhugh, and Caroll Race (hereafter, in text and figures, referred to as the Rochester Race) and it extended north to Main Street. By 1817 several mills were in operation on it such as the Red Mill erected in 1814 near Main Street. The one on the east side is called the Johnson and Seymour Mill Race as it was blasted by Elisha Johnson and Orson Seymour on July 4, 1817 while ground breaking ceremonies for the Erie Canal were taking place in Rome, New York. Water still cascades from this race to the river beneath Rundel Library. The Johnson and Seymour Race once continued north beneath the present Convention Center, Holiday Inn and Old Rochesterville to the Main Falls.

Both mill races provided power for many industries on both sides of the river north and south of the canal, but primarily north. Flour, farm implements, lumber, machine shops and foundries were some of the industries that flourished here in the 19th century.

There were five water power sites and mill races at Rochester (from downtown going north): the Rochester Race, Johnson and Seymour Race, Brown's Race, Third Water Power, and Upper Step-Lower Falls. Of the five the Brown's, Johnson and Seymour, and Rochester Races dominated the flour and industrial output of the city, as they were located closest to the Erie Canal. Collectively these sites formed the industrial and manufacturing core of Rochester thereby providing the economic underpinning of the city's rapid growth (Figure 28).

Wheat, floated down the Genesee River, supplied the grist for Rochester's mill stones. Early in the canal era, new mills were in operation on this city's three main races and in the first 10 days of the 1823 canal season, 10,450 barrels of flour were shipped eastward (McKelvey, 1949). In addition, 58 boats departed Rochester in this interval while 45 boats arrived, unloading, among other significant items, 4,000 gallons of beer and 2,300 gallons of whiskey at Gilberts Basin alone (behind the Old Stone Warehouse at South and Mt. Hope Avenues).

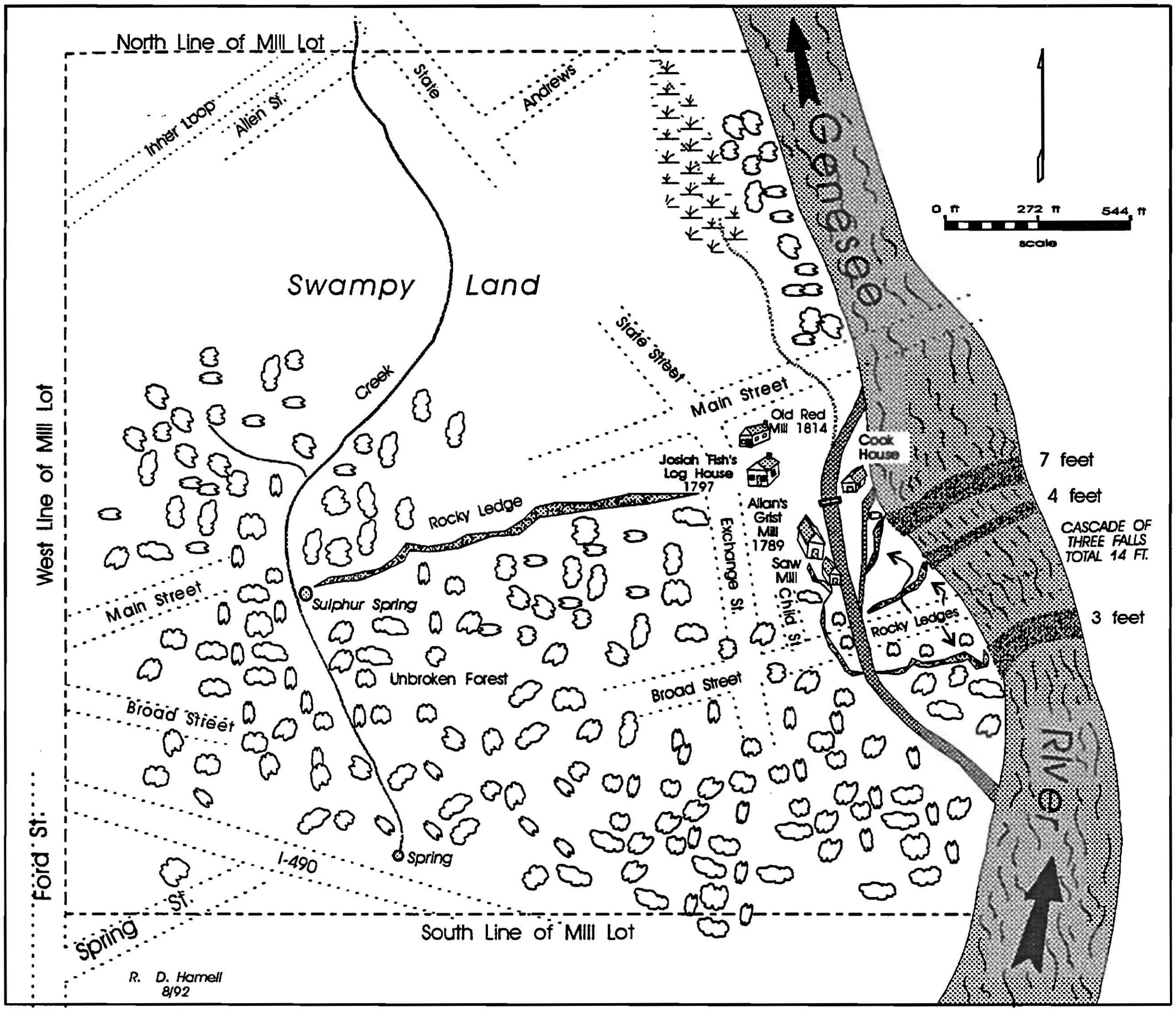

FIGURE 27 An Early Map of the 100 Acre Tract-Unsettled Rochesterville, circa 1789. [Redrawn from McKelvey, Blake, 1979, *Panoramic History of Rochester and Monroe County, New York,* p. 19]

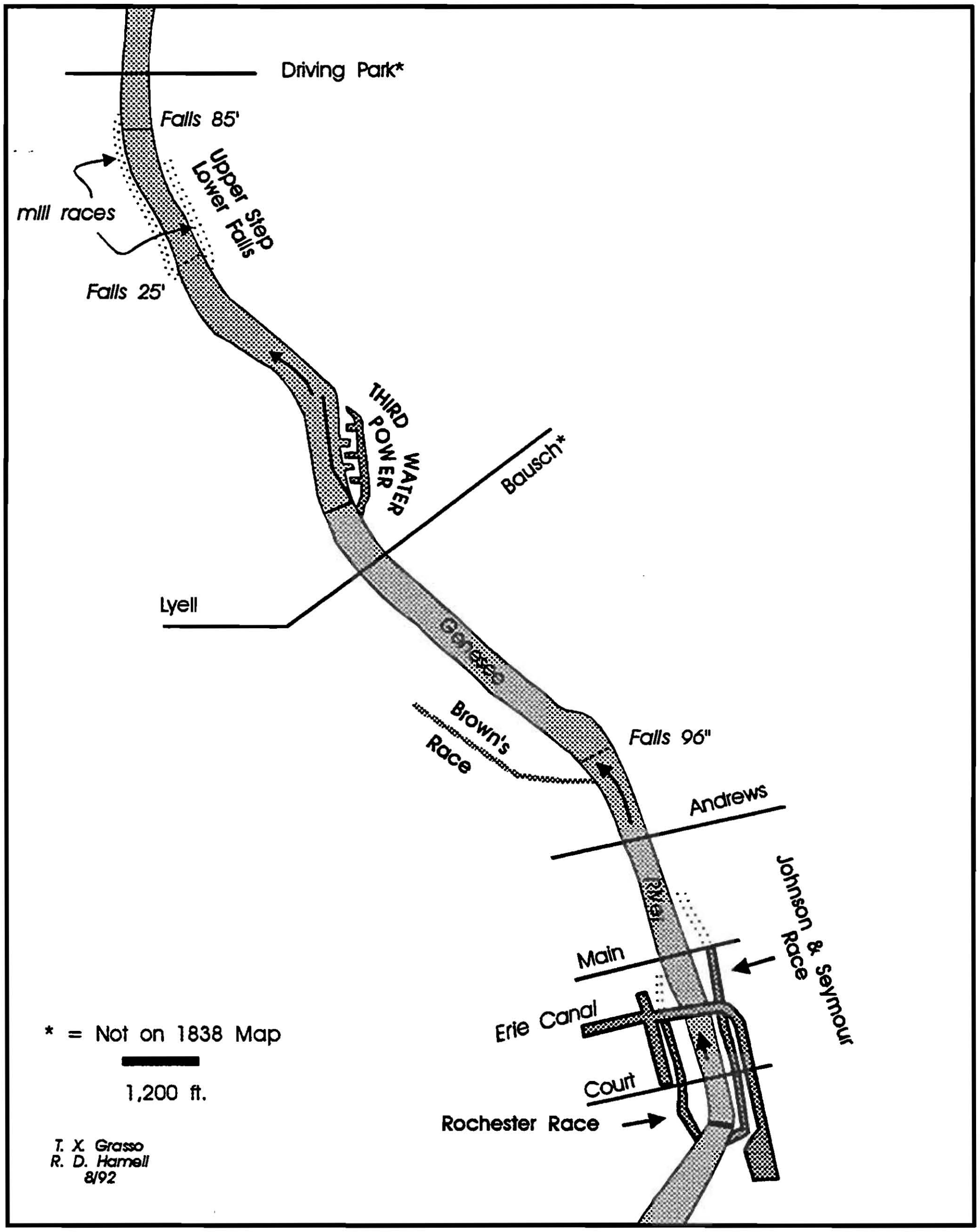

FIGURE 28 Rochester's mill races. Modified from S. Cornell, 1838: O'Reilly's *Sketches of Rochester.*

One can perhaps safely conclude that the rapid growth and industrial boom of the early years fueled an analogous but nearly unquenchable thirst for ardent spirits!

Oak Orchard Dolostone (Howell and Sanford, 1947)

Upstream and south of downtown the Oak Orchard Dolostone (Guelph), the uppermost formation of the Lockport Group, was once exposed. It formed a small rapids in the river and was a common fording point for travelers during low water. The rapids were located just north of the Interfaith Chapel on the University of Rochester campus. From the west side of the river the rapids were located opposite the point where Brooks Avenue joins Plymouth Avenue. The settlement that grew up at the intersection of Brooks Avenue and Genesee Street was known originally as Castletown or "The Rapids" or the "Genesee Rapids" (Rosenberg-Naparsteck, 1992).

By 1822 the State erected a dam at the rapids and constructed the Genesee Feeder on the east side that joined the river, just above the dam, with the Erie canal behind the Old Stone Warehouse (South and Mt. Hope Avenues). This feeder canal conveyed Genesee River water to the Erie Canal, thereby augmenting and replacing the water supply coming from Lake Erie, as most of the Lake Erie water, by the time it reached Rochester, was lost to evaporation and seepage. By 1918 Barge Canal construction had obliterated the rapids by blasting and by raising the level of the river when the Court Street Dam was put in. The pool thus created provides water for the Barge Canal east of the Genesee River.

The Oak Orchard Dolostone contains numerous vugs lined and/or filled with minerals and crystals such as gypsum, selenite, calcite, dolomite, sphalerite and fluorite. It also possesses a fairly high diversity assemblage of corals and other invertebrates although the preservation is often poor. Its inferred environment of deposition was shallow, subtidal marine but deeper than the underlying Penfield Formation.

The Oak Orchard is exposed in road cuts on I-390 north of the airport, I-490 near the NY 531 (Spencerport) interchange, I-490 and I-590 junction, I-490 near the Penfield Road interchange, and in the Barge Canal cut on the west side of the city which also exposes the underlying Penfield, Decew, and Rochester Shale in that order going northwest to Long Pond Road.

SALINA GROUP (Dana, 1863)

Above the Lockport Group is the Salina Group of late Silurian age. It is composed of shallow water, hypersaline, lagoonal deposits of dolomite, salt, and gypsum combined with nonmarine and occasional marine shales. Sparse and widely scattered exposures of the Salina Group may be found south of the city line to Honeoye Falls, Avon, and Caledonia and along the Erie Canal east of Rochester to Lyons. The mines at Garbutt, southwest of Scottsville, once extracted gypsum from the upper part of the Salina Group.

