GEOLOGY AND THE DEVELOPMENT OF UPSTATE NEW YORK'S DISTINCTIVE COBBLESTONE ARCHITECTURE

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INTRODUCTION

Cobblestone buildings are the most distinctive structures in upstate New York's regional architecture. Most of these handsome and durable buildings are farm houses built between 1825 and 1860, the prosperous years following the completion of the Erie Canal. Most of them are found in the glaciated lowlands bordering Lake Ontario in a belt that extends from Syracuse to Buffalo. Upstate cobblestone construction is characterized by 1-2 foot-thick, rubble-filled walls that are more than 50% by volume lime mortar, which are faced with a veneer of fist-sized cobbles laid in horizontal courses.[1] Individual cobbles are "framed" with hand-profiled mortar joints. The horizontal mortar joints separating the horizontal courses of stones are typically continuous across an entire wall and therefore more visually prominent than the vertical joints between adjacent cobbles within a course (Figure 1). Cobblestone construction techniques were used to build at least four of the architectural styles popular during the later half of the 19th century: Federal, Greek Revival, Gothic, and Italianate. Although U.S. examples of cobblestone buildings can be found from New England to Colorado, roughly 90% are located in upstate New York with the greatest concentrations are in Ontario and Wayne counties.

The development of cobblestone architecture and its prevalence in Ontario and Wayne counties is remarkable example of the interplay between the area's 19th-century human history and the bedrock and surficial geology of the area. The Erie Canal and the economic development it fostered was the impetus for constructing most of these buildings, but the lay of the land and the types of materials which were (and were not!) available to builders did much to determine how those buildings were constructed.

This paper and the accompanying field trip is designed primarily as an introduction to cobblestone architecture for geologists. Somewhat paradoxically, then, it focuses more on architecture and history, which most geologists will know less about, and less on geology, which most geologists will already know or easily learn. The first part of the paper is a cobblestone "primer" describing the technique and the types of materials it employs and the architectural styles to which it was adapted. The second part examines the cultural and geologic reasons for the development of cobblestone architecture in upstate New York.

Acknowledgements

The material in this paper is drawn from many different sources, but a few deserve special mention at the outset. Paul Briggs, a restoration mason working out of the Ithaca area, showed me how cobblestone masonry is done and infected me with his enthusiasm for cobblestone buildings. Much of my understanding of historical and architectural aspects of cobblestone buildings derives from a class that I co-taught with Professor Dan Ewing, formerly of the Hobart and William Smith Colleges Art department. In particular, I draw heavily in what follows from Dan's presentations on the architectural history and his analysis of the ways in which the Erie Canal was and was not important in the development of cobblestone structures. For those wishing to take up the subject for themselves, the Landmark Society of Western New York, in Rochester, has a superb collection of materials on cobblestones, including the amazingly comprehensive survey of upstate cobblestone structures compiled by Robert Roudabush in the

[1] There is considerable debate about what should and should not be called "cobblestone construction" and the term may apply to very different styles of masonry walls in other places. This article deals only with upstate New York cobblestones where the stones are relatively small, less than 20 cm in largest dimension, and framed with mortar.

late 1970s and recently updated by Stephen and Marion Wolfish. Cynthia Howk of the Landmark Society is a patient, knowledgeable and helpful guide to these collections. My thanks as well to the property owners who have given permission for the group to visit their homes: Mrs. Bernard Harkness, Mr. Herb Aldwinckle, Steve and Jane Westfall, Mr. and Mrs. Jack Beilstein, Mr. Gregory Nunn, Mr. Roger Cunninham, and Mr. and Mrs. Calvin Van Derlike.

PART I: A COBBLESTONE PRIMER

Figure 1 shows the basic components of cobblestone construction: cobbles, mortar, and structural stone components such as quoins, sills, and lintels. Each of these is discussed in detail below. Though assembling these components has often been described as a "lost art," Paul Briggs has shown that there is little mystery to building a cobblestone wall. The author learned most of the techniques described below in cobblestone masonry workshops led by Briggs, and in the application of those techniques to the construction of two small cobblestone structures on his own property, including one under Briggs' direct supervision.

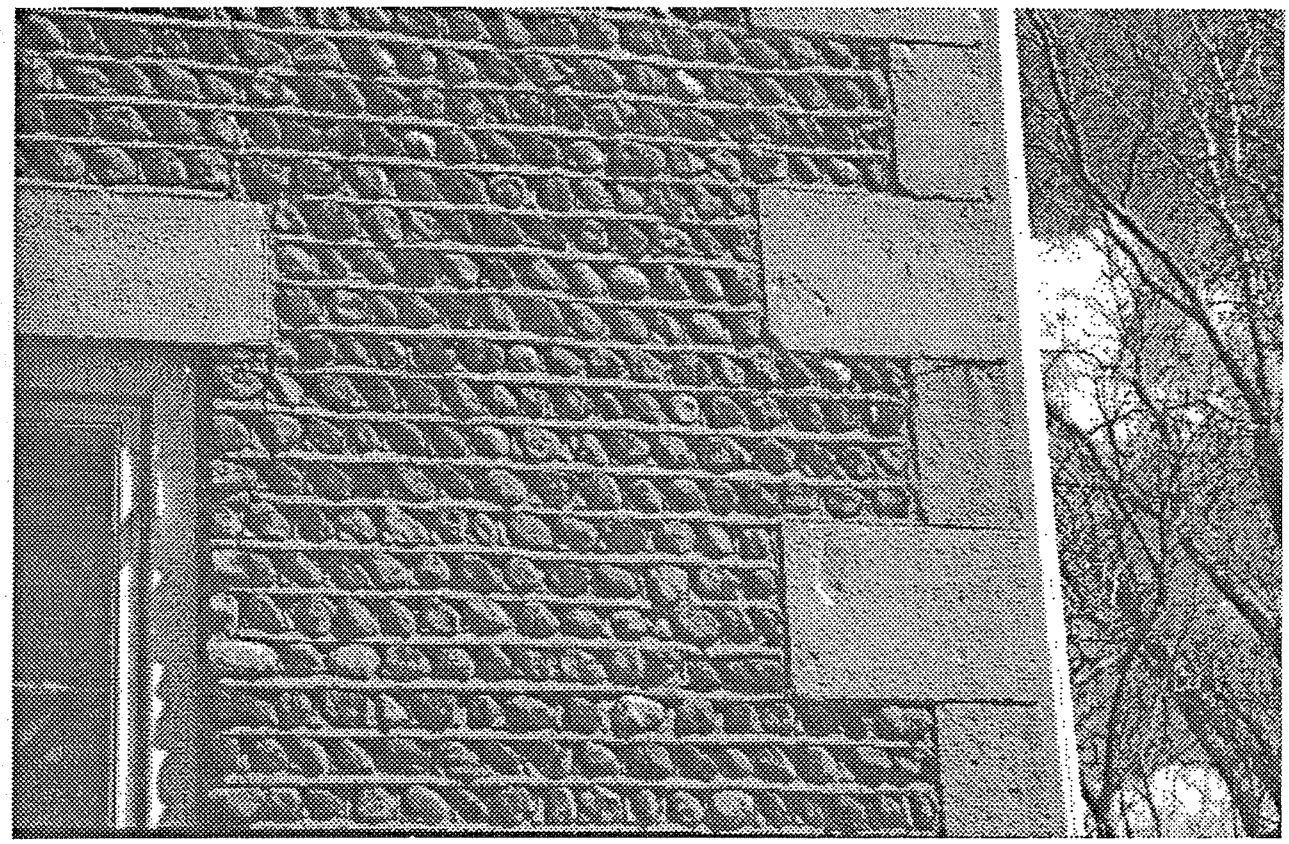

Figure 1. Part of a cobblestone wall. Note the rounded to subangular cobbles of varying lithologies, the prominent horizontal mortar joints, the cut stone blocks used to reinforce the corners (quoins), and the cut-stone lintel used to support the window opening. This wall is part of the Barnes House (STOP 2), a fieldstone type of cobblestone structure.

