History, Economy, and Geology of the Bluestone Industry in New York State

James R. Albanese, Department of Earth Science, SUC Oneonta 13820
William M. Kelly, New York State Geological Survey, 3136 CEC Albany, NY 12230

ABSTRACT

Upper Devonian sandstone units that occur in southeastern New York, known as *bluestone*, were a source of dimension stone for the construction industry of southern New York and eastern Pennsylvania long before their descriptions were reported in the geological literature in 1886. Various parts of the Sonyea and West Falls Groups have been quarried. However, the economic significance far outweighed the geological importance of the units, so precise relationships between the minable stone and its geologic unit or environment of deposition were and are largely unknown. The extraction of bluestone, like the exploitation of other low value per volume commodities, has been driven principally by market demand rather than by geologic availability. Descriptions of the properties of the stone are primarily cosmetic rather than petrographic.

The purpose of this trip is to demonstrate the association between the geologic and mining aspects of bluestone quarrying. It will explore the connection between the geology and the mines and examine historic and modern quarrying operations. Participants will learn of the technologies used to locate, identify, and extract currently recognized bluestone resources. In addition, changes in the style of mining and in parameters of the product that could be economically recovered throughout the history of the industry will be illustrated.

INTRODUCTION

Bluestone has been historically quarried in the Hudson Valley, central and southern New York, and northern Pennsylvania and continues to be quarried in some of these areas. Bluestone, or flagstone, is the trade, or commercial name for this type of dimension stone. The rock can be generally classified as a well-cemented, angular, medium- to fine-grained sandstone with its most outstanding characteristic being the bedding. Even-bedded rock that can be split in parallel layers is marketable as bluestone, regardless of its grain size, texture, color, or composition. In general, this bedding characteristic and its resistance to wear and weathering, the result of being composed primarily of quartz, give the stone its economic value. The "blue" of the bluestone name came from the color of the stone quarried in Ulster County during the 19^{th} century, and is no longer an accurate description. The color of bluestone varies from the more common blue and gray colorations to include green

through red-purple varieties. The stone is used for sidewalks, veneer, stair treads, curbing, and in other places where durability and a non-skid surface are required.

STRATIGRAPHY

The rocks that compose the bluestone resource are generally of Upper Devonian age. The bluestone quarries in the Deposit-Hancock region are generally developed in rocks of the Upper Walton and Slide Mountain Formations. These are middle Late Devonian units of Frasnian age assigned to the West Falls Group (Rickard, 1975). The Walton Formation is the Catskill-facies equivalent of the Rhinestreet Formation. Whereas the Rhinestreet Formation was deposited in a marine basin environment, the Walton Formation consists of non-marine sandstone and shale. The Walton Formation is approximately 1900 feet thick and contains greenish gray sandstone, green shale and red sandstone and shale. The red beds are relatively rare, constituting about 12% of the stratigraphic section (Sutton, 1963). The Rhinestreet Formation is divided into several dark or black shale members in south-central New York. These units, traced eastward, interfinger with tongues of Catskill facies rocks of the upper Walton Formation. This marine-non-marine change occurs in the area of the Deposit-Nineveh Quadrangles. Sutton (1963) suggested that several dark gray shale units in the upper Walton can be correlated with the black shale units of the Rhinestreet Formation to the west. The Slide Mountain Formation a coarse, non-marine green sandstone, is the equivalent of the uppermost members of the Rhinestreet, Gardeau, and Nunda Formations to the west. In New York, the Upper Walton Formation of the West Falls Group is the predominant source of bluestone in this area. This group corresponds to the New Milford Formation from which the majority of northern Pennsylvanian stone is quarried (Krajewski and Williams, 1971).

PETROLOGY and DEPOSITIONAL ENVIRONMENT

In addition to its characteristic parallel bedding planes the petrology of bluestone contributes to its utility as a building stone. In the most general case, bluestone can be described as mineralogically stable, having a great resistance to ordinary weathering, and being almost as durable as quartzite (Wadeson, 1986). Historically the composition of bluestone, as described in Dickinson (1903), is of angular quartz grains, two feldspars, one decomposed and the other very fresh, cemented with an acid resistant material, probably silica.