Pittsford Shale (Sarle, 1903)

The lower 20 to 40 feet (7 to 12 m) of the Salina Group, resting on the Lockport in the Rochester vicinity, is the Pittsford Shale. The Pittsford is a sequence of soft green, purple, red, and black shales, one or several feet thick, interbedded with thin fine grained dolostone beds, a few inches to several inches thick. Sarle (1903) first described the Pittsford Shale and its eurypterid fauna from exposures along the old Erie Canal north of Old Lock 62 and south of the Spring House Restaurant when the canal was deepened to 9 feet (3 m) in the winter of 1897-1898. Ciurca (1990) has redefined the Pittsford Shale restricting the name to just a bed of black shale a few feet thick that contains eurypterids (see description in Roadlog; **STOP 1,** p. 79). At the time of its discovery the Pittsford Shale's eurypterid fauna was the earliest one then known and contained 6 species belonging to the genera: *Hughmilleria, Eurypterus, Pterygotus,* and *Mixopterus.* The remainder of the fauna consisted of a rare graptolite, brachiopod (*Lingula*), bivalve (*Pterinia*), Ostracod (*Leperditia*), xiphosurans (pseudoniscids), and phyllocarids.

The Pittsford Shale is a nearshore more shallow water environment than the underlying Oak Orchard Formation probably representing an estuarine, or bay environment. The eurypterids were possibly gently rafted in from a fresh water source most likely to the north.

Overlying the Pittsford Shale is the remainder of the Salina Group namely the Vernon, Syracuse, and Camillus Formations all poorly exposed in southern Monroe County. They are blanketed by Pleistocene glacial deposits.

LATE PALEOZOIC

The Acadian and Alleghenyan Orogenys of Late Paleozoic age produced the Appalachian Mountains. Relative to the Rochester region, these orogenic forces had their greatest impact in New England, eastern most New York State, and Pennsylvania from Williamsport south. In the Genesee Valley the previously deposited strata were given a gentle dip of $1/2^{o}$ south.

MESOZOIC-CENOZOIC ERAS

Throughout the Mesozoic and Cenozoic Eras the Genesee region was undergoing erosion and the Genesee River gradually came into existence. The details of how the Genesee River came to be may be found in the countless publications of Herman Leroy Fairchild but particularly his 1928 *Geologic Story of the Genesee Valley and Western New York.*

Just before the Pleistocene Epoch, nearly two million years ago, the Genesee River flowed north from Avon turning east at Rush nearly to Honeoye Falls where it continued its northward flow through what is now the Irondequoit Valley as shown on Figure 29. At this time the Genesee River joined the Ontario River somewhere near the center of what is now the Lake Ontario Basin. Had the Genesee River remained in its preglacial course human events of the 18th and 19th century would have taken a drastically different direction. The glaciers of the ice age were about to make some dramatic changes in the landscape of the Rochester region.

GLACIAL HISTORY

Pleistocene Epoch

During the Pleistocene Epoch, numerous "ice ages" affected the Northern hemisphere, separated by intervals of milder, ice free, interglacial episodes. The last glacial event, called the Wisconsinan Stage, was the one that left the most indelible imprint on the face of New York State. Although there is documented evidence of earlier glacial stages, the bulk of the depositional record is from the Wisconsinan time. This late Wisconsinan ice sheet was at its maximum extent 19,000 to 22,000 years ago and covered nearly all of New York State, except for a small triangular area in southwestern New York near Salamanca-Olean called the Salamanca Re-entrant. The present course of the Allegheny River in this area was controlled by the ice margin.

Glacial Moraines

At the south edge of the city stretches a southwardly convex, linear, lobe of hills and knolls approximately 4 miles long called the Pinnacle Hills Moraine. From west to east the main components of the range are Oak Hill, now the University of Rochester campus, Mount Hope Cemetery, Highland Park, Colgate-Rochester Divinity School campus, Pinnacle Hill, Cobbs Hill and several smaller knolls extending east to Winton Road (Figure 30). Pinnacle Hill, (750 feet; [27 m] above sea level) is the highest hill in the complex and rises 230 feet (70 m) above the city plain below. The Pinnacle Hills Moraine is part of the Albion-Rochester Moraine deposited nearly 13,000 years BP, and is the best example of a kame moraine north of the south end of the Finger Lakes.

The Pinnacle Hills Moraine formed when the melting edge of the glacier retreated north from the Finger Lakes region then readvanced south to a position that is now the north slope of the Pinnacle Hills Moraine. When this occurred the rock debris in the ice, ranging from fine clay, silt, and sand to boulders, was dumped at the melting edge as an irregular subaqueous ridge (kame moraine), deposited in a proglacial lake parallel to the ice front. The moraine today is a series of irregularly shaped mounds crudely resembling large "eggs in a basket": Mount Hope Cemetery and Highland Park are good examples of this topography. The Pinnacle Hills Moraine is one of several other major recessional moraines in New York State marking successive, positions of the ice margin.

Recessional moraines may be deposited directly by the ice, in which case they are crudely stratified and composed of glacial till, a poorly stratified mixture of boulders, cobbles, sand and clay. If a moraine is constructed by meltwater flowing off the glacier, it tends to be made up of well-sorted, stratified sand and/or gravel and is known as a kame moraine. The term

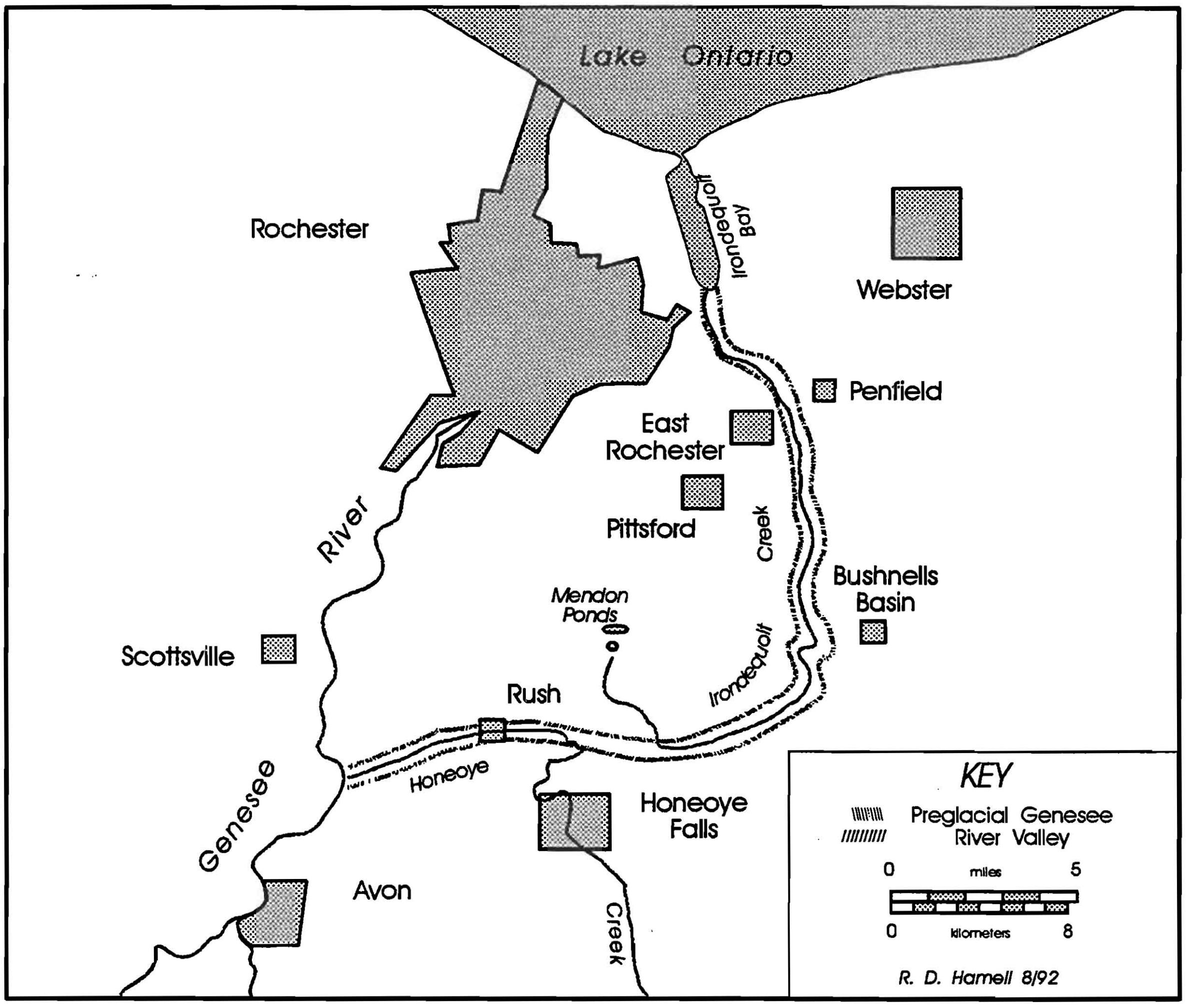

FIGURE 29 Preglacial Genesee River near Rochester

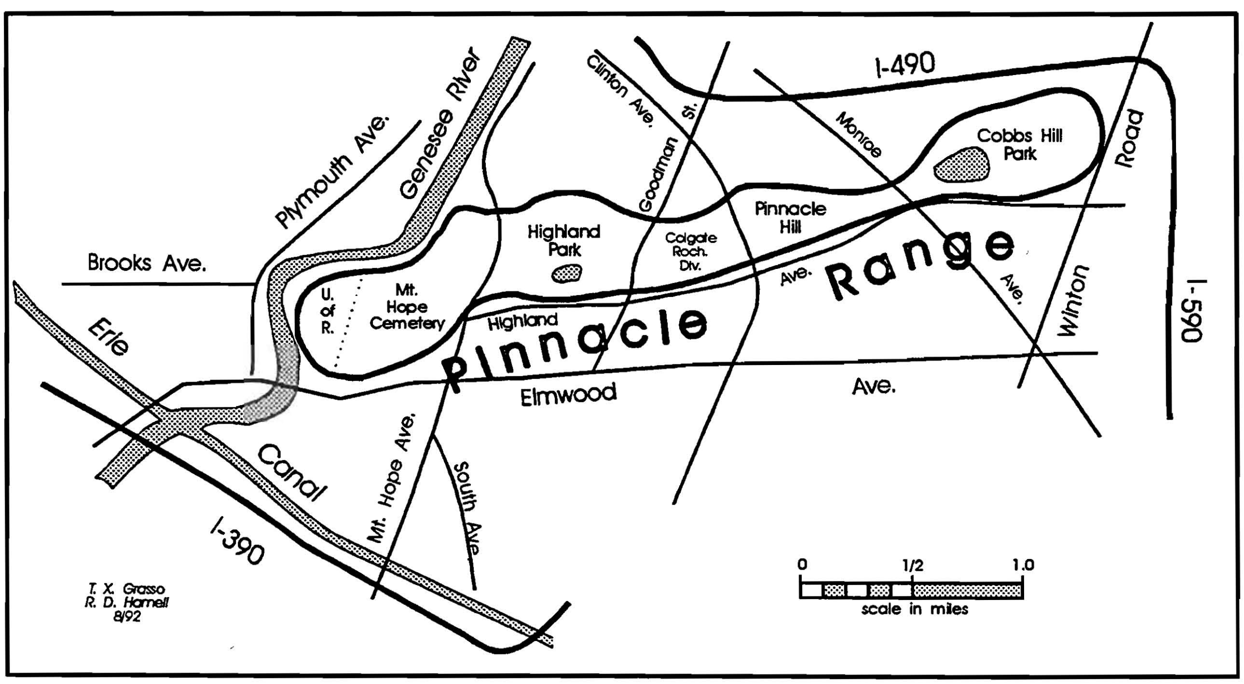

FIGURE 30 Map of the Pinnacle Range

kame has a Scottish origin meaning mound or knoll. The Pinnacle Hills Moraine is primarily a kame moraine, although thin glacial till deposits cap most of the hills in the range. This attests to a minor readvance of the ice which overrode the moraine. The moraine forced the ice to flow over its crest leaving the till behind when the glacier melted. The contorted and faulted strata revealed by 19th century quarries in the Pinnacle Hills Moraine were deformed when the ice advanced over the moraine (Fairchild, 1923).

