NEW YORK MINERALOGICAL CLUB

GEORGE F. KUNZ
COMPETITION PAPERS
1997

Featuring articles by
John H. Betts, Martin Becker, Edward Force,
and Howard Heitner

With special supplement on the discovery and naming of kunzite
with articles by
George F. Kunz, Lawrence H. Conklin,
and Frederick M. Sickler
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GEORGE F. KUNZ
(1856-1932)
CLUB FOUNDER AND FIRST PRESIDENT

FEATURING ARTICLES
BY
JOHN H. BETTS, MARTIN BECKER, EDWARD FORCE, AND HOWARD
HEITNER

WITH SPECIAL SUPPLEMENT ON THE DISCOVERY AND NAMING OF KUNZITE
WITH ARTICLES BY
GEORGE F. KUNZ, LAWRENCE H. CONKLIN,
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INTRODUCTION

George F. Kunz in 1932 bequeathed funds to the New York Mineralogical Club to encourage the study of New York area mineralogy. The club established a prize, given at the discretion of the club officers, to be awarded to outstanding contributions to area mineralogy. For many years it was known simply as the Kunz Prize. At that time the club limited the award to articles about mineral occurrences within 100 miles of New York City. Eventually, for reasons now forgotten, the award was discontinued.

Beginning in 1996, the New York Mineralogical Club reinstated the George F. Kunz Competition with a first prize of $500 each year. The club also extended the regional coverage in recognition that now members are willing and able to travel farther to collect minerals. The competition is not limited to members of the club and is open to everyone.

Four papers were submitted to 1997 competition. All are presented in this publication.

1997 COMPETITION COORDINATOR

Vivien Gornitz, Research Scientist at the Goddard Institute of Space Studies, Columbia University

1997 JUDGES

Peter Nalle, mining consultant, and former vice-president in charge of mining and exploration for St. Joe Lead Co., member of the Mineralogical Society of America since 1944.

Cap Beesley, founder and president of the American Gemological Laboratories.

Joseph Peters, Senior Research Scientist at the American Museum of Natural History.
The following article won the $500 first place prize for best paper in the New York Mineralogical Club 1997 George F. Kunz Competition.

ANTHONY’S NOSE, NEW YORK: A REVIEW OF THREE MINERAL LOCALITIES

John H. Betts
215 West 98 Street, #2F
New York, New York

This paper describes three mineral locations in the vicinity Anthony’s Nose, a prominent highland east of the Hudson River in New York State. Two of the sites are over 150 years old and have been long forgotten. Yet surprisingly minerals may still be easily collected at these sites. Unfortunately there has been much confusion about the exact localities and mineral occurrences. This paper attempts to clarify and correct much of the misinformation, and describe the present collecting opportunities.

INTRODUCTION

At the 1997 Rochester Mineralogical Symposium a fine mineral specimen of calcite coated with drusy quartz was offered for sale by Phil Scalisi. The location listed was Anthony’s Nose, New York. The size and quality of the specimen was impressive, yet a specimen from the location had never been encountered by this author. When and where was this specimen found? Were many others found or was it a small, one-time discovery? Seeing that specimen, currently in the collection of Steve Nightingale of Chatham, New York (fig. 1), started research into Anthony’s Nose as a mineral location.

Figure 1 - Hexagonal tabular crystal of white calcite coated with drusy quartz (13 x 20 cm. overall) from the Steve Nightingale collection. Detail view on right shows late-growth quartz druse forming drip-like formations.

(Photo by Steve Nightingale)
In researching the location many references were found to Anthony’s Nose in old mineralogical literature dating back to 1825. Minerals attributed to the Anthony’s Nose area include:

- Amphibole (Robinson, 1825; Whitlock, 1903; Manchester, 1931)
- Apatite (Beck, 1842; Mather, 1843; Whitlock, 1903; Manchester, 1931)
- Barite (Robinson, 1825)
- Calcite (Robinson, 1825; Beck, 1842, 1849, 1850; Dana, 1892; Whitlock, 1903; Manchester, 1931)
- Chalcopyrite (Whitlock, 1903; Manchester, 1931)
- Epidote (Manchester, 1931)
- Garnet (Manchester, 1931)
- Hematite (Robinson, 1825)
- Hornblende (Robinson, 1825)
- Limonite (Manchester, 1931)
- Magnetite (Robinson, 1825, Beck, 1842; Mather, 1843; Whitlock, 1903; Manchester, 1931)
- Marcasite (Robinson, 1825)
- Melanterite (Mather, 1843)
- Molybdenite (Manchester, 1931)
- Natrolite (Manchester, 1931)
- Oligoclase (Manchester, 1931)
- Pyrite (Robinson, 1825; Mather, 1843; Manchester, 1931)
- Pyroxene (Whitlock, 1903; Manchester, 1931)
- Pyrrhotite (Robinson, 1825; Beck, 1842; Mather, 1843; Whitlock, 1903; Manchester, 1931)
- Quartz (Manchester, 1931)
- Stilbite (Manchester, 1931)

It is curious that Whitlock in *Calcites of New York* only mentions the calcite occurrence on Anthony’s Nose in his introduction referencing other authors research. He did not choose to include the calcites from Anthony’s Nose in his study, even though they are exceptional mineral specimens.
MINERAL LOCALITIES ON ANTHONY’S NOSE

During the research it became apparent that there are at least three separate locations in the Anthony’s Nose region (fig. 2). Along the Hudson River, where the railroad tracks cut through the hillside, is where the calcite with drusy quartz was found. Northeast of Anthony’s Nose summit on a small ridge north of Mine Hill is the Philips Mine known for pyrite, pyrrhotite and fine apatite crystals. Finally, there is a road cut east of the Bear Mountain Bridge on Route 6 that has produced a wide variety of minerals notably epidote and assorted zeolites.

Figure 2 - False color aerial photograph of Anthony’s Nose region taken in 1994 on the left, and USGS topographic map of the West Point Quadrangle, photo revised in 1981, of the same area on the right and the three mineral localities described in this paper.

Unfortunately most authors seem to have had little first hand knowledge of mineral occurrences and often grouped minerals from these separate localities under one general heading of “Anthony’s Nose, NY”, or they attributed minerals from one location in the region to another. Most notable among these mistaken references is Minerals of New York (Jensen, 1978) that attributes the calcite with drusy quartz to the Philips Mine. This is incorrect.

LOCATION

Anthony’s Nose is a large highland of approximately four square miles on the eastern shore of the Hudson River, 3.5 miles northwest of Peekskill, New York and about 33 miles north of the George Washington Bridge, Manhattan Island, New York. (fig. 3) Anthony’s Nose is directly east of the Bear Mountain Bridge, connecting Peekskill to Bear Mountain State Park via Route 6.

In the past, Anthony’s Nose was an area of geologic interest to mineral collectors. Nearby could be found no fewer than sixty mines. Two miles to the west were the magnetite iron mines
in Bear Mountain State Park and Harriman State Park. Over 40 mines in this area, dating back to the revolutionary war, worked the magnetite deposits of the Reading Prong that extends north-northeast through New Jersey and southern New York. The last of these mines, The Forest of Dean Mine, operated from 1756 to at least through 1928 is widely represented in old mineral collections (Newland and Hartnagel, 1928).

Five miles southeast of Anthony’s Nose can be found the old emery mines near of Peekskill. Many mines were operated for corundum over an area of five by seven miles southeast of Peekskill for use as an abrasive.

Eight miles to the north-northeast of Anthony’s Nose, near the old settlement of Philipstown, now part of Clarence Fahnestock State Park, are several iron mines...
that worked the Philips vein for iron ore. The vein ran continuously for eight miles and varied in thickness between three and thirty feet. The ore was primarily magnetite and locally was quite pure and compact. The Denny, Sunk, Canada, and Philips mine can still be visited by following the hiking trails in the state park.

Finally, the Catskill aqueduct that supplies the water to New York City from upstate New York was excavated through the area from north to southeast and passed two miles east of Anthony’s Nose (fig. 4). Many geologic reports were prepared of the area during the planning and construction of the aqueducts. The aqueduct required excavating deep trenches and long tunnels affording geologists and mineral collectors the opportunity to study the geology.

REGIONAL GEOLOGY

The prominent summits in the Hudson Highlands, including Anthony’s Nose and nearby Dunderberg are likely cores of eroded anticlines and the surrounding sedimentary and metamorphic rocks are the troughs of synclines. Anthony’s Nose is composed of Canada Hill granite (fig. 5), a medium to coarse grained granite. Often this granite has a streaked, foliated appearance due to crudely oriented biotite crystals. Other minerals include microcline and orthoclase feldspars, gray quartz, red-violet garnets and rutile needles. Upon weathering the

---

Figure 5 - Geologic map of the Anthony’s Nose and Peekskill region (from Berkey and Rice, 1921).
Canada Hill granite takes on a dull gray appearance with quartz and garnet becoming prominent due to their resistance (Berkey and Rice, 1921). Canada Hill granite has been dated by Potassium-Argon dating to between 800-900 million years old by the Lamont-Doherty Earth Observatory of Columbia University (Schuberth, 1968).

Within the Canada Hill granite are lenticular pods Grenville gneiss that predate the formation. It has been noted that the Canada Hill granite was particularly effective at invading and assimilating the older rocks it invaded. Current theories about the origin of the Canada Hill granite propose that it formed through the granitization of an older rock of similar mineralogy, possibly an arkose sandstone, without ever going through a fluid phase. This process is thought to be the result of the introduction of hot fluids and gases from a deeper magmatic body nearby. (Schuberth, 1968)

Because Canada Hill granite are among the oldest granites in the region, much of the Grenville and Pre-Cambrian faulting has been obscured through rehealing, injection, or recrystallization. One fault in particular that runs from south-southwest to north-northeast extending from the north end of Iona Island, through two of the mineral locations in this paper is perfectly rehealed and completely crystalline, exhibiting equal strength to surrounding rock. (Berkey and Rice, 1921)

HUDSON RAILROAD CUT CALCITE LOCALITY, CORTLANDT, WESTCHESTER COUNTY, NEW YORK

The calcite coated with drusy quartz that first aroused interest in Anthony’s Nose came from the railroad excavations for the New York Central Hudson River Line during the 1840’s.

History

In 1842, no mention of this calcite occurrence was made by Beck in his exhaustive Mineralogy of New York. In the second annual addenda to that book (Beck, 1849) under the mineral discoveries listed for 1848 there is the following entry:

Carbonate of Lime, in six-sided tables obtained in blasting a tunnel for the Hudson Railroad, at Anthony’s Nose. This truly magnificent specimen, and almost unique, is presented by John E. Henry, Engineer on the above Road.

This concise report is the first mention found of the calcite occurrence and provides more detail about the occurrence than any subsequent reports in the mineral literature. It pinpoints the discovery to a tunnel on Anthony’s Nose, of which there are four. It also gives the discoverer and his position which explains how the specimens were encountered. It can be assumed that the site dates to 1848, as the same article makes no mention of the discovery for the year 1847.
Figure 6 - Illustration of two calcite specimens from Anthony's Nose from page 88 of Third Annual Report of the Regents of the University (1850) which was compiled by Beck as an addenda to his Mineralogy of New York

Subsequent reports in the literature add little to this information. The third annual report (Beck, 1850) pictured two specimens with line drawings (fig. 6). Along with the illustrations was the following description of the occurrence:
A novelty in the occurrences of calcareous spar [calcite], is the recent discovery of groups of crystals in the form of flat, six-sided tables, of curious sizes, from half an inch to two inches in diameter. These crystals have been found in the coarse granite near Anthony's Nose, on the Hudson River, during the excavations for the railroad on the banks of that stream. The accompanying cuts are drawn from a specimen presented to the State Cabinet by John E. Henry, which is one of the best I have seen from the locality. It is more than a foot in length and breadth. I have received several fine specimens from Mr. Cyrus Fountain, of Peekskill, who has been for several years actively engaged in collecting minerals of Westchester and Putnam counties; and to whom I acknowledge myself indebted for many interesting facts, which he has from time to time communicated.

The original specimen illustrated in the line drawings is still in the collection of the New York State Museum in Albany (fig. 7). Since that time, there are no reports in the literature of newly excavated specimens, though several books mention the occurrence, often incorrectly attributing the calcite occurrence to the Philips Pyrrhotite Mine.

Figure 7 - The original specimen donated by John E. Henry illustrated in Beck (1848) pictured in figure 6. Specimen No. 1597, New York State Museum, Albany, NY. 17 x 8 x 3 cm.
Calcite Description

Though calcite specimens from Anthony's Nose are not commonly available through mineral dealers, they are widely represented in private and museum collections. The Smithsonian Institution and American Museum of Natural History both have them in their collections. For those planning a visit to Anthony's Nose, two large specimens can be seen in the geology display at the Trailside Museum (fig. 8) located in the Bear Mountain Zoo, located just west of the Bear Mountain Bridge. These specimens were donated from the collection of Williams College.

The specimens on display at the Trailside Museum illustrate two basic types: calcite with drusy quartz overgrowth (fig. 9), and plain calcite crystals. Both show calcite crystals up to two inches across as thin tabular six-sided crystals. Those with the overgrowth of quartz often show a reddish-brown color probably due to iron staining. During visits to the site no visible signs were left inside the tunnels or nearby cuts of the calcite. However nearby in the surrounding bedrock small veins up to six inches wide were observed. It is assumed that the calcite specimens were extracted from pockets within a large calcite vein in the Canada Hill granite. This assumption is supported by the nearby rock dumped to build the railroad bed that likely came from the tunnel excavations. Calcite specimens found in the railroad bed are confined to a short length of the tracks south of the second railroad tunnel. The localized occurrence indicates that these calcites were not imported material, rather the result of blasting the adjacent tunnel.
Current Status and Collecting

The tunnels cut for the New York Central Railroad are directly beneath, and south of, the Bear Mountain Bridge, along the eastern bank of the Hudson River. All tunnels have recently been sprayed with a gunnite-type concrete obscuring the tunnel bedrock from collecting. However the rocks removed during tunnel excavation were used as fill of the railroad bed along the river. Several areas of the railroad bed are scattered with calcite and quartz combinations typical of this locality. However the spectacular specimens of 150 years ago are long gone.

