Minerals of the Washington, D.C. Area

by

Lawrence R. Bernstein

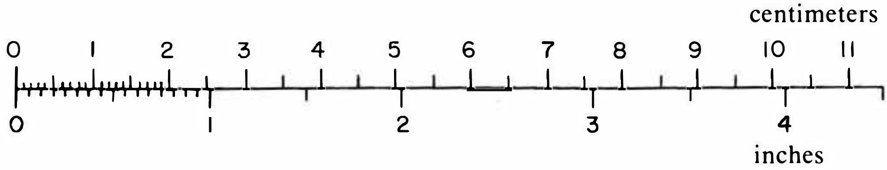
1980

Department of Natural Resources
Maryland Geological Survey
Kenneth N. Weaver, Director

Educational Series No. 5

METRIC SYSTEM

Length



1 centimeter (cm) = 0.394 inch

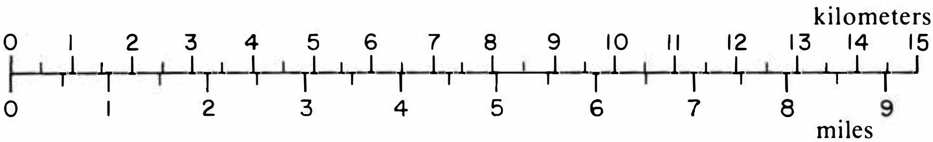
1 meter (m) = 39.4 inches (in) = 3.28 feet (ft)

1 kilometer (km) = 3281 feet = 0.62 mile (mi)

1 inch = 2.54 centimeters

1 foot = 30.5 centimeters

1 mile = 1.61 kilometers = 1609 meters



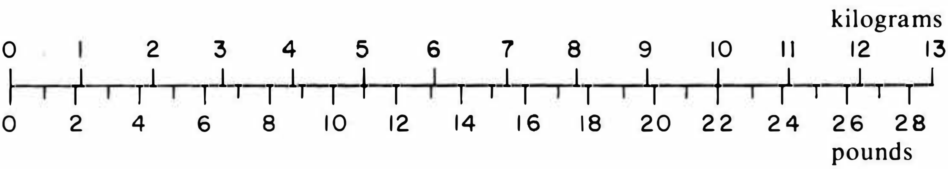
Mass

1 kilogram (kg) = 2.205 pounds (lb) = 35.3 ounces (oz)

1 metric ton (t) = 1.102 short tons = 2204.6 pounds

1 ounce = 28.35 grams

1 pound = 453.6 grams = 0.4536 kilogram



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Photograph Credits: All photographs by the author except Fig. 26, George Brewer; Fig. 55, courtesy of Bryan Eagle; Fig. 65, Ben Kinkead.

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Grossular crystals on rodingite from the Hunting Hill quarry, Hunting Hill, Maryland. Largest crystal is 1.2 cm across.

INTRODUCTION

> "There was no talk, no hope, no work, but dig gold, wash gold, refine gold, load gold; such a bruit of gold, that one mad fellow desired to be buried in the sands least they [the prospectors] should by their art make gold of his bones,—."
>
> —Thomas Studley and Anas Todkill (two of Captain John Smith's companions), 1608*

In 1608, England brought its search for gold to what is now the Washington, D.C. area. The unexplored Virginia territory held the possibility of yielding vast amounts of precious metals and gems, which England hoped could match Spain's mineral discoveries in South and Central America. In an attempt to locate this anticipated mineral wealth, the early explorers were accompanied by numerous prospectors and assayers (called "refiners"), whose enthusiasm inspired the words quoted above. The English treasury never did become stocked with Virginia gold; but minerals and mining have nevertheless played a significant and often colorful role in the development of the Washington, D.C. region.

The serious geological study of the area began with Captain John Smith's explorations of Chesapeake Bay and the Potomac River in the early seventeenth century. Smith was never infected by the gold fever, realizing that the value of the Virginia colony lay more in its agricultural potential than in its mineral wealth. Smith was a careful observer, however, and did make some notable geological contributions. He made a distinction between the soft sediments of the Coastal Plain and the hard rocks of the Piedmont, noting the abundance of red clays in the Coastal Plain and the nodules of iron ore that they contain. He shipped samples of this iron ore to England for analysis. Smith also reported visiting an Indian mine near the Quiyough (probably Occoquan) River, where a silvery mineral (galena or specular hematite (?)) was obtained.

The first mineral resource to be exploited by the settlers was the nodular iron ore of the Coastal Plain sediments. Iron mining began in the seventeenth century and was of importance from colonial times into the nineteenth century. One iron furnace, the Muirkirk furnace in Prince George's County, Maryland, produced iron from local ores until 1916.

In 1808, high grade chromite deposits were discovered in central Maryland by Isaac Tyson, Jr. These deposits made Maryland the leading chromium producer of the world from 1828 to 1850 (Vokes and Edwards, 1968), most of the chromium going into the manufacture of yellow paint pigment. During the eighteenth and nineteenth centuries, Maryland was also an important source of copper, the copper in the original dome of the National Capitol coming from Maryland mines.

The early explorers' dreams of gold were finally realized (to a modest extent) in the Washington area during the mid-1800's, with the discovery of gold in Montgomery County, Maryland. Commercial recovery of gold, although always on a small scale, continued intermittently into the 1950's, and people still try their luck panning the local streams or scouring the old mine dumps for the precious metal. Although the deposits are small, a few spectacularly rich specimens of gold have been found.

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*From Smith, 1612, p. 21

At various times the Washington area has also produced substantial amounts of feldspar, mica, quartz, and steatite (soapstone). Important locally produced building stones have been marble, granite, sandstone, schist, and "Potomac Marble" (limestone conglomerate). Mining activity peaked around Washington, as in much of the country, during the Revolutionary, Civil, and World wars.

At present, mineralogical highlights of the area other than those already mentioned include gem garnets, vivianite crystals, and gypsum rosettes. The largest known apophyllite crystals in the world, associated with superb green prehnite and fine zeolite crystals, have come from suburban Virginia. All told, more than 250 localities for over 200 minerals in the Washington area are given here, including localities for such rare minerals as coalingite, wittichenite, mackinawite, and lipscombite. Most of these localities are described for the first time.

Nearly all of the described localities were visited by the author during the period from 1973 through 1977. Where no references are given, the described minerals were collected and subsequently identified by the author using physical, chemical, optical, and powder X-ray diffraction techniques.

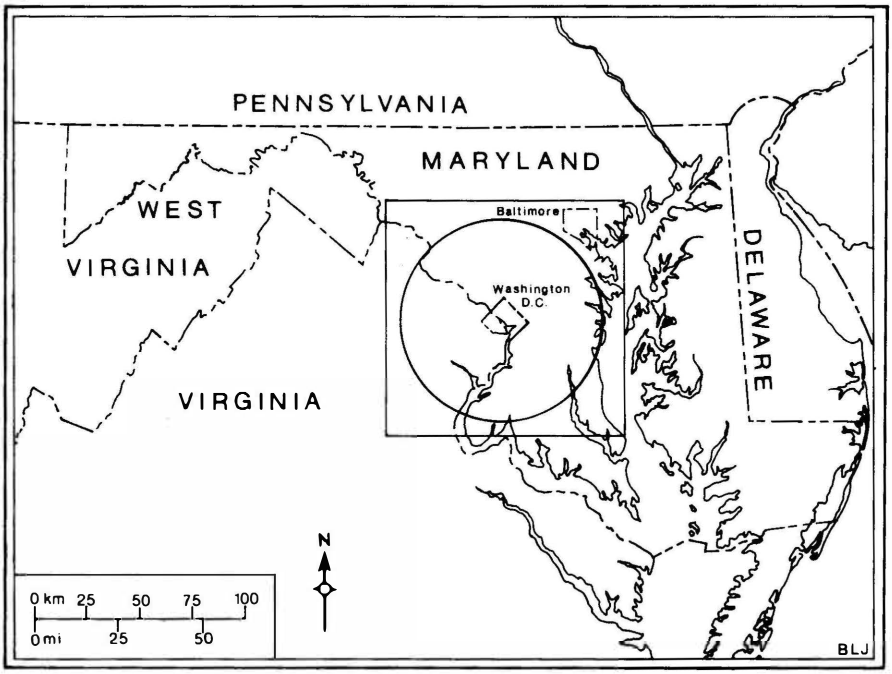

Figure 1. Index map (1:2,500,000) showing region covered in this report. Area in circle is covered in most detail.

Scope of Report

This report covers approximately 14,500 square kilometers centered around Washington, D.C., with the region within a 50 kilometer radius of the city covered in most detail (see Fig. 1). The localities are divided into two broad categories: *major localities* and *other localities. Major localities* are those that were accessible at the time of writing, are of the greatest mineralogical interest, or are particularly representative of a certain type of deposit. The *other localities* are all additional locations of unusual minerals, including many that are no longer accessible. These are only given for the region of most detailed coverage. I have selected only those localities that contain unusual or well-crystallized minerals, and have made no attempt to include those quarries and other rock exposures that show no evidence of such material.

It is useful to remember that an increasingly large portion of the region around Washington is urban and suburban and subject to rapid changes in land use and ownership. This means that roadcuts, mines, quarries, and other mineral exposures are rapidly and often permanently destroyed. Fortunately the reverse is also true, and new excavations, roadcuts, and quarries are continually being made and deserve attention.

With these facts in mind, I have put the localities in a geological perspective, giving them not as just isolated occurrences but showing how they fit into the geological context. With such information one can, for instance, predict that if gypsum crystals occur in a certain gray clay at one location, they are likely (though not certain) to occur in that same clay exposed somewhere else. This information is useful even if the original locality becomes inaccessible. In this sense, many of the localities should be considered mainly as clues to where similar material may turn up in the future.

Mineral Collecting

Before proceeding, a few aspects of mineral collecting in the region should be mentioned. First, *it cannot be stressed too strongly that most of the localities given in this book are on private property and under no circumstances should collecting be done without the owner's permission.* If permission is obtained, remember to leave the collecting area in as good condition as it was found, leaving no trash or large holes. In operating quarries one must always wear a hardhat, safety glasses, and hardtoed shoes, and be especially careful not to leave behind any metal equipment as this can damage the rock crushing machinery. Such conduct will hopefully keep the localities open to collectors and may even encourage the reopening of some locations that are now inaccessible.

Much public property is restricted for collecting, and none may be done within National Parks. Areas around reservoirs and many roadcuts also require special permission for mineral collecting, usually from a state or county agency.

It should also be remembered that during the summer, vegetation in the woods around Washington often takes on jungle-like aspects, making many localities essentially inaccessible. Also, summer is when poison ivy, poisonous snakes, mosquitoes, and gnats are at their peak, making early spring and late fall, or even winter if snow and ice are not prohibitive, the preferred seasons for collecting. By employing a good measure of common sense and courtesy, mineral collecting can continue to be an enjoyable and rewarding experience.

Acknowledgments

I am grateful to many persons at the U.S. Geological Survey for their assistance, particularly Mary E. Mrose for her critical reading of the manuscript and for X-ray diffraction work on several minerals, and Albert J. Froelich for supplying valuable information on the geology of the region. I also profited from discussions with many local mineral collectors, who are cited in the text, especially Herbert Corbett and John Griesbach. Special thanks are given to Clifford Frondel of Harvard University for his helpful advice and support. I am especially grateful to Eugene C. Robertson of the U.S. Geological Survey for his generous assistance and support throughout the preparation of this report.

GEOLOGY

Introduction

From New Jersey to Georgia the eastern United States is broadly divided into three regions based on geology and topography. These three zones lie roughly parallel to the coast and are, going inland: (1) the Coastal Plain, (2) the Piedmont, and (3) the Appalachian Highlands (Fig.2).

The Coastal Plain is low lying with relatively little relief. Its large rivers, actually estuaries, are very slow moving and are tidal. Lithologically the Coastal Plain is characterized by unconsolidated and poorly consolidated sediments such as sand, gravel, and clay, which form gently dipping beds and are less than 136 million years old.

Piedmont areas are at a somewhat greater elevation (about 70 to 260 meters above sea level near Washington) and generally have rolling hills with more relief than the Coastal Plain. The rocks of the Piedmont are usually hard, coarsely crystalline, folded and faulted. They are metamorphic and igneous in origin, ranging in age from about 400 million to 1.2 billion years. Several periods of intense folding, faulting, and metamorphism took place during this interval. The Piedmont rocks slope downward to the southeast under the younger Coastal Plain sediments. Near where rivers cross from the Piedmont to the Coastal Plain there are often falls and rapids, and this boundary has been termed the Fall Line.

The Piedmont region has been very deeply weathered, and in most places has a very thick soil cover. Much of the soil formed in place from disintegrated rock and is called saprolite, which often displays the textures and structures of the original rock. Due to the extensive weathering, fresh exposures of the metamorphic and igneous rocks are uncommon and of small extent, which has made the detailed geology of the Piedmont particularly difficult to unravel and mineral deposits difficult to locate.

Within the Piedmont are unconformable deposits of Triassic age (225-190 million years old). These deposits consist of westward dipping beds of shale, sandstone, and conglomerate, with occasional volcanics, intruded by masses of the igneous rock diabase. These rocks are found in a discontinuous belt from Massachusetts through North Carolina, and were deposited in large basins partially bounded by faults (grabens). According to the theories of plate tectonics, these basins opened up as North America was separating from Europe and Africa to form the Atlantic Ocean.

The Appalachian Highlands is a mountainous area incorporating several physiographic provinces and contains a complex mixture of highly folded to undisturbed rocks. The Appalachian region is mostly west of the area covered in this report.

Washington, D.C. itself lies directly on the Fall Line, with Great Falls of the Potomac River reflecting the transition from the narrow, swift moving river of the Piedmont to the broad, slow moving estuary of the Coastal Plain south of the city. As could be expected, the rocks of the Piedmont and Coastal Plain differ greatly in their mineralogy and are treated separately in the subsequent descriptions.

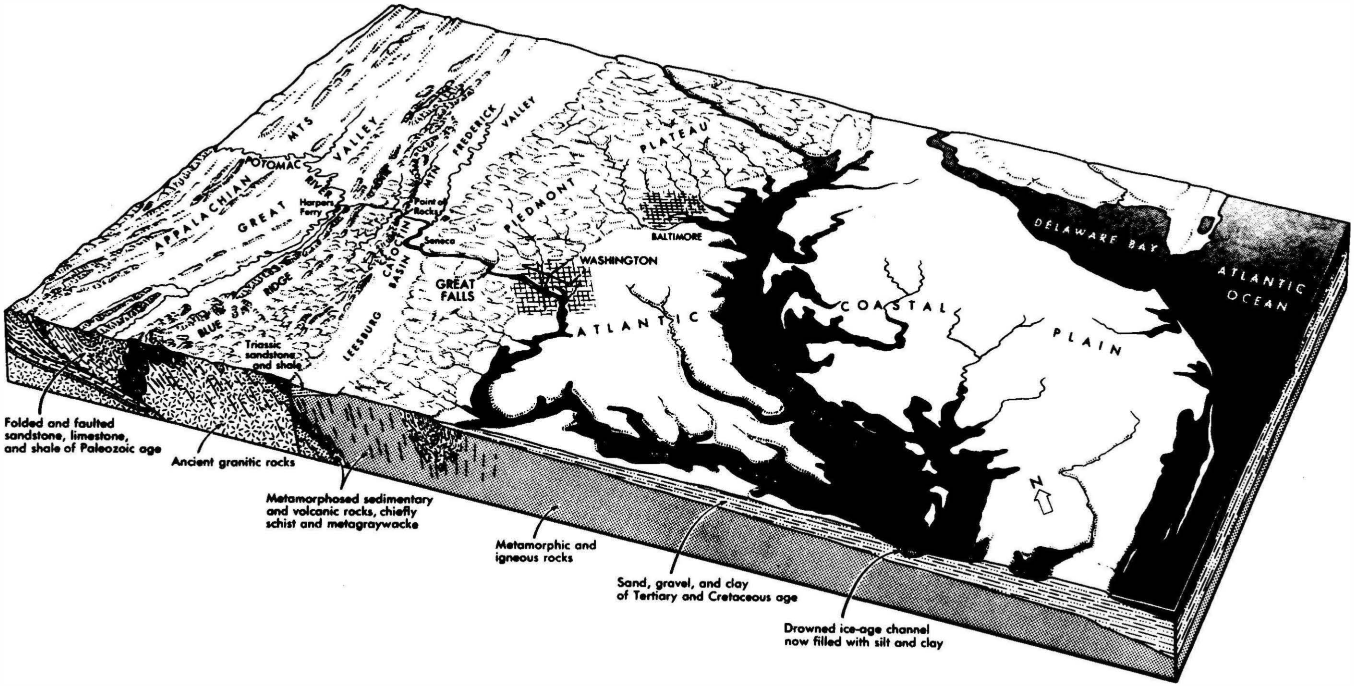

Figure 2: Block diagram of the D.C. region showing physiographic provinces and major geographic and geologic features. (Source: U.S. Geological Survey)

Coastal Plain

The clay, sand, and gravel of the Coastal Plain have never been subjected to high pressures or temperatures and generally remain unconsolidated. They range in age from Lower Cretaceous (136-94 million years old) to Quaternary (less than three million years old), and are divided into a number of formations on the basis of their compositions, textures, and ages (see Fig. 3). A complete description of all the Coastal Plain formations is beyond the scope of this book, but further information can be found in the references given at the end of the chapter.

The sediments that are generally of the greatest mineralogical interest are those of Cretaceous age. The Cretaceous sediments are only exposed in the western portion of the Coastal Plain and dip about sixteen meters per kilometer to the southeast under Tertiary sediments, mostly of Miocene age (about 20 million years old). Unusual or well crystallized minerals are most often found in the gray clays and glauconitic, clay-rich sands, commonly near their contacts with layers of quartz sand or with other formations.

Probably the best known mineral deposits of the Coastal Plain are the nodules and layers of iron ore that are abundantly distributed through the Cretaceous Arundel Clay (see p. 25). These nodules and layers consist of varying proportions of siderite, limonite, and hematite, with variable amounts of incorporated sand and lignite. Localized zones in the clays have produced a number of other minerals, including gypsum, vivianite, jarosite, basaluminite, and a variety of uncommon phosphates. Gypsum, where observed, occurs in the clays of the Potomac Group and Severn Formation, although it also occurs in similar clays of Miocene age further to the southeast (Ostrander and Price, 1940, p.66). The gypsum ranges from small anhedral masses to large euhedral crystals, often arranged in rosettes. Jarosite and basaluminite are occasional associates of the gypsum.

Vivianite, in nodules usually consisting of radiating acicular crystals, has been found in a number of isolated localities in the Washington area. In the one location where the nodules were observed in place (see p. 92) they occurred at the very top of the Severn Formation, just beneath Miocene sediments. Some of the finest known vivianite crystals were found in a similar environment further south, at a roadcut in Richmond, Virginia (Bland, 1966). Large nodules consisting of limonite and rockbridgeite with a host of other phosphate minerals, though not vivianite, were found in a very narrow zone in sandy clay at Greenbelt, Maryland (see p. 101).

Also occurring in the clays and glauconitic sands are masses of carbonized wood called lignite. The lignite often contains and commonly is replaced by marcasite. Silicified wood is also found, sometimes containing quartz crystals, in the gravels of the Patuxent Formation and also in Quaternary gravels, especially around Beltsville, Maryland and Fort Belvoir, Virginia.

The Tertiary sediments are predominately quartz sand and gravel, with beds of clay, glauconitic sand, and diatomite (formerly called diatomaceous earth). A bed of glauconitic sand known as the Aquia Greensand Formation, of Paleocene age, directly overlies the Cretaceous deposits in places. This material is green to bluish when fresh, but quickly becomes rust-colored upon exposure to air. Some of the Aquia, however, is a quartz-rich sandstone which has been used as a building material. Beds of diatomite, which are usually chalky white and consist of the siliceous skeletons of microscopic algae called diatoms, were mined in Calvert County, Maryland for use as a

Period	Epoch	Age (m.y.)*	Formation		Description	Characteristic Minerals
QUATERNARY	Pleistocene to Recent	0-2		Lowland Deposits	Gravel, sand, silt, and clay	Occasional glauconite and marcasite; rare vivianite
	Pliocene	2-7		Upland Deposits	Gravel and sand, locally limonite cemented; minor silt and red, white, and gray clay	Limonite common
	Miocene	7-26	Chesapeake Group	St. Mary's Formation Choptank Formation Calvert Formation	Dark-green to yellow clay and sandy clay; argillaceous sand; diatomite; local calcareous or silica-cemented sandstone	Occasional gypsum and quartz crystals. Heavy minerals reported are, in approximate order of abundance: zircon, staurolite, garnet, epidote, tourmaline, sillimanite, rutile, kyanite, and chloritoid (Dryden, 1932)
TERTIARY	Eocene	38-53	Pamunkey Group	Nanjemoy Formation	Glauconitic sand, silt, and clay; olive green to dark gray	Glauconite, fluorapatite
				Marlboro Clay	Pink to silvery-gray clay	Occasional gypsum
	Paleocene	53-65		Aquia Formation	Highly glauconitic, argillaceous, well-sorted fine to medium grained dark-green to blue-green sand; some beds of quartz sand and sandstone	Glauconite; occasional phosphate nodules, especially near base. Heavy minerals reported are, in approximate order of abundance: zircon, staurolite, garnet, rutile, epidote, tourmaline, kyanite, chloritoid, sillimanite, andalusite, corundum, topaz, brookite, dumortierite, monazite, glaucophane, anatase, zoisite, titanite, muscovite, chlorite, hypersthene (?), and clinozoisite (?). (Dryden, 1932)
				Brightseat Formation	Dark-gray to gray-green argillaceous, micaceous silt and sand; local indurated calcareous beds	Mica common; occasional phosphate nodules
CRETACEOUS	Upper Cretaceous	65-90		Severn Formation	Dark-gray, micaceous, glauconitic, argillaceous, fine- to coarse-grained sand; some basal gravel	Glauconite and mica common; occasional, but commonly well-crystallized, vivianite and gypsum
				Matawan Formation	Dark-gray, micaceous, glauconitic, argillaceous sand and silt	Glauconite, mica
				Magothy Formation	White lignitic sand and white to orange-brown limonite-stained quartz gravel; dark-gray, laminated silty clay	Limonite, some marcasite
	Lower Cretaceous	90-136		Patapsco Formation (includes Arundel Clay) Patuxent Formation	Dark-gray and maroon lignitic clay; white, pink, red, and brown variegated clay; white to orange-brown sand and gravel	Siderite, limonite, and hematite nodules abundant in lignitic clay; occasional marcasite and gypsum

Figure 3: Coastal Plain Deposits of Washington, D.C. and Vicinity (from Dryden, 1932; Maryland Geological Survey, 1968; and Virginia Division of Mineral Resources, 1963).

*Millions of years before present (approximate) mild abrasive and in filters.

When looking for minerals in the Coastal Plain, it should be kept in mind that there are two basic types of occurrences: those that are homogeneous throughout large portions of a formation, such as the iron ores, glauconitic sands, and diatomite; and those that are restricted to very narrow zones within a formation, such as the gypsum and vivianite locations. While specific localities for both types of occurrences are given in this book, minerals in the first category can generally be found in any exposure over a large region surrounding the locality, while those in the second category occur only in very isolated exposures.

Piedmont

Glenarm Supergroup

The large series of metamorphic rocks that underlie the Washington area Piedmont are predominately in a group of related formations known as the Glenarm Supergroup. The Glenarm Supergroup, named for outcrops near Glenarm, Maryland, is underlain by Precambrian basement, known in this area as the Baltimore Gneiss. The age of the Glenarm has stirred considerable controversy, but is generally agreed to be either very late Precambrian or early Paleozoic.

The formations in the Glenarm that are present in the Washington area are, from the base upwards: (1) a thin layer of quartzites and quartz-rich schists called the Setters Formation; (2) the moderately magnesian and aluminous carbonate rocks of the Cockeysville Marble; and (3) the thickest part of the supergroup, consisting of the schists and gneisses of the Wissahickon Group. Higgins (1972) also includes the Chopawamsic Formation, the Quantico Slate, and the James Run Formation in the Glenarm, although Crowley (1976, and personal communication) excludes them.

Interesting features of the Maryland section of the Glenarm Supergroup are the gneiss domes. These are places where the underlying Baltimore Gneiss has formed domelike upwellings into the overlying formations. These domes are of interest to the mineralogist as they often provide complete exposures of the Glenarm rocks. Also, certain zones in the schists around them contain high concentrations of kyanite and staurolite, due, in part, to the increasing metamorphic grade towards the domes. In addition, swarms of pegmatite veins and dikes commonly surround these domes.

Setters Formation

This formation consists primarily of micaceous and feldspathic quartzites, often containing coarse schorl crystals. A slight foliation is usually present and the upper portion of the formation, near contacts with the Cockeysville Marble, often grades into schist and gneiss. The quartzites usually contain few minerals besides quartz, feldspar, and mica, but some radiating groups of schorl crystals can be very attractive. The schistose portions of the formation often contain abundant kyanite, staurolite, and garnet crystals (see for example Crowley and Cleaves, 1974; and Crowley, 1976). The Setters Formation is exposed along the flanks of the gneiss domes, and in this environment excellent kyanite crystals have been collected near Soldiers Delight, Texas, and Reisterstown, Maryland. There are few specific localities listed for these kyanite deposits, but a knowledge of this basic geologic information, together with the relevant geologic maps, should aid in uncovering new localities for kyanite and staurolite in the Washington-Baltimore area.

Cockeysville Marble

The Cockeysville Marble directly overlies the Setters Formation, and as with the Setters it is generally exposed along the flanks of the gneiss domes. It consists primarily of metadolomite and calcite marble, with smaller amounts of calc-schists and gneisses and other calc-silicate rocks. The more siliceous rocks tend to be more abundant towards the top and bottom of the formation.

Metadolomite (a type of marble, composed primarily of dolomite) is usually the predominant rock type exposed and tends to be fine grained, with a light tan to gray color (sometimes called "bluestone"). The metadolomite often contains substantial amounts of pyrite as well as fine-grained and dispersed calcite, phlogopite, quartz, and graphite, with occasional tremolite and diopside.

The calcite marble is usually coarser grained than the metadolomite, consisting of intergrown calcite crystals as much as several centimeters across. The calcite marble tends to be white and usually contains some phlogopite with minor pyrite and titanite.

The marble grades into calc-silicate rocks that contain abundant tremolite and diopside, and sometimes scapolite, dravite, quartz, and feldspar. These are generally the rocks of the greatest mineralogical interest. In addition to the above mentioned more common minerals, less abundant minerals such as fluorite, pyrrhotite, and rutile also occur. These minerals are sometimes found in contact zones surrounding pegmatitic pods, as at the Greenspring quarry (p. 38). Calc-silicate zones are also common at the Howard-Montgomery quarry (p. 51). Some of the finest mineral specimens to come out of the Cockeysville are the nearly transparent brown dravite crystals, which are especially common at the Texas quarries (p. 33).

For greater detail on the petrology, mineralogy, and structures of this formation, the reader is referred to the papers by Choquette (1960) and Sanford (1980).

Wissahickon Group

The Wissahickon Group is a thick sequence of a large variety of metamorphic rocks. These include mica schists, chlorite schists, boulder and pebble gneisses, phyllites, and other related rocks. The Wissahickon also contains numerous quartz veins and pegmatites, as well as intrusive granitic rocks, interlayered serpentinites and other ultramafic rocks, and scarce calc-silicate zones. Areas underlain by Wissahickon rocks can usually be distinguished by the abundance of muscovite flakes in the residual soil.

The Wissahickon schists contain a typical suite of moderate to high-grade accessory metamorphic minerals, the most common and conspicuous ones being almandine and staurolite. Quartz, muscovite, plagioclase, biotite, and chlorite are the major minerals, and schorl is also often abundant. Kyanite, andalusite, and sillimanite are all quite scarce, with apatite, magnetite, epidote-clinozoisite, allanite, monazite, zircon, and xenotime reported as minor accessories (Hopson, 1964).

The schists often display clear evidence of retrograde metamorphism (where higher grade metamorphic minerals alter to lower grade ones), such as the partial or total replacement of garnet and staurolite by chlorite and magnetite, and less commonly the replacement of andalusite, kyanite, and sillimanite by fine-grained muscovite (sericite). In some chlorite-rich areas the schist contains well-formed magnetite crystals.

The Wissahickon gneisses produce few well-crystallized specimens and little outside of the common rock-forming minerals. The enclosed quartz veins, pegmatites, and serpentinites do contain a wide variety of minerals, however, and these are discussed separately.

Chopawamsic Formation

The Chopawamsic Formation is a sequence of metavolcanic and metasedimentary rocks about 2,000 to 3,300 meters thick located in northeastern Virginia. It underlies the Ordovician (Pavlides et al., 1980) Quantico Formation, and overlies Wissahickon rocks, making it probably Cambrian or early Ordovician in age. Metavolcanic rocks are predominant, and include metamorphosed basalts, andesites, volcanic breccias, tuffs, and other volcaniclastics (rocks derived from fragmental volcanic sediments).

The rocks range from granular to schistose in texture, the more tuffaceous and more mafic rocks tending to be more foliated. Many of the rocks are vesicular (having small cavities, or vesicles) and amygdaloidal (containing vesicles which were later filled with minerals), the amygdules often containing epidote, chlorite, and calcite. According to Southwick et al. (1971), major minerals in Chopawamsic rocks are: quartz, sodic plagioclase, microcline, epidote, chlorite, biotite, actinolite, hornblende, muscovite, and carbonate; with titanite, apatite, iron-titanium oxides, pyrite, and zircon as accessory minerals.

Well-formed actinolite and hornblende crystals are found in some of the Chopawamsic schists. Several large quartz-pyrite veins of the gold-pyrite belt (see p. 117) occur in these rocks, but their genetic relationship to the Chopawamsic Formation is unknown.

Higgins (1972) gives the name James Run Formation to a similar sequence of rocks in Maryland that occurs in a belt extending northeastward from south of Baltimore. This formation is more highly metamorphosed than the Chopawamsic, and includes some high-grade gneisses.