Cobblestone Materials

Cobbles

The cobbles themselves are simply fist-sized rocks. There are two basic types, "fieldstone" and "lake-washed." Fieldstone cobbles are subangular to rounded rocks that vary in average dimension from approximately 10 to 20 cm. These cobbles are derived from glacial till and outwash deposits and many lithologies are represented in a typical fieldstone wall: sandstone, limestone, quartzite, gneisses, and coarse and fine-grained igneous and metamorhpic rocks. Dark red to gray Medina sandstone cobbles are the most abundant type of cobble. Builders were careful to exclude shales and sulfide-bearing cobbles, but with those exceptions, fieldstone cobbles are samples of the locally available cobble-sized glacial debris. Fieldstone structures are the earliest cobblestone buildings. Though they continued to be built throughout the cobblestone era (roughly 1825 to 1860), fieldstone structures are less common among later cobblestone buildings.

"Lake-washed" cobbles are the same glacially-derived stones as found in fieldstone structures, but these cobbles are typically very well-rounded prolate ellipsoids. They are called lake-washed because many accounts describe collecting these stones along the shores of Lake Ontario, particularly near Sodus, N.Y., in Wayne County. While these wave-rounded cobbles are abundant on the Lake Ontario shore, similarly shaped cobbles can be found in tills and outwash deposits and may have been hand-picked for that reason, thus all so-called "lake-washed" cobbles may not have been rounded by wave action in a lake. Though lake-washed cobbles include the same sizes and range of rock types seen in fieldstone structures, many structures, particularly in the latter years of the cobblestone era, use only lake-washed stones of a similar size (usually 4-7 cm), shape (all prolate or all oblate ellipsoids), lithology (typically the Silurian Medina sandstone) and colors (overwhelmingly dark red).

Though less than 50% of a cobblestone wall is made up of cobbles, constructing a two story house still requires a large pile of rocks. Several accounts describing gathering the rocks for a structure survive. Boys were paid ten cents a day to walk beside a "stoneboat," a sled pulled by an ox or other draft animal, and throw cobbles turned up by plowing into the sled. Other accounts describe farmers who hauled wheat to Sodus for shipping returning with a wagon load of cobbles. Records of the construction of the Phelps Baptist Church (1845) indicate that the congregation supplied the cobbles, which were brought to the site by ox cart from the fields in the surrounding area. There are also accounts of community "bees," similar to barn raisings for the purposes of collecting and/or sorting the stones. Size sorting of the stones was clearly important. Schmidt (1966, p. 2) describes how the stones were sorted using an iron "beetle ring" or with a board or with appropriately sized holes. In some cases it took a period of a few years to gather the stones needed for a building and these were supplied by the future owner of the building, not the mason.

Mortar

Cobblestone walls use lime mortar, not the Portland cement mortars used in modern masonry construction. Lime mortars have been used since antiquity. Their main ingredients are lime and sand. Lime is produced from the "burning" of limestone, a decarbonation reaction:

$$CaCO_3 + \text{heat} \rightarrow CaO + CO_2(\text{gas})$$

This reaction is endothermic, requires sustained temperatures of 800-1100° C and results in a 44% weight decrease. The resulting product is quicklime, CaO, which was pulverized and either used immediately or sealed in casks for later use. The author knows of one large lime kiln that survives in South Sodus in Wayne County. This is a masonry "chimney" roughly six to eight meters square and approximately ten meters high. Limestone from a nearby quarry was loaded in from the top, and a fire was kept burning at the base until the reaction was complete. Probably there were many lime kilns operating in the area during the cobblestone era, some of which may have been little more than a pit with limestone piled on top of firewood. Phelps village historian John Parmalee suggests that many large farms had their own lime kilns (Parmalee 1986, p. 62). This might explain why a cursory survey of period classified advertising turned up ads for stone, nails, lumber, bricks and other construction materials, but not lime.

Regardless of its source, the quicklime was "slaked" or saturated with water. Slaking hydrates the lime and produces a lime paste or putty roughly two to three times the volume of the powdered quicklime.

Several accounts describe the slaking process as being done in a in a two meter square pit at the construction site. This pit was prepared and the slaking process begun in the fall prior to the summer in which a building project was to be undertaken. This extended "seasoning" is possible because, unlike Portland cement based mortars, lime mortars require air to cure and harden. Thus, as long as a layer of water remained on the lime putty, it would not set. Regardless of the extended "soaking" such a treatment would allow, a common feature of all cobblestone mortars is the presence of white chunks of unground quicklime in the mortars.

To make the final mortar, the lime putty is mixed with sand and other variously reported ingredients (clay, cow manure, and "secret ingredients"). Reported recipes give the ratio of lime to sand as varying from one part lime to four to seven parts sand by volume. The sands used in cobblestone buildings are typically glacial outwash sands that have abundant brown and red lithic clasts. Several cobblestone houses, particularly later ones with more refined mortar joints, show the use of two "grades" of mortar, a bedding mortar with coarse sands for use in the interior of the wall to better support layers of cobbles, and a finer jointing mortar that was used on the exterior. Clay was a common additive used to increase plasticity and provide some coloring. The resulting mortars are notable for their warm brown and tan colors which make them very distinct from the cool blue to gray tones of Portland cement-based mortars (this is painfully obvious where Portland mortars have been used to repair cobblestone structures).

Lime mortars are critical to cobblestone construction because they set more slowly, are more plastic and are easier to work. Paul Briggs has suggested that the attribution of cobblestone masonry as a "lost art" may in part result from attempts by modern masons to duplicate cobblestone techniques using modern mortars that set too quickly, are too stiff, and are to difficult to trowel. As an aside, synthetic Portland cements were developed in Britain in 1824, but did not become common in the U.S. until 1880. Naturally occurring cements capable of setting under water, which 19th-century builders called "hydraulic cements" or "water limes," were known in upstate New York during and were important in the construction of Erie Canal locks.

Structural Stone Components

Because lime mortars are porous, relatively soft and have low tensile strengths, corners and wall openings in cobblestone structures are potential areas of weakness. Most cobblestone masons address these weaknesses by reinforcing the corners and openings with another, stronger material. In the classic cobblestone, this is done with cut dimension stone, usually limestone or sandstone, but there are also examples that use rough stone blocks, brick, or even wood for these purposes. The soft lime mortar that might be exposed at an exterior corner would be easily abraded and could thus weaken the building. To overcome this difficulty, corners are typically formed using rectangular blocks of stone called "quoins" (the word is derived from the French word for "corner"). Window sills are potentially vulnerable because water shed by the window can percolate into the porous mortars of the sill and be degraded by subsequent freeze-thaw cylces. Thus the horizontal, upward facing surfaces of windows and doors require a sill to protect the underlying mortar. Lentils span wall openings such as windows and doors to support the wall above. A more decorative use of cut stone is a "water table," a line of sill-like cut stones that define the top of the foundation wall (often of very rough stone construction) and the cobblestone wall above.

In most cobblestones, the structural stone components are cut stones prepared by skilled stone masons (probably rarely the same mason who laid the cobblestone). Figure 2 shows a quoin from an 1853 school building in Gypsum, N.Y. (STOP 5), that is typical of cobblestone stone work. The block is dressed to an accurate rectangular shape on the exterior surfaces. A decorative tooled margin created by repeated chisel blows creates the decorative exterior band, while the interior has a dimpled surface created by repeated blows of a bush hammer (for more information on stone cutting and interpreting the tool marks left on cut stones, see Cramb, 1992). Though the techniques used to dress cut-stone vary little from cobblestone to cobblestone, the type of stone used for structural components does. All of the cobblestones the author is familiar with in the Ontario and Wayne county areas use a light-gray weathering, fine-grained, massive limestone, probably the Devonian Onondaga. Oral tradition for at least one cobblestone house, the Barnes House south of Geneva (STOP 2), identifies a quarry in the

Onondaga near Seneca Falls as the source of stone. Farther to the west, dark red Medina sandstone or Lockport dolomite is used for cut-stone components.