Proglacial Lakes and the Rerouting of the Genesee River

Proglacial lakes formed when the glacial ice sheet acted as a dam because the terrain in central and western New York slopes to the north. Therefore, as long as the ice occupied the Lake Ontario basin and blocked the Mohawk Valley, the St. Lawrence, and western outlets, waters from northward flowing streams and glacial meltwater were impounded in front of the ice as proglacial lakes. The southern border of the lakes was the high land to the south, while the lake waters to the north impinged against the ice. The glacial lakes found outlets to the ocean either west past Chicago and down the Mississippi or east past Syracuse and Rome and out the Mohawk-Hudson Valleys. In the Genesee Valley fifteen proglacial lakes, at various elevations, existed from 19,000 to 9,000 years BP (Muller et al., 1988).

One of these proglacial lakes was Lake Dawson (13,000 years ago) at approximately 480 feet above sea level, and over 200 feet higher than Lake Ontario. It flooded most of the Rochester area north and east of downtown. The relict shoreline of this lake extends from just north of Ridgeway Avenue, northwest of Rochester, to I-590 just south of the Monroe Avenue interchange, southeast of the city, as shown on Figure 31. Twelve Corners at an elevation of 491 feet above sea level, was less than 11 feet above Lake Dawson's waters (Figure 31).

Contemporaneous with Lake Dawson, Lake Scottsville existed in the Genesee Valley, dammed at its northern end by the Pinnacle Hills Moraine. This lake, at an elevation of 540 feet (165 m) above sea level, was the immediate precursor of the Genesee River, and extended up the valley to Avon. Previous to Lake Dawson time the eastward trending portion of the ancestral Genesee Valley, past Rush and Honeoye Falls, had been filled and buried by glacial deposits making this outlet unavailable for Lake Scottsville. Lake Scottsville's waters drained northward across a sag or saddle in the Pinnacle Moraine at the University of Rochester and did not reoccupy the older valley. The Genesee River flowing due north in its new postglacial course, emptied into Lake Dawson about one mile north of the present High Falls, which then came into existence near the Bausch Street Bridge as the river tumbled over the edge of the Niagara Escarpment forming a series of rapids (Figure 31).

Continued withdrawal of the ice margin farther north exposed a lower outlet than Lake Dawson. The result was a 45 foot (14 m) drop of Lake Dawson's water to form Lake Iroquois at an elevation of 435 feet (133 m) above sea level. As Lake Scottsville completely drained, the mouth of the river shifted north one mile (approximately two miles north

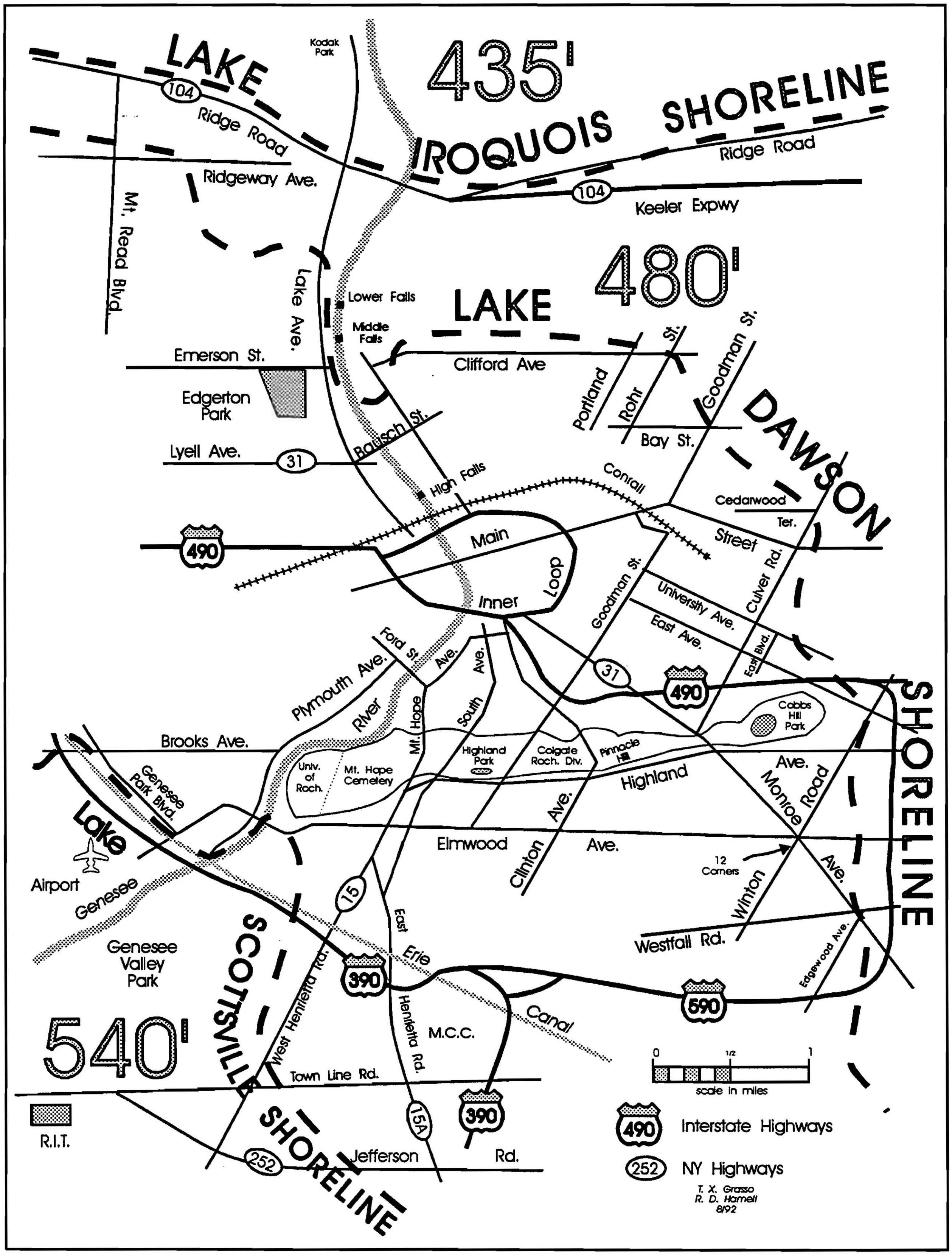

FIGURE 31 Proglacial Lakes in the Rochester Vicinity

of the High Falls) to a point just north of the Veterans Memorial Bridge near Kodak. The High Falls became a cascade just north of its present location and was only 40 feet (12 m) high, compared to nearly 80 feet (24 m) today. Contemporaneously the Middle and Lower Falls emerged as a series of small rapids with the Middle Falls near the Veterans Memorial Bridge and the Lower Falls a short distance north. Once the ice pulled back from Covey Hill in the St. Lawrence Valley, Lake Iroquois lowered to form Early Lake Ontario 50 feet (15 m) above sea level approximately 10,000 years ago. The region which had been depressed earlier by the ice's weight, permitted the existence of a lake approximately 200 feet (61 m) below the present level of Lake Ontario. At this time the mouth of the river extended another nine miles north from its previous location to a position seven miles north of the present southern shore of Lake Ontario at Charlotte, whereupon all three waterfalls were etched into relief and retreated upstream (south) nearly to their present positions. At the same time the lower portion of the gorge, near to and south of Stutson Street, was incised by river erosion. After this time, the region continued to rise due to isostatic rebound, which was greater in the north than in the south. Consequently modern Lake Ontario rose in elevation from the Early Lake Ontario stage and spilled over on its south shore to form Irondequoit Bay, Long Pond and the other bays and inlets along the south shore of Lake Ontario.

In summation the Rochester Gorge formed by river erosion carving its way through solid bedrock as lakes first fell then rose beginning approximately 12,600 years ago. Rochester's most remarkable and certainly its most significant feature had come into existence.

SUMMARY AND CONCLUSIONS

As we have seen, Rochester's preeminence as a water powered industrial giant did not begin with Indian Allen or the purchase of the 100 Acre Tract by Rochester, Fitzhugh, and Carroll. It was preordained for greatness by its long geological history. Back through the arch of time, one can glimpse the seeds of its growth in the deposition of the resistant Lockport Dolostone and its subjacent Clinton and Medina Group strata. The Silurian seas that rose and fell resulted in a depositional package of sediment that contained rock units of varying resistance to the destructive force of erosion. The Grimsby-Kodak Sandstones, Reynales Limestone, and Lockport Dolostone are resistant, while the Queenston, Maplewood, Sodus-Williamson, and Rochester shales are relatively weak. All were uplifted near the end of the Paleozoic Era imparting a southerly dip to the strata and after millions of years the Niagara Escarpment was etched into relief.

Leaping forward to the Pleistocene Epoch, the Pinnacle Hills Moraine temporarily dammed proglacial Lake Scottsville which was prevented from escaping eastward past Rush because the old channel was choked with glacial debris. As Lake Dawson dropped to the Lake Iroquois level, Lake Scottsville drained north across the Pinnacle Hills Moraine forming the Rochester Canyon; first as a series of rapids north of the Bausch Street bridge and then later as the well defined Upper Falls. In a similar fashion, but later in time, a series of rapids farther north would eventually evolve into the Middle and Lower Falls. Finally, the ice melted back and Lake Iroquois fell to form Early Lake Ontario below the present level of Lake Ontario. The Rochester Gorge became deeply incised through its entire length. As Early Lake Ontario waters rose to form modern Lake Ontario the lower gorge from Charlotte to the base of the Lower Falls was flooded.

And so, the rapids and waterfalls came into existence; namely "The Rapids" at the University of Rochester campus at the top of the Niagara Escarpment, the original Upper Falls downtown near Broad Street over the Penfield Formation, the High (Main) Falls over the Gates Member of the Rochester Shale (Figure 32), the Middle Falls over the Reynales Limestone, and the Lower Falls over the Kodak-Grimsby Sandstones. These majestic cascades and waterfalls lay waiting thousands of years for people to one day take up their inheritance. Though humans have nearly spoiled it through neglect, abuse, oversight and overuse, we have finally begun to dimly comprehend how precious, how significant, how important and how beautiful the river and its canyon are for us today. Let us hope that we never forget!

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historical significance. We will attempt to recreate that portion of the trip through western Wayne and Eastern Monroe counties to Rochester. In addition, Sir Charles Lyell traveled through New York State in 1841 (Lyell, 1845), visiting both Amos Eaton and James Hall. Our itinerary therefore incorporates some of Lyell observations.

Eaton's Trip - Syracuse to Rochester 1826

The canal route west from Syracuse follows a series of swampy meltwater channels through Camillus, Jordan, and Port Byron to Montezuma. The melancholy travelers described the "tedious period" as they were "plunged into a swamp of white cedar, pine, hemlock, etc." and there was "nothing cheerful or amusing in it. . . spirits are uncommonly dejected."

The Eaton party arrived at Jordan on Thursday, May 11, and noted that the Saliferous rock [Salina Group] is found nearby and that it persists nearly to Rochester. Also at Jordan there was a Clinton's ditch lock, with an eleven foot lift to the east, located just west of the aqueduct over Skaneateles Creek. George Clinton (p. 287) noted that "the lock and aqueduct are made of a very coarse grained limestone containing terebratulites." However on the return trip Thursday, June 1 he wrote (p.300):

> "In going up I was told by Doctor Eights that it was a coarse grained limestone he having dissolved it entirely. Seeing him so confident and not having an acid by me, I was fool enough to take it upon trust, maugre the evidence of the senses. It is nothing more or less than a sandstone....." [Oriskany Sandstone with *Hipparionyx*]

Today some of these original Clinton's Ditch building stones line the walls of the realigned Enlarged Erie (1845), just west of the enlarged aqueduct and now a village park in Jordan.

A short distance north of the Enlarged Erie aqueduct at Montezuma, the line of Clinton's Ditch crossed the Seneca River on grade, the horses towed the boats across the river on a long towpath bridge. Some poles of this towpath bridge yet remain. Eaton's class crossed the Seneca River on Thursday, May 11, and Asa Fitch described how "the towpath is built on 130 bents . . . in a state of rapid decay and will need rebuilding in a few years." Rezneck (1959) interpreted the poorly handwritten word "bents" as "boats" and thus thought the Seneca crossing to be a pontoon or float bridge.