Lithologically, bluestone is a non-marine sub-graywacke according to the classification system of Pettijohn (1957) and a low-rank graywacke in the usage of Krynine (1948). Figures 1a and 1b show the composition of bluestones.

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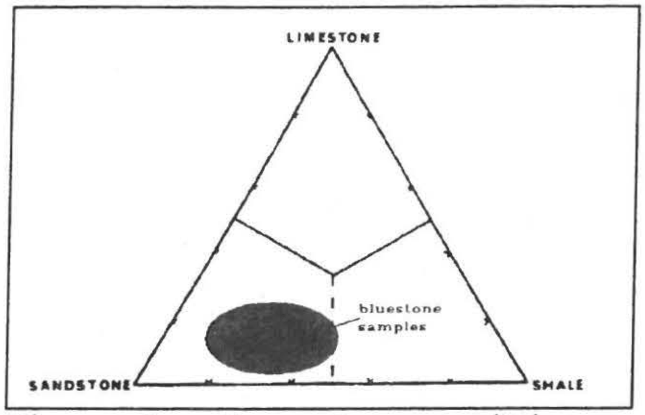

Figure 1a. General composition of bluestones.

The physical properties of Pennsylvania bluestone are very likely to be similar to those of the rocks quarried in the Deposit-Hancock area. The specific gravity of the Pennsylvania stone is 2.48. Percent H_2O absorption (porosity) is 5.3%. Porosity in other commercial sandstone is 2-15%. Permeability is 48.9 millidarcies, considered to be in the "good" permeability range. Weight loss through 16 sodium sulfate test cycles was 13.8% (Krajewski & Williams, 1971). The durability of the stone is better than that of other commercial sandstone, such as the Crab Apple Sandstone quarried in Tennessee.

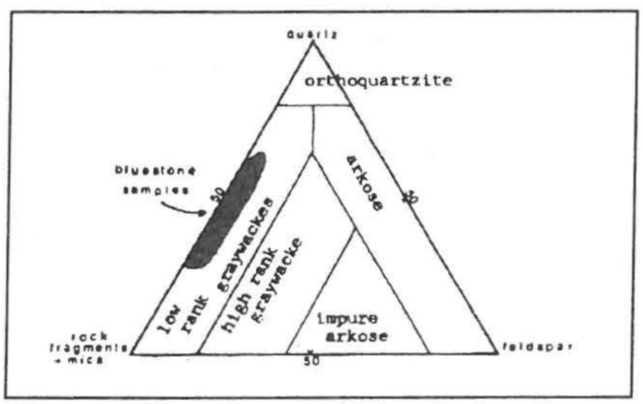

Figure 1b. Composition of bluestone from northeastern Pennsylvania (Krajewski & Williams, 1971).

The clastics of the Catskill delta complex were derived from both sedimentary and low-grade metamorphic terrain to the east and southeast of the delta complex. These sediments, including those that comprise the bluestone resource, were deposited in a shoreline and non-marine coastal alluvial plain environment characterized by lagoons, tidal flats, and low gradient

through red-purple varieties. The stone is used for sidewalks, veneer, stair treads, curbing, and in other places where durability and a non-skid surface are required.

