# Stone Tool Procurement in the Susquehanna Valley

In Conjunction With
The Creation of a Collection of Lithic Material to be Used For
Educational and Scientific Research

A Thesis and Creative Project
By
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#### Abstract:

The author examines the chert and chert-bearing formations of the Susquehanna and Schoharie River valleys. The paper explores the different general terms and criteria that have been used to describe and classify lithic raw materials. The classic types of lithic materials occurring within New York State and their characteristics, sources and distribution are examined. Methodological problems and needs are defined and discussed. Future research directions are outlined.

Introduction: This project was an attempt to identify and create a collection of the materials used by the Indians to make their tools and weapons as found in the area of Otsego, Chenango, and western Schoharie counties. Later research and questions encouraged the expansion of the research universe to include Greene, Onondaga, Montgomery and Saratoga counties. There are a number of notable people who have devoted a lifetime to this work but in the words of Gary Fogelman, [it is hoped] "that there [will] be continued research and hopefully continued reporting on the lithics of the area and that these subsequent efforts [will] refine and correct such as would be necessary" (Fogelman 1999:3). It is hoped that this project has met that expectation.

The goal of this project is to identify the source of lithic materials as found in the bedrock and in the glacial till of the Susquehanna Valley. (The sample collection area was expanded as needed to try and answer questions that arose during the project.) The questions eventually answered with this research would be what cultural material found at archaeological sites was brought in from other areas, what was quarried from bedrock, and what material was found in the glacial till?

To find the answers to these questions it was necessary to:

- •familiarize myself with the geology of New York State and in particular, the Susquehanna Valley.
- •identify the materials that could be used to make tools (chert, flint, siliceous material) and become familiar with the process of shaping lithic materials
- •from historical accounts identify possible work sites or quarries
- •photograph the bedrock outcrops and identify exact locations using GPS and highway reference markers
- •collect samples from the various identified locations, being careful to extract samples from various points along the exposure

- •collect samples of the rock material immediately adjacent to the chert, flint, or siliceous material as well as collect and identify fossils associated with those beds
- determine color variations of the lithic material
- determine workability of the various materials

Strangely enough, there is very little information available about chert, flint and siliceous materials coming from the professional world. The explanation for this may be that, quite simply, there is no real economic value associated with chert; it is not a resource that our modern culture values. One quarry owner that I spoke with told me that he had paid over \$85,000 in cores to be assured that he would **not** drill into and blast out chert that would contaminate the quality of his dolostone. Nevertheless, chert was an invaluable resource to our ancestors. It therefore behooves us to delve deeper into the question of tool procurement for the edification of archaeologists, anthropologists and historians.

Much of the information for this project came from sources that consider archaeology an avocation. Many of these "amateur" archaeologists started out as collectors of projectile points and moved on to making their own tools. These flintknappers carry with them an enormous amount of knowledge concerning locations of material and workability of material. For this project I attended knap-ins and consulted as many flinknappers as was possible. Some of our local flintknappers have been making points for 20 to 30 years and have acquired an immense amount of data relevant to precise locations of lithic material. Four gentlemen in our area that I am particularly indebted to are Al Kronimus, Paul Trotta, Barry Keegan and Mike Tarbell, all of whom have been actively involved in teaching, research, publishing and flintknappping for many years and graciously consented to make their resources and services available to me for this project. I was also assisted by professionals in the field of archaeology and geology. I received extensive help and guidance from David Moyer of Birchwood Archaeological Services, Dr. Renee Walker and Cindy Klink, Department of Anthropology and Archaeology, SUNY Oneonta, Dr. Alex Bartholomew, Department of Geology, SUNY New Paltz, Jack Holland, Buffalo Museum of Science.

One of the peripheral questions examined during this project, to a minimal degree, was that of patination. Archaeologists find tools and projectile points that have lain in the ground for centuries; this material acquires a patination that hides the true color of the lithic material. By examining quantities of the various types of lithic materials found in situ at outcrops, some information of an empirical nature was gathered. It is hoped that eventually it might be possible to determine patination for each lithic material. This would potentially be of great assistance to archaeologists helping them to identify lithic preferences of various cultures, as well as help them to determine migration or trade routes.

The core of this project is the creation of a collection of lithic material to be used for educational and scientific research. This collection will be used to educate future students and be curated by the University of New York at Oneonta. As stated earlier, we take chert for granted, but without good material, earlier cultures would have perished. At the very least, without a good source of chert nearby, early peoples would have been much less likely to inhabit an area. I would venture to say that in that earlier time, everyone grew up knowing just exactly what to look for if they needed to replace a tool in their tool kit. Students today without that essential societal mentoring do not have that instinct and must therefore be taught recognition. For this reason, it is important that a collection be assembled to assist students in gaining this insight into prehistoric life. In general, it is difficult to sort out the nomenclature associated with chert. In some cases some cherts will have several different names, yet in reality be part of the same chert class. In some regions, one chert may have significant color variations and for this reason have several different names. With a collection, it may be possible for students to work through this morass and be able to distinguish a chert by color, texture, characteristic, region, and name thus helping them on their way to becoming better archaeologists.

Andrefsky (2004:41-43) supports this stating that very few people today appreciate rocks or recognize their differences because modern technology seldom incorporates rock. Archaeologists who study prehistoric technology are some of the rare few who today deal with rock classification and variability. And yet, even among this select group of geologists and archaeologists, lithic raw-material identification is poorly developed due to a "lack of consistent lithic material definitions used by geologists and archaeologists, and partly due to the variations in local and regional use of terminology." He goes on to state that beyond these problems many archaeologists do not understand the characteristics that they should be looking for such as: texture, color, composition, and grain size.

Workability was another key issue that I hoped to address through this project. Not only are most archaeologists unable to precisely name the material used to make tools or weapons, they are usually totally unfamiliar with the effort required to produce a tool or weapon from lithic material. As always, it is one thing to read about the attributes of a good lithic material, but is quite another thing to be able to use that material and create a good tool, and therefore innately recognize the material for its qualities. It is hoped that by working with flintknappers, I will be able to create a scale of workability for all the various types of chert found in our area, but further, by becoming familiar with patination, be able to recognize the lithic material used in making tools found in public and private collections and thus through frequency, determine the most used lithic materials. This would also help us to determine lithic material preferences of peoples, migratory routes and trade relations.

For what appeared initially as a very straight forward project, this became a very difficult and time consuming project, but certainly extremely interesting and worthwhile both personally and institutionally. In speaking with a few archaeologists such as Gary Fogelman and Jack Holland, who have dedicated much of their professional careers to clarifying the chert questions, they both felt that there was an immense amount of work yet to be done, especially in the area of the Susquehanna Valley. They were very supportive of the project.

It is hoped that in the future faculty and students will continue to add to the collection. As Lavin and Hammer both experienced before me, to advance the study of stone tool procurement, it is equally important for archaeologists and geologists to be able not only to recognize the material that can be used to make a stone tool, but also be able to name the type of chert the tool is made from and that means that often you must be able to recognize the lithic material the chert is bedded in. To that extent, I have tried to collect and identify fossils found in the bed material to correlate the lithic tool material with the bed material. For this project material has also been collected from stream beds that have cut into the glacial till. By examining the macro and microfossils found with the cherts and associated bedrock and comparing these findings with the chert cobbles found in the till, it may eventually be possible to identify accurately the cherts in the till and correlate that material to the artifacts found in the archaeological record.

One very satisfying aspect of this project is that it highlights the interdisciplinary nature of archaeology today. To complete a project of this scope I have relied on information gleaned from historical documentation from past expeditions and research, geologists, paleontologists, archaeologists, experimental archaeologists and flintknappers, and cultural anthropologists. Each field poses different questions but by putting the research of each group together it allows us to understand the big picture.

As archaeologists, our major interest in lithic acquisition patterns is based on what they can tell us about prehistoric lifeways and cultural processes. Lithic source identification should not only allow reconstruction of acquisition systems, but also provide insight into other anthropological processes, contributing to studies of cultural distribution, culture chronology, and culture change (Lavin 1983:1).

Accurate identification of the lithic raw materials that were used for tool making has the potential of becoming an important research tool; however, a brief review of the literature shows that more localized research needs to be done to add to the understanding that researchers such as Wray, Hammer, Lavin and others have already brought to the field. In many instances identifications need to be reviewed and terms need to be clarified. Our need for a system of viable raw material identification is predicated on the idea that knowing the correct source location of a material can help in establishing procurement patterns, trade

arrangements, seasonal movements, etc. Lavin states that "even if a material's location is known in only the most general terms, such as being "exotic," or coming from the Ohio valley," inferences are possible". Holland feels that does not go far enough, that young archaeologists should be familiar with the geology of their area and know which ones are chert-bearing (personal communication). The purpose of this investigation will be to review the existing literature and to create a comparative collection for university students so that they can better understand the existing taxonomy of the more common New York State lithic materials and to examine the terminology and methodology of previous classificatory schemes. "It is hoped that eventually work in this field will result in a body of easily usable criteria with which archaeologists can make standardized identifications of lithic types and source location" (Hammer 1976:39).

In 1948 Charles Wray, published the results of seven years of intense research. As he saw it, the problem of classifying the types and sources of material utilized in chipped and polished stone artifacts would have to be attacked by a geologist. He collected samples from all the geologic formations from which early peoples got their raw materials. Each source was macroscopically examined, then thin sections (.02 of a millimeter thick) were made and examined using a petrographic microscope to reveal their crystalline structure and their mineral content. Thanks to Wray, thin sections and polished sections were made so that both visual and petrographic studies were available for later researchers (Wray 1948:25).

"The terms flint, chert, chalcedony, jasper and many others are used to describe the materials used by early peoples to make tools. Geologists and archaeologists agree that these similar materials are primarily silicon dioxide,  $SiO_2$  or silica, which is arranged in micro- or crypto-crystalline arrangements. The differences between the different silica based minerals are the types and amounts of impurities, crystal shape and articulation, and amount of water present in the crystal structure. These subtle differences usually only manifest themselves in terms of minor color variation; thus lithic materials are differentiated primarily on the basis of color and texture. Due to the large areas of overlap, definition by color may be very difficult or impossible. Since specific gravity, hardness, refractive index, and bead and scratch tests of these materials are similar; such tests cannot be used to separate varieties of siliceous materials" (Hammer 1976:40). [figure 1 and 2, page 14 (Hammer 1976:42-43)]

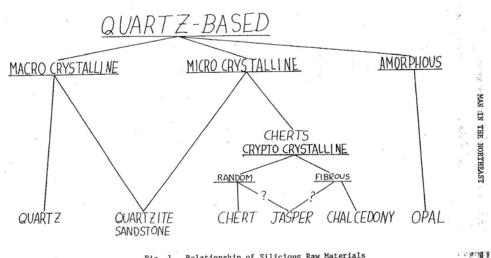


Fig. 1. Relationship of Silicious Raw Materials Based on Crystal Size and Arrangement (After Dana 1961, Pettijohn 1957).

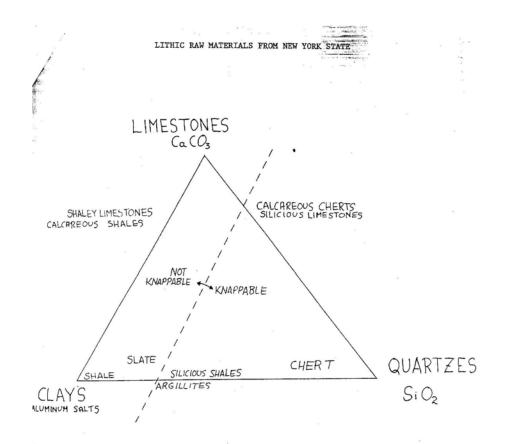


Fig. 2. Relationship of Some Sedimentary Rocks Based on Chemical Composition (After Pettijohn 1957).

In 1948 Wray defined flint as a cryptocrystalline opaque, transparent or translucent variety of quartz with the same general characteristics and composition as quartz. Chert possesses a characteristic conchoidal fracture—an important element of tool making for the Stone Age man. Chert colors range from jet black through blues, reds, yellows, greens, grays, browns and whites. The colors vary accordingly with the pigmentation or the molecular structure. "When the color is due to pigmentation, yellow may result from organic inclusions, gray with pyrite or graphite, and red with hematite or limonite" (Wray 1948:25-26).

"Under the high-power microscope, the substance [chert] appears as a fine mosaic of chalcedonite and quartz, with or without some scattered particles of calcite, dolomite, mica, pyrite, hematite, limonite, argillaceous and clastic materials, carbonaceous impurities, and fossil fragments. Minute quartz veinlets are fairly common" (Wray 1948:26).

"Flint most commonly occurs as nodules (globular, ellipsoidal, discoidal, and irregular in form) associated primarily with limestone, dolomite, and shale (calcareous strata). Flint often occurs in the form of thin lenses also associated with limestone, dolomite, and shale. Bedded flint is almost entirely confined to shales. The flint found in shales often contains a high iron content" (Wray 1948:26).

Although the debate continues, both Hammer and Lavin make similar recommendations to simplify the terminology and thus clarify the academic discussions relating to lithic materials. Future researchers as well as future archaeologists in general, should be cognizant of the debate so that future work will reflect uniformity in terminology and reduce present obfuscation. At present, contemporary researchers are getting closer to settling age old debates: differentiation between flint and chert; should chalcedony be considered the rock or the mineral; is jasper an impure chalcedony or impure chert; and should we regard siliceous limestones and shales as true cherts. Figure 1: page 6 shows the relationships between some of the silicious materials based on crystal size and articulation, while Figure 2: page 6, suggests how clays, limestones and quartz-based minerals are related, based on chemical composition. Until a better system emerges, Hammer and Lavin suggest the following terms and definitions (Hammer 1976:41).

<u>Chert</u>: The proposed term for the general group of siliceous micro- and crypto-crystalline materials. This definition would not include transitional types such as argillite, siliceous shales and limestones. Generally, cherts are dark, Munsel value 5 and lower, brown, grey, green, blue, black, deep red or any mixture. The texture is smooth and the luster ranges from dull to waxy (Hammer 1976:41).

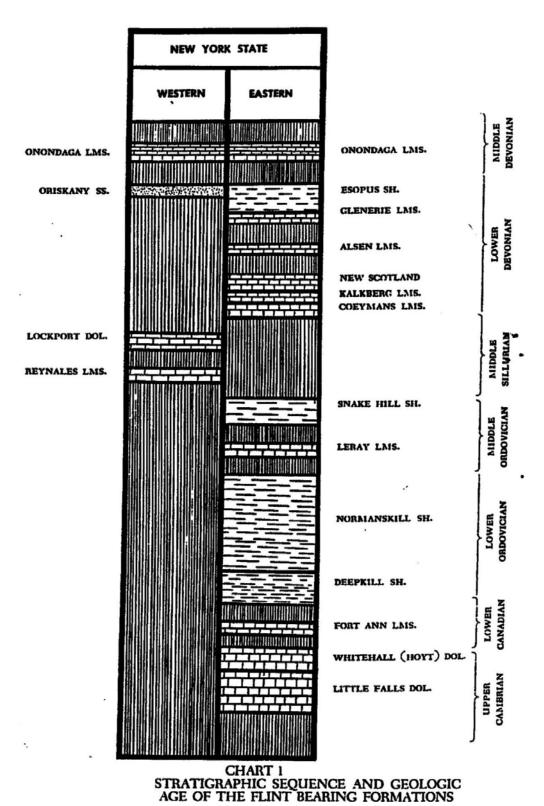
<u>Flint</u>: The common, unscientific and non-specific term for any of these substances cited above or below.

<u>Chalcedony</u>: A light colored chert which may be translucent and waxier than chert. Unless the previously mentioned discussion of chert and chalcedony should eventually lead to some identifiable chemical or structural difference, chalcedony should not be used as a generic term and it should be subsumed under the definition of chert, except as part of a proper type name, such as Chalcedony Hill.

<u>Jasper</u>: A mustard yellow, red through brown chert. This term, like chalcedony, should be subsumed under the term chert, with the same qualifications cited above. The name may be retained for a proper type name, such as Vera Cruz Jasper.

Since Wray's time, much research has been done leading both Lavin (1983:27-30) and Hammer (1976:43-44) to suggest that until such time as geologists involve themselves in the discussion, the terms Jasper and chalcedony should be dropped. Archaeologists should, when using the term chert, preface the term with the appropriate descriptive adjective such as waxy, lustrous, translucent, etc. Chalcedony should only be used when describing microcrystalline fibrous quartz crystals and the use of the term jasper should be abandoned except when used as a proper name (Lavin 1983:30-32).

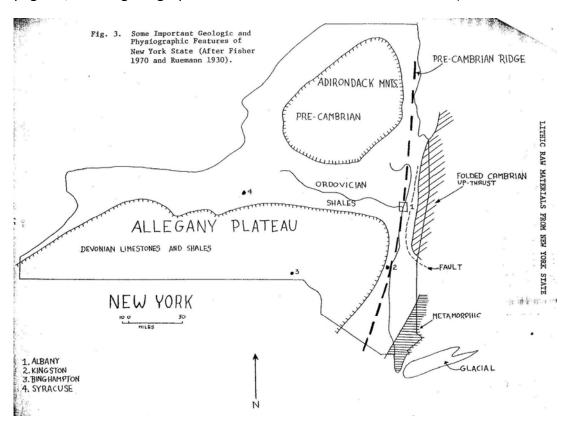
According to Wray (1948), there were seventeen different formations that produced flint. In geologic age, they range from the Cambrian through the Ordovician, Silurian, and Devonian periods of the Paleozoic era see chart 1, page 9, (Wray 1948:27). In geologic literature, these formations are known as the Little Falls dolomite, Whitehall (Hoyt) limestone, Fort Ann dolomite, Deepkill shale, Normanskill shale, Leray limestone, Snake Hill shale, Reynolds limestone, Lockport dolomite, Helderberg limestone series (Coeymans, Kalkberg, New Scotland, and Alsen), Oriskany series (Glenerie limestone, Esopus shale, and Oriskany sandstone), and the Onondaga Limestone. By the time of this writing, using Jack Holland's work, 90 different types of cherts are described in New York State, Onondaga now being expanded to include Edgecliff, Nedrow, Moorehouse, and Seneca. Paul Trotta, a local flintknapper, scholar, aptly states that Wray paved the way with his significant work but we can describe him as more of a "lumper" and Holland, having done much to expand our knowledge of chert is recognized as a "splitter." Both Holland and Fogelman in personal communications and in their literature ascribe the need for further work defining New York cherts. The work has only begun.

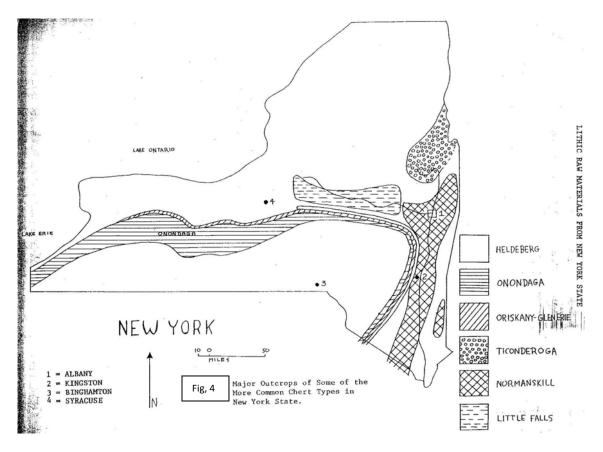


(Wray 1948:27)

Some of Wray's work remains true to this day. The outcrop of these flint bearing formations are confined to a few limited areas in New York. A narrow east-west belt that runs from the north shore of Lake Erie through the vicinities of Buffalo, Syracuse, Utica, and down the west side of the Hudson Valley and leaving the state near Tri-States. Another narrow belt occurs along the Niagara Escarpment in Ontario, Canada and enters New York near Niagara Falls and extends eastward to Rochester and Sodus Bay. A rather small area of flint occurs in the vicinity of Watertown. A scattering of isolated patches of flint occurs along Lake Champlain, around Saratoga, Little Falls, the Mohawk Valley and in the highlands east of Albany and along the east side of the Hudson Valley (Wray 1948:28). [See fig. 4, map of Lithic Raw Materials, page 19]

Setting the stage for the work done in this thesis, the reader must know that the three major physiographic features of New York State are the Adirondack Mountains, the Alleghany Plateau and the Lake Ontario-Mohawk-Hudson-St. Lawrence lowlands, see figure 3: page 18 (Hammer 1976:45). The Adirondacks are the oldest formation in the state, being composed of an upthrust of Precambrian rocks through later deposits. The Precambrian rocks were formed prior to 100 million years ago and are primarily igneous or highly metamorphic (see Table 2, page 20, for the geologic periods and their dates—Hammer 1976:57)





The lake and river lowlands are mostly of Ordovician age, having been deposited as sedimentary rocks on top of the older Cambrian formations. Many of the Ordovician formations, particularly the eastern ones, are rich in chert. The Allegany Plateau is the youngest of these features, being primarily composed of Devonian sedimentary rocks, of which most are chert-bearing (Hammer 1976:44). Figure 4, page 19 (Hammer 1976:49)

To assist the reader of this thesis the use of geologic maps is recommended and will aid the reader and future researchers in locating various formations. If you look at the New York State Geological Highway Map that accompanies Isachsen's book *Geology of New York (2000)*, you will see that specific formations are identified on these maps by a two or three letter code, such as Oag. The first letter identifies the period as shown in Table 2, page 20. The second or third letter is an abbreviation of the formation name. The symbol Oag defines the Austin Glen formation of the Ordovician period. Tables 3, 4 and 5 (pages 20-22) show specific naturally exposed formations in three areas of New York State (Hammer 1976:57-59). Tables 4 and 5 are self-explanatory since these formations have not been seriously disturbed and appear in their proper stratigraphic sequence, from the oldest on the bottom to the top. The Ordovician stratigraphy of the Champlain trough and the Hudson Valley, as represented by Table 3, has been seriously disturbed by tectonic pressure resulting from the rise of the Green, Berkshire and Taconic Mountains to the east. The result is two distinct sequences, the "normal" on the

west bank of the Hudson, and the eugeosynclinal on the east bank (Hammer 1976:44). [see figure 5 (Hammer 1976:46)—page 23]

TABLE 2

Geologic Periods, Their Dates and Standard Symbols
(After Holmes 1965:157)

Geologic Period	<u>Dates</u> (Millions of Years Ago)	Symbol
Devonian	350-400	D
Silurian	400-440	S
Ordovician	440-500	0
Cambrian	500-600	-€
Precambrian	600 and earlier	-C

TABLE 3

Generalized Sequences of Chert Bearing Strata of the Lower Ordovician in Eastern New York State (After Fisher 1970; et al)

Normal Sequence	Eugeosynclinal Se	quence
Austin Glen Oag Normanskill On	Austin Glen Mt. Merino	Oag Omi
	Indian River	Omi*
	Stuyvesant Falls	Osf*
* Stratigraphic :	celationship not clea	ar.