West from Montezuma the canal follows the bed of Lake Iroquois and, as stated earlier, from Lyons to Fairport the Fairport meltwater channels. George Clinton (p. 287) wrote:

> "We put up for the night at a lock about 6 miles beyond Montezuma [Lockpit]. During our journey we observed several water-snakes, one of which had a small catfish in his mouth, and although chased about for some time preserved his hold until being knocked on the head by a pole, he sunk......we have had recourse to fishing in order

to pass away pleasantly this tedious period. The thing once commenced, of course it was not long confined to such narrow limits......the fish heretofore caught consisted of suckers, dace, and a small fish exactly resembling........the one called *shiner* by the Albanians. This day (Friday, 12th) I caught a yellow perch. We stopped for the night at Palmyra. During the day we observed large numbers of the *Anadonta marginata* [bivalvia] floating on the canal......

Saturday 13. Stopped at Bloss's within 5 miles of Rochester" [Brighton at Jct. of I-490 and I-590].

Asa Fitch recorded the same section of the trip as follows:

"Thursday May 11.....The river [Seneca] has scarcely any current and is not over 4 feet deep.

From here all the way to Buffalo mile boards are put up. From here to Lockpit 6 miles west-the canal is at present on a level with the surface of the river. Alluvial formations are marly clay and black marl. Had to stay on board again at night no tavern for 5 miles of Lockpit.

Friday May 12.....Left boat took a walk collected botanical specimens and thought of home......Ate dinner at Lyons.....considerable business is done here. Messers Hulbert and Root remain to give lectures on Botany and Chemistry. The former is clever fellow rather green in his manners having had but little acquaintance I suppose in company. But he learns with eagerness.....Took supper at Newark. Stayed for the night at Palmyra-slept on shore.

Saturday May 13 Fine weather......finally have gotten through immense swamps of the canal. Beautiful vallies [*sic*] and gently sloping hills [meltwater channel and drumlins]......Pleasant ride to Bushnell's Basin. Few buildings here. Temperature at 2:30 o'clock 86° in a cool shade. High southwest wind blows sand in our eyes [kames and esker] and on our clothes. This deprived us of a good view of the Great Embankment. Put up opposite Bloss's Canal Hotel about 3 miles East of Rochester. I am the daily assistant tomorrow of which I have to bring in my bottle for the boatmen which is the practice of the assistants each day."

Let Lyell's diary speak for him (1845, p.19):

"In the course of this short tour, I became convinced that we must turn to the New World if we wish to see in perfection the oldest monuments of the earth's history, so far at least as relates to its earliest inhabitants. Certainly in no other country are these ancient strata developed on a grander scale, or more plentifully charged with fossils; and, as they are nearly horizontal, the order of their relative position is always clear and unequivocal."

Lyell, jointly with James Hall, examined the drumlins in the Rochester area. Lyell had seen similar features in Sweden, and he wrote (1845, p.24):

"Geologists are all agreed that these and other similar ridges [the drumlins] surrounding the great Canadian lakes, and occurring at different heights above them, were once lines of beach surrounding great bodies of water. Whether these consisted of lakes or seas, -- how the water came to stand at so many different levels, and whether some of the ridges were not originally banks and bars of sand formed under water, are points to be explored."

ROCHESTER

AND

ALBANY.

Red Bird Line of Packets,

In connection with Rail Road from Niagara Falls to Lockport.

1843.

1843.

12 hours ahead of the Lake Ontario Route!

The Cars leave the Falls every day at 2 o'clock, P. M. for Lockport, where passengers will take one of the following new

Packet Boats 100 Feet Long.

THE EMPIRE!

Capt. D. H. Bromley,

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and arrive in Rochester the next morning at 6 o'clock, and can take the 8 o'clock train of Cars or Packet Boats for Syracuse and Albany, and arrive in Albany the same night.

☞ Passengers by this route will pass through a delightful country, and will have an opportunity of viewing Queenston Heights, Brock's Monument, the Tuscarora Indian Village, the combined Locks at Lockport, 3 hours at Rochester, and pass through the delightful country from Rochester to Utica by daylight.

N. B.---These two new Packets are 100 feet long, and are built on an entire new plan, with

Ladies' & Gentlemen's Saloons,

and with Ventilators in the decks, and for room and accommoda tions for sleeping they surpass any thing ever put on the Canal.

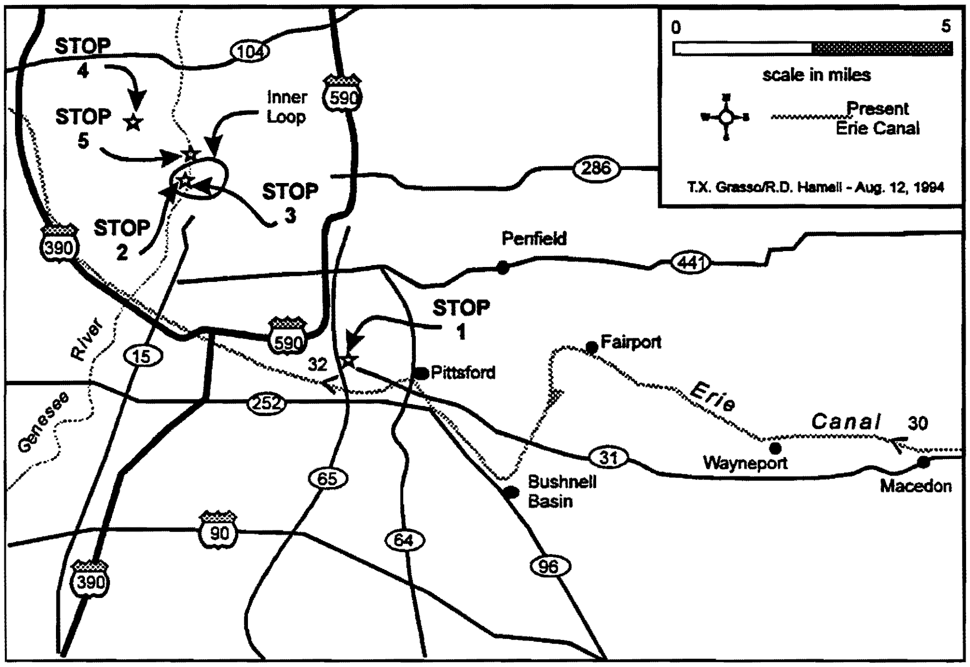
For Passage apply at Railroad and Packet Office, Niagara Falls.

September. 1843.

T. CLARK, } Agents
J. J. STATIA, }

[From D. Veeder, 1968, *The Original Erie Canal at Fort Hunter*; Fort Hunter Canal Soc., NY, p. 10]

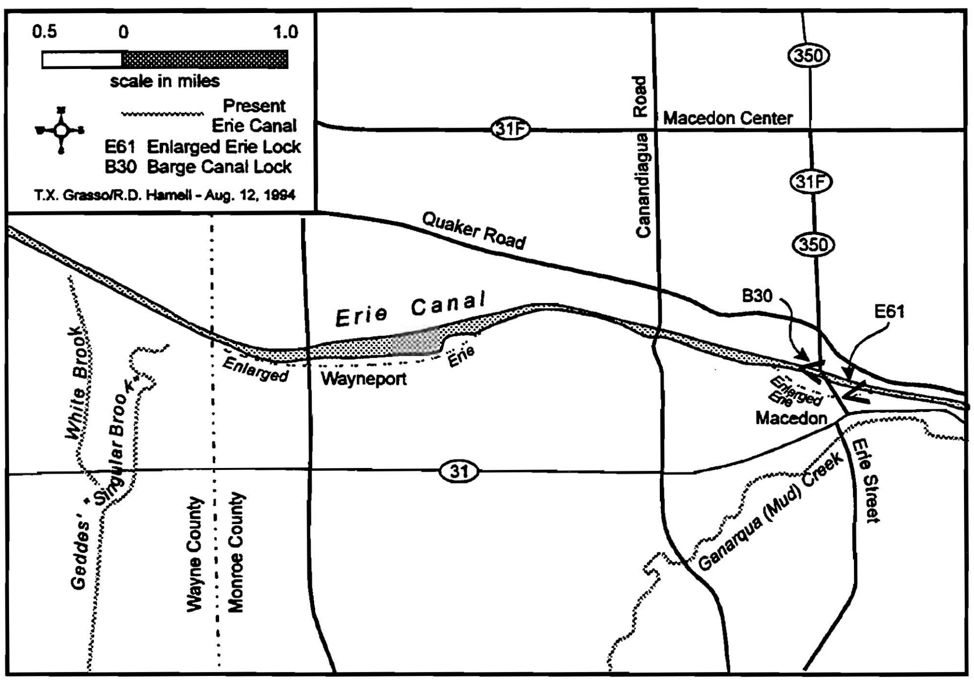
ROADLOG



MAP 1 Field Trip Stops

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Begins at intersection of Wilson Blvd. and Elmwood Ave.
0.00	0.00	Proceed east on Elmwood to I-490
2.00	2.00	Pinnacle Hill with TV transmitters on top on left at intersection of Clinton Ave.
4.00	2.00	Jct. I-590 proceed east on Elmwood. I-590 is on alignment of Old Erie Canal.
5.3	1.3	Jct. East Ave (NY96) proceed east on Elmwood.
5.5	0.2	Jct. I-490 turn right (SE) onto I-490.
10.0	4.5	Exit I-490 at Pittsford-Palmyra (Exit 26) interchange. Proceed east on NY31 to Macedon.
11.4	1.4	Cross Erie Canal.

12.6	1.2	Jct. NY250. Proceed east on NY31. Route East to Macedon offers many fine vistas of drumlins and other glacial features.
16.4	3.8	Enter Wayne County - Town of Macedon.
19.4	3.0	Enter Village of Macedon.
20.2	0.8	Jct. NY31F and NY350. Turn left (N) on these routes.
20.4	0.2	Cross alignment of Old Erie Canal. Old Lock 61. Turn left (W) at Lock 30 (Macedon Lock) on the Barge Canal. Lock 30 has a lift of 17 ft. (5 m) West and was completed in 1916.



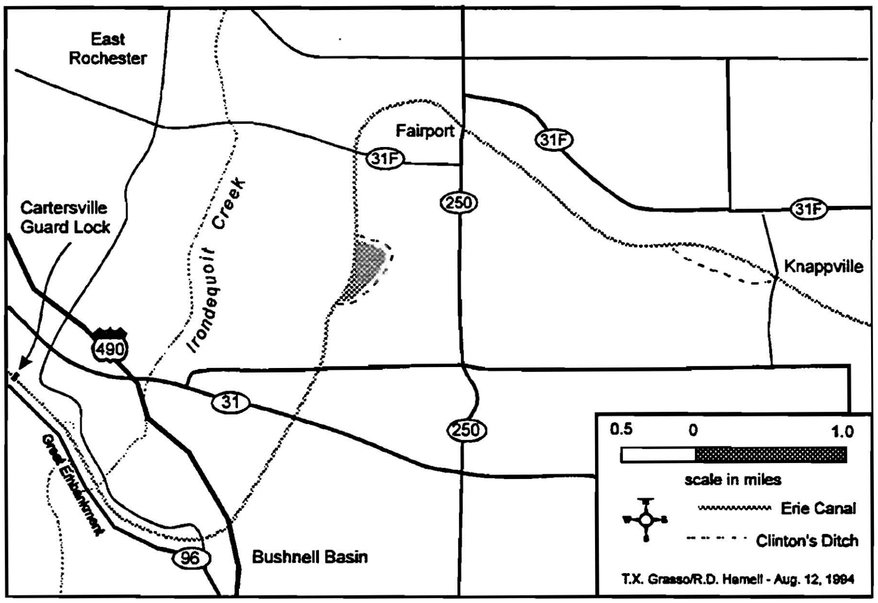
MAP 2 Erie Canal Macedon to White Brook

Board canal boat SAM PATCH for Lock 32 (Pittsford Lock) west of Pittsford. (There is no Lock 31).

<u>**The distances listed below are approximate miles from the head of Lock 30.**</u>

0.0	0.0	Head of Lock 30. The Erie Canal here partly restored the flow of the ancient Great Lakes (and proglacial) waters through the Fairport meltwater channels. From here to Fairport the canal route follows the main meltwater channel.

1.0	1.0	Bridge over canal.
1.9	0.9	Old Erie Canal channel veers left (S) of the present canal through the hamlet of Wayneport. Start of widewaters created by Barge Canal construction which allowed water of present canal to back up against old canal bed.
3.1	1.2	Wayneport Bridge.
3.4	0.3	Old canal loop enters present alignment - west end of widewaters.



