THE STRATIGRAPHIC RELEVANCE AND ARCHAEOLOGICAL POTENTIAL OF THE CHERT-BEARING CARBONATES WITHIN THE KITTATINNY SUPERGROUP

PHILIP C. LA PORTA
Queens College and Department of Earth and Environmental Sciences
C.U.N.Y.

INTRODUCTION

All of the formations to be visited on this field trip are Cambro-Ordovician in age and were deposited in very shallow waters (shelf settings) (Figure 1). A few of the formations contain shaley members but are almost entirely composed of dolomites and lesser amounts of limestone. The Cambrian formations are remarkably persistent both laterally and vertically and this leads to extensive facies continuities, covering distances as great at 50 to 100 miles (Read, 1985). The Lower Ordovician formations (capped by the Knox Unconformity; Sloss, 1963) have a more heterogeneous character, still with the same lateral persistence, but with considerably greater variations in facies composition.

The Cambrian cherts appear to be facies-controlled (porous oolitic layers, sandy layers, etc.) except for the top of the Allentown Formation. The upper Allentown appears to be a surface of unconformity, but is not marked by deep incisions, just shallow channel cuts. The zone of chertification follows this surface and occurs as a series of complex rubble zones, and silicification along joints.

The cherts within the Rickenbach Formation (Lower Ordovician) are facies-controlled and are widely persistent forming a distinct marker horizon. The lower member exhibits an intrastratal breccia, but there is no evidence of an associated unconformity. The Epler Formation contains chert which is facies-controlled, but the most obvious varieties of chert are associated with paleokarst features. Some of the paleokarst features were filled by argillite which has also suffered later silicification. The Epler Formation is overlain by the Ontelaunee, a fossiliferous carbonate, a good portion of which has been strongly dolomitized. Chert is ubiquitous to both members of the Ontelaunee Formation and the Harmonyvale (uppermost member) is strongly cut by erosion features. This eroision surface is very variable and in some places has incised all the way down into the Rickenbach Formation.

The great variety and volume of chert extant within the chert-bearing carbonates of the Kittatinny Supergroup has been known for some time (Markewicz, 1967). The use of chert beds as stratigraphic marker horizons or key beds was first implemented in this region by Markewicz (1967) and Markewicz and Dalton (1973). Their formation and member level subdivision (Fig. 1) will be used for the field trip. The chert appears to be restricted to specific units within members of the formations of the Kittatinny Supergroup. The chert-bearing facies are laterally persistent for substantial distances. (The host rock for the silica are often highly porous beds, unconformities and paleokarst fractures.) An extension of the chert stratigraphy has been the discovery, over the last two decades, of more than 200 small and large sites of prehistoric mining operations sites. The chert stratigraphy is the focus of this field trip and has been specifically designed to also aid the archaeologist conducting provenance studies in the field.

PREVIOUS WORK

Markewicz (1967) and Markewicz and Dalton (1973) were the first to use the lower chert-bearing unit of the Hope Member of the Rickenbach Formation as a stratigraphic marker horizon.The presence of the Hope Member has since become a stratigraphic aid, as a key bed, for field workers in the complex fold and thrust belt. The refined member-level stratigraphy for the Kittatinny Supergroup (Fig. 1) was presented by Markewicz and Dalton (1973, 1974, 1978). The member level subdivisions and stratigraphic section descriptions of Markewicz and Dalton (1977), represented the next logical step towards understanding the depositional environments in a region where both detailed lithostratigraphy and invertebrate fossils are rare. More recently, further refinement of the members into distinct stratigraphic units has been compiled during the mapping of the Hamburg Quadrangle by Canace (1988). To date, most depositional and paleoecological interpretations are drawn from detailed studies in contiguous states. Presently, the tectonic map for the Great Valley Sequence is being assembled by Herman and Monteverde (pers.comm. 1989).

Structural and stratigraphic studies published in recent years (Offield, 1967, Baker and Buddington, 1970) mention but do not discuss the chert within the Beekmantown Group. Fortunately, structural and stratigraphic studies conducted in contiguous states have helped to establish the chert stratigraphy. The studies of Wherry (1909) and Weller (1900) Wilson (1962) both document the stratigraphic position of chert as beds and nodules. The highly refined stratigraphic work of Zadnik and Carozzi (1963) within the Carpentersville, N.J. section is also directly applicable to studies further north.

The stratigraphic work of Hobson (1963) has aided the present research. Hobson noted the positions of chert-bearing units within the Cambrian System, within the base of the Rickenbach Formation, at the base as well as higher in the Epler Formation, and most particularly within the Ontelaunee Formation.

Professional archaeology within the Wallkill River Valley in New Jersey, is almost non-existent. At the turn of the century, Schrabisch (1909) conducted a site survey in Sussex, N.J. which noted the locations of two potential prehistoric chert quarries. The first was at Wildcat Rock, between Hamburg and Franklin, N.J. where it was said that blue flint was abundant in the fields. The second was at the base of the Wallkill Pond, in the town of Franklin, N.J. There was also a small excavation at the Hamburg Rockshelter by Philhower (personal collected notes and letters of Louis M. Haggerty 1930-1979). During the WPA (Works Progress Administration) days, Cross (1940) excavated a rock shelter at the Todd Estate which produced a trait list of prehistoric implements. Ritchie (1965) noted the great concentration of fluted projectile points in the vicinity of Pine Island, N.Y., and made mention of the archaeological potential of the valley. The current study efforts of the Orange County Chapter of the New York State Archaeological Society have still not been synthesized into any specific research design. To date, there is no cultural stratigraphy for the Wallkill River Valley in New Jersey, but there are countless stone tool collections in cigar boxes and tin cans, tucked away in garages and stored on work shelves awaiting analysis, and mute testimony to the potential wealth of information that awaits the researcher.

THE FIELD TRIP AREA

The field trip area lies within the rocks of the Great Valley Sequence. The focus of the present trip is the carbonates within the Beekmantown Group and the stratigraphically lower Cambrian Age formations. The last field stop occurs along the southwest flowing Paulins Kill. The area is bounded on the east by Precambrian igneous and meta-sedimentary rocks, and to the west by the Martinsburg Formation. A belt of Grenville-Age marble underlies the eastern portion of the valley bottom. The carbonates to be discussed and observed occupy the NE-SW trending axis of the Wallkill River Valley.

THE ARCHAEOLOGICAL APPLICATION OF THE CHERT STRATIGRAPHY

A major outcome from this writer's chert stratigraphy studies in the area has been the creation of a well structured framework for lithic provenance studies in archaeology. The decades of the sixties and seventies produced only a handful of prehistoric quarry sites in the field trip area. As the chert stratigraphy was refined the number of prehistoric quarry discoveries grew. The period between 1979 and 1984 witnessed the discovery of a few dozen small quarries. The last five years of work have had the cooperation of Frank Markewicz and most recently several members of the New Jersey Geological Survey. The member-level subdivision of the Kittatiny Supergroup combined with the more recent chert stratigraphy has led to the discovery of nearly 150 new quarries of various types. A full spectrum of new problems now confronts us. The quarries are currently being categorized into large open cut quarries, such as the location along the Paulins Kill, smaller outcrop quarries, screes, workshops, exploration pits, conical shafts, and failed explorations. Furthermore, the quarries cluster into districts each of which is associated with a complex of open-air sites. Most recently, a number of outcrop quarries have been discovered, which occur in the centers of large open air sites. Many of these quarries appear in woodlots between furrowed fields. The chert stratigraphy has allowed the writer to move quickly over the landscape, marking member and formation contacts, then proceeding along strike to discover new quarries. The method allows one to gather both geological and archaeological data or focus more specifically on one particular task, for example attitude measurements using the chert beds where bedding is difficult to discern.