Ijamsville and Urbana Formations

These formations occur in northwestern Montgomery and Howard Counties and southern Frederick County, Maryland, and probably overlie the Wissahickon Group (Hopson, 1964). Metasedimentary and metavolcanic phyllites are interbedded with lesser amounts of slates, metasiltstones, metasandstones, metagraywackes, and thin beds of marble. The phyllites and slates are generally very fine-grained and dark gray although they range from silvery and micaceous to dark green or purple. Under the microscope these rocks are found to contain paragonite, chloritoid, and stilpnomelane, in addition to the predominant chlorite and muscovite (Hopson, 1964). More sandy portions also contain quartz and albite, with epidote, tourmaline, apatite, titanite, zircon, monazite, xenotime, anatase, rutile, magnetite, hematite, limonite, and leucoxene as accessory minerals (Hopson, 1964).

Well-crystallized mineral specimens have not been reported from these rocks, although magnetite octahedra up to several millimeters across are often conspicuous in the phyllites. A small copper mine near Barnesville, Maryland (see p. 86) apparently was operated in Ijamsville phyllite. Scarce calc-silicate layers are probably the most promising places to look for additional minerals.

Quartz Veins

Characteristic of the Piedmont near Washington are the abundant quartz veins. These most commonly cut through the schists and gneisses, occurring less commonly in the granitic rocks and only rarely in other associations. The veins range in size from isolated stringers a few millimeters in width to great masses traceable for over a kilometer. The presence of a vein is most commonly evidenced by the concentration of coarse quartz fragments (termed quartz float) in the saprolite or other soil.

Quartz crystals are common in the cavities of these rocks, and any area where these veins are especially prevalent should be considered as a potential producer of fine crystals. While the quartz in these veins is generally white, gray, or light brown, the crystals in cavities range from water clear (as at Aspen Hill, p. 90) to dark smoky brown (as around Columbia, p. 59) to amethyst (as in Arlington, p. 103). In some veins, as at Aspen Hill, tiny inclusions of chlorite give some crystals a green color.

The quartz often contains large amounts of iron oxides and more rarely manganese oxides. Black coatings on quartz from Fairfax County, Virginia, have been identified by Charles Milton of George Washington University as lithiophorite. Some of these oxides result from the decomposition of sulfides, but most are the result of groundwater deposition.

The quartz veins nearly always have small amounts of fine-grained muscovite (sericite) in thin fractures, which is sometimes abundant enough to produce an incipient schistosity. The quartz also usually contains small amounts of feldspar and coarse muscovite, and the veins can grade into pegmatite. Quite abundant as well are embedded crystals of schorl, some making excellent specimens; in fact, some veins exist which are composed almost wholly of massive schorl.

Upon close inspection, rutile is occasionally observed in quartz veins. In some areas the quartz takes on a bluish color, indicative of the inclusion of multitudes of microscopic rutile needles. Two locations (see p. 59, 90) are known to produce specimens of rutilated quartz.

In addition, the quartz veins have produced a host of metallic minerals, most notably gold (see p. 81). While you cannot expect to encounter macroscopic gold very often, many of the veins, especially in Montgomery County, Maryland, when assayed are found to contain substantial amounts of gold as dispersed microscopic particles.

Sulfides, particularly pyrite, are fairly abundant in the quartz and often contain gold themselves. Cubic pyrite crystals, some several centimeters across, are common. Cubic casts from decomposed pyrite crystals are frequently found and some contain limonite or, more rarely, tiny sulfur crystals. Crystals of galena are not rare, though they are much less common than pyrite crystals and are generally smaller. Tiny masses of sphalerite are sometimes seen, and more rarely molybdenite and stibnite are reported.

All these minerals are to be expected in quartz veins and further investigation should turn up even more minerals. Unreported minerals such as cassiterite, scheelite (easily mistaken for quartz), wolframite, and fluorite have a high probability of being found. The quartz veins, in general, are probably some of the most profitable places to explore for new and interesting localities.

Minerals known from quartz veins in the area (arbitrarily defined as veins averaging 90% or more macrocrystalline quartz) are listed below. This list does not include minerals from other quartz-rich metallic veins or quartz cores in pegmatites.

Chalcopyrite (?)* (g)
Chlorite (m)
Feldspar (c)
Galena (r,g)
Goethite (c,s)
Gold (r)
  electrum (r)
Hematite (m,s)
Ilmenite (m)
Limonite (c,s)
Lithiophorite (m, s)
Manganese oxides (m, s)
Molybdenite (r)
Muscovite (c)
  sericite (c)
Platinum (?) (r,g)
Pyrite (m)
Pyrrhotite (?) (g)
Quartz (c)
  amethyst (r)
  blue (r)
  milky (c)
  rock crystal (r)
  rutilated (r)
  smoky (m)
  pseudomorphs: after calcite (r)
    after fluorite (r)
Rutile (r)
Schorl (c)
Sphalerite (r,g)
Stibnite (?)
Sulfur (r)
Tetradymite (?) (g)
Topaz (?)

*Abbreviations:

(c) - common
(m) - moderately abundant
(r) - rare
(g) - mostly from some gold-bearing veins
(s) - secondary mineral
(?) - unconfirmed

Pegmatites

Pegmatites have long been favorite collecting grounds for mineralogists, as well as major sources of wealth for miners and gem cutters. Some of the highest concentrations of rare-element and gem minerals occur within these rocks, as well as some of the largest and finest mineral specimens. While most pegmatites do not contain such unusual or spectacular minerals, pegmatites still afford one a better chance of finding good specimens than most other rock types, and any pegmatite-rich area is worthy of investigation. The Piedmont around Washington, especially in Maryland, is such a pegmatite-rich region, and although only a few pegmatites have been exploited, the prospects for new finds are good as long as there is continued construction and excavation to expose them.

The word *pegmatite* refers to any very coarse-grained igneous appearing rock, which generally occurs as veins, dikes, or isolated lenticular bodies, usually in a metamorphic or igneous environment. The grain size of the minerals in pegmatites is usually around a few centimeters; but, in some deposits, it ranges up to a meter or more. Giant "logs" of beryl and spodumene several meters long are found in certain pegmatites around the world, and crystals of feldspar and beryl up to nearly a meter across have been found in some of the pegmatites around Washington. While pegmatite can refer to a coarse-grained variety of any igneous rock, when used without qualification it denotes a rock of essentially granitic composition; that is, composed predominantly of feldspar, quartz, and mica. The term pegmatite also implies a certain mode of origin, where water vapor and gases, often containing high concentrations of dissolved rare and volatile elements and silica, are abundant and play a major role in the formation of the rock.

Pegmatites are divided into two broad categories of simple and complex, although there is no sharp distinction between them. Simple pegmatites consist almost wholly of feldspar, quartz, and mica, with garnet and schorl as common accessories. This is by far the most common variety of pegmatite around Washington, occurring throughout the gneisses, schists, and occasionally marbles of the Piedmont, as well as in some of the igneous bodies. Simple pegmatites are particularly prevalent as "swarms" of dikes around the gneiss domes. The schorl and garnet of these pegmatites sometimes make attractive specimens, and quartz crystals, occasionally of a smoky or amethyst color, occur in cavities. Such quartz crystals are often concentrated in the soil derived from a decomposed pegmatite. The quartz derived from pegmatites is often intergrown with feldspar and mica, which helps distinguish such material from that derived from quartz veins.

Complex pegmatites are far fewer in number but these contain most of the unusual minerals. Characteristic of the complex pegmatites in the Washington area are the minerals beryl, apatite, gahnite, and rare-earth minerals such as pyrochlore. Lithium minerals tend to be absent in this region. The complex pegmatites occur in the same geologic environments as the simple ones, and it is the presence of the unusual minerals listed above which distinguishes the two, although the complex pegmatites are usually larger than the average simple pegmatites.

An interesting feature of pegmatites, particularly complex ones, is that they are often concentrically zoned with respect to their mineralogy and texture, as illustrated in Figure 4. All of these zones are not present in every pegmatite, but virtually all complex pegmatites contain at least a quartz rich core in addition to a surrounding "pegmatitic" zone. In the complex pegmatites of the Washington area it is generally found that the rare-element minerals, such as beryl, are concentrated in the outer part of the wall zone, and in the albite zone and core margin area.

The term graphic granite applies to oriented intergrowths of feldspar and quartz, where the quartz forms long, parallel, angular rods within feldspar crystals. Such intergrowths are common in pegmatites, and good examples can be found in some of the old feldspar mines of Howard County, Maryland (Fig 28).

Before closing the section on pegmatites, it should be noted that one of the best known pegmatite regions in the U.S. is only a three-hour drive from Washington. This is the region around Amelia Courthouse, Virginia, about 50 kilometers west-southwest of Richmond.

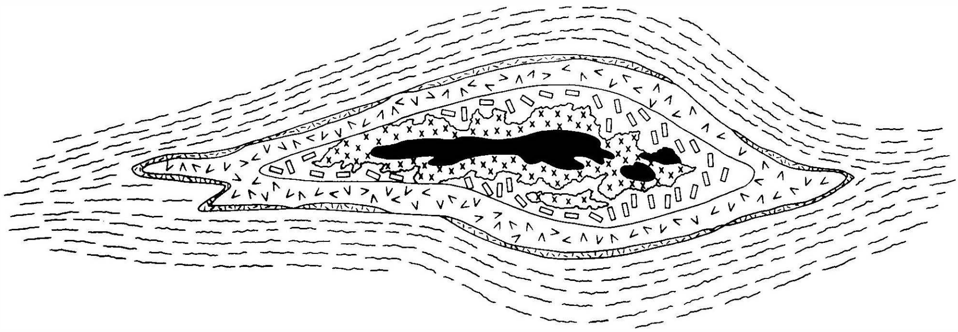

Figure 4: Generalized cross section of a typical complex pegmatite of the Washington, D.C. area.

Schist or gneiss

Pegmatite:

Border zone—fine-grained plagioclase, quartz, and muscovite.

Wall zone—coarse intergrown feldspar (mostly plagioclase), quartz, and muscovite; graphic granite in some pegmatites.

Perthite zone—coarse blocky perthite with interstitial quartz.

Albite replacement zone—albite (often cleavelandite) with muscovite and beryl.

Core—massive coarse quartz, with scattered feldspar, muscovite, and beryl.

Granitic Rocks

Masses of granitic rocks ranging in size from thin veins and dikes to large stocks are widespread around Washington. Many of these were apparently emplaced before or during the peak of regional metamorphism and show considerable foliation. Most of these rocks are not true granites in composition, but rather adamellites, tonalites, granodiorites, monzonites, and similar rocks. These are granitic in appearance but are given these other names because of differences in the types of feldspar and the proportions of quartz that they contain. In addition, numerous variants of the Wissahickon Group have been mistaken for granitic rocks, and some supposed granitic bodies are still in dispute.

In Maryland, granitic rocks occur in the cores of some gneiss domes and in scattered bodies through the Piedmont. Such bodies have been quarried around Ellicott City, Woodstock, Granite, and Guilford. Because the granitic rocks are quite fine-grained and contain very few cavities, they almost never produce good mineral specimens. In general, except for the intergrown feldspar, quartz, and mica, additional minerals require the use of a microscope to be seen. Accessory minerals from the Maryland granitic rocks include (Hopson, 1964): clinozoisite, hornblende, chlorite, apatite, tourmaline, titanite, rutile, monazite, zircon, magnetite, xenotime, garnet, clay minerals, and calcite.

Several fairly large granitic stocks also occur in Fairfax and Prince William Counties, Virginia, although their extent is still not well defined due to the scarcity of good exposures. These deposits have been quarried in the vicinity of Falls Church and Annandale (Watson, 1907), but these quarries have since been essentially obliterated. The best current exposure is at the Vulcan Materials quarries across Occoquan Creek from Occoquan (p. 108), in a foliated granite criss-crossed by numerous quartz veins. Few mineral specimens have come from these rocks.

Small dikes of generally unfoliated granitic rocks are fairly common in all the Piedmont schists and gneisses, and are particularly well exposed along the Potomac in the vicinity of Great Falls, especially on Bear Island. These dikes often contain schorl and garnet crystals and are gradational in texture and mineralogy with simple pegmatites. Aplite is the term applied to these dikes and veins when they are light colored and consist almost exclusively of fine-grained feldspar and lesser amounts of quartz. Aplite veins and dikes commonly cut granitic and other igneous rocks.

Gabbroic Rocks

Gabbro is a dark igneous rock of moderate grain size consisting almost wholly of plagioclase feldspar and pyroxene. If pyroxene is very predominant, the rock is called a pyroxenite, and if the rock is almost exclusively plagioclase it is an anorthosite. The presence of large amounts of olivine in a pyroxenite makes it a peridotite, and if the rock is exclusively olivine (usually with some chromite) it is called dunite. When a gabbro or pyroxenite is metamorphosed, amphiboles are usually formed, and a rock composed primarily of amphiboles is called an amphibolite. If a peridotite or dunite is metamorphosed and hydrated, serpentinite, actinolite and chlorite schists, and steatite are produced.

In the Washington area, gabbroic rocks compose the Baltimore Mafic Complex, which extends discontinuously from around Savage, Maryland northeastward into Pennsylvania. Gabbro and amphibolite are the predominant rock types (Fig. 5), with lesser amounts of the other rocks mentioned above. Dunite and anorthosite are especially uncommon and only occur as very thin layers and lenses in the other gabbroic rocks. Small gabbro quarries and exposures can be seen west and south of Baltimore, as in the vicinity of Ilchester and Hollofield. A very large abandoned quarry in these rocks is located northeast of Savage (see p. 62).

A smaller area of gabbro, granitic rocks, and amphibolite (called the Georgetown Mafic Complex) occurs in the western part of Washington, D.C. and to the west of the city, but is very poorly exposed and poorly defined. Masses of gabbro are also found to the north and west of Rockville, Maryland. A poorly exposed belt of gabbroic rocks also occurs in Fairfax County, Virginia, striking northeastward from Bull Run near Manassas, through Fairfax, to the Potomac just south of Difficult Run.

A moderate number of minerals have come from the gabbroic rocks of the area, although large euhedral crystals are very unusual. Cavities are very rare, but on weathered surfaces and in open joints calcite crystals are often found, which are derived from the high calcium content of the rocks. Minerals that occur in these rocks are: actinolite, apatite, calcite, chalcopyrite, chlorite, clinozoisite-epidote, garnet, hornblende, ilmenite, magnetite, olivine, plagioclase, pyrite, pyroxenes, quartz, and titanite.

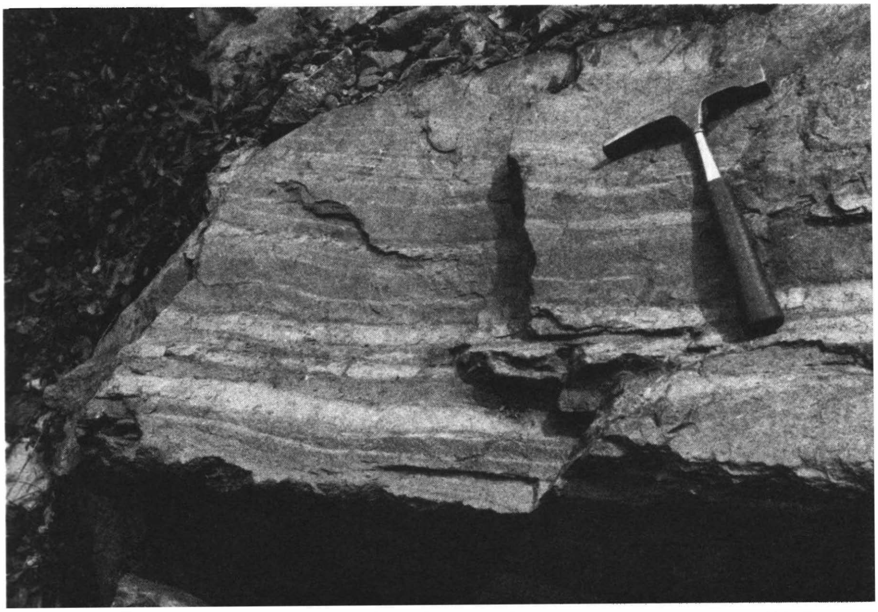

Figure 5: Rhythmically layered gabbro of the Baltimore Gabbro Complex at Ilchester, Maryland.

Serpentinite

As the name implies, serpentinite is a rock composed dominantly of the serpentine group minerals, particularly antigorite. The serpentine minerals (antigorite, lizardite, and chrysotile) are all polymorphs of $(Mg, Fe)_3Si_2O_5(OH)_4$; that is, they all have nearly the same chemical composition, but different crystal structures and physical properties. Chrysotile tends to be fibrous, forming asbestos; but all these minerals are generally intimately intergrown and microcrystalline and cannot be distinguished from each other by any simple tests. Williamsite is a popular name given to translucent green, gem-quality serpentine, which usually has black inclusions of chromite or magnetite. Picrolite is another popular name, given to waxy-appearing serpentine with a columnar to coarse fibrous habit.

Serpentinites occur as isolated bodies generally conformable with the enclosing schists and gneisses. They are often associated with small bodies of the closely related rock steatite and with nearby mafic igneous rocks. The Hunting Hill (p. 71) and Delight (p. 30) quarries in Maryland are the best exposures of serpentinite in the area, although any of the serpentinite regions indicated on the geologic map are potential sources of much the same material. Areas underlain by serpentinite are generally easy to recognize. The weathering of serpentinite produces a poor soil, and the vegetation in such areas tends to be sparse and stunted. Such "serpentine barrens" are characteristic of areas underlain by serpentinite throughout the world.

The serpentinites always contain considerable amounts of chromite or magnetite, and many of the serpentinite bodies have been important producers of chrome ore (see p. 29).

Associated with some of the large serpentinite bodies, particularly at Hunting Hill, are dikes and irregular bodies of the coarse-grained, light-colored, relatively rare rock known as rodingite. The rodingite is composed primarily of coarse crystals of diopside (some of which are colored emerald green by chromium), massive grossular and hydro-grossular, clinozoisite, and zoisite. Cavities in this rock often contain well-formed crystals of these minerals, as well as of calcite and aragonite. This rodingite is most likely the result of the metamorphism of coarse-grained gabbro, which was associated with the original peridotite and dunite that was altered to form serpentinite.

Various other veins and alteration zones in serpentinite produce a host of other minerals. For more information on the mineralogy of these deposits, see the descriptions of the Hunting Hill (p. 71) and Soldiers Delight (p. 29) localities.

Steatite

Like serpentinite, steatite (soapstone) is usually the result of the hydration of an ultramafic igneous rock such as peridotite or dunite, but where the alteration has proceeded to an even greater extent. The rims of serpentinite bodies are often composed of steatite. The rock steatite is dominated by the mineral talc, which gives this rock its characteristic soapy, slippery feeling.

Small lenticular bodies of steatite are quite numerous in the Wissahickon schists. These bodies are rarely more than a few hundred meters across, and are frequently associated with nearby serpentinite and metagabbro. The steatite is generally fine grained, and exposed surfaces are often pitted from the weathering out of carbonate crystals or pyrite. In some deposits the steatite is schistose, and sometimes grades into talc-bearing mica schists, while in other places it is entirely massive with no foliation. Steatite tends to decompose to a brown soil.

In addition to talc, steatite usually contains some carbonate mineral, most often magnesite-siderite, as well as chlorite, magnetite, limonite, and sometimes tremolite-actinolite. Tremolite and carbonate minerals are not known to occur together in steatite (Hopson, 1964). Good specimens of foliated talc, octahedral magnetite crystals, blades of actinolite and tremolite, and limonite pseudomorphs after pyrite have come from steatite in the area.

There are no active quarries in steatite, but fair exposures occur at Ednor, Maryland (p. 78), in Washington, D.C. (p. 22), around Arlington, Virginia (p. 103), and at numerous smaller localities. The local steatite was long used by American Indians for making bowls and other carvings, and most of the steatite bodies show some evidence of prehistoric mining.

Triassic-Jurassic Deposits

Although the Triassic-Jurassic rocks in the Washington area are of varied origins, they nevertheless occur in a distinctive association that is characteristic of Triassic-Jurassic deposits through much of the eastern United States. This association is basically that of reddish shales, sandstones, and conglomerates ("red beds") intruded by dikes, sills, and stocks of diabase, with some volcanic rocks. Towards the western, fault-bounded part of the Triassic-Jurassic belt near Washington the red beds commonly grade into coarse, lighter colored conglomerates.

The Triassic-Jurassic basin around Washington is an area of subdued topography, with low, broad hills. The eastern boundary merges topographically with the rest of the Piedmont, while the western, faulted boundary is marked by ridges of resistant pre-Triassic rocks.

Diabase

Diabase is a moderately fine-grained (about 1-5 mm), fairly dark igneous rock that is a compositional equivalent to the extrusive rock basalt. Diabase owes its dark color to the high proportion of iron-rich minerals that it contains, particularly pyroxenes. If somewhat coarser grained the rock is called a gabbro; and if the individual crystals are several centimeters across it is called a diabase pegmatite or gabbro pegmatite. Volcaniclastic rocks and thin beds of basalt frequently occur near the diabase in the area.

In the Washington area, Triassic-Jurassic diabase is most abundant in northern Virginia where numerous quarries have been opened to extract this rock for crushed stone. Smaller deposits also occur in neighboring Maryland. Some diabase dikes occur outside the limits of the Triassic-Jurassic basin, in the surrounding Piedmont. The diabase bodies produce a very wide variety of minerals, occurring both in the diabase and in various types of alteration zones within it and surrounding it. The mineralogy of this rock is discussed in the section on the diabase quarries of Virginia(p. 121).

Sedimentary Rocks

The Triassic-Jurassic shales and sandstones are composed mainly of quartz and feldspar, with smaller amounts of clay minerals, mica, chlorite, and magnetite. Finely disseminated hematite is the primary cause of their common and distinctive reddish hue. Some of the coarse conglomerate in the western portion of the Triassic basin is quite calcareous (containing a large number of limestone fragments) and has been called Potomac Marble or calico stone. Many fragments (clasts) in this rock are attractively colored in shades of red and yellow, and this stone has been quarried, cut, and polished for decorative use. Potomac Marble is well exposed north of Leesburg, Virginia, and near Point of Rocks, Maryland. Although few unusual and well crystallized minerals are found in any of these unaltered sedimentary rocks, a wide variety do occur near contacts with diabase intrusives and occasionally in fault zones, as is described in the subsequent section.

Diabase Contact Zones and Related Deposits

When the molten diabase was intruded, a number of changes were produced in the surrounding sedimentary rocks. These contact effects were generally greatest near the larger diabase bodies, which retained their heat for a long time and contained relatively large amounts of water and dissolved metallic elements.

The most common contact effect was the "baking" or contact metamorphism of the sedimentary rock, usually within a few meters and never more than a few hundred meters from the contact. In the red shales and sandstones the most common result of the "baking" was the partial reduction of the iron in the hematite, forming magnetite. This produced the gray or tan color characteristic of these rocks. Where this baked zone is fine grained, unfoliated, and hard the rock is known as hornfels. In some areas of intense contact metamorphism small nodules of fine-grained cordierite were produced in the hornfels.

In places, metallic minerals were concentrated in and near these contact zones. Perhaps the most common of these is specular hematite. This hematite occurs at a moderate distance from the contacts, usually in small segregations, and is nearly always associated with epidote. Good crystals of both these minerals are frequently found in small cavities.

Secondary copper minerals are other common associates of the contact zones. These minerals include malachite, azurite, pseudomalachite, libethenite, and chrysocolla as veins, films, and impregnations in the shale, sandstone, and arkose (sandstone containing a large proportion of feldspar grains). The copper minerals are usually found with specular hematite and often produce a very rich-looking rock. The bright greens and blues of the copper minerals, concentrated on fracture and bedding surfaces, give a misleading indication of the economic value of the rock, however, as testified to by the numerous abandoned, unprofitable copper mines and prospects in the area. The main problem is that most of the deposits are of a very small extent. Also, primary copper minerals such as chalcopyrite and bornite are only sporadically found in these zones.

The copper-rich zones often contain a substantial amount of silver, reportedly up to twenty ounces per ton of ore (625 ppm) (Hotchkiss, 1884). While production of copper alone from these deposits is almost certainly unprofitable, further geochemical prospecting could reveal small copper-silver deposits of economic potential. Small amounts of gold occur in some of these zones (D'Agostino and Hanshaw, 1970), and assays have detected substantial nickel (Hotchkiss, 1884; D'Agostino and Hanshaw, 1970).

Another mineral found in the contact zones is barite, though it is less common than the copper minerals. It usually occurs as veins of white, tabular crystals, and occasionally as disseminated grains. The origin of the barite and its relationship to the diabase are not clear. In one locality a vein of barite occurs directly in diabase, while at another locality a vein occurs in a fault zone not closely associated with a known diabase body. The veins are generally rather pure, containing only occasional quartz, malachite, and in one locality, calcite. Excellent barite crystals have come from vugs within these veins.

The number of known occurrences of metallic minerals within the local Triassic rocks is fairly large, as indicated on Plate 3. It should be remembered that most of these localities contain only a very small amount of material, and many are no longer accessible. The association of these minerals with diabase contacts is extremely common, and even where diabase is not exposed on the surface, the baking of the rocks indicates its presence nearby. In a few places copper minerals occur well outside the boundary of the baked zone, associated with plant fossils. In these places the copper-bearing solutions probably migrated along bedding or fault surfaces until precipitated on the organic material.

Contact zones in the calcareous conglomerates contain some additional unusual minerals. Within these zones calcite has recrystallized, as in a typical marble. Calc-silicate minerals such as epidote-clinozoisite, calcium-rich garnets, and more rarely xonotlite, are also characteristic of these zones. Magnetite, chalcopyrite, malachite, quartz crystals (sometimes amethyst), and other minerals are sometimes found, often in rather narrow zones. These rocks are best seen in several roadcuts and small quarries in the vicinity of Leesburg, Virginia (see p. 114).

Zeolites, especially stilbite and chabazite, are also known from the diabase contact zones, as at the Chantilly and Manassas quarries. It is evident that these contact and related zones are some of the most promising mineralogical sites around Washington, and there is every chance that more can be found. Further investigation will hopefully clarify the origins of these deposits and their relation to the diabase.

Additional Information

Only the more important formations and rock types in the immediate Washington area have been described here, and these have been considered mainly from a mineralogical point of view. For further information on the geology of the region, the references given below are recommended. Also, since much of the geology is incompletely understood and research is currently in progress, forthcoming publications of the United States and Maryand Geological Surveys and the Virginia Division of Mineral Resources, as well as journal articles, should contain valuable new information.

Selected References on the Geology of the Washington, D.C., area

General: Johnston, 1964; Lonsdale, 1927; Maryland Geological Survey, 1968; Parker, 1968; Toewe, 1966; Virginia Division of Mineral Resources, 1963.
Chopawamsic Formation: Southwick, Reed, and Mixon, 1971.
Gabbroic Rocks: Herz, 1951; Crowley, 1976.
Glenarm Supergroup: Choquette, 1960; Higgins, 1972; Reed and Jolly, 1963; Southwick and Fisher, 1967; Crowley, 1976; Fisher et al., 1977; Sanford, 1980.
Triassic Rocks: Roberts, 1928; Lindholm, 1979.

MINERAL LOCALITIES

DISTRICT OF COLUMBIA
Washington

Mineral localities in Washington, as in most large cities, tend to be of a very transient nature, confined to various temporary excavations and construction sites. Mineral collecting is mostly a matter of keeping one's eyes open for any place where rock has been recently blasted or land turned over. A knowledge of local geology and of previously reported minerals is, of course, also helpful. So, although most of the following localities are described in the past tense, they still exist as clues to where similar, or better, localities may be uncovered in the future.

1. Large specimens of botryoidal and stalactitic goethite, with limonite, iridescent hematite (turgite), psilomelane, and lepidocrocite were found in 1953-54 near Wheeler Road, just south of Oxon Run (John Griesbach, oral communication, 1975). Some of the goethite stalactites were exceedingly elongated and delicate. They occurred with the other minerals in hollow concretions at the base of the "Brandywine Gravel" (included in the Upland Deposits, Fig. 3). Carbonized cypress wood, often stained by limonite, was also found here. (Loc. 1).*

2. Small, dark blue vivianite nodules were found during excavations for the Commerce and Archives buildings along Constitution Avenue, at Fourteenth and Ninth Streets, N.W. (Benn, 1935). (Loc. 2).

3. Excellent marcasite crystals in lignitized wood were found in the excavation for the Australian Chancery, at 1700 Massachusetts Avenue, N.W. (S. Silsby, oral communication, 1975). (Loc. 3).

4. Foliated steatite containing chlorite and limonite pseudomorphs after pyrite occurs in a roadcut along 46th Street between Fessenden and Garrison Streets, N.W., at Ft. Baylor Park. (Loc. 4).

5. A specimen of psilomelane as a thin, botryoidal crust on white quartz from Connecticut Avenue at Chesapeake Street, N.W., is in the Smithsonian mineral collection (NMNH-D.C.)** (Loc. 5).

6. Twinned rutile crystals in quartz were found along Piney Branch near Spring Road, N.W. (A. Bonanno, oral communication, 1974). Titanite crystals in a granitic rock are also reported from this locality (Ulke, 1936). (Loc. 6).

7. At a roadcut along Rock Creek, just north of the National Zoo, staurolite crystals in gneiss occur (A. Bonanno, oral communication, 1974). (Loc. 7).

8. Specimens of jasper (NMNH-106404)*** and hornblende (NMNH-103068)*** from the vicinity of Pierce Mill, near Tilden Street in Rock Creek Park, are in the Smithsonian mineral collection. (Loc. 8).

9. Piemontite has been found in the gravel exposed along Harvard Street, N.W., near the National Zoo (Ulke, 1936). (Loc. 9).

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*This number designates the locality number as used in Plate 1.

**NMNH-D.C. refers to National Museum of Natural History, uncatalogued collection of minerals from Washington, D.C. and vicinity.
*** National Museum of Natural History specimen number.

10. A piece of massive white opal containing quartz fragments was reportedly found in soil on Blagden Avenue, near 16th Street, N.W. (Ulke, 1936). (Loc. 10).
11. A marcasite concretion was found at First and M Streets, N.E. (Ulke, 1936). (Loc. 11).