Access to the railroad bed is from two locations only. By parking near the train stop in Manitou, north of the Bear Mountain Bridge, you can hike south along the railroad tracks to the tunnels. However this adds approximately an additional one and one half miles to the hike.

The shorter alternative is to hike down from the eastern end of the Bear Mountain Bridge along a trail used by hikers (fig. 10). Parking is available along both sides of Route 9D, as this is where day-hikers can gain access to the Appalachian Trail. The trail head is on the west side of Route 9D, at the end of the stone wall that extends north from the end of the Bear Mountain Bridge. The trail is steep and slightly overgrown, though the hike is much shorter than the alternative hike along the railroad tracks.

Once at the railroad tunnel under the Bear Mountain Bridge, hike south along the tracks. Large Amtrak trains pass through the tunnels at very high speeds from both directions. Do not loiter in the tunnels and keep careful watch for oncoming trains.

Collectors should look on the western side of the tracks, the side closest to the river (fig. 11). Large white calcite crystal clusters and brown drusy quartz can be collected in

Figure 10 - Detail view of topographic map with trail shown from the east end of Bear Mountain Bridge down to the river and railroad tracks. Lower right corner shows location of the Route 6 road cut discussed later in this paper.
the rock dumped to build the railroad bed (fig. 12). This is also the safest place to avoid the frequent trains. Often black ash from years of trains passing the site will cover the specimens. The ash can be removed with ultrasonic cleaning.

Considering that 150 years has passed since this locality was first collected, it is surprising to still to find collectible specimens. Though the quality will never match the phenomenal calcites first collected during construction, this location is worthy of additional exploration in the future.
PHILIPS MINE, PHILIPSTOWN, PUTNAM COUNTY, NEW YORK

This is the oldest mining location in the Anthony's Nose region. Surprisingly the mine tunnels are still open and accessible to this day (fig. 13). Local residents have often visited the mines and many tell stories about ascending the tunnel into a large "glory hole" at the bottom. The hole was filled with water and there was a small boat that they used to paddle around the pool. Presently there is little chance that collecting underground that would be worth the risk. Collectors most likely will focus on the wide variety of minerals found on the dumps.

Confusing References

There is a great amount of incorrect information from resources as trustworthy as the USGS. If you ask local residents about the iron or pyrrhotite mine, you will get either a puzzled look or they will tell you about the copper mine. The USGS 7.5' topographic map of the West Point Quadrangle reinforces this by prominently showing Copper Mine Brook. (fig. 2) running from the mine. To add more confusion the Philips name was prominent among early mining companies. As mentioned in the introduction, the Philips mine in the Philips vein, in Philipstown, was widely exploited for iron ore. This is why much of the later references distinguish the mine on Anthony's Nose as the Philips Pyrrhotite Mine, though the proper name at the time was just the Philips Mine (Beck, 1894).

The location of the mine has caused confusion too. It is very close to the border between Putnam and Westchester counties. This has complicated research into the site because references must be checked under both county listings. In fact when Zodiac (1933) mapped the mine he showed that the southern half of the mine, including the main shaft, was in Westchester County while the northern half was in Putnam County. This is incorrect. Perhaps, a magnetic anomaly made Zodiac's survey inaccurate, but presently it is clear the mine is located entirely within Putnam County. By superimposing aerial photographs with topographic maps it apparent that the current boundary of the two counties passes south of mines altogether. All mineral labels for specimens should be corrected to reflect the location in Putnam County (Westchester County has just lost another mineral collecting site).

Figure 13 - Portal of the upper tunnel showing partial blockage, though access is still open to adventurous collectors.
History

The Philips Mine is on the northwestern flank of Mine Hill, northeast of the summit of Anthony’s Nose, was first operated for iron ore, though the high pyrrhotite and pyrite content made it less desirable than the nearby magnetite mines. It is unclear when the mine was first opened.

The earliest mention (Robinson, 1825) found to date of the minerals from Anthony's Nose are likely references to the Philips Mine. Following is the entry under the location Anthony’s Nose:

*Phosphate of Lime, asparagus stone, in sulphuret of iron. Phosphate of lime, under some varieties, is found in most of the mines of magnetic iron in New York; it is often in yellowish white, or reddish grains.*

*Hornblende, in large tabular masses, with pyrite and phosphate of lime.*

*Hepatic Sulphuret of Iron, in large quantities, mingled with Common Pyrites, and phosphate of lime.*

*Red Hematite, a few m. S. from Ticonderoga; it occurs mammilary, botryoidal, &c. (C.)*

*Fig. 113.*

*Sulphate of Barytes,*

*Calcareous Spar, and*

*Asbestus, are frequently found in the vicinity.*

With exception of the reference to hematite from Ticonderoga it is apparent that he is referring to the pyrite, pyrrhotite deposits at the Philips Mine.

Beck in the *Mineralogy of New York* (1842) was referred to the mine as "long since ceased operation" so it is assumed that mining dated at least to the early 1800's. Beck included an illustration of an apatite crystal (fig. 14) and writes:

*Apatite, in low six-sided prisms truncated on the terminal edges, has been found at Anthony’s Nose. These crystals are of a brownish or yellowish green color, and vary from half a line to an inch in length. They are either perfect or have their angles (edges) rounded and generally present two faces broader than the other four. This locality is believed to be first noticed by Dr. G. Troost.*

*Figure 14 - Apatite illustrated on page 247 of Beck's New York Mineralogy.*
The following year, Mather's *Geology of New York, Part I* (1843) there are three references to iron workings on Anthony's Nose. On page 84 we find the first reference:

"In Putnam County, there is a locality of sulphate of alumina and iron, and of sulphate of iron, in Phillipstown, on Anthony's Nose Mountain, about three miles from West Point, at an old iron mine where the ore contains pyrites. The earth from this place was used many years since by some of the inhabitants for dyeing."

The next apparent reference the Philips Mine is on page 117:

*Many localities might be mentioned in Putnam County, where pyrites decomposes with the formation of the sulphate of iron. The principal that have not been mentioned are.*

1. *An old iron mine on Anthony's Nose Mountain, about one and a half miles east of Fort Montgomery.*

2. *An old "silver mine" (but which contains no silver) on the top of the same mountain, three miles east of Fort Montgomery.*

Finally, on page 560, Mather mentions the poor quality of the ore which likely came from the same source that Beck (1842) used:

*A bed (of magnetic oxide of iron) was opened many years ago on Anthony's Nose Mountain, but it contained much pyrites and crystallized phosphate of lime, both of which injured the ore for the manufacture of iron."

Zodiac (1933) concludes that the three sites referred to by Mather are the Philips Mine, though this author requires further documentation before being convinced there are not other mines in the area.

The last historical reference to the Philips Mine was by Kemp (1894) who states the mine was opened "just after the war". It is assumed that Kemp was referring to the Civil War. Evidence indicates that Kemp was likely referring to the first reopening of the Philips Mine for the exploration of copper. On a map of 1872, the mine can be found under the name of the Hudson River Copper Mines.

After copper mining was abandoned, the Philips mine was worked as a source for sulfur for the production of sulfuric acid. The mine ore was carted to a sulfuric acid plant on the Hudson River near the sight of the Highlands train station. The ore was burned to create sulfur dioxide, the first step in the production of sulfuric acid. The resulting cinders were hematite (ferric oxide), and some attempts were made at using them in iron production (Newland and Hartnagel, 1928). By 1894 the ore from the Philips mine was no longer used in the production of acid because of cheaper Sicilian sulfur was available. However, during mining the ore from the Philips mine was highly prized due to the complete absence of arsenic (Kemp, 1894).
As will be seen in a later section, the mine was reopened a second time in 1907, also looking for economic quantities of copper.

During the post-World War II uranium rush, the area was prospected for uranium minerals. In 1953, Edward J. Chalmers of Glenville, NY located uranium occurrences on the dumps of the Philips pyrrhotite mine and in the area of Camp Smith, the New York State Military Reservation, on Anthony's Nose. Mr. Chalmers filed notices of his discovery, and in partnership

Figure 15 - Map adapted from Klemic et al. (1959) of the uranium exploration southwest of the Philips mine. Eleven drill holes sampled an extension of the ore body and found uraninite associated with magnetite and iron sulfides. The dumps and shafts of the Philips mine are in the upper right corner.
with Mines, Inc. of New York, developed an exploration plan that was accepted by the Defense Minerals Exploration Administration in 1955. He was granted a contract to drill eleven exploratory holes (fig. 15) to define the economical potential of the uranium ore. Based on his research the deposit was deemed submarginal given the market at the time (Klemic et al., 1959). At this time, and during subsequent studies by the U.S.G.S, the Philips mine was largely ignored and instead focused an extension of the Philips ore body to the southeast into Camp Smith where higher concentrations of uraninite were indicated.

Local Geology

The ore body, lenticular in shape is approximately 100 feet wide and over 300 feet deep, dips to the northwest at about 70 degrees and strikes northeast following the direction of surrounding formations. The ore thickness varies between 15 to 25 feet and thins out to the southwest. The northeast end of the ore body has not been exposed. The ore is primarily pyrrhotite, slightly nickeliferous, with smaller percentages of pyrite, magnetite and chalcopyrite. In addition to iron, the ore has a 30 percent sulfur content, 5 percent copper content, and .3 percent nickel content (Kemp, 1894). The ore is associated with feldspar, pyroxene, hornblende, quartz. All the ore minerals are disseminated through the surrounding rock (Loveman, 1911).

The sequence of ore deposition was pyrite first, followed by magnetite, with pyrrhotite and chalcopyrite last. The relative age of pyrrhotite to chalcopyrite has not been determined. In thin sections can be seen reaction rims around the magnetite of successive fringes of titanite and biotite. The presence of titanite is indication that the magnetite is titanium-rich and is partly ilmenite Loveman (1911) has proposed the following sequence for the local geology and ore body:

1. The quartz diorite country rock was intruded by a monzonite. Followed by dynamic disturbances which produced a gneissoid character to the intrusion and country rock.

2. A second intrusion of a pyroxene diorite intruded at the contact between the monzonite and the country rock. This intrusion was to become the wall rock of the ore body.

3. This second intrusion, mentioned previously, was likely a line of weakness and was subsequently highly fractured by local faulting producing a crush zone that provided voids for the future ore deposition.

4. Hydrothermal water deposited pyrite in the crush zone and in part replaced the silicates of the diorite.

5. Further shattering provided additional voids. Additional hydrothermal solutions deposited the magnetite then the pyrrhotite. The chalcopyrite appears to be simultaneous to the pyrrhotite deposition.
**Mine Workings**

There are two tunnels and one main shaft at the Philips Mine with several smaller shafts or inclines that may have been used for venting or ore haulage (figures 15 & 16). The upper tunnel runs south-southeast 68 feet, is five by six feet in section, and terminates 60 feet above the water level. The tunnel contains no timbering. The portal to the upper tunnel (fig. 13) is 56 feet below, and 70 north, of the main shaft. The lower tunnel runs south-southeast 300 feet to the ore body. The water level is presently up to the lower tunnel, making entry impossible (fig. 17). The lower tunnel portal (fig. 18) is 305 feet north-northwest, and 120 feet below, the main shaft (Zodiac, 1933).

The main shaft is at 750 feet above sea level and is roughly 20 feet in diameter. There is presently a chain link fence surrounding the main shaft to prevent entry. The main shaft is
inclined to the northeast, following the strike of the ore body. About 24 feet below the shaft it opens into a large excavated chamber. The central chamber was likely the merging of several levels of mining to follow the ore. Zodac reports, that during his inspection during 1932, the size of the chamber visible above the water level was 150 feet long by 20 feet wide and 85 feet high to the roof, with a smaller room off to the side that is 30 feet long by 30 feet wide by 12 high (Zodac, 1933).

Figure 18 - Portal of the lower tunnel. The water level of the mine is currently to the level of this portal and iron precipitated from the mine runoff can be seen in the foreground.
However the best description of the internal workings of the mine can found in the journals of William T. Howell (1873-1916). Howell (fig. 19) was a well known hiker in the New York and New Jersey highlands, and even served as a guide to the noted geologist Charles Berkey in his explorations of iron old mines in the area. Howell visited the Philips Mine several times during 1906 and 1907 and his journal recorded the events of the trips. In 1982 his journals were republished by Walking News, a New York based hikers organization, as *The Hudson Highlands* containing volumes I and II of his original writings. The following entry records his impressions of his first visit to the mine in 1906:

*When we came upon the mines, far up the mountain sides, we were forced to confess ourselves surprised beyond all expectations. An enormous mass of excavated material had been thrown out to form deposits comparable in size to one of the culm heaps one finds in the Pennsylvania coal regions. We found three shafts. The lower one, though entering on a level, had enough water in it to prevent us from entering very far. A strong cold draught of air, sufficient to blow out a lighted match, issued from the mouth of the opening. Where did it come in? The second adit, also level, we followed for some distance, but the lack of lights prevented extensive exploration.*

*Finally we came to the great opening at the very summit of the works, far above the culm-like deposit of bright red rocks which we had encountered lower down. We both exclaimed in astonishment as we came upon it in climbing up the slope. It was a great cavern, dropping down to unknown depths. Many feet down one could, by craning over the perilous edge, just see water. A shaft deep down led off somewhere toward the west; another half way up went southward toward the center of the mountain. We tossed a stone in. The effect was weird; almost awesome. We heard it strike once; a moment's silence, and it struck again; then followed a splash in a pool of water; once more a brief silence, and then a ker-chug in deep water, and a boom and a multitude of echoes came rushing up the hole to scare the wits out of one.*

After Howell's first visit to the mine it was reopened in search of copper ore. Under the direction of John Woodcock, mine foreman, the mine was dewatered and ore was blasted from one of the remaining pillars in the mine. *(Peekskill Union, January 28, 1907)* When Howell returned to the mine he reported the following:

*FEBRUARY 3, 1907.- A change has recently come over these mines. A ditch may be seen leading out of the entrance there, and a quantity of lumber half buried in the snow...*

*Since our last visit a canvas door has been added at the entrance, undoubtedly for the purpose of shutting off the great draught of air which tends to pass through the shaft. Last summer when S. and I paid our visit to this entrance, on a hot June day, a cold draught of remarkable force was blowing outward from the hole. The atmosphere in the mine being so much lower in temperature than the outside air was of course the reason for this. As the cooler, heavier air of the mine flowed out of this shaft, its place was taken by air sucked in at the large opening further up the mountain.*
Today the rush of air at this entrance was inward. This merely proves the correctness of the theory just advanced. The atmospheric conditions are now the reverse of those which prevailed last June, the air in the mine being warmer instead of cooler than the outside air. Hence it tends to ascend through the upper opening, creating a strong suction inward at the lower entrance. So great was this suction that when we entered the mine the pull upon the canvas door was so great as almost to upset us, and we could scarcely hold it back...