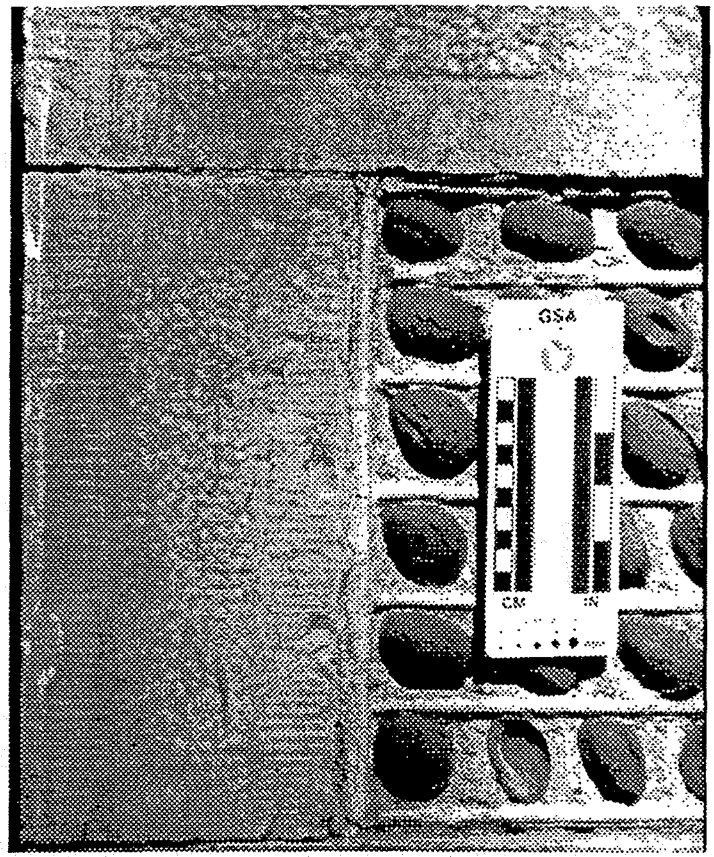

Figure 2. Cut-stone quoins in the 1853 Plainsville School (also known as Gypsum, STOP 5). These quoins have a "chisel-draughted edge" created by repeated chisel strikes and a dimpled central panel produced with a tool called a bush hammer—the stone mason's equivalent of a meat tenderizing mallet. This is a lake-washed cobble building as shown by the uniform color and size of the cobbles. Just visible in this photograph are the beaded mortar joints used between the courses.

Building a Cobblestone Wall

Figure 3 shows a small cobblestone wall under construction. Working from a foundation of large blocks, a set of backing stones for the inside wall is laid up and the quoins are laid true and square. To "fill" the space between the quoins with cobblestones, a thick bed of mortar is laid down. Individual size-sorted cobbles are then placed on this mortar bed so that their upper surfaces define a roughly horizontal line and the ends that project outward from the wall are flush with a guide string strung between the corners of the two quoins. These cobbles are placed so that they have approximately 2 to 4 cm gap between them. Once the stones are thus arranged, the mason fills the gaps between stones with mortar. As the mortar is thixotropic, this is best done by flinging a wad of mortar into the gap with a small trowel; repeated flings fill the gap up to the height of the stones on either side. With the gaps between cobbles filled, the joints are formed using a flat pointing trowel. The vertical joints across the entire wall are formed first. Using upward strokes, first on one and then the other side of the joint's center line, the mason creates vertical to inward sloping surfaces that meet as a broad V. Typically this is broader at the base than the top. Once all the vertical joints for a course have been formed, the mason shapes the upper surfaces of the two angled surfaces that will form the horizontal joint at the base of the course. This upper surface is created by running the trowel horizontally along the base of the stones, pressing inward and downward to create a mortar "shelf" that is angled down and away from the wall at roughly a 45° angle. Finally, the mason uses a slicing motion to cut away the excess mortar along this shelf and in the

Figure 3. A small cobblestone wall under construction. Note the "backing stones" that form the back of the wall and the line of cobbles along the front. In between is the "trough" which will later be filled with rubble and mortar in advance of starting the next course.

process forms the face of the lower part of the horizontal joint, a surface that slopes inward and down. The visual "line" of the joint is formed by the intersection of the two surfaces; while contact of the upper and lower surfaces of the joint with the cobbles may be very irregular, the line of the joint is produced by the intersection of the joint's upper and lower surfaces and its linearity and horizontality is limited only by the mason's skill.

Completion of the joint work for a course leaves an irregular trough between the backing stones and the stones laid up as the horizontal cobblestone course. This trough is important because it compensates for the different sizes of the cobblestones—larger stones can extend farther back into the trough than shorter ones. Such larger stones help to strengthen the final wall by "tying" the cobblestone work to the wall's interior. After one or two courses of cobblestone is laid, this trough is filled with mortar and waste stones, rocks that are not well sized shaped, or colored for the cobblestone exterior. Thus, cobblestone walls are a type of rubble-filled mortar construction.

Only two or three courses of cobblestones can be laid in a day. If more are attempted, the weight of overlying courses causes the slow setting mortar of lower courses to bulge and sag. And cobblestones cannot be laid during rain (unless the site is covered) or during freezing weather. Furthermore, it is the author's experience that cobblestones masonry laid up in the late fall (September or October) is very susceptible to spalling, probably because it does not dry and cure adequately before subjected to freezing temperatures. Given these constraints it is easy to understand why many large cobblestone houses took two or three years to complete.

There are important variations from the basic techniques discussed above. A few early cobblestones have mortar joints that form a hexagonal pattern around the cobbles, and some late, highly refined cobblestones have rounded bead mortar joints that must have been made with a special trowel (STOP 5). Schmidt (1966) and Shelgren and others (1978) have detailed drawings of these and other mortar techniques. Schmidt also identifies a few partially demolished cobblestone walls in which the cobblestones are a veneer applied to a much rougher rubble filled wall.

Development of Cobblestone Techniques

Cobblestones techniques show a progressive refinement over the cobblestone era. Schmidt (1966) has proposed division of cobblestone techniques into an early, middle and late periods based upon the nature of the mortar joints, the size of the cobblestones, and the sorting of the tones for color, shape, and size.

Early, 1825-1835: Early Period cobblestones are characteristically made of large fieldstones, typically with minimum dimensions greater than 10 cm. The horizontal joints of early cobblestones are commonly wavy and lack the striking horizontal lines of later cobblestones. Quoins may be dressed cut stones, but roughly shaped blocks are also common. Wooden or brick window sills and lintels are more common than in later structures.

Middle, 1835-1845: Middle Period cobblestones may be either fieldstone or lake-washed, or combine the two. Stones are typically smaller than in early cobblestones with minimum dimensions closer to 6 cm's. Some stones will show evidence of having been selected for shape, size or color, particularly on front wall of the structure. Stones may be set in color-selected rows, herringbone patterns, or bands of coarser and finer stones. Lake-washed stones first appear in the late 1830's and become the preferred stone type by 1845. Beaded mortar joints (see below) also first appear in this period.

Late, 1845-1860 and later: Late Period cobblestones carry the innovations of the Middle Period to extremes. Stone sizes become very small, less than 6 cm, and are selected for uniformity of color, size and shape. Mortar joints are highly refined and often beaded. Beaded joints emulate wood moldings; they are worked with a special tool that leaves a half-round ridge or "bead" protruding from the joint surface. The uniformity of the stones and the refined mortar work give late period cobblestone walls a uniformity that contrasts starkly with early and middle fieldstone walls.

The increasing refinement of cobblestone technique suggests some insights into late 19th century aesthetics. Given that the number of courses of cobblestone that can be laid at one time are limited, using smaller stones is much more labor intensive. This explains the frequently made observation that larger cobbles are used on the sides and backs of buildings. Add to the use of small stones the more refined, and presumably skilled, treatments of the mortar joints, and it is clear that the refined styles of late period houses must have been significantly more expensive. This is supported by the fact that even on refined late period houses, it is usually only the front wall that receives the most refined treatment. In an age when Americans were embracing the new technologies of the Industrial Revolution, it may well be that the much more uniform and mechanical nature of the refined late-period cobblestones was seen as more "modern." In many ways, one looks at these late period walls and gets the sense that they are really cobblestone walls imitating brick or some other more "uniform" and man-made material. Architect and cobblestone expert Carl Schmidt was the first to note and this phenomenon: "Small lake-washed stones had no structural feeling, they were merely veneer. The sparkle and life of the varicolored fieldstone walls disappeared because all the stones were of the same size and color. The machine-made appearance of such a wall is monotonous. The fieldstone walls of the Early Period and the first half of the Middle Period expressed a feeling of material correctly used; the did not make a display of the mechanical skill of the masons as did the cobblestone work of the Late Period" (Schmidt, 1966, p. 6).