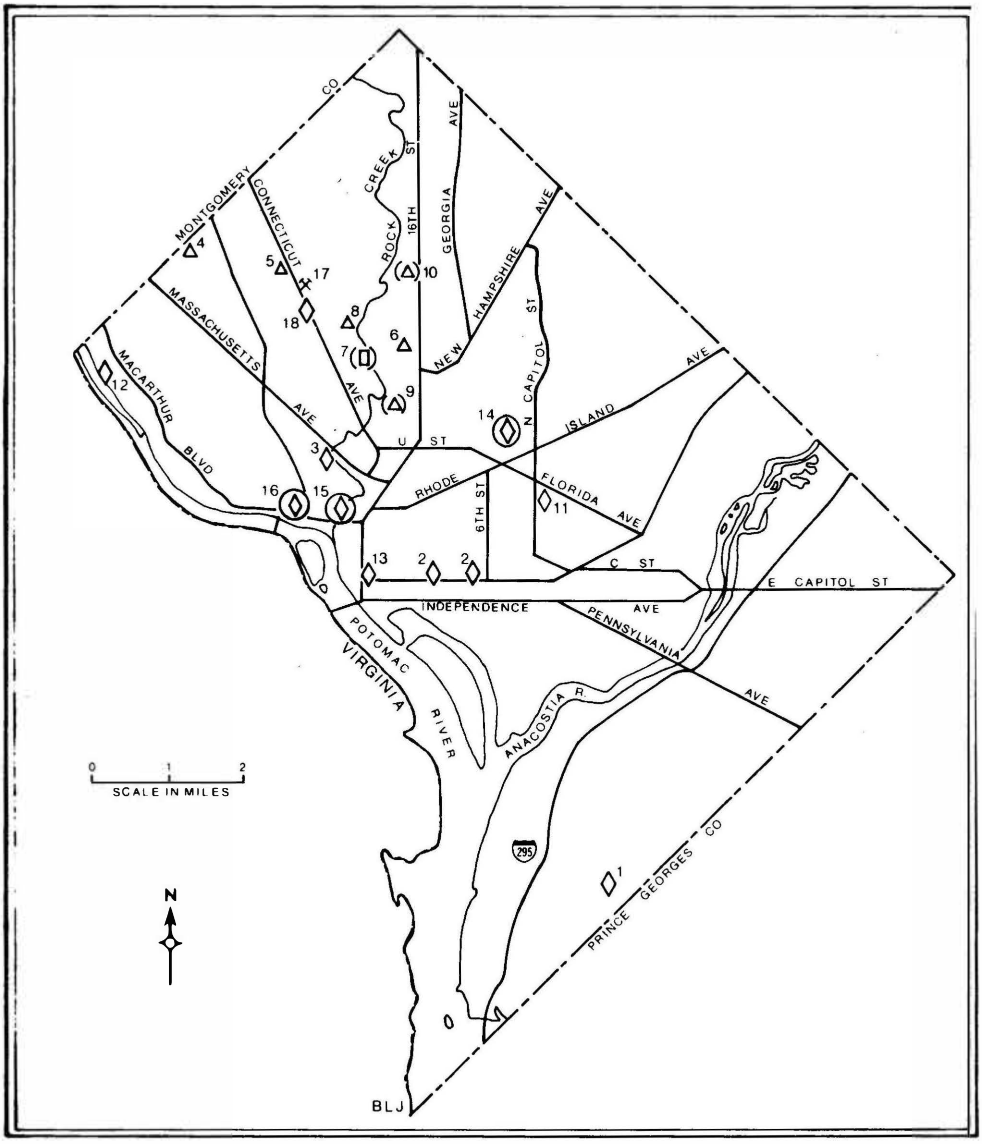

Figure 6: Locations of mineral deposits in Washington, D.C. Symbols are the same as those used on Plate 1.

12. Laumontite crystals were found in "stone quarries along Connecticut Avenue,"(Ulke, 1936).
13. Kyanite in diorite and ilmenite in quartz from near Chain Bridge in Washington were found in 1896 (Ulke, 1936). (Loc. 12).
14. A large piece of galena with encrusting cerussite was found in gravel from about seven meters beneath the surface at Constitution Avenue between 22nd and 23rd Streets, in March, 1933 (Ulke, 1936). (Loc. 13).
15. Andalusite in mica schist was found in the bed of Rock Creek (Ulke, 1936).
16. In excavations on the grounds of Howard University have been found blue-green apatite crystals in quartz (in 1897), chabazite, stilbite, and calcite on diorite, and crusts of melanterite (Ulke, 1936). In the Howard University shaft of the Waterworks Extension Project, 1883-1885, were found analcime crystals up to 2 cm across, tremolite, hornblende, stilbite, and calcite (Ulke, 1936, and Smithsonian specimens (NMNH-DC)). (Loc. 14).
17. A specimen of gold in quartz from Longbridge, where M Street crosses Rock Creek, is in the Smithsonian collection (NMNH-12013). Light yellowish-green apatite crystals up to 5 cm across in white quartz, with biotite, calcite, laumontite, and epidote crystals, were reportedly found in the Waterworks Extension Project shaft and tunnel near here (Ulke, 1936). (Loc. 15).
18. Excellent rutile crystals ranging up to 7 cm long, in quartz and chlorite with feldspar crystals and actinolite, were found in the Foundry Branch shaft of the Waterworks Extension Project, and near the former mouth of Foundry Branch, which is now entirely underground in Georgetown (NMNH-78429, 104561). Also reported (Ulke, 1936) from this site are calcite, hornblende, epidote, ilmenite, pyrite (large masses in diorite with quartz), schorl, zoisite, heulandite, and analcime, in quartz veins and hornblende diorite. (Loc. 16).
19. A pit in steatite and chlorite schist, called the Rose Hill quarry, was located just east of the intersection of Albemarle Street and Connecticut Avenue, N.W., and was first worked in prehistoric times by American Indians (Holmes, 1890). Actinolite crystals occurred in the steatite (NMNH-D.C.). (Loc. 17).
20. Milky quartz crystals, ilmenite, biotite, apatite, and schorl, in quartz veins and tonalite, were found near the intersection of Connecticut Avenue and Van Ness Street, N.W. (NMNH-D.C.). (Loc. 18).
21. Dark green hornblende crystals up to three centimeters long occur in Wissahickon schist at the National Zoological Park (NMNH-D.C.).

The following additional minerals have been found at unspecified locations within Washington:

Chrysocolla—crusts on rocks (Ulke, 1936, and NMNH-D.C.).

Titanite—light-green, transparent crystals in chlorite are in the Smithsonian collection (NMNH-45848), from an unidentified waterworks tunnel. This material was analyzed by F.W. Clarke (Clarke, 1910), and gave:

Oxides	Weight Percent
TiO_2	40.82
SiO_2	30.10
MnO	trace
CaO	28.08
MgO	0.40
Ignition	0.54
Total	99.94

MARYLAND

ANNE ARUNDEL COUNTY

Annapolis

Vivianite has been reported from gray clay in a bog at Greenbury Point, about 3.2 km east of Annapolis (Ostrander and Price, 1940). (Loc. 1).

Arnold

Seams of lignite with pyrite occur in the Cretaceous Magothy Formation at North Ferry Point (Cape Sable) on the Magothy River (Little, 1917). These deposits were apparently of considerable commercial importance at one time, as indicated by Ducatel (1837): "The deposits of lignite and pyrite, already referred to as occurring at Cape Sable on the Magothy, furnish the material from which large quantities of alum ($KAl(SO_4)_2 \cdot 12H_2O$) and copperas ($FeSO_4 \cdot 7H_2O$) are annually manufactured for the supply of nearly the whole Union." Pieces of amber up to about ten centimeters across have also been found here (Robinson, 1825). (Loc. 2).

Hanover

Marcasite, hematite, and nodules containing iridescent siderite are reported from sedimentary beds at Hanover (Ostrander and Price, 1940). (Loc. 3).

Pinehurst

Radiating crystals of marcasite on logs of lignitized wood in Cretaceous gray clay have been found about 1.6 km north of Pinehurst. Marcasite, limonite, and hematite occur in the sand and gravel here (Ostrander and Price, 1940). (Loc. 4).

Miscellaneous Localities

Iron Mines in the Coastal Plain of Anne Arundel, Prince George's, and Baltimore Counties

Nodular siderite-limonite iron ore was mined in numerous places from a belt which runs from Washington, D.C. to northwest of Baltimore. This ore was first noted by Captain John Smith and was mined from Colonial times into the early twentieth century. The siderite ore occurs in beds of lignitic gray clay (red-orange when weathered) of Early Cretaceous age, particularly in the Arundel Clay (Fig. 3). When fresh and free of inclusions the siderite nodules are gray to light tan, massive, and break with a conchoidal fracture. Small crystals of siderite and less commonly gypsum occur in fractures. Most of the nodules, however, are at least partially oxidized to orange-brown limonite and contain abundant inclusions of quartz sand and other materials. Limonite is used as a generic term to include a mixture of poorly defined

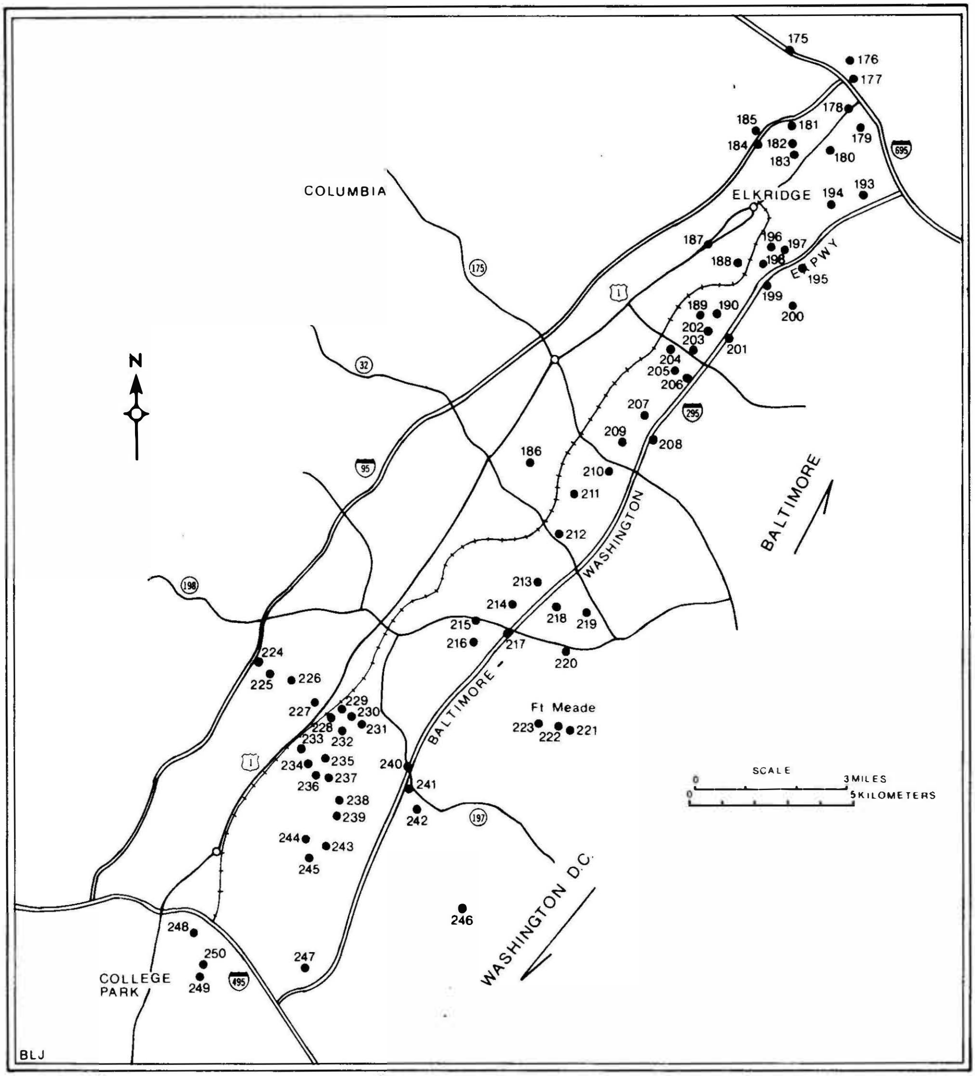

Figure 7: Locations of iron mines in the Coastal Plain of Anne Arundel, Prince George's, and Baltimore Counties, Maryland (after **Sterrett, 1911**).

No. on Fig. 7	Loc. Plate I	County	Name of Locality
175	15	Balto.	Kennedy ore bank
176	16	Balto.	Excelsior Brick and Pottery Co. banks
177	16	Balto.	o. b. NW of Lansdowne
178	17	Balto.	o. b. NW of Halethorpe
179	17	Balto.	Virginia ore banks
180	18	Balto.	Kraft ore banks
181	19	Balto.	Miller ore banks
182	19	Balto.	Ring ore bank
183	19	Balto.	Coursey ore bank
184	19	Balto.	Randle ore bank
185	19	Balto.	Stapleton ore banks
186	49	Howard	Haslup and Scaggs o. b.
187	50	Howard	Talbott ore bank
188	50	Howard	Brooks ore bank
189	51	Howard	Hobbs ore banks
190	51	Howard	Brown ore banks
193	5	A. Arundel	Benson ore banks
194	5	A. Arundel	Soper Hall ore banks
195	7	A. Arundel	Hollins ore bank
196	6	A. Arundel	Randel ore bank
197	6	A. Arundel	Crook ore bank

Note: o.b. means ore banks

Figure 7: Locations of iron mines in the Coastal Plain of Anne Arundel, Prince George's, and Baltimore Counties, Maryland (continued).

No. on Fig. 7	Loc. Plate I	County	Name of Locality
198	9	A. Arundel	German ore bank
199	9	A. Arundel	Plumbmer ore banks
200	8	A. Arundel	Smith ore bank
201	10	A. Arundel	Timber Neck ore banks
202	10	A. Arundel	Lafey ore bank
203	11	A. Arundel	Anderson ore bank
204	11	A. Arundel	Dorsey ore banks
205	12	A. Arundel	Disney ore bank
206	12	A. Arundel	Harmon ore bank
207	13	A. Arundel	Ellicott ore bank
208	13	A. Arundel	Goldwine ore bank
209	13	A. Arundel	Bennett ore bank
210	14	A. Arundel	Linthicum ore banks
211	15	A. Arundel	Hobbs ore banks
212	16	A. Arundel	Brown and King o. b.
213	17	A. Arundel	Skully ore bank
214	17	A. Arundel	Priest deposit
215	20	A. Arundel	Ties ore bank
216	20	A. Arundel	Tyson ore banks
217	20	A. Arundel	Waters ore bank
218	17	A. Arundel	Rose ore bank
219	18	A. Arundel	Sydicum ore bank
220	19	A. Arundel	Welch ore bank
221	21	A. Arundel	Berkley ore bank
222	21	A. Arundel	Rieve ore bank
223	21	A. Arundel	Gosweiler ore bank
224	11	Pr. George's	Kirwan ore bank
225	11	Pr. George's	Nicholson ore bank
226	11	Pr. George's	o. b. 1 km NW of Contee
227	12	Pr. George's	California ore banks
228	12	Pr. George's	O'Brien ore banks
229	12	Pr. George's	Hooff ore banks
230	13	Pr. George's	Allan ore banks
231	13	Pr. George's	Shriver ore banks
232	13	Pr. George's	Roberts ore bank
233	14	Pr. George's	o. b. 1 km E of Muirkirk
234	14	Pr. George's	Duvall ore banks
235	14	Pr. George's	Milbrook ore bank
236	14	Pr. George's	Friel ore bank
237	14	Pr. George's	Tyson ore banks
238	15	Pr. George's	Green ore banks
239	15	Pr. George's	Ashland ore bank
240	16	Pr. George's	John Sadilek ore banks
241	16	Pr. George's	Joseph Sadilek ore bank
242	17	Pr. George's	Haker ore bank
243	18	Pr. George's	Swampoodle ore banks
244	18	Pr. George's	Donaldson ore banks
245	18	Pr. George's	Mason ore banks
246	19	Pr. George's	Jones ore bank
247	20	Pr. George's	Hedgman ore banks
248	21	Pr. George's	Buck ore bank
249	22	Pr. George's	Skaggs ore bank
250	22	Pr. George's	Reed ore bank

Note: o.b. means ore banks

hydrated iron oxides and hydroxides, which here result from the decomposition of the siderite and other iron bearing materials. It is sometimes quite powdery, and when bright orange or yellow it is called ocher, which has been used as a paint pigment.

An interesting feature of many nodules is that they are hollow. If these hollow nodules are heated they will explode violently, accompanied by a sharp noise, and occasionally even the heat of the sun is sufficient to produce this reaction. Some of the hollow nodules contain limonite or hematite ocher. According to popular belief, American Indians would mix water with the ocher in these nodules to produce paint, and they have thus been termed "Indian Paint Pots."

The iron-rich clays were probably deposited in poorly drained bogs and swamps, and frequently contain numerous plant fossils, notably lignitized wood. The lignite often contains or is replaced by marcasite, with good crystals occurring in cavities. Small amounts of gypsum and vivianite also come from these deposits. A few dinosaur bones were found at the Muirkirk mines (see p. 97).

Virtually all the mines and furnaces indicated on the map (Fig. 7) are now obliterated, but similar material is easily and abundantly available from any roadcut, clay pit, or other excavation nearly anywhere within this belt of Arundel Clay.

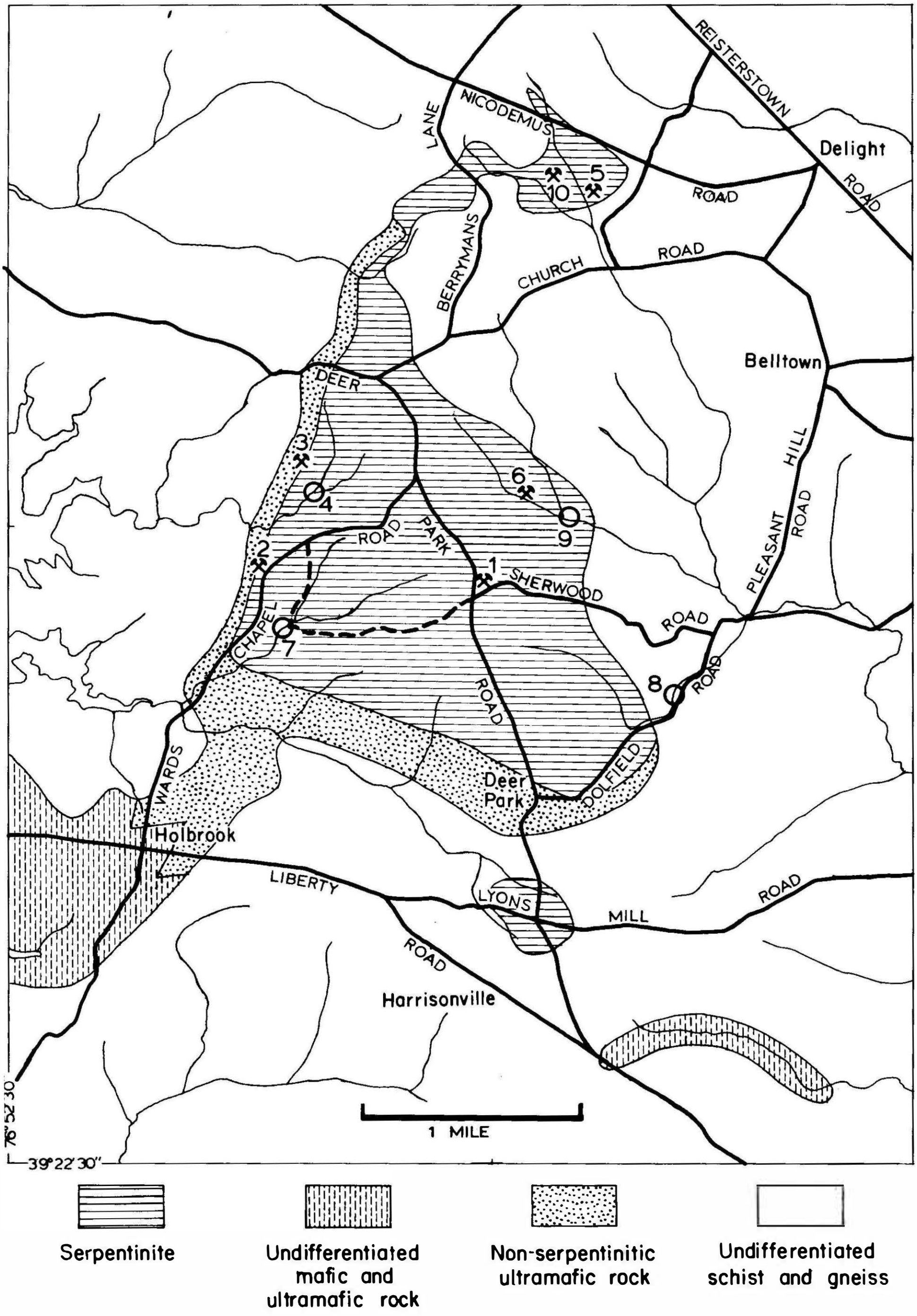

Figure 8: Distribution of serpentinite and locations of mines in the Soldiers Delight region, Baltimore County, Maryland. Adapted from Pearre and Heyl, 1960, Plate 40, and Crowley, 1977. 1. Choate mine; 2. Weir mine; 3. Harris mine; 4. Old Triplett placer; 5. Calhoun mine; 6. Unnamed chromite mine; 7. Triplett placer; 8. Dolfield (Rose) placer; 9. Gore placer; 10. Delight quarry.

Soldiers Delight

Location

Soldiers Delight is an area rather than a particular locality, and its extent is indicated on Figure 8.

Description

The Soldiers Delight district is underlain by serpentinite, and is characterized by rolling hills with a thin soil cover that supports grasses and generally scrubby vegetation. A number of chromite mines and small stone quarries have been opened in this district, but the serpentinite can also be readily examined in any roadcuts, creeks, trails, clearings or excavations, as this rock is generally only a few centimeters beneath the surface.

The serpentinite at Soldiers Delight differs from that at the Hunting Hill quarry (p. 71) in that it contains abundant chromite rather than magnetite. The pitch-black chromite is usually found as grains several millimeters across disseminated through the massive serpentinite (known as "birdseye ore"), but veins and lenses of massive chromite up to more than a meter across are not rare. Williamsite is commonly associated with concentrations of chromite.

Veins of magnesite are also fairly common, as are scattered masses of goethite and manganese oxides. Talc, calcite, and chlorite, including the pink to purple chromian chlorite kammererite, also occur in the serpentinite, and chalcedony and jasper are often found as float.

The two chromite mines briefly described below are the most accessible ones remaining and display mineralogy representative of the entire region. For further descriptions and histories of the mines in this region the publications by Pearre and Heyl (1960) and Singewald (1928) are recommended.

Minerals

(Also see Delight quarry, p. 30)

Aragonite—acicular white to tan crystals in fractures
Brucite—pearly, white to light-green micaceous plates
Calcite—white veins and rhombohedral crystals
Chlorite—green micaceous plates
Chromite—black grains and narrow veins in serpentinite
Goethite—black to brown masses in weathered serpentinite
Magnesite—chalky white veins
Manganese oxides—black masses in weathered serpentinite
Quartz—chalcedony and jasper common as float
Serpentine—variety williamsite occurs near concentrations of chromite; variety picrolite also present
Talc—massive, or foliated white to light-green crystals, in altered serpentinite

Choate Mine
(Loc. 1)

This mine is located just east of Deer Park Road, 1.6 km north-northwest of Dolfield Road and just southeast of a scenic overlook. An inclined shaft leading into the water-filled mine is still visible and a number of small pits and dumps are located in the vicinity. Some small lenses of granular chromite can be seen in the rock around the adit and "birdseye ore" is abundant. Specimens of the other minerals listed above can be found with some digging in the surrounding small dumps.

Weir Mine
(Loc. 2)

This location is reached by taking Wards Chapel Road for about 2.4 km north-northeast from Liberty Road (Route 26). The mine is about 100 meters west of the road, just north of a lumber yard.

The Weir mine was the largest chrome working in this district, though few traces of it remain today. The shaft has entirely caved in, but remnants of the dumps are scattered through the woods. Most of the minerals listed above can be found here, and plates of green chlorite up to several centimeters across are abundant.

Delight Quarry
(Also called: Dyer quarry, Soldiers Delight quarry)
(Loc. 10)

Location

This quarry is located just south of Nicodemus Road, 1.8 km west of Reisterstown Road (Route 140) and about 0.4 km west of Cherry Hill Road in Delight. It was opened sometime before 1928, and includes the site of a shaft of the Calhoun chromite mine (Pearre and Heyl, 1960). The Arundel Corporation of Baltimore is presently operating the quarry for crushed stone, and their permission is required to enter the property.

Description

The Delight quarry is situated in a northern extension of the Soldiers Delight serpentinite body (see Fig. 8). The serpentinite here has undergone extensive low temperature hydrothermal alteration along a large number of shear and fracture zones. Hydrothermally altered zones are characterized by large amounts of chalky white magnesite, white opal, and "deweylite" (a yellow to brown, soft, waxy mixture of serpentine minerals and a talc-like mineral). These altered zones most commonly form curving sheets from a few centimeters to a meter thick, bounded by slickensides.

The magnesite is often mixed with a substantial amount of opal, and separate veins of white, translucent opal also occur. In some places botryoidal brownish-yellow chalcedony occurs as apparent replacements of the opal. Drusy quartz crystals, colorless to almost black, frequently are encountered in these zones.

This quarry is known particularly for the large quantities of the serpentine rock picrolite (see p. 17), which occurs in areas around large shear zones.

Masses of picrolite over a meter across are not rare, and the coarse fibers are often curved into attractive wavelike patterns (Fig. 9). Large rhombs of calcite are sometimes found in this material, as are concentrations of fine chromite grains.

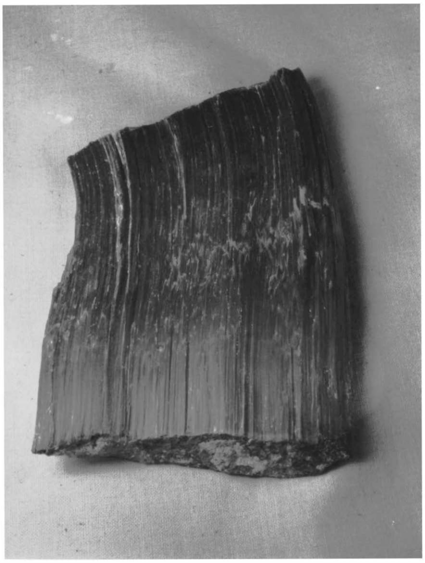

Figure 9: Serpentine (variety picrolite) from the Delight quarry, Delight, Maryland. Specimen is about 12 cm x 7.5 cm.

Chromite is common throughout the serpentinite and occasionally forms coarse disseminated grains and small massive lenses. Rutile was reported as being abundant in a "hornblendic rock on the south edge of the serpentine" (Ostrander and Price, 1940). Garnierite has also been reported from this quarry (Ostrander and Price, 1940). Due to the extensive alteration of the rock at the Delight quarry, and the abundance of fracture fillings, replacement zones, and small cavities, it can be expected that a number of additional minerals will turn up upon further investigation.

Minerals

Calcite—rhombohedral crystals embedded in picrolite, up to 4 cm across; also as drusy crystals in cavities
Chlorite—green flaky to powdery material in some shear zones
Chromite—black grains throughout serpentinite; also small veins, often with translucent serpentine (williamsite).
Dolomite—(Ostrander and Price, 1940).
Garnierite—bright green, reported by Ostrander and Price (1940).
Limonite—orange-brown stains abundant.
Magnesite—chalky white veins, common.
Magnetite—(Ostrander and Price, 1940).
Manganese oxide dendrites—with magnesite and opal.
Opal—white; mixed with magnesite and as separate translucent veins, often with dendritic manganese oxides.
Quartz—drusy crystals less than 3 mm long, in cavities of shear zones.
Chalcedony—white, yellow, or brown botryoidal fracture fillings in shear zones, occasionally with moss-like dendritic inclusions.
Jasper—(Ostrander and Price, 1940).
Rutile—(Ostrander and Price, 1940).
Serpentine—constitutes bulk of serpentinite; includes antigorite, lizardite, chrysotile, and clinochrysotile, picrolite is common; williamsite is occasionally found.

Bok Asbestos Mine

Hollofield
(Loc. 11)

Location

This mine is reached by taking Dogwood Road northeast for about 0.5 km from Johnnycake Road in Hollofield, and then following a small dirt road north for about 200 meters (Fig. 10). Some of the old trenches are still visible in the woods, running southward down the hill. Collecting can be done by digging in the dumps surrounding the pits, and by looking for exposed material in the dirt road leading to the mine.

Description

The Bok asbestos mine is situated in a body of partially amphibolized layered gabbro and pyroxenite. This rock is a portion of the Baltimore Mafic Complex (p. 16).

The asbestos mined here was the white, fibrous variety of the amphibole

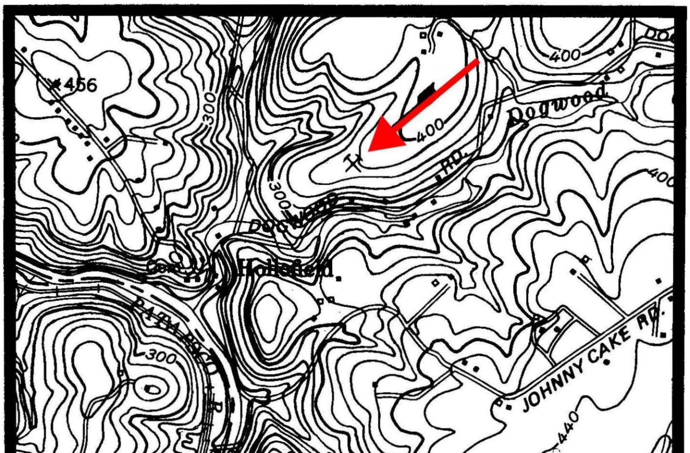

Figure 10: Location of the Bok asbestos mine, Hollofield, Maryland. (U.S. Geol. Survey Ellicott City quadrangle, scale 1:24,000).

anthophyllite (Fig. 11). Anthophyllite fibers up to at least fifteen centimeters long can still be found in the small dumps, though most of the best material undoubtedly was removed during mining. Associated with the anthophyllite are talc, actinolite-tremolite, chlorite, and magnetite.