MAP 3 Erie Canal White Brook to Cartersville

3.6	0.2	Monroe County-Wayne County line.
5.3	1.7	Lynden Road Bridge - this site was known as Knappville - a sleepy community in old canal days.
7.0	1.7	Enter village of Fairport.
7.6	0.6	Fairport (Main Street) lift bridge (1914-1915), one of sixteen between here and Lockport and the first one west of the Hudson River on the Erie Canal. Daniel and Henry Deland established the Deland soda and saleratus (baking soda) chemical works on north bank of the canal just east of this

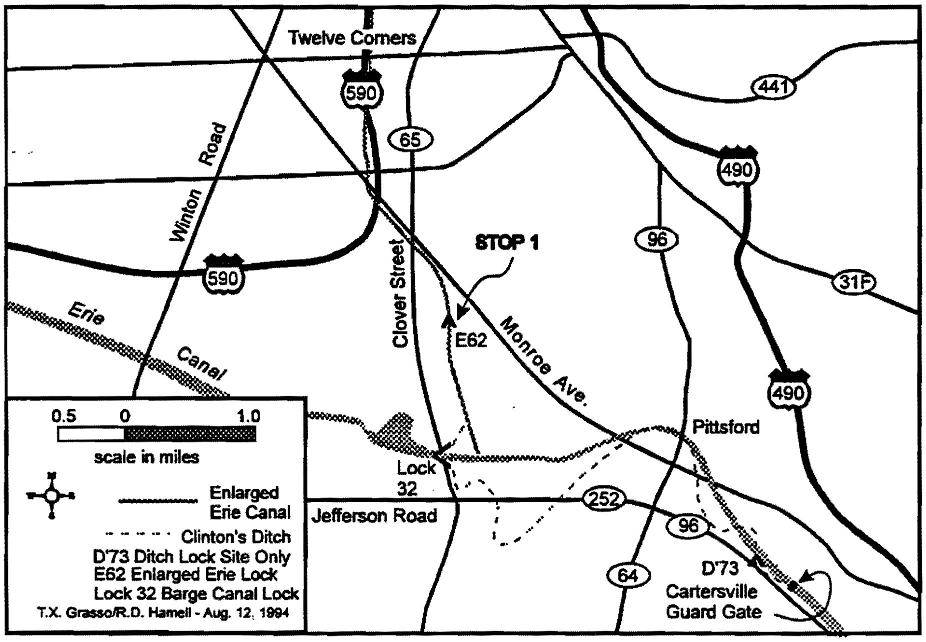
		bridge in 1852. It burned in 1893. The Box Factory and Village Cafe occupy the site.
8.5	0.9	NY31 bridge over canal. This site was known as Fullamtown in Amos Eaton's time as Elisha Fullam, in 1822, built a tavern and warehouse here along with other buildings. Travelers proceeding west to Rochester often transferred to stagecoach at Fullamtown as the overland route was 8.5 miles (13.7 km) shorter.
9.15	0.65	Start of the Oxbow on left (E) - a large loop of Clinton's Ditch that was cutoff when the enlarged Erie was constructed through here circa 1855.
10.3	1.15	NY31 bridge.
11.1	0.8	I-490 bridge.
11.2	0.1	Site of Bushnell's Basin canal break in November 1974. Canal washed out due to collapse of a sewer tunnel being bored beneath the canal. Navigation was not restored until late 1975 - nearly a year later.
11.4	0.2	Marsh Road bridge - Bushnell's Basin.
12.0	0.6	East (SE) end of the Great Embankment. The Erie Canal vaults Irondequoit Valley nearly 60 feet (18 m) above the valley's floor. A culvert nearly 500 feet (152 m) long conveys Irondequoit Creek beneath the embankment. The passage high above the surrounding terrain was sharply curved at its western end (NW) as it followed the serpentine crest of the Cartersville Esker. Dryer (1890, p. 203) described it as a "*kame which extends from Cartersville on the west to and beyond Bushnell's Basin on the east. The north end is a sharp ridge of very coarse gravel, fifty feet in hight* [*sic*], *one mile long and in shape like a rude fish-hook.....Irondequoit river.....has cut the kame completely in two. In the southern portion the gravel is overlain by fifty feet of fine sand which spreads out toward the southeast.....The Erie Canal avails itself of this kame to cross the valley and by a fifty foot embankment restores what probably once existed as a natural feature.*" Upham (1893, p. 190-191) described the feature as part of an esker and kame belt "*.....from a point about a mile east-southeast of Pittsford village to its termination about a mile southeast and south of*

the village of Bushnell's Basin....." Fairchild (1896, p. 135-136) described it fully beginning with ......"*nearly opposite Cartersville and north of Bushnell's Basin is a conspicuous esker.....*" Giles (1918, p. 208-211) named the Cartersville Esker and included a contour map of its northwest portion near Pittsford.

The "rude fish-hook" part of the embankment was deemed too sharp for tugs and barges during Barge construction. Therefore, a new great embankment was built cutting off the esker loop and straightening the canal's alignment. The old loop is still marked by a line of trees north of the present canal.

The new embankment was begun in 1908 and completed in the spring of 1912. The original part of the older embankment over Irondequoit Creek was also modified at this time. In October, 1912, the Great Embankment over Irondequoit Creek collapsed down to the level of the creek in the worst canal breach of its history in this district. Water leaking through the new concrete floor eventually weakened the Irondequoit Creek culvert until it collapsed. Within a few weeks the breach was dammed at each end and a temporary wooden flume erected on piles 60 feet (18 m) high to convey canal boats across the break until the embankment and culvert could be rebuilt. This was accomplished in 1918. The south (SW) wall of the current trough bows outward where the flume used to be as the engineers poured the new wall around the flume. They removed it in the winter of 1917-1918 to pour the new concrete floor. Small tunnels (galleries) were built into the new structure to channel off any leaks and to permit visual inspection. This part of the embankments has held ever since

12.75	0.75	West (NW) end of Great Embankment. When Eaton's party crossed the embankment in 1826 blowing sand prevented them from having a good view of the Great Embankment
13.65	0.9	Mitchell Road bridge. The Clinton's Ditch Pittsford Lock (Lock 73) was located just southeast of this bridge. The LAFAYETTE locked up through here on Saturday May 13, 1826.



MAP 4 Erie Canal Cartersville to Old Erie Lock 62 (STOP 1)

14.15 0.5 NY31 bridge - Enter Pittsford

Between this bridge and the Main Street bridge is the Schoen Place district. In the later part of the 19th century and into the 20th century lumber yards, a malt house, and warehouses lined the south side of the canal while coal sheds, a flour mill, and fruit evaporators were located on the northside. A grain and bean processing mill and Pittsford Lumber Company still survive on the north side amid the rows of boutiques, shops, and restaurants.

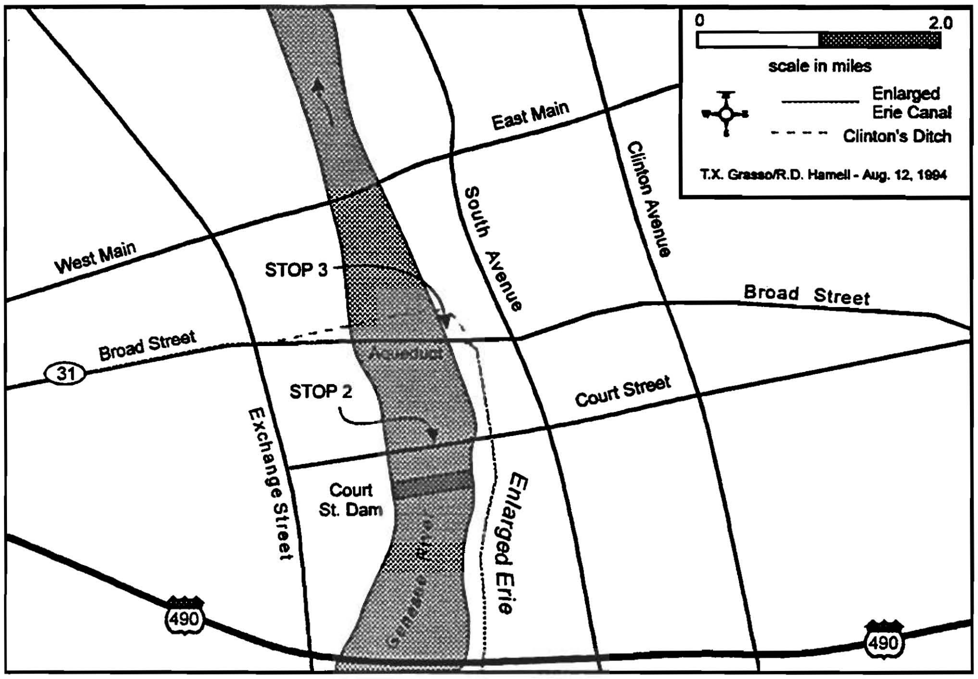
14.4 0.25 Main Street bridge

14.6 0.2 Conrail bridge.

The south abutment of the bridge rests on the Barge Canal Bed of the Vernon Formation of Ciurca (1990). It is the youngest of four eurypterid bearing horizons in the lower 100 feet (30 m) of the Vernon Formation. When the canal is drained in the winter the exposure reveals several feet of black shale grading upward into greenish shale. The fauna consists of *Eurypterus pittsfordensis* and rare *Mixopterus* remains.

The other horizons, in order of superposition are the Harris Hill Bed, Monroeav Bed and the Pittsford Bed. Ciurca equates the

"Gananda Bed" of Hamell (1978) with the Barge Canal Bed although the two are 10 miles (16 km) apart.



MAP 4A Map of STOP 1

14.8 0.2 NY31-Monroe Avenue bridge.

The state maintenance shops near the west end of the bridge were built around 1928. Clinton's Ditch ran on the south side of the canal from here to Lock 32.

15.6 0.8 The Old Erie Canal veers north towards Monroe Avenue and downtown Rochester. The present channel from here to Greece was opened in 1918.

15.8 0.2 Cross alignment of Clinton's Ditch in its northward course to downtown Rochester.

15.9 0.1 Clover Street (NY65) bridge and Lock 32.

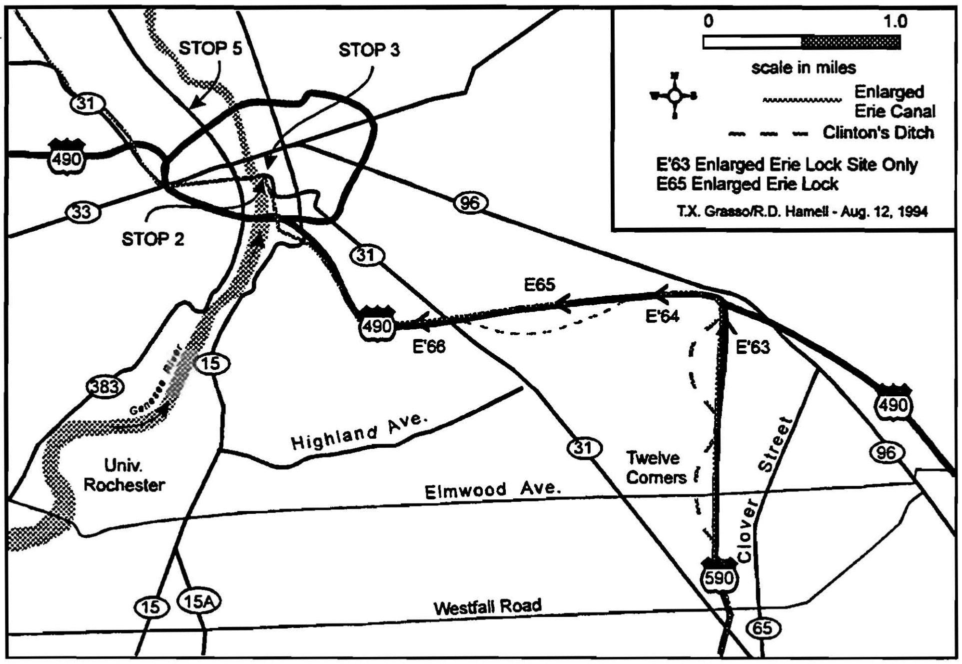
Lock 32 (1917) is the third Pittsford Lock. The first, Lock 73 (1822), was located near the Mitchell Road Bridge; the second, 0.9 mile (1.5 km) north of here is the Enlarged Erie Lock 62 (**STOP 1**). Lock 32 has a lift of 25 feet (7.5 m).