Architectural Styles

While there are a few very plain and utilitarian cobblestone buildings, they are the exception rather than the rule. Most are cobblestones are highly stylized buildings that were built in one of the architectural styles that dominated the period: Federal (1780-1830), Greek Revival (1820-1850), Gothic Revival (1830-1880), and Italianate (1840-1880). The accompanying road log describes cobblestone examples of each style and notes some of the characteristic identifying features of these styles. These designs were adopted from pattern books that were common in the middle and late 19th century. For example, the *Wayne County Sentinel*, a weekly newspaper published in Palmyra contains the following advertisement in its Tuesday, October 18, 1831 (Volume 9, number 5) edition:

The Practical House Carpenter
Being a complete development of the Grecian orders of Architecture, methodised (sic) and arranged in such a Simple, Plain and Comprehensive manner, as to be easily

understood; each axample (sic) being fashioned according to the style and practice of the present order, three examples of the Doric order, three examples of the Ionic order, one example of the Corinthian order, and one example of the Cowpastie order, with all their details drawn to a large scale; to which are added a series of designs for Porticoes, Frontispieces, Doors, Windows, Caps and Sills, Frames, Sashes and Shutters, Base and Surces, Trusses for Roofs and Partitions, Stairs and &c. Engraved on Sixty-four large Quarto Copper Plates; by Asher Benjamin, Architect; Author of the "American Builders Companion" and "The Rudiments of Architecture" --Just received, and for sale at the Palmyra Bookstore, by E. B. Grandin, June 2, 1831

Beyond the fact that particular architectural styles, like the types of cobblestone work itself, allows us to roughly date cobblestone structures, these architectural styles are interesting again for what they tell us about the people who built these houses. Why, for example, would a farmer in upstate New York, build a house with elements taken from a Greek temple? Architectural historians have traced the origins of these fashions to American sympathies and national aspirations; for the Greek Revival these include pride in the American Revolution and democratic principles, as well as a desire to embrace an alternative to the British influences of the Federal Period. The roots of these styles and their symbolism are beyond the scope of this paper, but it is ironic that the people who built the upstate's cobblestone houses probably believed that these structures were and would be important more for the symbolism of these national styles rather than the local cobblestones with which they were built.

PART II: WHY DID COBBLESTONE ARCHITECTURE DEVELOP IN UPSTATE? WHY DID IT END?

Certainly the most widely circulated theory for the abundance of cobblestone structures in upstate New York is the "Erie Canal Theory." Though it may not be the earliest mention of it, this theory is well stated by Carl Schmidt in his 1966 volume on cobblestone masonry:

The building of the Erie Canal from Rochester to Buffalo between 1823 and 1825 provided the numerous masons necessary to build the scores of cobblestone structures in Western New York State......contractors realized that many more masons were needed to complete the canal within the specified time and that Western New York State could not supply them. Hence, they advertised for masons in New England and Pennsylvania. After the canal was completed many of these imported masons purchased farms and made Western New York their home. Consequently, there were many more masons than the building craft could normally assimilate. They needed masonry work to supplement their farm incomes. This is probably the principal reason for so many cobblestone houses on or near Ridge Road and the area paralleling the Erie Canal east and west of Rochester.
(Schmidt, 1966, p. 3)

Variants of this theory call upon English and/or Irish emigrants as the "imported masons." While it is certainly true that the beginning of cobblestone construction correlates well with the opening of the Erie Canal, correlation is distinct from causation and several lines of evidence call this theory into question.

Some cobblestones may predate the completion of the Erie Canal in 1825. There is no consensus on the age of the first cobblestone structure and many structures with construction details suggesting an early age are not reliably dated. Roudabush's survey of cobblestone structures identified one structure in Farmington, Ontario County, that has an 1810 inscribed on a portico. In a more in-depth survey of Ontario County cobblestones, Swartout (1980) questions the reliability of this date, but also reports a deed transfer record for this property dated 1825. While 1810 would be very early, this structure does seem to be pre-1825 and shows several interesting features suggesting an early date, including wooden lintels, pilastered front corners and cobblestone back corners without the use of quoins. There are several well-dated buildings constructed in the years 1825-1827 in widely separated areas of Ontario and Wayne counties; given that most buildings are undated, it seems likely that there are some pre-1825 cobblestones.

Roudabush (1980) points out that there are problems with the theory both in the location and the timing of the demand for masons during canal construction. The demand for masons in canal construction was primarily for the construction of locks and aqueducts, but 65% of the locks and 68% of the aqueducts on the original canal were east of Syracuse, while only 4% of cobblestone structures are found there. Roudabush's survey of dated cobblestones indicates that almost half of all the well-dated cobblestones, 47%, were built in the decade between 1836 and 1845. But the early success of the canal led to canal expansion projects that widened and deepened the canal. Reconstruction of the canal locks and other works began in 1832 and continued until 1862. Thus, during the peak years of cobblestone construction, there should have been sufficient employment for masons on the canal.

There is also a disparity between the masonry structures associated with the canal and cobblestone construction. Locks and other canal structures were built primarily with large, carefully cut and shaped limestone blocks (STOP 10). In contrast, cut stone was a relatively minor part of most cobblestone houses. A contract for the 1838 construction of the Tuttle house just west of Geneva (now the Cobblestone Restaurant) survives in the Ontario County archives and it calls for the stone components of that building, including "cut stone ready cut" to be delivered to the site by the owner, suggesting that the masons simply incorporated the precut blocks into the cobblestone walls, a task requiring care but little skill. In Lockport, west of Rochester, the canal crosses the escarpment of the Lockport Dolomite in a flight of five locks. Heralded in its day as one of the engineering feats of the world, this series of locks must have employed many masons. Interestingly, there are houses in Lockport that *were* made by canal masons (Plante, 1994). These are not cobblestone structures, but instead are made of cut stone blocks and much more closely resemble the type of stone work seen in canal locks and aqueducts.

Finally, there is little in the way of contemporary descriptions of cobblestone masons, but this silence may in itself be significant. For example, Schmidt's 1966 book reproduces the text of two accounts by farmers who had cobblestone buildings constructed for them. Both accounts are letters sent to local farm magazines and recommend these techniques to other farmers. In describing the benefits of cobblestone construction, they say nothing about "special" masonry skills being required. If cobblestone masonry was a difficult "art" requiring highly specialized skills, it seems likely that these accounts would have mentioned the necessity of finding a mason skilled in the technique, but they do not.

Given these above, it seems more reasonable that indigenous masons built these structures. How were cobblestone building techniques first introduced into the area? Shelgren and others (1978, p. 7-13) document cobblestone buildings in the southern part of England that predate upstate cobblestones and are similar in many ways. This could be the source, but structures built with rubble-filled cobblestone walls are known back into classical times and it may be that the technique developed independently in different areas at different times. It seems altogether possible that a capable 19th-century workman familiar with the basics of mortar and faced with an abundance of rounded cobbles and a scarcity of square or rectangular rocks would be able to invent the technique for himself.

Though Erie Canal masons may have played only a small role in the development of cobblestone buildings, the Erie Canal and the economic development it fostered are critically important. Begun in 1817, completed through Rochester by 1823, and fully operational by 1825, it is difficult to overstate the importance of the Erie Canal, both regionally and nationally. For farmers in rich agricultural counties such as Ontario, Wayne, and Monroe, the canal provided a way to transport their produce to larger markets. This fundamentally changed the nature of agriculture along the canal's route by allowing these farmers to shift from subsistence farming, to cash crops, particularly wheat. With the development of cash crops and markets in East Coast cities like New York, upstate farmers began to experience significant prosperity in the years following the canal's construction. Out of that same prosperity, came the desire to build more permanently, in effect to build a structure that was not only functional, but symbolically important as well. Masonry, and especially stone, have always been the preferred materials for such structures. Masonry construction is more permanent, has greater resistance to fire, does not have to be painted, and has always been associated with solidity and prosperity. These advantages were all the more persuasive because wood construction of the early and middle 19th-century used heavy timbers held together by mortise and tenon joints secured with wooden pins. This type of construction was much more expensive than the dimension lumber framing that we are familiar with today and required the services of a skilled carpenter. Board construction was uncommon because both boards (which had to be sawed from timbers, an additional step) and nails, which were individually handmade by a blacksmith, were expensive.