The knowledge of the exact location of prehistoric lithic resources should allow the archaeologist to locate the place of origin of chert. The outcrop to outcrop study has led to the creation of a chert classification

	Formation Name Used on N.J. Geol. Map	Formations Recognized by H. B. Kummel and Others	Formations Recognized by A. A. Drake and F. J. Markewicz	Current Stratigraphy As Used by F. J. Markewicz and R. F.	Dalton	
LOWER ORDOVICIAN	KITTATINNY LIMESTONE	Beekmantown	Epler (Oe)	Ontelaunee Formation	Harmonyvale mbr. OO_2	
					Beaver Run mbr. OO_1	
				Epler Formation	Lafayette mbr. Oe_3	
					Big Springs mbr. Oe_2	
					Branchville mbr. Oe_1	
			Rickenbach (Or)	Rickenbach Formation	Hope mbr. Or_2	Crooked Swamp Dolomite Facies Or_3
					Lower mbr. Or_1	
CAMBRIAN		Allentown	Allentown (Ca)	Allentown Formation	Upper mbr. Ca_2	
					Limeport mbr. Ca_1	
		Tomstown	Leithsville (Cl)	Leithsville Formation	Walkill mbr. Cl_3	
					Hamburg mbr. Cl_2	
					Califon mbr. Cl_1	

Fig. 1 Correlation Chart for the Beekmantown Group and Cambrian System borrowed from Markewitz and Dalton, 1977. The figure depicts the more recent member level stratigraphy employed in this research.

which was designed with the archaeologist in mind. The use of the stratigraphy requires no special training or analytical procedure. The following is meant to be purely descriptive which also enforces the beliefs of the writer, that what is needed first in archaeological geology is not analytical techniques, but solid field data. The research documents the inter-outcrop variation of the chert within a single member. This aids in focusing the provenance study to a specific outcrop. Many of the chert-bearing members are laterally persistent for miles. To describe a chert as originating in the Leithsville Formation is useless as the Leithsville Formation occurs in New York, Pennsylvania and New Jersey. This has been the downfall of most provenance studies, along with the lack of field data and the heavy reliance on analytical methods. An example of the refinement of the study is as follows: an open air site in the Vernon Valley, near DeKay's Hamlet produces an assemblage of Early Archaic stone tools. The diagnostic artifacts appear to have been manufactured from the distinctive blue-gray brecciated and laminated chert of the Upper Allentown member which occurs as an outcrop quarry at the site. Along with the diagnostic artifacts are two large cores of which one has been heat treated. Both cores are manufactured from the chert pods within the Wallkill Member of the Leithsville Formation. This portion of the Vernon Valley lacks outcrops of the Wallkill member. The microfossil residue, closely spaced unsealed fractures, and the large size of the core aids in fingerprinting the core as having originated at the outcrop quarry at the Rudinski Farm, some 3 miles to the west. The smaller heat-treated core shows concentric banding, glassy to waxy luster after heat treatment, and is roughly fist size. Pods of this size, with concentric algal banding are common at a small outcrop quarry along Lake Road in Hamburg, 5 miles to the southwest. The glassy texture is the result of heat-treatment. Both specimens are pods, but that is the common characteristic of the Wallkill member chert at all locations. The other characteristics aid in distinguishing quarries within the same member. Each chert type possesses characteristics which are common to all specimens within that member. The other characteristics vary and aid to distinguish explicit quarries.

Oftentimes, a number of quarries will occur in a small geographic area. In addition, some stratigraphic members such as the Branchville Member of the Epler Formation offer a wide assortment of potential lithic resources. Because of this close association, entire assemblages can be accurately traced back to a small ravine or a complex of small outcrop quarries. Such is the case at Haven's Estate, where quarries occur in the Upper Allentown member, the Lower Rickenbach and the Branchville Member of the Epler Formation. On first inspection the diversity of lithic types occurring on a site may lead to some confusion. On close inspection it is revealed that all the diverse lithic types could be acquired with little effort, in one small ravine.

Occasionally, a chert bed is so distinctive that artifacts can be traced for many miles and related to a particular bed within a member. Such is the case for a group of stage 2 bifaces found in Highland Lakes, N.J. and fingerprinted to a distinct mottled blue bed of chert in Rock Island, N.J. ten or so miles away. The same can be done for the green chert within the Big Springs member of the Epler Formation and much of the white and lavender chert within the Branchville Member.

The potential for this type of study is obvious to the archaeologist. Thus the chert stratigraphy has become a research tool. The present study employs a large archived surface-gathered artifact collection which has accumulated for 60 years. Preliminary examination has already revealed a cultural preference for distinct lithic types, and lithic preference for certain functional types. An example of the former would be the great number of Lamoka-like projectile points fashioned from the white and lavender chert from the Branchville Member. An example of the latter would be the great number of unprepared cores fashioned from the welded brecciated chert of the Lower Rickenbach Member. The writer would like to approach questions concerning the role of human cognition in resource selection, prehistoric land utilization, and the variation of the fundamental strength within each chert type. These are a few of the many problems to be considered on this trip.

DESCRIPTION OF CHERT TYPES

Leithsville Formation (C1)

Califon Member (C1l). The chert within the Califon Member occurs as rounded pods and colloform masses. Some pods are circular in crosssection, while others are elongate. The pods may be as large as 3 feet to less than 6 inches in diameter. They are usually limonite encrusted and produce a rank, fetid odor when struck by a hammer. The bottom portions of the pods possess an unusual coxcomb structure, which is vuggy and may contain druses of quartz. The centers and bottoms have a fibrous texture, while the outer portions of the pods are homogeneous, waxy and never fibrous. Unlike the core, the outer portions are usually darker in color, and possess a pitchy to waxy luster. The colors range from black, to gray, to blue gray, but orange and black mottled varieties are not rare. The chert within the Califon Member usually occurs in the lower unit associated with sulfides.

A unique aspect of the Califon Member chert is its variation in strength or consistency from the core to the outer portions of the nodules. The centers of the pods are fibrous and impossible to work into stone tools. When found on sites, they are generally mistaken for early stage cores, when actually they should be treated as exhausted and discarded cores. The outer darker portions bear a subconchoidal to conchoidal fracture, and even the thinnest flakes are opaque along the edges. The outer areas also contain concentric open fractures, which often control initial reduction. The unsealed fractures cause the chert to break away from the fibrous core as concentric shells. Artifacts of Califon chert are more common along the southwest flowing drainages within the Great Valley Sequence in New Jersey. Discarded artifacts are common at sites along the Piedmont and Coastal Plain as this chert occurs in quantity within the glacial drift. Outcrops are uncommon because the Califon Member is easily eroded and usually underlies valleys occupied by ponds. Therefore quarries in this member are rare. Most Califon chert was gathered from glacial drift or from residual soil within these same solution valleys. Chert masses occurring as a residual can be seen near Califon, New Jersey. Because Califon chert is extremely tough, reduction sites often produce as many hammerstone spalls as chert flakes. Artifacts of Califon chert are uncommon in the Wallkill

River Valley. Recovered artifacts are usually diagnostic prepared and unprepared cores, and large bifaces. Artifacts examined in archived collections bear a waxy patination, and the surface colors can approach olive green. The artifacts are always limonite encrusted from the oxidation of minute evenly dispersed sulfides within the chert, and the artifact may illustrate any number of the physical characteristics described above.

Hamburg Member (Cl_2). The Hamburg Member of the Leithsville Formation is best exposed along Wildcat Rd. in Franklin N.J., on a series of hillsides south of Rt. 23 in Hamburg, N.J., and north of Rt. 23 along Scenic Lake Rd., in Hamburg, N.J.

The chert occurs as a series of continuous and discontinuous, closely-spaced beds, from 1 inch to 6 inches in thickness, occurring between alternating dark green, pink, and gray argillic, finely-laminated dolomites and infrequent shale beds. The chert is characteristically black, but weathers to light blue and blue-black on the surface. Unique to the Hamburg Member chert are veinlets of white quartz, as well as open vugs lined with microcrystalline quartz. When the white quartz veinlets are widely dispersed, the chert appears to bear phenocrysts. When the quartz venation is closely spaced, the chert appears banded or dendritic. Sulfide inclusions are ubiquitous in this chert. Hamburg chert has a vitreous to waxy luster and is translucent only when the white quartz veinlets are concentrated. Associated with this member is a lower unit of silicified dolomite, which is homogeneous, sparkly, and occurs as thin flaggy beds.

Small outcrop quarries and screes are commonly developed within this member and good exposure above river valleys is part of the reason. Beds of the Hamburg Member can be steeply inclined, creating easy access by simple prying techniques. Hamburg chert is very dense as is attested to by the great numbers of chert hammerstones fashioned from this material, which appear in archived collections. Where thick beds of this chert occur, they are usually intersected by sets of open and sealed fractures. Open fractures appear to aid in the quarrying process, but create some of the limitations within the reduction sequence. Often breakage in bifaces occurs along quartz lined vugs or unsealed fractures. Discarded artifacts in the early stages of reduction, the result of failure along fractures, are very common.

The Wallkill Member (Cl_3). The base of the Wallkill Member is marked by a rather distinctive chert zone. The chert occurs as beds up to 2 feet in thickness, and contains chertized algal beds, pisoids, and silicified dolomite. Broken pieces commonly exhibit a shardy appearance, which may represent a fossil coquina concentrateor a rubbly, brecciated chert zone. The nature of the shardy clasts is yet undecided. Fresh surfaces are light gray and black where the chert is concentrated, but weathered surfaces are brown.