#### TABLE 4

Geologic Column for the Eastern Escarpment of the Allegheny Plateau (After Fisher 1962, 1970; Goldring 1943; Ruedemann 1930)

Period	Groups and Formations		
Devonian	Hamilton Shales and Sandstones	*	
,	Onondaga Group Esopus Shale	Dou #	
	Oriskany Sandstone Glen Erie	Do # Dgl #	
,	Heldeberg Group Alsen * Becraft # New Scotland Kalkberg Coeymans Manlius *	Dhg	
Ordovician	Ordovician Shales and Grits Schenectady Grit and Shale Canajoharie Shale *#	Osc *	
	Normanskill Series Austin Glen Normanskill Mt. Merino	Oag *? On Omi	
	Stuyvesant Falls	Osf *#?	
Various Camb	orian and Precambrian Chertless For	mations	

<sup>\* =</sup> Not chert bearing

<sup># =</sup> Not continuous in distribution

# LITHIC RAW MATERIALS FROM NEW YORK STATE

TABLE 5

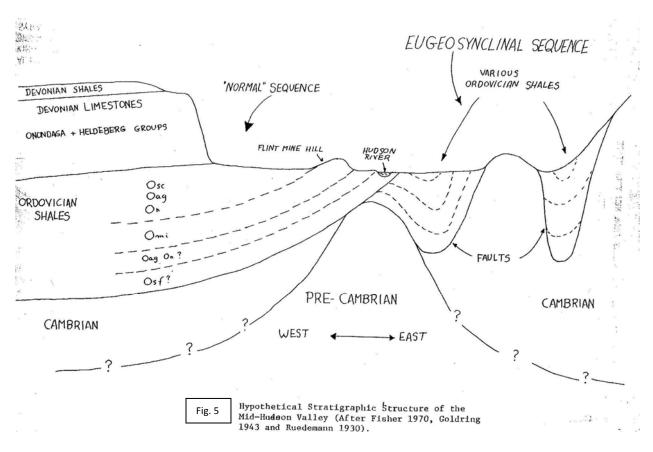
Generalized Geologic Column of the Northern Escarpment of the Allegheny Plateau (After Fisher 1962, 1970)

Period	Groups and Formations		
	Hamilton Shales and Sandstones Dhm *		
Devonian	Onondaga Limestone Don Oriskany Sandstone Do #		
Silurian	Silurian Shales and Dolomites * Scs, Sv, S1, etc.		
	Ordovician Shales * Franfurt Shale Of * Utica Shale Ou *		
Ordovician	Ordovician Limestones # Trenton Limestones #		
	Black River Group Chaumont ?		
Various Cambrian and Precambrian Chertless Formations			

<sup>\* =</sup> Not chert bearing

(Hammer 1976:58)

<sup># =</sup> Not continuous in distribution



The reason that we must concern ourselves with the geology and stratigraphy of the area is that cherts are usually identified according to the host rock. If there is a classificatory problem concerning rock formations, then this problem will also show up when we try to classify and identify cherts. In the Hudson valley the problem of the normal and eugeosynclinal sequences makes it extremely difficult to differentiate between the Deepkill, Stuyvesant Falls and the Normanskill formations and the cherts that they include. It is still a topic of debate whether these three formations may all be the same, under different names, or that they may in truth be different formations (Hammer 1976:47).

Hammer in his 1976 work states that the "petrology and structural geology of any area is highly complex and anyone doing archeological work in an area is strongly advised to consult the [1989 New York State Geological Highway Map] 1970 Geological Map of New York State (Fisher et al. 1970) and the various New York State Museum Bulletins dealing with the geology of the particular area under investigation" (Hammer 1976:47). There are also available, enumerated on the aforesaid map, at least 94 *Guidebooks to Geological Field Trips*, published by the New York State Geological Association, that students and future researchers will find extremely helpful.

The cherts of New York State fall into two general categories, those occurring in limestone and dolomites, and those occurring in shales. One chert, the Oriskany, occurs in

sandstone, but it is not very common. The Oriskany is present in the research area and although I did not find chert, the formation does serve as an identifiable stratum and is therefore useful. "There is no specific difference between cherts from differing host rocks, although cherts in limestones generally tend to be somewhat waxier than shale cherts, and the limestone cherts tend to be black, blue or gray while the shale cherts (such as Normanskill) tend to be green or greenish hues of blue, gray or black. The sandstone cherts are usually gritty or sandy due to the presence of quartz particles, the "sand" in sandstone being in suspension in the chert. Limestone cherts usually occur in thin lenses or planes of nodules, rarely forming beds more than 6 inches in thickness, while the shale cherts, such as Esopus, or Normanskill, occur in regular beds, sometimes several feet thick with discolorations parallel to the bedding plane. Transitional beds are usually absent in limestones, while they are common in shales" (Hammer 1976:47).

Chart 2 There is a partial correlation between color and distribution which is given below.

Black Cherts--Heldeberg, Glen Erie, Oriskany, Eastern Onondaga, along the northern and eastern escarpment of the Allegheny Plateau.

Austin Glen-Not too common, west bank of the Hudson river.

Brown and Red Cherts--Indian River, in two areas east of the Hudson River and north of the Hudson valley.

"Jasper"--rare in New York, only reported from Staten Island (Rutsch 1970).

Green Cherts--Normanskill, Stuyvesant Falls, Mt. Merino, Austin Glen, Deepkill?, common in the Hudson valley, see Figure 6.

Blue and Gray Cherts--Western Onondaga, Little Falls, Mt. Merino,
Ticonderoga-Blue and gray cherts occur randomly throughout
the State.

Unfortunately there are many exceptions to the above, and by itself color is not a sufficiently precise characteristic for identification of specific chert types.

#### (Hammer 1976:55)

Initially, lithic researchers relied on a macroscopic, nondestructive analysis whereby the source of a hand specimen of chert might be distinguished through megascopic characteristics such as color, texture, reaction to simple chemical test (such as application of HCL [dilute hydrocloric acid]), and presence of visible inclusions. Some cherts exhibit very diagnostic characteristics that make them almost unmistakable, such as the Mines chert, which is

identified by its coarse oolitic texture; in this case the chert is literally packed with ooids. Normanskill chert can be identified by is distinctive color—green to greenish-black, shaley texture, and lack of reaction to HCL (Lavin 1983:4). Conversations with Holland, Fogelman, Trotta and Kronimus stressed that probably a majority of cherts can be identified by their macroscopic details—color, texture, patination, etc.—but still, it needs to be recognized that because of the similarity of many of the cherts, it will greatly facilitate future research if we build up a data bank of information from thin sections, XRF, INAA, fluorescence and other test methods. Trotta stated that just like carpenters who recognize the difference between pine, hemlock, spruce and fir, people who choose to work with New York cherts will also gain a recognition sense of the various cherts over time. In our culture today we just don't have a lot of people working in this area. Hammer laments the need for a closer association with geologists because of the need to understand stratigraphy and paleontology to further understand chert. Unfortunately chert is not researched very often because it does not have a place in economic geology; because as stated, most quarries go to great lengths and expense to avoid blasting into the chert layers which would contaminate their product be it limestone or dolostone. Chute in his work states that at the Clark Reservation, Jamesville, Pools Brook, and the noncherty part of the Edgecliff have the highest purity and are therefore sought after; however, the sandstone at the base of the Edgecliff Member and the cherty part of the Edgecliff are stripped separately and wasted (Chute 1970:1-22).

Lavin states the majority of chert types within her research universe, the Delaware Watershed, were "macroscopically homogeneous in texture and of neutral gray or black"—tones that are ubiquitous throughout the six states that Lavin surveyed. "Cherts of various hues (e.g., bluish gray, brownish yellow, yellowish brown, etc.) do occur, but they are not diagnostic of a single formation." As stated earlier, the application of macroscopic analysis is sufficient for many types of chert but for those cherts such as those occurring in the Onondaga, macroscopic analysis in itself may be inadequate for pinpointing the sources of these cherts. "The technique does have value as an initial stage in the identification process by delineating the number of possible chert types represented by a specimen and facilitating identification through microscopic analysis" (Lavin 1983:4).

# Methodology

Historical and contemporary literature was reviewed to establish the location of earth structures, worksites, and quarries.

Historical and contemporary literature was reviewed for an account of artifacts recovered from each site and from what materials the artifacts were constructed.

Geology maps were consulted to get a better idea of New York State geology.

New York State Guidebooks were consulted so that specific outcrops could be located.

Professionals in the field of geology and archaeology were consulted.

Experimental archaeologists and flintknappers were interviewed.

Existing collections were examined.

River, stream and creek sites were examined for availability of tool quality lithic material. Using the advice of local flintknappers an educated guess was made as to what type of chert was available at each site. Once material was determined, geology maps were consulted to find bedrock sources of the same material. Jack Holland was consulted and drew maps to help me locate some of these sites.

Trips were made to known sites where coordinates and elevations were recorded, photos were taken of the site, and samples were collected, bagged and tagged. As often as possible, five gallon buckets of samples were collected so that a variation of the material quality, color and texture could be determined. GPS coordinates and elevations were recorded for each sample collected.

When practicable, fossils and bedrock samples were collected.

Photos were taken of the rock samples.

When possible, tools were made from the samples so that workability could be ascertained.

Texture- No tangible grain=fine; some grain tangible=medium; rough to touch=coarse

Fracturability (a measure of quality)- good to poor. A fine-textured, good fracturing material would be rated good to excellent in quality; medium-textured, good fracturing material as marginal in quality; and all poor fracturing material as poor in quality (Jarvis 1988:26-27)

The Munsell color chart was used to determine color.

#### History

Early archaeologists noted the characteristics of lithic material as part of their exploration, and these will be helpful in this project. In 1848, E. G. Squier made an extensive survey and exploration of New York for the Smithsonian Institution of Washington and the Historical Society of New York. His main intention was to survey and explore the earth works and "enclosures" of the Indigenous peoples of New York. As he states, "The Indian tribes...have left few monuments to attest their former presence. The fragile structures which they erected for protection and defense have long ago crumbled to the earth: and the sites of their ancient towns and villages are indicated only the ashes of their long-extinguished fires, and by the few rude relics which the plough of the invader exposes to his curious gaze" (Squier:1851). Of Otsego County he only mentions the existence of a circular earth-work near Unadilla. The closest county he surveyed to our research area was Chenango County where he discovered a number of village sites. He dates a settlement near Oxford in Oxford Township by the presence of a two-hundred year old tree that is growing in the ditch just outside of where the palisade wall would have stood. He found only rough pottery at this site. He found a more modern "castle" near Norwich but again with no mention of stone. Finally in Greene township, about two miles below the village he speaks of an interesting mound on the bank of the Chenango River, approximately six feet in height and forty in diameter. An examination of the mound was made in 1829 and it was found to contain a great number of human bones and below them more bodies that had been burned. At one point in the mound approximately 200 arrow-heads were discovered. He states that they were of the usual form, and of yellow or black flint. Another pile of sixty or more was found in another place in the same mound but he neglects to

describe them further. So much of what we find interesting today was considered so mundane in the past that it was not considered necessary to write it down. Squier describes the stone ax or hatchet he found in the vicinity of an ancient work on the Susquehanna River in Pennsylvania, near the New York State line. "The material is [described as being] of intense hardness, resembling porphyry. It is, nevertheless, worked with mathematical accuracy, and highly polished. The edge is very sharp" (Squier:1851). He also mentions an ornamental hatchet that was made of a delicate material, a greenish-colored slate, found near Springport, Cayuga County. Squier claims that many "relics" found near Scottsville, Wheatland township, Monroe County near Springport, Cayuga County were made from a green, variegated slate.

Another early writer, Henry R. Schoolcraft, wrote his book *Notes on The Iroquois; or Contributions to American History, Antiquities, and General Ethnology* in 1847. It was his opinion "a desideratum in American statistics, that a complete census, of one of the primary socks, who had lived in our neighborhood all this time, and still preserve their nationality, should be taken. This task New York executed in 1845" (Schoolcraft:1847). The book is a wealth of information, stippled with ethnocentric opinion, but well worth reading. He investigated many early village sites and mounds but made mention in most cases only of artifacts of note- carved items, stone rings, religious reliquary, etc. Apparently the stone work was too mundane to find noteworthy. He does make reference to "the era" stating that "this era is not less strongly marked by stone hatchets, pestles, fleshing instruments, arrow heads and javelins of chert and hornstone; amulets of stone, bone and sea shells, wrought and unwrought; needles of bone, coarse pottery, pipes, and various other evidences of antique Indian art" (Schoolcraft: 1847). Both Schoolcraft and Squier seem more intent on describing

their fortifications than anything else. Schoolcroft mentions an ancient entrenchment on Allen's creek, a tributary of the Genesee River about three miles north of the village of Le Roy and about ten miles northeast of Batavia. At this site Schoolcraft was impressed with a stone tomahawk that he called a "cassatete." The shape of this instrument resembled an ancient crossbill. It tapered gradually to the ends, which were rounded and proceeded to a sharp point. In the center of the crescent was an orifice for a "helve." He thought that the instrument had been made from a dark "silicious" slate and the tool that carved it had to have been harder than that. He also mentions pipes that were made from granular limestone. Other articles found on this site were said to be "evidently made of the greenstones or trap of New England, like those found on the Connecticut River in Massachusetts. The pipe of limestone might be from that part of the country" (Schoolcraft 1847). The final statement from Schoolcraft lends light to the difficulties faced by today's researchers. "The maker of arrow and javelin heads, for this was a distinct art, was superseded by the superior efficacy of fire arms; and his red descendant at this day, as well as the gleaner of antiquities, is alike at a loss to find where the ancient artist in chert and hornstone procured his materials, of so suitable a quality and facture, and how he obtained the skill to chip and form them into such delicate and appropriate patterns" (Schoolcraft:1847)

Probably one of the most intriguing collections that I encountered was that of William M. Beauchamp, who in 1897 was hired by the regents of the university to "increase the state collection illustrating New York aboriginal life, and for preserving such facts as might seem to them of most value." Beauchamp was well aware of the work of Squier, the "crude" work of Schoolcraft and of Morgan's "valuable" *League of the Iroquois*, both produced nearly a half

century earlier. Up until the 1890's stone and other relics had only come into state collections by donation, there had been no systematic or sustained work in that area, Beauchamp's intention was to remedy that situation. In Beauchamp's day, lithic artifacts left by the "aborigines" were classed as flaked or chipped forms of stone and to him the most interesting were the picked or polished stone items. Although Beauchamp speculated that much of the caches frequently found in his day may have come from other areas, he did give strong evidence to the use of local materials: argillite, jaspers of every hue, white quartz, chalcedony, schist, hornstone found in the corniferous limestone, sandstone, flints of bluish or brownish grey and their favorite yellow jasper. Celts, gouges and pestles were made of local pebbles of basalt and striped slate; bowls were made of steatite none of which was available locally, supporting Beauchamp's idea that much of what was produced in New York was imported. While in New York migrating groups availed themselves of the grey or drab cherts from the prevalent limestone's. Beauchamp was the first of the authors that focused on lithic tools in great detail (Beauchamp:1897).

In 1920 Arthur C. Parker wrote a two-volume bulletin on, *The Archeological History of New York,* published for the New York State Museum. In this work, one volume concentrated on mapping the reported findings of Indian burial mounds, fortifications, villages, work shops and quarries. In my three county research area, Parker notes that there were 21 such site in Schoharie, 43 in Otsego, and 12 in Delaware County. In the other volume, Parker writes a scientific work discussing everything from the origin of material culture to evidences of various occupations in New York. He describes in great detail many archaeological sites in New York

and among the details describes the lithic tools found and from what materials they are made; he also includes detailed drawings of these tools.

In 1965, William A. Ritchie made a major contribution to the understanding of New York Archaeology, especially with regard to lithic implements. In his book, *The Archaeology of New York State*, Richie outlines in great detail the Native American occupation of New York from the earliest occupants—Paleo-Indian hunters—to the Garoga Phase. Of importance to my research, he not only discusses cultural development but includes settlement sites, but also such details as utensils of stone and clay, ornaments, weapons and tools as well as food preparation, all of which have some aspect of lithic development. Richie is also famous for his quintessential bulletin 384, *New York Projectile Points: A Typology and Nomenclature*. This book gives a general description of projectile points, size and proportion, age and cultural affiliation and remarks that cover what the points are usually made from. Both books are invaluable guides to the archaeology of New York and a must for lithics buffs (Ritchie:1965, Ritchie:1961).

In 1993, Robert E. Funk, after completing eight summer field seasons from 1971 through1978 and having worked on the state highway salvage program on various sites along the Susquehanna River Near Binghamton, published his *Archaeological Investigations In The Upper Susquehanna Valley, New York State.* In 1968, William Ritchie, the New York State Archaeologist convinced Funk that the Susquehanna Valley should be a high priority region of investigation and might hold solutions to research problems of importance to New York archaeology. Richie felt the valley was a desirable research target because the area was

relatively undisturbed, and had an abundance of productive archaeological sites. It held a critical geographic position between Indians of the Mid-Atlantic coastal province and interior upstate New York. Funk and his colleagues eventually narrowed their research area to cover the area from Sidney to Oneonta. His work lists the artifacts found at each site including stone tools and the material they are made of which greatly assists this research (Funk:1993, Funk:1998). Funks work researching archaeological sites along the Upper Susquehanna River from Wells Bridge to Schenevus points to the abundant use of eastern Onondaga chert. An interesting point from his work is the number of times that a question mark appears behind the use of the term "Esopus" leading the researcher to investigate Esopus and Onondaga sources more aggressively than some others.

Gary L. Fogelman has written two books on the archaeology/geology of Pennsylvania. In this work, *Pennsylvania Chert: Identifying Some of the Materials Used By The Indians In Pennsylvania and Surrounding Area*, Fogelman reveals the diversity of cherts available in a given area and he concede, a situation most likely duplicated most places across the state and country. This book is Fogelman's second attempt to put some order to the many and varied materials the Indians used for their tools and weapons. Fogelman arranges the cherts in alphabetical order, using both known names and "correct" names and connecting them to known cherts or groups of cherts. The author focuses on the various ways chert forms, the various ways the Indians went about gathering and extracting it, and the various ways it was treated after procurement.

In Fogelman's book he makes numerous references to the work of Charles Foster Wray who wrote *Varieties and Sources of Flint Found in New York State (1948)*. It was the definitive work in defining lithic tool material for many years and if you study the literature it is still oft quoted. Wray described the then known 19 different chert types by age, outcrop, form of occurrence, megascopic description and petrographic description. Wray made thin sections of each type and described them in great and accurate detail which is why his work is still quoted. However, his source descriptions lack sufficient precision to relocate the lithic material being described. This in part is due to urban sprawl completely changing the face of the landscape, and in part to using donated samples that may have lacked the necessary information to easily relocate the source rock.

William A Oliver, Jr. wrote two treatises' on the Onondaga chert: 1) Stratigraphy of the Onondaga Limestone (Devonian) in Central New York (1956) and 2) Stratigraphy of the Onondaga Limestone in Eastern New York (1956), both published by the Bulletin of the Geological Society of America. Both of these documents are well worth reviewing and are invaluable in coming to terms with type locality, formation appearances and characteristics, as well as diagnostic fossils. These two documents were used extensively.

Late in the research process, a dissertation by Ver Straeten (1996) in affiliation with the University of Rochester was presented to me. The portion of the dissertation that was given to me was an appendix, entitled "Locality Register of Upper Lower and Lower Middle Devonian Sites in This Ph. D. Study." The appendix is a county by county list of outcrop sites listing site

location, formation and chert type. As you might guess, this will be an invaluable list for future researchers.

Another resource heavily utilized were the Guidebooks to Geological Field Trips published by the New York State Geological Association. Each guidebook outlines a university field trip; each field trip is carefully designed to clarify for college and university students a particular geologic phenomenon. One of the guides that was of particular use to me was the "Devonian Stratigraphy and Paleoecology in the Cherry Valley, New York Region." This tour was written by Donald W. Fisher, State Paleontologist. Each guidebook not only outlines the purpose of the field trip but also lays out the stops to be taken and what is to be seen at each stop. The difficulty in using the guides is that the books are catalogued by year and not by content information so a great deal of patience is required by the researcher to find the pertinent information needed.

As mentioned earlier various difficulties arise when we try to interpret the observations and description of early authors. The names of various rocks have changed through the years making it difficult for us to know exactly what material the early writers were referring to. The early writers were interested in different aspects of early culture than we are today so the information that we need is sketchy. Eurocentric opinions were predominant so they undervalued the work of the Indians as artists and focused on artifacts that were unusual in nature. The early writers, up until Beauchamp, did not write a great deal about lithic development. Many early writers remarked on the exotic materials because they caught their eye and glossed over the more mundane, ordinary items made from local drab cherts.

The more contemporary twentieth century authors such as Ritchie and Funk, were more specific in their descriptions of artifacts found at the various sites and what material was used. It became clear that early people living in our three county area were using material that would not be readily available from a bedrock source. The lithic material used by most people was predominately eastern Onondaga that is found as a bedrock material either north or east of the research area. The explanation for this may be three fold: trade, migration and glaciations, with the most likely explanation for the abundance of tool quality lithic material in the three county region being glaciation. Normanskill and Pennsylvania Jasper are examples of the exception; those two were probably derived by trade or migration

It is through examination of this known body of historic literature and local artifact assemblages that we will be able to most readily determine lithic sources. By comparing maps and historic accounts of known archaeological sites and comparing this with maps of surface geology and bedrock geology, it might be possible to determine where early peoples were obtaining their stone tool materials. Furthermore, by examining more closely the historical record and assemblages found at each horizon, it might eventually be possible to determine the preference of individual cultures for certain stone materials and assign specific tasks to specific rock types. This would of course give us insight into workability and durability of the materials. Closer examination of historic literature and artifact assemblages, could for groups that are more sedentary, "inform on the types of extraction forays conducted or trade engaged in" (Odell:2004).