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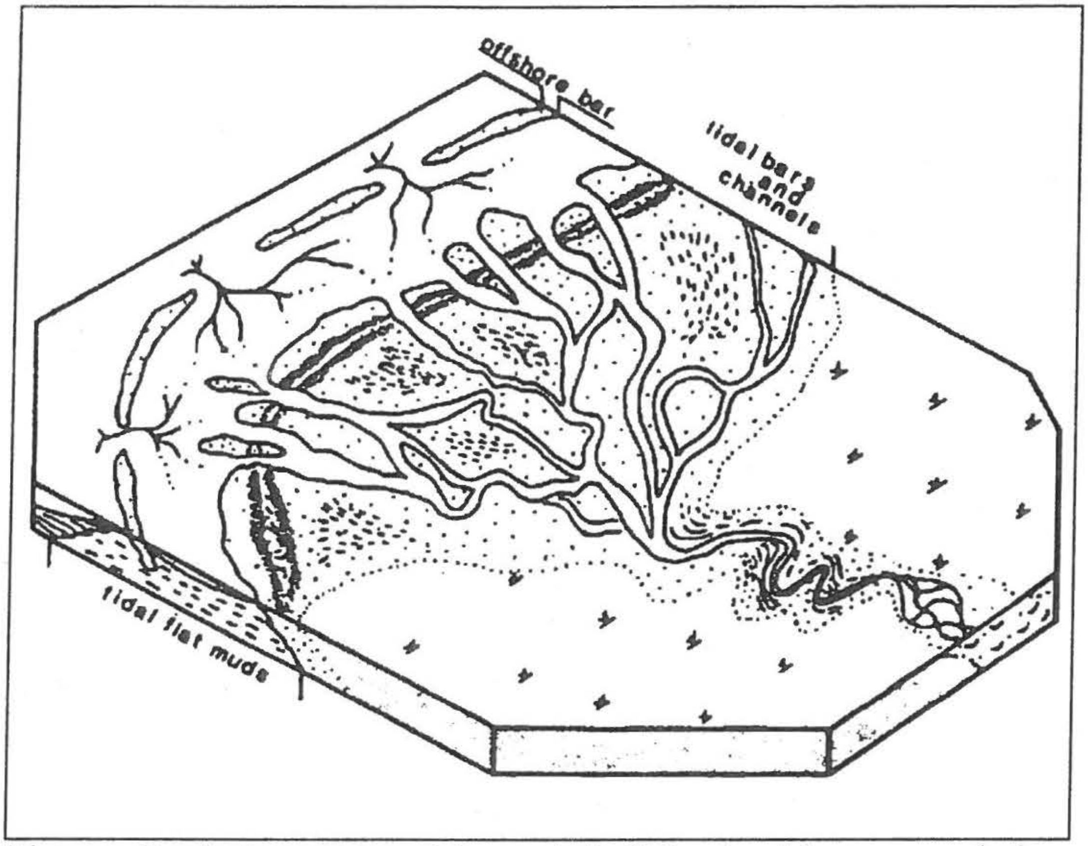

Figure 2. Paleogeographic model illustrating an origin of bluestone deposits (after Krajewski & Williams, 1971).

Descriptions of the paleogeography, sedimentary processes and non-marine facies of the Catskill delta are given by Woodrow (1985) and Sevon (1985).

Krajewski and Williams (1971) conducted an investigation of 875 bluestone quarries in northeastern Pennsylvania the results of which also apply to the of bluestone in New York. Most of the quarries studied, 811, were located in Susquehanna County, with the remainder in Bradford, Wyoming, Lackawanna, and Wayne Counties. Mining in this region was conducted since the 1880's. Krajewski & Williams attempted to classify the quarries by type of sedimentary depositional environment. They distinguished among beaches, offshore bars and interchannel bars. Geologically, the source of the bluestone in the Pennsylvania region is the New Milford Formation, which varies between 400 and 500 feet thick. Here, as in New York, the bluestone is a dense, compact sandstone deposited in a fluctuating marine and freshwater environment. Individual layers are 1 to 20 feet thick and commonly wedge out laterally. A parting lineation, defined by ridges and grooves on the bedding surfaces establishes the paleocurrent direction. It has been suggested that the alignment of elongate grains that help to define the parting lineation impart a zone of weakness along which the stone can be split (Krajewski & Williams, 1971).

A modern lithological analysis of bluestone indicates it is composed of grains of quartz, rock fragments, feldspar, and other minor components. High-grade metamorphic minerals are lacking. The matrix is composed of detrital and recrystallized clay minerals. The rock is cemented largely by quartz with lesser amounts of calcite. The rocks are mostly fine to very fine sandstone, moderately well sorted, with elongate mineral grains. Modal analyses of bluestone samples are given in Table 1.

Table 1. Mean mineral composition of bluestone from three environments of deposition: 1 = offshore bar, 2 = beach, 3 = interchannel bar (Krajewski & Williams, 1971). Abbreviations: Qtz - quartz, RxF -rock fragments, Mic - micas, Op - opaques, Mtx - matrix, Cc - calcite.