Minerals

Actinolite-tremolite—green acicular crystals in actinolite-chlorite schist
Anthophyllite—white, commonly as asbestos with fibers up to at least 15 cm; sometimes ligniform (woodlike)
Chlorite—green, micaceous plates in actinolite-chlorite schist
Magnetite—crude octahedra, and massive
Talc—white, massive with anthophyllite

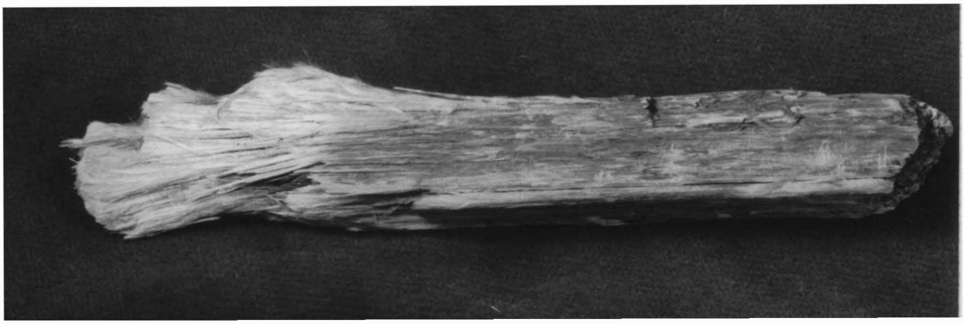

Figure 11: Anthophyllite asbestos from the Bok asbestos mine, Hollofield, Maryland. Specimen is 11 cm long.

Quarries in the Cockeysville Marble

The following five quarries, as well as the Howard-Montgomery quarry in Howard County (p. 51), are located in the marble and related rocks of the Cockeysville Marble. The mineralogy and geology seen in all these quarries, and in any other exposures of this formation, are very similar. For general characteristics of the Cockeysville Marble see p. 10.

Texas Quarries
(H.T. Campbell Limestone Quarry)

Texas
(Loc. 12)

Location

These quarries are located in the town of Texas, just east of Interstate Route 83. Permission from the Harry T. Campbell Sons' Company, the current operator of the quarries, is required to enter the property.

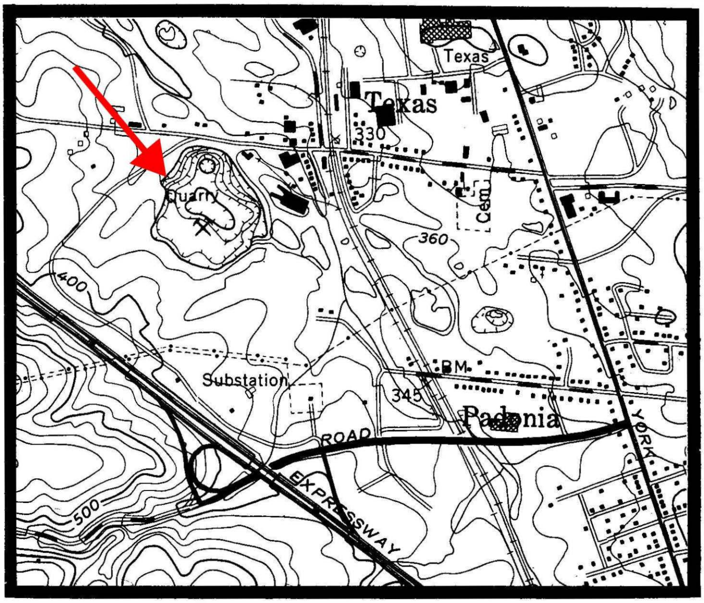

Figure 12: Location of the Texas quarries, Texas, Maryland, (U.S. Geol. Survey Cockeysville quadrangle, scale 1:24,000).

Description

The Texas quarries are a group of very large openings in the Cockeysville Marble, the largest of which is currently operating. The rock here is broadly divisable into two categories: (1) fine-grained, gray dolomite rock, which is prevalent, and (2) coarser grained, white calcite marble. Calc-silicate zones and pegmatitic pods of quartz and feldspar also occur.

Fine crystals of dravite (brown tourmaline), often well terminated, are fairly common in the calcite marble, usually associated with phlogopite crystals that are up to several centimeters across. Gray and pink scapolite crystals, some quite large (10 cm long) occur in the calc-silicate zones, as do crystals of tremolite and gray-green diopside. Purple fluorite was commonly found at one time in the marble, and probably will be uncovered again. Pyrite crystals, both pyritohedra and octahedra, are quite easily found, as is massive pyrrhotite.

Minerals

Amphibole—fibrous variety known as "mountain leather" (Ostrander and Price, 1940). (Recent X-ray studies indicate that much so called "mountain leather" is actually sepiolite, a clay mineral)
Apatite—large greenish masses have been found
Barite—white crystals and masses (Ostrander and Price, 1940)

Calcite—white, coarsely crystalline in calcite marble; rare euhedral crystals
Chlorite—green flakes, especially in shear zones
Diopside—light gray-green crystals in calc-silicate zones
Dolomite—fine-grained, gray from disseminated graphite, in dolomite marble; Ostrander and Price (1940) reported pink crystals
Dravite—magnesian tourmaline; brown elongated crystals, sometimes transparent and often terminated, usually with phlogopite in calcite marble.
Fluorite—small purple masses in calcite marble
Galena—(Ostrander and Price, 1940)
Graphite—disseminated fine particles in dolomitic marble and occasionally as larger flakes in dolomite and calcite marbles
Limonite—orange-brown stains common, especially near pyrite and pyrrhotite
Manganese oxide dendrites—on marble.
Margarite—(Ostrander and Price, 1940).
Microcline—gray to light-green masses with quartz in pegmatitic pods.
Molybdenite (?)—(Ostrander and Price, 1940)—probably graphite.
Muscovite—chromian ("fuchsite"); emerald-green flakes, locally concentrated in calc-silicate zones.
Phlogopite—brown plates; common throughout marble, often segregated in layers; some fine crystals up to at least 3 cm across.
Pyrite—common as irregular masses, occasionally as small octahedra or pyritohedra.
Pyroxene—partially altered to serpentine (Ostrander and Price, 1940)
Pyrrhotite—fairly common as silvery-bronze masses.
Quartz—gray to brown in calc-silicate zones, pegmatitic pods, and small grains scattered through marble; crystals reported by Ostrander and Price (1940).
Rutile—silvery, striated crystals in calc-silicate zones.
Scapolite—white, gray, to pink crystals up to several centimeters across, in calc-silicate zones with quartz and tremolite; fluoresces a bright yellow in longwave (>366 nm) ultraviolet radiation.
Serpentine—reported from "altered pyroxene" (Ostrander and Price, 1940).
Sphalerite—(Ostrander and Price, 1940).
Talc—white, fibrous to foliated masses in calc-silicate zones.
Titanite—dark-brown crystals (Ostrander and Price, 1940)
Tremolite—white, bladed crystals, often in radiating aggregates, in calc-silicate zones with quartz and talc; also as pseudomorphs after diopside.
Wollastonite—(Ostrander and Price, 1940)

Marriottsville Quarry
Hernwood, (Loc. 13)

Location

The Marriottsville quarry is about 4.8 km northeast of Marriottsville, and is reached by taking Marriottsville Road for about 0.3 km northeast from its juncture with Wards Chapel Road. The quarry is currently operated for crushed stone by the Flintkote Stone Products Company, and permission to enter it must be obtained at the quarry office.

Description

This is another large opening in the Cockeysville Marble on the western flank of the Woodstock gneiss dome. White, coarsely crystalline calcite marble, and gray to tan, fine-grained dolomite marble are dominant, with subordinate calc-silicate rocks and pegmatitic pods. Schistose or gneissic rock, containing large amounts of phlogopite-biotite and quartz, is commonly interlayered with the marble. At some places in the quarry, layers of calcite marble and of phlogopite-biotite-, quartz-, titanite-, pyrite-rich rock, each a few centimeters thick, alternate regularly with each other to produce large volumes of layered white and brown rock. It was noticed that pyrite is often greatly concentrated in calcite marble directly overlying large gneissic layers (as in Fig. 14).

This quarry is near the contact with the overlying Wissahickon Group (see p. 10), and some of the schists of this group are exposed in the roadcuts along Wards Chapel Road, about 0.4 km north of Marriottsville Road. Narrow zones in the schists here contain abundant blades of kyanite, as well as crystals of garnet and staurolite.

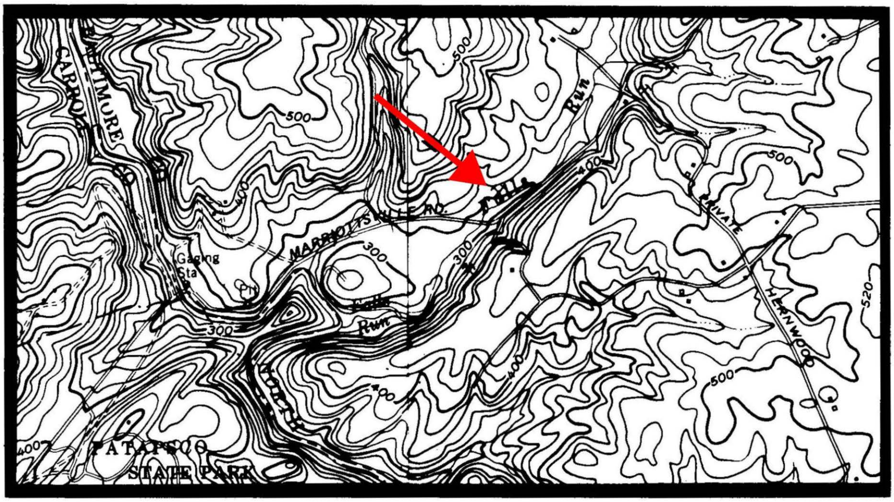

Figure 13: Location of the Marriottsville quarry, Hernwood, Maryland. (U.S. Geol. Survey, Ellicott City and Sykesville quadrangles, scale 1:24,000).

Minerals

Apatite—light-green masses in calcite marble
Biotite—common in some of the gneissic layers
Calcite—white, coarsely crystalline; occasional highly modified prismatic crystals in cavities, some doubly terminated
Chalcopyrite—small, irregular masses in marble
Chlorite—green flakes, mostly on shear surfaces
Diopside—gray-green crystals in calc-silicate zones

Dolomite—fine-grained, tan to gray
Dravite—elongated brown crystals in calcite marble
Graphite—disseminated in dolomite marble, giving it a gray color; also occasional larger flakes
Limonite—orange-brown stains abundant, mostly from oxidation of pyrite
Microcline—occasional gray to light green crystals with quartz
Muscovite—occasional plates with quartz, euhedral crystals in cavities
Phlogopite—abundant throughout marble, segregated in layers together with quartz
Pyrite—common as irregular masses; concentrated in calcite marble immediately overlying large gneissic layers.
Pyrrhotite—silvery-bronze, magnetic masses; some hexagonal, platy crystals to 1 cm in cavities.
Quartz—gray to dark-brown, mostly in calc-silicate rocks and pegmatitic pods; drusy crystals in cavities.
Rutile—rare, silvery, striated crystals in calc-silicate zones.
Schorl—crystals up to several cm in pegmatitic pods (J.S. White, Jr., written communication, 1977).
Talc—occasional foliated masses with tremolite.
Tremolite—white, bladed, often radiating crystals, in calc-silicate zones with quartz and talc.

Figure 14: Marble (white) and gneissic layers (dark) of the Cockeysville Formation at the Marriottsville quarry, Hernwood, Maryland.

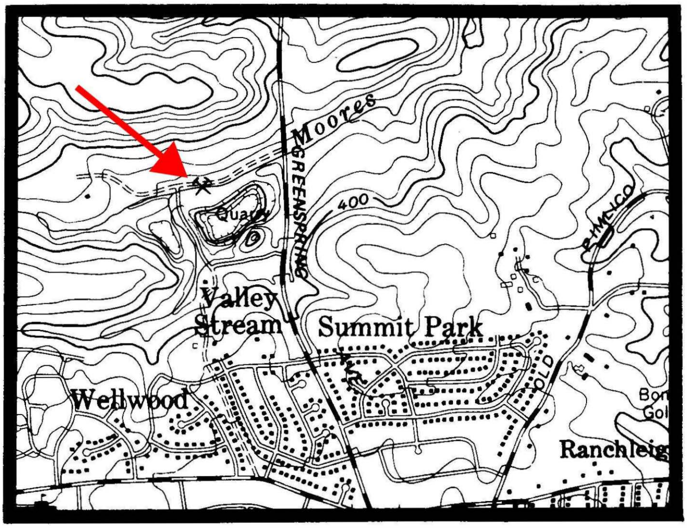

Figure 15: Location of the Greenspring quarry, Towson, Maryland. (U.S. Geol. Survey Cockeysville quadrangle, scale 1:24,000).

Greenspring Quarry
(McMahon Quarry)
Towson, (Loc. 14)

Location

This quarry is located just west of Greenspring Avenue, about 0.8 km north of Smith Avenue and about 1.2 km south of the Baltimore Beltway (Route 695), between Towson and Pikesville. It is currently operated for crushed stone by the Arundel Corporation of Baltimore, and permission to enter the quarry must be obtained from them.

Description

The Greenspring quarry is a large opening in a predominantly gneissic facies of the Cockeysville Marble. The rock is primarily calc-gneiss, with scattered layers and lenses of calcite marble. Pegmatites and small quartz veins are common, and a fine-grained mafic dike (containing a high proportion of iron and magnesium minerals, here mostly amphiboles), at least fifty meters long and averaging ten centimeters in width, was also observed.

Most of the unusual and well-crystallized minerals are found in and immediately adjacent to pegmatitic pods. Crystals of schorl and dravite, up to several centimeters long and a couple of centimeters wide, are common in this environment, and single crystals which apparently show extensive compositional variations between these two tourmaline end-members are encountered. Muscovite, phlogopite, small cubic crystals of pyrite, and elongated silvery rutile crystals are also characteristic of these areas.

Massive pyrrhotite is found throughout the marble layers, as are phlogopite and smaller amounts of dravite, gray scapolite, chalcopyrite, brown titanite, and tremolite. Some small, pale emerald-green crystals of chromian muscovite were also observed in this rock.

Minerals

Amphibole—in mafic dike
Calcite—white, intergrown crystals make up the bulk of the marble; also in calc-gneiss
Chalcopyrite—irregular masses and occasional tetrahedral crystals in marble
Chlorite—green coatings on shear surfaces
Clinozoisite-epidote—light-green masses in calc-gneiss and in shear zones
Dolomite—gray, fine-grained layers in marble
Dravite—brown, elongated crystals, largest around pegmatitic pods
Garnet—small crystals in pegmatitic pods
Graphite—small black flakes in marble
Limonite—brown stains, mostly from weathering of pyrite and other sulfides
Microcline—white, tan, or light-green crystals in pegmatitic pods and calc-gneiss
Muscovite—coarse crystals in pegmatitic pods
Chromian muscovite ("fuchsite")—light emerald-green crystals in marble
Phlogopite-biotite—common throughout marble and calc-gneiss; also in mafic dike
Pyrite—small cubic and, more rarely, octahedral crystals in marble, most commonly in and adjacent to pegmatitic pods; also as fine-grained, sometimes iridescent coatings on fracture surfaces
Pyrrhotite—massive, in marble, with coarse white calcite
Quartz—in veins, pegmatitic pods, and calc-gneiss; occasional crystals in cavities
Rutile—elongated prismatic, striated, silver-colored crystals, at contacts between pegmatites and marble, with dravite and muscovite
Scapolite—occasional small gray crystals that fluoresce yellow in longwave ultraviolet radiation; with tremolite in marble
Schorl—black, coarse crystals in pegmatite; some crystals apparently grade into dravite at contacts with marble
Sphalerite—small grains (Ostrander and Price, 1940)
Talc—white foliated masses with tremolite
Titanite—occasional small brown crystals in marble
Tremolite—white bladed crystals

CARROLL COUNTY

Mineral Hill Mine
Louisville, (Loc. 1)

Location and History

This mine is located 1.2 km southeast of Louisville, and about 1.6 km east of Route 32, just to the north of the Morgan Run branch of Liberty Lake reservoir. It is reached by going east for about 1.6 km on the first dirt road (actually more of a path) north of the reservoir from Route 32, until the dumps are visible on a hill to the north. Large, fresh dumps cover the top of the hill, and some older dumps, shafts, and open pits are found in the woods further north. Another shaft with dumps is located on the bank of the reservoir, and is visible from Route 32.

This is one of the oldest copper mines in Maryland, opened in about 1748 by a British Company (Heyl and Pearre, 1965). The mine was first worked by large open pits, which are still visible, until it was closed during the Revolutionary War. It was reopened in 1849 by Isaac Tyson, Jr., and worked nearly continuously by as many as a hundred men until it finally closed in 1890. The eastern part of the large dumps was bulldozed in 1965 and some rock hauled

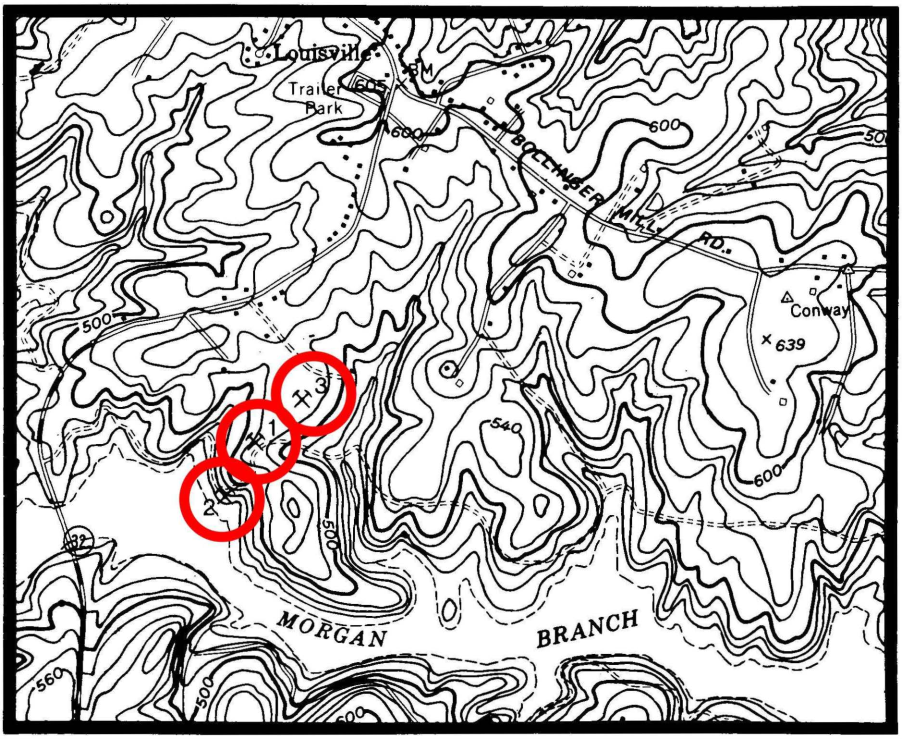

Figure 16: Location of the Mineral Hill mine, Louisville, Maryland. (1) Main shaft and dumps; (2) shaft; (3) Pre-Revolutionary War workings. From Heyl and Pearre, 1965. (U.S. Geol. Survey Finksburg quadrangle, scale 1:24,000).

off for use in road building (Heyl and Pearre, 1965).

The underground workings are flooded and inaccessible, but collecting can be done on the dumps. This is mostly reservoir property, and permission from the City of Baltimore must be obtained before collecting here.

Description

The Mineral Hill mine was opened in a group of northeast trending magnetite-quartz veins and mineralized shear zones in quartz-mica schist, chlorite-amphibole schist and gneiss, and talc schist. The veins consist mainly of massive magnetite or magnetite plus quartz, with varying amounts of chalcopyrite, bornite, and cobalt sulfides. With a little wandering through the woods, it is still possible to encounter these veins cropping out.

Blocks of magnetite up to at least fifty centimeters across are common in the dumps as dark gray, dense masses, often with a pseudo-cleavage passing through the multitudes of constituent magnetite grains. In places, magnetite and chalcopyrite are mixed in almost equal proportions, producing a salt-and-pepper appearance.

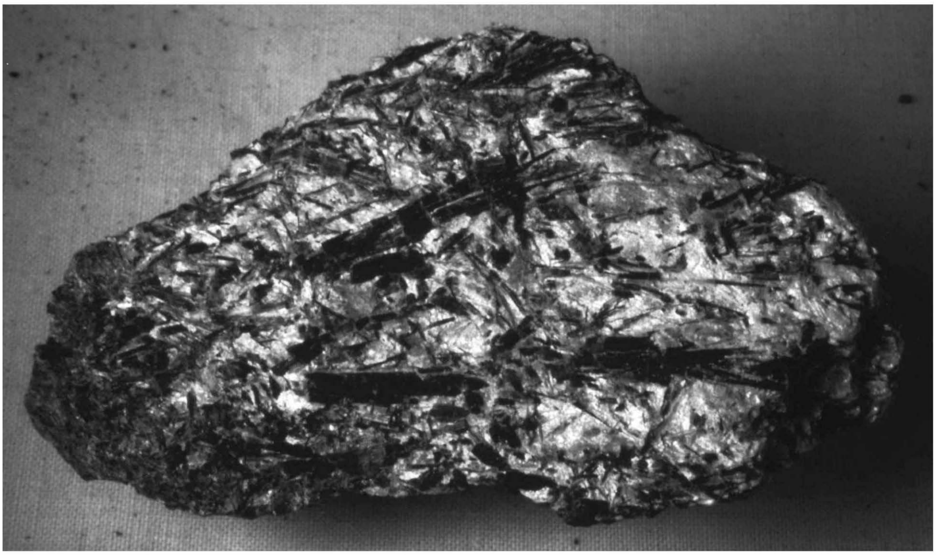

Figure 17: Actinolite crystals in talc schist from the Mineral Hill mine, Louisville, Maryland. Specimen is about 8 cm long.

The cobalt minerals of these veins are in the linnaeite group, $(Co,Ni,Cu)_3S_4$, and one of the members of this group, carrollite, Co_2CuS_4, was named after its occurrence in Carroll County. At Mineral Hill, the composition apparently ranges between carrollite and siegenite, $(Ni, Co)_3S_4$ (Heyl and Pearre, 1965). These cobalt minerals occur as silvery metallic veins, masses, and small octahedral crystals in the massive magnetite and sometimes in the shear zones.

Also found in the magnetite veins are specular hematite, dark-blue gahnite, sphalerite, flakes of gold, covellite, and small amounts of the secondary copper minerals that are common in the shear zones. Platy ilmenite was found in a quartz-rich portion of a magnetite vein.

The mineralized shear zones occur in the chlorite-amphibole and talc schists. Secondary copper minerals, particularly emerald-green brochantite and darker green malachite, are abundant, with smaller amounts of chalcopyrite, bornite, hematite, magnetite, and carrollite-siegenite. Botryoidal pseudomalachite is the third green secondary copper mineral found here, being less common than brochantite or malachite, of which brochantite is the more abundant.

Also occurring in the talc schists and chlorite-amphibole schists are siderite crystals, limonite, hornblende, and actinolite. The actinolite crystals are especially attractive in the white talc schists (Fig. 17). Small epidote crystals are found in cavities in amphibole gneiss, and other cavities contain small calcite crystals.

The Mineral Hill mine is probably the most interesting, and most prolific, metal mine still accessible in the Washington area, and is well worth a visit.

Minerals

Actinolite—dark-green, elongated prismatic crystals in schists and gneiss
Bornite—in magnetite veins and in shear zones
Brochantite—emerald-green crusts, mostly in shear zones
Calcite—in schists and gneiss; scalenohedral crystals in cavities
Carrollite-siegenite—silvery to pinkish-gray octahedra, and masses in magnetite veins and in shear zones. Heyl and Pearre (1965) give the following analysis for this material:

Elements	Wt. Percent
Co	36.08
Ni	7.65
Cu	9.98
Fe	2.25
S	41.89
Insol.	0.50
Total	98.35

Chalcocite—sooty-gray with chalcopyrite
Chalcopyrite—brassy grains, masses, and veins in magnetite veins and in shear zones
Chlorite—green, micaceous plates in schists and gneiss
Covellite—blue coatings with chalcopyrite and bornite
Epidote—small crystals in cavities, in amphibole gneiss

Gahnite—dark-blue masses and occasional octahedral crystals in quartz-magnetite veins. Shannon (1923) gives the following analysis of this material:

Oxides	Wt. Percent
SiO_2	1.50
Al_2O_3	54.50
FeO	4.86
MgO	0.42
ZnO	34.48
CoO	1.48
CuO	0.14
MnO	0.26
Insol.	1.50
Total	99.14

Gold—small flakes in magnetite (NMNH-68028); very rare
Hematite—specular; in magnetite-quartz veins, occasionally in shear zones
Hornblende—dark-green, in amphibole schist and gneiss
Ilmenite—platy subhedral crystals in quartz
Limonite—brown-orange stains common
Magnetite—massive, forms large veins with quartz; as smaller veins and as crystals in shear zones
Malachite—green crusts, occasional acicular crystals, mostly in shear zones
Muscovite—in quartz-mica schist and in small pegmatites
Plagioclase—in quartz-mica schist and in small pegmatites
Pseudomalachite—lustrous, dark-green botryoidal crusts in shear zones
Pyrite—in magnetite-quartz veins
Quartz—white to smoky, abundant in veins with magnetite
Siderite—light brown rhombohedral crystals in talc schist
Siegenite—see carrollite-siegenite
Sphalerite—occasional dark brown grains in veins of magnetite

Springfield Mine
(Sykesville Mine, Mr. Tyson's Mine)
Sykesville, (Loc. 2)

Location and History

This mine is located about 0.8 km north of Sykesville, and about 0.5 km west of the junction of old Route 32 and new Route 32 (Fig. 18). The large open trench and several shafts and small pits are now caved in and overgrown, but collecting can still be done on the rather extensive dumps. The mine is on property currently owned by the Episcopalian Church, whose permission should be secured before entering it.

This mine was first opened in 1849 by Isaac Tyson, Jr. for iron, and then operated for copper from 1852 to 1869. It was briefly reopened around 1880 for iron, and then again in 1916 by the Shawinigan Electro-products Co., which took out hematite-quartz ore for the production of ferrosilicon (Heyl and Pearre, 1965).

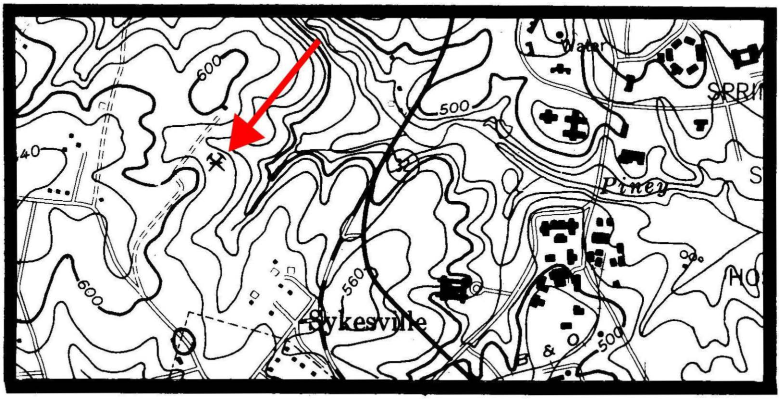

Figure 18: Location of the Springfield mine, Sykesville, Maryland. (U.S. Geol. Survey Finksburg quadrangle, scale 1:24,000).

Description

The Springfield mine is similar in many ways to the nearby Mineral Hill mine, both being iron-copper deposits. The Springfield mine, however, contains a larger proportion of specular hematite and a smaller amount of magnetite than found at Mineral Hill. The ore here reportedly was hematite-quartz near the surface, but mostly magnetite-quartz at depth, with chalcopyrite becoming abundant below about twenty or thirty meters (Heyl and Pearre, 1965). The country rock is mostly quartz-mica schist, locally grading into chlorite-amphibole schist, talc schist, and steatite.

Malachite is rather abundant at this mine, sometimes in very attractive banded and fibrous masses. Lustrous black goethite is also found, as well as bright red-orange earthy limonite. Dark-blue gahnite is occasionally seen, usually with magnetite. Attractive specimens of actinolite crystals in talc schist also occur here.

Heyl and Pearre (1965) reported that a sample of typical ore contained 7.84 percent Cu, 0.22 percent Zn, 28.91 percent Fe, 0.19 percent Co, 0.027 percent Ni, 31 ppm of silver, and no detectable gold.

Minerals

Actinolite—dark-green acicular crystals, common in chlorite-amphibole schist and talc schist

Azurite—blue stains, rare

Bornite—masses reported up to at least 1.4 kilograms (Heyl and Pearre, 1965); mostly from northern dumps

Calcite—white to light pink, in small lenses
Chalcanthite—(Ostrander and Price, 1940)
Chalcocite—sooty-gray masses, often with malachite and hematite
Chalcopyrite—small to large masses, mostly with magnetite
Chlorite—green micaceous plates common in chlorite-amphibole schist
Chrysocolla—(Ostrander and Price, 1940)
Covellite—blue metallic coatings, usually with chalcopyrite or bornite
Epidote—occasional small crystals, with quartz
Gahnite—cobaltian; dark-blue, with magnetite and quartz
Goethite—lustrous, black, botryoidal masses
Idaite—(NMNH-103479)
Limonite—red to brown masses and stains
Linnaeite—cuprian; silvery to pinkish-gray metallic masses and rare octahedral crystals in magnetite. Shannon (1926e) gave the following analysis for two samples of this material:

Element	Weight Percent (1)	Weight Percent (2)
Co	44.44	48.63
Ni	trace	trace
Cu	6.50	4.43
Fe	4.57	3.55
S	44.89	43.56
Insol.	——	0.68
Total	100.40	100.85

Magnetite—massive with quartz, and occasional crystals in steatite
Malachite—common; sometimes as banded, fibrous masses
Pyrite—uncommon, in magnetite-quartz veins
Quartz—milky to gray with hematite and magnetite; occasional crystals with calcite
Riebeckite-arfvedsonite (types of amphibole)—green radiating crystals on quartz (Ostrander and Price, 1940)
Siderite—tan grains in steatite, often altered to limonite
Talc—massive, in steatite and talc schist

FREDERICK COUNTY

Farmers Cooperative Limestone Quarry
New London, (Loc. 1)

Location

This quarry can be reached by taking Lime Plant Road for about 1.6 km east from Route 75 in New London (Fig. 19). Two pits are visible just south of the road, one water filled and one which operated until 1973. They are now owned by Luck Quarries, Inc., of Richmond, Virginia.

Description

This small marble quarry is situated in a narrow body of Wakefield Marble, sandwiched within the phyllites of the Ijamsville Formation. The marble here is attractively variegated in shades of purple, green, and pink, and was crushed and used mainly for decorative purposes. The quarry contains abundant very steeply pyramidal calcite crystals, and also a number of interesting metallic minerals.