# MAN IN THE NORTHEAST

# TABLE 6

Composite Stratigraphy of the Major Chert Bearing Formations in New York State (After Fisher 1962, 1970; Ruedemann 1942, 1930; Wilmarth 1968; Wray 1948)

Period	Group	Formation	Symbol Remarks
	Onondaga	Onondaga Limestone Esopus Shale	Don Dob, Dou Dou
Devonian		Oriskany Sandstone Glen Erie Limestone	Do Dg1 — Contemporaneous
	Heldeberg	Becraft Limestone New Scotland " Kalkberg " Coeymans "	Dhg — Heldeberg Dhg Cherts Dhg —
Silurian	Lockport	Lockport Dolomite *	S1
	Trenton	Normanskill Shale Austin Glen Shale @	On Oag Also in Eugeosyn- clinal, Snake Hill
	Eugeosynclinal	Mt. Merino Shale @ Indian River @	Omi Contemporaneous
Ordovician	Beekmantown	Stuyvesant Falls @	Osf Old Deepkill?
	Black River	Chaumont Limestone*	Obr Leray?
	Beekmantown	Ft. Ann Dolomite	Obk
	Wappinger	Halcyon Lake	Ow
Cambrian	Beekmantown	Little Falls Ticonderoga Dolomite Whitehall Dolomite	Cbk Knauderack  Cbk Contemporaneous

<sup>@ =</sup> Part of eugeosynclinal sequence

(Hammer 1976:60)

<sup>\* =</sup> After Wray 1948. No proper geologic term found; association questionable

**Chert Bearing Units: Published Information:** (arranged with respect to table 6, page 36, top to bottom)

# **Onondaga Limestone**

Authors Note: "In New York, the Onondaga Formation has been divided into five members: In central New York, Oliver (1954) named these subunits the Springvale, Edgecliff, Nedrow, Moorehouse, and Seneca" (Lavin 1983)

Age: Middle Devonian

Authors Note: Youngest chert bearing formation in New York State

**Type Location:** Diver's Lake Quarry, Fort Erie, Ontario

**AKA:** Eastern Onondaga, Central Onondaga, Western Onondaga, Divers Lake, Black Rock, Seneca, Moorehouse, Nedrow, Clarence, Edgecliff, (early name Corniferous Limerock in which referred to the Hornstone now known as chert)

**Stratigraphy:** Devoninan System, Onondaga Formation, Edgecliff, Clarence, Nedrow, Moorehouse, Seneca Members (Holland 2004)

**Outcrop:** "The chert-bearing Onondaga Limestone forms an escarpment outcropping continuously from the Province of Ontario, across western, central and eastern New York to the Hudson Valley, at which point it turns south-south-westward entering New Jersey and Pennsylvania at Tristates. Outcrops occur in the counties of Erie, Genesee, Monroe, Livingston, Ontario, Seneca, Cayuga, Onondaga, Madison, Oneida, Herkimer, Otsego, Schoharie, Albany, Green, Columbia, Ulster, Sullivan, and Orange" (Wray 1948).

"There seems to be a greater percentage of chert in the western sections from Bristol Valley west to Buffalo than in the eastern part of the formation. The chert occurs usually as nodules closely spaced along planes parallel to the bedding of the limestone or as thin layers which follow the bedding planes. These nodules and layers are thin, seldom over four or five inches thick and are not continuous. In most cases any attempt to trace a layer of chert to another outcrop, however near, has been disappointing" (Wray 1948).

"The middle division of the formation has prolific amount of chert. The top part has chert but much less than the middle division. The lower division has practically no chert" (Wray 1948)

The Onondaga limestone, of which only the middle layers are chert bearing, runs continuously from Ontario eastward, along the edge of the Allegheny Plateau, into New York, turning south

along the Helderbergs and south by southwest along the Catskills, Shawangunks and into Northern New Jersey, Pennsylvania and eventually, Tennessee" (Hammer 1976).

The Nedrow Member and Seneca Member are recorded only as far east as Cherry Hill, New York, the Moorehouse as far east as Babcock Hill. The Edgecliff Member extends to the Hudson Valley, at least as far south as Albany in Albany County. In lower New York, New Jersey and the Delaware Water Gap area, the Onondaga is treated as a single homogeneous unit. Onondaga outcrops in the Albany-Catskill area are described as massively bedded light gray to blue-gray limestone with chert lenses" (Lavin 1983).

Buffalo, Erie County to Albany, south to the Pennsylvania boundary (Holland 2004)

**Megascopic Description:** "For the most part, the color of the flint is dark gray or blue-gray. The flint containing sponge spicules is usually a lighter color. A slight variation in characteristic color is noted in various parts of the state. In eastern New York, it is a lighter, more brilliant blue; in central New York it is a drab gray; in western New York it is a mottled blue-brown or tan chert; around Buffalo its color verges on Black; while in Ontario, the mottled variety is again characteristic. Variations of all the above occur in all sections along with colors ranging from black to blue to tan to whitish and even with reddish stains. The flint breaks with an excellent conchoidal fracture and possesses a dull vitreous luster and is rarely earthy" (Wray 1948).

"The Edgecliff Member consists of light gray to pink coarsely crystalline limestone. Above it is the Nedrow Member, a dark shaley limestone. Overlying it is the Moorehouse Member, a medium gray, very fine-grained limestone. The uppermost member is the Seneca. All four limestone members are chert-bearing" (Lavin 1983).

The Edgecliff is the most important building stone, its durability is shown by its relief on all outcrops. It is a massive light gray to pink, crystalline limestone. It is richly fossiliferous and most noted for its assemblage of corals and large crinoids columnals of up to 1 inch in diameter. The matrix between the large fossils is composed of shell debris. Also present are net-like bryozoans, bivalve brachiopods and trilobites (Nye 1978:358-359).

Petrographic Description: "The Onondaga flint contains a fin-grained matrix of chalcedonic particles. Dusty calcite is extremely abundant. Small dolomite rhombs are fairly abundant. Spherules of chalcedonite and mica flakes are rare. More fossil fragments are present in eastern than in western New York. For that reason, more flamboyant, fibrous charcedonite is found in eastern than in western New York. Very little carbonaceous matter is present in most samples of the flint. Pyrite may be present in small amounts. Various degrees of calcite replacement by silica, as well as silica replacement of corals can be observed. Veinlets of vug quartz formed in shrinkage cracks are not rare. Xenolithic inclusions of partially silicified limestone are common" (Wray 1948).

"Colors for Western Onondaga rage from tan, khaki through light gray to milky light blue. The texture is smooth and waxy, while many of the colors are mottled and cloudy. The Central Onondaga is a cloudy dark to brownish blue chert in a similarly colored limestone matrix with a smooth waxy texture. The Eastern Onondaga ranges in color from dark brownish blue to blueish black to black. The chert is hard, smooth and waxy. Goldring reports medium and dark gray Onondaga chert in the Coxsackie quadrangle" (Hammer 1976).

Onondaga Chert "is highly similar to Helderberg Chert except for the following features:

- •fibrous chalcedony frequently occurs in veins, seams, and spherules; less heavily chalcedonized than the Helderberg.
- •large (0.5 mm in diameter) dolomite rhombs frequently abundant.
- •no clastic quartz (except for one specimen from western New York).

Intra-formational variability is great enough that Onondaga cherts from four different regions within the outcrop area can be distinguished.

"\_\_\_\_\_\_ is so finely subdivided that it appears almost isotropic. Numerous large patches and rhombs of dolomite common, as well as small dolomite rhombs scattered throughout. Some Middle Devonian fossils occur, mostly brachiopods, crinoids, trilobites, and corals. Ooids and peloids rimmed by chalcedony are common, also with an apparently isotropic fabric. Many of the fossils and peloids are replaced by coarsely fibrous chalcedony. Much of the chert has large veins and patches of fibrous chalcedony unrelated to the fossils. Abundant pyrite, some of which is euhedral, but no other opaques or carbonaceous matter. Chert is clear and free of iron oxide stains. Slides from Albany County (54A-57A) differ only slightly from those slides from southern Green County (5A) in that they are less highly altered to chalcedony" (Prothero 1983:403).

**Munsell Color:** 5YR4, N6, N5 Western Onondaga; N4-N5 Central Onondaga; N2-N3 Eastern Onondaga (Hammer 1976).

"The most common color description of Onondaga chert north of Orange County, New York, is gray-dark gray, with Munsell values N3-N4; medium gray,N5; light gray,N6-N7:and whitish gray. Black or grayish black, N2 is common" (Lavin 1983).

**Distinguishing Characteristics:** Onondaga chert is characterized by a mottled dull, vitreous, gray-blue flint with excellent conchoidal fracture, its lack of a definite patina upon weathering, its inclusions of partially silicified limestone, and petrographically by it high calcite content, rarity of spherules and spherulites of chalcedonite, and the presence of veinlets of vug quartz.

**Characteristic Fauna:** "Fossils characteristic of the Onondaga Formation include the corals <u>Rugose</u> and <u>Zaphrentis</u>, brachiopods <u>Spirifer</u>, <u>Atrypa</u>, and <u>Athyris</u>, and one trilobite <u>Odontocephalis</u>; the bryozoans <u>Fenestrellina</u> is conspicuous" (Lavin 1983).

# Table 7 Onondaga Formation

		Rock Types, Grain Size,	
Member	Facies	Sedimentary Structures	Fossils
Seneca Member	New Scotland	shale that contains calcium carbonate and fine- grained limestone that contains much clay less pure (contains much clay) with several thin volcanic ash beds (Tioga ash beds)	brachiopods, including some with pinkish shells shells, called <u>Chonetes lineatus</u> sea floor animals similar to those found in New Scotland Formation
Moorehouse Member (Fig. 8.13)	Kalkberg	fine- to medium-grained limestone thin to medium-thick layers varying amounts of chert	many fossils of sea floor animals
Nedrow Member*	New Scotland	medium-grained limestone (upper) shale that contains calcium carbonate (lower)	platyceratid gastropods and sparse fossils of sea floor animals
Edgecliff Member	Coeymans	medium- to coarse-grained limestone  medium to thick layers  chert  blanket-like layers built by corals, scattered coral reefs	similar to those found in Coeymans Formation rugose & tabulate corals pelmatozoans brachiopods trilobites mollusks

<sup>\*</sup>The Nedrow Member occurs in central New York. To the east and west, it gradually becomes a cleaner limestone with c like the rest of the Onondaga Limestone and less like a separate member.

(Isachsen 2000:116)

#### **Esopus**

**Age:** Lower Devonian

Type Locality: Esopus Creek near Esopus, New York, Catskil, New York

**AKA:** Sharon Springs

**Stratigraphy:** Devonian System, Esopus Formation (Holland 2004)

**Outcrop:** "The Esopus Shales outcrop along a narrow north-south belt in the Hudson Valley of Eastern New York in the counties of Albany, Green, and Ulster" (Wray 1948).

"Orange, Otsego, Schoharie, and Ulster Counties" (Holland 2004)

Authors Note: The author collected samples from along State Route 20 between Cherry Valley and Sharon Springs, New York. Samples were taken from the famous quarry site excavated by Funk and road cuts near Cherry Valley. The chert near Cherry Valley is a bedded chert while much of the ancient quarry area was in nodule form dug from the hillside.

Esopus trends in a narrow band from Oswego County, New York, to near Kinderhook. At this point the formation trends northeast-southwest through Orange County and into northwestern New Jersey, closely following the Delaware River Valley and crossing over it into eastern Pennsylvania at Bushkill. In the northern Helderbergs, the lower and upper parts of the Esopus Formation are highly siliceous or "cherty," especially in the areas of Esopus Creek and Catskill. The lower "cherty" bed has been traced from the Catskill area to Port Jervis" (Lavin 1983).

**Form of Occurrence:** "Nodules varying in size from one to six inches in diameter occur singly and in seams in the lower eight to twelve feet of the formation" (Wray 1948).

**Megascopic Description:** "It is questioned whether these nodules may be classified as flint. It is a homogeneous dull blackish-gray, slightly vitreous flint with a hardness of seven, and with a well developed conchoidal fracture. Weathering produces a slight grayish cast to the surface. Freshly exposed surfaces effervesce very slightly with hydrochloric acid" (Wray 1948).

"The chert is dull, dark and muddy black or gray. The chert may weather gray and appears in the Esopus Shales. Ruedemann (1930) does not consider it a true chert but refers to cherty layers within the Esopus formation. Even though this formation appears as far west as Oswego County, the chert bearing strata are limited to the Esopus creekbed between Kingston and Catskill, New York. This material is probably a transitional one, being a siliceous cement infused with clay and grit particles of the host rock" (Hammer 1976).

Like Snake Hill the Esopus is a siliceous shale; dark gray to black in color. (Holland 2004)

"The Esopus Formation is a Lower Devonian unit consisting of chocolate, light olive, buff, medium to dark gray, or blackish silty to sandy shales, finely arenaceous siltstone and finegrained sandstone" (Lavin 1983).

#### Munsell Color: N3

**Petrographic Description:** Petrographic analysis reveals a very dense fine-grained matrix of argillaceous and bituminous matter with a few angular and rounded fragments of clastic quartz. The matrix is packed with fossil fragments, probably pteropods, which appear as sections of tubes replaced by chalcedonite. Dusty calcite, some dolomite rhombs, and mica splinters—possibly representing secondary micas from the clays are present. Ilmanite and leucoxene, the latter possibly derived from the ilmanite, comprise the opaque minerals" (Wray 1948).

**Distinguishing characteristics:** "The Esopus Shale flint [often referred to as a siliceous or indurated shale] may be easily recognized by it dull, dense black appearance, slight vitreous luster and its reaction to hydrochloric acid. Petrographically, it is recognized by its dense argillaceous and bituminous matrix, the abundance of the fossil pteropods and their chalcedonic replacement. When ground, the specimen gives off a strong petroleum odor" (Wray 1948).

Authors Note: Nodules found in the streambeds and dug from the hillsides have a characteristic patination that is brown to greenish brown.

Characteristic Fauna: Pteropods (Wray 1948)

Brachiopods (*Ambocoelia, Chonostrophia complanata, Leptocoelia flabellites, Orbiculoidea*) and gastropods (*Platyceras*) (Lavin 1983)

### Oriskany

**Age:** Lower Devonian

**Type Locality:** Exposure of the flint may be seen at Phelps, New York and at Kimber Springs, near Syracuse, New York (Wray 1948).

AKA: Ridgely, Shriver

**Stratigraphy:** Devonian System, Tristate Group, Oriskany Formation, Ridgely Member (Holland 2004)

**Outcrop:** "The Oriskany Sandstone outcrops in a discontinuous narrow belt from the Province of Ontario, across central New York and petering out in eastern New York near the Hudson Valley. Outcrops occur in small patches in the Province of Ontario, and the counties of Genesee and Livingston. Continuous outcrops occur in Ontario, Seneca, Cayuga, Onondaga, Madison, Oneida, and Herkimer Counties" (Wray 1948).

Albany, Herkimer, Onondaga, and Ulster Counties (Holland 2004)

**Form of Occurrence:** Nodules, ranging from one quarter to eight inches in diameter, occur at the top of the formation. M. H. Stow gives the following description: —"Conditions of Sedimentation and Source of the Oriskany Sandstone as Indicated by Petrology." American Association of Petroleum Geologists Bulletin, vol. 22, no. 5, p.546, 1938

"Imbedded in the top layer are numerous black nodular masses composed of sand grains bound by black cherty cement. This glack matrix may considerably exceed the sand grains in quantity. Such black nodules are a characteristic feature of the top of the Oriskany wherever found throughout the area of investigation. They probably represent a last phase of Oriskany sedimentation. Oriskany sand cemented into nodules rather than Oriskany reworked after consolidation" (Wray 1948:40 from M.H. Stow: Megascopic Description)

**Megascopic Description:** "This very sandy chert or silicified sandstone is a coarse granular black material with vitreous or glassy spots" (Wray 1948).

"The chert is dull black with quartz grains included. The material is hard with a conchoidal fracture, but the macroscopic particles in suspension obviously affect the workability of the chert. The Oriskany Chert is contemporaneous with Glen Erie Chert" (Hammer 1976)

Bluish gray, dark gray, black (Holland 2004)

Munsell Color: N2 (Hammer 1976)

**Petrographic Description:** "The chert contains a fine-grained matrix of phosphatic and calcareous matter and chalcedonic particles. In this cementing material are quantities of irregular and rarely rounded grains of clastic quartz and minor amounts of pyrite, magnetite, zircon, and hornblende" (Wray 1948).

**Distinguishing Characteristics:** "This nodular Oriskany material is characterized by its black sandy appearance, vitreous or glassy spots, and petrographically by its abundant content of irregularly shaped grains of clastic quartz" (Wray 1948).

Characteristic Fauna: "Spirifer" arenosus, Rensselaeria ovoides, "Spirifer" mucrchinsoni, Rhipidomella musculosa, Hipparionyx proximus

#### **Helderberg Limestone Cherts**

Authors Note: "There are six limestone formations in the Heldeberg group; in descending order they are the Alsen, Becraft, New Scotland, Kalkberg, Coeymans and Manlius. Only the middle four of these are chert-bearing" (Hammer 1976).

"The group includes eight formations, mainly limestone, although dolomite, sandstone, and shale units are also present. In New York they are, in descending order, the Rondout Limestone and Dolomite, Manlius Limestone, Coeymans Limestone, Kalkberg Limestone, New Scotland Limestone, Becraft Limestone, Alsen Limstone, and Port Ewen Shale. The six uppermost formations are chert-bearing" (Lavin 1983).

**Age:** Lower Devonian

Type Locality: Catskill, New York area

**AKA:** Listed in stratigraphic order from bottom to top: Manlius, Coeymans, Kalkberg, New Scotland, Becraft, Alsen, Port Ewen (Holland 2004)

**Stratigraphy:** Devonian System, Helderberg Group, Alsen, Becraft, Coeymans, Kalkberg, New Scotland, Port Ewen Formations (Holland 2004)

**Outcrop:** "The Helderberg Limestones are confined to a narrow belt in eastern New York, running east from near Syracuse to the Hudson Valley and then running sout, south-westward, leaving the state of Tristates and continuing on into Pennsylvania and New Jersey. In New York, the chert-bearing starata outcrop in the counties of Madison, Oneida, Herkimer, Fulton, Montgomery, Schenectady, Albany, Greene, Columbia, Ulster, Sullivan, and Orange" (Wray 1948).

**Form of Occurrence:** "Helderberg chert occurs as small nodules and localized lenses in the upper part of the Coeymans formation, in various parts of the Kalkberg, in the upper most twenty feet of the New Scotland, and scattered in the Alsen member. Rarely have any nodules been reported from the Becraft formation" (Wray 1948).

"The Helderberg rocks occur along the northern edge of the Allegheny Plateau in a thin, ribbonlike band from Cayuga Lake in west-central New York to the Hudson Valley near Kinderhook. At this point the band trands south and then southwest, flanking the eastern edge of the Plateau and entering northwest New Jersey near Port Jervis and eastern Pennsylvania. Helderberg outcrops are also found in two Devonian outliers east of the Hudson River-Becraft Mountain and Mount Ida in Mellenville, northeast of Hudson, New York. The Helderberg rocks crop out again west of the Susquehanna River" (Lavin 1983).

**Megascopic Description:** "Helderberg chert is characteristically a dense, dull shiny black to blue-black to gray-blue, somewhat splintery, homogeneous flint. Little variation exists at all between the flints of the Helderberg Limestone series. Fracture planes are common, along which the chert separates upon concussion. These fracture planes contain films of calcium

carbonate. Conchoidal fracture is of poor to medium development. Weathering develops but a week patina, usually a thin, grayish to white coating. Many of the nodule have a thick encasing layer of tripoli" (Wray 1948).

"All of these cherts are black or very dark bluish black with a characteristic white dendritic scaling which occurs parallel to the original bedding plane. The cherts are smooth and waxy and may have pockmarks or impure inclusions scattered throughout. These cherts occur along the same area as the Onondaga chets except that they do not extend west of the general area of Syracuse and Utica. West of this point the Helderberg limestones either dip below the surface or do not exist (Hammer 1976)

"Helderberg chert from New York is describes as black and blue-gray; it weathers grayish to white. Black chert has been ascribed to the Kalkberg, New Scotland, Alsen, and Port Ewen formations. Blue gray chert has been reported from the Becraft Formation in Albany County. Bluish black varieties of Helderberg chert are found only in the Hudson Valley; cherts from the Helderberg outcrops in southwestern Orange County, New York and northwestern New Jersey are dark gray" (Lavin 1983).

Munsell Color: N2, 5BG2, 5BG1 (Hammer 1976)

Petrographic Description: "The Helderberg cherts are composed of a fine to medium-grained cryptocrystalline matrix of chalcedonic particles with an occasional irregular shaped grain of clastic quartz. Spherules of fibrous chalcedonite are fairly common. Single rhombs and strings of dolomite rhombs occur—especially in the New Scotland Limestone. Areas of dusty calcite are of common occurrence, especially within areas of fossil replacement. Large fossil fragments, predominantly brachiopods, are numerous and clearly show the replacement of calcite by the silica. The areas of fossil replacement are rich with carbonaceous material. Pyrite is common and occurs more often inside the fossil areas—possibly indicating a secondary origin of the pyrite from organic substances. Spots or pellets of carbonaceous material are common throughout the matrix" (Wray 1948).

"As might be expected from a group with numerous formations, the texture are highly variable and difficult to generalize. The chert tends to be highly recrystallized to fine patches of fibrous chalcedony, but veins of chalcedony are not common (unlike the Onondaga chert). Fine carbonate is often a large percentage of the rock, but dolomite rhombs tend to be small and dispersed (unlike the large dolomite rhombs often found in slides of Onondaga chert). Fracture planes are frequently recrystalized by calcite. Fossils are very common and often very large and well-preserved. The include brachiopods, trilobites, corals, and bryozoans. Opaques are usually fairly abundant, commonly as dusty carbonaceous matter and pyrites in some. Carbonaceous matter frequently ghosts carbonate particles. Clastic quartz is common in many

specimens, but absent in the Onondaga slides. Chalcedony spherules are occasionally well-developed; other specimens seem to show relict peloids" (Prothero 1983:394).

Coeymans Chert- "Distinct from other Helderberg textures: large patches of subhedral carbonates invade an extremely fine, carbonaceous matter-clouded chert, with abundant fine scattered pyrites and a little clastic quartz. Virtually no fossils or resolvable chalcedony, except for large clouded patches that may be poorly preserved fossils. Fractures healed with calcite" (Prothero 1983:396).

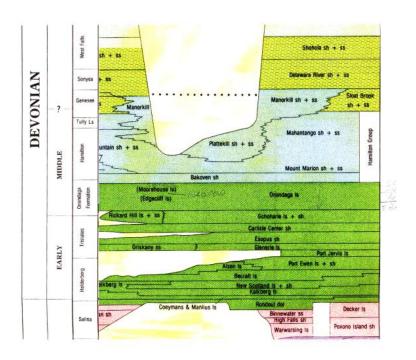
New Scotland Chert "is characterized by normally abundant angular clastic quartz grains, 0.1-0.5 mm in diameter. Heavily chalcedonized specimens virtually lacking in carbonates are also only known from the New Scotland Formation. In this respect, they are similar to Little Cattail Creek Chert except for the fact that they are finer-textured and have fewer opaques, and lack rutile needles, apatite, and opalization" (Prothero 1983:397-398)

Kalkberg Chert-"is usually a partially silicified limestone, with 30-50% dusty carbonates in a fine, uniform-textured chert matrix with minor fibrous chalcedony. The chert is heavily clouded by opaques, which outline ghosts of peloids, ooids, or are concentrated in stylolites. Many slides show very well-preserved large fossil fragments, but others have none. Clastic quartz, when present, is much finer-grained than other Helderberg cherts. Dolomite rhombs, when developed, are small (Prothero 1983:401-402).

The rocks of the Helderberg Group are largely limestones with small amounts of dolomite and shale. Each facies of the group was deposited in a shallow marine sea. Each facies represents a different set of environmental factors. The upper part of the Malius contains large, ovoid fossils of stromatoporoids (probably a sponge) and corals. Blue stone used for fireplaces comes from the Manlius Formation (Nye 1978:357).

**Distinguishing Characteristics:** "Helderberg chert is distinguished by its dense black color and by films of calcium carbonate between the fracture planes in the chert, and petrographically by its abundance of large fossil fragments, very high carbonaceous content—usually associated with the fossils, abundance of dusty calcite and of dolomite rhombs, and by the strong evidence of silica replacement of the fossils" (Wray 1948).