Geological Factors Important to the Development of Cobblestones

The geology of upstate New York is also critical to the development of cobblestone buildings. In the area in which cobblestones are most abundant, the weak shales and evaporites of the Silurian Salina formation are sandwiched between the more resistant Lockport Dolomite (below)and Onondaga Limestone (above). The slight south dip of these units (approximately 1°) produces a broad east-west strike belt that has been scoured by glaciation to produce an east-west trending lowland that has little topographic relief. It is across this lowland that most of the Erie Canal was constructed. The greatest expense in canal building is in the construction of locks. As the canal profile in Figure 4 demonstrates, the first 100 miles from the Hudson to the top of the Mohawk watershed Utica requires 51 locks and has an elevation gain of 406 feet. Just west of Utica, the canal enters the outcrop belt of the Salina formation and the "lowlands" south of Lake Ontario. For the next 225 miles, only 25 locks are needed to accommodate 210 feet of elevation change (up and down), with a net elevation gain of 86 feet to Lockport. These same lowlands were also excellent farmlands. Thus, the geology of upstate New York was critical to the development of the canal and thus to the prosperity and cobblestones houses which followed.

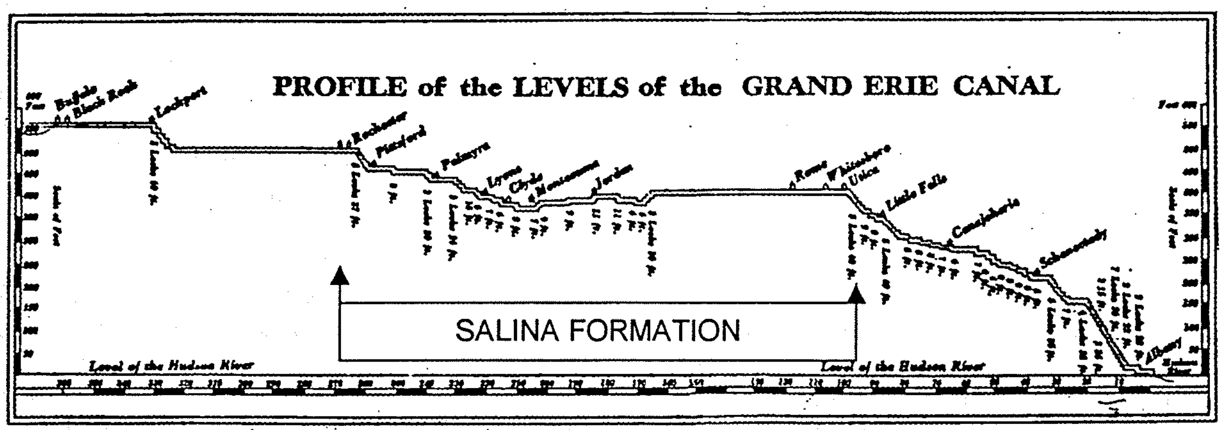

Figure 4. Profile of the original Erie Canal. The east-west trending outcrop belt of relatively weak Silurian rocks from Utica west helped to produce the subdued topography of the lowlands bordering Lake Ontario. Without this lowland, the Erie Canal would not have been feasible (Figure modified from

As middle- to late-19th- century upstate farmers began to consider building new masonry homes that would reflect their growing prosperity they faced one important problem. Good building stones crop out sporadically along the trend of the Onondaga Limestone and southward, and in scattered areas to the north of the Lockport Dolomite (Figure 5). But in most of the area in which cobblestone buildings are common, locally available stone consists chiefly of glacially deposited, potato-shaped cobbles. Limestone outcrops were sufficiently close to provide lime and cut-stone components, glacially deposited outwash sands were abundant and widespread. Using these materials that were at hand, cobblestone building techniques and cobblestone buildings emerged.

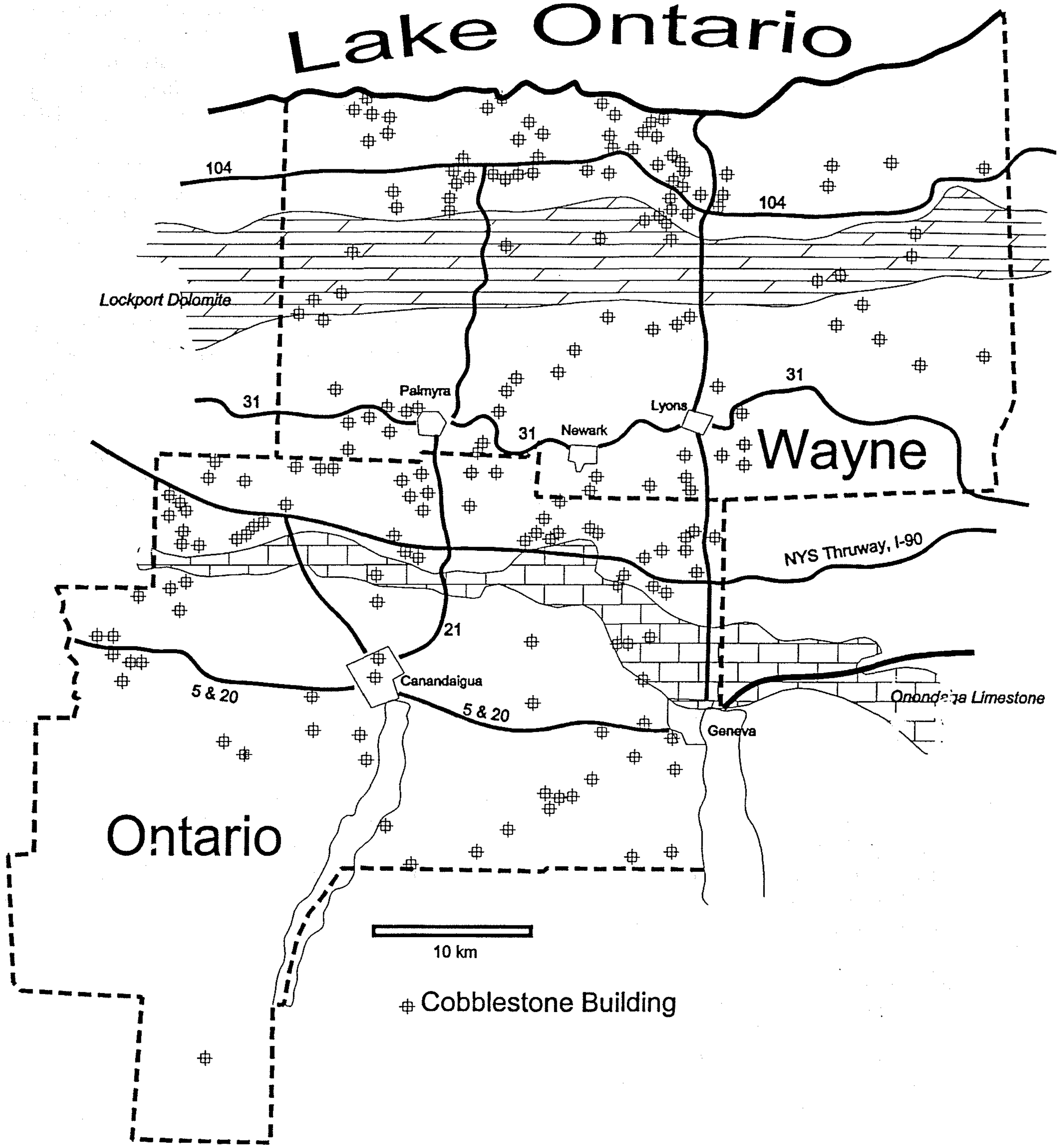

Figure 5. Map of Ontario and Wayne counties showing the distribution of cobblestone structures relative to the areas underlain by Onondaga limestone and Lockport dolomite. Outcrops of these units are sparse. Cobblestone structure location information compiled from Swartout (1981) and Wayne County Historical Society (1979).