	GRAINS					MATRIX	CEMENT	
	Qtz	RxF	Mic	Fsp	Op	Mtx	Qtz	Cc
Type 1	31.5	22.1	3.8	3.1	2.6	26.7	8.7	1.5
Type 2	38.5	26.5	4.2	5.1	1.2	14.1	9.1	4.2
Type 3	35.9	21.0	2.7	3.4	1.5	23.3	10.3	2.1
Total(n=26)	34.9	22.9	3.8	3.5	1.8	22.1	9.4	2.4

From east to west in their study area, Krajewski & Williams (1971) noted an overall decrease in grain size, increase in matrix content, and decrease in cement. To the west, quarries in offshore-bar environments were the more prevalent type. Eastward, quarries in beach type and interchannel-bar type environments were found to be dominant. This observation is consistent with the paleogeography of the Catskill delta complex.

The color of bluestone is imparted by the matrix materials (Krajewski & Williams, 1971). Red or lilac stone has hematite in the matrix. Green stone has green iron-bearing matrix minerals such as chlorite. The matrix of brown stone contains limonite and organic material, while "blue" bluestone is characterized by unaltered iron minerals in the matrix and an absence of hematite. They reported that the blue stone was recovered deeper in a quarry block while the other colors were found around the edges. Chemical analysis reported by Krajewski & Williams and shown in Table 2 indicates that there is an inverse relationship between ferrous and ferric iron in red and blue bluestone.

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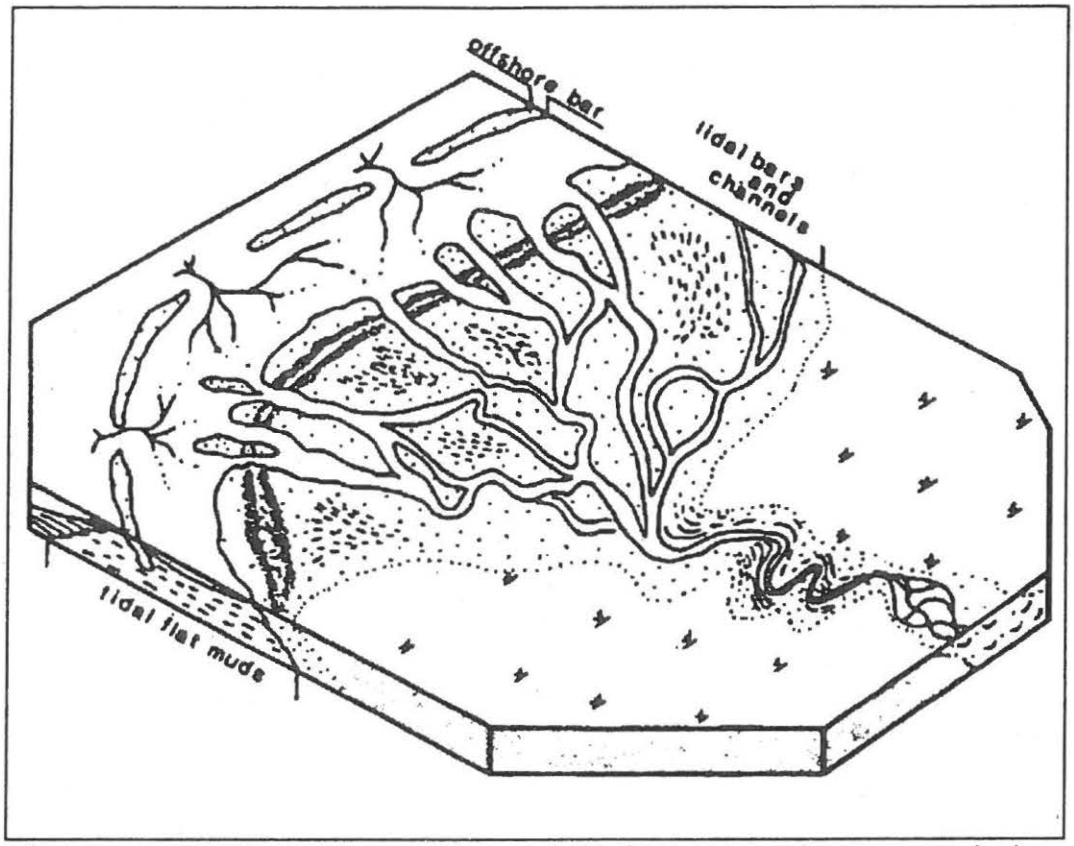

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Table 2. Chemical composition of bluestone of various color (Krajewski & Williams, 1971).