**Characteristic Fauna:** "The Coeymans Formation contains the brachiopod *Gypidula* coeymansensis and the coral *Favosites helderbergiae*. The brachiopod *Eospirifer macropleura* is characteristic of the New Scotland Formation, and the brachiopod Leptaena rhombidalis is especially abundant in the Becraft Formation" (Lavin 1983).



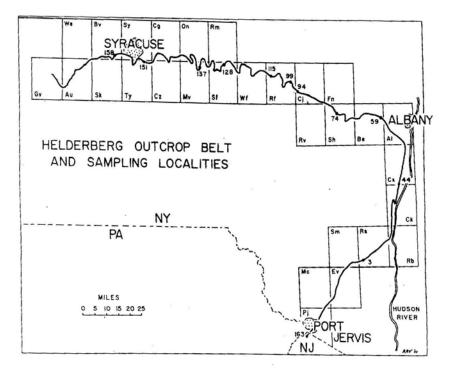


Fig. 6 Line of outcrop of Helderberg Group in New York. Numbers indicate 12 selected localities from which 200 samples of the Manilus have been studied

Chart 3: Top map (New York State Geologic Map, Plate 3:1990)

#### Normanskill

Age: Lower Ordovician (Wray 1948)

Lower and/or Middle Ordovician (Lavin 1983)

Type Locality: Flint Mine Hill, near Coxsackie, New York, West Athens Hill

AKA: Coxsackie, Flately Brook, Flint Mine Hill, Mount Merino, Pleasantville

**Stratigraphy:** Ordovician System, Normanskill Group, Mount Merino and Indian River Formations. (Holland 2004)

**Outcrop:** Outcrops of the chert occur extensively in the Hudson Valley of eastern New York in the counties of Ulster, Dutchess, Green, Columbia, Albany, Renselaer, Saratoga, and Washington (Wray 1948).

"Greene Orange, Rensselaer, Saratoga, Ulster, and Washington Counties" (Holland 2004).

"Normanskill formations appear in the central and northern Hudson valley in a triangular area bounded by the Mohawk valley in the north, between Schenectady and Melrose, New York, and south to the town of Ravena, New York. South of this area the outcrops generally follow the Hudson valley, bearing toward the southwest along the Shawangunk Mountains. Much of the western part of this area is dominated by the Austin Glen formation, which in many laces contains no chert. The best outcrops of Normanskill cherts occur at Mt. Merino, south of Hudson, New York, at Flint Mine Hill, near Coxsackie, New York, near Glenmont, New York, and in the creek bed of the Normanskill south and west of Albany. Two massive outcrops occur in Washington County, near Mt. Willard" (Hammer 1976).

"The formation is centered in New York along the central and north Hudson River Valley. West of the river, the formation crops out throughout Saratoga, eastern Schenectady, and northern Albany Counties. Below Albany, it closely follows the river until around New Paltz, where it trends southwest into Orange County" (Lavin 1983).

**Form of Occurrence:** "The chert occurs near the bottom of the Normanskill formation and is always associated with the shale beds. Continuous beds occur, varying from two to ten feet in thickness. Due to the greater resistance of chert to the process of weathering, the flints often stand out as distinct rides in the outcrops" (Wray 1948).

**Megascopic Description:** "Much of the chert appears as indurated shale. It is a hard, splintery flint varying in color from light green to dark green to black and often in associations of black

and green and red and green. Most of the red and green chert occurs in Washington County. The darker gray and black varieties are more common in the central and southern part of the Hudson Valley—the blackest variety being found at Stockport and Van Wie's Point, New York. Normanskill chert weathers with a light gray to white patina forming white colored ridges as landmarks on the landscape" (Wray 1948).

"They are primarily green, green and black, black, bluish green, dark olive green, also red, red with black, grayish green, and dark gray. The texture is always smooth and the luster ranges from dull to waxy. Many of the cherts weather white, and some of the blue varieties develop a chocolate brown patination between the weathering and the fresh chert" (Hammer 1976).

"The chert is usually described as black, grayish black, green, dark green, grayish green, bluish gray, red, red and green, and black and green" (Lavin 1983).

"Often mistaken for Deepkill chert which does not weather white as does Normanskill" (Holland 2004).

"With the Taconic Sequence resting unconformably upon clastics of varying ages is a succession of shales and graywackes about 2000 feet thick. The basal unit (called the Indian River Slate in the northern Taconics) is a green or red shale or slate locally with green chert or siliceous argillite. The munit (Mt. Merino black shale and chert ) is the mot graptoliferous with many genera represented, while the upper unit (Austin Glen Graywacke) is composed of tan weathering greywacke interbedded with gray and black shales."

**Munsell Color:** 5BG4/1, 5BG3/1, 5GY3/1, 5GY4/1, 5GY5/1, 5B4/1, 5G3/2, 5Y3/1, 2.5YR3/2, N3, 2 and others (Hammer 1976)

Petrographic Description: "Normanskill chert possesses a relatively fine-grained matrix of cryptocrystalline chalcedonic particles with numerous scales of muscovite and fragments of clastic quartz as its principal constituents and exhibiting mass polarization with extinction parallel and at right angles to the bedding planes. This was probably produced by pressure. Veinlets of what appears to be introduced quartz have been observed. A very little calcite has been noted in these veins. Large dolomite rhombs are common. Chalcedonite is extremely rare. Some sericite needles are present—probably derived from the alteration of the clayey material" (Wray 1948).

"Petrographic analysis indicates that the chert consists mainly of cryptocrystalline silica. Dolomite rhombs, muscovite scales, and clastic quartz grains are common. The chert has a well developed conchoidal fracture and does not effervesce with dilute hydrochloric acid" (Lavin 1983).

"Very fine-grained chert with abundant ghosts of siliceous microfossils (chiefly radiolarians) and 20-50% finely divided clays and micas. Matrix generally massive, but well laminated in a few slides. Minor opaques (chiefly pyrite), sometimes filling fossil cavities. A few slides show minor chlorite alteration" (Prothero 1983:385).

**Distinguishing Characteristics:** "The Normanskill chert is characterized by a light green color, often banded by reds, greens, and blacks, and which, upon weathering, produces a light gray to white patina" (Wray 1948).

**Characteristic Fauna:** Radiolarians, graptolites, and sponge spicules (Wray 1948).

\*"At this point it is not clear if the Mt. Merino and Indian River formation are part of the Normanskill formation or not. Outcrops of the Austin Glen, Mt. Merino and Indian River formations have been referred to as belonging to the Normanskill and , for the Mt. Merino, also belonging to the Deepkill formation. The evidence is not at all clear"

### Deepkill

AKA: Stuyvesant Falls, Mt. Merino, Deep Kill

Stratigraphy: Ordovician System, Deepkill Formation (Holland 2004)

**Age:** Lower Ordovician; oldest flint-bearing shale in the state

**Type Locality:** Mount Merino

**Outcrop:** "The outcrops of this chert-bearing shale are confined to the eastern part of the state in the Hudson Valley and in Columbia and Greene Counties. The two known exposures of this chert occur on the south-east side of Mt. Merino, just south of Hudson, New York and at Flint Mine Hill, near Coxsackie, New York. Flint Mine Hill is one of the largest and most important prehistoric flint quarries in the eastern part of the United States" (Wray: 1948).

"Deepkill chert, which is mentioned in archeological literature, is hard to find and may not exist. Since Deepkill is not a modern geologic term, and since I could not find out what happened to the old Deepkill, I assume that it has been renamed. The lower half of the Deepkill creek, from NY route 43 west to the Hudson was examined and no chert was found. I can only assume that the Deepkill chert referred to was mistake for green varieties of Normanskill or Mt. Merino chert" (Hammer 1976)

Authors Note: The author was able to collect samples of what was believed to be Deepkill from a road cut along route 23B at the southeast corner of Mount Merino. It is a gray-black silicified shale that breaks with a concoidal fracture.

**Form of Occurrence:** The characteristic folding and faulting of this region has made it difficult to ascertain the stratigraphic position of this chert. The association of graptolites in the shales indicates that I should be positioned in the upper part of the formation. Deepkill occurs in extensive beds which vary in thickness from one to more than four inches, and are interbedded with siliceous green shales (Wray: 1948).

**Megascopic Description:** "Deepkill is characteristically a pale green-gray to apple-green color but grays and blue grays and even reds occur. All of the above varieties upon weathering develop a brownish stain. Discontinuous black markings, which might represent worm trails, are common. The flint possesses a well developed conchoidal fracture" (Wray 1948).

Deepkill weathers brown, not white as does Normanskill chert (Holland 2004).

"Greenish shales with interbedded green, brown, and gray quartzites; interbeds of siltsone and chert (Lucier 1966:C17).

#### **Munsell Color:**

Petrographic Description: "Deepkill chert has a relatively fine-grained cryptocrystalline matrix of chalcedonic particles, sprinkled with spherulites of chalcedonite. A few rounded grains of clastic quartz and small scales of mica are fairly common in the matrix. Dolomite rhombs are numerous. The green variety of the flint seems to be especially rich in spherules of chlorite—probably derived from the mica. Mass polarization of the mica and quartz fragments can be observed but not as clearly as in the Normanskill flint. Hematite dust occurs in irregular masses or groups scattered in the matrix. A halo of yellow stain occurs around the grains of hematite. Occasional spots of carbonaceous matter are common" (Wray 1948).

**Distinguishing Characteristics:** "Deepkill flint is distinguished by its characteristic apple green color, and its tendency to weather brownish. In the thin section, it is distinguished by mica slivers, dolomite rhombs, spherules of chorite, abundant carbonaceous spots, the mass polarization of mica and clastic quartz fragments, and the presence of radiolarians, graptolites, and sponge spicules" (Wray 1948).

**Characteristic Fauna:** "Radolarians, graptolites and sponge spicules comprise the fossil content of the flint" (Wray 1948).

#### Snake Hill

Age: Middle Ordovician

AKA: None

**Stratigraphy:** Ordovician System, Snake Hill formation (Holland 2004)

Type Locality: North end of Saratoga Lake

**Outcrop:** Wray states that Snake Hill is found exclusively in Saratoga County, eastern New York and can be found in two locations: near Schuyler, northeast of Saratoga Lake and the creek bed of Anthony Kill between Round Lake and the town of East Line.

Saratoga and Schoharie Counties (Holland:2004)

Form of Occurrence: The Snake Hill like the Deepkill and Normanskill which it is associated with (Wray: 1948) occurs in relatively thick continuous beds. The Snake Hill is found very close to the Mount Merino cherts but has a totally different lithology. Snake Hill is a slump block that "fell" off the Taconic escarpment when it was under water; it was part of a thrust fault. This block slumped down into the basin and came to a halt right next to present day Saratoga Lake. As a result of this occurrence, Snake Hill is different than anything else around it. The Snake Hill would have been located much farther east if it had not slumped. Current research suggests that it would not be compared to the Normanskill as it is much younger than the Normanskill (personal correspondence with Bartholomew).

**Megascopic Description:** This chert is termed an indurated or siliceous shale, greenish-gray in color and weathers whitish. It chips poorly and often is splintery (Wray 1948)

"Snake Hill is more accurately described as siliceous shale. Darker in color than Esopus; is black in color" (Holland 2004)

#### **Munsell Color:**

**Distinguishing Characteristics:** Its shaley nature, splintery fracture and whitish weathering are the distinguishing features of the Snake Hill chert (Wray 1948).

#### Characteristic Fauna:

#### **Mount Merino**

Age: Odivician

AKA: Normanskill, Pleasantdale

Stratigraphy: Ordovician System, Normanskill Group, Mount Merino Formation (Holland 2004)

Type Locality: North end of Saratoga Lake

**Outcrop:** Part of a eugeosynclinal sequence.

Authors note: The outcrop was not found but large cobbles are prevalent along the lake and in

the nearby stream bed.

**Bed Thickness:** Unknown

Form of Occurrence: Unknown

**Megascopic Description:** It appears to be an indurated shale, dark grey to black.

Green, black, weathers white (Holland 2004)

**Munsell Color:** 

**Distinguishing Characteristics:** 

Characteristic Fauna: Unknown

**Little Falls** 

**AKA:** Knauderack Chert, Whitehall

**Stratigraphy:** Cambrian System, Little Falls Dolomite Formation

Age: Upper Cambrian; considered the oldest chert-bearing formation in New York

**Type Locality:** Both sides of the Mohawk River at Little Falls, New York.

**Outcrop:** Outcrops of chert-bearing dolomite occur in Montgomery, Herkimer, Fulton, Saratoga, Warren, Washington, and Hamilton counties. The best exposures of the chert are found on both sides of the Mohawk River at Little Falls and the area of Middleville, New York. A quarry site is reputedly located on Knauderack Creek on Big Nose Mountain in the Mohawk Valley. (Wray: 1948).

"The Little Falls Chert outcrops in five north-south running areas with their southern boundaries abutting the northern edge of the Allegheny Plateau between Little Falls and the Saratoga/Fulton County line" (Hammer 1976).

**Bed Thickness:** Unknown

**Form of Occurrence:** The top part of the formation is very flinty and locally becomes a pure mass of flint. Layers and nodules of flint are common (Wray 1948).

Megascopic Description: Blue chert is most abundant but gray varieties are not rare. Dark brown, pearly, and light blue varieties are found in Montgomery County. Red varieties have been found in Herkimer County. The flint "often has a mineralized appearance, due to abundant, small bluish-green spots which have some resemblance to green copper carbonate (malachite). There is however, no copper at all in the rock and the green spots appear to be constituted of glauconite." Often a dendritic-like structure is observed in the pearly gray varieties. This characteristically is a gray or black color. The chert weathers whitish with yellow-brown stains, and has a well developed conchoidal fracture (Wray 1948).

"This chert is tan with milky blue inclusions, somewhat lighter than the Ft. Ann type. The Little Falls Chert grades into a milky medium gray, but the colors are usually mottle with many limestone and quartz inclusions" (Hammer 1976).

"In the Mohawk Valley the Little Falls consists of a thick series (up to 550') of dolostones variable in color and texture, usually admixed with rounded quartz grains and frequently penetrated by light gray and white chert nodules and stringers. Glauconite is occasionally present. Locally, pyrite may be common. Detrital quartz increases in volume stratigraphically downward and geographically northward; the northward increase is of such proportions that a separate facis, the Theresa, is seen to intertongue with the Little Falls. Interstitial hematite is prevalent in a red zone 8-10 feet thick, at the summit of the Little Falls Dolostone. This zone is riddled with pockets (vugs) of quartz crystals, termed "Herkimer Diamonds," and anthraxolite, a black lustrous carbonaceous mineral with nearly the same chemical composition as coal though it has different physical properties. The parent material (proto-anthraxolite) was probably vegetable and derived from the algal biostromal reefs of Cryptozoan, now largely obscured through dolomitization" (Guide to Field Trips, NYSGA:1965).

White, agua blue, black; black color is the result of anthraxolite (Holland 2004)

"In the Mohawk Valley, the Little Falls consists of a thick series (up to 550') of dolostones variable in color and texture, usually admixed with rounded quartz grains and frequently penetrated by light gray and white chert nodules and stringers." Glauconite is occasionally present. Locally, pyrite may be common. This zone is riddled with pockets of quartz crystals

locally known as "Herkimer Diamonds." Anthraxolite is commonly found in conjunction with the Little Falls Dolomite. The Little Falls has very few fossils (Unknown 1965:A21).

Munsell Color: N4 to N6

Petrographic Description: "The petrographic analysis revealed a very dense fine-grained cryptocrystalline matrix of chalcedonic particles. Numerous small angular grains of clastic quartz, and splinters of muscovite occur scattered uniformly throughout the matirix. A very few small spherules of chalcedonite occur. The opaque minerals compromise uniformly disseminated hematite dust, sporadic chunks and numerous spots of a titanium-bearing mineral—probably leucoxene—and an occasional mass of marcasite. The dendritic-like veins appear as an iron rich oxide of uncertain classification—possible glauconite or some oxide of manganese" (Wray:f1948.

**Distinguishing Characteristics:** "Characteristically, the Little Falls dolomite flint is a pearly, light blue to whitish flint with a gray dendritic-like structure. The surface appears slightly chalcedonous upon fresh fracture but weather with a yellowish-brown stain. In the thin-section, the extremely fine-grained texture of the matrix, the presence of clastic quartz grains, and the rare occurrence of chalcedonite is characteristic" (Wray 194830-32).

**Characteristic Fauna:** The Little Falls is mostly a dolomite so it probably does not have much in the way of well-preserved fauna. You might find stromatolites (personal communication: Bartholomew).

# Authors Collection with photo's of site, samples, fossils, geographic coordinates and elevations

#### **Becraft**

Synonym: None Known

Stratigraphy: Devonian System, Helderberg Group, Becraft Formation

Bedrock: Shaley limestone

Fossils: Abundant—a horseshoe shaped brachiopod, a sponge that looks like a ball that is found in a somewhat chertier bed called *Hindia*, and Crinoids,

Type Site:

Collection Site: Rickard Hill Road, east of Schoharie, just behind the high school

Coordinates:

County: Schoharie

Highway: Rickard Hill Road

Elevation:

Color: Chert from the Becraft formation at Rickard Hill is light blue-gray.

Characteristics:

#### Comments:



Photo 1: Rickard Hill Road, east of the village of Schoharie. Photo shows the division between the upper and lower Becraft member of the Helderberg Formation. The nearside of the road is a well known site for collecting fossils; this is also the collection site of the Becraft chert.



Photo 2: Rickard Hill outcrop showing the contact between the Becraft (upper) and the New Scotland (lower) members of the Helderberg Formation. Outcrop lies east of Schoharie, behind the high school.

#### **Carlisle Center**

Synonym:

Stratigraphy: Esopus, Carlisle Center and Schoharie Formations form the bulk of the Tristates Group.

Bedrock: The rock of these units was formed largely from sand and mud eroded from the land. Carlisle Center is mainly siltstones formed when from sediment washed from the land and were carried by streams into the Early Devonian sea.

Fossils: Contains few fossils of animals with shells or other hard parts. There is only one common trace fossil and that is *Zoophycus*, otherwise known as the "rooster-tails."

Type Site:

Collection Site: US 20 northeast of Cherry Valley

Coordinates: N42°49.363 W74°43.557

County: Otsego

Highway: US 20

Elevation: 1463

Color:

Characteristics:

# Comments: No reference of Carlisle Center by Holland, Fogelman, Hammer or Wray



Photo 3: Large boulder that has fallen from a ledge; the boulder shows the tell-tale rooster tails that in this case marks the contact between the Esopus and the Carlisle Center members of the Tri-States Formation. The Esopus is a shale formation and the Carlisle Center is a silty sandstone.



Photo 4: Eroded ledge indicates the contact between the Esopus and Carlisle Center.



Photo 5: The erosion marks the contact between the Edgecliff at the top and the Carlisle Center at the bottom. Outcrop is found on US 20 approximately ½ mile east of the 166, US 20 intersection.

# Coeymans

Synonym: Helderberg

Stratigraphy: Devonian System, Helderberg Group, Coeymans Formation

Bedrock: Clean medium to coarse-grained limestones scattered with small coral and stromatoporoid reefs

Fossils: pelmatozoans, corals, brachiopods (*Gypidula coeymansensis*), mollusks, trilobites, ostrocodes and crinoids

Type Site:

Collection Site: County highway 32

Coordinates: N42°9.976 W74°43.976

County: Otsego

Highway: County Highway 32

Elevation: 1328

Color: Dark gray to black

Characteristics:

Comments: The Coeymans and the New Scotland cherts are macroscopically similar.



Photo 6: Coeyman Member of the Helderberg Formation. Outcrop located just north of the Route 166, US 20 intersection, north of Cherry Valley, New York.



Photo 7: *Gypidula coeymansensis*, a fossil indicative of the Coeyman's limestone.

# Deepkill

Synonym: Deep Kill

Stratigraphy: Ordovician System, Deepkill Formation

Bedrock: shale

Fossils:

Type Site: Mount Merino

Collection Site: Southeast corner of Mount Merino

Coordinates: N42°13.5384 W73°49.3220

County: Columbia

Highway: State Highway 23B

Elevation: 277

Color: Black

Characteristics:

Comments: Deepkill weathers brown, not white as does Normanskill (there may be some exception to this rule, this still needs to be questioned).

Deepkill is the oldest (shale) chert-bearing formation in New York State.



Photo 8: chert at this site grades closer to shale

## **Edgecliff**

Synonym: Onondaga

Stratigraphy: Devonian, Onondaga Formation, Edgecliff Member

Bedrock: "Edgecliff is a massive, light-gray (in some places pink), very coarsely crystalline limestone characterized by a profusion of tabulates, large rugose corals, and crinoids columnals. This unit is a true coral biostrome, largely made up of coral skeletons in a matrix of crinoidal debris. The base of this unit is very sandy in most places. The sandy zone ranges from inches to several feet in thickness, lower levels can appear as a sandstone. Throughout this zone carries the Onondaga fauna and is therefore easily distinguished from the Oriskany sandstone. Very light-colored, whitish–gray chert nodules are found scattered widely and sparsely throughout the upper portion of the unit" (Oliver 1954:626).

Fossils: Dominated by comparatively few species of tabulate and rugose corals, very large crinoid columnals, up to 1 inch in diameter are common.

Type Site: Designated the Edgecliff Member from exposures at Edgecliff Park, southwest of

Syracuse and 1 mile northeast of Howlet Hill,

Collection Site: US 166, .55 miles east of the US 20, State Highway 166 intersection

Coordinates: N42°48.951 W74°44.179

County: Otsego

Highway: State Highway 166

Elevation: 1512

Color: White and black, gray, gray mottled, black

Characteristics:

Comments: The pink variety of Edgecliff was collected on top of Terrace Mountain.

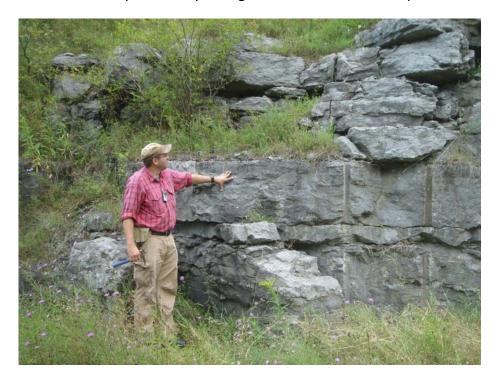


Photo 9: Outcrop located along Route 166 north of Cherry Valley



Photo 10: Favosites coral found in the Edgecliff –Route 166 north of Cherry Valley



Photo 11: Dolomitic rim around chert nodule found in Edgecliff, 1 mile north of Cherry Valley, New York.



Photo 12: Large Rugose Coral found in the Edgecliff Member.



Photo 13: Chert nodule found in the Edgecliff Member showing buff colored dolomitic rim or rind; the chert is light blue-



Photo 14: This photo is taken from the top of Rickard Hill Road outside of Schoharie. Terrace Mountain is in the background, the terraces are clearly visible at the right side of the mountain. Each terrace is caused by a more resistant layer. The second from the top is the Edgecliff formation.