For several hundred feet we passed along a level straight shaft, so low that we had to bend our heads. Roy wore a derby which he kept butting against the rock ceiling until it was a total wreck, to my intense joy. He was leading at this time, and talking. Suddenly his voice apparently changed from a normal tone to a roar, which was taken up by distant walls of rock and echoed and re-echoed. He jumped back exclaiming that he had nearly walked off into a black chasm.

What had really happened was that we had suddenly emerged from the shaft into a large chamber; the supposed chasm was a pool of water, apparently very deep. Later, with the aid of a torch, we found this pool to be about seventy-five feet in diameter, and at the far end a half-submerged shaft led to the northeast. The dome-like walls and ceiling above the pool had remarkable acoustic properties, and were responsible for the echoes which had startled Roy.
The pool was on our left; on our right was a striking vision. From some unknown point far above, the daylight came down, showing cliffs and overhanging shelves of rock all about the aperture there. At our feet stretched away and disappeared around a turn a second pool of water so still and black that for an instant it deceived us into believing we were standing on the edge of a precipice looking down into great abysses...

Coming into the shaft we had encountered a wheelbarrow and various tools, including a pick, a spade, a pair of overalls, and several sledges, belonging to the recent prospecting miners. They looked as though they had been there since the days of Adam.

In the large chamber we found other tools, including a sharp axe, a broken miners’ lamp filled with kerosene, and a package of dynamite! We left the last named article undisturbed, reasoning that it didn’t belong to us and we ought not to touch it!

FEBRUARY 17, 1907.-Since our visit to the old copper mine two weeks ago, the following item has been published in a Peekskill paper:

"The temporary work at the old copper mine, near Highland Station, has been brought to an end pending the report made on the analysis of the ore taken out.

"A force of men in charge of John W. Woolcock, entered an old tunnel after lowering the water, and at a distance of three hundred feet in the mine, blasted about ten tons of ore from one of the pillars.

"The ore was found to contain copper, nickel and sulphur, being very rich in the latter, but as phosphorus is mixed with it, it is not known yet whether it will pay to mine it. After the sulphur is burned out of the ore, the asbes will be re-burned to see if the copper and nickel are there in paying quantities.

"If the ore taken out is found to be rich enough to pay for the mining, work will be started immediately, as the ore further down in the mine is much richer, as the tunnel where Mr. Woolcock entered to get specimens for the test was abandoned when the mine was being worked before to go lower down to get at a much richer vein."

An interesting change had come over the interior of the lower shaft where we had gone in on the occasion of our last visit. The shaft was rapidly filling up with ice, in the form of crystal stalactites and stalagmites, formed by the slow dropping of water from the roof. I understand that the miners recently at work here found this entrance quite blocked with ice, and had to chop their way several hundred feet through the strange obstacle. Now, with their departure the shaft is again filling up, and by next Sunday may again be quite impassable.
Figure 20 - Photo of the upper tunnel to the Philips Mine during February, 1907 with large ice stalactites that prevented the photographer from entering the mine. (Howell, 1934)

About twenty feet within the entrance of this stately hall, as we might well term it, we placed the camera, and focusing it as well as we could in the dim light there, opened the camera shutter and retreated into the outer air, so as to allow as much light as possible to penetrate into the mine. We walked about among the snow drifts outside, smoking and enjoying the scenery from the mountainside, for eleven minutes, at the end of which time we returned and closed the camera shutter. With this long exposure, which had been carefully figured out from previous experiments in taking house interiors, we obtained a remarkable picture (fig. 20). Features of the shaft were caught by the sensitive plate which we had not been able to perceive with the eye.

After progressing a comparatively short distance into this place, quite in the dark, a strong draught of air making it impossible for us to keep our candles lighted, we perceived a dim light ahead. It should be remarked that this shaft was quite as notable for the snow drifts which lined its course as the lower shaft was for the ice effect. The snow had been carried in on the wings of the strong current of air which passed over our heads in the direction we were going. With a rope around my waist, the other end being held by Calkin and Peck, I now crawled forward on my belly through the snow, and soon came to the abrupt end of the shaft, which opened out on a great chamber, of unknown size to us then, and dark as night except on the right, where a shaft of light bent around a shoulder of rock a long distance above us.
Lying flat, with half my body extended out into space, I felt around and discovered that the big chamber into which our tunnel opened extended not only above but below our perch. I was looking over a cliff, and our pathway ended in a hole in the wall of the large chamber somewhere between the chamber's floor and roof. A lovely shaft to walk through in the dark, suddenly stepping off into nowhere! We found it all most interesting, and speculated as to where we were. Then we retraced our steps and went still further up the mountain to the big hole which drops straight down at that point. Just above this perpendicular chasm we discovered for the first time a narrow hole penetrating a great snowdrift, apparently, and came to the conclusion that it led to a chamber which branched southward from the side wall of the large chasm...

...One of its windows was the long shaft by which we had entered. Another was a circular opening directly in the middle of the roof, like a skylight in a dome. A third was the big entrance hole of the great perpendicular shaft of which this chamber was an offshoot to the south. From a small excavation in the southern extremity of this chamber I took a photograph, looking out into the great shaft, and showing in the foreground a drift of snow which had sifted down from the skylight above.

This first-hand account of exploring the mine during the dewatering provides the most detail of any description found in geological literature. Though Howell was not familiar with mining to provide an accurate interpretation of the excavations that he witnessed, it does give a sense of the amount of ore removed and the convoluted, complex underground workings.

Beside the underground working there are extensive dumps throughout the site that are likely to be the most interest to today's mineral collectors. Due to the concentrated iron and sulfur content of the mine dump, little vegetation has grown on the dumps (evident in aerial photographs of the site in fig. 16). Below the lower tunnel, to the north, there are several dumps (fig. 21) covering a wide area. The next largest dump is located downhill (north) of the main shaft.

Also of interest to present-day collectors are the many prospect pits to the south, southwest and west of the main shaft scattered in the woods. Both Zodiac (1933) and Klemic et al. (1959) report interesting mineralization. See Figures 15 and 16 for locations of known prospect pits.

![Figure 21 - Large dumps north of the lower tunnel. Note that little vegetation has grown on the dumps even though mining ceased over 90 years ago.](image-url)
Mineralogy

The following summary is derived from observation during the summer of 1997 and from Peter Zodac's (1933) exhaustive article on the mine.

Albite in massive greenish to gray-green to brown in association with black hornblende. Generally, as with most minerals from Philips Mine, the albite is heavily stained with limonite, penetrating the mineral to the extent that identity is obscured. The green variety of albite is attractive as a mineral specimen and is best found at the lowest dump at the Philips Mine.

Actinolite occurs as gray-green, poorly crystallized masses in altered rock or with magnetite. Also present as a constituent of the albite porphyry at the mouth of the middle tunnel as small masses and grains.

Amphibole var. Amianthus (Brucite ?) is found at the Philips Mine in small fibers with asbestos in minute veins in hornblende.

Amphibole var. Asbestos is found in several specimens as small tufts in crevices and minute veins in hornblende.

Apatite is the most collectable mineral at Philips Mine because they occur as translucent to opaque brown, yellow or green crystals up to one and a half inches long (fig. 22). They are best found within masses of pyrrhotite and are closely associated with pyrite often and the contact of these two sulfides. There are reports of crystals up to two inches long and another one and a half inches diameter (Zodac, 1933), however the larger crystals are often poorly crystallized and difficult to find unbroken. The collector can expect to find lustrous, doubly terminated crystals up to three quarter of an inch long without much difficulty. Reportedly the best crystals are found in pyrrhotite nodules that apparently were the nucleus around which the pyrrhotite formed. These are said to be found abundantly east of the upper tunnel, though the author has not found any such nodules during recent visits to the Philips Mine.

Aragonite occurs as encrustations of poor quality coating various minerals.

Figure 22 - Apatite in iron-stained pyrrhotite collected 1997. The crystal is doubly terminated and is a ½ inch long.
Arsenopyrite from the Philips mine is listed in the collection of the New York State Museum in Albany.

Barite was present in one specimen at Philips Mine found as amygdaloidal form in altered rock. This nodule contained minute grains of pyrite and was coated with a thin blue crust, apparently a copper sulfate.

Biotite is common as a primary constituent of the Canada Hill granite where a crude orientation of the biotite gives the granite a layered, foliated appearance. At the Philips Mine with it is associated with hornblende, magnetite, labradorite and apatite.

Calcite is abundant but not as collectable minerals specimens. Occurs as tabular, colorless masses in granite and as gray crystallized clusters on augite.

Chalcopyrite occurs at Philips Mine as massive, often brightly colored (peacock ore) associated with black hornblende.

Epidote is common in lenticular pods throughout the Canada Hill granite. It is found at the Philips Mine at westernmost prospect pits in the fault plane of the granite. Also visible as small yellow grains in quartz at the prospect pits.

Gypsum, var. Selenite is common at Philips Mine as micro crystal coatings in cavities and on other minerals. It is likely that these crystals formed since mining began as it is visible in the tunnels and on heavily decayed minerals on the dump.

Hematite as botryoidal formations resembling psilomelane occurs at the Philips Mine and as red coatings of magnetite. Slag-like specimens can be found at lower dumps and in the soil south of the mine road. These may be the by-product of an on-site smelting furnace, though there is little evidence that smelting took place at the mine.

Hornblende is common at Philips Mine as large masses and coarse crystalline specimens up to two feet long (Klemic et al., 1959). Associated with green albite on the lower dump of Philips pyrrhotite mine. Also occurs with augite, magnetite, pyrite, apatite and quartz. The best specimens of this mineral occur as small green crystals on magnetite and augite or as slender black crystals in small cavities in the hornblende masses.

Langite, possibly the first occurrence of this in America was reported at the Philips Mine by Zodiac (1933):

The best "find" at the mine is langite, a hydrous copper sulphate, which was found September 9th (1932), by Mr. Charles Travis. It occurs in minute, well-crystallized, bluish-green prisms in altered rock, and is associated with at least one other copper mineral, and possibly two, whose identifications have not yet been determined. This is believed to be the first occurrence of the mineral in America, and possibly the second in the world, as it has heretofore been listed from only one locality, Cornwall, England.
Magnetite was once the principal ore at Philips Mine when the mine was worked in the early years for iron ore. It is found commonly on the dumps, notably at the northwest of middle dump. Magnetite is associated with hornblende and augite and can be found in large masses on the dumps. No crystals have been reported from the mine.

Oligoclase occurs as massive specimens and is a common mineral in the surrounding country rock.

Opal, var. Hyalite was found in a single specimen from a prospect in the fault plane of the granite. The specimen was small but showed botryoidal form. (Zodiac, 1933)

Orthoclase is common as part of the Canada Hill granite and as part of the dark hornblende gneiss visible at the mouths of the tunnels.

Pentlandite from the Philips mine is listed in the collection of the American Museum of Natural History in New York City.

Pyrite is widespread on the dumps at the Philips Mine as cubic masses within the pyrrhotite and recognizable by the bright yellow color. It is associated with magnetite, hornblende and albite.

Pyroxene, var. Augite is common as large masses. A five and a half pound specimen was found at the Philips Mine that measured 5 x 4 x 2.5 inches on the lower dump (Zodiac, 1933). Augite is associated with magnetite, hornblende and milky quartz and is common as an alteration of the older hornblende in the pegmatites.

Pyrrhotite is the most common mineral on the dumps at the Philips Mine. It is likely that this is due to the later workings of the mine for sulfur for the production of sulfuric acid that focused on sulfur-rich ore. It occurs as nodules and as massive ore. The nodular variety invariably has a euhedral apatite crystal in its core. Due to the long exposure to weather of the ore on the dumps, the pyrrhotite has been heavily stained with alteration minerals of iron. To date the author has not successfully found a way of cleaning this iron staining, making collecting the pyrrhotite fruitless at this time. However since the nodules contain the apatite crystals they are worth looking for.

Quartz is present as constituent of the gangue rock commonly showing crystal form however quality free crystals have not been seen on the dumps recently.

Titanite in well crystallized specimen at Philips Mine. It should be noted that Zabriskie (1995) misidentifies titanite as vesuvianite.

Uraninite was found as grains and crystals 1 to 25 mm long associated with magnetite and hornblende in the pegmatite bodies near the mine. The uraninite was dated by isotopic dating to 920 million years old (Klemic et al., 1959). Uraninite is found in greater concentrations in the prospect pits southwest of the main shaft along the mine road.
Alteration minerals from the iron ores: limonite, goethite, copiapite, melanterite, lepidocrocite. (Zodiac, 1933)

Current Status and Access

Presently the original mine road from the northeast is closed because it crosses through private property (fig. 10). It is posted No Trespassing and collectors are advised to stay clear of these houses. (As of the summer of 1997, several of these properties, with nice summer homes, were for sale.)