		Board bus - roadlog begins at Clover Street (NY65) and entrance to Lock 32 Canal Park.
0.0	0.0	Proceed north on NY65.
0.6	0.6	Jct. French Road - turn right (E) on French Road.
0.9	0.3	Cross alignment of Old Erie Canal.
		In World War II landing craft were built on the southside of French Road in the old canal.
1.2	0.3	Jct. NY31 (Monroe Avenue) - turn left (NW) on Monroe Ave. Pittsford Plaza on left.
1.7	0.5	Turn left between the second and third signal light opposite the Marine Midland Bank. Proceed straight to the back of the plaza between the Firestone store (left) and First Federal Bank (right).
1.8	0.1	**STOP 1 - Enlarged Erie Pittsford Lock 62 and Pittsford Shale.**

Lock 62 had a lift of 9.2 feet (2.8 m), going west, and was completed as a single chamber, enlarged lock (110 feet by 18 feet; 33.5 m by 5.5 m) by Jesse Petersen in 1855 for $26,260,77. It was doubled by James Wiltsey in 1873 for $34,269.19. At the upper end of this second chamber a drop gate was installed instead of the typical vertically hinged miter gates. This new type of lock gate was horizontally hinged and operated like a draw bridge so that when it was open it rested upstream on the floor of the canal. It was the invention of George Heath and was called Heath's Tumble Gate. They were installed on many Enlarged Erie Locks. The lock was lengthened in 1887-1888 to permit the passage of double headers (two boats lashed together) by B. T. Smith for $25,021.26. The final improvement came in 1890 when a water powered turbine, propelled by the overflow water, was installed at the base of the vertical shaft at the head of the lock. The turbine was in turn connected to geared shafts that operated rope cables wound around capstans and winches which then pulled boats in and out of the locks. These appliances were installed by Nicholas and William Wewple for $1,100. Lock 62 was abandoned at the end of the 1920 season.

Walk along the drive a few hundred feet north of Lock 62 at the base of the canal embankment behind Wegmans.

Pittsford Shale - Several feet of black shale and thin dolostones are exposed here. Ciurca (1990) has redefined the Pittsford Shale restricting it to only the eurypterid-bearing black shale and associated dolostones and renaming it the Pittsford Bed. The Pittsford Bed bears enormous numbers of the eurypterid *Hughmilleria socialis* along with *Eurypterus pittsfordensis*, *Pterygotus monroensis*, and several other non eurypterid species.



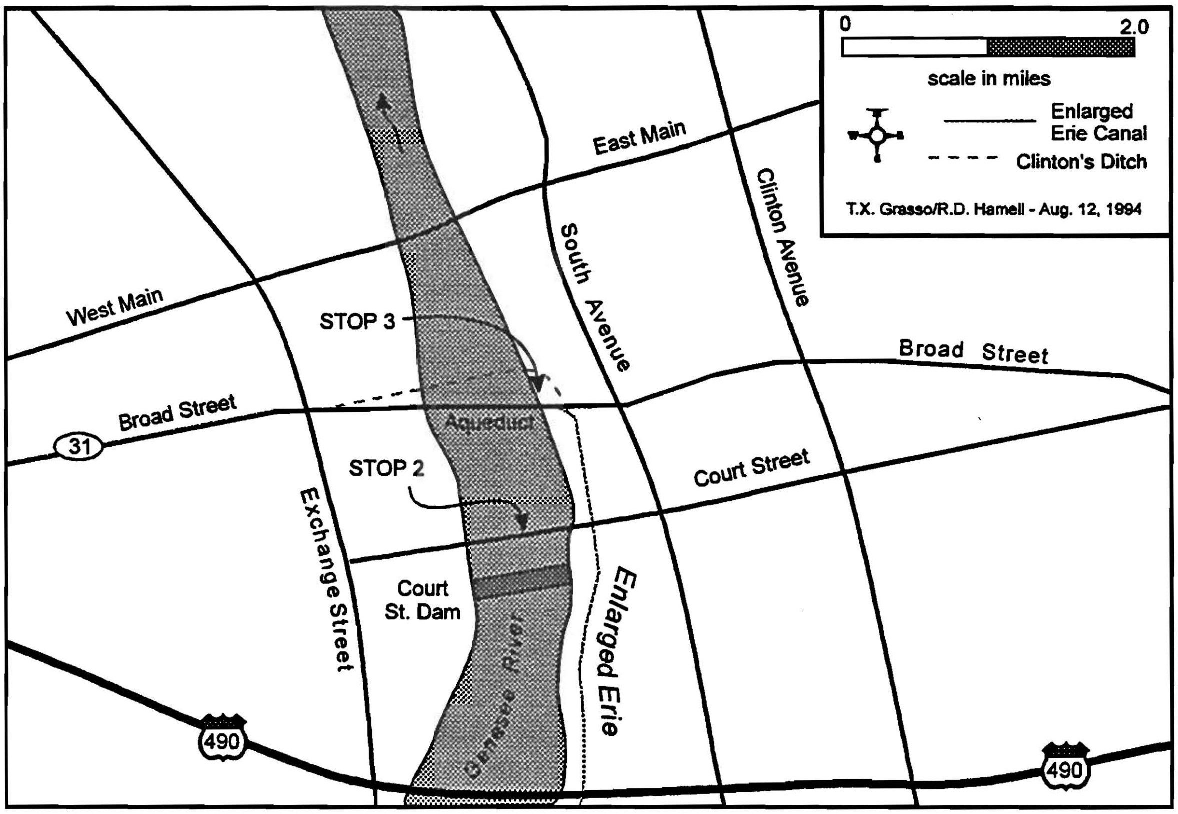
MAP 5 Route to Downtown Rochester

2.0	0.2	Return to NY31-Monroe Ave. Turn left. (NW)
2.7	0.7	Jct. I-590 Rochester interchange. Turn right (N) on I-590 which is built on the alignment of the Old Erie Canal.
4.5	1.8	Jct. I-490. Proceed west on I-490 to Downtown Rochester.
5.6	1.1	Pinnacle Range (Cobbs Hill) on left.
5.8	0.2	Old Erie Canal Lock 65 (Reservoir Lock) on right. It had a lift of 8.8 feet (2.7 m) going west. This was one of the five locks (Locks 62 through 66) east of Rochester that locked westbound boats up to the aqueduct level. Lock 66 was just west of Monroe Ave. and was the last lock west toward Lockport. Locks 32 and 33 on the Barge Canal accomplish the same task today. Clinton's Ditch took a large loop to the south here hugging the base of Cobbs Hill. Enlarged Erie construction cut off the loop thereby creating large "widewaters" between the new towpath and old canal bed. Lock 65 was at the east end

of this "reservoir". Lake Riley in Cobbs Hill Park is all that remains today.

7.6 1.8 Exit at Number 16 Clinton Ave. Downtown.

8.2 0.6 Turn left (W) on Court Street.



MAP 5A Downtown Rochester

8.4 0.2 **STOP 2 Genesee River, Aqueduct, Court Street Dam.**

Just downstream from the Court Street bridge was the head of the 14 foot (4.3 m) cascade that was the original Upper Falls of the Genesee River at Rochester. They were blasted to make way for the first Erie Canal Aqueduct.

Farther downstream is the Broad Street bridge resting on the Enlarged Erie Canal Aqueduct made of Onondaga Limestone and built from 1836 to 1842 by Josiah Bissell for $445,347. When it was completed it had an interior width of 43 feet (13 m), a length of 800 feet (244 m), and was the third longest of the 32 aqueducts on the entire line of the canal. This structure replaced the Clinton's Ditch aqueduct that was just to the north. The original aqueduct was completed in 1823, had an interior width of only 17 feet (5 m), and was constructed of

Grimsby Sandstone. This is worth noting because all other Old Erie Canal aqueducts had wooden trunks supported by stone piers, with arches only on the towpath side for its support. The engineers opted for the stone design due to the severe floods on the Genesee River before the Mount Morris Dam was completed in 1953 (Figure 12). The deck that supports Broad St. was built in 1924 and rebuilt as it stands today in 1974.

Upstream from the Court Street bridge is the Court Street Dam, called a sector dam because each gate is a pie shaped section of a circle. Gates are hinged at the base of the downstream side of the structure and float in a chamber notched into the bed of the river. The level of the water in this submerged chamber can be raised or lowered thereby controlling the gates and the pool above. The dam was completed in 1917, as part of the Barge Canal construction for the canal's Genesee crossing south of here at Genesee Valley Park. RG&E generates hydroelectric power at the west end of these structures.

		Proceed west on Court Street.
8.5	0.1	Jct. Exchange Street. Turn right (N).
8.6	0.1	Cross Broad Street. The 1826 travelers put in at Child's Basin, located where the bank is today at the northeast corner of Broad and Exchange Streets.
		Eaton's party arrived at Rochester on Sunday, May 14th. George Clinton walked back on the canal about one mile to examine some "lime rock" [Lockport] along the banks, finding fluorspar in it. Clinton wrote:
		"In the afternoon visited the falls and procured specimens of the saliferous rock [Queenston, Grimsby], grayband [Kodak], ferriferous slate, [Maplewood], iron rock [Seneca Park], ferriferous sandrock [Reynales]. . . At this place . . . the geodiferous limerock [Lockport] and the calciferous slate [Rochester] meet, the latter becomes geodiferous."
8.7	0.1	Jct. Main Street. Turn right (E).
8.8	0.1	Cross Genesee River
8.9	0.1	Jct. South Avenue. Turn right (S)

9.0	0.1	**STOP 3 Penfield Formation, Lockport Group in the Genesee River**

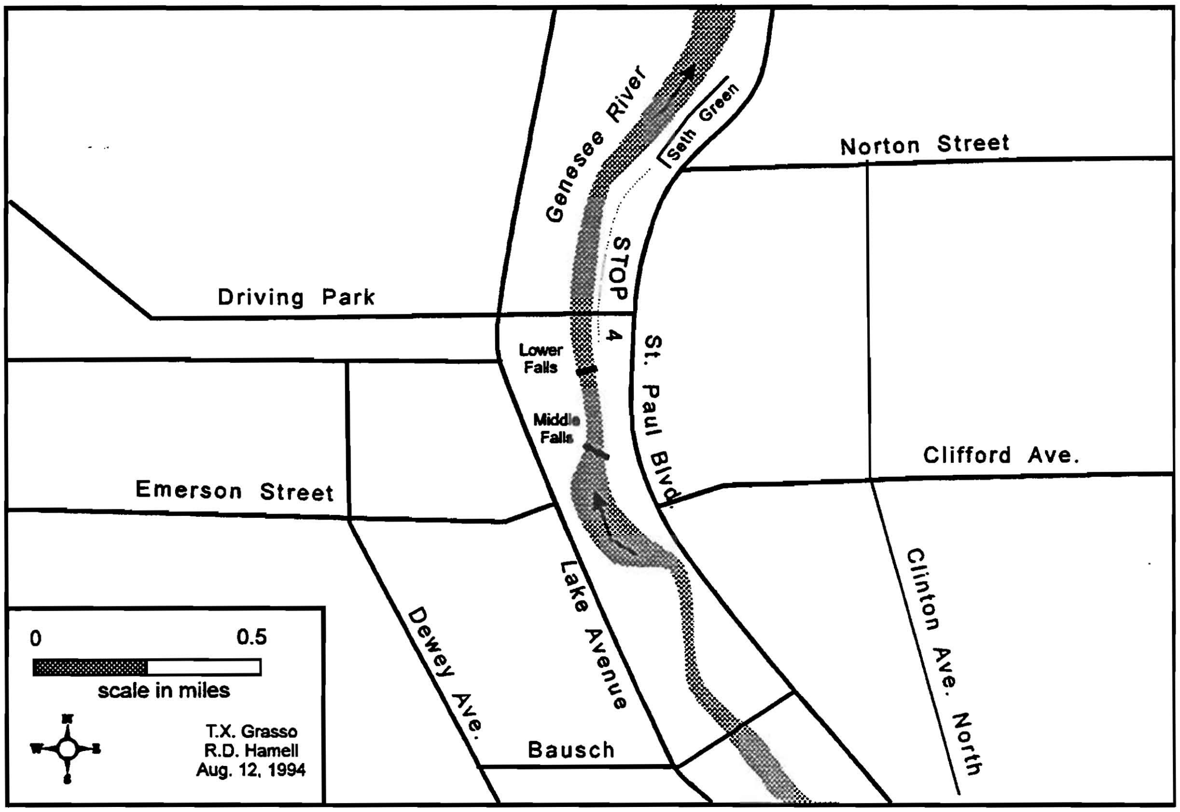
Stop at drive leading down to the back of the Convention Center and RG&E Water Street Substation just north of Broad Street. Follow the path, through the gate between the aqueduct and the south end of the RG&E brick building.