### **Esopus**

Synonym: Sharon Springs, Cherry Valley Chert

Note: Sharon Springs was the original name but that name was being used in a western formation (Kansas?) so in the 1940's the name was changed.

Stratigraphy: Devonian System, Esopus Formation

Bedrock: Shale

Coordinates: N42°49.360 W74°43.622 (these coordinates are for US 20 collection site not the

Funk site)

County: Otsego

Highway: US 20

Elevation: 1424

Color: N3

Characteristics: "Esopus is a homogeneous dull blackish/gray, slightly vitreous and with a well developed conchoidal fracture. Weathering produces a grayish to white cast, often mottling the surface" (Fogelman 1999:26). Samples contain fossils and when struck give off a slight petroleum odor.

Comments: When looking for chert samples along the creek beds, Esopus is fairly easy to spot because of the "blockiness" of the cobbles and their characteristic greenish-brown patination. Esopus cobbles were found in the Schoharie, Fox, and Stoney Creeks.

Esopus found at the ancient quarry site described by Funk has a whitish to grayish cast to the weathered surface and some samples show mottling. Esopus cobbles found in the ancient pits dug along the hills of West Creek a short distance away from Funk's quarry show the greenish-brown patination.

Esopus has a pretty wide range of chert grades; you can pick up a block of Esopus and spall it up and at one end of the spectrum you will find, at the courser end that it will work almost like shale. On the other end of the spectrum, the finer grades, of which there is an abundance of in Esopus, it tends to have a higher silica content and have a better microcrystalline structure—it's more glassy (personal communication: Paul Trotta).

The first Esopus outcrop examined was found on County Route 166 approximately 2 miles north of Cherry Valley. It is a low lying outcrop, very crumbly, about 3-4 feet in height. This marks the upper level of the Esopus and has the characteristic rooster tails—Zoophycus. The Esopus is a bentonite chert. It is probably more your bentonite derived chert because of the volcanic ash which is a different type of silica; the ash bed in the Esopus are known as the Sproutbrook. The British call these Liddite cherts—a massive tabular type of chert (personal communication: Alex Bartholomew).

## Gastropod fossils present.

Large, characteristic blocky, greenish-brown cobbles of Esopus were readily found in Fox, Stoney, Cobbleskill and Schoharie Creeks.

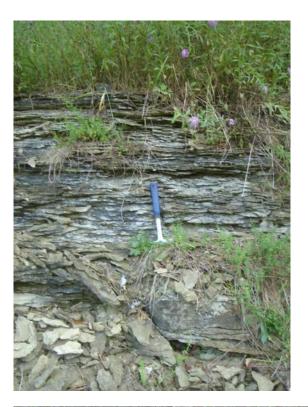


Photo 15: Esopus outcrop along Route 166 north of Cherry Valley, New York.



Photo 16: Rooster-tails (Zoophycus), indicative of the Esopus Member of the Tristates Formation.



Photo 17: Excellent quality Esopus; the rock hammer indicates a bentonite layer. Outcrop located on US 20 aproximately ¼ mile east of the railroad overpass.



Photo 18: above is the area that Funk covered in his work on the "Cherry Valley" Chert.



Photo 19: Although difficult to see, the dark area in the foreground and immediately behind the trees (leaves removed for the photo) to the left are pits dug by early people in search of Esopus Chert.

## **Flint Ridge**

Synonym: Van Port Chert

Stratigraphy: Vanport Member of the Allegheny Formation of the Pennsylvania System

Bedrock:

Collection Site: Flintridge,

Coordinates: N39°59.314, W082°14.665

County: Licking and Muskingum, Ohio

Highway:

Elevation: 1236 feet

Color: Milky white to blue to yellowish, Nethers variety is referred to as Banded or Ribbon chert and is very colorful—reds, blues, yellows, etc.

#### Characterists:

Petrographic Analysis: "Very fine-grained, even-textured chert with finely disseminated carbonate throughout. Blotchy texture of opaques (mostly iron oxides) suggest ooids, pellets, and fossils. Some slides have large (0.5-1.0 mm in diameter) fragments of fossils, mostly brachiopods and crinoids. Texture is finer-grained and more homogeneous than Helderberg

and Onondaga cherts; also distinguished by lack of dolomite, clastic quartz, and chalcedony veins (Prothero 1983:415).

Comments: A lot of the material had to be heat treated which accounted for the diversity of color (Fogelman 1999:27))



Photo 20: Chert was mined from pits, presumably in cobble form at Flint Ridge, Ohio. This is very reminiscent of the Cherry Valley Esopus quarry. Although difficult to see, this photo shows one of hundreds of fairly deep pits dug into the area to recover chert cobbles.



Photo 21: Again, it is difficult to see, but the pits stretch into the woods as far as the eye can see, showing the extensive nature of the quarry operation at Flint Ridge and presumably at many other locations along the 26 mile long ridge.

### Kalkberg

Synonym: Helderberg, Hannacroix

Stratigraphy: Devonian System, Helderberg Group, Kalkberg Formation

Bedrock: Dolomitic limestone

Collection Site: US 20, .4 miles east of the US 20, State Highway 166 intersection

Coordinates: N42°49.347 W74°43.685

County: Otsego

Highway: US 20

Elevation: 1347

Color: N2, black

Characteristics: forms in nodules, lenses and stringers, stringers range in thickness between 2-6 inches; there is little color change in the specimen

Comments:"It's good stuff, the only thing I've found over the years is that it has lots of active cracks along with healed cracks. With an active crack if you hit it with a hammer to try and get a spall, you'll get a nice spall but this will break right in half. The healed cracks are ones that over the years, over time, I think has with the action of water and silica in solution filled the cracks, knitting the pieces together. You can see them [the cracks], but even using percussion, you can knap across them and the spall remains intact. It's a nice material, but it's hard to get nice medium to large spalls from it; so I have used it for small tools and projectile points. Identifying features: quite dark, dark gray to black, very glossy, glassy material, sometimes when you get a spall knocked off there will be shiny little particles in it like quartz" (personal communication: Paul Trotta).

Fogelman—(With reference to Kalkberg taken from Rt. 30 road cut near Cherry Valley, New York) "It is a dark gray to gray/brown color, and shows slight rootbeer color translucency on the thin edges. It's a splintery chert, with frature lines running through it, and so-so quality. It's difficult to find sections large enough and pure enough to work" (Fogelman 1999:36).

Indicative of Kalkberg is brachiod—<u>Bilobites</u>—which for clarification purposes has a "heart" shape and in cross section looks likefingernails. Some of the crumbly layers in Kalkberg are probably bentonite (Bald Mountain) (personal communication: Alex Bartholomew).

A good outcrop of Kalkberg can be seen where County Route 166 meets the access road to US 20 just north of Cherry Valley. The stringers here are quite thick at this location.

Authors Note: Kalkberg appears on both sides of the road at the intersection of US 20 and County Route 166; because of the southerly dip of the beds, the Kalkberg at this location is probably the same as that on County Route 166 and this can be verified by comparing the shale intervals and the thick bands of visible chert. At this location however, the cherts on each side of the road are of different colors. On the south side of the road the Kalkberg is the well-known black. On the north side of US 20 the Kalkberg could be confused with the Edgecliff light blue to blue-gray. Seen side-by-side the Kalkberg in this case is a slightly darker gray.

In this case, it is possible that the difference in color is related to the way the chert was formed. If the chert is formed from ash beds the chert will have a lighter cast to them and if they are formed from the sponges they may have a darker cast. This is the sort of thing that leads to the difficulty in recognizing various cherts.

"There are several famous, sometimes diagnostic, ash beds. The ash beds in the Kalkbergs are called the Bald Mountain ash beds, those in the Esopus are called the Sproutbrook and the one in the Onondaga is called the Tioga ash bed or the OIN (the Onondaga Indian Nation ash beds). The ash beds are found in the beds along County Highway 166 and US 20 as well as along Interstate 88. The can be traced all over the eastern United States; they thicken and thin and in some places reach a thickness of 3 feet. Massive volcanic ash deposits were shot into the air and rained down out over the ocean and were deposited right when the limestones were deposited. The ash--the volcanic glasses--were changed into bentonite, the bentonite clays that swell and expand massively, but because they have silica in them, in the form of the volcanic glass, they got concentrated as chert to some extent" (personal communication: Alex Bartholomew).



Photo 22: Kalkberg with thick beds of chert found at the intersection of Route 166 and the on-ramp to US 20, north of Cherry Valley, New York.



Photo 23: Upper Kalkberg with shaley intervals (Kalkberg facies but may be New Scotland age), US 20 just north of railroad overpass at Route 166, US20 intersection.



Photo 24: This photo shows the Kalkburg on the opposite side of US 20 but the chert in this outcrop is of a light bluish-gray color.

## **Little Falls**

Synonym: Knauderack, Whitehall

Stratigraphy: Cambrian System, Little Falls Dolomite Formation.

Bedrock: Dolomite

Fossils:

Type Site: Knauderack Creek, Big Nose Quarry site

Collection Site: Knauderack Creek, 6 miles east of Palatine Bridge

Coordinates: N42°54 W74°295

County: Montgomery

Highway: State Highway 5

Elevation: 445 feet

Color: White, aqua blue, black

Authors Note: The samples found by the author were white with a black dendritic pattern. The texture ranged from smooth and glassy to sugary.

### Characteristics:

Comments: I did find the characteristic Little Falls that is cream or white with dendritic markings. Several other colors were present but I am unsure whether they fit in the Little Falls category.

Authors Note: Large amounts of Little Falls Chert were found by the author following the Knauderack Creek to its origin on Big Nose. The actual quarry was not located.

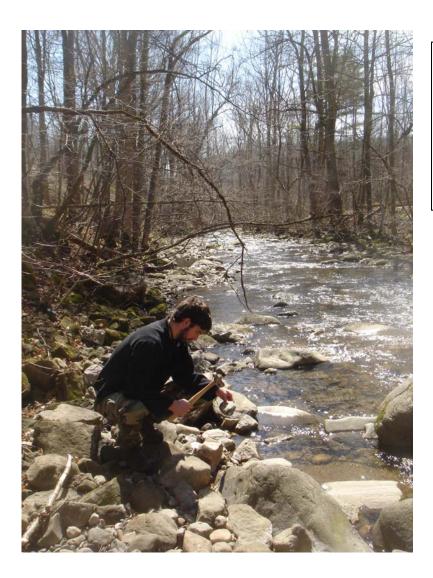


Photo 25: At the source of the Knauderack Creek is the quarry that has filled this stream with abundant cobbles of Little Falls chert. The stream dumps into the Mohawk River about 6 miles east of Palatine Bridge, New York.



Photo 26: This is typical example of Little Falls chert, white to cream colored chert with characteristic black dentritic lines tracing through it.

### **Manlius**

Synonym:

Stratigraphy:

Bedrock: Upper Manlius is fine to medium grained limestone, slightly uneven, medium to thick layers. The Lower Manlius is fine-grained limestone and dolostone, medium to thin layers; some laminations

Fossils: stromatoporoids, brachiopods, mollusks ostracodes and trilobites; the Lower Manlius is marked by the tentaulites

Type Site:

Collection Site: County Highway 32, 2 miles north of the intersection of County Route 54 and

State Highway 166

Coordinates: N42°49.511 W74°3.667

County: Otsego

Highway: County Highway 32

Elevation: 1280

Color:

Characteristics:

# Comments:



Photo 27: Coeymans, Manlius Contact County Route 32



Photo 28: The hammer indicates the contact between the Manlius (lower) and the Coeymans (upper), members of the Helderberg Formation. This outcrop is located on County Route 32, about 2 miles north of the State Highway 166, County Route 54 intersection.

#### Moorehouse

Synonym: Corniferous, Onondaga

Stratigraphy: Devonian System, Onondaga Formation, Moorehouse Member

Bedrock: "Fine-grained limestone separated by thin shaley partings. The individual units range from 2 inches to 5 feet thick. Chert is common in this member, but varies in amount. It is dark gray and forms more or less a continuous strata 1-5 inches thick. It is generally present in the lower half of the member, but is more abundant in the upper half (Oliver 1954:628).

Fossils: Many species first appear here—<u>Bellerophon sp.</u>, "<u>Pleurotomaria</u>" sp., <u>Loxonema sicula</u>, and <u>Coleolus crenotocindium</u> are especially characteristic.

Type Locality: Southwest extremity of Moorehouse Flats at the Onondaga County Prison Quarry, half a mile south of the County Penitentiary at Jamesville.

Collection Site: .7 mile north of the County Route 166 and County Route 54 intersection

Coordinates: N42°48.620 W74°44.179

County: Otsego

Highway: County Route 166

Elevation: 1462

Color: Gray, gray mottled, black

Characteristics: On certain bedding surfaces there are indications of wave action and concentration of coarse fossil debris. The lines of fossil concentration make a pattern on the surface of the beds similar to mud cracks. The chert-bearing zone in the Moorehouse is characterized by gastropods, although on inspection, the brachiopods still dominate numerically (Oliver 1954:630).

Comments: The chert nodules in this member often have a white or light colored "halo" surrounding them. Moorehouse chert is biogenic in origin so the chert forms from sponges forming an opalene silica.

Note: "Chert is derived in several ways; in the Onondaga it mostly comes from sponges. They build skeletons or secrete skeletons out of silica—which look a little like jacks--the net work of pieces are called spicules. In the Onondaga they are made out of amorphous opaline silica , a silica with water--SiO $_2 \cdot H_2O$ . Silica is normally resistant to dissolution but this type of silica can be dissolved very slowly and the silica gets concentrated into chert layers, so you get it spread

throughout the formation as nodules or as bedded layers. A lot of times you will see that they gave a white rim around them. When the chert nodules form it pushes the magnesium out of the chert nodule and you get a concentration of magnesium around the edges—you get a dolomitized ring. This is why you find a black core of chert with a white ring around it"

"The other way you can get chert is from ash bed—silica ash—and there are pretty good concentrations of the ash—fossil ash—called bentonites in the Onondaga, the Esopus and the Kalkberg. (personal communication: Alex Bartholomew).

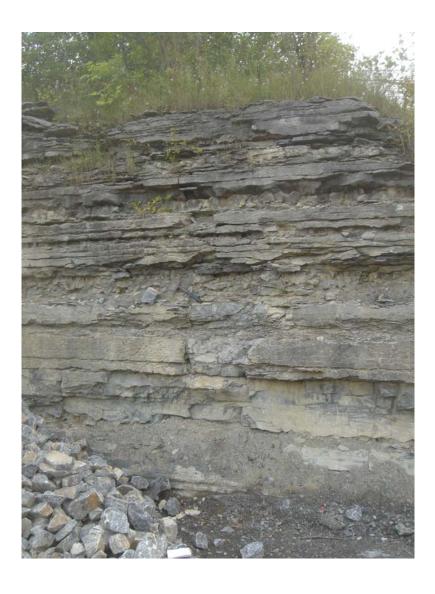


Photo 29: The hammer marks the contact between the Nedrow member (lower) and the Moorehouse member(upper) of the Onondaga Formation. Route 166, 1 mile north of Cherry Valley, New York.



Photo 30: Schoharie River, near Middleburgh Route 145; this is probably the Moorehouse Member of the Onondaga Formation. Limestone is eroding away leaving the chert to stand proud of the parent matrix.





Photos 31 and 32: Two examples of fossils being completely replaced by silica; these two fossils were found in the bedrock of the Schoharie Creek just outside of Middleburgh, New York.



Photo 33: Onondaga chert, probably Moorehouse, being eroded out of the softer limestone.

## **Mount Merino**

Synonym: Normanskill, Pleasantdale

Stratigraphy: Ordovician System, Normanskill Group, Mount Merino Formation

Bedrock: Further investigation is needed. I was unable to follow the stream to its source to locate a possible rock outcrop. All the cobbles are at least fist size and very water worn. It appears to be a shale based chert.

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Type Site:

Collection Site: North end, east side of Saratoga Lake

Coordinates: N43°02.4157 W73°42.8513

County: Saratoga

Highway: County Route 9

Elevation: 203 feet

Color: Green, black

Characteristics: Weathers to a shiny black.

Comments: Some confusion exits with Mount Merino. Normanskill and possibly Deepkill are found on Mount Merino. Mount Merino might belong to the Normanskill or the Deepkill formations. I asked Jack Holland where I might find this chert and he directed me to the Saratoga Lake area where I was successful in locating specimens of Mount Merino.

There is no description of Mount Merino made by Hammer, Lavin or Fugelman.

Interview: This is the same stuff you can find down along the Hudson; quite a bit farther south than Saratoga Lake. This is heavily patinated, shiny black, looks like most of the samples have been smoothed by pounding and the texture looks grainy or sugary. These cherts are like Esopus Cherts which I am very familiar with. This chert, like Esopus might be a gradational chert and I am guessing that this [sample being examined] may be at the shale end of the spectrum. This looks like pretty tough stuff to knap (personal communication: Paul Trotta).

Mount Merino weathers to a characteristic well rounded, shiny black. Large cobbles of easily identifiable Mount Merino were found in Fox, Stoney, Cobbleskill and Schoharie Creeks.

Authors Note: The cobbles found at Saratoga Lake and at the various creek sites are weathered to a distinctive shiny black with some traces of white filling in the depressions and crevices.



Photo 34: A large cobble of Mount Merino is located in the center of the picture; it shows the very characteristic shiny black patina.



Photo 35: This is the location where large nodules of Mount Merino can be found; it is where Mill Creek dumps into the north shore of Saratoga Lake. A quarry is reputed to be located further up toward the source of Mill Creek.

# **Nedrow**

Synonym: Onondaga

Stratigraphy: Devonian System, Onondaga Formation, Moorehouse Member

Bedrock: Throughout the central area the unit consists of a lower shaley zone, which grades upward to more massive fine-grained limestone in beds 2 to 6 inches thick. The thickness of the bed at the collection site ranges from 10-15 feet.

"Overlying the Edgecliff member throughout the central area is 10-14 feet of thin-bedded and shaley limestones. The lower very shaley part bears the gastropods and ranges from 2-5 feet thick. The upper zone bears the same brachiopods as the lower, but the Platyceratid gastropods are absent. The Nedrow beds are medium gray, very fine-grained, and argillaceous" (Oliver 1954:627).

Fossils: Fossils are abundant, gastropods are the most abundant. <u>Platyceratid gastropods</u>. The beds are also characterized by a low turbinate form of <u>Heliphyllum halli</u> and by <u>Amplexiphyllum hamiltoniae</u>, both rugose corals rare elsewhere in the Onondaga (Oliver 1954:627).

Type Site: 1 mile south of Nedrow, at the Indian Reservation Quarry, between Quarry Road and U.S. 11 just south of their intersection

Collection Site: Intersection of US 11 and Interstate 81 south of Syracuse, North end of the Onondaga Reservation

Coordinates: N42°57 W76°05

County: Onondaga

Highway: Intersection of US 11 and Interstate 81

Elevation: 533

Color: Mottled gray and black also solid black

Characteristics:

Comments: More work needs to be done to determine whether the samples collected are in fact from the Nedrow or from another member.

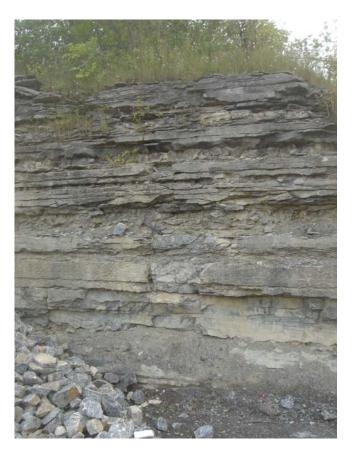


Photo 36: This photo shows the contact between the Nedrow (bottom) and the Moorehouse (upper) as found at an outcrop located on Route 166, 1 mile north of Cherry Valley, New York.



Photo 37: The rock hammer indicated the contact between the Edgecliff and the Nedrow formations. The outcrop is located on US 20 northeast of Cherry Valley.



Photo 39: This photo shows the contact between the Nedrow (bottom) and the Moorehouse (above). The outcrop is located on US 20 Northeast of Cherry Valley, New York.





Photos 40 and 41: Two views of the Nedrow outcrop located at the intersection of highway 11 and Interstate 81, just south of Syracuse, marking the north end of the Onondaga Reservation.

## Normanskill

Synonym: Coxsackie, Flately Brook, Flint Mine Hill, Mount Merino, Pleasantville

Stratigraphy: Ordovician System, Normanskill Group, Mount Merino and Indian River

**Formations** 

Bedrock:

Fossils:

Type Site: Flint Mine Hill, West Athens Hill

Coordinates: N42°19941 W73°49719

County: Columbia and Greene

Highway: State Highway 23A

Elevation: 174

Color: Black, red and green

Characteristics: The texture is always smooth and the luster ranges from dull to waxy. Many of the cherts weather white, and some of the blue varieties develop a chocolate brown patination between the weathering and the fresh chert.

Comments: Often mistaken for Deepkill chert which does not weather white as does Normanskill

Samples of Normanskill chert was collected from Willard Mountain, West Athens Hill and Coxackie.



Photo 42: Flintmine Hill near the town of Coxsackie, New York. (location 1)



Photo 43: Flintmine Hill near the town of Coxsackie, New York (location 1)



Photo 44: Flintmine Hill, Coxsackie Chert (location 2)



Photo 45: Flintmine Hill, Coxsackie Chert (location 2), a large boulder of "Normanskill Chert"

# Oriskany

Synonym: Ridgely, Shriver

Statigraphy: Devonian System, Tristate Group, Oriskany Formation, Ridgely Member

Bedrock: sturdy well cemented sandstone

Fossils: brachiopods

Type Site: Jamesville, New York in the prison quarry

Coordinates: N42°40.9788 W74°19.1464

Collection Site: Terrace Mountain

County: Schoharie

Highway: From Schoharie take 1A northwest turn north on Sunnyside Road

Elevation: 1133

Color: bluish gray, dark gray, black

Characteristics: It is a sturdy, well cemented sandstone. Oriskany almost always has a concoidal fracture, in some places it has beautiful big fossils, usually brachiopods. On Terrace Mountain it is almost a siliceous limestone where the lime rock, the calcite, has dissolved away and left behind the molds of the fossils in the sand.

Comments: Indians may have used Oriskany as a grind stone for ground stone tools such as celts, the rock breaks into almost perfect rhombs. The Oriskany is world famous for its big fossils, this formation can be followed down to Virginia and Maryland.

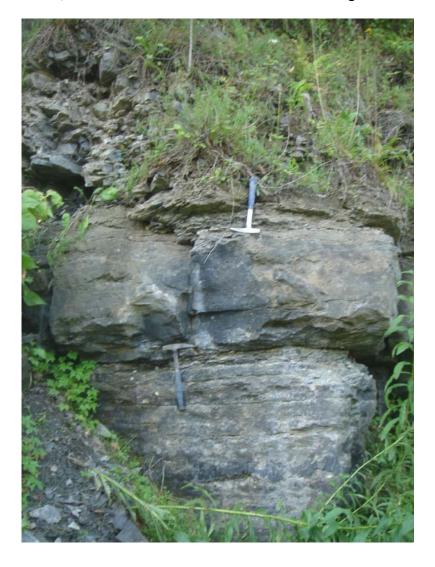


Photo 46: The rock hammers indicate the contact between the Esopus (top), Oriskany (middle), and Kalkberg (bottom) formations. The outcrop is located on US 20 northeast of Cherry Valley, New York.