The Appalachian Trail passes within 200 yards of the lower mine dumps, in the section south of South Mountain Pass Road. From the east end of Bear Mountain Bridge, drive north along Route 9D to South Mountain Pass Road, turn right and proceed approximately .7 mile to a small turn out on the right. This is where the Appalachian Trail from the south meets the road. Park off the road near the trail. Hike south along the Appalachian Trail (white trail markers). Continue 100 feet past the metal vehicle gate, and then bushwhack uphill to the left through the trees for 300 feet. If you encounter a small stream, stay to it’s right and this will lead you to the lowest mine dump. From here the mine areas are clearly visible through the woods, as no vegetation can grow on the iron oxide saturated ground. The lack of vegetation can be seen as you are bushwhacking uphill as an area of no tree cover—keep heading towards that opening and you will encounter the mine within 100 yards.

It is possible to find the mines by continuing on the Appalachian Trail further to a blue blazed trail the goes uphill to the left. Old topographic maps show the Appalachian Trail went this way to a spring on Mine Hill, then passed thorough the mine workings. However this route has not been well mapped recently and it is safer to follow the route suggested.

Most minerals are encrusted with iron oxide coating making collecting and field identification difficult. Larger rocks must be broken open to expose fresh surfaces and cavities for collectable mineral specimens. Pyrrhotite ore is easily recognized on the dump by the iron oxide (limonite/goethite) coating. The product of the decay of the pyrrhotite drips around to the bottom of each nodule forming a coating and conglomerating with nearby rocks and debris.

Apatite is associated with pyrrhotite nodules that contain the bright yellow pyrite, often near the contact of the two minerals. Apatite varies from brown to green to yellow. Most of the larger crystals are opaque while the smaller crystals (<2mm) can be very translucent.

Cool breeze strongly emanates from the upper tunnel (fig. 13), caused by air entering the large shaft being cooled by the surrounding rock creating downward flow. The lower tunnel is partly caved at the entrance and water filled, preventing air from escaping at that level.

There are several known prospect pits scattered southeast, south and southwest of the main shaft. The furthest of which is 500 yards southwest. The known prospects are mapped in Figures 15 and 16. These prospects have also been a source of minerals for collectors.
ROUTE 6 ROAD CUT, CORTLANDT, WESTCHESTER COUNTY, NEW YORK

This location is the only modern site included in this article. In March, 1991 the New York State Department of Transportation widened the road cut opposite the scenic overlook on Route 6, three quarters of a mile southeast of the Bear Mountain Bridge. The excavated rock was dumped down the embankment northeast of the parking area (Zabriskie, 1992).

Driving from the eastern end of Bear Mountain Bridge, follow Route 6 three quarters of a mile southeast of the bridge to the scenic overlook. Park at the overlook. Collecting at this site is best in the excavated rock that was dumped down the hill across Route 6 from the road cut northeast of the parking area (fig. 23). After parking, hike east along Route 6 for 50 yards then proceed downhill carefully, as the dumped rock can be unstable.

This location was the site of a New York Mineralogical Club field trip in 1994 during which many different mineral species were collected. At the time the dumped rock was fairly fresh as was the road cut that was widened. Upon inspection in 1997 the road cut was found to be extensively overgrown with high weeds. Since the actual road cut itself has never been the primary focus of collectors, this situation is unimportant. The dumped rock in the collecting area also shows overgrowth but is still accessible to collectors. Recently, several additional mineral new mineral occurrences have been identified from this location by field collectors.

Mineralogy

Following is a summary of the known minerals found at the Route 6 road cut:

Figure 23 - Top, view from scenic overlook parking area east along Route 6. The collecting area is downhill to the right. Bottom, view of the rock dumped during the 1991 widening of the road cut.
Apatite - collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Chabazite - orange rhombohedral crystals, confirmed by X-ray identification, were collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Chondrodite - scarce, unverified.

Clinohlore - common as crystals in cavities associated with epidote (fig 24).

Epidote - both massive and crystalline forming bright green micro crystals and in pockets associated with clinohlore (fig. 24). This is the primary mineral of interest to collectors at the Route 6 road cut.

Feldspar - in a cuttable grade that could be called moonstone.

Gahnite - as crystalline specimens were reported by D.O.T personnel during the blasting, though positive identification has not been made to date.

Hematite - many bladed crystals up to ½ inch found on one specimen.

Hornblende - as crystals in pockets and massive crystals in the surrounding rock.

Magnetite - scarce.

Heulandite - collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Natrolite - as long acicular crystals in cavities up to two inches long (fig. 24). Often coated with flesh colored stilbite completely obscuring the natrolite except where crystals have broken (fig. 25). This may turn out to be mesolite or scolecite as testing has not been completed.

Pyrite - widely scattered through the dump especially to the northeastern end, furthest from the parking area. Pyrite specimens are easily found as the surface is heavily rust stained and the heavy weight are sure indicators. Upon breaking open these specimens the cubic crystal structure can often be identified.
Stilbite - as micro crystal coatings upon natrolite crystal (fig. 26) giving the appearance of thick, fuzzy acicular crystals. Where these have been broken the square cross section of natrolite is distinctly visible. Stilbite also found as radiating crystals in narrow seams in the surrounding rock.

Titanite - massive gray and rarely as crystals, confirmed by X-ray identification, were collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Vesuvianite - recently reported by Zabriskie (1995) however positive identification has not been made at this point in time.

Since this is the youngest site on Anthony’s Nose it has received much less scrutiny by collectors and professionals. Therefore not much has been written about the location. The relative freshness of the rock on the dump makes this site better for collectors compared to the 100 year old rock available at the other two locations. The author suspects that as this site receives more attention that additional minerals will be added to the list above.

CONCLUSION

The author hopes that by mapping mineral locations and clarifying the mineral occurrences at each site, that collectors will once again turn their attention to these sites for field collecting. The sites in this paper, that are up to 150 years since old, are extreme examples of lost sites that still offer collectors potential for good specimens.

ACKNOWLEDGMENTS

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specimen in his collection and assistance in researching the mineral literature; Alex Gates of Rutgers University, Newark, NJ for reviewing the geology; Dr. William M. Kelly and Mike Hawkins of the New York State Museum. A special thanks is extended to Mike Hawkins for sharing first-hand information, assistance in researching the localities, obtaining illustrations and reviewing this paper for accuracy.

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MILLINGTON QUARRY REVISITED: A REVIEW OF RECENT MINERAL OCCURRENCES

Martin Becker
54 Balsam Street
Wayne, New Jersey 07470

INTRODUCTION

Located in Somerset County New Jersey, Millington Quarry has received much less attention than the historic Paterson and Prospect Park localities for being a producer of fine trap rock specimens. Collecting at the quarry is not permitted by the owners, however permission has been occasionally granted to local rock and mineral clubs. This permission coupled with the sporadic appearance of specimens at regional gem and mineral shows has made a limited number Millington minerals available to collectors. Cummings (1985) notes that expanding operations in late 1980’s has recently made the quarry, which began operations in 1895, an important producer of mineral specimens.

GEOLOGY/MINERALIZATION/ZONATION

Millington Quarry is situated in the lowermost southwest extension of the Hook Mountain Basalt or third Watchung Mountain (Fig. 1). This basalt is the youngest of three major flood basalts that formed in response to Mesozoic rifting associated with the breakup of Pangea. The three major flood basalts comprising the Watchung Mountains, the Orange Mountain Basalt, first flow, the Preakness Basalt, second flow, and the Hook Mountain Basalt, third flow, are separated by reddish-brown sandstones, siltstones and shales of fluvial and alluvial origin.

The Hook Mountain Basalt was deposited during the Jurassic in two separate flow events on top of the Towaco Formation which dips to the northwest. The contact between the Towaco Formation and overlaying Hook Mountain Basalt can be observed in the lowermost excavation area of the quarry.

Cummings (1985) delineates four well defined zones of mineralization based on variations in basaltic composition. The majority of mineralization within the quarry reflects the northwest structural dip of the Towaco Formation and occurs primarily near the top of interfaces between the four zones identified by Cummings (1985). The paragenesis for minerals of the Watchung Basalts is carefully explained in Peters et al. (1978) and includes five crystallization periods: 1) the saline period; 2) the quartz period; 3) the prehnite period; 4) the zeolite period; and 5) the calcite period. (For a detailed explanation of zonation: see Cummings, 1985; paragenesis: see Peters et al., 1978).
MINERALS

The Cummings (1985) compilation of mineral specimens from Millington Quarry lists twenty-four secondary minerals and indicates the common occurrence of apophyllite, analcime, natrolite and iron sulfides. My experiences in the quarry identify prehnite, apophyllite, datolite and calcite to be among the most commonly occurring minerals in all four zones (Fig. 2).
The following compilation and description of mineral specimens represents some of the more well crystallized and/or rare specimens I have observed or acquired over the last ten years. As with any mineral collection, personal preferences as to what is exotic or “collection worthy” takes place in this discussion and pictorial.

<table>
<thead>
<tr>
<th>Mineral Name</th>
<th>Chemical Composition</th>
<th>Crystal System</th>
<th>Cleavage/Fracture</th>
<th>Hardness</th>
<th>Luster</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analcime</td>
<td>NaAlSi₃O₈·H₂O</td>
<td>Isometric</td>
<td>(001) perfect</td>
<td>5.5-5</td>
<td>vitreous</td>
<td>white</td>
</tr>
<tr>
<td>Apophyllite</td>
<td>KC₆₃(Si₂O₇)_{3}·F·8H₂O</td>
<td>Tetragonal</td>
<td>(010) perfect</td>
<td>4.5-5</td>
<td>vitreous, pearly on (001)</td>
<td>colorless, white, pale green, yellow and rose</td>
</tr>
<tr>
<td>Calcite</td>
<td>CaCO₃</td>
<td>Hexagonal</td>
<td>(1011) perfect</td>
<td>3</td>
<td>vitreous to earthy</td>
<td>white to colorless, gray, red, green, brown</td>
</tr>
<tr>
<td>Datolite</td>
<td>CaB(SiO₃)(OH)</td>
<td>Monoclinic</td>
<td></td>
<td>5-5.5</td>
<td>vitreous, waxy</td>
<td>white, green and yellow</td>
</tr>
<tr>
<td>Heulandite</td>
<td>Ca₂Al₂Si₆O₁₇·6H₂O</td>
<td>Monoclinic</td>
<td>(010) perfect</td>
<td>3-3.5</td>
<td>vitreous, pearly on (010)</td>
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<td>FeS₂</td>
<td>Isometric</td>
<td></td>
<td>6-6.5</td>
<td>metallic</td>
<td>pale brass yellow</td>
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<tr>
<td>Sphalerite</td>
<td>ZnS</td>
<td>Isometric</td>
<td>(011) perfect</td>
<td>3.5-4</td>
<td>resinous</td>
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<td>Natrolite</td>
<td>Na₂Al₂Si₃O₉·2H₂O</td>
<td>Orthorhombic</td>
<td>(110) perfect</td>
<td>5-5.5</td>
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<td>Hexagonal</td>
<td>conchoidal</td>
<td>7</td>
<td>vitreous</td>
<td>clear, smoky, purple, white</td>
</tr>
<tr>
<td>Stilbite</td>
<td>NaCa₂Al₂Si₃O₉·14H₂O</td>
<td>Monoclinic</td>
<td>(010) perfect</td>
<td>3.5-4</td>
<td>vitreous, pearly on (010)</td>
<td>white, yellow, red, brown</td>
</tr>
<tr>
<td>Pectolite</td>
<td>Ca₂Na₂H(SiO₄)₂</td>
<td>Triclinic</td>
<td>(001) {100} perfect</td>
<td>5</td>
<td>vitreous to silky</td>
<td>white, red, gray, orange</td>
</tr>
<tr>
<td>Prehnite</td>
<td>Ca₂Al₂[Al₂Si₃O₉]·(OH)</td>
<td>Orthorhombic</td>
<td>conchoidal</td>
<td>6-6.5</td>
<td>vitreous</td>
<td>light green and yellow</td>
</tr>
</tbody>
</table>

(Fig. 2) Common physical properties of Millington Minerals discussed in text. Physical properties of minerals compiled from: Cummings (1985); Klein and Hurlbut (1985); Peters (1984); and Peters et al., (1978).

**Analcime:** Analcime at Millington Quarry occurs as white, translucent, trapezohedrons averaging 2 centimeters or less (Fig. 2); (Photo 1). Samples of analcime tend to be quite rare and characteristically associated with the lowermost portion of the quarry along the interface of zones one and two. Larger analcime crystals occur within gas pipes of dark black basalt containing minor amounts of chalcedony and pyrite.

**Apophyllite:** Apophyllite is a commonly occurring mineral within the quarry and can be found within all four zones. Some of the more desirable specimens among collectors grow as rosettes of green, pink, or clear crystals (Fig 3); (Photo 2). Crystals typically grow in combinations of {110}, {011}, and {001} forms and can resemble a combination of a cube and octahedron. Apophyllite crystals, up to 5 centimeters, are frequently associated with datolite, pectolite, calcite, prehnite and pyrite occurring in gas pipes and vugs. Tiny apophyllite crystals occasionally frost prehnite specimens.
Calcite: Perhaps the most abundant mineral in the entire quarry is calcite, occurring in all four zones of the quarry in vugs, gas pipes, veins and within vesicles of scoriaceous basalt. Calcite crystal up to 10 centimeters occur in clear, white and yellow and in more rare instances brown colors with luster ranging from transparent to opaque (Photo 3). Typical crystal forms encountered include: e\{011\}; r\{101\}; f\{022\} and v\{213\} (Fig 3). Calcite commonly is associated with most mineral species in the quarry.

Datolite: Datolite crystals are concentrated in the lower two zones of the quarry and become progressively more rare in the third and fourth zones. Waxy to vitreous crystals, up to 1 centimeter, occur in light yellow to green colors and frequently form the lining of gas pipes and vugs. The largest of monoclinic crystals are nearly equidimensional with respect to the a, b and c
axes of symmetry. Smaller datolite crystals are commonly associated with apophyllite, pectolite and small pyrite crystals.

Heulandite: As with analcime, samples of heulandite tend to be very rare at Millington Quarry. Clear, white and yellowish-brown crystals, up to 2 centimeters, tend to be vitreous with pearly luster on the {010} face (Fig. 3). Heulandite tends to be concentrated in vugs associated with scoriaceous basalt at the interface between zones 2 and 3. Small crystals of stilbite and calcite commonly occur with heulandite (Photo 4).