	Red	Brown	Green	Blue
SiO_2	71.50	76.60	69.60	73.70
TiO_2	1.03	1.15	0.81	1.66
Al_2O_3	13.50	11.60	12.50	11.40
Fe_2O_3	3.22	1.82	1.70	0.94
FeO	1.68	1.87	2.99	3.58
MnO	0.06	0.03	0.06	0.07
MgO	1.19	1.02	1.34	1.31
CaO	0.75	0.22	0.45	1.38
Na_2O	1.54	0.57	0.59	0.69
K_2O	2.80	2.24	2.58	1.88
H_2O	2.13	2.17	2.89	2.26
	99.40	99.29	95.81	98.87

HISTORY and QUARRYING TECHNIQUE

The quarrying of bluestone as a dimension stone industry began during the mid 1800's in the area from southern Albany County southward through Greene, Ulster, Sullivan, and Delaware Counties, and into Broome county. The stone from the Hudson River counties, Albany, Greene, and Ulster, was shipped by barge to New York City, while that of the other counties was shipped by rail to Philadelphia and inland locations.

Quarries were (and are) originally located by finding outcrops of sandstone that appeared to be suitable for the production of bluestone. This process of prospecting for bluestone is usually random. Productive quarries have been found by hunters walking through the woods on a hunting expedition. The evaluation of a prospective quarry is based on the experience of the quarryman, the location of existing local quarries and luck (Wadeson, 1986). Figure 3 shows the locations of operating and inactive bluestone quarries of southeastern New York, centered in the Delaware County area of this field trip, as determined by airphoto interpretation.

The major expense of opening a quarry was in the past and is now the stripping of overburden to expose the rock. The overburden consists of soil, glacial deposits, and rock that may not be suitable for stone. This material is dug and blasted away and usually disposed of close to the potential quarry. In many modern quarries, the stripping procedure is one of removing the waste material from a previous quarrying operation when sites are reoccupied in response to demand for particular types of stone changes.

Once the overburden and other materials are cleared, the quarrying of the stone begins. The stone occurs in blocks usually bounded by two sets of vertical joints that trend generally