Photo 47: Terrace Mountain as seen from the top of Rickard Hill, Rickard Hill Road, Schoharie, New York. You can clearly see the terracing on the distant mountain; the terrace second from the top marks the extremely hard, erosion resistant, Oriskany formation.

### Seneca

Synonym: Onondaga

Stratigraphy: Devonian System, Hamilton Group Onondaga Formation Seneca Member

Bedrock: The Seneca Limestone, resting on the Moorehouse, is a dark shaley rock underlying the Marcellus and containing abundant fossils. The Seneca is divided into 5 zones, the first or lowest being the Tioga Bentonite; the second is similar lithologically to the Moorehouse but is distinguished by its lack of fauna; the third zone is noted by its unique pink color derived from the "Pink Chonetes;" the fourth zone is the series of limestone that tends to be darker gray and continues to darken through the fifth zone, chert becomes less common in this zone.

Fossils: The Seneca is characterized by <u>Chonetes lineatus</u>, <u>Dalmonites selenurus</u> and large coiled cephalopods.

Type Site: The member is named for the numerous exposures found in Seneca County

Coordinates: N42°492 W74°4317

County: Otsego

Highway: US 20 approximately 1 mile east of the County Highway 166 and US 20 intersection

Elevation: 1575

Color: Medium gray to dark gray

Characteristics:

Comments: The Seneca Member is underlain by the Tioga Bentonite Ash Beds, an unfossiliferous clay also known as the Onondaga Indian Nation ash beds. The clay of this bed is an ochre color when fresh but turns a dull gray upon weathering; the clay bed is usually recessed where is exposed and it usually weathers back a foot or so from the face of the beds above and below it. The Tioga Bentonite Ash bed is a time plane from which other formations can be determined. The Tioga Bentonite Ash bed forms not only lithologic break but a sharp faunal break as well, separating the Moorehouse from the Seneca member. About 25 species of the Moorehouse are not found above the ash bed (Oliver 1954:629).

The Onondaga-Marcellus contact is gradational. At the top of the Seneca (zone 5) is a series of alternating layers of shale and limestone. The six feet of very dark, bituminous limestones and included black shales mark a decline of the generally favorable conditions in the Onondaga Sea.

### **Snake Hill**

Synonym: None known

Stratigraphy: Ordovician System, Snake Hill Formation

Bedrock: Indurated or siliceous shale

Fossils:

Type Site: a restricted small area in Saratoga County, eastern New York

Collection Site: Fitch Road area, northeast of Saratoga Lake

Coordinates: N43°o2.6515 W73°42.4891

County: Saratoga

Highway: Fitch Road

Elevation: 289 feet

Color: greenish-gray weathering to white, black

Characteristics: Weathers to a buff to brownish patination that shows on the cobbles.

Comments: (interview) This looks like it was formed from shale, it looks really good. What was the source? I collected a piece that looked very much like this several years ago from Fox Creek in Schoharie County; it had the same characteristics--jet black, not grainy, very nice material.

Note by author: Two trips were made to the Burnt Hills area exploring the Round Lake East Line location. I found good black shale, bordering on slate, but found no chert. The reference to Schuyler was too vague and was not pursued. I did find Snake Hill in two locations at the north end of Saratoga Lake. Both sites appeared to have been extensively used. One of the sites did not have a rock face exposed but the hill site had been hollowed out and cobbles of good size were readily available if you dug into the mud. The second site appeared to have been an early quarry site; the bed rock was exposed at this site. Local residents stated that they had played there as children and found many artifacts. Both sites are located on private property and they requested that the sites not be published.



Photo 48: A cobble of Snake Hill chert found in what has been purported to be an old quarry, located northeast of Saratoga Lake.



Photo 49: Photo of second quarry site found with the help of local residents, also located northeast of Saratoga Lake.



Photo 50: Snake Hill formation exposed at the second quarry site.



Photo 51: Photo shows what appear to be "ramps" built up to gain access to chert-bearing strata of the outcrop face.

#### **Further Research:**

Although slides exist for some of the chert types (Wray:1948, Lavin and Prothero:1983) examined in the research area, it is important that thin sections be made for more chert types and specifically for samples collected in the research project area. Personal communication with Dr. Bartholomew assured me that the slides made by Prothero for his petrographic analysis were viable for my research area. Even though the samples were collected in a different localities the fossil indicators are consistent, the variability comes with the difference in color, texture and workability. There are also variations in the texture of the parent rock that may make it more difficult to identify the chert, so more samples of bedrock should be made. An effort should be made to correlate all of the existing data: geology, paleontology, and archaeology, and empirical data gleaned from interviews to create a compendium of data relevant to lithic studies.

Work remains to be done in the area of patination. I have tried to photograph samples showing both clean and patinated surfaces. A collection of these photos should be made placing the samples side-by-side to show patination of the same material from different sites. Perhaps acidity of soils or water has an effect on patination. Artifacts recovered from archaeological sites all show patination. Willful destruction of the artifact to gain more information is counterproductive, so knowing what color a lithic material patinates to could be very advantageous for archaeologists. Patination studies may be a strong tool for archaeologists to identify chert sources which will lead to a better understanding of a people and their migratory habits.

There is an incredible amount of variance in chert colors and it is very difficult to describe them. Many are mottled or striated. Many cherts change color with thickness. Cherts such as Kalkberg, Normanskill or Edgecliff have an enormous range of color. The color variance of some cherts may be due to whether they have an ash derivation or biologic derivation. A minute change in trace element composition can greatly change the color of the sample so you can have an Edgecliff for example that can be white, gray or pink. If you are reading Wray's work, his samples may be gray, Prothero's may be white and my samples may be pink. It would be very useful to have a pamphlet that contained pictures of all the known cherts, set out by chert type, and examined the color spectrum and assigned a Munsell number to that color. Having a universal "language" for describing color and comparing cherts from around the state would be an extremely useful tool for archaeologists.

It would be very helpful to map out the various known archaeological sites of repute (those that have been excavated in some detail) and compare them to the known chert sources, either quarries or river sites with abundant good chert in them. Perhaps following Funks criteria would be a good starting point. For his work in the Upper Susquehanna, he

eliminated sites such those listed by Parker (1922) that have not been rediscovered or field checked since the time that he published his report. He also eliminated all "possible" sites, Euroamerican sites, and sites that lacked cultural affiliation. This pared the sites down from over 850 to a few hundred. The information used in the research projects would thus contain less chance material and less empirical data and may lead to a better understanding of materials used by people from the Archaic through the Woodland periods (Funk 1993:245).

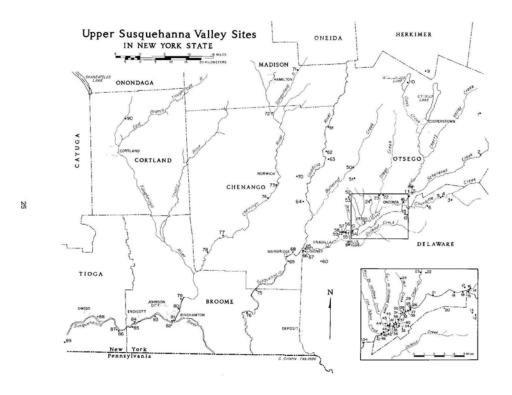


Figure 7: Archaeological sites on the Upper Susquehanna River

#### Figure 1. Location of archaeological sites in the Upper Susquehanna Valley, New York State.

Map of the Upper Susquehanna drainage showing sites and localities mentioned in the text. 1, Pleasant Brook site; 2, Hudson Lake sites; 3, Mud Lake East; 4, McCulley No. 1 site; 5, McCulley No. 2 site; 6, Davenport Creamery site; 7, Brown Knoll site; 8, Goodyear Lake site; 9, Weaver Lake site; 10, Deowongo Island site; 11, Osterhoudt site; 12, Lockout site; 13, Hillipp site; 14, Fortin site locus; 15, Fortin site locus; 16, Street site; 17, Oneonta Bypass Bog; 18, Adequentaga site; 19, Messina site; 20, Vly Bog; 21, Shearer site; 22, Winnie Hill site; 23, Munson site; 24, Fredenburg site; 25, Mattice No. 1 site; 26, Deer Blind Rockshelter; 27, Hendrick No. 3 site; 28, Crandall-Wells site; 29, Camelot No. 2 site; 30, Camelot No. 1 site; 31, Maple Torrace site; 32, Mill Creok Mouth; 33, Chamberlain Hill Road; 34, Rose Meander sites; 35, Enck No. 2 site; 36, Enck No. 1 site; 37, Rose site loci 1, 2, 3; 38, Gillingham Rockshelter No. 2; 39, Mattice No. 2; site; 40, Calder Hill Ravine Rockshelter; 41, Gillingham Rockshelter No. 1; 42, South Shelter No. 1; 43, South Shelter No. 2; site; 40, Calder Hill Ravine Rockshelter; 41, Gillingham Rockshelter No. 1; 42, South Shelter No. 1; 43, South Shelter No. 2; 44, West Shelter No. 1; 45, South Shelter No. 3; 46, Corn (Veen-Conner) site; 47, Van Smith sites; 48, Kuhr No. 1 site; 49, Kuhr No. 2 site; 50, Bemis site; 51, Lake Misery; 52, Ostadas site; 53, Outpots site; 54, Sternberg site; 55, Lans No. 2 site; 57, Gardepe site; 58, Johnsen No. 3 site; 59, Johnsen No. 1 site; 60, Russell Beach Swamp; 61, Davis site; 62, Green site; 63, Wells site; 64, Harrington Rockshelter; 65, Egli site; 66, Wessels site; 67, Clum site; 68, Bainbridge site; 69, Green site; 70, White site; 71, Ninemile Swamp site; 73, Jambas site; 74, Miner site; 75, Nineveh Crossing site; 76, Onaquaga site; 77, Van Ness site; 78, Bates site; 79, Castle Greek site; 80, Broome Tech site (Otsiningo?); 81, Roberson site; 82, Temple Concord site; 83, Palmer (Willow Point) site; 84, Roundtop site; 85, Castle Garden

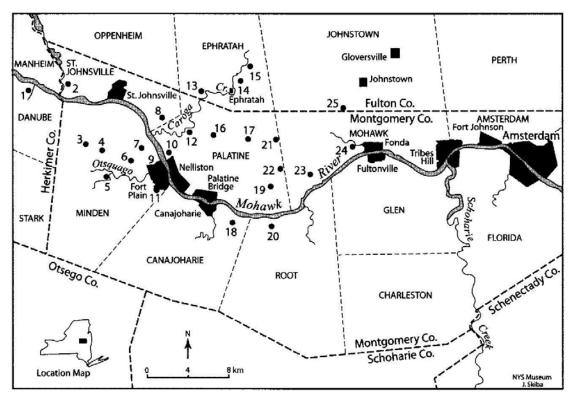


Figure 1. Map of the Middle Mohawk Valley, showing some of the archaeological sites of the Mohawk Iroquois mentioned in the text. Locations are confined to sites in Fulton and Montgomery Counties, New York. Key: 1, Indian Castle; 2, Ganada No. 2; 3, Elwood; 4, Fox Lair; 5, Otstungo; 6, Second Woods; 7, Oak Hill No. 1; 8, Jackson-Everson; 9, Galligan; 10, Wormuth; 11, Swart-Farley; 12, Wagner's Hollow; 13, Klock; 14, Garoga; 15, Smith-Pagerie; 16, Kilts; 17, Getman No. 1; 18, Horatio Nellis; 19, Rice's Woods; 20, Rumrill-Naylor; 21, England's Woods; 22, Coleman-Van Duesen; 23, Briggs Run; 24, Caughnawaga; 25, Cayadutta. Modified from Snow (1995:Figures 1.1, 1.2).7

Figure 8: Archaeological Sites along the Mohawk River

More work should be done comparing glacial movement with till sites and the various cherts that can be found in river and stream beds. According to Funk (1993:247-248) the single most productive area of his research project was from Goodyear Lake south to Owego. The Unadilla and Chenango rivers were second and third followed by Schenevus Creek, the Susquehanna River north of Goodyear Lake, and Otego Creek. Of the valley floor sites more than 88 percent of them are on outwash planes and terraces, kame terraces and deltas, and flood plains. Funk states that second in importance as a variable in the site selection process next to the occupation area is proximity to a river or water source. Early people were living on top of or in proximity of several hundred feet of glacial till. How much of this till was tool quality lithic material and how much was available to early peoples as they traveled these river highways? Is the ratio of stone artifacts at various Susquehanna sites proportional to the various chert types found in the till that is proximate to the village sites?

Probably the most interesting and frustrating aspects of this research project was following up on chert sources, especially quarries sites that were mentioned in historic literature. There are a number of quarries mentioned in historic literature and yet they are incredibly difficult to find. One day was spent following the Knauderack Creek and exploring the knoll on top of Big Nose and although I did find the chert I was looking for the ancient quarry suspected of being there eluded me. Part of this might be due to vegetation covering the site and our interpretation of quarry. As in the case of Flint Ridge, Ohio, West Athens Hill, and Cherry Valley, the quarries are pits dug all over the hill sides and at various times of the year these pits, depending on size can be hard to find and harder yet to photograph. For further research, I would like personally to be involved with the Mount Merino and Little Falls quarry search, as well as exploring more the old Snake Hill quarry that I did find but found no literature on.

Due to time constraints, many of the topics that I wanted to develop in this paper just couldn't feasibly be incorporated and remain to be done by future researchers. Of those topics not explored was workability. This is really an area that will almost have to be left to those individuals such as Al Kronius, Paul Trotta, Mike Tarbell and others that have blazed the trail creating a resurgence of flintknapping. It is these individuals with years of experience that we should turn to for creation of a scale of workability. What should the scale look like? What factors should concern us? How should we describe texture or luster? Flintknappers use among other terms, sugary as a textural term, should a lexicon of textural terms be explored and defined so that a universal language develops. Heat treating is another issue; Lavin compiled a chart showing the results of her heating treating of various lithic materials (1983) but many flintknappers feel that New York cherts are particularly unresponsive to heat treating (personal communication), more work could be done in this area. Another area practicing flintknappers to comment on with regard to workability is tool use. What tools work best with which lithic material?

An interesting question that arose during the research was why there appears to be so little Esopus found in the archaeological record from sites in the Susquehanna valley? The Esopus quarry near Cherry Valley yields a very high quality stone tool material. As one novice flintknapper discovered, with Esopus, he was readily able to knock off 3-4 inch spalls, larger than with any other New York chert he had tried. Kronimus, along with his own collecting, has several collections of projectile points that he has purchased from people in the Goodyear Lake area and in these the vast majority of the points are Esopus. He readily points out that these collections may just be personal preferences of the collection maker and not representative of the points found in the Goodyear Lake area. However it does show us that in some locations Esopus points were abundant, we just aren't seeing those numbers in the published literature. Have we just not explored those areas sufficiently, after all, the Susquehanna River provides

easy access to the present-day Cooperstown area and it is just a short hike from there to Cherry Valley. If the quality is so great, why don't we find more tools made of that material in the archaeological record?

The last topic to explore for future work is really one in which much work has already been done. The purpose of this research was to make a comparative study of lithic materials. At the beginning of this project, I had, very unscientifically, and predominantly based on communication with flintknapper friends, decided that early people in the Susquehanna Valley area had used the glacial till to supply themselves with the lithic material needed for tool making. In some senses that was based on the idea that humans prehistoric or modern will seek the easiest, fastest way to do anything. Hence, why trudge miles out of your way to sweat and slave, quarrying stone material when you can just go to the nearest river or creek and pull the necessary cobbles from the streambed?

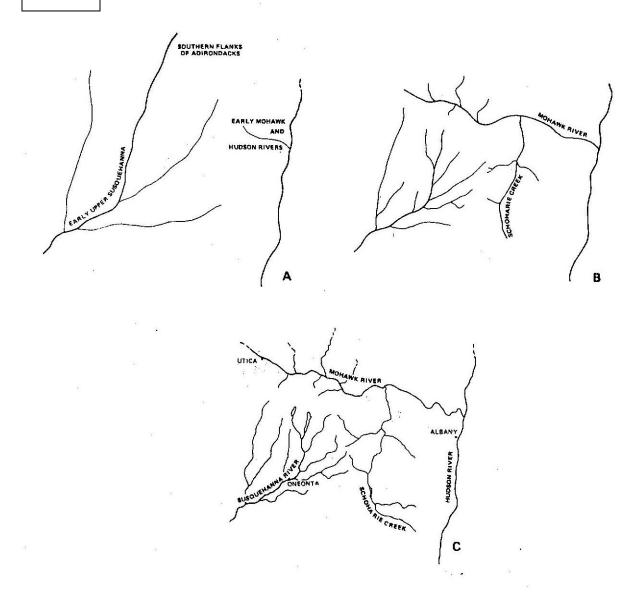
On more than one occasion, I traveled in the company of Al Kronimus, to a number of creeks—Cobleskill, Stoney, Schoharie and Fox—and each time came away with several five gallon buckets of excellent, knapable, lithic material. The only sweat I broke was carrying the buckets to the truck. Indians and knappers have never really needed to know the name of the material they were knapping, they just needed to be able to recognize material that was quality material for knapping. And here is the rub, the most dominant lithic material in the archaeological record—Onondaga Chert—is really the least positively identifiable chert in the cobble assemblages. We easily identified Mount Merino, and Esopus and there was always a large amount of knapable, black, siliceous, chert that we called Onondaga in the form of large workable cobbles. However, there was always a question mark behind the name we applied to the material, not its workability, but its specific name. Bartholomew speculates that most likely the glaciers have removed a large portion of the Onondaga chert-bearing strata from the upper end of the Susquehanna and Schoharie valleys and redeposited them as till. Part of our future work should therefore entail collecting cobble from these stream beds and with the help of thin sections connect the till material with known chert outcrops.

At present, an extensive amount of work has been done by geologists such as Dr. P.J. Fleisher (1977) of SUNY, Oneonta in the area of Pleistocene geology. The numerous drumlin fields have been mapped so that at least the progress of the last Wisconsonian glacial lobes can be mapped. Glacial moraines and lakes have been mapped throughout the Susquehanna Valley. The course of the early Susquehanna and Mohawk rivers has been mapped and we now have a very good idea where the chert bearing formations of New York can be found. Combining all this information into one easily read compendium would be a marvelous tool for archaeologists as well as student geologists.

As I walked the Schoharie Creek stream bed, I couldn't help but wonder if this wasn't the major source of Onondaga Chert in the Schoharie and Susquehanna River Valleys. As the pictures show (page 72), one can see the massive blocks of chert being eroded out of the surrounding bed rock. Fleisher states that the valley of Schenevus Creek and Charlotte Valley are similar in some respects. They both have northeasterly trends, both have oversteepened valley walls and truncated spurs and both head in ice scoured uplands along the Schoharie-Susquehanna drainage divide. Tributaries that join Schenevus Creek were enlarged because they paralleled the path of the ice flows.

Fleisher's drawings show that the ancestral Susquehanna drained a much larger area starting at the flanks of the Adirondack Mountains, far above the Mohawk River (map page 90). Fleisher also shows that ablation till and stratified drift clogged the valley floors of the Susquehanna to a depth of 200 feet. As measured through well cores, the bedrock floor between Oneonta and Wells Bridge is about 400 feet below the flood plain (Fleisher 1977:10, 78). With that much glacial till present it is hard to imagine that it does not represent a constant source of tool material. Each flood season would reveal a new bounty of material.

Figure 9



To discover the path of the last stage of glaciations, one need only examine the drumlin maps and you can readily see that the drumlins hint at three lobes (map page 104) of the glacier approached the present-day head of the Susquehanna and Schoharie River Valleys. These three lobes either followed the existing river valleys or accumulated in such a way that as the three lobes converged they rode over the top of the Helderberg escarpment. In either case, as the topography of the Susquehanna and Schoharie valleys show, abundant material was worn away and redeposited as till.

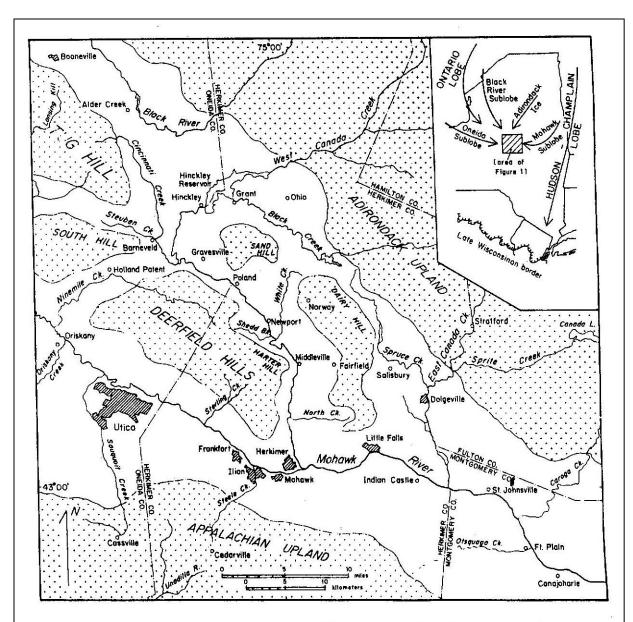


Figure 1. -- Location map of the West Canada Creek Valley and surrounding regions. Upland areas are patterned. This map serves as a base map for Figures 8, 9 and 11 thru 13. Inset map shows general flow direction of glacial lobes and sublobes that affected the region during Late Wisconsinan time and the maximum extent of Late Wisconsinan glaciation.

Here are some closing thoughts about New York cherts from knapper Paul Trotta. "I think New York cherts in general tend to be quite tough. If you talk to other flintknappers from Texas, Missouri, etc., places where they have easy access to really high quality chert, hand the

Texas knapper a piece of New York cherts and they're going to say you want to throw that stuff over the side!"

For one thing on the lithic hardness scale, New York cherts show up very hard and as you go to other parts of the country every knapper would agree they have better quality material, materials that are closer to glass, ultra high silica content, it can be heat treated to even further affect the crystalline structure to get more glass-like. New York cherts generally don't heat treat, particularly the darker varieties; so you can't even improve the knapability of it very effectively by heat treating. Looked at from the perspective of cherts across the continental United States our cherts are a lower grade of chert."

"However, if you were an aboriginal person, prior to establishing a sense of trade, that's all you had so you had to use it, they used it and they used it effectively enough to wrest a living from the land. Did they make real artsy projectile points and other tools? No! Some of the earliest tools, like Clovis points, like those found at the Lamb site, were nicely made Clovis points but even those were not exceptionally well made Clovis points as opposed to something made from obsidian or jasper. As a twentieth century knapper, if you value your tendons in your wrist and elbow, what you want to do is get the best material so you kind of look down your nose at New York chert."