If flat or block-shaped stones, ones easier to build with, had been widely available in the Ontario lowlands, they probably would have been used instead of cobblestone. Two lines of evidence support this assertion. First, as one moves south from the Onondaga outcrop belt, cobblestone houses become scarce and one sees instead stone structures built with dark-colored Devonian siltstones and sandstones taken from formations above the Onondaga. The nearly perpendicular intersection of bedding planes and joint surface in these rocks produce slab and block-like stones that would have been much easier to build with. Geneva Hall on the campus of Hobart and William Smith is a good example. It was constructed in 1822 of slabby silt and sandstones from outcrops along the lake to the south brought to the site by boat. There are a few stone buildings in the lowlands where cobblestones are dominant, but all of these that the author is aware of are within a mile or less of stone quarries. Given that Late Period cobblestone builders carefully selected cobbles for color, shape and size and strove for uniformity, it seems likely that they would preferred the more regular stone blocks had they been available at reasonable cost.

Only a few cobblestone structures were built after 1865. Why was cobblestone construction essentially abandoned after that date? A few authors have suggested that the construction of New York's roughly 700 cobblestone buildings may have exhausted the supply of cobbles. Hogwash. No geologist, and no person who has ever exercised a shovel in northern Ontario or southern Wayne County could accept this theory—there are probably enough cobbles in these areas to rebuild the great wall of China several times over. Instead, the demise of cobblestone construction likely was caused by a combination of technological and economic factors. The increasing prevalence of steam powered saw mills, the continuing development of machines that could make low-cost nails, and the ability to transport lumber and nails by rail all served to lower the cost of the materials for building a frame house. To take advantage of lower cost nails and dimensioned lumber, George Washington Snow invented the "balloon frame" house in 1832. Using this system, very much like modern frame construction, a few relatively unskilled men could quickly frame a house. Thus the labor costs for wood frame houses were also reduced, a particularly important factor in the inflationary labor markets that followed the Civil War (Tenney, 1987). All of these factors increased the cost differential between a cobblestone house and a frame house. The old advantages of cobblestone construction, durability, lack of maintenance, and fire resistance remained, but now that much cheaper alternatives were available, farmers began their transformation into consumers: they realized that they could buy other increasingly available goods rather then build these handsome structures.

HOW TO LOOK AT A COBBLESTONE HOUSE

With their understanding of the natural stone materials used in cobblestone houses, their experience in "reading" the visual clues of composition, texture, and pattern in outcrops, and their training in recording such details, geologists are well-adapted to looking at and understanding many of the subtleties of cobblestone construction. What follows is a brief checklist of observations that may be useful for those just beginning to look at these interesting buildings:

<u>The Building</u>

- Function? (home, barn, church, etc.)
- Architectural style and stylistic elements that support this designation?
- Presence of a date stone?
- Evidence that the house was built in stages? (Many are!)
- Quality of moldings, door facings, etc.?
- Later additions/modifications/renovations?
- Location relative to local geology? Were alternative materials readily available?

<u>Cobbles</u>

- Types of cobbles--field or lake-washed? Sizes? Colors? Variations within the structure?
- Patterns defined by color/size/orientation of cobbles? (e.g., herringbone, color bands, etc.)
- Number of cobble courses per quoin on front, side and rear walls?

<u>Mortar</u>

- Sand size ranges in the mortar? Bedding (coarse) and finish (fine) mortars?
- Presence, abundance of white lime "lumps?"

<u>Joint Work</u>

- Basic form of the joint work, both vertical and horizontal joints—V-shaped, beaded, etc.?
- Linearity and horizontality of joints?

<u>Structural Stone Components</u>

- Presence and types of materials used for quoins, sills, lintels, "water tables"?
- Tool markings on cut-stone components?
- Changes in quality of stone components from front, to side, to rear of building?
- Is this building representative of the early, middle, or late cobblestone period?

Having made these observations, one can then ask some of the more interesting questions—Who built this building and why? What factors influenced their choice of styles, techniques and periods? What does the building itself tell us about the people who built it? How does this building fit into the context of upstate cobblestones? Where did the materials come from?

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ROAD LOG FOR GEOLOGY AND THE DEVELOPMENT OF UPSTATE NEW YORK'S DISTINCTIVE COBBLESTONE ARCHITECTURE

PLEASE NOTE! ***All of the houses described below are private residences. Anyone wishing to visit these structures must obtain the permission of their owners! The description of these houses in this road log in no way implies the permission of the owners for others to trespass on these properties!***

STOP 1: COBBLESTONE TOOLS AND TECHNIQUES, HWS CAMPUS

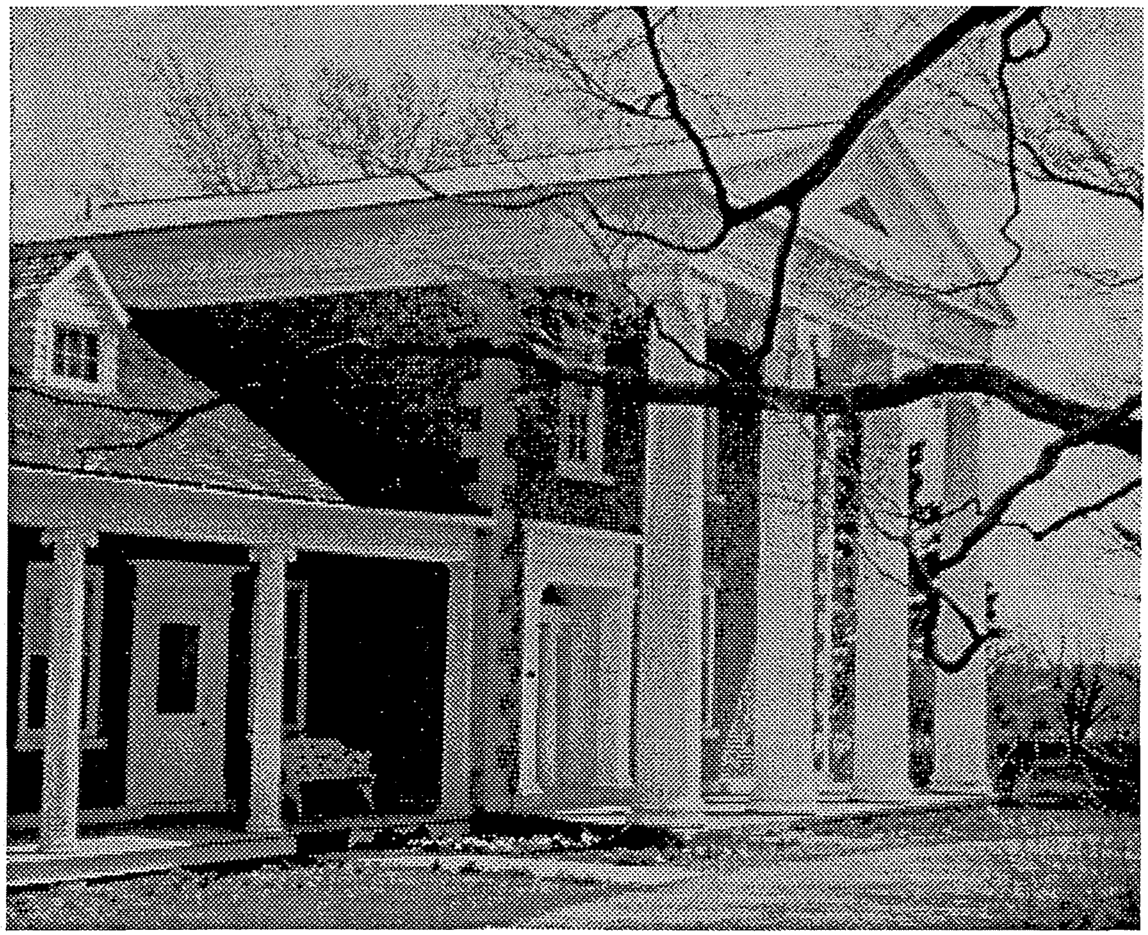
A demonstration of basic cobblestone techniques. Some cobbles, mortar, stone and basic masonry tools will be available and participants will have a chance to test their skills as cobblestone masons.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0.0	Intersection of Routes 5 and 20 (Hamilton St.) and Pulteney St. in Geneva, entrance to HWS campus. Head west toward Canandaigua (left if leaving HWS campus on Pulteney St.)
1.3	1.3	Stop light and intersection with Pre emption Rd., County Road 6. Turn left (south) onto Pre emption Rd. The Cobblestone Restaurant on the SW corner of this intersection was originally a single story cobblestone house built in 1838/39. The building contract for this house is preserved in the Ontario County Archives. The house was built by Clark Morrison, Amos Siglee, and Samuel O. Coddington for a price of $1550 excluding materials, which were supplied by the owner, Joseph H. Tuttle. The stucco second story was added in 1915.
7.0	5.7	Stop 2. Barnes House. Park on shoulder on left.