A second chert zone occurs in the upper unit which is a sparkly coarse grained dolomite. Here, thin stringers and wispy beds of an opaque black chert, sometimes associated with sulfides, are common. Above this occurs a zone of unique pods of chert. The chert pods occur as concretionary masses, from 1 to 20 inches in diameter, and may be elongate, ellipsoidal, or tube-like in form. The texture ranges from glassy to saccharoidal, and the textural types are distinctly zoned within each mass. Waxy, highly lustrous pieces are very common. The colors range from dark blue-gray to light gray with patches of white, and thin pieces are often highly translucent. Concentric color banding and claystone cores are common, as well as ankerite skeletal casts, which conform to the concentric layering of the chert. These pods are best developed on the Rudinski Farm, south of Pine Island, New York. Polished sections bear evidence of burrowing, and the outer surfaces of the pods have a hide-like leathery appearance. Fairly disseminated rod-like and spherical microfossil material is occasionally found in these pods. Conjugate shear fractures, unsealed in most cases, penetrate each pod.

Quarries within the Wallkill Member occur on the the west facing slopes along the eastern margin of the Wallkill River Valley. Quarries occur as outcrop workings, screes, and conical shafts sunk into swampy soil at the base of outcrops. The Wallkill Member usually occurs as a terrace above swamp areas, therefore access is limited. There is strong evidence at archaeological sites suggesting that Wallkill chert is heat-treated during the critical reduction process.

Allentown Formation (Ca)

Limeport Member (Ca_1). The chert within the Limeport Member is most conspicuous as chertized oolite sequences. Beds are usually thin, less than 3 or 4 inches, but infrequent concentrations of 8 or 9 inches do occur. Silicification appears to follow the highly porous oolite sequences, and when this facies is laterally persistent, the chert beds can be traced for some distance. The contacts between chert-rich sequences and the adjacent dolomite is often gradational, and in many instances the silica content decreases outwards from a central zone of concentration. The algal-rich sequences of the lower and middle units are often silicified, and the silicification appears to be determined once again, by the amount of available porosity or open spaces within the algal structure (Bathurst 1981). The middle and upper units often contain thin stringers of chert associated with sulfides. The chert is usually black, becoming gray to blue-gray northward near Warwick, N.Y. Broken outcrop samples glisten from cleaved oolites, but the matrix chert is usually waxy or resinous, depending upon the concentration of oolites. Thin slivers are usually highly translucent to transparent, revealing the rounded form of the oolites, but when the oolites are concentrated, the chert may appear nearly opaque. Chertized oncoid and pelletal facies are very common in the lower two units of the Limeport Member.

Chert-rich sequences within the Limeport Member are common, but chert infrequently occurs in the concentration to be quarried. Also, much of Limeport Member occupies valley floors within the Wallkill River Valley. Quarries in this member are more common along the southwest flowing drainages of the Paulins Kill, Musconetcong and Pequest Rivers. A series of small quarries occur in Wantage Township, near Hamburg, New Jersey. Great quantities of Limeport chert occur at sites in the Wallkill River Valley, indicating that larger quarries or great numbers of smaller outcrop workings do exist.

Upper Allentown Member (Ca_2). The lower unit within the Upper Allentown Member, a micritic dolomite which weathers light blue, often contains black chert as thin beds and clots. The contacts between the chert beds and surrounding dolomite are sharp boundaries, and beds are very thin, concave upwards, and may occur as a series of alternating ribbons and clots. The chert is homogeneous vitreous, and black. Oftentimes sealed fractures criss-cross the chert, and these fracture surfaces are sometimes coated with white micro-crystalline quartz.

The upper unit contains thin beds and seams of oolitic chert. This chert is often blue-gray, and possesses a sugary to resinous luster. Fresh outcrop samples illustrate an unusual step-like outer surface along bedding surfaces. Within 200-250 feet of the upper contact of the Upper Allentown Member, there is a zone of silicified algal structures (Aitken, 1967). These domal algal forms are banded white and gray chert, and serve as excellent facing indicators. The algal-rich beds are visible at the Havens' Estate as well as other localities not scheduled for this field trip. Within 50 feet of the upper contact with the overlying Rickenbach Formation there occurs a series of thin discontinuous beds and rubble zones comprised of ribbon chert and chert occurring as irregular masses and clots. The rubble zones mark the beginning of an unconformity which can be traced from north of Warwick, N.Y. south to Phillipsburg, N.J. These rubble chert zones are rather extensive, the chert ranging in color from dull black to light blue and white convoluted masses. The clasts are always angular, vuggy, and interstices in the surrounding dolomite are filled with a druses of white quartz crystals, and fine grained white quartz coats many of the chert clasts. Above the rubble zone are a series of thin to thick quartzite beds. Where the quartzite is absent, there is occasionally an ash-gray porcelain-like chert, which occurs as irregular masses.

In the Vernon Valley, there occurs a rather unusual chert within the Upper Allentown Member. The chert is light blue, blue-gray, or ash gray and occurs as finely laminated masses. The laminations may represent relict bedding features. The texture varies from glassy to saccharoidal within a single hand sample. The glassy layers contain vacuoles where euhedral dolomite rhombs have been dislodged by weathering. The chert masses are always brecciated and the dolomite which fills interstices between chert masses is very coarse grained. Individual beds may be greater than 12 inches in thickness, and a myriad of different colors and textures can be obtained from a single outcrop. These breccias may be intrastratal and genetically related to doline formation during the development of the Knox-Beekmantown Unconformity, or related to the unconformity at the top of the Upper Allentown Member (Kerens, 1988). A similar chert, finely laminated, brecciated, ox blood red in color occurs near the upper surface of the Upper Allentown Formation at the Delaware River bridge on I-78 south of Easton, Pennsylvania.

The unique chert occurring within the Upper Allentown Member in Vernon Valley appears to have supported a great number of small outcrop quarries. The presence of fine laminations will aid in distinguishing this chert from that of the Harmonyvale Member of the Ontelaunee Formation, which can also appear light powder blue. There also appears to be a cultural preference for the thin beds of black chert occurring in the lower unit, as great numbers of projectile points, which represent the Brewerton manifestations are fashioned from this chert. Virtually all of the rubble zones are worked as outcrop quarries. Hammerstones and chert debitage litter these outcrop surfaces. It is difficult to delimit the boundaries of a quarry within the rubble zone because the chert is discontinuous and workings may occur over a great distance along strike.

The Rickenbach Formation (Or)

Lower Member (Or_1). The chert within the lower member always occurs as tightly welded brecciated masses of angular to sub-angular clasts. The chert beds are discontinuous masses up to 100 feet in length and may attain thicknesses of up to 3 feet. The chert itself occurs as transparent to opaque black clasts welded into a matrix of translucent to opaque light blue to dark blue gray chert matrix. Occasionally, entire chert beds are lodged within the brecciated masses, and broken beds and clasts can often be re-fitted. In some instances, the welded fragments, appear to blend into each other causing a color gradation without grain boundaries. A simple hand sample of this latter variety may exhibit color variation from light gray to black. More often, the matrix chert is dull opaque gray and the chert clasts are vitreous opaque black masses. The physical attributes of the chert breccia varies from outcrop to outcrop, and the most spectacular examples occur in DeKay's Hamlet, Vernon Valley, New Jersey. At this location the chert clasts are usually embedded in a coarse dolomite.

At DeKay's Hamlet, single chert clasts were apparently separated from the dolomite matrix before manufacturing into stone tools. At other locations, this initial sorting process is not necessary. The chert from the lower member makes its presence in the archaeological records as great quantities of unprepared cores. When bifacially prepared pieces are found, they usually illustrate the brecciated form, and the welded clasts appear to offer little problem to the manufacturer. Most artifacts exhibit a mottled appearance.

The Hope Member (Or_2). The chert within the Hope Member occurs in two distinct zones. The lower chert zone or 7 inch cherts is a series of discontinuous beds 3 to 6 feet in diameter and up to 6 inches in thickness. At some locations, between 3 to 5 or as many as 7 chert zones are present. The beds are usually convex upwards and are black to dark blue in color. Hand samples are highly vitreous, translucent and may contain fine laminations or ooids. An algal origin for this chert has been suggested (pers. comm. N.J. Geological Survey, 1988). Above this is yet another chert zone comprised of thin wispy convex upward beds, as well as clots, of chert. This chert is dark blue-gray, translucent to transparent in thin slivers and will exhibit very fine dark colored laminations. Silicified domal algal structures are also associated with this member.

Actual quarries in the Hope Member are uncommon, as this member is easily eroded and often occurs in low swampy areas. The thinness of the beds and low relief lead to the occurrence of small outcrop quarries developed along strike.

The Crooked Swamp Dolomite Facies (Or_3). The sugary light blue dolomite of the Crooked Swamp Dolomite Facies contains chert in several different forms. At some locations great masses of silicified dolomite occur. The chert appears to disrupt bedding and is often cross-hatched with microcrystalline quartz occurring in the fracture spaces. These chert masses can be several feet in diameter and thickness, and can be easily traced along strike. The chert is light gray to blue gray, its texture is vitreous, and individual seams are rarely greater than 1 or 2 inches in thickness. The whole mass has a gnarled appearance.