In closing, I would have to agree with Jack Holland in that many of the New York cherts are identifiable by color, texture or patination and this identification process get easier the more you work with chert. If you work with cherts, being able to identify the fossils indicative to either the chert or the formation is of immense value. Some of the cherts such as Kalkberg and Moorehouse still elude my ability to easily recognize them in the cobble form. There are variations in color that will make it difficult to identify, Becraft from Kalkberg if that Kalkberg is derived from ash, both will have a very light gray-blue color; even some Edgecliff might elude identification if it is not attached to some bedrock. If a definitive identification is to be made, and if I were to continue this research, I would recommend that an effort be made to make thin sections of each sample that has been definitively identified and connected to an outcrop.

### **Conclusion:**

In conclusion, I humbly join those that have gone before me—Wray, Hammer, Lavin, Holland, Fugelman and others—who began this research before me. Some, like Holland, have devoted years towards better understanding of cherts, their characteristics, their locations, and their many varied appearances. Each of these researchers came to the realization that the task was much more monumental than originally supposed. They each realized that in the end more people had to become involved in the task and that to truly understand chert, there had to be a collaborative effort on the part of a number of disciplines, particularly, geologists, geoarchaeologists, archaeologists, anthropologists, experimental archaeologists and flintknappers.

In the end, with the help of Jack Holland, I was able to begin locating chert sources in the research area, but more importantly identify the cherts themselves. Even though Holland's information was extremely accurate, I still needed the help of Dr. Alex Bartholomew to help me identify the chert bearing formations in more complex areas like Cherry Valley. Much of the literature, although enlightening in characteristic details, still lacked exactitude when it came to location. Even famous quarries were/are difficult to locate because of the deliberate and necessary effort by investigators to maintain the integrity of those sites, to hopefully prevent wholesale destruction of them and preserve the sites for future researchers. Many quarries are rumored to exist but there seems to be a decided lack of firm evidence.

The research took an immense amount of time; because of the difficulty in finding the cherts, quite often multiple trips were made to the same research areas. In some cases, it was necessary to eventually seek out the help of trained professionals who knew how to interpret the stratigraphy of a particular area. In that regard, there are a few areas that will have to be revisited because the researcher has still been unable to gain all the data needed to complete the research desires. Some of the difficulty in finding the cherts, along with the deliberate obfuscation was the problem of urban sprawl since the last recorded collection effort and the problem of vegetation that has grown up in areas that are no longer in constant use by farmers, town highway departments or quarry operators. I was fortunate that David Moyer and his team of archaeologists were willing to "hunt" for chert sources at the end of a hard days work. I owe much of the success of this paper to him.

This research as it expanded showed a need for more synthesis of information. Since the project focused on lithic procurement in the Susquehanna Valley, a need to know what lithic material was used became apparent. Chert-bearing outcrops in the Oneonta to Binghamton stretch are few in number yet maps show numerous archaeological sites in the same region, see map pages 98-99. The supposition was that early people were using glacial till as their lithic tool source. Numerous stream beds were searched in the company of local knapper Al Kronimus and massive quantities of workable chert were found; some easily identifiable by their texture, color, or patination. Others acquired a vaguer description, such as Onondaga or Helderberg.

To truly derive the projects full potential, a comparative study of regional lithics needed to be constructed. Lithic material—the chert—needed to be found in situ so that till material

could be compared to it. This opened a need to research the most recent glacial period. In which direction had the various lobes of the glaciers approached and in which direction had they proceeded? What did the stratigraphy look like in those regions before the glaciers so drastically altered the appearance of the environment? In other words, what cherts could we reasonably expect to see in the research universe?

Thanks to Dr. P. J. Fleishers work on glaciations in the central New York area, the preglacial streams had been mapped showing the paths that glaciers might have taken. New York State geologic maps show what the bedrock geology looks like today. Consulting maps showing the placement of drumlins and tracing the existing preglacial streams gives us an idea of what lithic material is available and whether we could reasonably assume it might have found its way into the Susquehanna or Schoharie Valleys.

To confirm the research hypotheses, the archaeological site data was researched.

Because of his work in the Susquehanna Valley, Funks data was examined closely to determine what lithic material was present in the artifact assemblages. "Onondaga" was by far the most common lithic material used although Esopus, Normanskill, West Onondaga and others—often referred to as exotics—were present. When Esopus was identified it often was accompanied by a question mark leading to the supposition that it might be difficult to identify it when it appears in the archaeologic record.

As research progressed it was "discovered" that there was a abundant number of geologic field trip guides available. Each guide book is relevant to a particular geologic question; very seldom was that question related to chert. However, regardless of the intent of the trip, most often a stratigraphic record was present affirming the possibility of chert in the

area of the tour. There remains a real need to catalogue the information provided in the guidebooks. For the few bits of very valuable information gleaned, hours of patient searching was needed.

The scope of the initial project was realistic, but the need to acquire additional information with respect to geology, paleontology, archaeological records, glacial surveys and numerous repeated trips to locations expanded the scope of the research such that a line had to be drawn. This opens the door to future research in the areas of workability, patination, collection expansion and thin section analysis.

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# Appendix A: Fossils

All fossil sketches (Dunn and Rickard 1961:C10-C19)



Photo A1: Edgecliff, State Highway 166, north of Cherry Valley, IMG\_4645, rugose coral



Photo A2: Edgecliff, State Highway 166, north of Cherry Valley, rugose coral



d. Tentaculites gyracanthus, ×3.
e. "Orthoceras" (Anastomoceras) rudis, ×34.

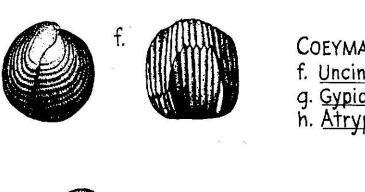
Figure A1



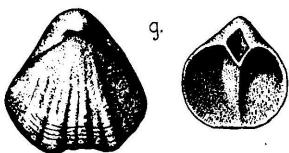
Photo A3: Coeymans Fossils, Rt 32, north of Cherry Valley, IMG\_4614



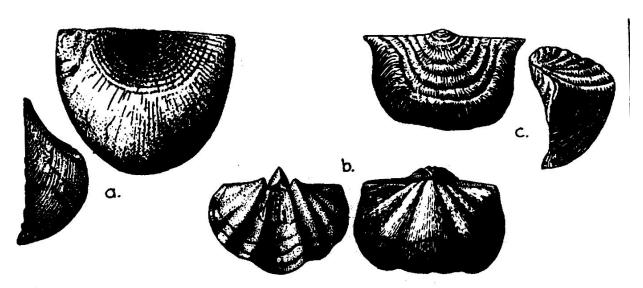
Photo A4: Coeymans Fossils, Route 2, north of Cherry Valley, IMG\_4616



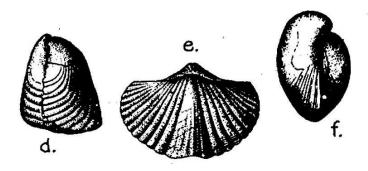
COEYMANS LIMESTONE FOSSILS: f. Uncinulus mutabilis, × 11/8. g. Gypidula coeymanensis, × 11/8. h. Atrypa reticularis, × 11/8.







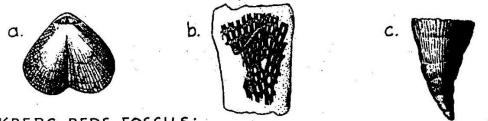
NEW Scotland Beds fossils: a. <u>Strophonella leavenworthana</u>, x 1 %. b. "S"(<u>Eospirifer</u>) <u>macropleura</u>, x 34. c. <u>Leptaena rhomboidalis</u>, x 34.



BECRAFT LIMESTONE FOSSILS:
d. <u>Uncinulus campbellanus</u>, ×1%.
e. "<u>Spirifer</u>" <u>concinnus</u>, ×1%.
f. <u>Gypidula pseudogaleata</u>, ×1%.



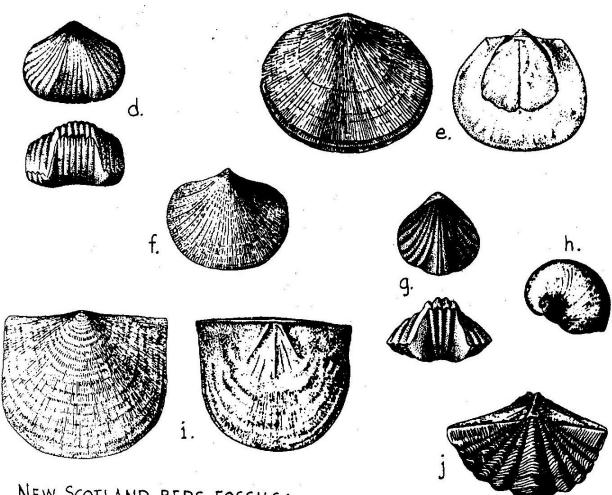
Photo A5: Becraft Fossils, Rickard Hill Road, Schoharie, IMG\_4654



- KALKBERG BEDS FOSSILS:
- a. <u>Bilobites varicus</u>, × 3. b. <u>Fenestrella compressa</u>, × 1½. c. <u>Streptelasma</u> (<u>Enterolasma</u>) <u>strictum</u>, × 1½.

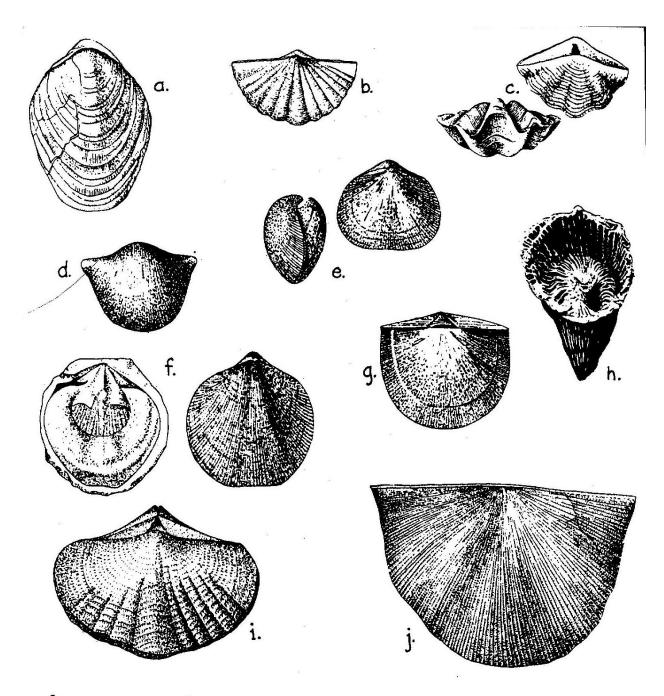


Photo A6: Kalkberg, altered by ash deposition, note fossils, US 20, north of Cherry Valley, IMG\_4617



NEW SCOTLAND BEDS FOSSILS:

d. Uncinulus abruptus, × 1%. e. Rhipidomella oblata, × 1%, × 1½. f. Isorthis perelegans, × 1%. g. Stenoschisma formosum, × 1%. h. Platyceras ventricosm, × 1½. i. Leptostrophia becki, × 1%, × ¾. j. "5" perlamellosus, × 1%.



SCHOHARIE AND ONONDAGA LIMESTONE FOSSILS:

a. Amphigenia elongata, x 34. b. "Spirifer" duodenarius, x 14.

c. "Spirifer" raricosta, x14. d. Chonetes hemisphericus, x14.

e. Schizophoria propinqua, ×14. f. Atrypa impressa, ×14. g. Schuchertella pandora, ×14. h. Zaphrentis prolifica, ×34.

i. Elytha fimbriata, ×1/2. j. Strophonella ampla, ×1/4.



Photo A7: Oriskany, Terrace Mountain, dark color with fossils

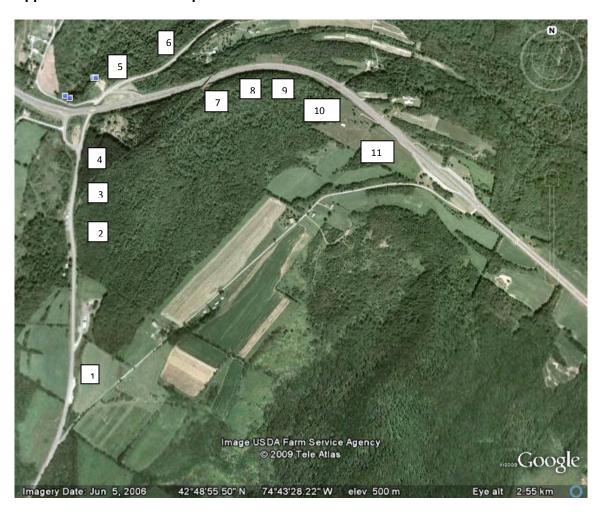


Photo A8: Esopus, US 20, north of Cherry Valley, IMG\_4630, fossil upper right corner



Photo A9: Esopus Fossils, US 20, Funk quarry site, IMG4701

**Appendix B: Reference Maps** 



Map B1: Map of Cherry Valley collection area:

County Highway 166 runs north-south on left edge of map

US 20 runs east-west across top half of map

County Route 54 runs diagonally, northeast-southwest across the map connecting 166 with 20

North of US 20, State Highway 166 continues as County Route 32

Location 1: Nedrow and Moorehouse

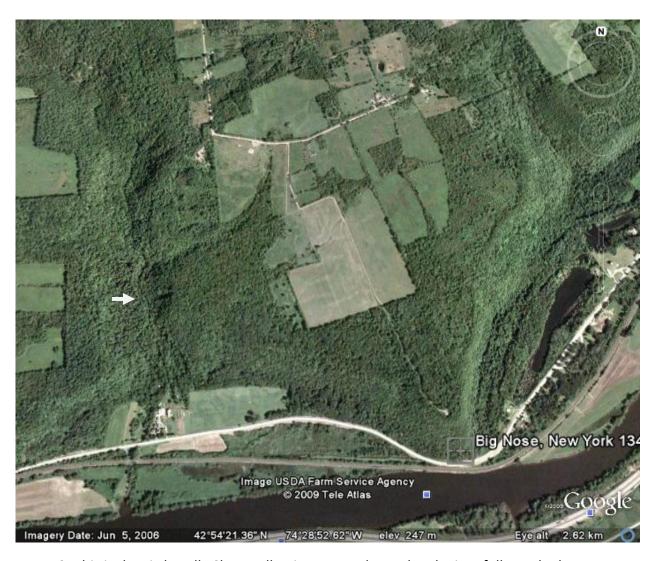
Location 2: Edgecliff Location 3: Esopus Location 4: Kalkberg Location 5: Coeymans Location 6: Manlius Location 7: Kalkberg Location 8: Esopus

Location 9: Carlisle Center

Location 10: Edgecliff and Carlisle Center Location 11: Moorehouse and Nedrow

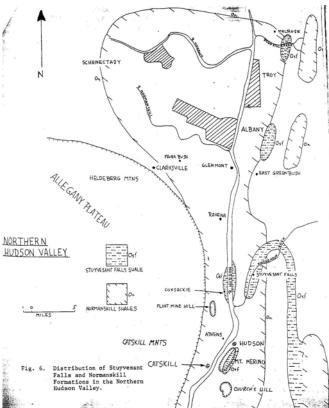


Map B2: Mount Merino Chert can be found just north of the Cedar Bluffs area and by following Mill Creek to the east. Snake Hill Chert quarry sites can be found along Fitch Road. Access is very limited for both areas.



Map B3: This is the Little Falls Chert collection area. The Mohawk River follows the bottom edge of the photo, paralleling the river is US 5. The Knauderack Creek (marked by the white arrow) runs along the left third of the map, Big Nose is marked on the right side of the map. It is said that there is a quarry on Big Nose that can be reached by following a tributary of the Knauderack Creek that has its source on Big Nose.





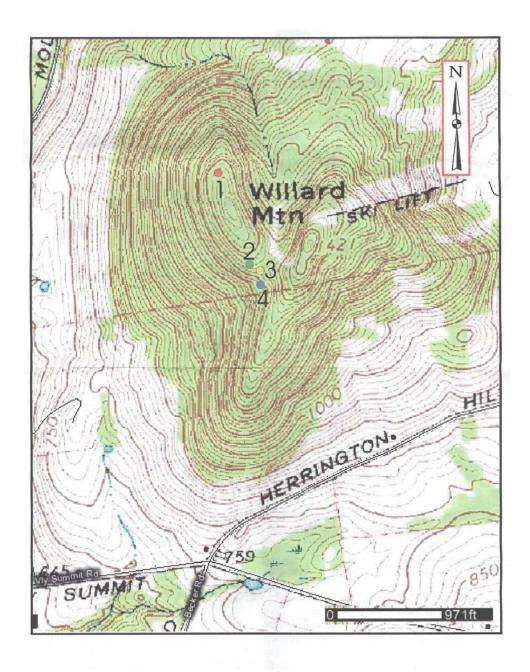
Map B4: Deepkill and Normskill Formations located in the area of Coxsackie, Mount Merino, Willard Mountain and West Athens Hill. Bottom map (Hammer 1976:50).



Map B5: Just to the right of Schoharie is a large quarry, leading out of the quarry area is Rickard Hill Road. The Becraft Chert and fossils (site marked by a white cross) were collected at this site. Oriskany and Edgecliff can be found on Terrace Mountain located in the upper left hand corner of the map.



Map B6: Just to the left of Middleburgh, located in the lower right hand corner, is the Schoharie Creek. Where State Route 145 touches the river (site marked by white cross), large cobbles of "Onondaga" were collected and Moorehouse Chert was found to be eroding out of the limestone.



 $Location\ of\ chert\ sample\ \ collections\ by\ Doug\ Idleman\ on\ 06/20/09\ at\ Willard\ Mountain\ Town\ of\ Easton,\ New\ York.$ 

## Map B7:

#### **Appendix C: Compositional Analysis**

As discussed throughout this paper, the primary purpose of lithic raw-material identification is to determine the source location of the stone material used in tool manufacture. Throughout the paper I have focused on macroscopic techniques but by now it should be evident to the reader that because of the great variation of material even within a source area, researchers should continue to develop geochemical avenues of exploration.

Stone is composed of elements classified into one of three groups: 1) major elements (those that make up 2% or more of the sample); 2) minor elements (from 2% to 0.1% of the sample); and 3) trace elements (those in concentrations less than 0.1%). The geochemical techniques focus on the trace elements to determine provenience. Geochemical analysis does not determine chemical compounds or minerals, nor does it discuss texture, color or fossil content. It merely focuses on trace element variation. If mineral content is to be determined petrographic analysis should be done through the use of thin sections. Thin sections, thin slivers of rock less than 1 mm in thickness are scanned using a polarized microscope to determine mineral content and rock texture. All geochemical techniques measure the radiation emitted or absorbed by atoms when the nucleons or electrons move between various energy levels. By studying the radiation levels researchers can determine the number of the atoms involved and therefore the elements present in the sample (Andrefsky 2005:42-43).

Andrefsky (2005:44-45) outlines the pros and cons of several (6) geochemical analysis methods: x-ray fluorescence spectrometry (XRF), particle induced X-ray emission analysis (PIXIE), electron microprobe analysis (EMPA), instrumental neutron activation analysis (INAA), inductively coupledplasma emission spectroscopy (ICP), and atomic absorption spectroscopy (AAS).

- •X-ray fluorescence spectrometry penetrates the sample to a depth of about 200  $\mu m$  so primarily evaluates only the surface of the sample. Differences in surface characteristic can cause problems in measuring the intensity of different wavelengths. Using this method eliminates the need to crush artifacts but the surface characteristics or weathering may influence the results of the analysis.
- Particle induced X-ray emission analysis is similar to XRF producing the same kind of electron excitement and emission. The major difference is that the particle beam can be focused on a small area of the sample rather than the whole sample as with XRF. The disadvantage of PIXIE is that is it much more expensive than XRF. In addition to cost, to examine a sample with PIXIE the sample must be highly polished.
- •Electron microprobe analysis is currently the most popular method of elemental analysis. The main advantage of this technique is that it can examine a single crystal without destroying its

relationship with the texture of the rock. The samples are scanned with a focused electron beam which causes the mineral to emit secondary X-rays. This technique works best with homogeneous materials such as cherts and obsidians.

- •Instrumental neutron activation analysis requires irradiation of a sample in a nuclear reactor by a prolonged neutron bombardment. Some elements with undergo nuclear reaction to produce radioactive isotopes. The amount of gamma photons produced when isotopes decay is proportional to their concentration. This technique requires only small samples but an entire artifact can be scanned if necessary. Over 50 elements can be identified with this technique making it an ideal method to use when inter-formational cherts need to be identified.
- •Inductively coupled plasma emission spectroscopy requires that a solution of the sample be heated until it becomes a plasma flame at 6000° C. To do this, the solution must be injected into a stream of argon and heated with a radio frequency coil. The emission spectrum is analyzed to determine the elements present and their relative concentrations. ICP is believed to be more effective in determining the provenience of silicates than XRF.
- •Atomic absorption spectroscopy is another flame type analysis. The sample is crushed and sprayed into a flame causing the compounds in the sample to dissociate into their constituent atoms. Light of the characteristic wavelength for the element is shone through the flame, the atoms of the element absorb the light, and the total amount of light absorbed is calculated to determine concentrations of each element.

Various researchers discussed in this paper used geochemical methods to better determine the provenience of silicas in their research areas. A local researcher, Kenneth Sliviak of Hartwick used X-ray diffraction (XRD) to detect variations between Helderberg and Onondaga samples. Samples were ground to a fine powder and then placed in the XRD. Five runs were made for each chert type. Sliviak determined that slight structural differences between the Helderberg and Onondaga chert could be detected with this method. Future researchers may be able to use this method conducting tests on each of the different Onondaga and Helderberg facies.

Kuhn and Lanford (1987:57-69) took chert samples from the New York State Museum and the University at Albany, SUNY, Department of Anthropology collections to conduct their trace element analysis using X-ray fluorescence as their method. Three regional samples were defined.

 Helderberg-Kalkberg collected from Catskill, New York, represents western Hudson Valley Helderberg chert resources

- 2. Normanskill- Stuyvesant Falls and Normanskill cherts collected from outcrops at Flint Mine Hill, West Athens Hill, Deepkill Creek, Sleepy Hollow Lake, Mt. Merino, and Church's Hill, represents middle Hudson Valley Normanskill chert resources
- 3. Beekmantown- Fort Ann and Ticonderoga/Whitehall cherts collected from outcrops near Fort Ann and Smiths Basin, New York, represents upper Hudson Valley chert resources

X-ray induced X-ray fluorescence was used to measure the trace element content of each specimen. The radioisotope cadmium 109 was used to excite the samples because this source gave good elemental sensitivity to elements from iron through zirconium, this group containing the elements important to the study. The X-ray induced fluorescent analysis technique was used because it allowed for easy measurements, required no sample preparation other than cleaning of the specimen, and it was nondestructive of samples.

The results of the analysis suggested that the system developed may be useful for raw material identification of chert artifacts. After compiling their data, the researchers stated that using this method, they expected to be 90% accurate over time. For future research Kuhn and Lanford desired a larger sample size from outcrops representing the Normanskill, Helderberg, and Beekmantown groups. At this point, the classification functions presented would incorrectly identify Little Falls, Beekmantown, Onondaga, or exotic cherts as either Helderberg, Normanskill, or Beekmantown. To use this system, Onondaga, Little Falls and exotic cherts from outside the state would have to be identified using traditional macroscopic techniques.