STOP 2. BARNES HOUSE, FIELDSTONE GREEK REVIVAL HOME, 1835 TO 1838.

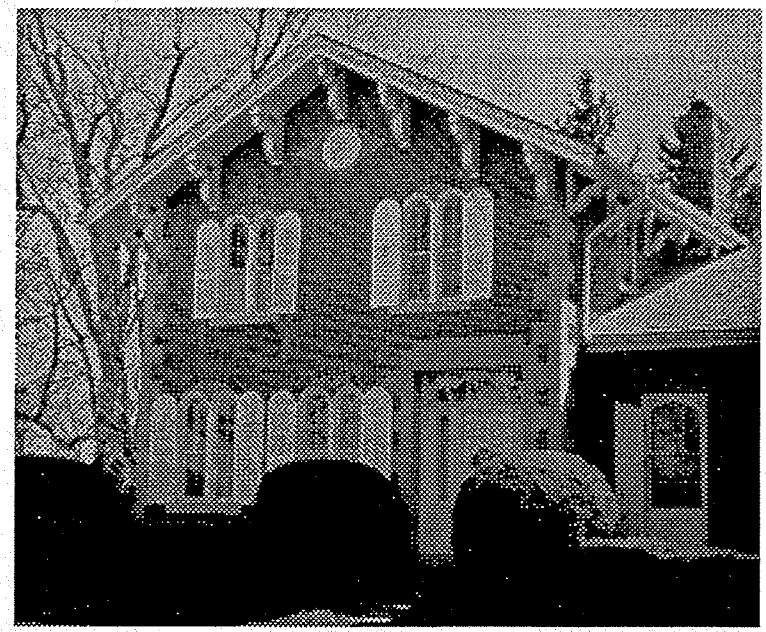
This house is an excellent example of a Greek Revival cobblestone (Figure 5). It was built over a period of three years, beginning with the north wing in 1835 and completed in 1838. Key features identifying this as a Greek Revival are the portico with Ionic columns, the wide cornice moldings which simulate the entablature of a Greek temple, the recessed doorway, and the massive lentil over the doorway. Features to examine and discuss: lithologies of the cobblestones, cut-stone components and their tool marks, character of mortar joints, variations in technique from the front to the back of the house, assignment to one of the cobblestone periods (early, middle, late).

Return to vehicles, turn around and head north on Pre emption Rd. Reset odometer to 0.



CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0	0	Stop 2, Barnes House
2.5	2.5	Turn left (west) at intersection with Billsboro Rd.
4.5	2.0	Billsboro Rd. (here called Lake to Lake Rd.) joins Route 14A, turn right (north) onto Route 14A

6.7	2.2	Rt. 14A turns sharply to the right (east), continue straight onto short access road to Leet Rd. STOP 3 is on the left. Park on the right shoulder of the access road.



STOP 3. RIPPEY HOUSE, LAKE-WASHED ITALIANATE HOME, 1854

This is home is made of lake-washed cobbles and was built in the Italiante style very late in the era of cobblestone construction. The features which identify it as Italiante are the shallow roof angles, the deep eaves, the decorative brackets supporting the eaves, and the paired windows with rounded arches. The Italianate style called for "compressed" vertical elements, tall and relatively thin windows, for example. After 1850, improvements in glass-making technology allowed these windows to have a few large panes of glass, in contrast to the small panes used in earlier styles. The other common Italianate style, though though rarely made of cobblestones, is the "cube and cupola," a two story box like house with a shallow-angled roof that rises in four panels to a central cupola. Features to examine and discuss: lithology, size and sorting of the cobblestones, nature of the mortar joints, quality of mortar work around the windows, comparisons with Barnes house, assignment to one of the cobblestone periods (early, middle, or late).

Return to vehicles and head north on Route 14A.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
10.7	4.0	Traffic light, intersection with Rt. 5 and 20. Turn left (west) on Rt. 5 and 20.
11.7	1.0	Baron House, a Greek Revival cobblestone house built in 1848, on the right (north) side of the road.
15.8	4.1	Intersection with County Rd. 20, turn right (north).
18.6	2.8	Stop sign, intersection with County Rd. 4. Continue straight.
19.9	1.3	Intersection with State Rt. 488, turn left (west) on 488.

20.8	0.9	STOP 4. Oliver Warner House (Landmark Farms). Park in driveways by the barn, on the left (south) side of road.

STOP 4. OLIVER WARNER HOUSE, FEDERAL STYLE FIELDSTONE HOUSE, 1840

This house was clearly built in stages; the front, west wing was built in 1840 in the Federal style. Features which mark this as a Federal style house the semicircular stone-trimmed fanlight, the door treatment, the shallow cornices, and the relatively thin, elegant moldings. Unlike the Greek Revival style, the Federal style uses thin vertical elements and shallow openings which accentuate the building's flat surfaces. Features to see and discuss: types and variety of cobbles, extraordinary cut-stone work, variations in construction techniques in different wings of the building, comparisons with other buildings we have seen. Can you hypothesize on the chronology of the wings?

Return to vehicles, turn around and head back (east) on Rt. 488. (Rt. 488 curves northward after intersection with County Rd. 20.)

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
21.7	0.9	Intersection with County Rd. 20, continue on 488.
25.1 (Reset mileage)	3.4	Intersection of Rt. 488 with Rt. 96. Reset odometer to 0 a this point. Turn left (west) on Rt. 96.
2.6	2.6	North of village of Clifton Springs, turn right (north) on County Rd. 25.
2.8	0.2	Cross NY State Thruway
3.1	0.3	Cross Canadaigua Outlet, bear right on far side of bridge
3.7	0.6	Village of Gypsum, intersection with County Rd 27 (Plainsville Rd, enters from the left, north). Turn left (north) onto County Rd 27
3.9	0.2	STOP 5. Plainsville School (east side of road), and Second Baptist Society of the Town of Phelps church (now both private residences).

STOP 5. PLAINSVILLE SCHOOL, 1853, AND SECOND BAPTIST SOCIETY CHURCH, 1835. COMPARISON OF EARLY AND LATE COBBLESTONE PERIODS

These two structures, now private residences but once public buildings, are on opposite sides of Plainsville Rd. in the village of Gypsum, also called Plainsville. They are excellent examples of the differences between early and late cobblestone construction. In examining the buildings, make sure to note the contrasts in quoins, lintels, sills and other structural components, sizes and lithologies of the cobblestones, mortar, and the tooling of the joints. The owner of the church building says that the building was built by the congregation with the help of a mason and relates the following story, the truth of which is difficult to assess: The mason showed the amateur builders how to lay cobblestones in the parts of the wall framing the front door, where the joints are relatively straight and horizontal. As the distance from the door increases and the amateurs took over, the joints bob and weave like drunken sailors. Features to examine and discuss: the contrasts in materials, techniques and architectural styles between these two buildings.

Gypsum is so named for gypsum deposits in the Salina formation that were discovered along the Canadaigua Outlet just south of town in 1812. The town was originally called Plainsville, but when it got its own post office the name had to be changed because there was already a Plainsville, N.Y. (Parmalee, 1986).