Natrolite: Acicular, radiating crystal groups of natrolite, up to 5 centimeters, infrequently occur in vugs and gas pipes along the interface of zones one and two in the lowermost part of the
quarry. Blasting characteristically destroys most specimens of this delicate mineral (Photo 5).

**Pectolite:** Gas pipes and vugs of pectolite occur in the lowest portion of the quarry along the interface of zones one and two. Crystals grow as densely packed aggregates of radiating crystals. White is the most common color of pectolite at Millington Quarry, however, more rare varieties of brick red and orange exist. Pectolite can occur with apophyllite, calcite and datolite (Photo 6).

**Prehnite:** Prehnite occurs throughout the entire quarry in all four zones. Lusters and colors of prehnite are highly variable, ranging from waxy to vitreous in shades of yellow, light-green and greenish-yellow. The best specimens occur as isolated, botryoidal crystal groups, up to 3 centimeters, in vugs and gas pipes along the interface of zones one and two in the lowest part of the quarry (Photo 7). Prehnite commonly occurs with calcite, apophyllite and pyrite.

**Pyrite:** Small pyrite crystals, less than 0.5 mm, are commonly associated with apophyllite, datolite and prehnite. Crystals grow in a variety of forms including pyritohedron, octahedron, combinations of pyritohedron and octahedron, and twinned pyritohedrons (Fig. 3). The greatest concentrations of pyrite crystals occurs in lowermost two zones of the quarry.

**Quartz:** Quartz is common to Millington Quarry and typically crystallizes in vugs and gas pipes in all four zones. The best specimens occur in dark black basalt which contains solution pyrite and chaledony. Smoky, clear and milky quartz are much more common than the amethyst varieties (Fig. 8); (Photo 8). Crystals up to 1.0 centimeters are not uncommon and can be associated with calcite, hydrocarbons and more rarely, selenite.

**Sphalerite:** Rare sphalerite crystals, in both black jack and ruby jack varieties occur in the quarry. Crystals, up to 1 centimeter, grow as tetrahedrons and dodecahedrons on prehnite and datolite in vugs and gas pipes associated with zones one and two (Fig. 3); (Photo 9).
Stilbite: Tan, botryoidal aggregates of stilbite crystals up to 3 centimeters, infrequently occur along the interface of zones two and three. These botryoidal crystals can be associated with small, less than 1 centimeter, isolated sheaf-like aggregates of crystals (Photo 10). Stilbite tends to be concentrated in vugs of scoriaceous basalt and can be associated with heulandite and calcite.

![Images of different minerals]

Figure 3 - Some common crystal forms displayed by Millington minerals. Compiled from Klein and Hurlbut (1985) and Peters (1984). Crystal forms include: a) isometric: trapezohedron; b) monoclinic: {010} prominent; c) tetragonal: combination of {110}, {011} and {001} forms; d) isometric: tetrabedron; 3) hexagonal: forms include e{01{12}}, r{10{11}}, f{02{21}} and φ{21{21}}; and f) isometric: pyritohedron, octahedron, combined pyritohedron and octahedron and octahedron and twinned pyritohedrons.

CONCLUSIONS

The established reputation of the more famous Paterson and Prospect Park localities for producing fine trap rock mineral specimens is one which has been developed for over one hundred years (e.g. Peters 1984 and Peters et al., 1978). In contrast, Millington Quarry offers collectors current and exciting alternative assemblages of trap rock minerals which differ in color, luster and crystal habit relative to these localities. Undoubtedly, continued mining
operations will result in a reputation at the Millington Quarry for being a producer of fine trap rock mineral specimens which rival more historic New Jersey mineral localities.

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CONNECTICUT IRON AND THE ROXBURY IRON MINE

Edward Force
42 Warham Street
Windsor, Connecticut 06095

INTRODUCTION

Iron deposits often form at the bottom of bodies of water, where particles of oxidized iron, eroded from older rock and carried by streams, fall to the bottom when streams reach lakes, swamps, or oceans that stop their flow and make them drop their sediments. The iron accumulates on the bottom, where it is covered with silt. In time a layer of "bog iron ore" (iron oxide) builds up. This ore, goethite or limonite, was dug out of swamps and smelted in Connecticut and elsewhere in Colonial days as a source of iron.

But the iron that settled in the coastal waters of the Iapetus Ocean along the shores of Proto-North America was subjected to tremendous pressure and heat later. Five hundred million years ago, the Iapetus Ocean stretched from Proto-North America to Proto-Africa, with an island group called Avalonia halfway in between. Then the continents slowly began to move toward each other, ultimately forming the super-continent of Pangaea. In the process, the floor of the Iapetus Ocean, being thinner and thus lighter than the rock of the land masses, rose above the land plates and was squeezed, twisted and compressed into metamorphic rock.

Once Pangaea had formed (about 250 million years ago), it began to pull apart. Cracks formed between pieces of land in the process. One crack widened into the Atlantic Ocean. Proto-North America, the Iapetus Terrane (the former ocean floor), and Avalonia were all on the west side of it. They had been squashed together and now were all part of North America. Another big crack formed in the Iapetus Terrane about halfway between the Proto-North American and Avalonian Terranes. A body of water was formed here, and its bed filled with sediment which became the Newark Terrane, the bedrock of Connecticut's Central or Triassic Valley.

The land west of this body of water (which later became dammed near Middletown and formed Glacial Lake Hitchcock) became Connecticut’s Western Highlands. Erosion cut the highlands down and exposed much that had been buried, and the glaciers bulldozed the land even more--two to four miles deep. By the time the first settler’s arrived, numerous iron deposits in northwestern Connecticut were at or very near the surface, and it was not long before the colonists, eager to find usable metals, discovered them.
CONNETICUT IRON AND THE ROXBURY IRON MINE

COLONIAL MINING

The colonists smelted the bog iron ore first, for it was easy to obtain and easy to smelt. When bog iron was found in the New Haven-Branford area, John Winthrop, Jr., who had smelted iron in Massachusetts, was called to New Haven and began to mine iron in 1648. Within ten years he was operating a blast furnace at the south end of Lake Saltonstall in East Haven. Other furnaces were built wherever bog iron ore was being mined: Killingworth, Voluntown, Stonington, Woodstock, Stafford, Hebron, etc. Bog iron ore was even found in my home town of Windsor and smelted along Stony Brook in Suffield.

About a century later, Jared Elliott discovered that the black beach sand along Long Island Sound contained iron. In fact, you can still collect it by running a magnet through black sand. Eliot had it smelted and made into steel at his son’s furnace and forge in Killingworth, wrote a book describing the process, and won a gold medal from the Royal Society of Arts in London. But he never produced enough steel to make his fortune.

The colonists needed more iron than they could get out of the swamps of Connecticut, so they kept an eye open for iron ores while they hunted for gold and silver. Iron ore was found on Mine Hill in western Roxbury and first mined in 1724, but not much was accomplished in its first quarter century. Then a clever German promoter had a bright idea. A little sphalerite and galena had been found at Roxbury, and he knew that there is often a little silver where there is galena. Since there was very little galena at Mine Hill, there wasn’t enough silver there to make mining it feasible, not to mention profitable, but he sold stock in a silver mine anyway—like every other silver mine in Connecticut, it mined most of its silver from the pockets of its investors! The promoter seems to have cast a few bars of iron which he painted silver, but whatever his well paid workmen did in his employ was kept quiet, though in the end, the investors ascertained or at least suspected the truth and invited him to leave town.

At this point the story gets slightly confused. The investors may have hired a second clever German to work for them, or it may have been the first (and only) one who, as he was leaving Roxbury, let a wooden box slip off his wagon and break open. His slave saw the contents and reported that there were sparkling silver bars inside. The news attracted a new round of investors, but the mine failed to reward them with silver.
One of the investors in the Roxbury mine (he was also a part owner of the Salisbury iron mines) in pre-Revolutionary days was a big tough Connecticut-born hombre named Ethan Allen. He was constantly quarreling with his partners and employees and ordering them to meet him in the town square, where he stripped to the skin and challenged them to a fight. Everybody was happy when he moved to Vermont and found a socially acceptable outlet for his pugnacity as the leader of the Green Mountain Boys. Another investor, Jabez Bacon, had enough faith in the Mine Hill deposits to buy up whatever land titles he could get in hopes of consolidating mining operations under his direction, but at that time the iron deposits in Salisbury were easier to mine and smelt than the Roxbury iron. The Salisbury mines played an important role in the Revolution, while Mine Hill lay quiet. Nothing else was really accomplished there until 1837. The big problem was that, unlike the easily smelted iron oxides found at Salisbury, the Roxbury ore was siderite, an iron carbonate full of solid and gaseous impurities that defied the primitive technology of the time.

**MINE HILL DEVELOPMENT**

By 1837 it was known that the Roxbury siderite was excellent for making steel, so a small smelter was built and the technique of roasting the ore was invented to drive off impurities of the gaseous kind. In time bigger operations took shape. Three adits (horizontal mine tunnels) were dug, the roaster-smelter complex was enlarged, and a narrow-gauge railway was built for the ore carts to run on. Pulled by donkeys, the carts were loaded inside the mine and then ran down the rail line to be dumped on a flat area level with the top of the roasting ovens.

The ore was poured into the tops of the twin ovens, and when it came out it didn’t look a bit like siderite any more. The bottoms of the roasting ovens were on the same level as the top of the furnace, and it too was filled from the top. Wheelbarrow loads of roasted ore, charcoal and limestone flux were dumped in, their proportions determined by the ironmaster to give the best results. The charcoal was set afire and fanned with a blast of air (hence the name “blast furnace”) from a bellows run by a steam engine. The
ore and flux were added when the temperature inside the furnace had reached the right heat, and the limestone combined with the impurities in the iron to form a light slag that floated on the surface of the molten iron and could be skimmed or drained off.

From inside the furnace, the molten iron was directed into a channel of wet sand, with smaller channels going off on both sides. The iron that solidified in the main channel formed a "sow" that weighed up to two hundred pounds, while the "pigs" in the side channels weighed about seventy pounds each. This is the source of the term "pig iron".

At least that's what happened when everything was working right, but more often than not, something went wrong. First of all, the furnace had to be kept going nonstop, for if it cooled, the molten iron inside would solidify into a huge "salamander" and the furnace would have to be torn apart to remove it. The Roxbury furnace had a good source of water from a reservoir up the hill and was advertised as never running dry, but summer droughts and winter freezes were always a threat, for without water to be boiled to make steam, the furnace could not run.

The steam engines of the day also tended to break down sooner or later, which also brought work to a standstill. The air ducts could get plugged, robbing the furnace of the blast that fanned the flames and made the charcoal bum hot enough to melt the iron. The gases given off in the smelting process were ducted down to ground level and burned to produce heat to boil the water into steam, but at times they ignited prematurely and exploded, burning down the wooden structures around the furnace and sending several workmen to kingdom come.

In short, the technology needed to smelt siderite successfully—and safely—did not exist at that time, and even the skill of the ironmasters could not prevent accidents from happening. In fact, the efforts to overcome the known problems sometimes created new problems. The furnace only ran successfully for five years. New owners moved the rest of the iron-and-steel operation to Bridgeport and kept the furnace running for three more years before rebuilding it in 1871 to use a hot air blast rather than a cold one, believing that this would increase iron production. It only increased the technical problems, and later in 1871 they gave up altogether.
By that time, the discovery of big iron deposits in Pennsylvania and then in the Mesabi Range of Minnesota made small-scale mining and smelting a losing proposition. By the end of the 16th century, only one of Connecticut's numerous iron furnaces (the Beckley Furnace, in East Canaan) was still running. It closed in 1923, leaving not only a towering furnace but also a mountain of slag, both still to be seen just off Lower Road.

The end of mining meant the end of the community that had grown up around the Roxbury ironworks. Wooden buildings, built far enough from the furnace to be out of danger of catching fire, included housing for the miners and other workers, a barn or stable for the horses and mules, a company store, storehouses for iron bar's and products such as kettles that were cast on the premises, as well as for limestone, charcoal and other supplies needed by the ironworks or the community. When the mine closed, the people left, the buildings were either dismantled or abandoned to burn or rot away, and in time only the stone structures remained as we see them today: roasting ovens, furnace, foundations and loading dock.

No iron was mined at Roxbury after 1871, but the Columbia University School of Mines bought the property later and used it for training purposes. The site changed hands, a couple of

Figure 4 - Topographic map of the Roxbury area showing the location of Mine Hill and the present-day Mine Hill Preserve owned by the Roxbury Land Trust.
Magnetite was once the principal ore at Philips Mine when the mine was worked in the early years for iron ore. It is found commonly on the dumps, notably at the northwest of middle dump. Magnetite is associated with hornblende and augite and can be found in large masses on the dumps. No crystals have been reported from the mine.

Oligoclase occurs as massive specimens and is a common mineral in the surrounding country rock.

Opal, var. Hyalite was found in a single specimen from a prospect in the fault plane of the granite. The specimen was small but showed botryoidal form. (Zodiac, 1933)

Orthoclase is common as part of the Canada Hill granite and as part of the dark hornblende gneiss visible at the mouths of the tunnels.

Pentlandite from the Philips mine is listed in the collection of the American Museum of Natural History in New York City.

Pyrite is widespread on the dumps at the Philips Mine as cubic masses within the pyrrhotite and recognizable by the bright yellow color. It is associated with magnetite, hornblende and albite.

Pyroxene, var. Augite is common as large masses. A five and a half pound specimen was found at the Philips Mine that measured 5 x 4 x 2.5 inches on the lower dump (Zodiac, 1933). Augite is associated with magnetite, hornblende and milky quartz and is common as an alteration of the older hornblende in the pegmatites.

Pyrrhotite is the most common mineral on the dumps at the Philips Mine. It is likely that this is due to the later workings of the mine for sulfur for the production of sulfuric acid that focused on sulfur-rich ore. It occurs as nodules and as massive ore. The nodular variety invariably has a euhedral apatite crystal at its core. Due to the long exposure to weather of the ore on the dumps, the pyrrhotite has been heavily stained with alteration minerals of iron. To date the author has not successfully found a way of cleaning this iron staining, making collecting the pyrrhotite fruitless at this time. However since the nodules contain the apatite crystals they are worth looking for.