The best calcite crystals are generally found immediately to both sides of the quarry entrance, in narrow fractures and vugs in the marble. These are colorless to light yellow, often transparent, and appear nearly prismatic.

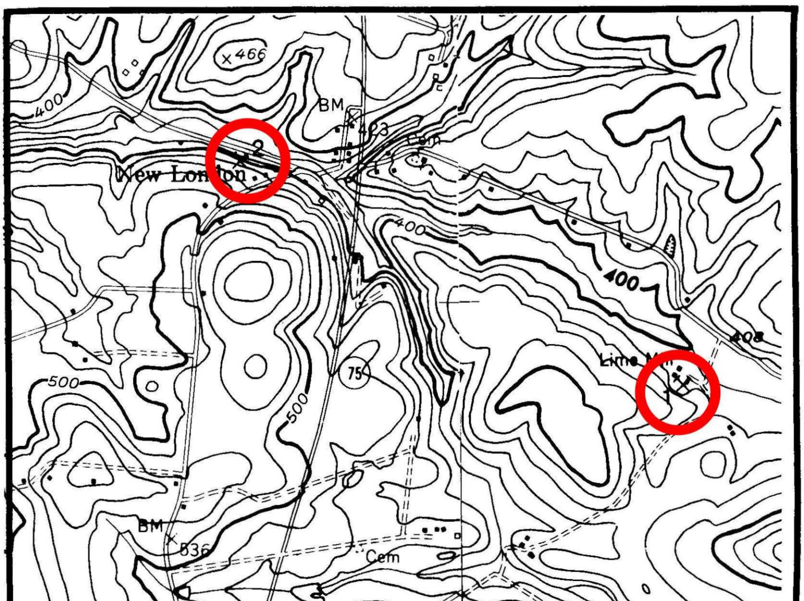

Figure 19: Locations of the Farmers Cooperative limestone quarry (1) and the New London mine (2), New London, Maryland. (U.S. Geol. Survey Libertytown quadrangle, scale 1:24,000).

Bright-pink manganoan calcite is also found in the quarry, usually as coarsely crystalline rhombohedral masses associated with milky quartz.

Dark-green sphalerite is quite abundant in the marble, together with chalcopyrite and smaller amounts of galena and specular hematite. Small amounts of barite also occur, though rarely in well-formed crystals. Malachite is seen as a secondary coating on the other minerals, as are manganese oxide dendrites, often quite delicate (see Fig. 20). Hemimorphite and smithsonite have been found here recently (G. Brewer, oral communication, 1975), as have rosasite, cuprite, and linarite (H. Corbett, oral communication, 1975).

Metallic minerals have been found in similar environments throughout this part of Frederick County, and Pearre and Heyl (1965) describe these deposits in detail. At the nearby New London copper mine (see. Fig. 19), now totally overgrown, Pearre and Heyl (1965) reported the occurrence of calcite, quartz, barite, chalcocite, bornite, pyrite, chlorite, specular hematite, muscovite, micrograins of tourmaline and titanite, orthoclase, actinolite, malachite, cuprite, silver and gold, in a fissure vein (probably a fault) striking N 69° W and dipping southward 70° in black phyllite and a thin lens of marble.

Figure 20: Manganese oxide dendrites on marble from the Farmers Cooperative limestone quarry, New London, Maryland. Specimen is 5 cm high.

Minerals from Marble Quarry

Barite—small, white, crumbly masses in marble
Calcite—dominant constituent of marble; crystals in vugs.
  Manganoan calcite—pink, rhombohedral crystals with milky quartz
Chalcopyrite—brassy, usually massive, associated with other metallic minerals
Chlorite—green flakes common in marble, giving it a green color
Cuprite—small, modified octahedral crystals (H. Corbett, oral communication, 1975)
Galena—occasional grains associated with sphalerite, chalcopyrite
Gold—a few flakes have been reported by quarry workers
Hematite—specular; occasionally found in marble
Hemimorphite—crusts of tiny white crystals (G. Brewer, oral communication, 1975)
Limonite—orange stains common
Linarite—small, elongated blue crystals (H. Corbett, oral communication, 1975)
Malachite—green stains on marble, commonly associated with manganese oxides
Manganese oxides—dendrites and coatings on fracture surfaces
Quartz—massive, white, associated with manganoan calcite; some euhedral crystals to several centimeters long in cavities
Rosasite—crusts of tiny green crystals (H. Corbett, oral communication, 1975)
Smithsonite—reported as white crusts (G. Brewer, oral communication, 1975)
Sphalerite—light to dark-green, resinous to metallic, associated with chalcopyrite and lesser galena and hematite in marble

Point of Rocks Goethite Locality

(Washington Junction Ore Banks)
Point of Rocks, (Loc. 3)

Location

This locality (Fig. 21) is reached by going about 0.8 km north of Route 28 on Barrenger Creek Road in Point of Rocks, to the community center and field on the right (east). Goethite is found in the woods across the field, in elongated, deep trenches that probably represent an old iron mine. A little digging in the surrounding woods will uncover the same material. It is suggested that this locality be visited in early spring or late autumn, when the jungle-like summer undergrowth has receded somewhat.

Description

Goethite is a very common iron-oxide-hydroxide whose usual appearance does not cause mineral collectors to make it one of the more desirable mineral species. The goethite from Point of Rocks, however, is exceptional for its

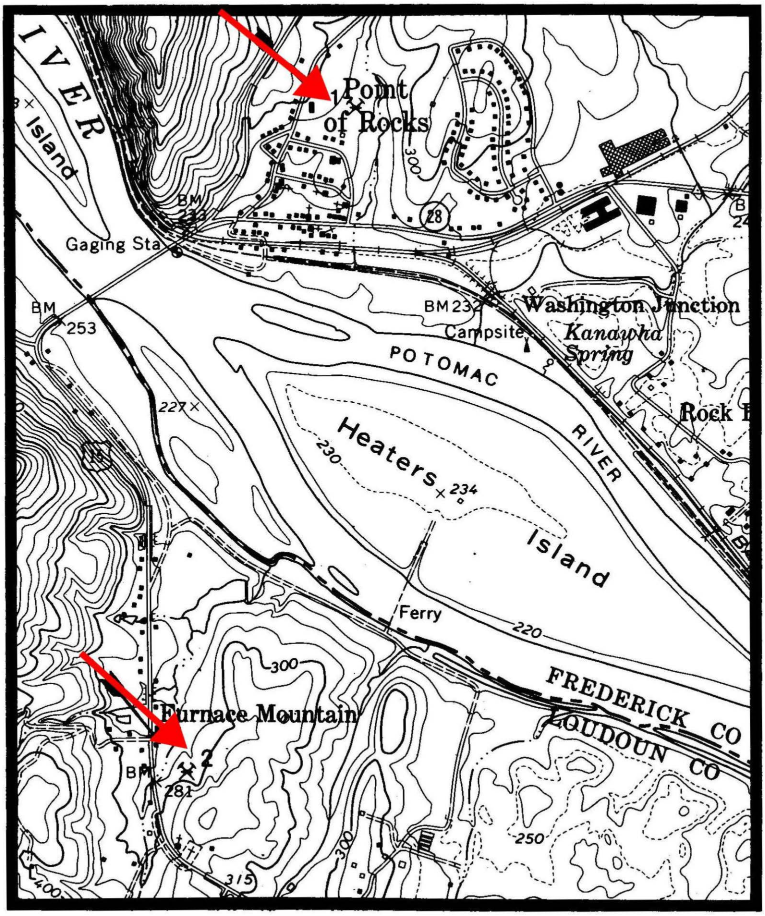

Figure 21: Location of the Point of Rocks goethite locality (1), Point of Rocks, Maryland, and the Furnace Mountain iron mines (2), Furnace Mountain, Virginia, (U.S. Geol. Survey Point of Rocks quadrangle, scale 1:24,000.)

occurrence in highly lustrous, black, botryoidal and stalactitic masses (see Fig. 22). Goethite masses up to over a meter across are abundant, occurring loose in the soil. The insides of cavities are where the black, lustrous material is found.

The geology of this deposit cannot be directly observed, as the soil cover here is very thick and no bedrock is exposed. The only mineral seen associated with the goethite is massive milky quartz, which is generally not as abundant as the goethite. The Geologic Map of Maryland (Maryland Geological Survey, 1968) shows this locality to be on the faulted contact of the Harpers Formation and the Loudoun Formation. The goethite apparently formed in this fault zone, perhaps with some quartz veins.

Singewald (1911, p.204-205) indicated that the iron ore continued for about 400 meters to the north, and also extended continuously along the fault line across the Potomac into Virginia (see Fig. 21). A number of large excavations can still be observed around Furnace Mountain in Virginia, which supplied ore for the nearby Potomac Iron Furnace. Substantial amounts of zinc and lead apparently occurred in this goethite-limonite ore (Luttrell, 1966).

Minerals

Goethite—large masses, often botryoidal and stalactitic, sometimes with lustrous, hard, black surfaces

Quartz—massive, white, usually containing goethite

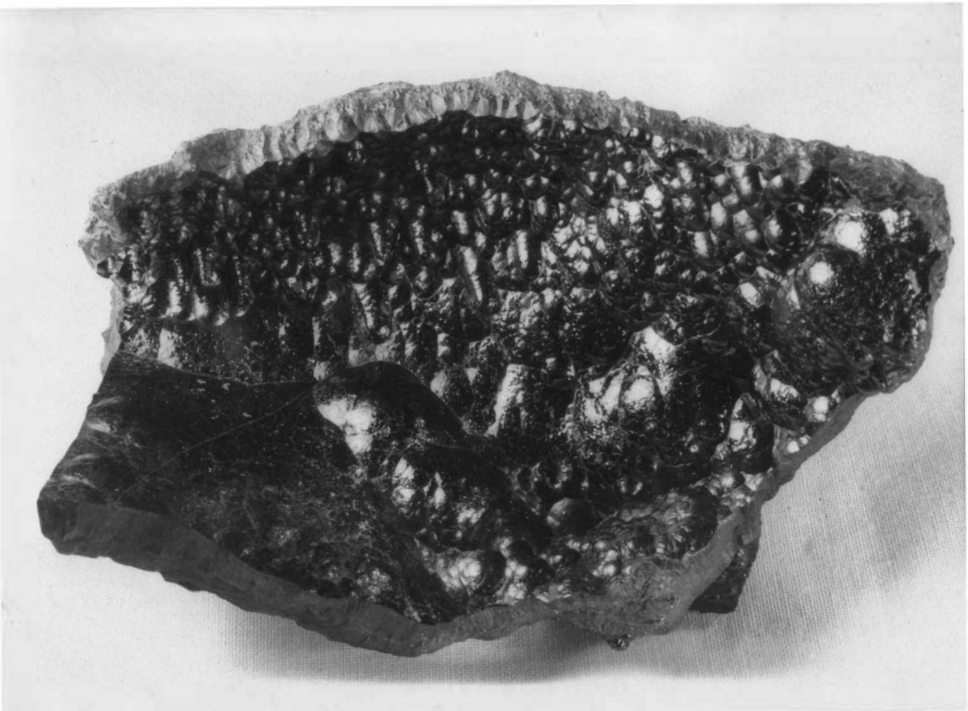

Figure 22: Lustrous black goethite from Point of Rocks, Maryland.

Howard-Montgomery Quarry, (Brighton Quarry) Clarksville, (Loc. 1)

Location

This active crushed stone quarry is located just south of Brighton Dam Road, about 1.8 km from the Patuxent River (Fig. 23). Permission to enter the quarry must be obtained at the quarry office.

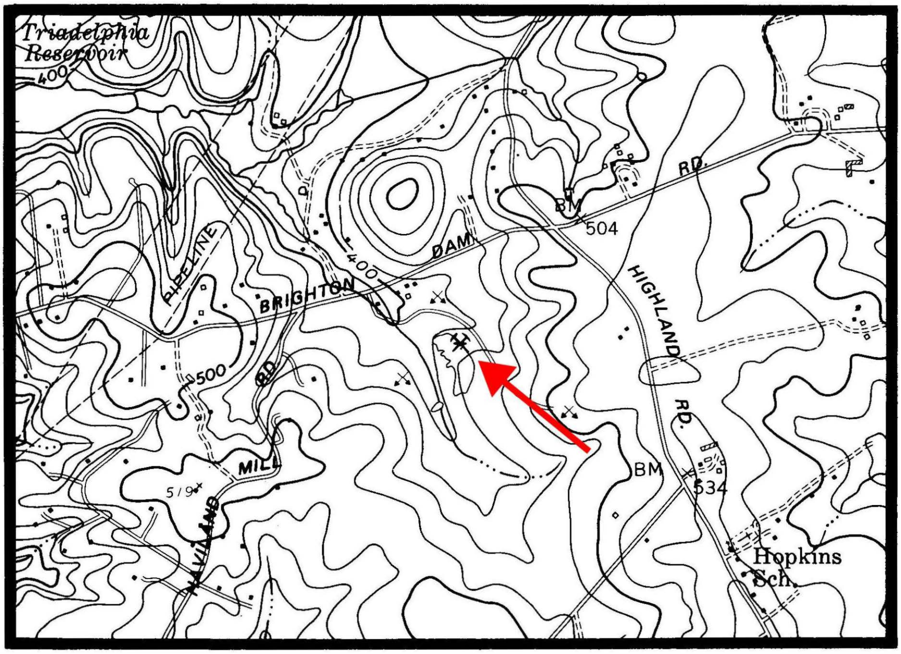

Figure 23: Location of the Howard-Montgomery quarry, Clarksville, Maryland. (U.S. Geol Survey Clarksville quadrangle, scale 1:24,000).

Description

The Howard-Montgomery quarry is situated in a rather thin portion of the Cockeysville Marble along the southern flank of the Clarksville gneiss dome. The mineralogy and geology is characteristic of the Cockeysville Marble (see p. 10), though there appears to be a rather high proportion of schistose and gneissic layers exposed here. Throughout much of the quarry, layers of coarse-grained white calcite marble alternate with layers of calcite-phlogopite-quartz schist (see Fig. 24), which sometimes grade into a calcite-bearing biotite-quartz gneiss, especially towards the upper parts of the quarry. Metadolomite is somewhat less abundant than calcite marble, and usually occurs as fine-grained gray layers.

Figure 24: Alternating calcite-rich and phlogopite-rich layers in the Cockeysville Formation at the Howard-Montgomery quarry, Clarksville, Maryland.

The calc-schist layers contain chalcopyrite and pyrite as common accessories. Dravite is also present, although uncommon.

Pods of quartz, from milky to dark smoky-brown in color and up to at least twenty centimeters across, are fairly common in the marble. The quartz sometimes contains gray feldspar crystals, as well as some chalcopyrite, pyrite, muscovite, and phlogopite. A number of other minerals are found in and near contacts with these quartz pods, and with quartz-rich areas in general. These minerals include abundant tremolite and lesser amounts of talc, sometimes in sheets over four centimeters across. Phlogopite, rutile, and pyrite are also often concentrated near these contacts.

Small cavities that are present in the marble and in the more siliceous rocks, particularly in the north wall of the quarry, have produced a number of well-crystallized specimens. Some well-formed rutile crystals have been found in and around these cavities (see Fig. 25). Some excellent hexagonal plates of pyrrhotite less than six millimeters across have also been found in these cavities, as well as calcite crystals, some doubly terminated, and small crystals of quartz, muscovite, pyrite, tremolite, and dravite. A few crystals of the rare mineral mackinawite, $(Fe, Ni)S_{1-x}$, have also been found (George Brewer, oral communication, 1975).

Because this quarry is still fairly new and unexplored, additional minerals can be expected to turn up in the future. For more information on what to anticipate, see the section on the Cockeysville Marble (p. 10), and also descriptions of the other quarries in this formation.

Figure 25: Rutile crystals (up to 3 mm) in marble from the Howard-Montgomery quarry, Clarksville, Maryland. Photograph by George Brewer.

Minerals

Biotite—black crystals in gneiss
Calcite—white; some scalenohedral crystals in small cavities
Chalcopyrite—small grains
Chlorite—green flakes in fractures
Dolomite—gray, fine-grained, in layers of dolomite marble
Dravite—occasional brown crystals in calc-schist and in marble, with phlogopite
Feldspar—gray crystals with quartz, uncommon
Limonite—brown to orange stains common, especially near pyrite
Malachite—occasional coatings, mostly with chalcopyrite
Mackinawite—black, tetragonal flattened bipyramidal crystals to 2 mm with pyrrhotite (George Brewer, verbal communication, 1975; X-rayed)
Muscovite—in quartz, some euhedral crystals in cavities
Phlogopite—brown crystals, common
Pyrite—common; some good cubic crystals with octahedral modifications occur
Pyrrhotite—occasional anhedral masses; also excellent hexagonal plates in cavities
Quartz—mostly in segregations; milky to dark smoky brown; occasional euhedral crystals in cavities
Rutile—elongated, striated, commonly twinned silvery crystals up to 2 cm long with quartz; less commonly in cavities
Scapolite—(Karl Funkhouser, oral communication, 1975)
Talc—white, foliated to fibrous masses, usually with quartz and tremolite
Tremolite—white, bladed crystals common, usually aggregated; with quartz

Ben Murphy Mica Mine
Scaggsville, (Loc. 2)

Location and History

The Ben Murphy mine is located immediately to the west of U.S. Route 29, 1.8 km north of the Patuxent River. Some of the dumps are visible from the road. The old pits were in the small ravine that goes under the road and are now nearly indiscernible. Collecting is restricted to the dumps near the road.

This mine was operated intermittently in the first half of this century and was last commercially worked during World War II. It is now mostly on land of the Washington Suburban Sanitary Commission and their permission must be secured before entering the property.

Description

This mine was opened in a pegmatite dike typical of the complex pegmatites in the Wissahickon Group of Howard and Montgomery Counties. As the pegmatite is no longer exposed, the exact zonal arrangements of the minerals could not be observed; however, the following zones could be inferred from observation of the dump specimens (see also Fig. 4). Going inward from the walls:

Border Zone:	Marginal, fine-grained, and less than three centimeters wide, consisting of quartz and muscovite, with some plagioclase and yellow beryl;
Wall Zone:	Graphically intergrown albite and quartz with occasional greenish beryl crystals;
Intermediate Zone:	Coarsely intergrown quartz, albite, and muscovite with some reddish microline; occasional crystals of yellow-green beryl, green gahnite, reddish-orange spessartine, and gray apatite;
Core:	The core zone apparently consisted of discontinuous gray quartz pods.

Muscovite often occurs in rather large "books" up to at least twenty centimeters across, which have a green color typical of the muscovite from many nearby pegmatites. White to light-green sericite is common in fractures and in contacts between minerals. The albite at this locality does not occur as the variety cleavelandite, as it does in the very similar pegmatite at the Kensington Mica mine (p. 67), but instead as fine-grained, sugary aggregates, apparently as replacements of microcline.

Gahnite is quite abundant as anhedral masses, often as inclusions in beryl crystals. Gahnite is also found as flattened crystals within muscovite, as are crystals of quartz, columbite-tantalite, spessartine, and iron oxides. The beryl crystals here are seldom more than a few centimeters long, but are often quite well-formed as yellow to yellow-green prisms. Autunite is fairly common as thin green flakes on fracture surfaces.

Although the Ben Murphy mine has been a collecting spot for many years, good specimens of beryl, gahnite, spessartine and inclusions within mica can still be found with some digging. A careful search of the beryl could well be rewarded with the discovery of bertrandite or phenakite crystals, as yet unreported from this locality. The surrounding area is crossed by similar pegmatites, and any new exposures are worth exploring.

Minerals

Albite—white to tan; intergrown in border, wall, and intermediate zones; sugary aggregates as replacements of microcline

Apatite—greenish-gray masses in intermediate zone, commonly with beryl and spessartine

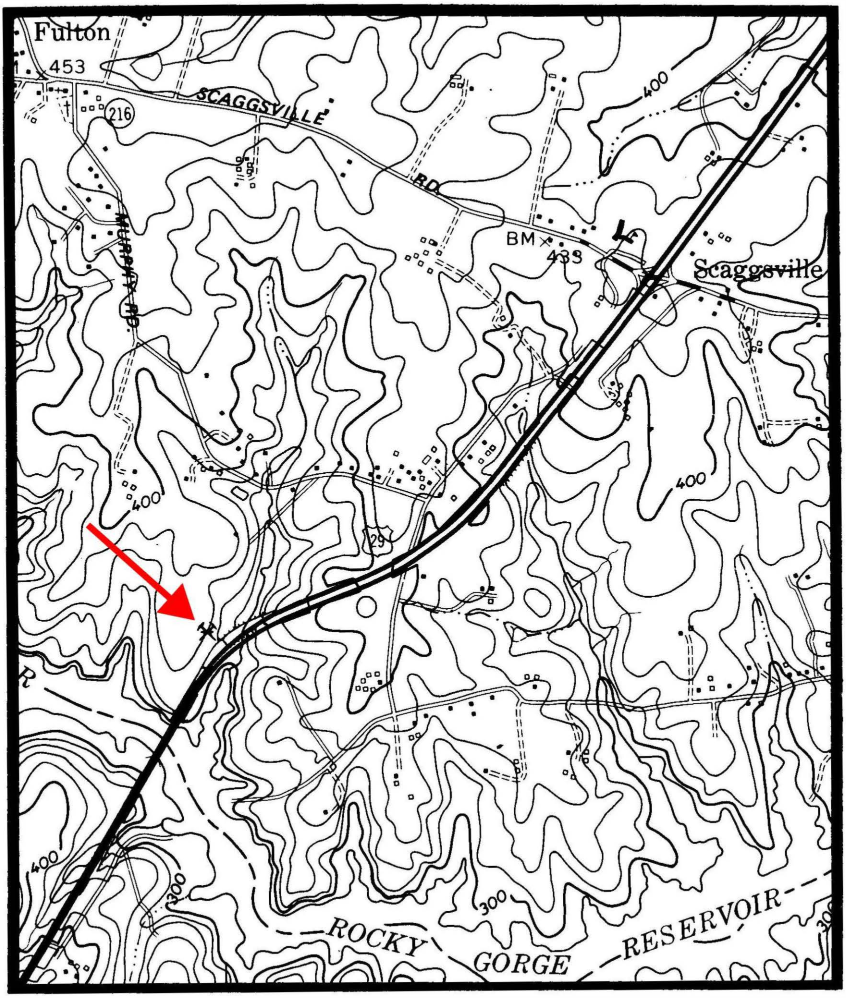

Figure 26: Location of the Ben Murphy mica mine, Scaggsville, Maryland. (U.S. Geol. Survey Clarksville quadrangle, scale 1:24,000).

Autunite—fairly common; fluoresces green in ultraviolet radiation
Beryl—yellow grains in border zone; greenish-yellow, subhedral to euhedral prismatic crystals with basal pinacoid in wall and intermediate zones, to at least 15 cm across
Columbite-tantalite—orange discs around 1 mm across as inclusions in muscovite; X-rayed (Blandford, 1955)
Gahnite—dark-green masses up to 2 cm across rather common in intermediate zone, usually associated with spessartine; sometimes within beryl crystals; also as small flattened crystals in muscovite
Hematite—reticulated growths within muscovite
Limonite—brown to orange stains
Manganese oxides—black, often dendritic; commonly associated with spessartine
Microcline—reddish anhedral crystals in intermediate zone, in places replaced by sugary albite
Muscovite—coarse greenish books to at least 20 cm across; sericite common on fracture surfaces and in contacts between minerals
Quartz—intergrown gray to brown anhedral crystals; dominant in core
Schorl—common in schist immediately surrounding pegmatite
Spessartine—cinnamon colored, fractured subhedral crystals up to 2 cm across; in intermediate zone, commonly with gahnite

Frost Quarry
(Fannie Frost Feldspar Quarry)
Woodstock, (Loc. 3)

Location

This quarry is reached by taking Route 99 for 2.1 km southeast from the intersection with Woodstock Road (Route 125) to Green Clover Road, and following this north for 1.2 km (Fig. 27). Turn left and go for about 60 meters, then turn left again on a dirt road and go for about 250 meters, where the quarry will be visible on the right. The quarry, which was about 150 meters long, 30 meters wide, and 10 meters deep, is now partially filled with water, and is surrounded by large dump piles. It was operated in the early part of the twentieth century for feldspar.

Mosquitoes, poison ivy, and copperhead snakes are rampant during the summer, and it is very strongly recommended that this quarry be visited only in early spring or late fall.

Description

This large pegmatite opening is on the western flank of the Woodstock gneiss dome, where the pegmatite has intruded the Cockeysville Marble. The contact between the two is unfortunately no longer visible, and specimens of the marble are scarce on the dumps. Zoning within the pegmatite is not clearly exposed, but there is a distinct quartz core a few meters wide, surrounded by

Figure 27. Location of Frost quarry, Woodstock, Maryland. (U.S. Geol. Survey Ellicott City quadrangle, scale 1:24,000).

extremely coarse-grained feldspar and diopside. Albite crystals to thirty centimeters, and microcline crystals over a meter across can be seen.

This otherwise granitic pegmatite is unusual for the high proportion of iron, magnesium, and titanium minerals that it contains. The most common of these is diopside, which occurs as dark-green prismatic crystals up to at least thirty centimeters long and ten centimeters wide. Other pyroxenes, and amphiboles, have also been reported from this pegmatite (Ostrander and Price, 1940). Reddish-brown titanite crystals up to 2.5 centimeters long are locally common in the pegmatite, displaying the characteristic disphenoidal habit. Small masses of pyrrhotite are fairly common.

Often associated with titanite are elongated aquamarine beryl crystals, up to several centimeters long, light blue, and fairly transparent, though never more than five millimeters wide.

Many other minerals were reported by Ostrander and Price (1940), but were not encountered by the author during recent visits to the now overgrown dumps; a number of these were probably present in the marble rather than in the pegmatite. In the mineral list below, those minerals reported only by Ostrander and Price (1940) are preceded by an asterisk (*).

Minerals

*Actinolite
Albite—white, subhedral crystals in pegmatite, to at least 30 centimeters across
*Allanite
Beryl—elongated, light blue, transparent crystals in pegmatite
Biotite—occasional black plates in pegmatite
*Clinoziosite-epidote
Diopside—dark-green, splintery, prismatic crystals to 30 cm long and 10 cm wide
*Dolomite—(probably from marble)
Garnet—probably grossular (J.S. White, Jr., written communication, 1977)
*Hornblende
*Idocrase—(from marble)
Limonite—abundant brown stains
Microcline—gray to tan crystals in pegmatite that may exceed a meter in size
Muscovite—uncommon, in pegmatite
*Orthoclase (?)
*Phlogopite—(from marble)
*Pyrite
*Pyrope (?)
Pyrrhotite—small silvery grains with diopside in pegmatite
Quartz—gray to smoky
Titanite—well formed, reddish-brown, disphenoidal crystals in pegmatite

Other Localities

Atholton

Apatite, epidote, quartz crystals (including amethyst), spessartine, and zircon were reported from a quarry at Atholton, just north of Route 32 on U.S. Route 29, which is now totally covered over and mostly underneath Route 29 (Nicolay and Stone, 1967). The rock quarried was probably Guilford Granite (Crowley, oral communication, 1977). (Loc. 4).

Carrolls Mill

Fibers and tiny stubby prisms of sillimanite occur with kyanite and garnet in "strongly pegmatized schist" at the western flank of the Clarksville gneiss dome near Carrolls Mill (Hopson, 1964). (Loc. 5).

Clarksville

Ostrander and Price (1940) reported smoky quartz crystals in soil from a field near Clarksville. (Loc. 6).

Columbia

Colorless, smoky, rutilated, and amethyst varieties of quartz crystals have been found during construction work throughout Columbia in recent years. George Brewer (oral communication, 1974) reports colorless to smoky crystals from excavations at Faulkner Ridge and Bryant Ridge Elementary schools and at Thunder Hill, and rutilated quartz from Dag Hammarskjold College. Construction workers have reported amythest from unspecified localities. The quartz crystals are generally found in soils derived from rocks containing small quartz veins and pegmatites. Cubic pseudomorphs of limonite after pyrite are also found in the soil and schist of the Columbia area. (Loc. 7).

Cooksville

1. The Rice mine was located about 1.6 km north of Cooksville on Route 97, west of the intersection with Old Frederick Road (Singewald, 1911). Magnetite was reportedly found here, but no trace of the operation remains. (Loc. 8).
2. At the Forsythe Mine across Route 97 from the Rice mine, yellow limonite was mined in the 1850s (Singewald, 1911). (Loc. 9).

Daniels

At an abandoned quarry at Daniels, formerly called Alberton, anthophyllite asbestos and possibly large rutile crystals were reportedly found at a contact between serpentinite and "schistose actinolite" (Ostrander and Price, 1940). Daniels is located about 6.4 km north of Ellicott City. (Loc. 10).

Ellicott City

1. Several granite quarries, now mostly covered, were operated just east of Ellicott City. They reportedly contained feldspar, biotite, quartz, calcite, stilbite, and olivine (Ostrander and Price, 1940). (Loc. 11)

2. Nontronite, a clay mineral in the montmorillonite group, constitutes about 20% of a lamprophyre dike on Route 144 about 130 meters west of Cooper Run (Hopson, 1964). (Loc. 12).

3. A specimen of pyrite, galena, and chalcopyrite in a calcite lens in chlorite schist, labelled as coming from Ellicott City, is in the Smithsonian collections (USNM-DC).

Glenelg

Cubic pseudomorphs of limonite after pyrite are abundant in the soil around Glenelg. (Loc. 13).

Ilchester

Good specimens of graphic granite (intergrown microcline and quartz) occurred at the Mount Saint Clement College quarry, on the property of Saint Mary's College, on a dirt road about 0.8 km west of the main building. The small quarry has been filled in but graphic granite can still be found as float in the vicinity (see Fig. 28). (Loc. 14).