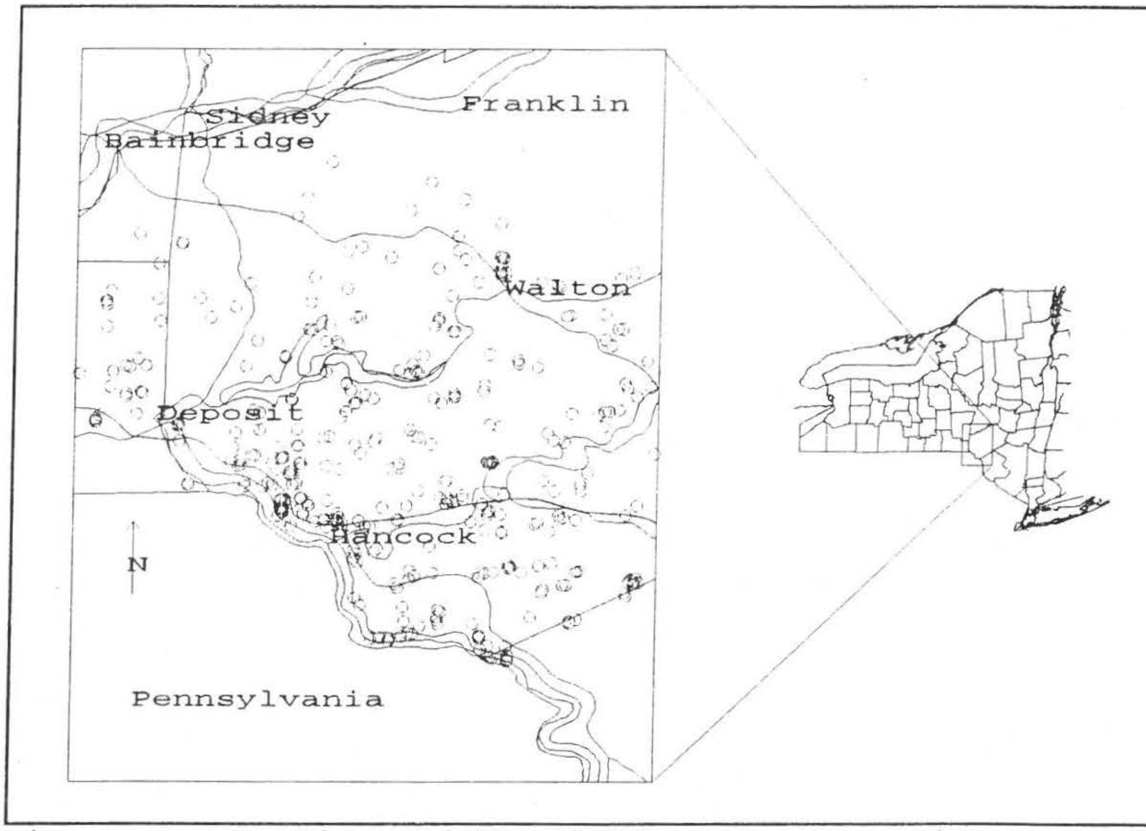

Figure 3. Operating and inactive bluestone quarries located by airphoto interpretation in and around Delaware County.

north-south and east-west. The stone is split horizontally within each block. Depending on the character of the stone, the thickness of each split layer, referred to as a lift, ranges from one inch to several feet. Each lift is extended horizontally as far as possible within the block. If the lift cannot be followed to the edge of the block, the rock must be cut. Bluestone can be cut by scoring a line on the surface and then snapping it, much the same as glass is cut. Hand drilling and plug-and-feather methods for cutting the stone have given way to diamond blade saws, but the basic method is the same. In this way, stone of saleable dimensions-length, width, and thickness-is produced.

Bluestone is sold in seven standard classes, based on its dimensions. Pattern or flag stones are those that range in thickness from 1/2" to 3" and has a minimum surface dimension of 1 square foot, increasing in multiples of 36 square inches. Thicker stone, 1" to 4", that is longer than it is wide (10" to 24" by 3' to 8') is sold as tread for stairways. Similar in dimension to tread, but of random lengths, is coping stone, used as a topping for walls, and sill stone, for windows. Large pieces of stone, with more than about 16 square feet of surface, are referred to as slab stone. Thinner stone is cut into randomly sized parts for use as veneer. Bluestone with at least one

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The type of edge on the stone is also used in its classification for market. Bluestone can be snapped (producing a smooth, natural edge), pitched (formed by snapping the stone at a angle not perpendicular to its surface), machined, cut by a guillotine-type cutter, or sawn. Sawing of bluestone, a relatively modern method of preparing it, is done with an abrasive circular or wire saw. This produces a very smooth, straight cut, which is not always desirable. Stone cut in this way is often flamed, a processes that uses a gas torch on the wetted surface to spall the sawed surface, thereby simulating a snapped edge.

The final method of classifying bluestone is by its coloration. The most common color classes are; purple, blue-green, gray-green, tan, and red. Color classification is the most subjective feature and often varies from stone to stone from the same quarry.

ECONOMICS

In quarryman's jargon, "rock" is the material that is thrown over the side as waste and "stone" is the material that can be sold. Bluestone, defined on this basis, like other economic commodities, is a material that can be removed from the ground and sold for a profit. The bluestone industry can be subdivided into three major parts, quarrying, distribution, and marketing. Bluestone quarries have historically been two or three person seasonal operations (Dickinson, 1903), and this tradition generally continues. There are interdependent reasons for this tradition. The quarries are usually small because they are bound geologically by joint patterns, and the quantity of marketable stone that can be produced from each is therefore limited. This situation results in a low value per quarry making the operation profitable to a limited number of workers. The quarries also tend to be relatively remote, and the topography of the area makes access difficult, especially considering that bluestone is a heavy and fragile product. The distributors, who buy the stone from the quarrymen and ship it to the markets, are generally located near major transportation routes for ease in shipping. Quarry operations are generally independent, but there is a growing number of operator-distributor partnerships. These partnerships have advantages for both the operator and the distributor. The quarryman benefits when the distributor contributes to the high start-up cost involved in opening a new quarry, the distributor in return, is assured of a continuous supply of stone (Wadeson, 1986). The consumer of bluestone is basically the construction industry and the bluestone market suffers the same variability of economic conditions. A study of the market for Pennsylvania bluestone (Mikutowicz and Schenck, 1970a, b) indicated that the demand for the product was related to the degrees of knowledge of applications and qualities of bluestone by the architects, who specify particular building materials. The independence of the operators and the distributors has resulted in a relatively restricted marketing area, a subject being addressed by associations of producers and distributors.