A second variety occurs as thin wispy beds, clots and algal replacements. Occasionally thick beds containing chertified oolites will occur. Thin splinters of the bedded chert often will be highly translucent to transparent and exhibit finely layered dark laminations.

Chert within the Crooked Swamp Facies rarely occurs in such concentration as to warrant the development of quarries. Small outcrop quarries and screes can be traced along strike.

The Epler Formation (Oe)

Branchville Member (Oe_1). A thick chert sequence occurs at the base of the Branchville Member. At the Lake Illiff section (Markewicz and Dalton, 1977) the lowest chert beds are dark blue to blue-black and contain a fine venation of lighter blue chert. The beds attain a thickness of up to 1 foot and may be laterally continuous over substantial distances. At the nearby Harmonyvale section, the lowest chert beds are opaque black with a brown venation, up to 1 foot thick, and laterally discontinuous. Above this zone, there are sporadic occurences of a series of ash gray porcelain-like chert beds, which are finely laminated, opaque, may contain sulfides, and are present as discontinuous beds up to 6 inches thick. This chert also occurs as convoluted masses and infillings within solution features, where it attains a gleaming white porcelain-like luster and color. Above this zone occur beds and lenses of a distinctive orchid to lavender colored chert, which may contain oolites, and is often associated with algal-rich beds. The chert is highly translucent and brecciated masses are commonly encountered. In some instances boudins of lavender chert occur, and bedding plane slabs illustrate soft-sediment boudinage structures. Commonly, the lavender chert will grade laterally into a white translucent, waxy chert, which contains vacuoles where dolomite euhedra have weathered out. This variety can attain extreme whiteness, and near transparency, or occur as brecciated masses along with lavender fragments. Occasionally lavender and white brecciated masses are found lightly welded, with coarse dolomite and sphalerite infillings between clasts. Above this zone occur intermittent dark maroon laminated shale beds, which appear to mark the transition into the Big Springs Member. The maroon shales and much of the lower unit of the Branchville Member can be highly siliceous and break with a conchoidal fracture.

All the varieties of chert described above are quarried in the Wallkill River Valley. At some archaeological sites in Sussex, N.J., entire assemblages of artifacts can be precisely provenanced to a series of outcrop quarries in a single ravine or hillside. At the Haven's Estate along the Beaver Run Creek, all the lithic resources mentioned above are mined in one small ravine. Countless scattered small outcrop quarries occur along strike, each marking the location of a concentration of white or lavender chert. Archived collections have shown that a cultural preference has been toward the white and lavender chert. These collections exhibit a Lamoka-like projectile point form which is characteristically fashioned from the white chert. At the Harmonyvale section, a one-half mile traverse along strike in the Branchville Member has allowed the discovery of more than 20 small outcrop quarries. Along quarry walls, in the porcelain-like chert beds, there is indication of heat treatment of the chert, which turns the chert a dark brown, tan, carmel to nearly maroon.

Big Springs Member (Oe_2). The previously described lavender and white chert beds can also be found in the Big Springs Member, where they usually occur as brecciated masses. At the Harmonyvale section, an alternating maroon and white chert occurs. This chert is vitreous, slabby, and may represent the silicified equivalent of the upper maroon shale in the Branchville Member. The beds are nearly 1 foot thick in places. Above the maroon chert is a unique jade green chert which occurs as thick and thin beds, up to 8 or 9 inches thick and it contains numerous vacuoles where dolomite euhedra have been dislodged. Much of the Big Springs Member is highly silicified.

As previously described, wherever the white and lavender chert occurs it is mined out, and the Big Springs Member contains many small quarries. The maroon chert can be easily confused with heat-treated Pennsylvania jasper from the Hardyston Formation. Projectile points of the Broadspear Traditions, fashioned from the green chert beds have been located in archived collections. Once this chert is seen in hand sample, it should not be confused with the Normanskill chert.

Lafayette Member (Oe_3). Discontinuous beds of a steel blue-gray chert occur at the top of the Lafayette Member. The chert is finely laminated, highly lustrous and occurs in beds up to 8 to 10 inches thick. Thin splinters are translucent on the edge. Occasionally, vacuoles are present in this chert, where dolomite rhombs have weathered out. On Skull Island, south of Pine Island, New York, a light blue and gray mottled chert occurs in the Lafayette Member. The colors appear convoluted and may represent original bioturbation structures.

Quarries within the Lafayette Member are rare. Dislodged beds are noticeable when one works along strike. Outcrop workings are usually small and artifacts fashioned from the gray chert will exhibit fine laminations. The blue-gray chert bed on Skull Island is so distinctive that Stage II bifaces have been provenanced from 10-15 miles away back to this one particular bed of chert.

Ontelaunee Formation (Oo)

Beaver Run Member (Oo_1). The greatest concentration of chert in the region occurs in the Ontelaunee Formation and particularly in the Beaver Run member. At the Harmonyvale section the first variety of chert occurs approximately 75 feet above the base of the formation. This chert occurs as great masses up to 3 or 4 feet in thickness, which appear to disrupt bedding. The chert beds are discontinuous, and can be traced along strike as a series of hummocky ledges. The chert is dull opaque black to translucent gray, highly porous and rugose, appearing much like the lower chert unit of the Crooked Swamp Dolomite Facies. Occasional microcrystalline quartz is visible in vugs and pockets, and brecciated, lightly welded masses are common. The texture of the chert is further modified by penetrative cleavage which criss-crosses the chert, and creates quartz-lined fractures. This chert in general is described as gnarled.

A second zone of chert occurs in the middle unit as a series of distinct beds which can be 50 feet in thickness at the Harmonyvale section. At the Parlins' Kill Lake section these beds are up to 2 feet thick and 150 feet long and at Beaver Run, they are up to 6-8 feet thick. The beds appear to pinch and swell, occasionally occur as convex upwards pods, are always dull gray to black, possess a pitchy, dull to lustrous texture, and may occur as mottled and resinous varieties. This chert bears a peculiar petroleum-like or sulphurous odor when struck, as does the surrounding dolomite. Organic halos and dark splotches are commonly present in the chert of the middle unit. The upper unit is usually devoid of chert beds, but when they do occur, they are usually lighter in color, and possess more of the physical attributes of the Harmonyvale Member chert.

The archaeologist should pay particularly close attention to the presence of the Ontelaunee Formation. By far, the largest quarries in the Wallkill River Valley are developed in the Beaver Run Member of the Ontelaunee Formation. Quarries along the Paulins' Kill, Beaver Run Creek, and the Wallkill River may be 300 feet in length. The quarries at the Harmonyvale section are a string of smaller workings, as many as 50 in the Beaver Run Member, which stretch for 2,000 feet along strike, wherever the chert concentrates. The quarries themselves are characterized by countless conical pits and excavations parallel to beds. Oftentimes, large beds are entirely dislodged, and tree falls in the quarries indicate that the debitage occurs to a considerable depth. The ground is generally littered with quartzite hammerstones and anvils, some of which weigh up to 75 to 100 pounds. Chert debitage, evidence of very early stage reduction is everywhere. Very infrequently, late stage bifaces and failed objects occur along the quarry face, along with pottery.

Harmonyvale Member (Oo_2). The transition into the Harmonyvale Member is marked by the appearance of lighter-colored varieties of chert; first dark blue grading upwards to a series of rhythmic beds of light blue chert. Occasionally, dark and light gray with red mottled varities are present but the light blue predominates over all. The chert is usually homogeneous, lacking vacuoles, laminations or any type of inclusions. The blue color is consistent throughout and beds are up to 8-10 inches thick. When brecciated masses occur, the clasts are generally very light colored and nearly the color of the matrix chert. Organic halos and splotches may be present and cleavage may penetrate the chert beds, rendering them fractured along distinct flat planes. Sometimes, the infilling along cleavage planes is lighter colored. At the Sarepta Quarry, near Hope, New Jersey, the Harmonyvale chert occurs as convex upward pods, of black chert, 5-8 feet in diameter, 6 inches thick, and contain floating quartz grains.

Mottled dark and light blue varieties are common in the lower portion of the member.

The Harmonyvale Member was apparently highly sought after, possibly because of its general consistency. In locations where both the Beaver Run and Harmonyvale Members are present, the Beaver Run Member is often neglected in favor of the Harmonyvale Member. Because the chert of the Harmonyvale Member is restricted to fewer and thinner beds, the quarries in the Beaver Run Member appear to be more extensive. In locations where both members exist, such as at Beaver Run Creek and Harmonyvale, the primary focus of quarry activity appears to be the Harmonyvale Member. The two members are adjacent to each other and therefore the quarries generally include both members. Chert of the Harmonyvale Member is apparently preferred for the Laurentian Tradition of stone tool making. At the Phillips Estate, a small quarry, approximately 75 feet by 30 feet, was developed in the Harmonyvale Member. The site includes mounds of tailings and a rock-cut shaft following a six inch thick chert bed, which dips along with bedding approximately 47° NW. The Harmonyvale section also includes some extensive workings in the Harmonyvale Member. The Ontelaunee Formation with its numerous chert beds often occurs in areas of higher relief. Because the Harmonyvale Member occurs stratigraphically further up section, it usually has received more erosion, and hillsides are often littered with tailings, rendering this member very noticeable in the field.