Quartz is present as constituent of the gangue rock commonly showing crystal form however quality free crystals have not been seen on the dumps recently.

Titanite in well crystallized specimen at Philips Mine. It should be noted that Zabriskie (1995) misidentifies titanite as vesuvianite.

Uraninite was found as grains and crystals 1 to 25 mm long associated with magnetite and hornblende in the pegmatite bodies near the mine. The uraninite was dated by isotopic dating to 920 million years old (Klemic et al., 1959). Uraninite is found in greater concentrations in the prospect pits southwest of the main shaft along the mine road.
Alteration minerals from the iron ores: limonite, goethite, copiapite, melanterite, lepidocrocite. (Zodiac, 1933)

Current Status and Access

Presently the original mine road from the northeast is closed because it crosses through private property (fig. 10). It is posted No Trespassing and collectors are advised to stay clear of these houses. (As of the summer of 1997, several of these properties, with nice summer homes, were for sale.)

The Appalachian Trail passes within 200 yards of the lower mine dumps, in the section south of South Mountain Pass Road. From the east end of Bear Mountain Bridge, drive north along Route 9D to South Mountain Pass Road, turn right and proceed approximately .7 mile to a small turn out on the right. This is where the Appalachian Trail from the south meets the road. Park off the road near the trail. Hike south along the Appalachian Trail (white trail markers). Continue 100 feet past the metal vehicle gate, and then bushwhack uphill to the left through the trees for 300 feet. If you encounter a small stream, stay to it's right and this will lead you to the lowest mine dump. From here the mine areas are clearly visible through the woods, as no vegetation can grow on the iron oxide saturated ground. The lack of vegetation can be seen as you are bushwhacking uphill as an area of no tree cover - keep heading towards that opening and you will encounter the mine within 100 yards.

It is possible to find the mines by continuing on the Appalachian Trail further to a blue blazed trail the goes uphill to the left. Old topographic maps show the Appalachian Trail went this way to a spring on Mine Hill, then passed though the mine workings. However this route has not been well mapped recently and it is safer to follow the route suggested.

Most minerals are encrusted with iron oxide coating making collecting and field identification difficult. Larger rocks must be broken open to expose fresh surfaces and cavities for collectable mineral specimens. Pyrrhotite ore is easily recognized on the dump by the iron oxide (limonite/goethite) coating. The product of the decay of the pyrrhotite drips around to the bottom of each nodule forming a coating and conglomerating with nearby rocks and debris.

Apatite is associated with pyrrhotite nodules that contain the bright yellow pyrite, often near the contact of the two minerals. Apatite varies from brown to green to yellow. Most of the larger crystals are opaque while the smaller crystals (<2mm) can be very translucent.

Cool breeze strongly emanates from the upper tunnel (fig. 13), caused by air entering the large shaft being cooled by the surrounding rock creating downward flow. The lower tunnel is partly caved at the entrance and water filled, preventing air from escaping at that level.

There are several known prospect pits scattered southeast, south and southwest of the main shaft. The furthest of which is 500 yards southwest. The known prospects are mapped in Figures 15 and 16. These prospects have also been a source of minerals for collectors.
ROUTE 6 ROAD CUT, CORTLANDT, WESTCHESTER COUNTY, NEW YORK

This location is the only modern site included in this article. In March, 1991 the New York State Department of Transportation widened the road cut opposite the scenic overlook on Route 6, three quarters of a mile southeast of the Bear Mountain Bridge. The excavated rock was dumped down the embankment northeast of the parking area (Zabriskie, 1992).

Driving from the eastern end of Bear Mountain Bridge, follow Route 6 three quarters of a mile southeast of the bridge to the scenic overlook. Park at the overlook. Collecting at this site is best in the excavated rock that was dumped down the hill across Route 6 from the road cut northeast of the parking area (fig. 23). After parking, hike east along Route 6 for 50 yards then proceed downhill carefully, as the dumped rock can be unstable.

This location was the site of a New York Mineralogical Club field trip in 1994 during which many different mineral species were collected. At the time the dumped rock was fairly fresh as was the road cut that was widened. Upon inspection in 1997 the road cut was found to be extensively overgrown with high weeds. Since the actual road cut itself has never been the primary focus of collectors, this situation is unimportant. The dumped rock in the collecting area also shows overgrowth but is still accessible to collectors. Recently, several additional mineral new mineral occurrences have been identified from this location by field collectors.

Mineralogy

Following is a summary of the known minerals found at the Route 6 road cut:

Figure 23. Top, view from scenic overlook parking area east along Route 6. The collecting area is downhill to the right. Bottom, view of the rock dumped during the 1991 widening of the road cut.
Apatite - collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Chabazite - orange rhombohedral crystals, confirmed by X-ray identification, were collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Chondrodite - scarce, unverified.

Clinohlore - common as crystals in cavities associated with epidote (fig 24).

Epidote - both massive and crystalline forming bright green micro crystals and in pockets associated with clinohlore (fig. 24). This is the primary mineral of interest to collectors at the Route 6 road cut.

Feldspar - in a cuttable grade that could be called moonstone.

Gahnite - as crystalline specimens were reported by D.O.T personnel during the blasting, though positive identification has not been made to date.

Hematite - many bladed crystals up to ½ inch found on one specimen.

Hornblende - as crystals in pockets and massive crystals in the surrounding rock.

Magnetite - scarce.

Heulandite - collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Natrolite - as long acicular crystals in cavities up to two inches long (fig. 24). Often coated with flesh colored stilbite completely obscuring the natrolite except where crystals have broken (fig. 25). This may turn out to be mesolite or scolecite as testing has not been completed.

Pyrite - widely scattered through the dump especially to the northeastern end, furthest from the parking area. Pyrite specimens are easily found as the surface is heavily rust stained and the heavy weight are sure indicators. Upon breaking open these specimens the cubic crystal structure can often be identified.

Figure 24 - Small pocket of lustrous epidote crystals with clinohlore collected in 1994.
Anthony's Nose, New York: A Review of Three Mineral Localities

Stilbite - as micro crystal coatings upon natrolite crystal (fig. 26) giving the appearance of thick, fuzzy acicular crystals. Where these have been broken the square cross section of natrolite is distinctly visible. Stilbite also found as radiating crystals in narrow seams in the surrounding rock.

Titanite - massive gray and rarely as crystals, confirmed by X-ray identification, were collected by D.O.T. and New York State Museum personnel during the 1991 excavation.

Vesuvianite - recently reported by Zabriskie (1995) however positive identification has not been made at this point in time.

Since this is the youngest site on Anthony's Nose it has received much less scrutiny by collectors and professionals. Therefore not much has been written about the location. The relative freshness of the rock on the dump makes this site better for collectors compared to the 100 year old rock available at the other two locations. The author suspects that as this site receives more attention that additional minerals will be added to the list above.

CONCLUSION

The author hopes that by mapping mineral locations and clarifying the mineral occurrences at each site, that collectors will once again turn their attention to these sites for field collecting. The sites in this paper, that are up to 150 years since old, are extreme examples of lost sites that still offer collectors potential for good specimens.

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MILLINGTON QUARRY REVISITED: A REVIEW OF RECENT MINERAL OCCURRENCES

Martin Becker
54 Balsam Street
Wayne, New Jersey 07470

INTRODUCTION

Located in Somerset County New Jersey, Millington Quarry has received much less attention than the historic Paterson and Prospect Park localities for being a producer of fine trap rock specimens. Collecting at the quarry is not permitted by the owners, however permission has been occasionally granted to local rock and mineral clubs. This permission coupled with the sporadic appearance of specimens at regional gem and mineral shows has made a limited number Millington minerals available to collectors. Cummings (1985) notes that expanding operations in late 1980’s has recently made the quarry, which began operations in 1895, an important producer of mineral specimens.

GEOLOGY/MINERALIZATION/ZONATION

Millington Quarry is situated in the lowermost southwest extension of the Hook Mountain Basalt or third Watchung Mountain (Fig. 1). This basalt is the youngest of three major flood basalts that formed in response to Mesozoic rifting associated with the breakup of Pangea. The three major flood basalts comprising the Watchung Mountains, the Orange Mountain Basalt, first flow, the Preakness Basalt, second flow, and the Hook Mountain Basalt, third flow, are separated by reddish-brown sandstones, siltstones and shales of fluvial and alluvial origin.

The Hook Mountain Basalt was deposited during the Jurassic in two separate flow events on top of the Towaco Formation which dips to the northwest. The contact between the Towaco Formation and overlaying Hook Mountain Basalt can be observed in the lowermost excavation area of the quarry.

Cummings (1985) delineates four well defined zones of mineralization based on variations in basaltic composition. The majority of mineralization within the quarry reflects the northwest structural dip of the Towaco Formation and occurs primarily near the top of interfaces between the four zones identified by Cummings (1985). The paragenesis for minerals of the Watchung Basalts is carefully explained in Peters et al. (1978) and includes five crystallization periods: 1) the saline period; 2) the quartz period; 3) the prehnite period; 4) the zeolite period; and 5) the calcite period. (For a detailed explanation of zonation: see Cummings, 1985; paragenesis: see Peters et al., 1978).
The best mineral specimens at the Millington Quarry occur in vugs and gas pipes which range approximately in size between 3 and 30 centimeters along the interfaces between these four zones. Additionally, some pocket mineralization occurs within scoriaceous basalt at the boundary between the two basalt flows and as vein minerals. However, mineral specimens from scoriaceous basalt and veins are much more rare at the quarry. Mineralization tends to be highly localized along the interfaces of the four zones, typically extending no more than a couple of horizontal meters within an excavated area.

**MINERALS**

The Cummings (1985) compilation of mineral specimens from Millington Quarry lists twenty-four secondary minerals and indicates the common occurrence of apophyllite, analcime, natrolite and iron sulfides. My experiences in the quarry identify prehnite, apophyllite, datolite and calcite to be among the most commonly occurring minerals in all four zones (Fig. 2).
The following compilation and description of mineral specimens represents some of the more well crystallized and/or rare specimens I have observed or acquired over the last ten years. As with any mineral collection, personal preferences as to what is exotic or "collection worthy" takes place in this discussion and pictorial.

<table>
<thead>
<tr>
<th>Mineral Name</th>
<th>Chemical Composition</th>
<th>Crystal System</th>
<th>Cleavage/Fracture</th>
<th>Hardness</th>
<th>Luster</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analcime</td>
<td>NaAlSiO₄·H₂O</td>
<td>Isometric</td>
<td>(001) perfect</td>
<td>5.5-5</td>
<td>vitreous</td>
<td>white</td>
</tr>
<tr>
<td>Apophyllite</td>
<td>KCa₃(Si₂O₇)₂·F·8H₂O</td>
<td>Tetragonal</td>
<td>perfect</td>
<td>4.5-5</td>
<td>vitreous, pearly on (001)</td>
<td>colorless, white, pale green, yellow and rose</td>
</tr>
<tr>
<td>Calcite</td>
<td>CaCO₃</td>
<td>Hexagonal</td>
<td>(1011) perfect</td>
<td>3</td>
<td>vitreous to earthy</td>
<td>white to colorless, gray, red, green, brown</td>
</tr>
<tr>
<td>Datolite</td>
<td>CaB(SiO₄)(OH)</td>
<td>Monoclinic</td>
<td>perfect</td>
<td>5-5.5</td>
<td>vitreous, waxy</td>
<td>white, green and yellow</td>
</tr>
<tr>
<td>Heulandite</td>
<td>Ca₆Al₃Si₃O₁₂·6H₂O</td>
<td>Monoclinic</td>
<td>(010) perfect</td>
<td>3.5-4</td>
<td>vitreous, pearly on (010)</td>
<td>white, yellow, red, brown</td>
</tr>
<tr>
<td>Pyrite</td>
<td>FeS₂</td>
<td>Isometric</td>
<td>perfect</td>
<td>6-6.5</td>
<td>metallic</td>
<td>pale brass yellow</td>
</tr>
<tr>
<td>Sphalerite</td>
<td>ZnS</td>
<td>Isometric</td>
<td>(011) perfect</td>
<td>3.5-4</td>
<td>resinous</td>
<td>yellow, brown, black</td>
</tr>
<tr>
<td>Natrolite</td>
<td>Na₂Al₃SiO₆·2H₂O</td>
<td>Orthorhombic</td>
<td>(110) perfect</td>
<td>5.5-5</td>
<td>vitreous</td>
<td>white</td>
</tr>
<tr>
<td>Quartz</td>
<td>SiO₂</td>
<td>Hexagonal</td>
<td>conchoidal</td>
<td>7</td>
<td>vitreous</td>
<td>clear, smoky, purple, white</td>
</tr>
<tr>
<td>Stilbite</td>
<td>Na₂Ca₂Al₃Si₃O₆·14H₂O</td>
<td>Monoclinic</td>
<td>(010) perfect</td>
<td>3.5-4</td>
<td>vitreous, pearly on (010)</td>
<td>white, yellow, red, brown</td>
</tr>
<tr>
<td>Pectolite</td>
<td>Ca₄NaH(SiO₄)₃</td>
<td>Triclinic</td>
<td>(001) {100} perfect</td>
<td>5</td>
<td>vitreous to silky</td>
<td>white, red, gray, orange</td>
</tr>
<tr>
<td>Prehnite</td>
<td>Ca₂Al₂(AlSi₃O₁₀)(OH)H₂O</td>
<td>Orthorhombic</td>
<td>conchoidal</td>
<td>6-6.5</td>
<td>vitreous</td>
<td>light green and yellow</td>
</tr>
</tbody>
</table>

(Fig. 2) Common physical properties of Millington Minerals discussed in text. Physical properties of minerals compiled from: Cummings (1985); Klein and Hurlbut (1985); Peters (1984); and Peters et al., (1978).