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REFERENCES

Dickinson, H.T., 1903, Quarries of Bluestone and Other Sandstones in the Upper Devonian of New York State, New York State Museum Bulletin 61, 112 p.

Krajewski, S.A., and E.G. Williams, 1971, Upper Devonian Flagstones (Bluestones) from Northeastern Pennsylvania: The Relationship Among Bedforms, Occurrence, Composition, Texture, and Physical Properties: The Pennsylvania State University, College of Earth & Mineral Science Experimental Station, Special Publication 3-71, 185 p.

Krynine, P.J., 1948, The Megascopic Study and Field Classification of Sedimentary Rocks, Jour. Geol., v.56, p130-165.

Mikutowicz, W.G., and G.K. Schenck, 1970a, Marketing and Distribution of Pennsylvania Bluestone, Mineral Economics Monograph, Special Report 70-3, Department of Mineral Economics, The Pennsylvania State University.

Mikutowicz, W.G., and G.K. Schenck, 1970b, Future Strategies for Pennsylvania Bluestone Industry, Mineral Economics Monograph, Special Report 70-4, Department of Mineral Economics, The Pennsylvania State University.

Pettijohn, F.J., 1957, *Sedimentary rocks*, 2nd ed., Harper Brothers, 718 pp.

Rickard, L.V., 1975, Correlation of Devonian Rocks in New York, New York State Museum Map and Chart 24, NYS Education Department.

Sevon, W.D., 1985, Non-marine facies of the Middle and Late Devonian Catskill coastal alluvial plain: *in* D.L. Woodrow & W.D. Sevon (eds.) *The Catskill Delta*, Geol. Soc. of Amer. Spec, Pap. 201. pp. 79-90.

Sutton, R.G., 1963, Report to the New York State Geological Survey on the correlation of the upper Devonian strata in south-central, New York: New York State Geological Survey Open File Report 1x241.

Wadeson, Paul, 1986, History, Terms, Techniques, and Geology of Bluestone, First Hancock Bluestone Symposium, 1986, 21 p.

Woodrow, D.L., 1985, Paleogeography, paleoclimate, and sedimentary processes of the Late Devonian Catskill Delta: *in* D.L. Woodrow & W.D. Sevon (eds.) *The Catskill Delta*, Geol. Soc. of Amer. Spec, Pap. 201, pp. 51-64.

NYSGA BLUESTONE ROAD LOG

Leave Oneonta, go west (right) on Rt. I-88 to Sidney, Exit 9 (25 miles).

Go south (left) on Rt. 8, away from Sidney (4.6 miles).

Cross intersection with Rt. 206 in Masonville, continue south on Rt. 8 to Rt. 10 (13.4 miles).

Go north (left) on Rt 10 at Stilesville, just past the river.

Continue 1.2 miles on Rt. 10 and pull off on north (left) side, outcrop on right.

Stop 1.
Thick-bedded (up to 20') sandstone layers interbedded with sandy shale containing sandstone rubble and intraformational breccia. Shale is red and weathers rusty. Good evenly bedded bluestone, some cross-bedding, plant fossils. Well-jointed; the main joint set is roughly N-S and the subsidiary set roughly E-W. Outcrop is 0.5 miles long along the south side of the road. More thinly, parallel-bedded and cross-bedded units can be seen on the east end of outcrop.

Continue on Rt. 10 for 4.9 miles.

Pull off on north (left) side of road into parking area, just west of intersection with Sands Creek Road.