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ROAD LOG FOR THE STRATIGRAPHIC RELEVANCE AND ARCHAEOLOGICAL POTENTIAL OF THE CHERT-BEARING CARBONATES WITHIN THE KITTATINNY SUPERGROUP

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0.0	From Chester, New York, take Route 94 south to DeKay Road, in Vernon Valley, New Jersey
19.4	19.4	Make a right turn onto DeKay Rd.
20.3	0.9	Make a left turn onto Price Rd.
21.1	0.8	STOP 1 is the Paleokarst feature on right.

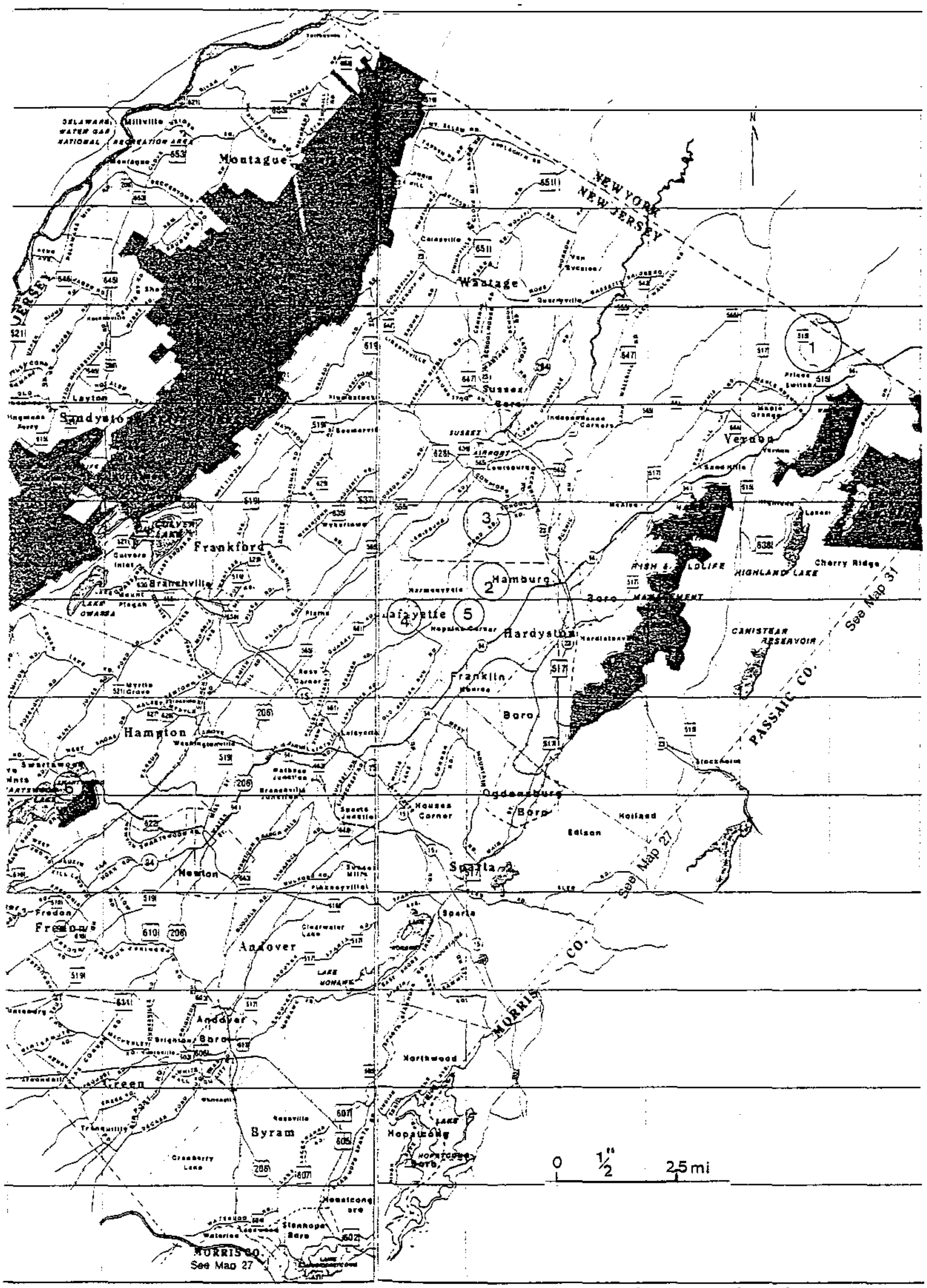


Fig. 2 Map of the General Study Area depicting field trip localities in open circles.

STOP 1. PALEOKARST FEATURES AT DeKAY'S HAMLET (Fig. 3).

The paleokarst features at DeKay's Hamlet are unique for several reasons. They are clearly visible on the Wawayanda topographic atlas sheet, and are outlined in Fig (3). The single hole-like depressions are of great areal extent, and the likelihood of discovering more in the vicinity is very good. The infilling within the inverted depressions contains much more chert than is seen at other locations. The feature rests on the Upper Member of the Allentown Formation. To the writer's knowledge, this represents the deepest penetration of the Knox-Beekmantown erosional event in this area.

Along Price Road, the Allentown Formation is poorly exposed and is visible as thickly bedded coarse grained blue dolomite with thin beds and wisps of black oolite chert. Capping the Upper Allentown is a chert sequence of variable thickness. Sawed slabs of chert from the Price Road outcrops have yielded both algal rich beds and slabs with a structureless form. The chert sequence capping the Allentown at DeKay's Hamlet may represent algal beds in some locations, while in others the chert may represent a silcrete (Khalaf, 1988). Above this zone is the extensive rubble of the paleokarst feature. Chert clasts can be very large and the refitting of chert clasts, blocks, and beds within a single block of karst infilling dolomite is easily accomplished. The infilling between chert clasts and individual dolomite blocks is a very coarse grained buff dolomite.

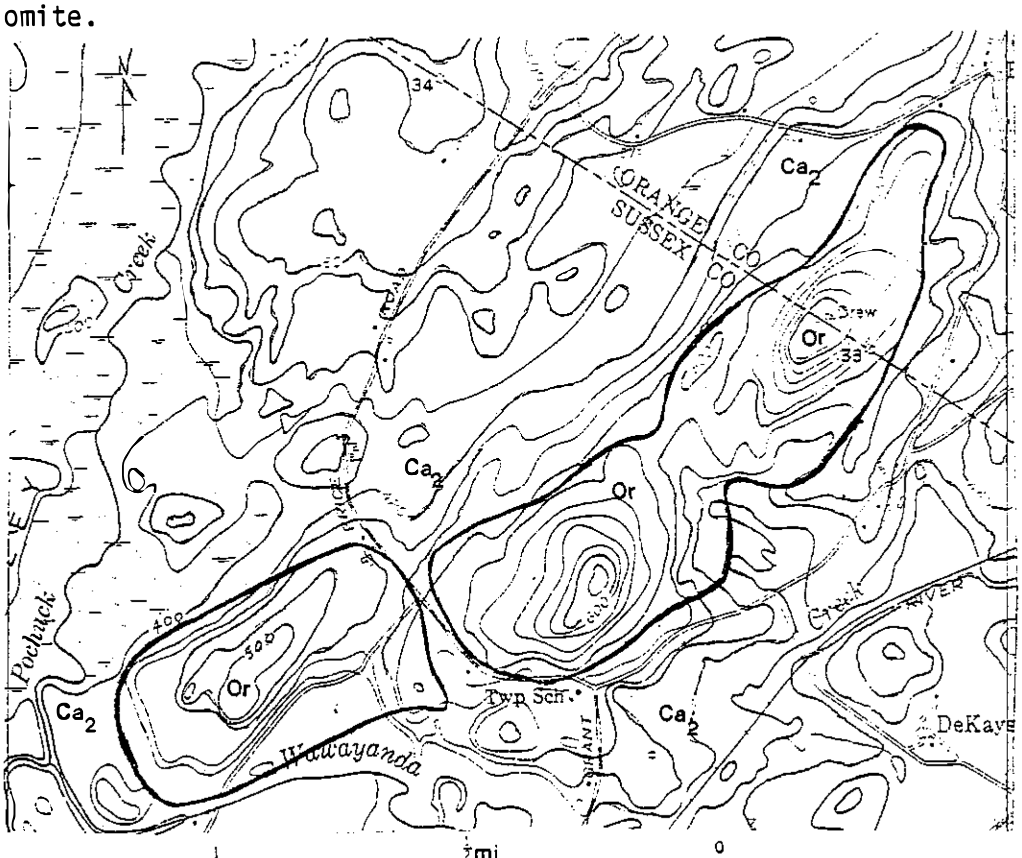


Fig.3 Outline of Paleokarst Feature, DeKay's Hamlet, Wawayanda Quandrangle

The chert clasts appear to be representative of the Hope Member and the Crooked Swamp Dolomite Facies of the Rickenbach Formation. At a nearby location along Owen's Station Rd. in Wantage Township, a similar chert breccia contains the preserved remains of cystoid-like organisms.