Hugh Jarvis met with success in his study of western Onondaga chert using neutron activation analysis (INAA) and a systematic sampling strategy. Jarvis' research first characterized the geological material of his research area and used the data to "source" archaeological material from prehistoric sites (Jarvis 1988:1). The results of his research are positive. They indicate that it is possible to characterize Onondaga chert outcrops based on a facies shift that is well represented in the relative levels of bromine, chlorine, and sodium. Jarvis and Luedtke agree that the intra-outcrop variation in chert is apt to be greater than interoutcrop variation, but with increased distance between sample locations, the chances of accurate characterization are much improved (Jarvis 1988:50).

Macroscopic analysis was conducted by Wray in 1948 and by Donald Prothero in 1983. It is possible that Wray's slides may still be available through the University of Rochester, Rochester New York, Dr. Harold L. Alling, head of the Department of Geology at the university was heavily involved with the petrographic analysis. Prothero's slides may be available through the Department of Anthropology at New York University.

## **Appendix D: Rock Photos**



Photo D1: Becraft, Rickard Hill Road, Schoharie, IMG\_4648



Photo D2: Deepkill, (bag 16), southeast corner of Mount Merino, IMG\_4477, fresh surface and brownish patination



Photo D3: Edgecliff, State Highway 166, north of Cherry Valley, IMG\_4644, light gray



Photo D4: Edgecliff, US 20, north of Cherry Valley, IMG\_4658



Photo D5: Edgecliff, US 20, north of Cherry Valley, IMG\_4670, white color



Photo D6: Edgecliff, US 20, north of Cherry Valley, IMG\_4675, blue-gray



Photo D7: Edgecliff, Terrace Mountain, IMG\_4677, pink



Photo D8: Edgecliff, Terrace Mountain, IMG\_4680, white to light-medium gray, with white patination



Photo D9: Esopus (bag 6A), Cherry Valley US 20, IMG\_4483



Photo D10: Esopus, (bag 9), Cherry Valley, US 20, IMG\_4512, high silica content, pyrite and quartz present



Photo D11: Esopus, (bag 6B), Cherry Valley, West Creek, IMG\_4534, white patination



Photo D12: Esopus, (bag 6B), Cherry Valley, West Creek site, IMG\_4536, darker Esopus with white patination



Photo D13: Esopus, US 20, Funk quarry site, IMG\_4700, fresh and patinated surfaces



Photo D13A: Banded or Ribbon Chert, Nethers Type, Jefferson County, Flint Ridge, Ohio, IMG\_4771, not as translucent as other chert varieties found in this region, has areas of red, orange, light blue, etc.

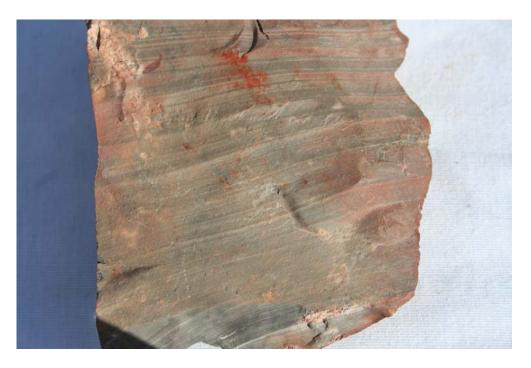


Photo D13B: Banded Chert, Nethers Variety, Jefferson County, Ohio, IMG\_4777



Photo D13C: Red variety of Nethers Chert, Jefferson County, Ohio, IMG\_4780



Photo D13D: Flintridge Chalcedony, Licking County, Ohio, IMG\_4792, usually a milky white but can vary to light blue or yellow



Photo D13F: Flintridge Chert, Licking County, Ohio, IMG\_4796, bluish white to yellow with quartz veining



Photo D14: Kalkberg, (bag 21), Leesville, NY, US 20, IMG\_4505, fresh surface, note fracture planes



Photo D15: Kalkberg, (bag 8), North of Cherry Valley, US 20 at RR overpass, IMG\_4526, lighter color due to ash



Photo D16: Kalkberg, (bag 6B), Cherry Valley, Funk quarry site (valley), IMG\_4530, striated variety



Photo D17: Kalkberg, (bag 6B), northeast of Cherry Valley, West Creek site, IMG\_4532



Photo D18: Kalkberg, (bag 8), north of Cherry Valley, US 20 at RR overpass, IMG\_4529, light bluish grey color



Photo D19: Kalkberg, (bag 12), I-88 between Cobleskill and Schoharie, IMG\_4558, light grey color



Photo D20: Little Falls Chert (Bag 19) top of Big Nose near quarry IMG\_4409, sugary texture



Photo D21: Little Falls Chert (bag 19) top of Big Nose, showing white patination, IMG\_4413, sugary texture



Photo D22: Little Falls Chert, (bag 13A) Knauderack Creek, IMG\_4438, fresh surface with dentritic feature and patinated surface



Photo D23: Little Falls Chert (bag 13B) Knauderack Creek, IMG\_4442, fresh surface pale green coloring



Photo D24: Little Falls Chert (?), (bag 13B) Knauderack Creek, IMG\_4446, mottled tan and brown banding



Photo D25: Little Falls Chert, (bag 13B) Knauderack Creek, IMG\_4448, banded chert



Photo D26: Moorehouse, State Route 166, north of Cherry Valley, IMG\_4662



Photo D27: Moorehouse, State Route 166, north of Cherry Valley, IMG\_4663



Photo D28: Mount Merino (bag 1), northeast shore of Saratoga Lake, IMG\_4427, fresh surface and highly polished patinated surface



Photo D29: Mount Merino, (bag 1), northeast end of Saratoga Lake, IMG\_4433, patinated cobble, patinated artifact



Photo D30A: Nedrow, (bag 5), Syracuse US 11 and I-88, sample taken from quarry located behind diner. Sample donated by Mike Tarbell; he has removed a number of spalls from this core. Notice the brown to brownish-green patination. IMG\_4835



Photo D30: Normanskill, (bag 15) Willard Mountain, IMG\_4468, fresh surface with white patination



Photo D31: Normanskill, (bag 15) Willard Mountain, IMG\_4472, banding and darker patination



Photo D32: Normanskill, (bag 14), Flintmine Hill, location 1, IMG\_4487, fresh surface



Photo D33: Normanskill, (bag 14A), Flintmine Hill (location 1), IMG\_4490, fresh and patinated surfaces



Photo D34: Normanskill, (bag 14B), Flintmine Hill, location 2, IMG\_4543, fresh and patinated surfaces



Photo D35: Normanskill, (bag 14B), Flintmine Hill, location 2, IMG\_4547, fresh and patinated surfaces



Photo D36: Normanskill, West Athens Hill, IMG\_4712, green



Photo D37: Normanskill, West Athens Hill, IMG\_4718, green with black streaks



Photo D38: Normanskill, West Athens Hill, IMG\_4728, green with brown patination



Photo D39: Normanskill, West Athens Hill, IMG\_4725, green with black "dendritic" pattern



Photo D40: Snake Hill (bag 2) quarry site 1, fresh surface and patinated surface of cobbles, IMG\_4415, northeast of Saratoga Lake



Photo D41: Snake Hill, (bag 3), northeast of Saratoga Lake, quarry site 2, IMG\_4453, fresh surface and white patination



Photo D42: Snake Hill, (bag 3), northeast of Saratoga Lake, quarry site 2, IMG\_4461, oily sheen, fresh surface



Photo D43: Cobben, southern Illinois, IMG\_4802, note the thick cortex, very homogenous texture



Photo D44: A variety of chert, IMG\_4807, from Georgetown, Texas chalk formation, known as the only true American Flint



Photo D45: Novaculite, from Magnet Cove, Arkansas, heat treated, used as a whetstone today, known as porcelain novaculite, used by early people to knap tools.



Photo D46: Oklahoma Fusilinid Chert, Cay County, Oklahoma, heated treated but is close to real color



Photo D47: Petrified Wood, ironized, from Rainy Buttes, South Dakota, not heat treated

## Appendix E

## Glossary

Argillaceous-Applied to all rocks or substances composed of clay minerals, or having a notable proportion of clay in their composition, as shale, slate, etc. Argillaceous rocks are readily distinguished by the peculiar "earthy" odor when breathed on.

Bedrock-1. The solid rock underlying auriferous gravel, sand, clay, etc., and upon which the the alluvial gold rests. 2. Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

Bentonite- A sedimentary rock formed from the alteration in place of volcanic ash. Largely composed of the clay mineral montmorillonite.

Brachiopods- A phylum of marine, shelled animals with two unequal shells or valves each of which normally is bilaterally symmetrical.

Carbonaceous- The carbonaceous sediments include original organic tissues and subsequently produced derivatives of which the composition is chemically organic.

Chalcedony- Cryptocrystalline quartz and much chert, commonly microscopically fibrous. The material of agate.

Chert- Mineral: A cryptocrystalline variety of quartz. Composed of interlocking grains generally not discernible under the microscope. Rock: A compact siliceous rock of varying color composed of microorganisms or precipitated silica grains. Occurs as nodules, lenses, or layers in limestone and shales.

Chertification- Essentially silicification, especially by fine-grained quartz or chalcedony, used mainly in the descriptions of the Mississippi Valley lead-zinc deposits.

Clastic rock- A consolidated sedimentary rock composed of the cemented fragments broken from preexisting rocks of any origin by chemical or mechanical weathering; e.g. conglomerate, sandstone, shale.

Concoidal- A type of rock or mineral fracture giving smoothly curved surfaces. Characteristic of quartz and obsidian.

Cryptocrystalline- The texture of a rock or ;mineral consisting of crystals that are too small to be recognized and easily distinguished under the light microscope.

Dendrite- A branching figure resembling a shrub or tree, produced on or in a mineral or rock by the crystallization of a foreign mineral, usually an oxide of manganese, s in the moss agate.

Dolostone- A tem proposed for a sedimentary rock composed of fragmental, concretionary, or precipitated dolomite of organic or inorganic origin.

Escarpment- A steep face terminating high lands abruptly. The steep face frequently presented by the abrupt termination of stratified rocks.

Eugeosyclinal- A geosynclines in which volcanism is associated with clastic sedimentation. A volcanic part of an orthogeosyncline, located away from the craton.

Flint- A dense fine-grained form of silica which is very tough and breaks with a conchoidal fracture and cutting edges. Of various colors, white, yellow, gray, and black.

Fracture- The manner of breaking and appearance of a mineral when broken, which is distinctive for certain minerals, as conchoidal fracture.

Gastropods- A member of the phylum Mollusca, class Gastropoda; usually with a calcareous exoskeleton or shell, which is asymmetrically coiled and without internal chambers or partitions.

Glauconite- A green mineral, closely related to the micas and essentially a hydrous potassium iron silicate. Commonly occurs in sedimentary rocks of marine origin.

Graben- A block, generally long compared to its width, that has been downthrown along faults relative to the rocks on either side.

Graptolite- Extinct colonial organism that produced chitinous enclosing and supporting structures; generally considered to be related to primitive chordates; one of the Graptolithina.

Hardness- Resistance to scratching or abrasion.

Horse- A large block of displaced wall rock caught along a fault, particularly a high-angle normal fault.

Inclusion- A crystal or fragment of another substance or a minute cavity filled with gas or liquid enclosed in a crystal.

Index fossil- 1. A fossil characteristic of an assemblage zone and so far as is known restricted to it. 2. A fossil, the name of which designates a biostratigraphic zone.

Index of refraction- Acharacterizing number which expresses the ratio of the velocity of light in vacuo to the velocity of light in the substance.

Indurated- Rendered hard; confined in geological use to masses hardened by heat, baked, etc., as distinguished from hard or compact in natural structure.

Jasper-Red, brown, green, impure, slightly translucent cryptocrystalline quartz with a dull fracture, abundant enough on Lake Superior and elsewhere to be a rock.

Limestone- A bedded sedimentary deposit consisting chiefly of calcium carbonate (CaCO<sub>3</sub>), which yields lime when burned.

Lithification- That complex of processes that converts a newly deposited sediment into an indurated rock. It may occur shortly after deposition—may even be concurrent with it—or it may occur long after deposition.

Lithology- The physical character of a rock, generally as determined megascopically or with the aid of a low-power magnifier.

Luster- The character of the light reflected by minerals; it constitutes one of the means of distinguishing them.

Macrofossil- Fossils large enough to be studied without the aid of optical magnification.

Macroscopic/Megascopic- A term applied to observations made with the unaided eye, as opposed to microscopic, made with the aid of the microscope. (Megascopic preferred)

Marcasite-White iron pyrites. A mineral, FeS<sub>2</sub> the orthorhombic dimorph of pyrite.

Matrix- In a rock in which certain grains are much larger than the others, the grains of smaller size comprise the matrix.

Megascopic- A term applied to observations made with the unaided eye, as opposed to microscopic, made with the aid of the microscope.

Metamorphic – Includes all those rocks which have formed in the solid state in response to pronounced changes of temperature, pressure, and chemical environment, which take place, in general, below the shells of weathering and cementation.

Microcrystalline- Applied to a rock in which the individual crystals can only be seen as such under the microscope.

Microscopic- So small or fine as to be invisible or not clearly distinguished without the use of a microscope.

Nodular- Having the shape or composed of nodules—small more or less rounded bodies generally somewhat harder than the enclosing sediment or rock matrix.

Oolite- A spherical to ellipsoidal body, 0,25-2.0 mm. in diameter, which may or may not have a nucleus, and has concentric or radial structure or both. It is usually calcareous, but may be siliceous, hematitic, or of other composition.

Paleontology- The science that deals with the life of past geological ages. It is based on the study of the fossil remains of organisms.

Paleozoic- One of the eras of geologic time—that between the Precambrian and Mesozoic.

Patination- a surface coating formed by the process of weathering (Wray 1948:42)

Petrography- That branch of geology dealing with the description and systematic classification of rocks, esp. igneous and metamorphic rocks and esp. by means of microscopic examination of

thin sections. Petrography is more restricted in scope than petrology, which is concerned with the origin, occurrence, structure, and history of rocks.

Petrology- The branch of geology dealing with the origin, occurrence, structure, and history of rocks, esp. igneous and metamorphic rocks.

Petrology- The science of the study of rocks (Wray 1948:42).

Polarization- The modification of lights so that it vibrations re restricted to a single plane. Polarizing microscopes are used in the analysis of petrographic thin-sections.

Pre-Cambrian- All rocks formed before the Cambrian.

Quarry- An open or surface working, usually for the extraction of building stone,, as slate, limestone, etc.

Radiolarian-Subclass of the Sarcodina consisting of marine protozoans that possess complex internal siliceous skeletons.

Rhombohedron- A crystal form in the hexagonal system bounded by six faces of rhombic outline.

Rhombohedron- A crystal in the form of a rhomboid, common form of calcite (Wray 1948:42).

Shale- A laminated sediment in which the constituent particles are predominantly of the clay grade.

Silica- Silicon dioxide, SiO<sub>2</sub>.

Siliceous- Of or pertaining to silica; containing silica, or partaking of its nature. Containing abundant quartz.

Siliceous shale- Hard fine-grained rock of shaly structure generally believed to be shale altered by silicification.

Silicification- The introduction of or replacement by, silica. Generally the silica formed is fine-grained quartz, chalcedony, or opal, and may both fill up pores and replace existing mineral.

Spherulite- A small, radiating, and usually concentrically arranged aggregation of one or more minerals generally of spherical or spheroidal shape, formed by the radial growth of acicular crystals in a rigid glass about a common center or inclusion.

Spicule- Tiny siliceous or calcareous object, commonly needle-shaped or branched, contained in the tissues of certain invertebrate animals such as sponges.

Stratigraphy- That branch of geology which treats of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

Structural geology- Study of the structural (as opposed to the compositional) features of rocks, of the geographic distribution of the features and their causes.

Texture- Geometrical aspects of the component particles of a rock, including size, shape, and arrangement.

Thin section- A fragment of rock or mineral ground to paper thinness (usually 0.03 mm.), polished, and mounted between glasses as a microscopical slide.

Vitreous- 1. Having the luster of broken glass, quartz, calcite. 2. Having no crystalline structure; amorphous.

Vug- a cavity, often with a mineral lining of different composition from that of the surrounding rock.

Appendix F: Spreadsheet

Bag Number	Chert Name	Coordinates	Collection Site	Elevation
31	Becraft	N42°39.9395 W74°18.1667	Schoharie Rickard Hill Road	756
28	Carlisle Center	N42°49.363 W74°43.57	Cherry Valley US 20	1463
37	"Cobben"		Southern Illinois	
34	Coeymans	N42°49.352 W74°43.976	Cherry Valley County Route 32	1328
16	Deepkill	N42°13.5384 W73°49.3220	Mount Merino	277
	Edgecliff	N42°48.951 W74°44.179	Cherry Valley State Route 166	1431
26, 27	Edgecliff	N42°41.2682 W74°19.5287	Terrace Mountain	1326
9	Esopus	N42°49.360 W74°43.622	Cherry Valley US 20	1424
6A	Esopus	undisclosed	West Creek	1490
7, 40	Esopus	undisclosed	Funk Site	1560
36	Flintridge, Banded		Flintridge, Jefferson, Co.	
35	Flintridge,Chalcedony	N39°59.314 W82°15.665	Flintridge, Licking, Co.	1236
37	Georgetown		Georgetown,	

			Texas	
21	Kalkberg		Leesville	
29	Kalkberg	N42°49.136 W74°44.174	Cherry Valley State Route 166	1347
6B	Kalkberg	undisclosed	West Creek	1490
8, 18?	Kalkberg	N42°49.347 W74.43.685	Cherry Valley US 20	1413
11	Kalkberg		I-88	922
19	Little Falls	N42°54.0300 W74°28.4861	Big Nose	445
13A	Little Falls	N42°54.2930 W75°29.5063	Knauderack Creek	672
13B	Little Falls	N42°54.2930 W75°29.5063	Knauderack Creek	672
	Little Falls	N42°54.2930 W75°29.5063	Knauderack Creek	672
	Manlius	N42°49.511 W74°43.667	Cherry Valley	1280
23	Manlius		NYS Hwy 443	660
17	Manlius	N42°41.63 W74°21.07	I-88	922
32	Moorehouse	N42°48.620 W74°44.187	Cherry Valley State Route 166	1462
	Moorehouse	N42°49.299 W74°43.331	Cherry Valley US 20	1575
33	Moorehouse	N42°36.5942	Middleburgh	604

		W74°20.7744		
1	Mount Merino	N43°02.4157 W73°42.8513	Saratoga	203
4	Nedrow	N42°58 W76°08	Syracuse US 11 and I-88	533
5	Nedrow	N42°57 W76°05	Syracuse, behind diner	633
	Nedrow	N42°49.299 W74°43.331	Cherry Valley	1511
12	New Scotland	N42°67.972 W74°39270	I-88	910
14A	Normanskill	N42°19.9823 W73°49.7292	Flintmine Hill location 1	219
14B	Normanskill	N42°20.1135 W73°49.6488	Flintmine Hill location 2	174
39	Normanskill	N42°17.3377 W73°51.4777	West Athens Hill	250
15	Normanskill	N43°01.0706 W73°31.5390	Willard Mountain	1263
37	Novaculite		Magnet Cove, Arkansas	
37	Oklahoma Fusilinid		Cay County, Oklahoma	
41	"Onondaga"		Arrowhead Lane, Schoharie	
22	"Onondaga"		Schoolhouse Road, off 145 near	

		Schoharie	
Oriskany	N42°40.9788	Terrace	1133
	W74°19.1464	Mountain	
Oriskany	N42°49.360	Cherry Valley	1424
	W74°43.622	US 20	
Seneca	N42°49.2	Cherry Valley	1575
	W74°43.17	US 20	
Snake Hill, site 1	N43°02.6515	Saratoga	289
	W73°42.4891	Lake site 1	
Snake Hill, site 2	N43°03.0632	Saratoga	278
	W73°42.1354	Lake site 2	
Mixed Cobbles,		Stoney Creek	680
Stoney Creek		and State	
		Route 30	
Mixed Cobbles, Fox		Fox Creek	
Creek		and State	
		Route 443	
Mixed Cobbles,			
Cobbleskill Creek			
	Oriskany  Seneca  Snake Hill, site 1  Snake Hill, site 2  Mixed Cobbles, Stoney Creek  Mixed Cobbles, Fox Creek  Mixed Cobbles,	V74°19.1464         Oriskany       N42°49.360 W74°43.622         Seneca       N42°49.2 W74°43.17         Snake Hill, site 1       N43°02.6515 W73°42.4891         Snake Hill, site 2       N43°03.0632 W73°42.1354         Mixed Cobbles, Stoney Creek       Mixed Cobbles, Fox Creek         Mixed Cobbles,       Mixed Cobbles,         Mixed Cobbles,       Mixed Cobbles,	Oriskany  N42°40.9788 W74°19.1464  Oriskany  N42°49.360 Cherry Valley W74°43.622  Seneca  N42°49.2 Cherry Valley W74°43.17  Snake Hill, site 1  N43°02.6515 Saratoga Lake site 1  Snake Hill, site 2  N43°03.0632 W73°42.4891  Snake Gobbles, Stoney Creek and State Route 30  Mixed Cobbles, Fox Creek and State Route 443  Mixed Cobbles,  Mixed Cobbles,  Mixed Cobbles,  Mixed Cobbles,  Mixed Cobbles,  Mixed Cobbles,  Mixed Cobbles,

Appendix G: Corrections, additions, new interpretations or changes in previously written material

Correction 1, page 17: Stratigraphic Sequence and Geologic Age of the Flint Bearing Formations--

Normanskill Shale is now considered to be Middle Ordovician and the Snake Hill and LeRay are Upper Ordovician.

Correction 2, page 20: Table 2: Geologic Periods, Their Dates and Standard Symbols (After Holmes 1965:157)—

New Age Dates: Devonian 416-359 Silurian 443-416 Ordovician 488-443 Cambrian 542-488 preCambrian 542 and older

Correction 3, page 20: Table 3: Generalized Sequences of Chert Bearing Strata of the Lower Ordovician in Eastern New York State (After Fisher 1970; et al)—

It is more consistent with modern geology to use the term "Autochthonous" instead of "normal sequence" and "Allochthonous" instead of "Eugeosynclinal sequence."

Correction 4, page 23: Figure 5: Hypothetical Stratigraphic Structure of the Mid-Hudson Valley (after Fisher 1970, Goldring 1943, and Ruedemann 1930).—

See correction 3

Correction 5, page 36: Table 6: Composite Stratigraphy of the Major Chert Bearing Formations in New York State (After Fisher 1962, 1970; Ruedemann 1942, 1930; Wilmarth 1968; Wray 1948)—

The Oriskany, Glenerie, and Esopus are part of the Tri-States Group, not the Onondaga.

Correction 6, page 52: Current thought suggests that the Ordovician rocks in Schoharie County all belong to the Schenectady Formation.