At the river level several feet of crinoid rich, coarse grained, sandy dolostone of the Penfield Formation may be examined. Ripple marks on the tops of some beds. The Penfield grades into the crinoidal Gasport Limestone and Goat Island Dolostone of the Niagara Region. These ledges are all that remain of the original Upper Falls.

The RG&E building rests on the original 1827 foundation of Hervey Ely's flour mill. Across the river in the park was the original site of Indian Allen's 1789 mill. Upstream, through the arches of the aqueduct, the Court Street dam can be viewed.

		Proceed south on South Avenue to Court Street.
9.1	0.1	Turn left (E) on Court Street.
9.2	0.1	Jct. Clinton Avenue - turn left (N) on Clinton Avenue.
9.6	0.4	Cross Main Street.
9.8	0.2	Jct. Andrews Street. Turn left on Andrews Street then immediate right (N) on Bittner Street.
10.0	0.2	Jct. Saint Paul Blvd. Proceed straight (N) on St. Paul.
11.7	1.7	Jct. Avenue E - Driving Park bridge (left). Proceed north on St. Paul.
12.1	0.4	Jct. Seth Green Drive and Norton Street. Turn left (W) on Seth Green.

Before the Days of Rapid Transit [Edward L. Henry, 1900]
[From *The Course of Empire: The Erie Canal and the New York Landscape*, 1984, Memorial Art Gallery of the University of Rochester, Rochester, New York, p. 32]



MAP 6 Rochester Gorge North of Downtown

12.2 0.1 **STOP 4 Lower Falls**

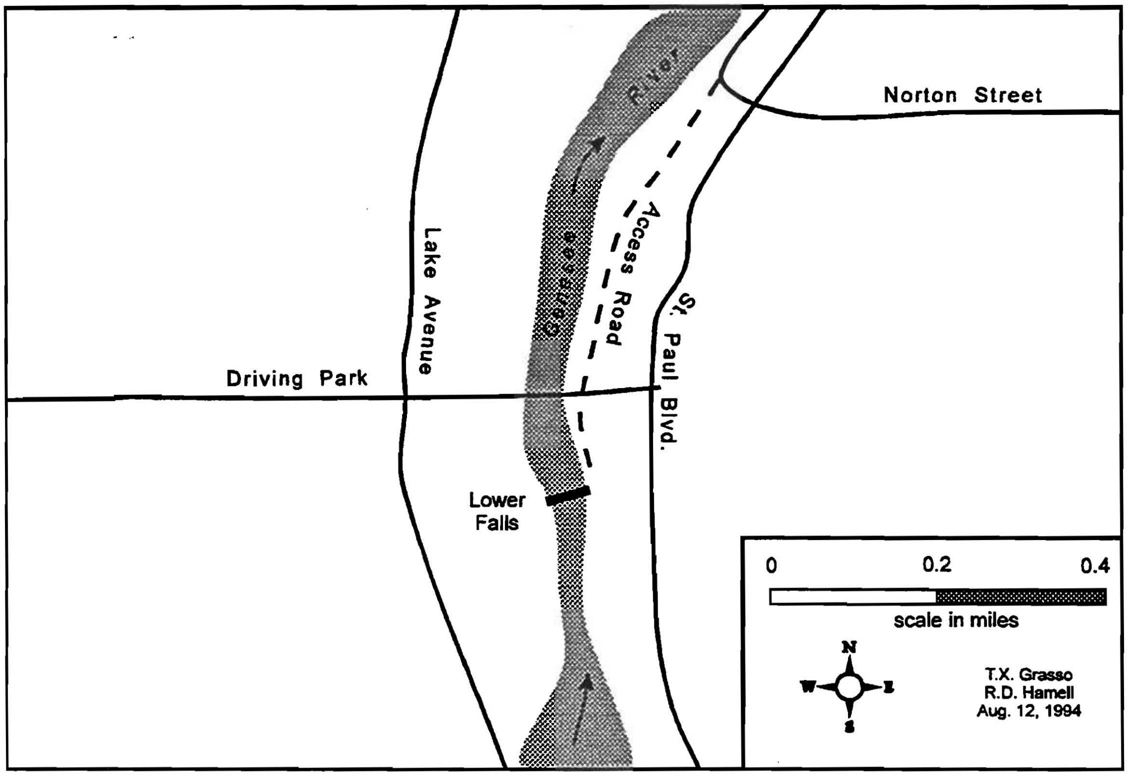
Eaton's entourage arrived at the west side of the Lower Falls on Monday May 15, 1826. Asa Fitch recorded that they stopped at the Upper Falls on route but could only see a small portion of them from the west side. Arriving at the Lower Falls at 10:00AM they stayed until 2:00PM. On the west bank Amos Eaton, upon his arrival, gave a lecture on the strata ".....could see the rocks clearly. They are 1st Saliferous rock [Queenston, Grimsby], 2nd Grayband [Kodak], 3rd Ferriferous slate [Maplewood], 4th Ferriferous Sandstone [Reynales]....."

"Swam across Genesee River twice about 1/2 mile above falls 1/4 mile wide....."

George Clinton noted (p. 289):

> "Is not Mr. Eaton's ferriferous sandstone rather poorly characterized. Some of the layers resembled shell limestone, contain petrifactions, and effervescing strongly with acids; others exactly resembled in external appearance the calciferous sandrock [Little Falls Dolostone, Tribes Hill Formation] obtained at Nose Hill [the Noses east of Canajoharie] and contained the same imbedded minerals, viz. hornstone, chalcedony, semi-

opal and agate. Is he right in considering shell-limestone, vermicular limestone and gypsum as mere beds in calciferous slate?"



MAP 6A Rochester Gorge and Lower Falls (STOP 4)

The Genesee River, diverted from its preglacial outlet through nearby Irondequoit Bay, has carved a post-glacial gorge approximately two hundred feet (62 m) deep during the past twelve thousand years. The strata revealed in the Rochester Gorge at this section are Upper Ordovician to Middle Silurian, overlain by Pleistocene till. James Hall, along with A.W. Grabau, named and described several of the formations in the gorge including the Rochester Shale, the first formally designated stratigraphic unit in North America (Brett, 1983).

The oldest unit in the gorge is the Upper Ordovician Queenston Formation, a series of brick-red, thin bedded shales and siltstones with several sandstone layers near the top (Figure 21). Although only the upper 50 to 60 feet (15-18 m) are exposed here, the Queenston Formation is more than 1,000 feet (300 m) thick and underlies much of the Lake Ontario Basin. The Queenston Formation represents extensive nearshore deltaic deposits, which covered much of the northern portion of the Appalachian Basin during Upper Ordovician time. This paleoenvironmental determination is based on well preserved sedimentary features including cross-stratification, ripple marks of both current and oscillation types, desiccation features including mud cracks, mud-chip pebble conglomerates, and sole marks (Liebe and Grasso, 1988). Following deposition of the Queenston, an interval of emergence prevailed, and a major erosion surface called the Cherokee Unconformity (Figure 17), widely traceable in eastern North America, was formed.

The overlying Grimsby Formation (also known as the "Red Medina") is a series of red-green mottled sandstones and silty shales. In his 1837 field notebook Hall originally described this unit (and the Queenston) as "sandstone, variegated, red and green, with fucoids." The base of the formation is marked by a massive 10 foot (3 m) coarse grained sandstone interpreted by Martini (1972) as a "low energy beach and/or bar(?)" deposit. This unit is overlain by a "Highly burrowed sequence of high tidal flat-flood plain or lagoonal environment which is cut through at times by shallow distributary channels and/or tidal channels" (Martini, 1972). Intraformational conglomerates and mud cracks are common. Fossils are rare in the formation, but specimens of the inarticulate brachiopod *Lingula* have been found elsewhere, and some of the massive sandstones near the middle of the unit contain excellent casts of the trace fossils *Arthrophycus alleghaniensis* and *Daedalus archimedes* (Hall's fucoids). The conspicuous bioturbated (burrowed) zone, 12 feet (4 m) below the Kodak Sandstone apparently correlates with the Thorold Sandstone of the Niagara Gorge (Brett et al., 1990). The origin of the prominent color mottling is not clearly understood; however, the green splotches are generally thought to represent the irregular alteration of ferric iron to the ferrous state by either downward percolating ground water or the presence of disseminated organic material (Liebe and Grasso, 1988).

The Grimsby Formation grades into the Kodak Sandstone, a 6 foot (2 m) thick, massive, fine grained, bioturbated gray sandstone. Hall, in his initial work in the Rochester Gorge, followed Eaton and described this unit as the "grayband", a coarse, gray sandstone which was harder than the underlying sandstones and less destructible. At one time the Kodak Sandstone was thought to be correlative with the Thorold Sandstone in the Niagara Gorge. Work by Brett et al. (1990) recognized that these units are two distinct sandstones separated by 10 feet (2-3 m) of red and green shale, informally known as the Cambria Member of the Grimsby Formation. This coincides with the work of Chadwick (1935) and Fisher (1966) who used the name Kodak for the prominent formation that forms the caprock of the Lower Falls.

The basal unit of Sequence II is the Maplewood Shale, a smooth, platy, in-part calcareous shale that unconformably overlies the Kodak Sandstone. This unit was described by Hall in his field book (1837) as a "ferriferous slate, soft and green, contains a few shells, and near its limit below, a very thin stratum, sometimes two, composed almost wholly of shells" In addition to these thin limestone layers, phosphatic pebbles are common, especially in the basal portion. The Maplewood is approximately 21 feet (7 m) thick here but becomes much thinner to the west where it is correlative with the Neagha Formation in the Niagara Gorge. Both formations are thought to represent either quiet, offshore marine or lagoonal deposits as part of the initial flooding of the transgressing Sequence II sea into the Rochester area.

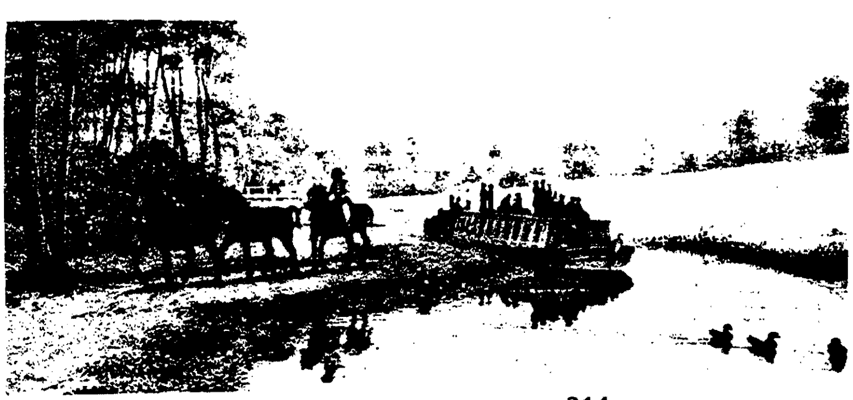
The youngest unit exposed along the access road to the Power Station is the Reynales Formation, although Hall (1843) first designated this unit the "Pentamerus Limestone" for the numerous pentamerid brachiopods present. The Reynales Formation consists mainly of 21 feet

(7 m) of gray, crystalline limestone or dolomitic limestone with numerous shale partings and is divided into three members. The lower member, the Brewer Dock Limestone 3 feet (1 m), is separated from the upper Wallington Limestone Member by the well known Seneca Park Hematite (1 foot; 0.3 m). The Seneca Park was previously known as the Furnaceville, but recent mapping by Brett et al. (1990) revealed that the iron ore in the Genesee Gorge is actually at a higher stratigraphic horizon than the type Furnaceville in Wayne County and, therefore, cannot be the same unit. The Seneca Park Member was originally deposited as a fossiliferous limestone. The hematite has since replaced most of the calcium carbonate; however, samples will still effervesce when acid is applied, indicating much of the original carbonate material remains. The mechanism and time of replacement are much debated, but consensus seems to favor a penecontemporaneous alteration of the original fossiliferous limestone by iron-rich solutions from streams descending the iron-rich Taconic landmass located in eastern New York State at that time.