In the surrounding valley, the outcrops of the Upper Member include a distinct intrastratal breccia zone with siliceous infilling. The chert horizons may represent the remains of a vast doline system which penetrates the Allentown Formation and creates a plexus of breccia zones which may be genetically related to the vast subaerial feature being viewed at the first stop. This unique chert breccia and silicified infilling has not been encountered elsewhere in the valley, and recent field evidence suggests that in the Vernon Valley, the karstification may proceed down as far as the Limeport Member of the Allentown Formation. Virtually all of the farm fields in DeKay's Hamlet show exposed beds of the breccia and the laminated infilling described under the Upper Allentown Member. Similar laminated chert beds and brecciated zones are visible in the Big Springs Member of the Epler Formation but these do not bear the color characteristics of the Upper Allentown Member chert. Therefore it is logical to assume that the process of silicification and brecciation is similar in both cases.

The paleokarst feature appears to have provided quantities of chert to Archaic as well as Woodland Age groups of hunter-gatherers. The workshops and screes have a different character about them because the quarrying process is unlike other locations. Here, large angular chert clasts are worked free from the surrounding dolomite, instead of mining a single continuous bed of chert as at other locations. In addition, the archived collections from the area exhibit diagnostic projectile points whose overall morphologies are statistically different from culturally similar stone tool inventories from neighboring areas. This measurable difference in physical attributes may be linked to the individual artisan or to the physical properties and limitations of the chert. The writer feels the latter reason may be more important at this location.

The breccia zones described above crop out on nearby farm fields and all have been quarried for the intrastratal breccias and silicious infillings.

22.8	1.7	Retrace route back to Rt. 94, make right and continue south to Beaver Run Rd.
32.8	10.0	Make right turn onto Beaver Run Rd.
33.6	0.8	Travel west to the Paige Farm on the right. STOP 2 is the paleokarst feature along Beaver Run Rd. and a chert quarry in the Ontelaunee Formation involving a traverse ending 0.2 mi. west of the well house at the bend in Beaver Run Rd.

STOP 2. THE PALEOKARST AT THE BEAVER RUN.

The traverse at Beaver Run begins in the Hope Member of the Rickenbach Formation, with the Leithsville and Allentown Formations behind you to the east (Fig. 4). Prominent within the Hope Member is a silicified intraformational conglomerate, in which both rounded clasts as well as matrix have been silicified. This intraformational conglomerate is also visible along the eastern edge of the Haven's Estate, and in the Richter Estate (see Fig. 4). The beds are inclined to the northwest and the intraformational conglomerate has been interpreted by some to represent the base of an extensive paleokarst system. The paleokarst is first visible within the Branchville Member of the Epler Formation, where the dolomite is brecciated and re-cemented in-situ. When this occurs within the Big Springs and Lafayette Members of the Epler Formation, the solution crevices contain a laminated green argillic infilling, which occasionally bears euhedral pyrite. Farther up-section the topographically inverted karst infilling is visible to your right. The feature stands 180 feet in elevation above the roadside, and is prominent at the 700 ft. contour interval in Fig. 4. The eastern half of the feature is developed within the Epler Formation. The dislodged and overturned masses of dolomite in the eastern portion of the feature are derived from the Big Springs and Lafayette Members.

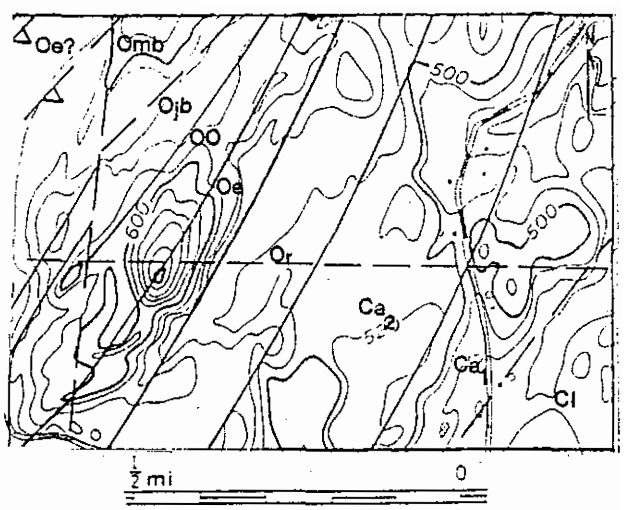


Fig. 4 The Paleokarst Feature and Prehistoric Chert Quarry along the Beaver Run Road Traverse

Midway through the paleokarst feature, large blocks of chert-bearing dolomite, derived from the Beaver Run Member are visible as a stack of disorientated re-cemented blocks. The slabs may represent the collapsed roof structure of the karst system. The paleokarst is best developed within the Lafayette Member. The evidence for karstification within the Epler Formation is visible along strike to the north into the Blair Estate Traverse and the Haven's Island #1 traverse, for greater than 6,000 ft. The feature continues to the south across Beaver Run Road more than 4,000 ft. to the Richter-Phillips Traverse (see Fig. 7).

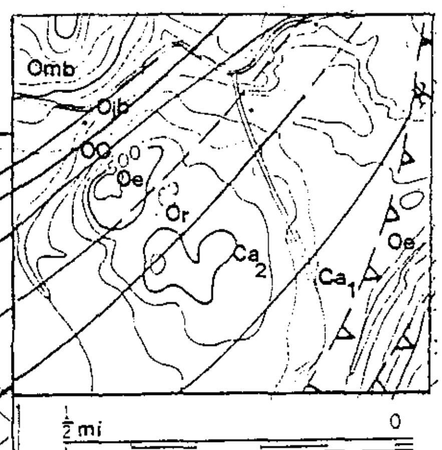
The thickened Ontelaunee Formation section may be the result of faulting (see Fig. 4), and as you continue up-section, you encounter the Jacksonburg Formation (Ojb). From this point, proceed north along strike in the Beaver Run member. Here, along the western edge of the traverse are a splay of intrusive dikes, thought to be upper-Lower Ordovician. Approximately 1,000 feet north, along strike and southeast of the Dagmar Dale Estate, is a prehistoric chert quarry developed within the Beaver Run Member. This quarry and associated scree is typical of those developed within the Beaver Run Member. There is an enormous quantity of broken chert, all representing the earliest stages of the lithic reduction process.

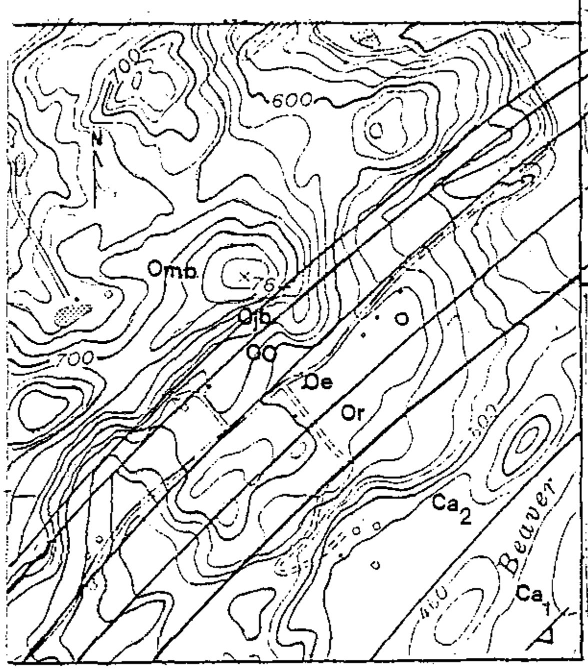
If time and interest exist, traverse downsection on the Blair Estate, of which you are presently on the western edge. Visible will be paleokarst within the Epler formation, chert quarries within the chert breccia zones of the Lower member of the Rickenbach Formation, and a series of convex upwards silicified algal beds present in the Upper Allentown Formation. The algal structures are present on the Haven's Estate and elsewhere within the Hamburg Quadrangle and may represent a distinct marker horizon.