Return to vehicles, turn around and go back to County Rd. 20.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
4.1	0.2	Turn left (east) on County Rd. 20.
4.2	0.1	Intersection with McBurney Rd., turn right (south) on McBurney Rd.
6.2	2.0	Outcrop of Onondaga Limestone on the right (south) side of road
7.9	1.7	Intersection with Rt. 488, turn right (south) on 488.
8.2	0.3	Pass under NYS Thruway, outcrops of the lower portions of the Devonian Onondaga Limestone flank the road.
8.7	0.5	Traffic light and intersection with Rt. 96. Turn left (east) and proceed into the village of Phelps.

The village of Phelps is unusual in that it has both excellent cobblestones and 19th century buildings made with cut stone blocks. This reflects the fact that Phelps is located on the falls of Flint Creek as the creek cuts across the resistant Onondaga Limestone and exposes this good building stone. The town hall, a beautiful limestone block building that combines elements of both Greek Revival and Federal styles, was built in 1849 from limestone quarried just west of town (Parmalee, 1986).

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
9.5	0.8	Cross Flint Creek
9.7	0.2	Phelps Town Hall (see above)
10.0	0.3	Two cobblestones, an early and a late one, face each other across Main St. Note the off-color Portland cement mortar that was used to repair the structure on the left (north) side of the street. A few houses further down the street there is a small Greek Revival house built with cut stone.
11.6	1.6	STOP 6. Hawks House. Park on the right shoulder, cross Rt. 96 with caution!

STOP 6. HAWKS HOUSE, LAKE-WASHED GOTHIC REVIVAL HOME, 1848

This house is a great example of the Gothic Revival style. Features that identify this as a Gothic Revival style include the pointed arches of the windows, the steeply pitched roof, the cross gables, and the wall-dormer windows of the second story. Features to examine and discuss include: comparisons with other structures, use of arches instead of than lintels to support window openings, an contrast between the front and rear of the home. Careful examination of the east-facing gable reveals that this house was added on to with a latter cobblestone addition.

Return to vehicles, and continue east on Rt. 96.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
11.8	0.2	Large cobblestone home and barns, left (north) side of the road.
12.0	0.2	Federal style cut stone home—one of very few in this area.
12.2	0.2	Intersection with Pre emption Rd. Continue east on Rt. 96.
13.1	0.9	STOP 7, Hanson Aggregates Gravel Quarry, park on right shoulder.

STOP 7. GRAVEL QUARRY IN GLACIAL OUTWASH DEPOSITS
A brief "arm waving" stop to see some of the glacial outwash deposits being quarried here and to review local glacial geology. Just visible to the west of this site is the Onondaga Limestone escarpment and a large quarry (the Oaks Corners quarry). Just to the north, across the Canandaigua Outlet, is the morainal topography of the Waterloo recessional moraine. Discussion of the materials needed for cobblestone masonry and their abundance in the region.

Return to vehicles, turn around (WITH GREAT CAUTION!) and return west on Rt. 96.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
14.0	0.9	Intersection with Pre emption Rd., turn right (north) on Pre emption Rd. Cross bridge over Canandaigua Outlet.

Once one crosses the Outlet, the drive from this point northward is through some of the best developed drumlin fields in the area. The underlying tills are filled with cobbles!

14.1	0.1	Climb hill on the north side of the Outlet's floodplain and into the morainal topography of the Waterloo recessional moraine
14.6	0.5	NYS Thruway underpass. Morainal topography quickly gives way to drumlin fields from this point northward.
17.0	3.0	Stop 8. Vandevort House (Optional stop depending upon time). Park on right shoulder.

STOP 8. VANDEVORT HOUSE, LAKE-WASHED, GREEK REVIVAL HOME, 1847
We will make this stop only if time allows. This house is remarkable for the way in which the mason who built it used various shapes and sizes of stones to simulate moldings, particularly on the front of the house. It would be interesting to know what the mason and the Vandervort's thought about these "moldings." Is this a high-refinement of the technique? or has the technique been pushed to the beyond the limit of the materials being used? Discussion: What were these people thinking?

Return to vehicles, continue north on north on Pre Emption Rd.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
18.7	1.7	Wayne County line

19.3	0.6	Good view of drumlin on the left (west) side of road
20.7	1.4	Federal fieldstone cobblestone house, right (east) side of road
21.3	0.6	Junction with Old Pre Emption Rd., bear to the right.
21.7	0.4	Pre Emption Rd becomes Leach Rd (which enters from the right), continue straight
22.4	0.7	Cross RR tracks.
22.6	0.2	Traffic light and intersection with Rt. 31 in the village of Lyons. Continue straight on Leach Rd.
22.7	0.1	Cross bridge over NYS Barge Canal
22.8	0.1	Stop sign. Turn left.
24.0	1.2	STOP 9. Salina Formation. Turn around and park on left (south) shoulder or in canal work building lot.

STOP 9 SALINA FORMATION

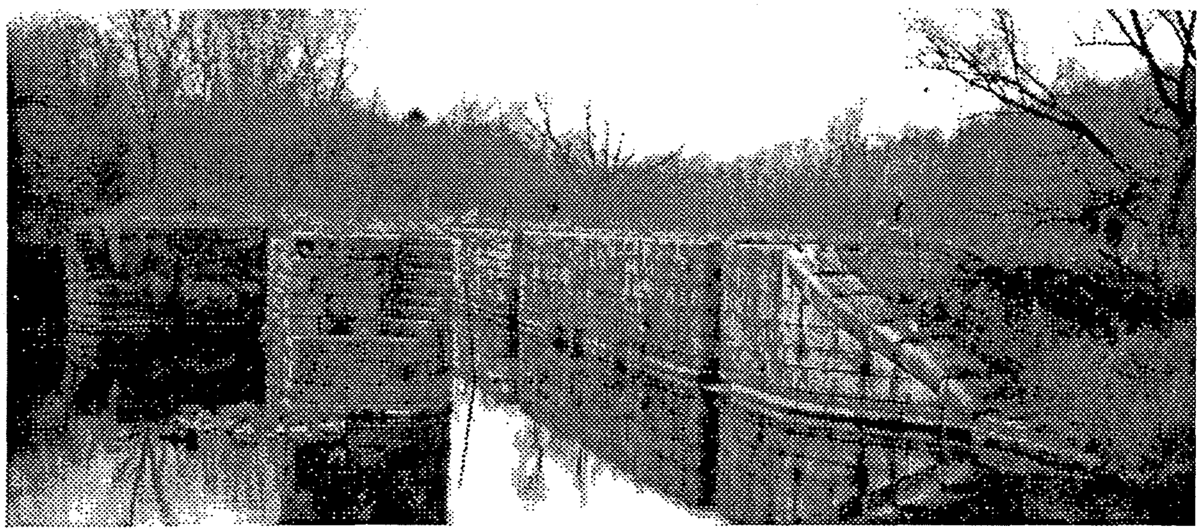
Green, tan, and maroon shales of the Silurian Salina formation are exposed in a low road cut at this site. Casts of hopper-shaped salt crystals can be found in some of the weathered shales. The Salina formation is significant to this field trip because of the topographic control it exerts over the regional landscape, creating the east-west lowland that made it possible to construct the Erie Canal. Discussion: Topography and the feasibility of the Erie Canal.

Return to vehicles and head back toward the village of Lyons.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
24.1	0.1	Intersection with Dry Dock Rd. Turn right (south) on Dry Dock Rd and cross NYS Barge Canal. On the other side of the canal, follow Dry Dock Rd. to the right (west).
24.7	0.6	STOP 10. Old Lock 56 of the Erie Canal. Park on the right shoulder and follow trail along the barge canal to the west for approximately 100 meters.

STOP 10. OLD LOCK 56 OF THE ERIE CANAL

The significance of this stop is two fold. First, it provides a fine setting in which to review the importance of the Erie Canal to the economic prosperity it helped to produce, and of which cobblestone farm houses are one manifestation. Second, it is a good place to review the "Erie Canal theory," the idea that cobblestones were built by unemployed masons who had been imported to build the canal. The disparities between the type of construction used on this lock and cobblestone construction should be quite clear.



End of field trip. To return to Geneva, continue on Dry Dock Rd. which intersects with Rt. 31 less than a mile from this point. Turn left (east) toward Lyons on Rt. 31. In Lyons (approximately 2 miles), turn south on Rt. 14 and follow it to Geneva (approximately 15 miles).