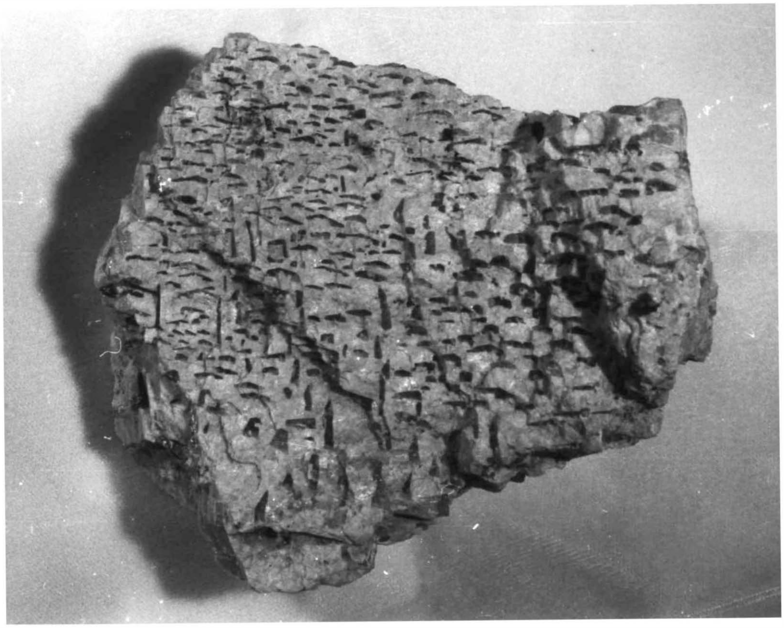

Figure 28: Graphic granite (intergrown quartz and microcline) from the Mount Saint Clement College quarry, near Ilchester, Maryland.

Marriottsville

1. Abundant scattered schorl crystals in Setters Formation quartzite (see Fig. 29) occur in the several flagstone quarries on Marriottsville Road within 2 km south of Marriottsville (Loc. 15).
2. A small opening in Cockeysville Marble, 0.4 km south of Marriottsville, reportedly produced tremolite, phlogopite, vermiculite, talc, and dendritic manganese oxides (Ostrander and Price, 1940). (Loc. 16).
3. Talc was reported from an opening 0.4 km west of Marriottsville (Ostrander and Price, 1940). (Loc. 17).
4. In schist near the Tunnel feldspar mine (see Fig. 30), kyanite, staurolite, garnet, limonite after pyrite, and quartz crystals were found (Ostrander and Price, 1940). (Loc. 18).

Figure 29: Schorl crystals in Setters Formation quartzite at a small flagstone quarry just south of Marriottsville, Maryland.

Pine Orchard

A pile of broken rock, mostly pegmatite, derived from local road construction and located just south of Interstate Route 70 near the "Enchanted Forest," contained flakes of autunite (J.S. White, Jr., oral communication, 1973). (Loc. 19).

Savage

Savage Gabbro Quarry—This large, currently abandoned quarry is located on property of the Rouse Company of Columbia, about 1.1 km east of Route 95, just north of Gorman Road. The gabbro in this quarry contains pyroxene, actinolite, chlorite, hornblende, calcite, limonite, pyrite, octahedral magnetite crystals, plagioclase, and occasional green titanite crystals in quartz. (Loc. 20).

Scaggsville

Schorl crystals in quartz are common along the Patuxent River near the Route 29 bridge. (Loc. 21).

Simpsonville

1. Maryland Mica Mine—The much overgrown and barely discernible pits and dumps of this mine can be seen in the woods about 0.8 km north-northwest of the intersection of Johns Hopkins and Sanner Roads. Quartz crystals, including amethyst, and muscovite, specular hematite in quartz, schorl, microcline, ilmenite, pyrite, limonite after pyrite, chlorite, amphibole, manganese oxides and pyrophyllite were reported from this old pegmatite opening by Ostrander and Price (1940). (Loc. 22).
2. Parlet Prospect—The remains of this small mica prospect are located in the small strip of woods adjacent to parking lot "D" at the Johns Hopkins University Applied Physics Laboratories, along Sanner Road just north of Johns Hopkins Road. Plates of muscovite with quartz, microcline, and albite occur in pegmatite. (Loc. 23).

Woodstock

Allanite surrounded by epidote, cubic pyrite crystals, and titanite were reported from abandoned granite quarries at Woodstock (Ostrander and Price, 1940). (Loc. 24).

Miscellaneous Localities

Feldspar and Quartz Mines in Northern Howard County and Southern Baltimore and Carroll Counties

A great number of small mines were opened in the pegmatites and large quartz veins of this region, mostly around the turn of the century. The pegmatites, with the exception of that at the Frost quarry (p. 56), were of simple mineralogy, containing microcline, sodic plagioclase, quartz, muscovite and biotite. Garnet, magnetite, and apatite are common as accessories.

Good specimens of graphic granite have come from a few of the mines (see Fig. 28). Feldspar and occasionally mica were the products of these small pegmatite operations, few of which were more than small pits or trenches on someone's farm. The quartz mines were of similar size, and produced crushed quartz under the tradename of "flint," which was used primarily for making sandpaper.

As the mineralogy of these deposits is quite simple and uniform, and the mines themselves are almost without exception obliterated, the deposits are here treated as a group, mainly for historical interest. The report by Singewald (1928) can be consulted for additional data. Hopson (1964) considers the pegmatites genetically related to the nearby gneiss domes, and reports them to be about 440 million years old.

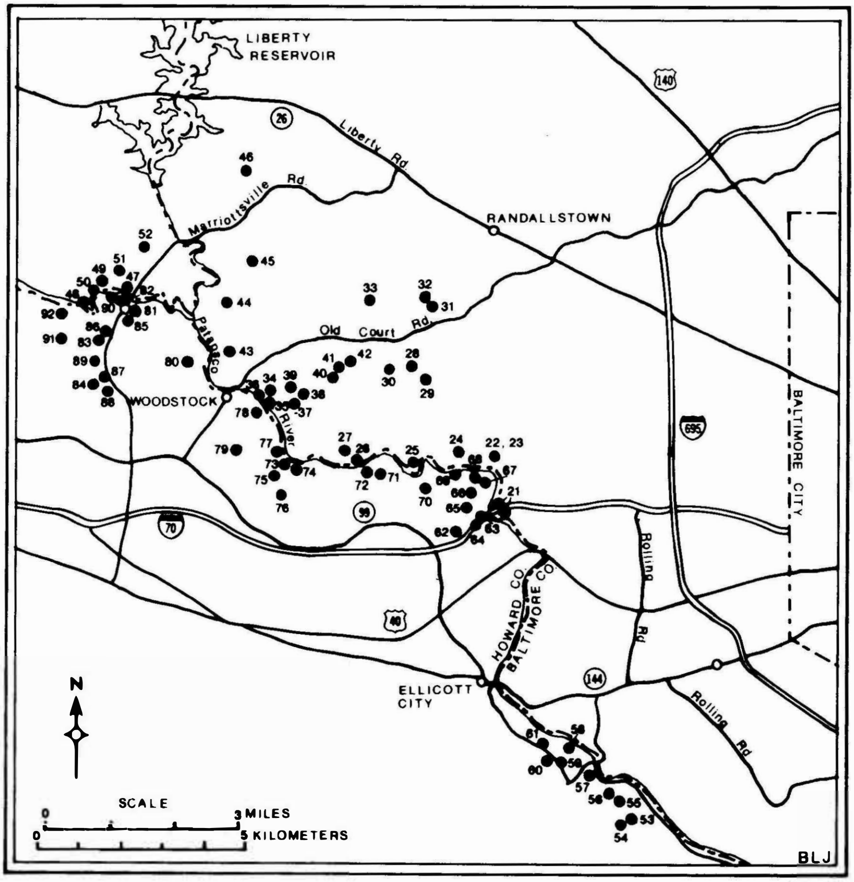

Figure 30: Locations of feldspar mines in Howard and southern Baltimore counties, Maryland (after Singewald, 1928, Plate IV).

No. on Fig. 30	Loc. Plate 1	County	Name of Locality
21		Balto.	Hollofield quarries
22		Balto.	Wilt quarry
23		Balto.	Humphrey quarry
24		Balto.	Picnic Woods quarries
25		Balto.	Alberton quarry
26		Balto.	Feeney & Atherton Feldspar Co. quarries
27		Balto.	Dietz quarry
28, 29		Balto.	Minckins quarries
30		Balto.	Rupp quarries
31, 32		Balto.	French quarries
33		Balto.	Offutt quarry
34, 35, 36		Balto.	Guilford & Waltersville Granite Co. quarries
37, 38		Balto.	James Peach quarries
39		Balto.	Quarries 1.2 km S of Granite
40		Balto.	U.F. Peach quarries
41		Balto.	Kemp quarries
42		Balto.	Worthington quarries
43		Balto.	Patterson quarries
44		Balto.	Poole Farm quarries

Figure 30: Locations of feldspar mines in Howard and southern Baltimore Counties, Maryland (from Singewald, 1928, Plate IV) continued.

No. on Fig. 31	Loc. Plate I	County	Name of Locality
45	–	Balto.	Hamilton quarries
46	–	Balto.	August Sandusky quarry
47	–	Carroll	Weetenkamp quarry & Tunnel mine
48, 49, 50	–	Carroll	DeVries quarries
51	–	Carroll	John Wallen quarry
52	–	Carroll	Oursler quarry
53	35	Howard	O'Connor Farm quarries
54	–	Howard	Cordy quarry
55, 56	–	Howard	Pindell quarries
57	28	Howard	Baltimore Feldspar Co. quarry
58	14	Howard	Mount St. Clement College quarry
59	34	Howard	Wharton quarry
60	34	Howard	Weber quarry
61	34	Howard	Fisher and Carozza quarries
62	33	Howard	Streker quarry
63, 64	33	Howard	Highe quarries
65	33	Howard	Fagan quarries
66, 67, 68	32	Howard	Theis quarries
69	32	Howard	Perry quarries
70	31	Howard	Gary quarry
71, 72	31	Howard	Dorseys Run quarries
73, 74	29	Howard	Arrington quarries
75	3	Howard	Frost quarry
76	29	Howard	Moody quarry
77	30	Howard	Shipley quarry
78	30	Howard	Unnamed feldspar quarry
79	30	Howard	Brown quarries
80	28	Howard	Baltimore Feldspar Co. quarries
81	25	Howard	Quarry near Marriottsville
82	25	Howard	Warfield quarry
83	26	Howard	Product Sales Co. quarry
84	26	Howard	Baugh & Sons Co. quarry
85	25	Howard	Quarry nr. Marriottsville
86	26	Howard	Zepp feldspar quarry
87	26	Howard	Mathews quarry
88	26	Howard	Wright quarry
89	26	Howard	Harold Stromberg quarry
90	25	Howard	Albert Sandusky quarries
91	36	Howard	Hanna quarry
92	36	Howard	Feazer quarry

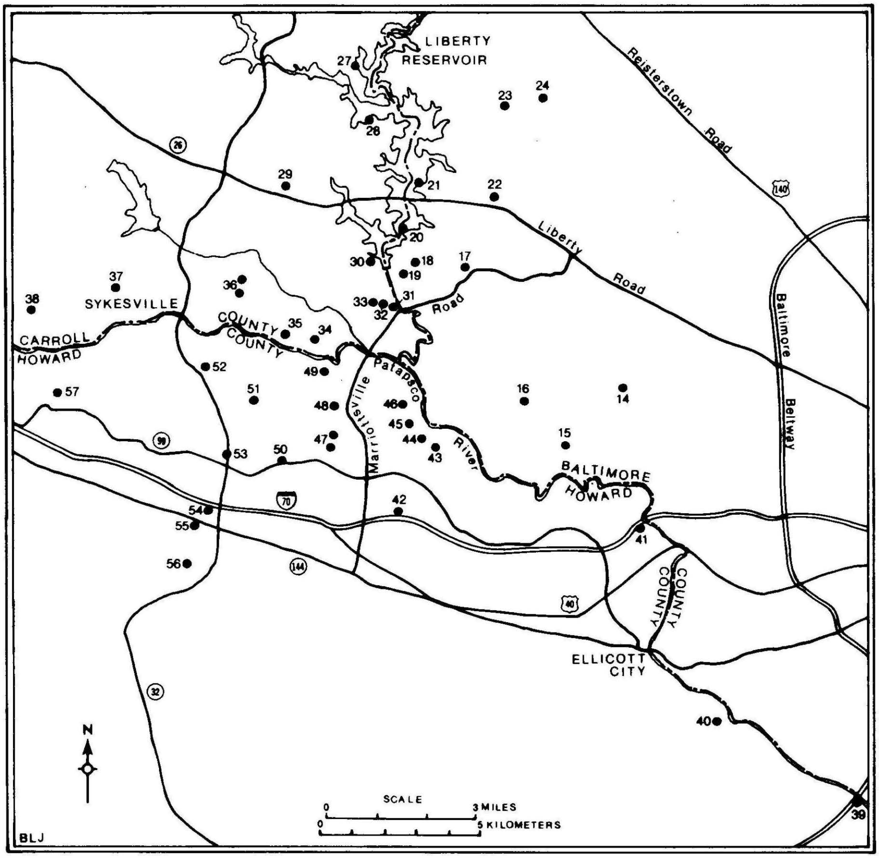

Figure 31: Location of quartz mines in Howard and southern Baltimore counties, Maryland (after Singewald, 1928, Plate VII).

No. on Fig. 31	Loc. Plate I	County	Name of Locality
14		Balto.	Minckins quarry
15		Balto.	Smoot quarry
16		Balto.	Worthington quarry
17		Balto.	Sandusky quarry
18		Balto.	Baer quarries
19		Balto.	Green quarry
20		Balto.	Anton Reisberg quarry
21		Balto.	Koiner quarry
22		Balto.	Allens Lane quarries
23		Balto.	Warner quarry
24		Balto.	Yox quarry
25		Balto.	Charles B. Gillett quarries
26		Balto.	Fritch quarry
27		Carroll	Brauning quarries
28		Carroll	Bennett quarry
29		Carroll	Ruch quarry
30		Carroll	Flint quarry woods
31, 32, 33		Carroll	Oursler quarries
34		Carroll	Richardson quarry
35		Carroll	Wesley Baker quarry
36		Carroll	Emma Feazer quarry
37		Carroll	Ruby quarry
38		Carroll	Trayer farm quarry
39	47	Howard	Lawyers Hill quarry
40	34	Howard	Thomas quarry
41	33	Howard	Fagan and Highe quarries
42	48	Howard	Howard Smith quarry
43, 44	29	Howard	Zepp quarries
45, 46	34	Howard	Baltimore Feldspar Co. quarries
47	37	Howard	Herbert Crooks quarry
48	26	Howard	Harold Stromberg quarry
49	25	Howard	Lee Rendu quarry
50	38	Howard	Richard Williams quarr
51	42	Howard	Unnamed quartz quarr
52	43	Howard	Day quarry
53	41	Howard	Iglehart quarry
54	40	Howard	Harry Akers quarry
55	39	Howard	Ridgley quarry
56	45	Howard	Hudson quarry
57	44	Howard	Beck quarry

MONTGOMERY COUNTY

Kensington Mica Mine
(Gilmore, Gilbert, B.H. Warner, or Gremoses Mica Mine)
Silver Spring, (Loc. 1)

Location and History

The remaining dumps of this mine can be found at the intersection of Stonington Drive and Remington Road, overlooking Northwest Branch. There is a cleared strip of county land here which represents a filled open cut and flattened dumps. Other small pits and dumps can be found in the area (see Fig. 32), but very little remains of them. A pile of sorted mica remains on the southwest corner of the intersection, and a network of trenches used in separating the mica is found bordering many of the streets in the neighborhood. During mining these trenches were flooded with water, and the mica was floated off and collected.

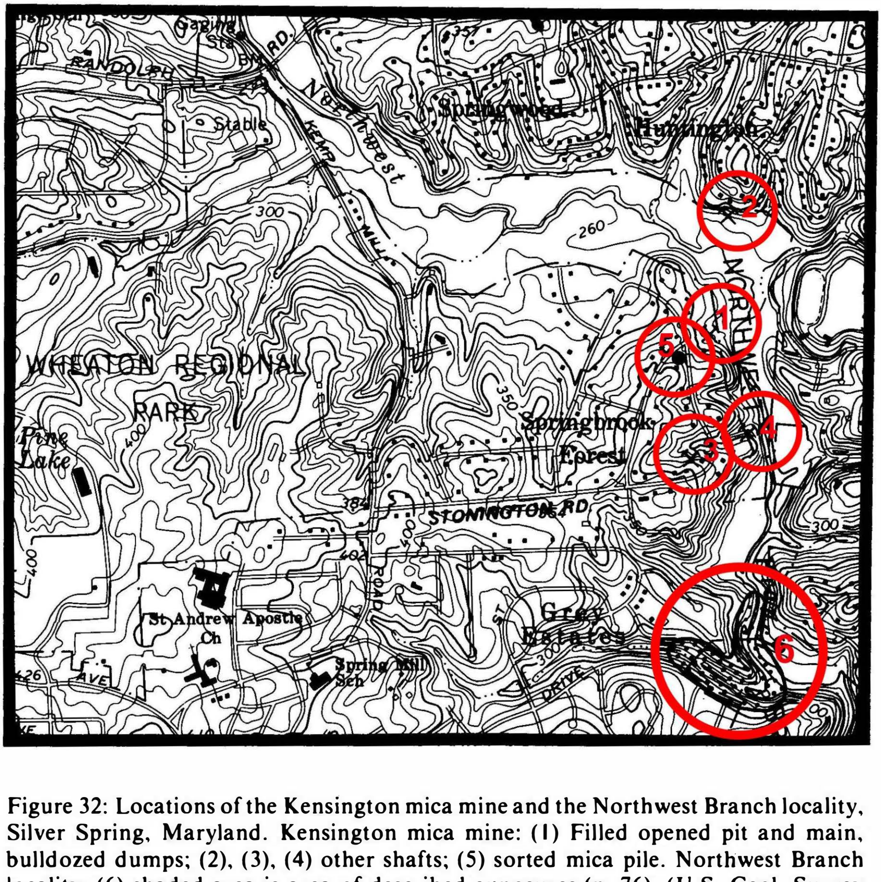

Figure 32: Locations of the Kensington mica mine and the Northwest Branch locality, Silver Spring, Maryland. Kensington mica mine: (1) Filled opened pit and main, bulldozed dumps; (2), (3), (4) other shafts; (5) sorted mica pile. Northwest Branch locality: (6) shaded area is area of described exposures (p. 76). (U.S. Geol. Survey Kensington quadrangle, scale 1:24,000).

Mica mining began here around 1882, when an open cut with a vertical shaft sixteen meters deep was opened on the present strip of county land. Two large horizontal tunnels and a number of long trenches were also operated in the vicinity (Sterrett, 1923; Schaefer, 1970). Mining continued sporadically on a small scale until World War I. Over ninety kilograms of beryl was taken from the dumps by one individual from 1971 through 1973.

Description

The Kensington mica mine should probably be classed as an obliterated locality, as little evidence of its existence can still be found. The mine was of considerable mineralogical interest, however, and is therefore included here. Additionally, the old dumps are periodically uncovered by landscaping and roadwork; and there is also a good chance that similar pegmatites will be found in the region.

This mine was opened in a complex pegmatite dike that was 3 to 5 meters wide with a strike of N30° E (Sterrett, 1923), conformable with the surrounding Wissahickon gneiss. From observations of dump specimens, 5 distinct zones within the pegmatite could be recognized by the author (also see Fig. 4):

Zone 1: A discontinuous, marginal border zone, 0-2 cm wide, consisting of fine-grained quartz, muscovite, and albite, with minor yellow beryl and limonite;

Zone 2: A coarser grained (about 1-5 cm crystals) wall zone containing intergrown albite, quartz, and muscovite; with yellow to yellow-green beryl (sometimes in euhedral prismatic crystals) and cinnamon color spessartine garnet as accessories;

Zone 3: A zone consisting of large (up to at least 15 cm across), reddish, blocky crystals of microcline perthite with some quartz and muscovite, where it is not wholly replaced by Zone 4;

Zone 4: A zone which consists primarily of coarsely crystalline albite, mostly the platy variety cleavelandite;

Zone 5: A quartz core, of unknown continuity, containing gray quartz with isolated albite, muscovite, and more rarely, beryl crystals.

Most of the unusual and rare-element minerals occur in the albite replacement zone (Zone 4), especially near the core. Greenish-yellow to yellow beryl crystals up to 33 cm across and 18 kilograms in weight are found in this region, although the crystals are rarely well-formed. Masses of gray-green manganoan apatite up to 15 cm across are also found in this area, often within beryl crystals. These fluoresce a bright, though mottled, yellow-orange in ultraviolet radiation. Dark to bright-green gahnite masses, commonly with beryl, are often found in the albite zone.

Spessartine forms subhedral crystals as well as anhedral masses up to several centimeters across, mostly in the wall zone but also in cleavelandite. It is often associated with manganese oxides, and sometimes with apatite. Autunite is occasionally found as small flakes on other minerals, especially near apatite.

Muscovite is of special interest at the Kensington mica mine due to its occurrence in three distinct habits. First, it forms typical green to brownish-black "books" from a few millimeters to at least 25 centimeters across.

Euhedral crystals of this habit have been found in small cavities in the outer albite zone, associated with small quartz and albite crystals. Flattened garnets and iron oxides are common as inclusions in these books. The second habit is as very fine-grained, white to light-green material known as sericite, which coats contacts between minerals and fills thin fractures. The third and most unusual habit of muscovite at this locality is as extremely fine-grained, waxy, greenish, ellipsoidal to spheroidal balls. These are confined to small areas in the albite zone, near replacements of microcline.

This pegmatite clearly possessed an unusual and interesting mineralogy, and it can be hoped that similar pegmatites will be exposed in the area so that more complete investigations can be made.

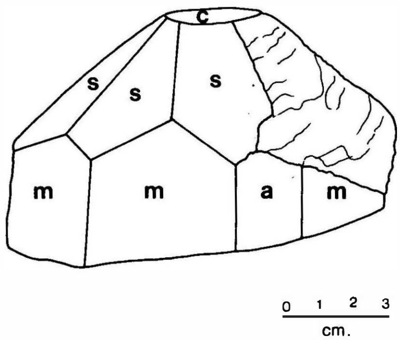

Figure 33: Sketch of a terminated beryl crystal from the albite zone at the Kensington mica mine, Silver Spring, Maryland.

Minerals

Albite—intergrown anhedral white crystals in border and wall zones; platy cleavelandite in albite replacement zone, also some pseudomorphs after microcline. A few tabular crystals of albite "moonstone," having a blue chatoyance, were found in the core margin area. The β refractive index, 1,530 (Shannon, 1926d), for the cleavelandite indicates highly sodic albite.

Apatite—gray to greenish-gray masses throughout the albite zone, especially near the core, where masses can exceed 15 cm; rare in wall zone; commonly associated with spessartine and manganese oxides.

Autunite—small yellow flakes, fluoresces green.

Bertrandite—tiny tan crystals and grains in altered beryl.

Beryl—small anhedral yellow grains in the border zone; yellow to yellow-green subhedral to euhedral crystals in the wall zone; large greenish-yellow subhedral crystals in the albite zone (see Fig. 33) and rarely in the core. The beryl displays a fair prismatic {1010} as well as basal {0001} cleavage.

Gahnite—dark to bright-green masses in albite zone, sometimes within beryl crystals. Part of a transparent octahedral crystal about 6 mm across was found by the author in core margin quartz. An analysis by T. M. Chatard (U.S. Geological Survey, 1884) gave:

Oxides	Weight Percent
SiO_2	0.57
Al_2O_3	55.46
Fe_2O_3	2.77
ZnO	40.07
MgO	0.59
CuO	undet.
Ignition	0.30
	99.76
Specific Gravity	4.59

Limonite—occasional pseudomorphs after pyrite in wall zone and as small veins and masses in core margin area.

Manganese oxides—black, dendritic on fracture surfaces; often associated with spessartine.

Microcline—large, brick-red, coarsely perthitic, blocky, glassy, anhedral crystals in microcline zone.

Muscovite—small plates in border zone; coarse green-brown plates in wall zone, core margin, and core; sericite common on fracture surfaces; extremely fine-grained balls in albite zone.

Pyrochlore-microlite (?)—a red-brown, vitreous, radioactive rare-earth mineral from the wall and albite zones may be uranium-bearing pyrochlore-microlite (formerly known as "hatchettolite"); also reported by Ostrander and Price (1940).

Quartz—gray to brown; intergrown in border and wall zones, interstitial in microline and albite zones; predominant in core as anhedral crystals up to at least 35 cm, judging from well-developed rhombohedral cleavage.

Schorl—black crystals abundant in schist immediately surrounding pegmatite.

Spessartine—reddish-orange; subhedral crystals and massive in wall and albite zones; as inclusions in muscovite crystals; commonly associated with apatite and manganese oxides. It is close to end-member spessartine, as revealed in the analysis given by Shannon (1926d):

Oxides	Wt. Percent
SiO_2	35.76
Al_2O_3	20.72
Fe_2O_3	0.76
CaO	1.22
MgO	0.50
MnO	34.40
FeO	6.66
	100.02
Refractive Index	1.813 ± 0.002

Zinnwaldite (?)—reported by Ostrander and Price (1940)

Hunting Hill Quarry
(Rockville Crushed Stone, Travilah, or Rockville Quarry)
Hunting Hill, (Loc. 2)

Location

This quarry is located four miles west of Rockville, and is reached by taking Travilah Road south from Route 28 for about 1.6 km to Piney Meetinghouse Road and the quarry entrance. This had been a very active crushed stone operation since its opening in 1955, and is now one of the largest stone quarries in the United States. Advance written permission from Rockville Crushed Stone, Inc. is required in order to collect here, because now collecting is generally prohibited.

Description

The Hunting Hill quarry is situated near the center of a roughly lenticular serpentinite body, about 6.5 km long and 1.5 km wide (see Fig. 34). The serpentinite is generally dark green to black and fine-grained, consisting primarily of antigorite with finely disseminated magnetite. Lesser amounts of other serpentine group minerals, chlorite, talc, and residual olivine occur in the serpentinite, but most of the other minerals at this quarry occur in various veins, dikes, and shear zones that cut through it.

The most abundant rock type after serpentinite is rodingite (see p. 18), which occurs as large, light-colored, generally vertical dikes, and in irregular masses. The rodingite is composed of gray to emerald-green diopside crystals up to 20 centimeters across, occurring in a fine-grained groundmass consist-

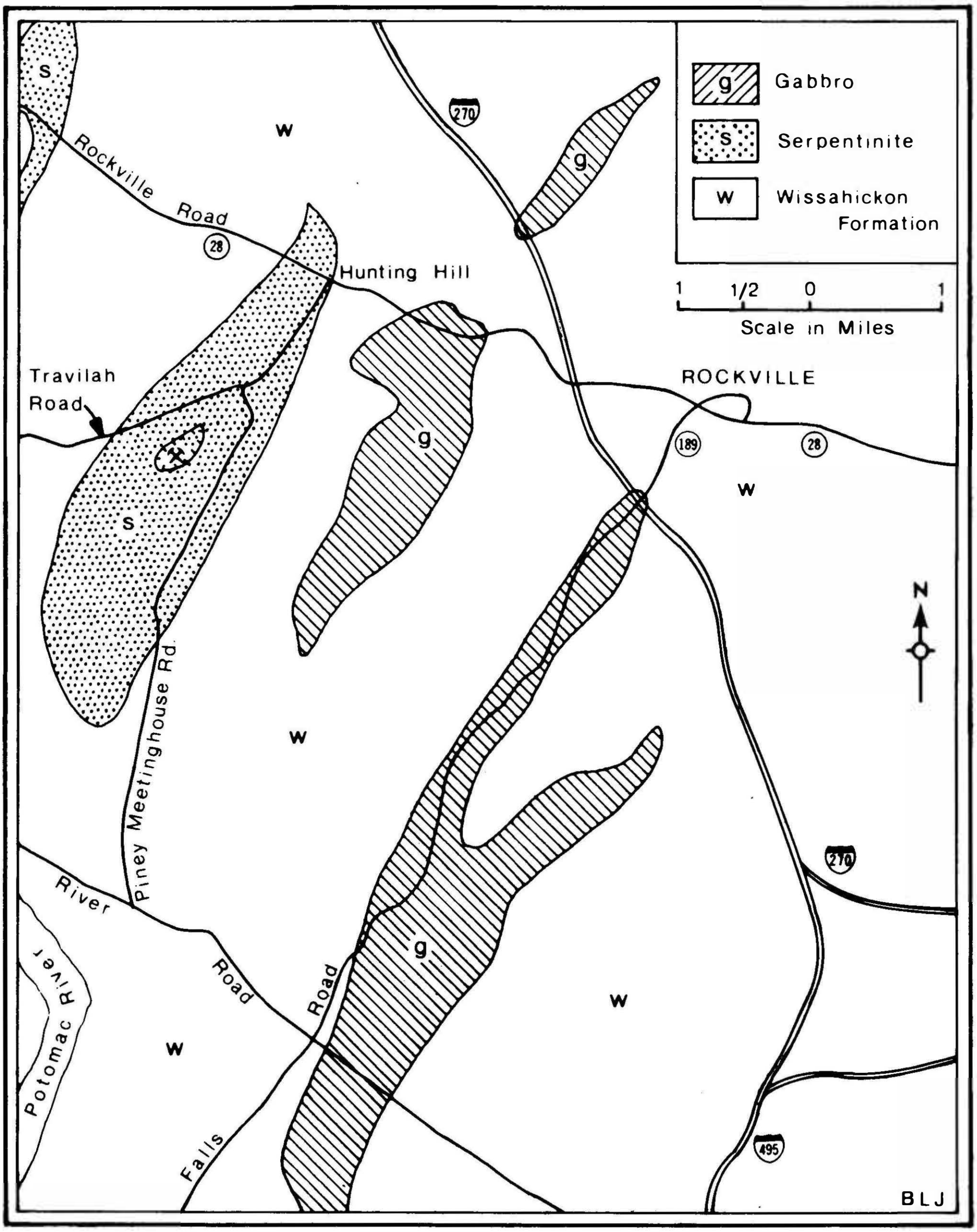

Figure 34: Location of the Hunting Hill quarry, Hunting Hill, Maryland and distribution of serpentinite and gabbro in the region. (after Larrabee, 1969).

ing of tan to cinnamon or pink massive grossular and hydrogrossular, yellow clinozoisite, and gray to pink zoisite. Tremolite crystals, commonly in radiating aggregates, are often encountered in the serpentinite adjacent to the rodingite bodies, and are in places found within the rodingite.

Narrow vugs in the rodingite have produced the superb transparent grossular crystals (see frontispiece), cinnamon colored and up to several centimeters across, that have made this one of the favorite collecting spots in the Washington area. In these same vugs are also found yellow clinozoisite crystals and light-green diopside crystals.