Analcime: Analcime at Millington Quarry occurs as white, translucent, trapezohedrons averaging 2 centimeters or less (Fig. 2); (Photo 1). Samples of analcime tend to be quite rare and characteristically associated with the lowermost portion of the quarry along the interface of zones one and two. Larger analcime crystals occur within gas pipes of dark black basalt containing minor amounts of chalcedony and pyrite.

Apophyllite: Apophyllite is a commonly occurring mineral within the quarry and can be found within all four zones. Some of the more desirable specimens among collectors grow as rosettes of green, pink, or clear crystals (Fig 3); (Photo 2). Crystals typically grow in combinations of {110}, {011}, and {001} forms and can resemble a combination of a cube and octahedron. Apophyllite crystals, up to 5 centimeters, are frequently associated with datolite, pectolite, calcite, prehnite and pyrite occurring in gas pipes and vugs. Tiny apophyllite crystals occasionally frost prehnite specimens.
Calcite: Perhaps the most abundant mineral in the entire quarry is calcite, occurring in all four zones of the quarry in vugs, gas pipes, veins and within vesicles of scoriaceous basalt. Calcite crystal up to 10 centimeters occur in clear, white and yellow and in more rare instances brown colors with luster ranging from transparent to opaque (Photo 3). Typical crystal forms encountered include: e\{011\}; r\{101\}; f\{022\} and v\{213\}; (Fig 3). Calcite commonly is associated with most mineral species in the quarry.

Datolite: Datolite crystals are concentrated in the lower two zones of the quarry and become progressively more rare in the third and fourth zones. Waxy to vitreous crystals, up to 1 centimeter, occur in light yellow to green colors and frequently form the lining of gas pipes and vugs. The largest of monoclinic crystals are nearly equidimensional with respect to the a, b and c
axes of symmetry. Smaller datolite crystals are commonly associated with apophyllite, pectolite and small pyrite crystals.

Heulandite: As with analcime, samples of heulandite tend to be very rare at Millington Quarry. Clear, white and yellowish-brown crystals, up to 2 centimeters, tend to be vitreous with pearly luster on the {010} face (Fig. 3). Heulandite tends to be concentrated in vugs associated with scoriaceous basalt at the interface between zones 2 and 3. Small crystals of stilbite and calcite commonly occur with heulandite (Photo 4).

Natrolite: Acicular, radiating crystal groups of natrolite, up to 5 centimeters, infrequently occur in vugs and gas pipes along the interface of zones one and two in the lowermost part of the
quarry. Blasting characteristically destroys most specimens of this delicate mineral (Photo 5).

**Pectolite:** Gas pipes and vugs of pectolite occur in the lowest portion of the quarry along the interface of zones one and two. Crystals grow as densely packed aggregates of radiating crystals. White is the most common color of pectolite at Millington Quarry, however, more rare varieties of brick red and orange exist. Pectolite can occur with apophyllite, calcite and datolite (Photo 6).

**Prehnite:** Prehnite occurs throughout the entire quarry in all four zones. Lusters and colors of prehnite are highly variable, ranging from waxy to vitreous in shades of yellow, light-green and greenish-yellow. The best specimens occur as isolated, botryoidal crystal groups, up to 3 centimeters, in vugs and gas pipes along the interface of zones one and two in the lowest part of the quarry (Photo 7). Prehnite commonly occurs with calcite, apophyllite and pyrite.

**Pyrite:** Small pyrite crystals, less than 0.5 mm, are commonly associated with apophyllite, datolite and prehnite. Crystals grow in a variety of forms including pyritohedron, octahedron, combinations of pyritohedron and octahedron, and twinned pyritohedrons (Fig. 3). The greatest concentrations of pyrite crystals occurs in lowermost two zones of the quarry.

**Quartz:** Quartz is common to Millington Quarry and typically crystallizes in vugs and gas pipes in all four zones. The best specimens occur in dark black basalt which contains solution pyrite and chalcedony. Smoky, clear and milky quartz are much more common than the amethyst varieties (Fig. 8); (Photo 8). Crystals up to 1.0 centimeters are not uncommon and can be associated with calcite, hydrocarbons and more rarely, selenite.

**Sphalerite:** Rare sphalerite crystals, in both black jack and ruby jack varieties occur in the quarry. Crystals, up to 1 centimeter, grow as tetrahedrons and dodecahedrons on prehnite and datolite in vugs and gas pipes associated with zones one and two (Fig. 3); (Photo 9).
Stilbite: Tan, botryoidal aggregates of stilbite crystals up to 3 centimeters, infrequently occur along the interface of zones two and three. These botryoidal crystals can be associated with small, less than 1 centimeter, isolated sheaf-like aggregates of crystals (Photo 10). Stilbite tends to be concentrated in vugs of scoriaceous basalt and can be associated with heulandite and calcite.

**Figure 3** - Some common crystal forms displayed by Millington minerals. Compiled from Klein and Hurlbut (1985) and Peters (1984). Crystal forms include: a) isometric: trapezohedron; b) monoclinic: {010} prominent; c) tetragonal: combination of {110}, {011} and {001} forms; d) isometric: tetrahedron; 3) hexagonal: forms include e{0112}, r{1011}, f{0221} and v{2121}; and f) isometric: pyritohedron, octahedron, combined pyritohedron and octahedron and octahedron and twinned pyritohedrons.

**CONCLUSIONS**

The established reputation of the more famous Paterson and Prospect Park localities for producing fine trap rock mineral specimens is one which has been developed for over one hundred years (e.g. Peters 1984 and Peters et al., 1978). In contrast, Millington Quarry offers collectors current and exciting alternative assemblages of trap rock minerals which differ in color, luster and crystal habit relative to these localities. Undoubtedly, continued mining
operations will result in a reputation at the Millington Quarry for being a producer of fine trap rock mineral specimens which rival more historic New Jersey mineral localities.

ACKNOWLEDGMENTS

I would like to thank Lloyd Goldstein for the use of Meadowlands Photography Studio and for his assistance in the photography of mineral specimens displayed in this pictorial.

REFERENCES


CONNECTICUT IRON AND THE ROXBURY IRON MINE

Edward Force
42 Warham Street
Windsor, Connecticut 06095

INTRODUCTION

Iron deposits often form at the bottom of bodies of water, where particles of oxidized iron, eroded from older rock and carried by streams, fall to the bottom when streams reach lakes, swamps, or oceans that stop their flow and make them drop their sediments. The iron accumulates on the bottom, where it is covered with silt. In time a layer of "bog iron ore" (iron oxide) builds up. This ore, goethite or limonite, was dug out of swamps and smelted in Connecticut and elsewhere in Colonial days as a source of iron.

But the iron that settled in the coastal waters of the Iapetos Ocean along the shores of Proto-North America was subjected to tremendous pressure and heat later. Five hundred million years ago, the Iapetos Ocean stretched from Proto-North America to Proto-Africa, with an island group called Avalonia halfway in between. Then the continents slowly began to move toward each other, ultimately forming the super-continent of Pangaea. In the process, the floor of the Iapetos Ocean, being thinner and thus lighter than the rock of the land masses, rose above the land plates and was squeezed, twisted and compressed into metamorphic rock.

Once Pangaea had formed (about 250 million years ago), it began to pull apart. Cracks formed between pieces of land in the process. One crack widened into the Atlantic Ocean. Proto-North America, the Iapetos Terrane (the former ocean floor), and Avalonia were all on the west side of it. They had been squashed together and now were all part of North America. Another big crack formed in the Iapetos Terrane about halfway between the Proto-North American and Avalonian Terranes. A body of water was formed here, and its bed filled with sediment which became the Newark Terrane, the bedrock of Connecticut's Central or Triassic Valley.

The land west of this body of water (which later became dammed near Middletown and formed Glacial Lake Hitchcock) became Connecticut's Western Highlands. Erosion cut the highlands down and exposed much that had been buried, and the glaciers bulldozed the land even more—two to four miles deep. By the time the first settler's arrived, numerous iron deposits in northwestern Connecticut were at or very near the surface, and it was not long before the colonists, eager to find usable metals, discovered them.
COLONIAL MINING

The colonists smelted the bog iron ore first, for it was easy to obtain and easy to smelt. When bog iron was found in the New Haven-Branford area, John Winthrop, Jr., who had smelted iron in Massachusetts, was called to New Haven and began to mine iron in 1648. Within ten years he was operating a blast furnace at the south end of Lake Saltonstall in East Haven. Other furnaces were built wherever bog iron ore was being mined: Killingworth, Voluntown, Stonington, Woodstock, Stafford, Hebron, etc. Bog iron ore was even found in my home town of Windsor and smelted along Stony Brook in Suffield.

About a century later, Jared Elliott discovered that the black beach sand along Long Island Sound contained iron. In fact, you can still collect it by running a magnet through black sand. Elliott had it smelted and made into steel at his son’s furnace and forge in Killingworth, wrote a book describing the process, and won a gold medal from the Royal Society of Arts in London. But he never produced enough steel to make his fortune.

The colonists needed more iron than they could get out of the swamps of Connecticut, so they kept an eye open for iron ores while they hunted for gold and silver. Iron ore was found on Mine Hill in western Roxbury and first mined in 1724, but not much was accomplished in its first quarter century. Then a clever German promoter had a bright idea. A little sphalerite and galena had been found at Roxbury, and he knew that there is often a little silver where there is galena. Since there was very little galena at Mine Hill, there wasn’t enough silver there to make mining it feasible, not to mention profitable, but he sold stock in a silver mine anyway—like every other silver mine in Connecticut, it mined most of its silver from the pockets of its investors! The promoter seems to have cast a few bars of iron which he painted silver, but whatever his well paid workmen did in his employ was kept quiet, though in the end, the investors ascertained or at least suspected the truth and invited him to leave town.

At this point the story gets slightly confused. The investors may have hired a second clever German to work for them, or it may have been the first (and only) one who, as he was leaving Roxbury, let a wooden box slip off his wagon and break open. His slave saw the contents and reported that there were sparkling silver bars inside. The news attracted a new round of investors, but the mine failed to reward them with silver.
One of the investors in the Roxbury mine (he was also a part owner of the Salisbury iron mines) in pre-Revolutionary days was a big tough Connecticut-born hombre named Ethan Allen. He was constantly quarreling with his partners and employees and ordering them to meet him in the town square, where he stripped to the skin and challenged them to a fight. Everybody was happy when he moved to Vermont and found a socially acceptable outlet for his pugnacity as the leader of the Green Mountain Boys. Another investor, Jabez Bacon, had enough faith in the Mine Hill deposits to buy up whatever land titles he could get in hopes of consolidating mining operations under his direction, but at that time the iron deposits in Salisbury were easier to mine and smelt than the Roxbury iron. The Salisbury mines played an important role in the Revolution, while Mine Hill lay quiet. Nothing else was really accomplished there until 1837. The big problem was that, unlike the easily smelted iron oxides found at Salisbury, the Roxbury ore was siderite, an iron carbonate full of solid and gaseous impurities that defied the primitive technology of the time.

MINE HILL DEVELOPMENT

By 1837 it was known that the Roxbury siderite was excellent for making steel, so a small smelter was built and the technique of roasting the ore was invented to drive off impurities of the gaseous kind. In time bigger operations took shape. Three adits (horizontal mine tunnels) were dug, the roaster-smelter complex was enlarged, and a narrow-gauge railway was built for the ore carts to run on. Pulled by donkeys, the carts were loaded inside the mine and then ran down the rail line to be dumped on a flat area level with the top of the roasting ovens.

The ore was poured into the tops of the twin ovens, and when it came out it didn’t look a bit like siderite any more. The bottoms of the roasting ovens were on the same level as the top of the furnace, and it too was filled from the top. Wheelbarrow loads of roasted ore, charcoal and limestone flux were dumped in, their proportions determined by the ironmaster to give the best results. The charcoal was set afire and fanned with a blast of air (hence the name "blast furnace") from a bellows run by a steam engine. The

Figure 2: The smelting furnace as it appeared about 1923 (from Hull, 1966).
ore and flux were added when the temperature inside the furnace had reached the right heat, and the limestone combined with the impurities in the iron to form a light slag that floated on the surface of the molten iron and could be skimmed or drained off.

From inside the furnace, the molten iron was directed into a channel of wet sand, with smaller channels going off on both sides. The iron that solidified in the main channel formed a "sow" that weighed up to two hundred pounds, while the "pigs" in the side channels weighed about seventy pounds each. This is the source of the term "pig iron".

At least that's what happened when everything was working right, but more often than not, something went wrong. First of all, the furnace had to be kept going nonstop, for if it cooled, the molten iron inside would solidify into a huge "salamander" and the furnace would have to be torn apart to remove it. The Roxbury furnace had a good source of water from a reservoir up the hill and was advertised as never running dry, but summer droughts and winter freezes were always a threat, for without water to be boiled to make steam, the furnace could not run.

The steam engines of the day also tended to break down sooner or later, which also brought work to a standstill. The air ducts could get plugged, robbing the furnace of the blast that fanned the flames and made the charcoal burn hot enough to melt the iron. The gases given off in the smelting process were ducted down to ground level and burned to produce heat to boil the water into steam, but at times they ignited prematurely and exploded, burning down the wooden structures around the furnace and sending several workmen to kingdom come.

In short, the technology needed to smelt siderite successfully—and safely—did not exist at that time, and even the skill of the ironmasters could not prevent accidents from happening. In fact, the efforts to overcome the known problems sometimes created new problems. The furnace only ran successfully for five years. New owners moved the rest of the iron-and-steel operation to Bridgeport and kept the furnace running for three more years before rebuilding it in 1871 to use a hot air blast rather than a cold one, believing that this would increase iron production. It only increased the technical problems, and later in 1871 they gave up altogether.
By that time, the discovery of big iron deposits in Pennsylvania and then in the Mesabi Range of Minnesota made small-scale mining and smelting a losing proposition. By the end of the 16th century, only one of Connecticut’s numerous iron furnaces (the Beckley Furnace, in East Canaan) was still running. It closed in 1923, leaving not only a towering furnace but also a mountain of slag, both still to be seen just off Lower Road.