Stop 2.
Rock suitable for bluestone with 1" bedding in 6' thick layers interbedded with shale layers up to a meter in thickness. Channel deposits composed of basal conglomerates, massive and cross-bedded sandstones, grading into parallel bedded layers at the top of each sequence. Some of the shale contains pyrite, weathering to produce the rusty coloration. Toward the east end of outcrop, very thick (30 feet) sandstone, some cross-bedded, overlying a shalely basal conglomerate, and underlying good bluestone layers. Toward the west end, a channel cut into existing cross-beds and overlain by shale overbank deposits.

Continue 0.1 miles on Rt. 10 then turn right (S) on Sands Creek Road.

Go 0.4 miles up Sands Creek Road (Delaware County Rt. 67), turn right into Indian Country Bluestone Company. This is an active, operating quarry. We are here as guests by permission of the company management.

Stop 3. Indian Country Bluestone Company
Prominent cross-bedding is displayed in the quarry. Note: such well-developed cross-beds are of interest only from the sedimentary structure standpoint, they are a disaster for a quarry. We will see a demonstration of bluestone splitting by old methods (by hand) and stone trimming with the guillotine. Please look over the yard to see the variety of products ready for shipping- pattern stone, tread, veneer, and crushed stone produced from the waste bluestone.

Continue south on Sands Creek Road to "T" intersection with Delaware County Rt. 17 (old Rt. 17) in Hancock (9.3 miles).

Turn left on Delaware County Rt. 17, which is also Main Street, following the signs toward Rt. 97.

Go 0.3 miles and turn right onto Front Street (the street sign is on the opposite side of the road across from McDonald's). Front Street is located between a Getty station and a NAPA store.

Follow Front Street to the left and along the railway tracks.

Go straight at stop sign (0.2 miles).

Continue on Front Street another 0.4 miles, passing the Delaware Inn on left. Note the 6', 8', and 10', 4" thick slabs of bluestone, dry-laid more than 100 years ago, that make up the front porch floor of the Inn.

Note bluestone in walls, steps, and sidewalks as we proceed through Hancock.

At the traffic light (0.1 miles), continue east on Delaware County Rt. 17 (Old Rt. 17).

Continue on Old Rt. 17, straight past traffic light, following Rt. 268 under the Rt. 17 overpass (1.6 miles), and stay on Delaware County Rt. 17 when Rt. 268 heads off left towards Walton.

Continue 1.3 miles and pull over before the big outcrop on left (N) side of road.

Stop 4.
Note: This is a dangerous place. Stay off the septum of sandstone on the south side of the road, between old and new

Routes 17. The drop on the other side is as great as the height of this outcrop. Be careful on the road because vehicles move past this blind curve at high speeds. Also, stay back from main outcrop face to avoid danger of rock falls.

Thick sandstone channel with shale overbank deposits. Stratigraphic packages consist of a breccia at the base, cross-bedded layers above, changing to planar layers near the top, typical of fluvial deposition. Some of these packages may represent a single flood deposit. The cross-bedding is at such a large scale that the rock may appear to be massive. Lateral accretion surfaces produced by channel migrations are visible on the upper surface of the outcrop on the south side of the road. Breccia layers contain shale pebbles, plant material, and concretions. Storm beds and features of soft sediment deformation are present.

Continue east 1.8 miles.

Turn left on unnamed road crossing the divided highway (Rt. 17).

Cross bridge (100 yards) and turn right towards Tylers Switch.

Continue east 0.4 miles to Tompkins Bluestone.

Stop 5. Tompkins Bluestone Company

At this stop we will be the guests of Tompkins Bluestone, one of this area's bluestone distributors. Tompkins uses laser-guided computer-controlled 3' and 10' circular saws to cut stone to whatever dimensions the market demands. They are involved in specialty stone cutting and carving as well as the production of stone for the more traditional applications as treads, flooring, and veneer.

Exit from Tompkins and turn right onto Old Rt. 17.

Return to Hancock (6 miles) and take NY 17 west to Deposit (approximately 10 miles).

Exit NY 17 and take NY 8 north toward Sidney.

At Sidney, turn right onto I-88 (east) back to Oneonta.