Larger cavities in the rodingite have produced large rhombohedral calcite crystals, radiating aragonite sprays, and coatings of microcrystalline dolomite. Prehnite, sometimes in coarse white crystals, is occasionally found in small vugs.

Other minerals occur in a variety of small veins and shear zones. The most common of these minerals is chrysotile asbestos, which occurs in innumerable short cross-fiber veins rarely more than 3 millimeters in width scattered through the serpentinite. Clinochrysotile, a type of chrysotile, forms extremely fine-grained, waxy, gray-green to gray-blue veins up to 5 centimeters wide in shear zones that nearly always display slickensides.

Veins of chalky white magnesite mixed with opal and residual fragments of serpentine, up to several centimeters thick, are rather common. A vein of hydromagnesite 5 millimeters thick, containing rosettes of tiny white acicular hydromagnesite crystals, was reported by Larrabee (1969). Veins of white to gray opal, often with moss-like manganese-oxide inclusions, have occasionally been found. Brown to green chalcedony veins up to 15 centimeters wide, and boxwork veins of quartz containing minute quartz crystals, were reported from the northern end of the quarry by Larrabee (1969).

Other veins found at this quarry are: veins of massive tremolite to 60 centimeters wide; and thinner veins of talc, penninite chlorite, anthophyllite, and "deweylite" (a yellow-brown, waxy mixture of serpentine minerals and a talc-like mineral). A single 6 centimeter wide vein of "bluish black, striated tourmaline crystals" was found in sheared rodingite float, with clinozoisite-epidote crystals to 2.5 centimeters long (Larrabee, 1969). Brucite, sometimes with huntite, is found in shear zones. A yellow-brown micaceous mineral, becoming bronze colored upon prolonged exposure to the air, has been identified as coalingite. This is only the second reported occurrence of this mineral, which was first reported from the New Idria serpentinite in Fresno and San Benito Counties, California (Larrabee, 1969). At Hunting Hill it is found as mica-like plates to several centimeters across in narrow shear zones.

For further information, the report by Larrabee (1969) gives a very complete account on the geology of this deposit. Several unknown minerals remain to be identified, and it is possible that some new minerals will be discovered here.

Minerals

Actinolite—(Larrabee, 1969)
Albite—very rare (J. Griesbach, oral communication, 1975)

Figure 35: Part of the Hunting Hill quarry, Hunting Hill, Maryland, in 1975, looking northwest. Light-colored vertical dike (r) is rodingite. (used with permission of James G. Topper)

Anthophyllite—creamy-gray veinlets in serpentinite float (Larrabee, 1969)
Antigorite—constitutes bulk of serpentinite as interlocking microscopic laths and plates
Aragonite—platy to acicular, often radiating, colorless crystals in cavities and fractures, often with calcite and dolomite.
Azurite—(Larrabee, 1969)
Biotite—(M.E. Mrose, oral communication, 1975)
Brochantite—green stains in fractures
Brucite—micaceous, white to pale green in shear zones
Calcite—white to light-yellow veins and crystals, usually in rodingite
Chalcocite—(Larrabee, 1969)
Chalcopyrite—(Larrabee, 1969)
Chlorite—in serpentinite, especially near margins of rodingite
Chromite—occasional tiny grains in serpentinite
Chrysocolla—(J. Griesbach, oral communication, 1975)
Chrysotile—small cross-fiber gash veins in serpentinite
clinochrysotile—waxy, hard, gray-green to gray-blue veins in shear zones, to 5 cm thick
Clinochlore—a chlorite mineral, in serpentinite
Clinozoisite-epidote—yellow, greenish-yellow, to tan in rodingite, sometimes as transparent crystals in vugs
Coalingite—yellow-brown to bronze micaceous flakes on shear surfaces in serpentinite
Diopside—white, gray, to green (chromian) in rodingite; crystals up to 20 centimeters across
Dolomite—white tiny crystals, commonly in small pisolitic masses with calcite; in rodingite cavities and carbonate veins
Grossular—yellow-brown, cinnamon-color or pink masses, veins, and crystals (some transparent) in rodingite
Hematite—red coatings on shear surfaces
Huntite—with brucite (Larrabee, 1969)
Hydrogrossular—massive and as crystals in rodingite; nearly impossible to distinguish from grossular without a test for hydroxyl
Hydromagnesite—acicular, radiating crystals in a narrow vein (Larrabee, 1969)
Idocrase—greenish to brown masses in rodingite
Limonite—orange-brown stains on fractures in rock
Lizardite—a component of the serpentinite
Magnesite—chalky white veins, usually with some opal, in serpentinite
Magnetite—black dust, grains, and small octahedral crystals throughout serpentinite; octahedra up to 5 mm reported by Larrabee (1969)
Manganese oxide dendrites—with opal and magnesite
Olivine—tiny residual grains in serpentinite
Opal—mixed with magnesite; also as gray to white veins, commonly with manganese oxide dendrites
Penninite—a chlorite mineral, in small veins and elsewhere in serpentinite
Platinum and palladium—traces reported by Larrabee (1969)
Prehnite—white to pale-green botryoidal aggregates and coarse crystals in vugs in rodingite
Pyrite—(Larrabee, 1969)
Pyrrhotite—(Larrabee, 1969)
Quartz—brown to green chalcedony, and tiny crystals in boxwork veins

Talc—flakes in serpentinite, as small veins, and in small zones of steatite, often with calcite
Tourmaline—bluish-black crystals, from a single vein with clinozoisite-epidote (Larrabee, 1969)
Tremolite—white elongated crystals, often as radiating aggregates in serpentinite, usually near and sometimes in rodingite.
Zoisite—fine-grained, gray or sometimes pink ("thulite"), in rodingite.

Northwest Branch Locality
Silver Spring, (Loc. 3)

Location

This exposure is reached by going to the end of Lamberton Drive in Silver Spring and heading west down the hill to the small creek (Fig. 32). This creek flows into Northwest Branch about a hundred meters downstream. The best specimens are found in alluvium along the creek down to the river. Relations of the schist, quartz veins, and pegmatites are best seen in the outcrops along the creek and especially along Northwest Branch.

Description

While this locality in all likelihood will not yield any spectacular specimens, it does provide an excellent exposure of many typical schist and quartz-vein minerals. Since the two creeks here are continually exposing new rocks, especially after heavy rains and in the spring, this locality should remain productive for some time.

Much of the schist here contains abundant almandine crystals ranging from pinhead size up to about 3 centimeters across. These usually occur as dark-red euhedral dodecahedral crystals, though they are often partially weathered to brownish limonite. Splitting the schist often frees complete single garnet crystals. An interesting feature of the garnets is that they are often at least partially altered to chlorite, a probable example of retrograde metamorphism. Cores of red garnet with green chlorite rims are fairly common.

Schorl is abundant in the schist, sometimes forming radiating aggregates in the plane of schistosity. Staurolite is particularly abundant, occurring as stubby, almost brick-shaped, dark red-brown to black, brittle crystals, often characteristically twinned into crosses or "X's" (see Fig. 36). It is almost always associated with garnet crystals. Some thin quartzite layers in the schist contain abundant epidote-clinozoisite, though rarely in well-formed crystals.

Figure 36: Elongated staurolite crystals, some twinned, and equant garnet crystals in mica schist from the Northwest Branch locality, Silver Spring, Maryland.

In addition to the schist, numerous fragments of quartz veins are present as float. Many of these contain fine schorl crystals and transparent quartz crystals are encountered in small vugs. Traces of pyrite and galena have also been noted. Rutile should be looked for here, although it has not been reported previously.

Some blocks of pegmatite are common in the stream deposits, and some nicely exposed pegmatite veins can be seen in the outcrops along Northwest Branch. These pegmatites are almost all simple in composition, consisting of sodic-plagioclase, microcline, muscovite, and quartz, although traces of greenish beryl and spessartine have been found.

Characteristic Minerals

SCHIST	QUARTZ VEINS	PEGMATITES
Almandine	Galena	Coarse feldspar, quartz, and muscovite
Chlorite-sometimes pseudomorphous after almandine	Pyrite	Beryl
Epidote-clinozoisite	Quartz-crystals	Spessartine
Schorl	Schorl	
Staurolite		

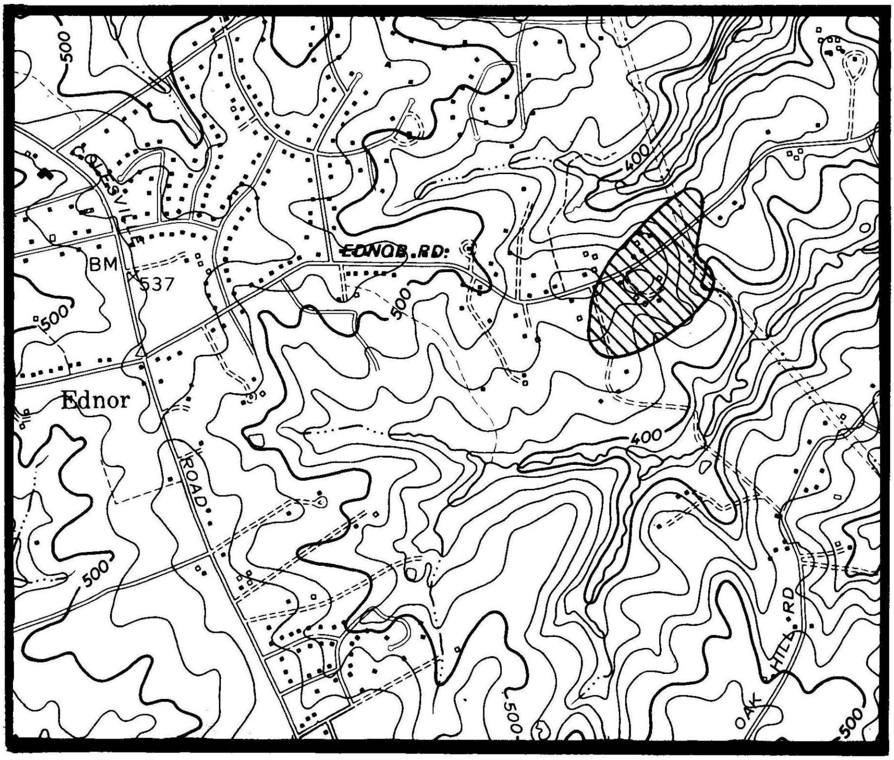

Figure 37: Distribution of steatite near Ednor, Maryland. Mapped by L.R. Bernstein, September 1975. (U.S. Geol. Survey, Clarksville quadrangle, scale 1:24,000).

Ednor Steatite Locality
Ednor, (Loc. 4)

Location

The steatite body here is centered roughly around the intersection of Ednor and Gamewell Roads, 1.6 km east of New Hampshire Avenue (Route 650) in Ednor. There is no particular spot where specimens are found, but since the soil here is generally only a few centimeters deep, any shallow excavations, such as from roadcuts or plowing, are likely to expose the steatite. In addition, the weathered outcrops in the lawns and fields (see Fig. 38) are possible sources of specimens (obtain permission before collecting).

Description

This locality consists of a small lenticular steatite (soapstone) body, surrounded by Wissahickon mica schist that contains numerous quartz veins. Talc and chlorite are the primary constituents of the generally massive and fine-grained steatite. Occasionally, coarsely crystalline foliated talc and coarse plates of chlorite are encountered (see Fig. 39). Much of the talc occurs as radiating fibrous aggregates, and is probably pseudomorphous after actinolite or some other mineral.

Masses of siderite-magnesite are also found, and these weather out of exposed surfaces to produce limonite-encrusted cavities. Additionally, octahedral magnetite crystals up to 5 millimeters across and limonite pseudomorphs after pyrite cubes up to 1 centimeter across, are fairly abundant throughout the rock.

Figure 38: Steatite outcrop at the Ednor steatite locality, Ednor, Maryland. This rock was evidently carved, and may represent an unfinished Indian bowl.

Minerals

Chlorite—green micaceous plates
Limonite—pseudomorphs after pyrite cubes, and as brown replacements of siderite-magnesite
Magnetite—irregular grains, and octahedral crystals to 5 mm
Siderite-magnesite—small tan crystals and masses; commonly altered to limonite
Talc—generally massive; may be coarsely foliated (Fig. 39).

Figure 39: Foliated talc from Ednor, Maryland.
Specimen is about 10 cm across.

Figure 40: Adit to a gold mine (probably the Harrison mine) along Rock Run, east of Brickyard Road, Potomac, Maryland.

GOLD MINES OF MONTGOMERY COUNTY

Introduction

In the mid-1800's, it was discovered that some of the quartz veins in Montgomery County contain substantial amounts of gold. A number of gold-mining operations commenced at that time, operating sporadically, with a brief rekindling of mining activity in the 1930's. Most of the operations centered around Great Falls, Maryland, but scattered veins were worked in Sandy Spring, Rockville, Bethesda, and across the Potomac in McLean, Virginia (see Kirk mine, p. 108). None of the mines remain in operation today. The last producing mine, the Maryland mine, was operated intermittently into the early 1950's. The pits and dumps of all these mines are now rapidly losing ground to the forces of weathering and vegetation, and the encroachment of housing developments.

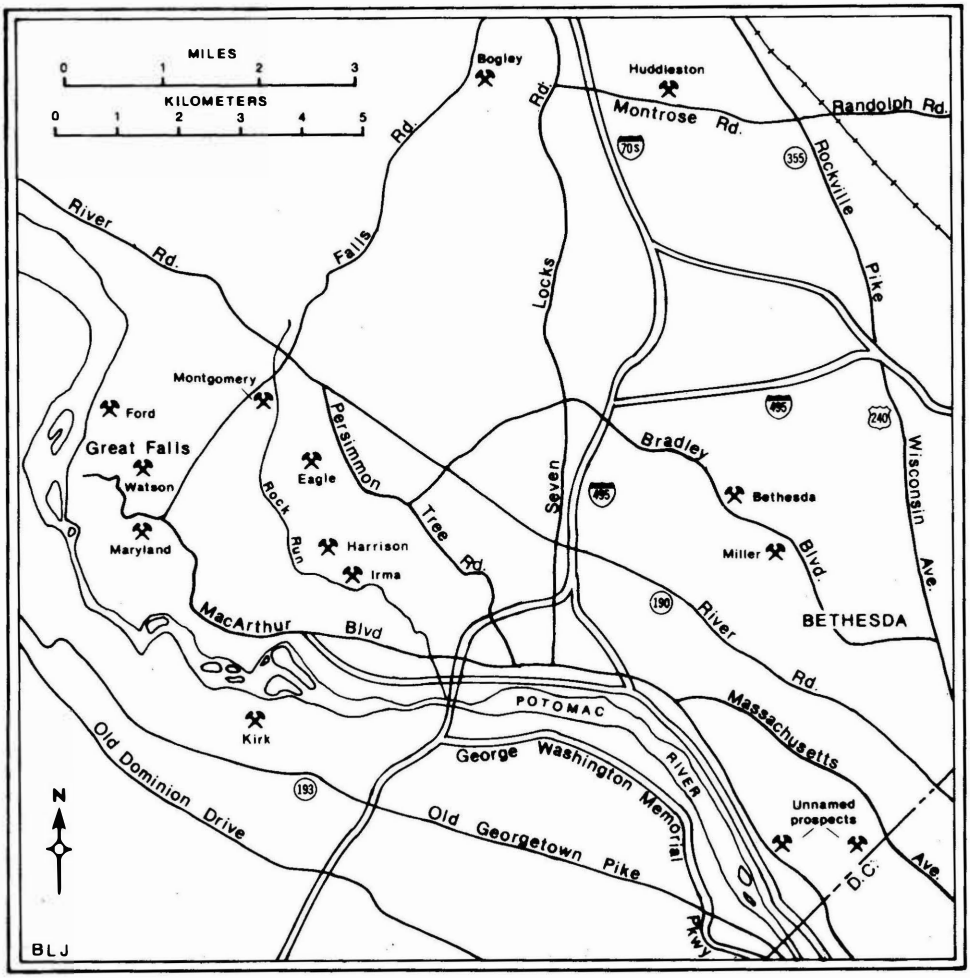

Figure 41: Locations of gold mines near Great Falls and Bethesda, Maryland (after Reed and Reed, 1969).

The gold occurs in native form in quartz veins, along with pyrite, galena, sphalerite, and ilmenite. These veins are often vuggy and filled with limonite from the alteration of sulfides. Gold also occurs in sulfide-bearing, silicified shear zones that usually follow the trend of the quartz veins. These veins and shear zones occur in the Wissahickon schists and gneisses, or occasionally in gabbroic rocks. Most of the gold is highly disseminated and microscopic, but exceptionally large masses were sometimes encountered. The largest reported piece is a 4.1 kg (9 pound) nugget recovered in the 1940's from the Ford Mine (Frank W. Stevens, oral communication, 1975).

At present, the only accessible and productive mine dumps are those of the Ford and Maryland mines, but both of these are on federal property and

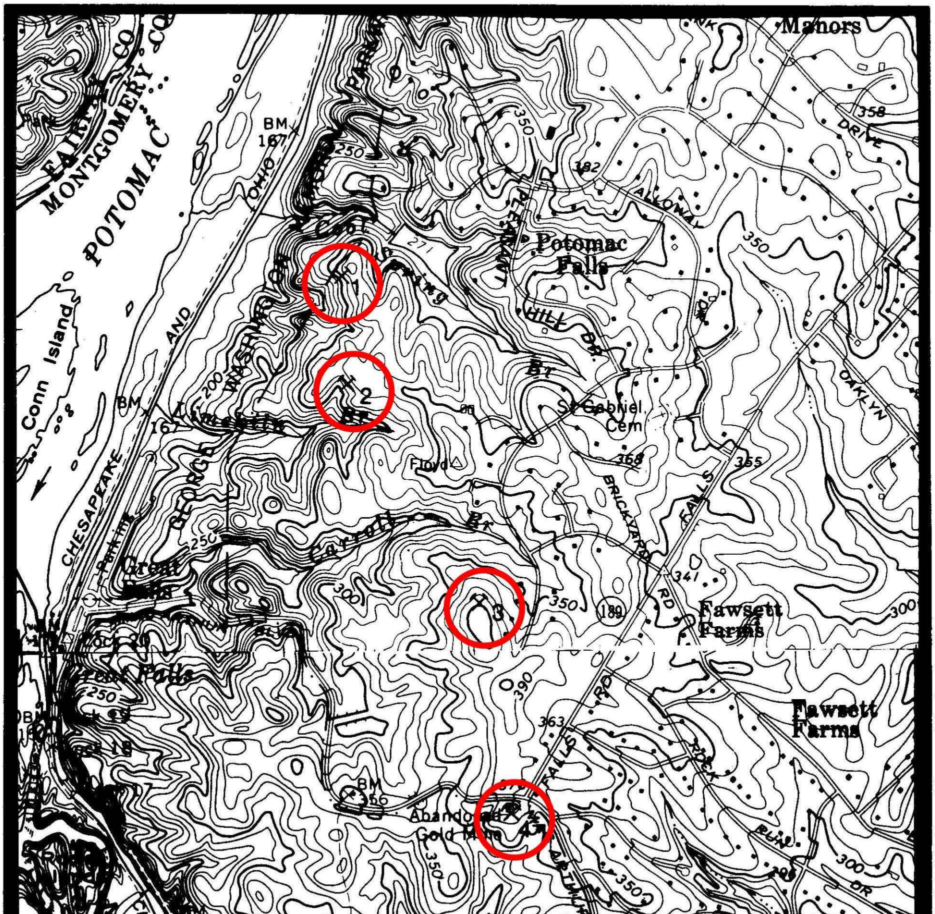

Figure 42: Locations of the Ford (1, 2), Watson (3), and Maryland (4) gold mines, Potomac, Maryland. (U.S. Geol. Survey Rockville and Falls Church quadrangles, scale 1:24,000).

mineral collecting is generally prohibited. The other mines listed below all produced gold at some time, but their current physical conditions tend to hamper, at best, any collecting and any reasonable chance of finding gold.

Another aspect to gold prospecting around Washington is the technique of panning. Gold has been successfully panned all along the Potomac near Great Falls, and a favorite area is that around the Angler's Inn in Cropley. Here the best panning material is obtained by scraping out sand from crevices in the bedrock. Commercial gold placer-mining operations existed on Rock Run in Potomac at several times. Around 1890, "many fine nuggets, weighing up to three or four ounces" were reported from this stream near the Montgomery mine (Emmons, 1890). Small amounts of gold can still be panned from most of the streams around Great Falls, and from Cabin John Creek and Bogley Branch near Rockville.

The following reports are the most useful for obtaining more detailed histories and descriptions of these mines: Emmons, 1890; Reed and Reed, 1969; Ulke, 1939; Weed, 1905; Zodac, 1947.

Minerals of the Gold-Bearing Quartz Veins and Silicified Shear Zones

Ankerite (1)
Chalcopyrite (2)
Chlorite
Epidote
Galena
Goethite
Gold
  electrum
Ilmenite
Limonite
Malachite (2)
Platinum (3) (?)
Pyrite
Pyrrhotite (2)
Quartz
Schorl (1)
Sphalerite
Tetradymite (4)
Topaz (3)

Maryland Mine (Including Allen Shaft), (Loc. 5)

This is the largest of the area gold mines, and is the easiest to locate. The workings begin a few dozen meters south of the intersection of Falls Road and MacArthur Boulevard in Potomac. The dumps are scattered through the woods, and much crushed rock remains around the site of the old crusher. The deposit consisted of milky quartz veins and adjacent silicified schist. Pyrite, commonly as cubes up to 2 centimeters across, if fairly common in both rocks. The pyrite tends to contain a high proportion of disseminated gold, and some pyrite assayed at 4.25 ounces gold (133 ppm) and 0.36 ounces silver (11 ppm) per ton (Weed, 1905). Galena is fairly common in the quartz

(1) Ulke, 1933
(2) Zodac, 1947
(3) Frank W. Stevens, oral communication, 1975
(4) Ulke, 1939

and is often associated with the largest masses of gold. The gold is found both in the quartz and in the silicified mica-chlorite schist. Brown sphalerite and platy ilmenite are occasionally seen in the quartz, and Zodac (1947) reported pyrrhotite, chalcopyrite, and malachite. Platinum has also been reported from this ore (Frank W. Stevens, oral communication, 1975), although this identification is questionable.

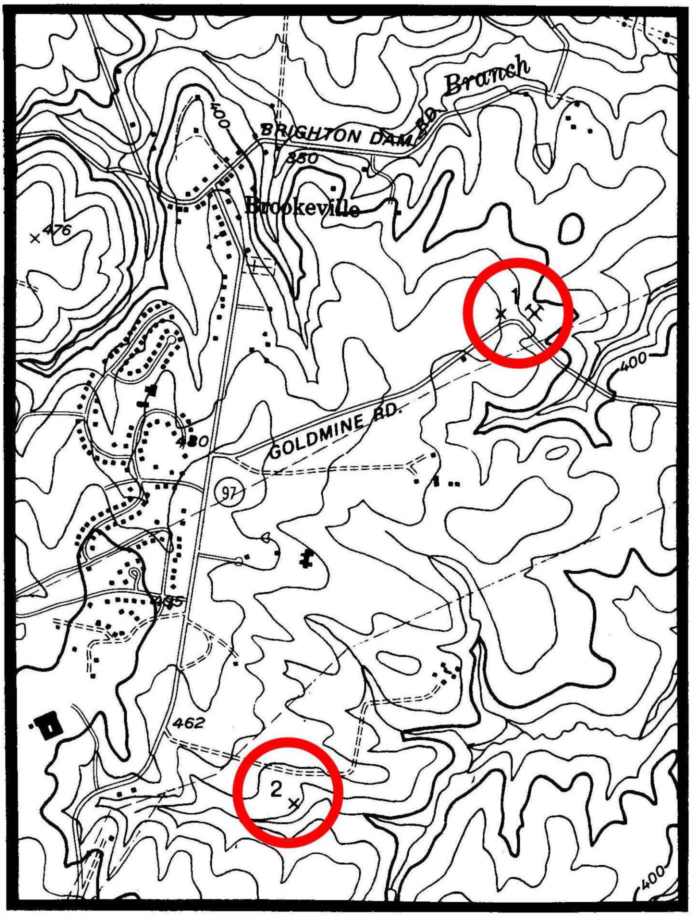

Figure 43: Location of the Ellicott gold mine. (1) Ellicott gold mine; (2) Olney "gold" prospect, see p. 90. (U.S. Geol. Survey, Sandy Spring Quadrangle, scale 1:24,000).

Ford Mine
(Allerton-Ream Property), (Loc. 6)

This mine is reached either from the Chesapeake and Ohio Canal towpath, or from Stanmore Court, by going around the lake (refer to Fig. 42). The ore at the Ford mine was predominantly sulfide-bearing schist and gneiss, with small criss-crossing quartz veins. The large shafts are still visible, and there are still many accessible dumps scattered through the woods. Most of the dump material, however, is of little interest to collectors. A few flakes of gold associated with limonite, in vugs formerly occupied by pyrite, have recently been found. Some residual pyrite also occurs, and limonite after pyrite cubes are common in the chlorite-mica schist. Small octahedra of magnetite are also found in this rock.

Ellicott Mine
Sandy Spring Mine, Brookeville Mine, (Loc. 7)

This is the site of the first gold discovery in Montgomery County, sometime before 1854. The mine was located in Sandy Spring, just north of Gold Mine Road, about 1 km east-northeast of Georgia Avenue (Route 97). Little evidence of it remains today, except for an overgrown pit and 100 meter shallow trench along the road, and a number of scattered quartz boulders. The ore here was described as being very rich, however, averaging about "$522 per ton" (at a gold price of about $20 per ounce) of very finely divided gold, occurring in quartz veins "amidst a decomposed talcose slate [schist]" (Emmons, 1849).

Mines Along Rock Run
Includes: Montgomery, Harrison, Eagle, Irma, Kirk and Kirk, Ramsey and Clarke, Russ, and Bradley Mines; and Rock Run Gold Placers, (Locs. 8, 9)

These mines consisted of a number of shafts and prospect pits in quartz veins along Rock Run. Most of them changed owners and names many times; most of their original names and locations have been lost. A few of the pits are still visible, and one tunnel, probably of the Harrison mine, is still accessible (see Fig. 40). Ulke (1939) reported some tetradymite from this area. These mines were described in some detail by Emmons (1890).

Other Small, Obliterated, or Unlocated Mines

Anderson Mine—About 0.8 km north of the Maryland gold mine (Weed, 1905). (Loc. 10).

Bethesda Mine—Near Bradley Boulevard at Bulls Run in Bethesda (Reed and Reed, 1969). (Loc. 11),

Bogley Mine—Just east of Falls Road, near Kersey Lane, in Rockville (Reed and Reed, 1969). (Loc. 12).

Fawsett Mine—Near the eastern end of Fawsett Road near Potomac (Frank W. Stevens, oral communication, 1975). (Loc. 13).

Gillotts Mine—About 0.8 km south of the junction of Falls Road (Route 189) and U.S. Route 270 in Rockville; reportedly contained gem-quality brown topaz (Frank W. Stevens, oral communication, 1975). (Loc. 14).

Grady Mine—Near the intersection of Chesley and Canfield Roads in Rockville (Frank W. Stevens, oral communication, 1975); large milky quartz boulders are still visible. (Loc. 15).

Huddleston Mine—Nothing remains of this once-rich mine except for a few small dumps scattered through a narrow patch of woods, just north of Montrose Road, 0.8 km east of U.S. Route 270 in Rockville. During recent work to widen this portion of Montrose Road, some large masses of pyrite (to 7 cm across), partially altered to limonite, were uncovered, but no gold was observed. The gold apparently occurred in quartz veins in gabbro, which here contained pyrite, schorl, chlorite, and white, gray, and pink ankerite (Ulke, 1933). Ulke (1933) reported the refractive indices of the ankerite to be ω = 1.694, ε = 1.510, and its composition to be:

Oxides	Wt. Percent
CaO	33.78
MgO	13.70
FeO	6.57
MnO	0.35
CO_2	45.69
Total	100.09

Specific Gravity: 2.88 (Loc. 16).

Miller Mine—Some of the dumps of what was probably the Miller mine are located in the front yard of the house at the corner of Bradley Boulevard and Wilson Lane. (Loc. 17).

Sawyer Mine—Located about 1.9 km west of Persimmon Tree Road at Saunders Lane (Frank W. Stevens, oral communication, 1975; Ostrander, 1938). (Loc. 18).

Stevens-Roudebush Mine—This small mine in quartz veins was located about 2.2 km south-southwest of the intersection of Falls Road and U.S. Route 270, and about 0.3 km west of Falls Road. Two carloads of ore, worth about $800 each, were reportedly shipped in the 1930's (Frank W. Stevens, oral communication, 1975). (Loc. 19).

Other Localities

Barnesville

1. A small copper mine was reportedly operated during the Civil War on the southwest side of a creek, 0.8 km northeast of Barnesville (J. F. Windolph, Jr. and W. Hilton, oral communications, 1975). The rock here is chlorite-rich phyllite of the Ijamsville Formation cut by numerous quartz veins. (Loc. 20).

2. A gold mine was reportedly opened to the northeast of the intersection of Mount Ephraim and Harris Roads, 2 miles northwest of Barnesville, possibly in Frederick County (J.F. Windolph, Jr., oral communication, 1975). (Loc. 21).

Figure 44: The Black Hills gold mine, Boyds, Maryland, now a storage cellar.

Boyds

Black Hills Gold Mine—A small gold mine or prospect was opened in the "Black Hills," 1.9 km west-northwest of Boyds, at the end of Black Hills Road (J.F. Windolph, Jr., oral communication, 1975). When visited by the author in 1975, the mine consisted of a roughly cubic pit about 3 meters on a side which had been converted into a storage cellar (see Fig. 44). The pit is in schist crossed by small quartz veins. Pyrite in quartz is quite common in the immediate vicinity. (Loc. 22).

Brookeville

A manganese mine in the vicinity of Brookeville and/or Mechanicsville (now Olney) was described first in 1835, then in 1862 (Ostrander and Price, 1940), but no trace of this mine has been seen for at least a hundred years and its existence is dubious.

Burtonsville

1. Small (less than 5 millimeters across) bright-green gahnite crystals with small spessartine crystals are found in pegmatite float along Dustin Road, about 0.8 km east of Route 29. (Loc. 23).