The end of mining meant the end of the community that had grown up around the Roxbury ironworks. Wooden buildings, built far enough from the furnace to be out of danger of catching fire, included housing for the miners and other workers, a barn or stable for the horses and mules, a company store, storehouses for iron bar’s and products such as kettles that were cast on the premises, as well as for limestone, charcoal and other supplies needed by the ironworks or the community. When the mine closed, the people left, the buildings were either dismantled or abandoned to burn or rot away, and in time only the stone structures remained as we see them today: roasting ovens, furnace, foundations and loading dock.

No iron was mined at Roxbury after 1871, but the Columbia University School of Mines bought the property later and used it for training purposes. The site changed hands, a couple of

Figure 4 - Topographic map of the Roxbury area showing the location of Mine Hill and the present-day Mine Hill Preserve owned by the Roxbury Land Trust.
promised by Smith in the “bound volume” for 1914. Here “California iris” was deleted, but so was “kunzite.” Only the species name spodumene was retained.

By 1919 things had obviously cooled down, and Frank Salmons, as president of the Pala Chief Gem Mine, wrote Kunz that he had “a half dozen fine specimens of kunzite. If you will be interested in same, I will be glad to send them on for your inspection.”

Kunz felt quite secure, as well as casual, about his beloved kunzite when he said the following in his memorial to kunzite collaborator, Charles Baskerville, in 1922:

*About 1903 a variety of spodumene was identified as new by the writer, and it was his intention to name it after J. Pierpont Morgan. It was, however, impossible to get in touch with Mr. Morgan at that time, and Dr. Baskerville then named this mineral after the writer.*

It seems amazing to me what self-serving remarks can be made by a person even allowing for some dimming of recollections of events 17 years past. I have often thought that the above quotation might instead have read:

*It was impossible to get in touch with Mr. Morgan at that time because he was in the bath, or because he was having lunch.*

In fairness it must be pointed out that in 1911 Kunz had the opportunity to name the recently discovered pink variety of beryl, and he called it “morganite” after his distinguished patron.

The name “kunzite” for the pink variety of spodumene, like all varietal terms, carries no scientific weight. The acceptance or rejection of such terms is, in the end, determined solely by popular usage. It is, however, still a universally recognized varietal term along with others such as hiddenite, tanzanite and emerald that will surely survive. Sicklerite and salmonsite are today valid species unrelated to spodumene and J. P. Morgan is remembered in morganite. But “California iris” is long abandoned, and Messrs. Heriart, Peiletch, Valiant, Giddens and Nichols have yet to be honored with any mineral names. The spirit of George Frederick Kunz can rest easy—his namesake is secure.
Figure 4. Superb crystal of kunzite from the Pala Chief mine; 14 cm. Photo by Harold and Erica Van Pelt. It was originally sold to J. P. Morgan by Kunz around 1903, then was donated to the American Museum of Natural History in New York. In the 1960's it was traded out to Peter Bancroft, and is now in the collection of William Larson. (This photo first appeared in Letters to George F. Kunz (Conklin, 1986)). From The Mineral Collector, Vol. X, No.8, October, 1903 pp. 113-114
The following article was originally printed in the May-June 1988 issue of Matrix magazine as part of their series on historic mineral specimens.

THE ORIGINAL SPECIMENS OF KUNZITE

Lawrence H. Conklin
2 West 46 Street
New York, NY 10036

It is generally assumed that the first specimens of kunzite were sent to George Kunz and Tiffany by Frederick M. Sickler from his White Queen mining claim in 1903.¹ Kunz lost no time in supplying pieces to Charles Baskerville who then named the new pink variety of spodumene “kunzite” in Kunz’s honor.

In 1952, during my sophomore year at the City College of New York, my professor Kurt E. Lowe, showed me a cut prism of kunzite that had been the property of Charles Baskerville, a City College chemistry professor, and had been used in the original determination and naming of


that species back in 1903.\textsuperscript{2}

The specimens depicted here are more examples of this "type" material from Baskerville's collection. The label is in the hand of Daniel T. O'Connell, and is initialed by him. O'Connell probably never met Baskerville (who died in 1922), as he arrived on the C.C.N.Y. scene in 1928.

However, he recognized the importance of these specimens, and saw to it that their history was not lost.

In a letter from Charles Baskerville to George F. Kunz, dated November 24, 1903\textsuperscript{3}, Baskerville states: "Perhaps it may be necessary for me to have a little more of the kunzite. I prefer the colored pieces, the small refuse from the cutting will answer." Those "small refuse" pieces are also here.

When and how they left City College is not clear, but they were in the famous O. Ivan Lee collection, thence to John Albanese, a dealer from New Jersey and finally went to Clifford Frondel and the Harvard Mineralogical Museum, before coming into the hands of the writer.

\textsuperscript{2} See Conklin, Lawrence H. Notes and Commentaries on Letters to George Frederick Kunz Privately printed, New Canaan, 1986. Page 81

\textsuperscript{3} See letter, Charles Baskerville to George Frederick Kunz, November 24, 1903. Library, American Museum of Natural History.
The last article reprinted here gives Mr. Sickler's first-hand account of his discovery. The article is from *The Mineral Collector*, Vol. XI, No.1, March, 1904 pp. 1-4. The complete series of the Mineral Collector has been reprinted in fifteen volumes and is available from Matrix Publishing Co. (717-432-7201).

### HOW KUNZITE WAS DISCOVERED.

*From The Jewelers Circular*

Kunzite, the new gem, which was discovered in California on the 8th of June, 1901, but which did not become generally known to the public until September of last year, has awakened considerable interest not alone among collectors, but amongst precious stone dealers and jewelers throughout the country.

Various descriptions and references to this stone have been made from time to time (see *Mineral Collector*, Oct., 1903), the first one appearing in *Science*, Sept. 2, 1903. It was a rather technical article and was from the pen of Dr. Geo. F. Kunz, gem expert for Tiffany & Co. Since that time various requests have been received from jewelers and other persons throughout the country asking for further details concerning this interesting gem—its discovery, its characteristics, its value, its use in jewelry, and whether or not it is plentiful.

Scientifically classified, kunzite is a variety of spodumene. Spodumene, as a mineral, is very abundant, and various varieties of its crystals when cut have proven more or less valuable as precious stones, but nothing like the kunzite variety has ever been seen until recently. A few of the yellow spodumene crystals have been found in Brazil, and species of the green variety (hiddenite) have been found in North Carolina, while some specimens quite like kunzite, but differing, inasmuch as they are opaque instead of transparent, have been found at Branchville, Connecticut. Kunzite is exceedingly pure, with a hardness of about 7, and specific gravity of 3.183; its crystals are sometimes etched and corroded.

The name of the gem was suggested by Dr. Charles Baskerville, who in a recent number of *Science*, stated: "On account of its unusual phosphorescence, as well as the other properties, I propose the name kunzite, for reasons unnecessary to give to American and European scientific men."

Dr. Kunz is one of the most widely recognized authorities on precious stones in North America.

The discoverer of kunzite is Fred. M. Sickler, of Pala, San Diego County, Cal. He was born in San Diego, July 12, 1879, his father being at that time a signal officer in charge of the Army Meteorological Observatory in that city. He was educated in the public schools of San Diego, and was chosen by the county board of education to represent the county at the Youths Congress, held at the Columbian Exposition. After supporting himself while working his way through the high school, where he made a special study of biology and chemistry, he started out to earn his living.
He worked in various mines, chemical laboratories and machine shops throughout the southwest. He traveled over several States and filled many positions of trust, working in smelters, assay offices and refining plants. During this time he made careful studies of ores and mineralogical specimens, and became something of an expert in some of these lines.

At the time he discovered the gem, afterward named kunzite, Sickler had just returned from the mines in Arizona and Mexico. Even as a boy he had picked up queer mineralogical specimens near Pala, which, for some reason or other, had interested him, and the locality haunted him. Whenever he returned home from an extended trip among the mines of the southwest he traversed San Diego County and the region around Pala, picking up rare specimens and saving them.

One day he learned that two sheep-herders had located a claim on Heriart Mountain, near Pala. The following day, June 8, he located the “White Queen” claim, while his father located the “Vanderburg” Claim. Afterwards they located conjointly the “Catarina” claim.

Speaking of the discovery of the stone and how he happened to make it, Mr. Sickler said:

“I examined the face of the cut of the claim and found lepidolite exposed. On the left hand side of the cut I noticed a rotten quartz streak, which reminded me of the quartz pay streak I had seen when working in a mine near Prescott, Arizona. My father, who was working with me, was anxious to follow up the quartz, so we abandoned the direction of the cut and started a drift at right angles to it. After going in six feet we came to a wall of amblygonite. On breaking down this wall we found a peculiar red clay in which were embedded great crystals of quartz.

While removing these we discovered spodemene of a pink or lilac color, some crystals of which were colorless and others straw yellow. I examined the crystals, but could not tell what they were. I had worked in assay offices and mines of many kinds of minerals, but had seen nothing like these crystals. The sun was almost down, but I held a crystal up and noticed the rosy tint which the stone possessed. My father and I picked up the gems at practically the same moment, and since we shared the work equally, I think that it is just that we should share the credit equally.

We examined the crystals and found that the crystallization was different from the tourmaline. I had been employed on a diamond drill in a Pala lithia mine for some time, and was familiar with rubellite. I took some of the stones with me to Mesa Grande, July 5, in order to find out if similar stones had been discovered there.

I spent an entire afternoon with the superintendent of the Tannenbaum mine, and as a result of my interview, I concluded that if my stones were tourmaline, that they were crystallized in an entirely different form than any known variety.
I visited at the same time some gem mines at Pamoo, with the same result. Then I immediately left for San Diego, where my friend, a Mr. Nichols, submitted them to all the leading jewelers and lapidists in the city. These gentlemen were unable to give a definite or conclusive answer as to what the stones were.

In San Diego, at the same time, I examined “Dana’s Mineralogy” and Dr. (George F. Kunz S. “Precious Stones of North America.” I read the description of the Branchville pink spodumene and perceived, that while the Branchville spodumene was opaque, except in small spots, my crystals were not at all opaque, and that on exposure to the elements they lost their pink color entirely, but retained their perfect transparency; for this difference, as well as the difference in size, I thought they could not be the same as the pink spodumene of Branchville.

After consulting every one I knew who was interested in mineralogy, I left for Los Angeles and consulted leading lapidists there, with little result. After remaining in Los Angeles for a few days I went to Oxnard, where I analyzed the mineral, and found it to consist mainly of lithia, aluminum and silica. I also determined the specific gravity of the mineral and tested it for hardness.

These results compared very closely with those determined by Mr. Macher, of the Pacific Gem Co., Los Angeles. The peculiar luminous properties of the stone were discovered by George H. Hazzard, late mining editor of the Los Angeles Express.

In December, 1902, I sent a specimen of my stone to Tiffany & Co., New York. They admired the stone very much and informed me that it was spodumene. A short time afterward I sold them thirty crystals of spodumene. These were the first crystals of this color which were ever brought before the public as gems.”

The mountain upon which the gem was found differs from all other mountains of the Pala group, and, in fact, all gem deposits of southern California, in that the lithia minerals are not confined to a single or possibly two veins, but occur in a great many veins.

There are several claims now located on the mountain and all are being developed by open cuts and are so similar in appearance and in dip, strike, etc., that a complete description of each would merely be a description of all. They are all within a mile of each other.

As regards kunzite and its use in jewelry, it may be said that it is being made up into all kinds of articles. Two varieties of colors have thus far been found, the lilac and the violet shades. Both are beautiful, clear and sparkling, gaining much additional brilliancy in the presence of an artificial light. In appearance it is extremely like tourmaline and is of about the same value. It is being cut in New York into all popular shapes, and is becoming very fashionable as pendant drop and brooch center pieces.
THE NEW YORK MINERALOGICAL CLUB

On September 21st, 1866 in the home of Professor Daniel S. Martin at 236 West 4th Street, the New York Mineralological Club was formed through the efforts of George F. Kunz, B. B. Chamberlin and Professor Martin. Monthly meetings followed at the homes of members, with hosts presiding. George F. Kunz was elected Secretary. At the sixth meeting in March, 1887 the name New York Mineralogical Club was officially adopted. A constitution and by-laws were approved at the eighth meeting. No president being required by this Constitution, none was elected until April, 1895 when George F. Kunz became the club’s first President, an office he held for many years. At the end of the club’s first year it had a membership of forty-six, including many notable mineralists.

The club’s fine collection of more than 700 mineral specimens from New York City is housed at the American Museum of Natural History. The collection includes specimens of beryl, chrysoberyl, garnet, tourmaline, stilbite and xenotime together with many other species.

During the 110 years the club has been in existence several honorary members have been appointed in recognition of contributions in the field of minerals and mineralogy. They include: Joseph Arons, Sir William Henry Bragg*, Russ Buckingham, Lawrence H. Conklin, Madam Marie Curie*, Edward S. Dana*, Clifford Frondel, Victor Goldschmidt*, Richard Hauck, Carl Krocki, Alfred Lacroix*, Charles Palache*, Frederick Pough, Waldemar T. Schaller*, Leonard J. Spencer*, Ernest Weidhaas*, Herbert P. Whitlock*, (*Deceased.)


Currently the club has a membership of over 250. Monthly meetings, with guest lecturer, are held on the second Wednesday of each month (except July and August) at the American Museum of Natural History, New York City. Meetings are open to the public. Frequent field trips are organized to interesting mineral localities in the vicinity of New York City and extended trips to more distant states. Each month a bulletin is published for members and guests with news, announcements and original articles about minerals and gemstones contributed by club members. The New York Mineralogical Club is affiliated with the Eastern Federation of Lapidary and Mineralogical Societies and the American Federation of Mineral Societies.

The club is dedicated to increasing interest in the science of mineralogy through the collecting, describing and displaying of minerals and associated gemstones. Anyone interested in gems and mineralogy is welcome as a member. Dues are $20.00 for individuals, $30.00 for families per calendar year. Inquiries should be addressed to the club at: New York Mineralogical Club, P. O. Box 77, Planetarium Station, New York, NY 10024-0077 or contact membership coordinator, Anna Schumate at 212-675-6979.