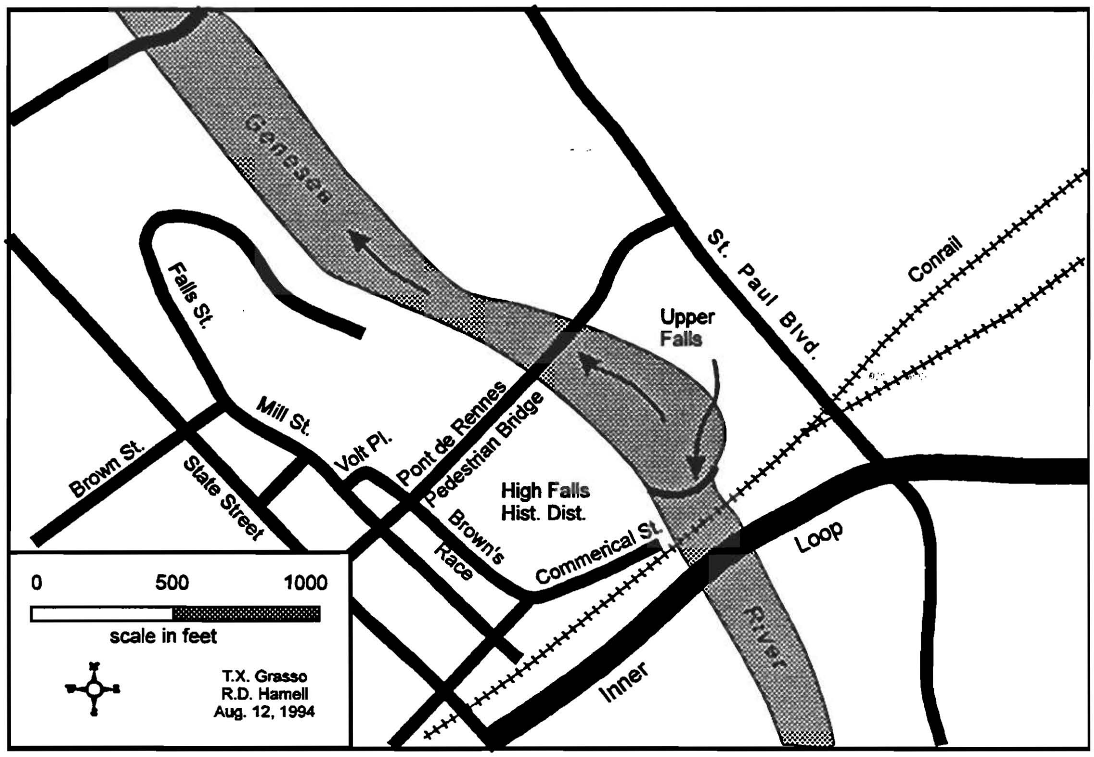
The Wallington Member (17 feet; 5 m) is a coarse grained, fossiliferous limestone, with beds of the smooth shelled brachiopod *Pentamerus*, as well as corals and bryozoans. The combination of dense strata packed with fossils and the replacement of some of the fossils and beds with chert make this unit particularly resistant, well suited to form the cap rock of the Middle Falls. The Reynales Formation then represents a shallow, clear water, offshore marine deposit of Sequence II.

Visible along the walls of the Rochester Gorge, but not easily accessible at this locality, is the upper member of Sequence II, the Sodus Shale, as well as the Williamson Shale and Irondequoit Fm. (Sequence VI) and the Rochester Shale (Sequence V). The latter unit, as well as the overlying Decew and Lockport Dolostone (Sequence VI) will be seen at **STOP 5.**

12.3	0.1	Return to St. Paul Blvd. Turn right (S).
12.7	0.4	Jct. Avenue E-Driving Park Avenue. Turn right (W). Cross Genesee River. Lower and Middle Falls on left.
13.0	0.3	Jct. Lake Avenue. Turn left (S)
14.7	1.7	Jct. Platt Street. turn left (E). Enter High Falls Historic District.
14.8	0.1	At end of Platt Street turn right on Browns Race.



Pittsford on the Erie Canal by George Harvey, ca. 1840. [From *The Course of Empire: The Erie Canal and the New York Landscape*, 1984, Memorial Art Gallery of the University of Rochester, Rochester, New York, p. 26]



MAP 7 Brown's Race Historic District and High (Upper) Falls (STOP 5)

STOP 5 High Falls (Upper Falls), Browns Race

Although visually attractive to visitors, the High Falls could rarely be seen as industrial development along Matthew and Francis Brown's mill race blocked the view. It was sometimes said that Rochester had developed the river, for commercial purposes, to such a degree that the best view of the river and its falls could only be had from the back door of a factory or mill.

The upper part of the Lewiston Member is exposed in the lowest part of the gorge's east wall below the Upper Falls while the Burleigh Hill Member of the Rochester Shale forms the conspicuous bulge in the middle portion (Figure 24). The overlying 25 feet (8 m) of the Gates Member makes up the upper portion of the gorge walls downstream from the Upper Falls while its uppermost beds form the brink.

The Decew Formation is exposed upstream from the lip of the falls, in the uppermost 6 to 10 feet (2 to 3 m) of the east side of the gorge just downstream from the falls and on the west side at the base of the stone wall, where the enterolithic structure is clearly discernible, (north wall of the Kidd Iron Works) east of the water wheel. Another exposure is at the top of Falls Street just north of its intersection with Brown Street.

Figure 32 High Falls looking south about 1910. Gorsline Building on west side, Rochester Railway and Light Company on east. Decew Formation forms small step just upstream from brink. (Stone Collection, Rochester Mus. and Sci. Center)

Walk along Brown's Race Street to view Brown's Race at Commercial Street. From here walk east on Commercial Street and opposite the High Falls Parking lot climb the embankment to the railroad. Walking east cross the river on the north side of the railroad bridge above the lip of the falls. Excellent vistas of the gorge and the historic district are obtained from this bridge. Continue walking east and then north along the railroad spur for Genesee Brewery to the Platt Street (Pont de Rennes) bridge (see Figure 32 for a 1910 view taken from this bridge) crossing back to the west side and returning to the starting point.

END OF TRIP - Return to U. of R.

The evening of May 15, 1826 was disastrous for Amos Eaton as at the end of the day he was struck by a fit of delirium. Asa Fitch wrote:

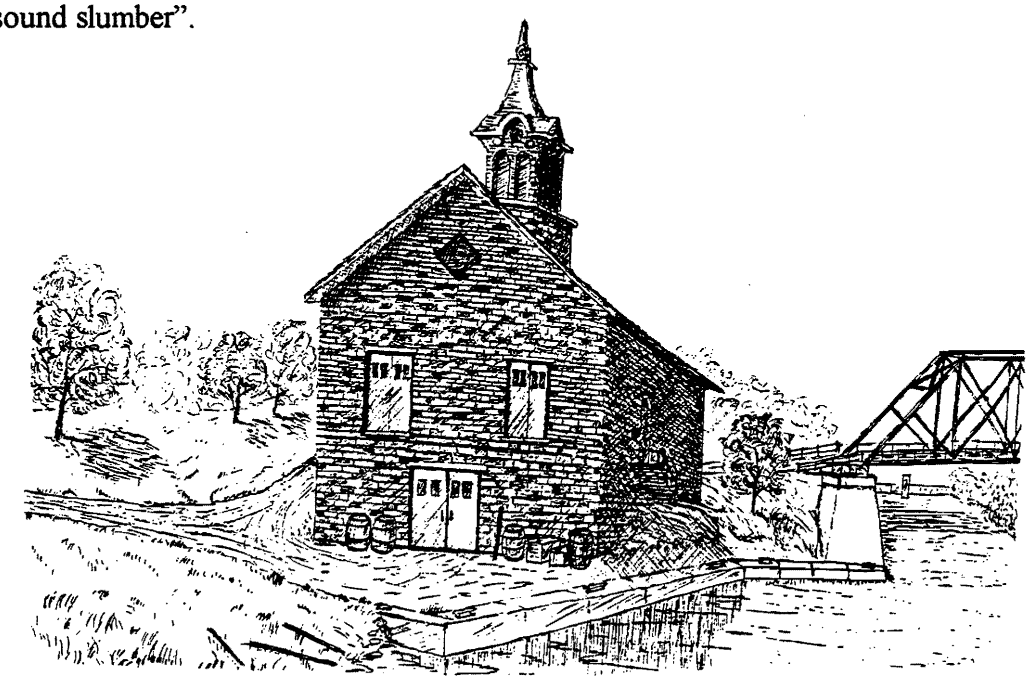
> "......met Prof. Eaton who was taken with a fainting turn. He leaned on my arm till we came to one end of the dock at the other end of which the boat

lay. Here he got so weak he could not proceed.....We took him into a store a few steps off and in a few minutes he became completely crazy.....We got him to the boat and for about a hour he continued as crazy as any body I ever saw. He thought he was among savages.....He thought the medicine Dr. Marvin gave him was poison and was uneasy about it. Said that the canal survey was not yet finished we might poison him if we wished that he would then drink with pleasure. After an emetic had operated his senses immediately came to him. He was afraid he had said or done something disgusting during his fit."

George Clinton described the event (p. 288) in more general terms:

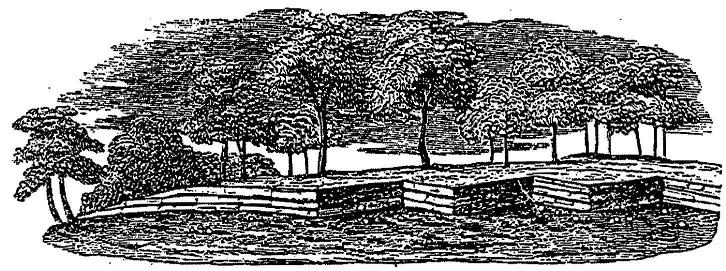
"In the evening Professor Eaton was seized with a fainting fit brought on probably by fatiguing himself so much during the day. He was delerious for nearly 1 hour, during which time the soundness of his remarks proved that his mind although uncontrollable, was by no means defective in strength. The physicians called in administered repeated doses of sulphate of zinc and ipecacuanha [a tropical plant the dried roots of which are used to make a preparation that induces vomiting]. As soon as their operation had ceased, his reason returned and he is now (10PM) enjoying an apparently sound slumber."

Hopefully we will not need similarly strong medication after the banquet following our trip to enjoy a "sound slumber".



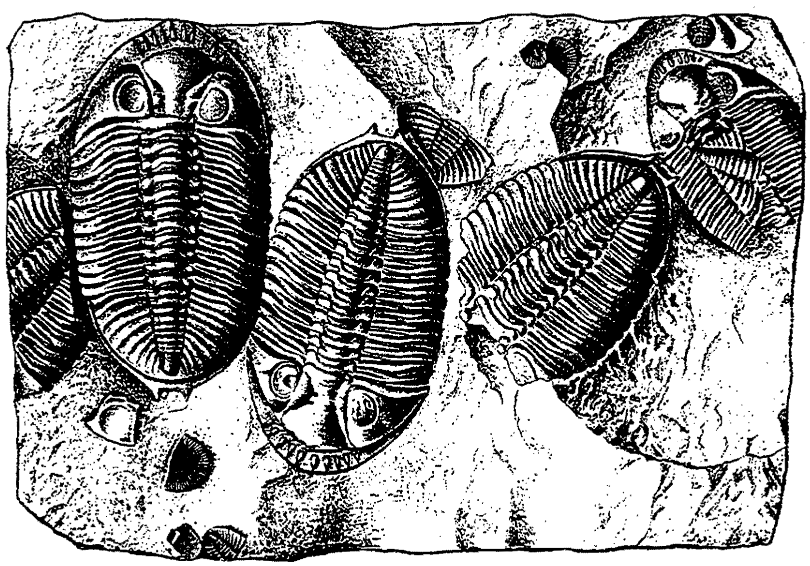
The Scheaffer Cold Storage House on the canal near Gasport, N.Y., built in 1870 and destroyed by fire in 1967. Drawing by E. Mayes.

[From R. Garrity, 1977, *Canal Boatman: My Life on Upstate Waterways*, Syracuse Univ. Press, Syracuse, N.Y., p. 98.]



CORNIFEROUS LIMESTONE.

Upper part of the Corniferous Limerock of EATON. *Seneca Limestone of the Annual Reports.*



TOP: From Hall, 1843, p. 161.

BOTTOM: *Odontocephalus selenurus*, Onondaga Limestone, Seneca County, New York. From Hall and Clarke, 1888, Plate 12.