33.8	0.2	Cont. south on Beaver Run Rd. to De Kort Rd.
35.6	1.8	Make right on DeKort Rd. and proceed north to Pond School Rd.
37.5	1.9	STOP on right across from Kimble Farm. STOP 3 is the Chert quarry at the Beaver Run Creek.

STOP 3. THE PREHISTORIC QUARRIES AT BEAVER RUN CREEK.

The traverse begins on the south side of Pond School Road, 700 ft. east of the road, in the Lower member of the Rickenbach Formation. The rubble zone marking the unconformity is at the top of the Upper Allentown Member. The chert breccia of the Lower Rickenbach is present here (Fig. 5). Above the chert breccia is the lower chert horizon of the Hope Member. Proceed up section into the Branchvile member of the Epler Formation. Visible from this point is yet another type of paleokarst infilling. Here are large cemented masses of a very coarse grained dolomite. Throughout the dolomite are clasts of lavender and blue chert. The clasts represent the broken and disrupted chert bearing beds of all three members of the Epler Formation. Two hundred feet to the south is a series of mound-like structures which represent a prehistoric quarry operation within the Branchville Member. The chert present is translucent white with lavender brecciated masses. This breccia is tightly welded, and the quarry is represented by buried tailings.





Haven's Estate Traverse

Fig. 5 Prehistoric Chert Quarries in the Ontelaunee Formation, Beaver Run Quarry Traverse and Alternate Stop the Haven's Estate, Hamburg Quadrangle.

Across School Pond Road to the west 300 feet is the prehistoric quarry at Beaver Run. This is an excellent location because the quarry has been acted upon by erosion and the prehistoric workings are visible.

The traverse begins 200 feet upsection in the Beaver Run member of the Ontelaunee Formation. A massive black chert zone is present in the Beaver Run member. Evidence of the reduction process is to be found at the quarry face. Many of the quartzite boulders and cobbles lying in the rubble represent the broken remains of discarded hammer and anvilstones. Approximately 75 feet above the thick chert sequence is the base of the Harmonyvale Member. There are a great number of conical depressions along strike in the many chert beds of the Harmonyvale Member. This pattern may represent the differential weathering of the solution cleavage within the Harmonyvale Member.

Both members of the Ontelaunee Formation are included in this quarry, and the workings and prospects extend an area of 450 feet by 300 feet. In this quarry, the Harmonyvale Member appears to be the preferred ore, as most of the deeper prospects are developed within this member. There is more archaeological visibility within the lower Beaver Run member, than in the Harmonyvale Member. The Beaver Run chert is usually conspicuous on the landscape, forming benches and topographic high areas. The prehistoric workings are usually extensive and the quarries can be developed continuously along strike. The tough ash-gray dolomite of the Harmonyvale Member, oftentimes caps the crests of hillisdes and is covered by vegetation. Prehistoric workings within the Harmonyvale member are much less visible to the observer. Usually, a single light blue chert bed will be worked continuously along strike for several hundred feet as at this location. Because Harmonyvale chert occurs as thinner beds, the conical pits and workings along strike exhibit less visibility. Chert beds within the Beaver Run member can attain thicknesses of 8 or 10 feet, which render the quarries conspicuous. The writer feels that when both members are present in one quarry complex, the Beaver Run Member may be a second choice of lesser grade ore. The more highly sought after ore is the light blue chert of the Harmonyvale Member. This seems to be substantiated through the examination of archived collections.

Great quantities of quartzite hammerstones are present at this site. One large pounding stone or anvil near the Beaver Run member weighs more than 100 pounds. A collection of very diagnostic hammerstones was made at this quarry. These are always fashioned from quartzite, perfectly round and flat along their top sides, much like a wheel. Many instruments of this kind have been collected as well as hammerstones which appear to approach this diagnostic form. The hammerstones in the quarry represent the continuum of mining instruments, from expedient tools to instruments which are midway or at some stage of refinement towards being diagnostic. The final stage of processing appears to be represented by the spherical form with the flattened edges, or achieving the ideal pre-determined form.

Most of the quarry workings represent the initial reduction process. Chert from the quarry is found as unprepared cores, prepared cores, and diagnostic tools throughout the valley. It appears that much of the reduction process took place away from the quarry site.

39.4	1.9	Return south along DeKort Rd. to intersection with Beaver Run and Fox Hill Rd.
39.5	0.1	Continue south on Beaver Run Rd. to private drive on right.
39.8	0.3	Follow drive to Perry Farm and Pond at Harmonyvale. STOP 4 is the stratigraphic section and prehistoric quarries at Harmonyvale.

STOP 4. THE HARMONYVALE TRAVERSE.

The Harmonyvale traverse begins at the base of the Branchville member of the Epler Formation (Fig. 6). The ravine to your east is occupied by the Hope member of the Rickenbach Formation, and the eastern edge of the summit is occupied by the Crooked Swamp Facies. Present is the sugary blue dolomite, which has a sulfurous odor on freshly broken surfaces, clots of varied-colored black and blue mottled chert, and silicified algal structures.

Proceeding up-section, the base of the Branchville Member exhibits discontinuous black chert beds, up to 8 or 10 inches thick. Small chert outcrop quarries are present within this horizon. Up-section and to the south, one encounters the white chert of the Branchville member. The outcrops are littered with prehistoric workshop debitage and 30-40 small outcrop quarries exist along strike to the south in this member.

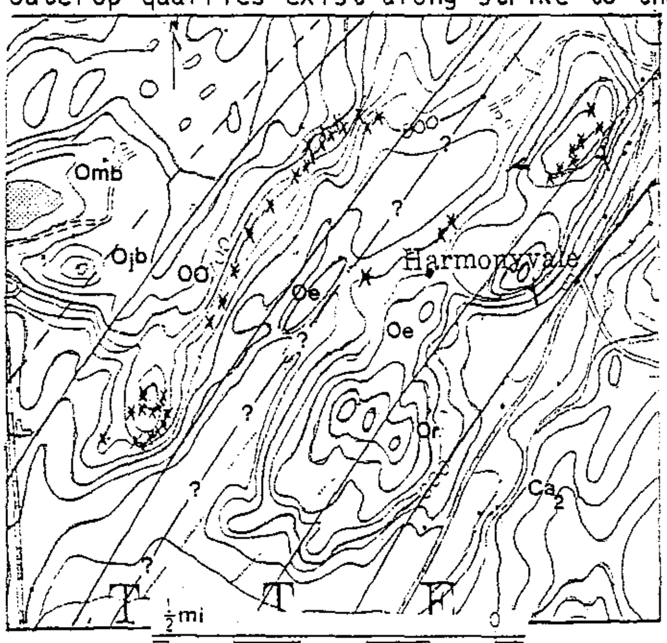


Fig. 6 The Harmonyvale Section in the Branchville Quadrangle clearly depicts the continuation of the Beekmantown Group to the south and west of the Hamburg Quadrangle. The areas marked X indicate the locations of prehistoric quarries. The quarries mark the traces of contacts between members.

The Big Springs member crops out within the woodlot near the eastern shore of the pond. The lower unit contains a unique variety of chert which is maroon and white, and slabby. It represents a silicified shale unit which is stratigraphically similar to the maroon shales within the Upper Branchville member, at Haven's Island #4 Traverse. Above this unit are a series of jade green and white chert beds. The green chert beds may represent the silicified equivalent of the argillaceous karst infilling ubequitous to the Big Springs Member. The white chert achieves an acme in form along this series of outcrops, where it is highly translucent, milky to waxy white to gray, highly lustrous, and occurs as both beds and clots. The laminated procelain-like gray chert is also present at these outcrops.

Close inspection will reveal prehistoric outcrop quarries, and a large quarry is buried under tailings at this location. The dolomite and chert blocks and rubble are part of the quarry tailings. Quartzite hammerstones, and chert debitage are abundant near the surface. Proceed along strike to the southeastern edge of the pond and back downsection 300 feet to the base of the Branchville Member, and the location of yet another prehistoric quarry. The principal ore here is the white chert and the porcelain-like chert. A small surface clearing has yielded hundreds of hammerstones and countless chert flakes. This series of quarries clearly illustrates the difficulty encountered when attempting to locate prehistoric chert mines. The ancient mining operations are usually buried in old tailings and fallen vegetation. This fact has also served to preserve their potential wealth of knowledge.

Now traverse up-section through the Big Springs and Lafayette members across the southern edge of the pond, and into the base of the Beaver Run member. Approximately 100 feet upsection occur the first series of dolomite and associated chert beds. The chert is vuggy, rugose and occurs in concentration as discontinuous swells which create topography to the south along strike. Each of these swells marks the location of very small chert outcrop quarries. Up-section is a second zone of chert which occurs as a series of beds which pinch and swell. The chert is homogeneous vitreous, and black, whereas the associated dolomite beds are thick and billowy. These chert beds are extensively quarried along the southwestern portion of the pond. The base of the steep ledge created by the resistant chert beds is covered with broken dolomite and chert beds, which have been pried from their ledges.

Transitional into the Harmonyvale Member is a dark and light blue mottled chert bed which is laterally continuous and eventually grades into a dolomite bed. The dolomite here is resistant, crosshatched, weathers to a white color and marks the lower Harmonyvale Member. Prehistoric mining activity is extensive here, but the precipitous climb and lush vegetation hinder close inspection.

Traverse along strike in the Beaver Run Member, passing the swells of rugose chert, and continue 1,500 feet to the 700 feet contour interval and a large scree developed along one bed of Harmonyvale chert. The workings in this light blue bed are continuous for 90 feet Below this scree is a large quarry face developed in the upper unit of the Beaver Run Member. Inspect the proliferation of chert. To the immediate west lies the Jacksonburg Formation. Turn south, and traverse to the pond along strike in the Epler Formation. End of the Traverse.

40.2	0.4	Take Beaver Run Rd. north to Ross Rd. Make right on Ross Rd.
40.7	0.5	Travel to the Phillips Estate. Park in drive on left by duck pond. STOP 5 is the Richter-Richter-Phillips Traverse.

STOP 5. THE RICHTER AND PHILLIPS ESTATES TRAVERSE.

The traverse begins in the rubble zone of the Upper Allentown member.

Proceed up section through a thick chert breccia zone of the Lower Member of the Rickenbach Formation (Fig. 7). The ravine to your west is underlain by the Hope Member of the Rickenbach Formation and a distinct chert horizon is visible to the south along strike. The bedding dips to the northwest (see Fig. 7). Traverse through the open field which is underlain by the Crooked Swamp Facies, further south along strike. The step cliff overlooking the ice pond is composed of the Hope Member and Crooked Swamp Facies. The distinct chert horizon is visible in this ravine. The wall of the cliff face contains a partially silicified intraformational conglomerate. Above this is a zone of sugary coarse grained blue dolomite containing wisps, beds and clots of a blue-gray translucent chert. This outcrop bears great resemblance to the Crooked Swamp Facies. The crest of this hill contains the Branchville member of the Epler Formation. The characteristic lavender and white brecciated chert zone is at the base of the member. Small prehistoric outcrop quarries are abundant along strike to the north. The ravine is occupied by the Lafayette Member and is much similar to the Lafayette Member ravine at Harmonyvale. You will cross this ravine to a hillside underlain by the Beaver Run Member of the Ontelaunee Formation. This is the Richter Estate.

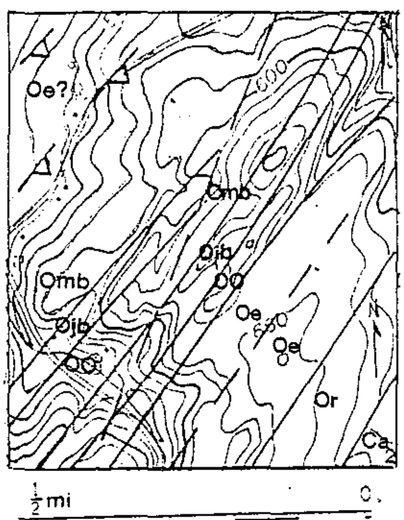


Fig. 7 The Richter-Phillips Traverse, Hamburg Quadrangle

The Beaver Run Member is covered by vegetation at this location. If you traverse north towards Beaver Run Road, you will cross over into the Harmonyvale Member, when the stratigraphic section thickens. Here are a number of small outcrop quarries and screes developed in the Harmonyvale Member. This light blue chert is very similar to the chert exposed in the quarry at the Phillips Estate, just to your west, and very similar to the chert at the Harmonyvale and the Beaver Run Quarries. The west facing slope is underlain by very fossiliferous Jacksonburg limestone. As you cross the Jacksonburg, you pass the location of a proposed fault, (see Fig. 7) and thereby re-enter the Beaver Run Member. Here the Beaver Run contains the upper chert-bearing unit, and a small prehistoric outcrop quarry and scree is present along the summit of the hill.

Passing westward, down the steep west-facing slope and into the Harmonyvale Member, you encounter a unique prehistoric quarry in the Harmonyvale Member. Vegetation-covered mounds of quarry tailings are present, along with the characteristic quartzite hammerstones. The unique feature of this quarry is what appears to be a rock-cut shaft which is about 10' x 10' and filled with tailings. A 6 inch thick light blue chert bed is inclined into the shaft at an inclination of 47° NW. The writer does not know how deep the shaft is or how extensive are the workings. As in the instance of the other quarries, all the workings are deeply buried and only a thin veneer of cultural debitage marks the locations of the ancient prospects. Erosion along steep slopes has exposed the workings and created a window into the past. Similar workings are present throughout this ravine which is to the north on the Phillips Estate. Just to your west is the Jacksonburg Formation repeated after the fault, and the Bushkill Member of the Martinsburg Formation (Omb) which comprises the western hillside and the termination of the traverse.

		Follow Ross Rd. east (0.9 mi) to Bunn Rd.
41.6	0.9	Make right on Bunn Rd. and proceed to Rt. 94.
42.3	0.7	Make right on Rt.94 and travel south to junction with Rt.206.
50.8	8.5	Follow Rt. 206 south to Mill St.
53.1	2.3	Make right on Mill St. Travel west
53.7	0.6	and make right onto Old Swartzwood Rd.
56.0	2.3	Proceed SW to Newton-Swartzwood Rd.
56.7	0.7	Merge to the right and proceed SW until you reach the T in the road. Make sharp left onto Dove Island Rd. and follow for 0.8 mi.
57.5	0.8	Park along roadside. STOP 6 is the chert quarry in the Ontelawnee Formation.

STOP 6. THE CHERT QUARRY ALONG THE PAULINS KILL.

The traverse along the Paulins Kill was suggested by Don Monteverde and Greg Herman of the New Jersey Geological Survey. They have noted large concentrations of chert within the Ontelaunee Formation. The prehistoric chert quarry on this traverse was located within the first day of research in the area.

The quarry is developed within the Beaver Run member of the Ontelaunee Formation, and has a length greater than 200 feet (Fig. 8). The chert beds pinch out to the north and south. To the writer's knowledge, the Harmonyvale Member is not present along this traverse. A distinct rubble zone occurs at the top of the section, and marks the incision of the Knox-Beekmantown Unconformity which removed the Harmonyvale Member at this location. The Jacksonburg Formation (Ojb) lies to our east under Paulins Kill Lake. The steep rise to your east is comprised of the Beaver Run Member and across Dove Island Road to your west lies the Epler and Richenbach Formations. If the stratigraphic formations contacts are interpreted correctly, the chert quarry is developed along the eastern limb of an antiform.

The series of black and gray chert beds have been extensively worked. The gently inclined beds allowed easy access to the chert. This factor often determines to what degree the chert beds will be exploited. Tailings from the initial stages of reduction are abundant and this is one of the few quarries where structure and erosion are combined for excellent viewing. The chert beds are thick and homogeneous, with well-spaced fractures, creating a valuable ore of the black chert.

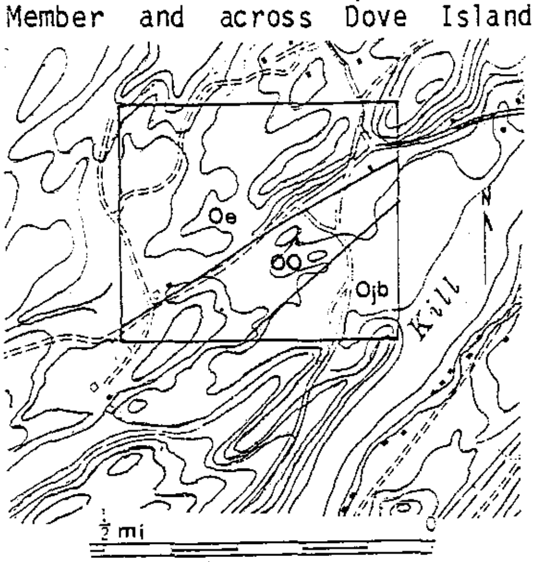


Fig. 8 Paulin's Kill Traverse, Newton East Quadrangle

		Retrace route east back to Mill St. in Newton.
61.3	3.8	Follow Mill St. east.
61.9	0.6	Make left onto Rt. 206.
		To get back to starting point in New York State,
62.9	1.0	Follow Rt. 206 north to Rt. 94 north.
64.2	2.3	Proceed on Rt. 94 north to Chester, N.Y. to exit from research area to the south for New York City vicinity.
77.5	14.6	Make right on Mill St. south, right onto High St. left onto Spring St. right turn onto Main St. proceed to Rt. 206S.
		Follow Rt. 206S to Interstate 80.

NOTES