2. Earth Products Company Feldspar Mine—Green beryl, garnets, muscovite, schorl, and albite were reported from this group of small quarries by Ostrander and Price (1940). These quarries were located near the eastern end of Dustin Road, about 1.6 km east of Route 29. They have been entirely filled in, and few traces of their former existence remain. A feldspar processing mill that produced chicken grit, flake mica, and pulverized feldspar opened here in 1913 and operated for a short time (Singewald, 1928). (Loc. 24).

Cropley

1. Magnetite octahedra to over 2 centimeters across in chlorite schist were recently collected at an undisclosed location in Cropley, near the Potomac River (Scott Silsby, oral communication, 1975). (Loc. 25).

2. At Widewater, along the Chesapeake and Ohio canal, 2.1 km southeast of Great Falls, bornite, magnetite, malachite, azurite, chalcopyrite, and epidote (Ostrander and Price, 1940), and native copper (Tim Novak, oral communication, 1975) were found in pegmatites and quartz veins. (Loc. 26).

Dawsonville

1. Gold, as small flakes and nuggets up to wheat-grain size, has been panned from a small run leading north into Great Seneca Creek, 1.6 km west of Dawsonville (J.F. Windolph, Jr., oral communication, 1975). Magnetite octahedra up to 1 centimeter across also occur in the gravel here, which is derived from Triassic conglomerate. (Loc. 27).

2. Cinnabar has been reported from Seneca Creek between Dawsonville and Seneca (J.F. Windolph, Jr., oral communication, 1975). (Loc. 28).

3. Sugarland Copper Mine—This mine is located on the crest of a small ridge about 5.6 km southwest of Dawsonville (junction Routes 107 and 28), and 0.8 km east-southeast of Hughes Road at Sugarland Road, in gray to tan Triassic shale and sandstone. The mine reportedly operated around 1900. A large inclined tunnel was driven to the west from a ravine for about 20 meters, and it then turned north for about 65 meters (John F. Windolph, Jr., oral communication, 1975). The mine is now mostly caved in and grown over, in the middle of a large farm. Occasional coatings of malachite and azurite can still be found. Several small copper prospects are located on this same ridge north of Sugarland Road, and other showings of secondary copper minerals occur in the vicinity (John F. Windolph, Jr., oral communication, 1975) (see Plate 3). (Loc. 29).

Dickerson

Two large quarries, now long abandoned and water-filled, were opened in diabase on opposite banks of the Little Monocacy River, 0.8 km west-southwest of Dickerson. Specular hematite, prehnite, albite, chabazite, epidote, garnet, laumontite, calcite, and "stibnite" (probably a misprint for stilbite) were reported (Ostrander and Price, 1940). (Loc. 30).

Etchison

1. Etchison Mine—Green chromian varieties of muscovite, tourmaline, and margarite, as well as talc, serpentine, magnesite, chrome-spinel, and rutile occurred in serpentinite at the Etchison mine, about 1.6 km west of the Etchison post office (Shannon, 1924, 1926c; Pearre and Heyl, 1960). The mineralogy of this deposit was apparently quite interesting, but the mine has been totally covered over, and no specimens can be found. Shannon (1924) gives the composition of the green chromian margarite as:

Oxides	Wt. Percent
SiO_2	30.74
Al_2O_3	50.24
Cr_2O_3	0.72
CaO	10.68
MgO	2.70
H^2O + 110° C	4.90
Total	99.98

Optics: biaxial (-); 2V about 30°; r < v strong;
$\alpha = 1.625$, $\beta = 1.633$, $\gamma = 1.635$

Shannon (1926c) gives the composition of the chrome-spinel as:

Chromite	$FeO \cdot Cr_2O_3$	48.80%
Magnesioferrite	$MgO \cdot Fe_2O_3$	20.20
Spinel	$MgO \cdot Al_2O_3$	30.36
		99.36

(Loc. 31)

2. Lyde Griffith property—This chrome deposit was located about 0.8 km north of Etchison, and was noted in 1838 by J.T. Ducatel (Pearre and Heyl, 1960). The mineralogy of this deposit was not described, but was probably similar to that at the Etchison mine, as both are in the same serpentinite body. (Loc. 32).

3. Octahedral magnetite crystals up to 4 mm across in serpentinite occur in a roadcut on Rocky Road, 2.8 km southwest from the intersection of Maryland Route 108 and Damascus Road (A.J. Froelich, oral communication, 1976). (Loc. 33).

Gaithersburg

1. Native copper in subhedral masses to several centimeters across was found during excavations for a sewer line in about 1962, at the northeast corner of the intersection of Quince Orchard Road (Route 124) and Longdraft Road, at a depth of 5.6 meters. The copper occurred in a quartz-epidote vein that trended north-northwest along a ridge, in a diorite porphyry that is converted to talc-bearing schist along shear zones (J.F. Windolph, Jr., oral communication, 1975). Specular hematite, azurite, malachite, limonite, and

possibly cuprite were associated with the copper. (Loc. 34).

2. Magnetite octahedra to 1.3 cm across occur in blocks of serpentinite excavated during the construction of townhouses just east of Quince Orchard Road, 250 meters north of Maryland Route 28 (A.J. Froelich, oral communication, 1976). (Loc. 35).

Glen

Rutilated quartz crystals are occasionally found in stream gravel along Watts Branch, 350 meters upstream from its juncture with Piney Branch. On the adjacent hill to the north are found veins of light-blue quartz in gneiss. (Loc. 36).

Glen Echo

Gold, galena, chalcopyrite, pyrite, sphalerite, and doubly terminated quartz crystals have come from the vicinity of Glen Echo (Ostrander and Price, 1940). (Loc. 37).

Olney

An open pit in a large quartz vein, possibly a gold prospect, is located 1.4 km northeast of Olney (see Fig. 43). Small deep-red rutile crystals occur here, and much of the milky to transparent quartz is asteriated when polished. (Loc. 38).

Rockville

1. Excellent quartz crystals, up to ten centimeters long and some doubly terminated, have been found on the east side of Georgia Avenue (Route 97), opposite Connecticut Avenue and just north of a cemetery, in Aspen Hill. The quartz crystals were common as float, but could be traced easily to small quartz veins which cropped out on the surface. Many of the crystals are distinctly green from chlorite inclusions, and frequently display "phantom" crystals from these and also from clay inclusions. Unfortunately, many of the veins are now under a shopping center parking lot, but similar material possibly still exists in the nearby fields and woods. (Loc. 39).

2. Large quantities of schorl, and masses of pyrrhotite up to a meter across, were found at the Halpine quarry (now entirely filled in), at the intersection of Viers Mill Road and Rock Creek (J. Griesbach, oral communication, 1975). Minerals were found in gneiss and quartz veins. (Loc. 40).

3. Cubic limonite pseudomorphs after pyrite up to 2.5 cm across have been found in the fields surrounding Peary High School, located on Arctic Avenue opposite Arctic Court (J. Griesbach, oral communication, 1975). (Loc. 41).

4. Eighty-seven grams of gold were recovered from quartz veins during excavation for the house at 228 Falls Road (Route 189), 200 meters southwest of Route 28 (Frank W. Stevens, oral communication, 1975). (Loc. 42).

Seneca

Sulfur in limestone was reported from the Potomac River near Seneca

(Ostrander and Price, 1940). No limestone crops out around Seneca; however, some limestone conglomerate from further up the river could have washed downstream.

Silver Spring

1. A slightly waterworn single crystal of amethyst, labelled as coming from Burnt Mills, is in the Smithsonian mineral collection (NMNH-105792). Burnt Mills is the neighborhood between Four Corners and Whiteoak to the west of New Hampshire Avenue. The specimen most likely came from Northwest Branch, where other varieties of quartz crystals have been found in the stream gravel.
2. A small quarry existed at the end of Hermleigh Road, east of Kemp Mill Road, where garnet in schist and beryl in pegmatite were found (J. Griesbach, oral communication, 1975). Small piles of rock can still be seen in the woods here. (Loc. 43).
3. Rutile crystals, pyrite, and pseudomorphs of quartz after calcite crystals have been found in quartz veins in the Harmony Hills section, which is near the intersection of Georgia Avenue and Windy Lane (J. Griesbach, oral communication, 1975). (Loc. 44).
4. During excavations for the Blair Apartments, on East-West Highway in downtown Silver Spring, cubic pyrite crystals up to 15 centimeters across were found (J. Griesbach, oral communication, 1975). (Loc. 45).

Travilah

A small steatite prospect, containing talc, chlorite, magnetite crystals, and limonite pseudomorphs after pyrite, is located along a creek entering Muddy Branch from the north, 500 meters south of Turkeyfoot Road and 700 meters southwest of the intersection of Turkeyfoot Road and Jones Lane. (Loc. 46).

Whiteoak

1. At the intersection of Paint Branch and Old Columbia Pike are large blocks of pegmatite, gneiss, and migmatite that were brought up during excavations for the adjacent apartment buildings. During the excavations in 1969, superb large specimens of blue, botryoidal hyalite coatings were found, some over a meter across! The remaining hyalite has since weathered to a white color, and can be recognized by its green fluorescence in shortwave or longwave ultraviolet radiation. Other unusual minerals found here are (partially from Cordua, 1969): metatorbernite, uraninite (?), chalcopyrite, covellite (as thin blue coatings on chalcopyrite), malachite, azurite, columbite (?), and blue to gray apatite. The copper minerals often occurred as segregations in pegmatite. (Loc. 47).
2. Euhedral, generally unweathered almandine crystals up to 2 centimeters across are found in chlorite-rich schist along Paint Branch just downstream from the above-mentioned locality. Large plates of chlorite also are found here. (Loc. 48).

Wheeler Road Vivianite Locality
Oxon Hill, (Loc. 1)

Location

This site is in the upper half of a large, two-tier roadcut on the northeast side of Wheeler Road in Oxon Hill, 0.5 km from the District of Columbia line (see Fig. 45).

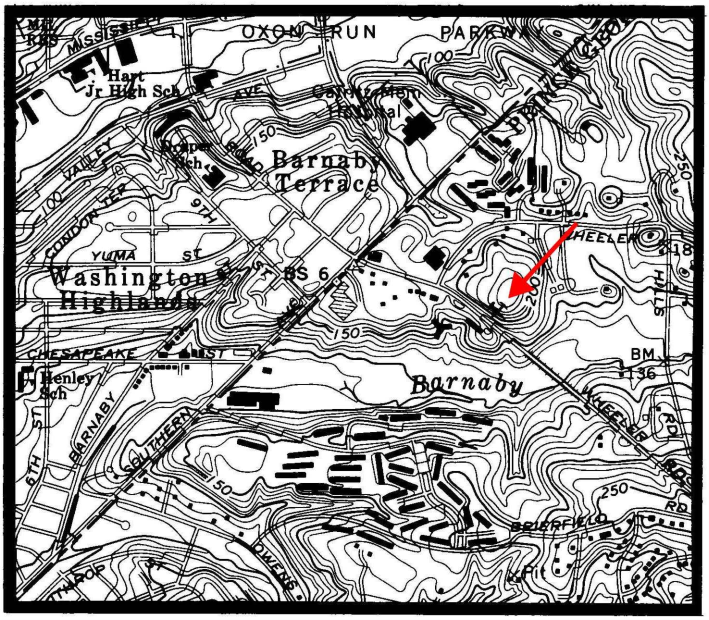

Figure 45: Location of the Wheeler Road vivianite locality, Oxon Hill, Maryland. (U.S. Geol. Survey Anacostia quadrangle, scale 1:24,000).

Description

This is the largest and most accessible vivianite occurrence in the Washington area, and vivianite nodules are found in abundance. The nodules occur directly beneath the unconformable contact of the Upper Cretaceous Severn Formation, a glauconitic gray-green clay, and the overlying Miocene Calvert Formation, here represented by limonite-rich argillaceous sand and gravel (see Fig. 46). The contact is highly fossiliferous, containing a jumbled mixture of Miocene and Upper Cretaceous forms. These include ammonites, nautiloids, molluscs, whale bone, possibly dinosaur bone, and shark teeth of both epochs. Such fossils are often concentrated in nodules of calcite-cemented sand, which probably represent filled depressions in a Miocene beach (Erle

Kauffman, oral communication, 1975). The bones themselves were almost certainly the primary source of the phosphate contained in the vivianite.

The vivianite nodules range from under 1 centimeter to over 30 centimeters across, the larger nodules generally consisting of a coalescence of smaller ones (see Fig. 47). Acicular vivianite crystals project radially towards the centers of the nodules, which are often hollow and contain euhedral crystal terminations. Some highly flattened nodules contained the largest crystals found to date. In these, the crystals are arranged radially inward within the plane of flattening, and reach 2 mm in width by nearly 2 cm in length. When fresh the vivianite is light green, but within a few days of exposure to air it becomes a deep blue, from oxidation of some of the ferrous iron. Much of the vivianite at this deposit has been further oxidized to brownish hydrous iron oxides.

Figure 46: View of vivianite occurrence on Wheeler Road, Oxon Hill, Maryland. Vivianite nodules occur below the fossiliferous contact of Miocene (M) and Cretaceous (K) sediments.

Tiny gypsum crystals, usually less than 1 millimeter in length, are occasionally seen in the vivianite nodules. Some small radiating yellow crystals observed in these nodules remain to be identified. It is quite possible that further investigation here will uncover a number of other minerals, particularly phosphates.

Minerals

Calcite—in fossils, and as cementing material in fossiliferous sandy nodules
Glauconite—dark-green micaceous grains in clay

Gypsum—tiny white crystals with vivianite
Limonite—brown, yellow, and orange encrustations and impregnations in clay, and as replacement of vivianite
Vivianite—light-green, oxidizing to blue, acicular crystals which radiate inward in nodules

Figure 47: Interior of a typical vivianite nodule from the Wheeler Road vivianite locality, Oxon Hill, Maryland. Specimen is 6 cm long.

Fort Washington Gypsum Locality
Fort Washington, (Loc. 2)

Location

To reach this locality, take Fort Washington Road southwest for 5.3 km from Indian Head Highway (Route 210) into Fort Washington Park. Turn onto the first road to the left (south) within the park, and follow this to the chain across the road and park. Walk past the chain and down the road for about 0.5 km, past some ruins, until you reach the large cliff overlooking Piscataway Creek (part of the Potomac estuary) (see Fig. 48). The gypsum crystals are found in the clays of this cliff, but as this is federal park property, collecting is generally not permitted.

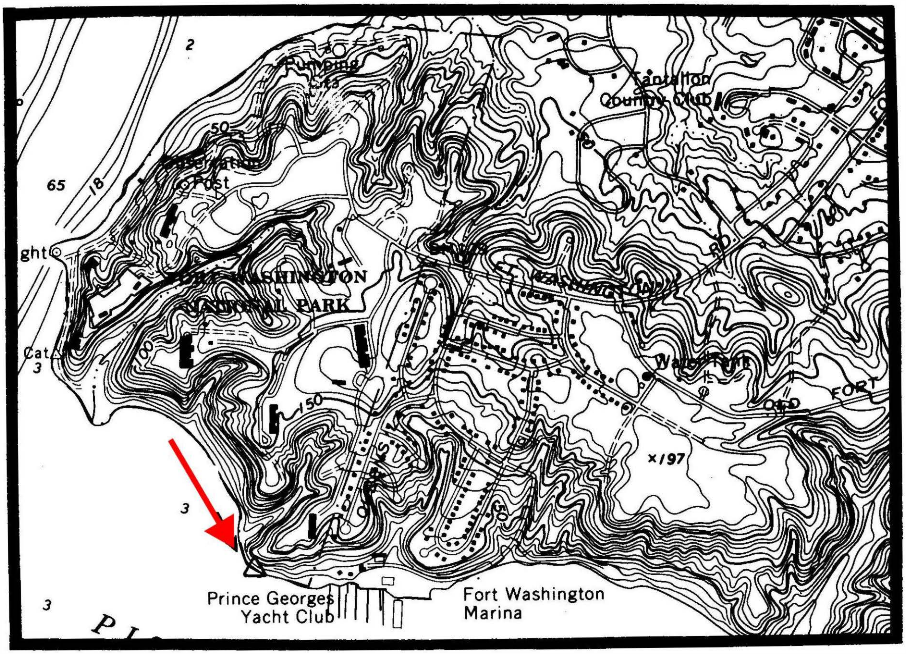

Figure 48: Location of the Fort Washington gypsum locality, Fort Washington, Maryland (U.S. Geol. Survey Mount Vernon quadrangle, scale 1:24,000).

Description

Gypsum crystals, displaying several different habits, occur abundantly in this outcrop of Cretaceous clay. The different habits of the gypsum are confined to particular zones within the clay, and these relations are summarized in the sketch of the outcrop (Fig. 51).

Although there is some gradation among these habits, they can generally be characterized as follows:

1. Small euhedral to subhedral rosettes: colorless, translucent rosettes, about 1-2 cm across.
2. Elongated crystals: colorless, transparent to translucent crystals, 1-4 cm long, 1-4 mm wide; elongated parallel to [101]; usually but not always in radiating groups.
3. Large euhedral crystals and rosettes: colorless, transparent single crystals 2-10 cm long, 0.5-2 cm wide; rosettes 2-10 cm across (see Fig. 49).
4. Subhedral to anhedral crystals: colorless to gray, translucent masses, less than 2 cm across.
5. Winglike rosettes: gray, translucent rosettes of flattened and curved crystals, colored by included gray clay, 3-15 cm across (see Fig. 50). These rosettes consist of several intergrown crystals, each with very large, rough, and concave (120) faces, large convex, and somewhat smoother (111) faces, and greatly subordinate (010) faces. These faces are all deeply striated parallel to [010], producing serrated edges and a winglike appearance. Additionally, most of the crystals are twinned on (100). Even the euhedral single crystals have rough and slightly concave (120) faces, and the winglike forms are extreme examples of this tendency.

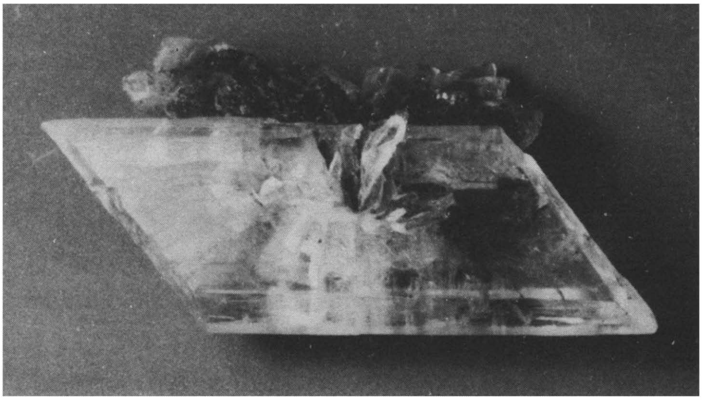

Figure 49: Single, euhedral gypsum crystal from Fort Washington, Maryland, about 4.5 cm long.

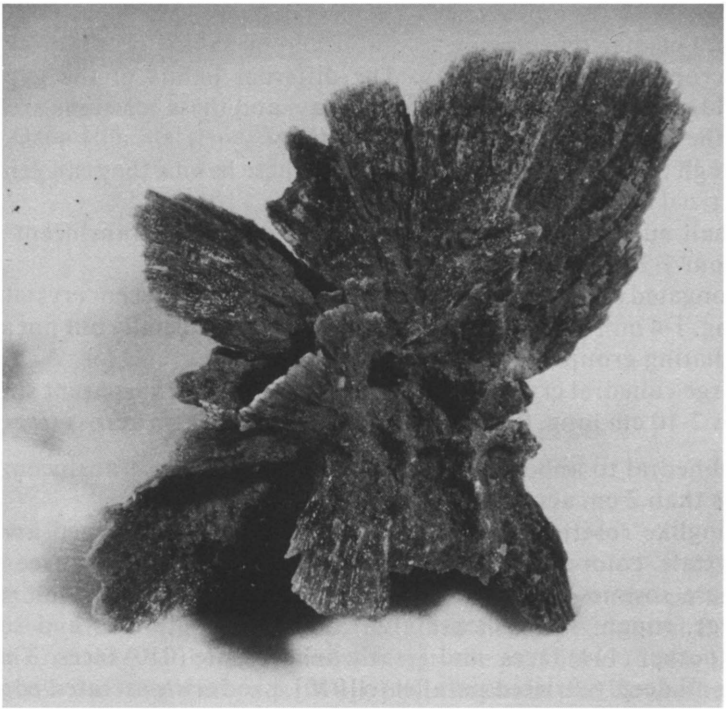

Figure 50: Winglike rosette habit of gypsum from Fort Washington, Maryland. Specimen is 11 cm in its greatest dimension.

In addition to gypsum, yellow jarosite and brown to orange limonite are fairly common, especially in the conglomerate and gray clay. Jarosite is commonly closely associated with the winglike gypsum rosettes.

Minerals

Gypsum—anhedral to euhedral transparent crystals, single and more commonly in rosettes; most abundant in thickest part of gray clay unit
Jarosite—yellow, earthy material in gray clay and conglomerate
Limonite—orange to brown cementing material in clay and conglomerate, commonly in small concretionary nodules.

Muirkirk Clay Pits
Muirkirk, (Loc. 3)

Location and History

These extensive clay pits are located to the north of Muirkirk Road, just east of its intersection with U.S. Route 1. A very active brick-making plant is currently operating at this site, and permission to enter the property must be secured from the office.

Mining in Muirkirk goes back to at least the early 1800's, though the product then was primarily iron ore rather than clay. An iron furnace was constructed here in 1847, at a site just across Muirkirk Road from the clay pits. Iron ore, mostly nodules and beds of siderite, limonite, and hematite, was brought in from numerous pits in the vicinity, one of which is indicated on Figure 52. The Muirkirk Furnace operated until about 1916 and was the last furnace to process Maryland iron ores. The iron it produced was reported to be of exceptionally high grade. The furnace, like other Maryland iron operations, eventually succumbed to higher production costs and the greatly reduced price of iron caused by the discovery of the Alabama and Lake Superior iron deposits. The Muirkirk mines were accorded some additional attention when several dinosaur bones were unearthed here during mining in the 1880's.

Description

The Muirkirk clay pits give an excellent exposure of a number of the mineralogical associations seen in the Coastal Plain deposits. The pits lie in clays with thin sandy beds of the Lower Cretaceous Potomac Group. Although the exposures are mostly of clays, several distinct mineral assemblages can be recognized.

Two types of concretionary iron deposits are found: siderite-limonite nodules and beds, and hematite nodules. The siderite-limonite nodules are light brown and often contain large amounts of sand and clay, giving them the popular name of "clay-ironstone." They often occur in lignite-rich areas of the clay, and the concretionary nodules commonly coalesce to produce solid layers up to a meter thick and of considerable areal extent. One large layer

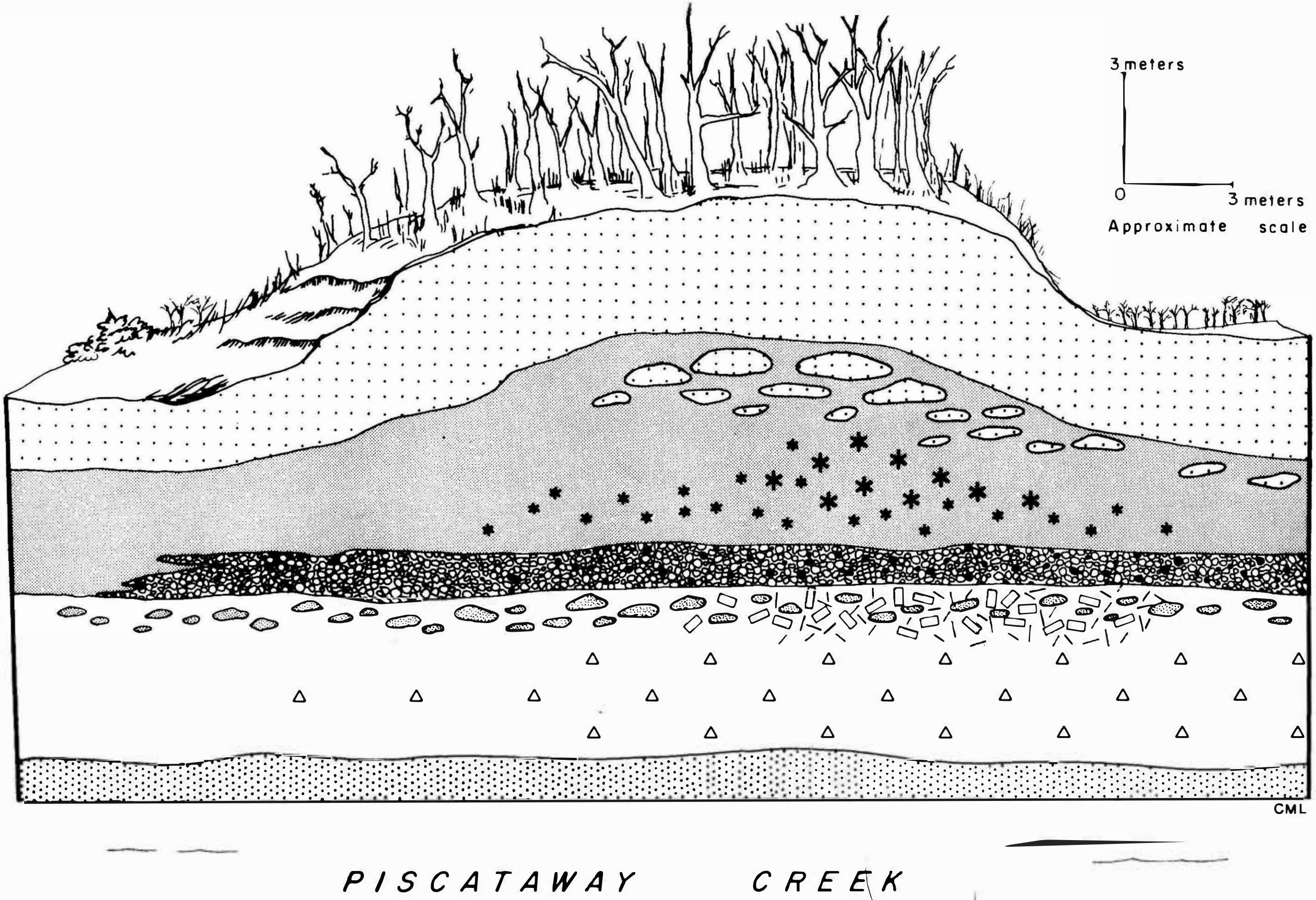

Figure 51: Schematic view of the gypsum-bearing cliffs along Piscataway Creek at Fort Washington, Maryland.

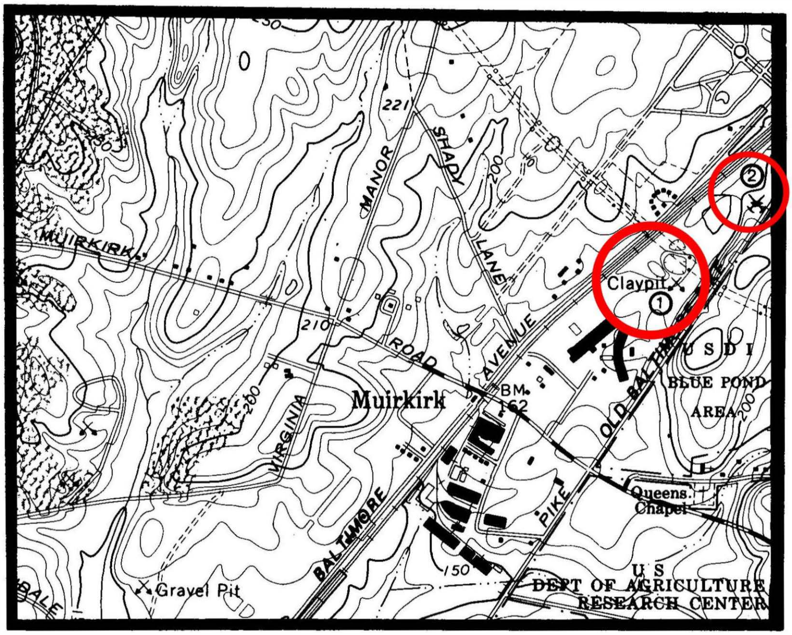

Figure 52: Location of the Muirkirk clay pits. (1) clay pits; (2) site of an old iron pit. (U.S. Geol. Survey Beltsville quadrangle, scale 1:24,000).

FIGURE 51: EXPLANATION

Beach sand.

Gray to orange sand.

Gray glauconitic clay.

Quartz conglomerate, limonite cemented, clasts 1-5 cm across.

Mottled white and red clay, with quartz pebbles and limonite nodules.

Gypsum habits (see text)

1. Small euhedral to subhedral rosettes.
2. Elongated crystals.
3. Euhedral crystals.
4. Anhedral to subhedral masses.
5. Winglike rosettes. Relative sizes are indicated.

was found to occur at the boundary of gray clay and underlying fine sand. More limonite-rich nodules are orange to yellow and are frequently ocherous.

The hematite is black to bright red (a black coating is almost always present on surfaces) and tends to occur in gray clay as discrete nodules, up to at least 30 centimeters across. The hematite nodules are not as abundant or as widespread as are those of siderite.

Marcasite is common as crystals and masses within and replacing lignitized wood. The marcasite tends to oxidize and crumble when exposed to air, forming melanterite and other iron sulfates as well as sulfuric acid. Specimens of the marcasite can be preserved in a sealed glass or plastic container.

Small subhedral gypsum crystals occur in narrow zones in white to gray clay. The crystals found at this locality are small and poorly formed, but better specimens may turn up as new areas are exposed.

Vivianite, although not previously reported here, can be expected, especially near fossil bones. The clay pits are gradually encroaching on the sites of the old iron pits where dinosaur bones were once found, so the outlook for further mineral and fossil discoveries is quite good.

Minerals

Gypsum—subhedral, colorless masses under 3 cm, in narrow zones in white to gray clay

Hematite—red to black, forming nodules with dark gray coating

Limonite—with siderite in nodules, and as cementing material in some sandy layers; sometimes ocherous

Marcasite—massive and in well-formed crystals; in and replacing lignitized wood; decomposes upon exposure to air

Siderite—tan to orange (from admixed limonite), massive, forming concretionary nodules and beds; usually contains considerable sand and clay

Other Localities

Bladensburg

At the eastern end of Jackson Street, near the intersection of Kenilworth Avenue and the Baltimore-Washington Parkway, is a large exposure of Coastal Plain sediments, mostly in the Patapsco Formation. Siderite-limonite nodules are abundant, and silicified wood and marcasite in lignitized wood also occur here (Loc. 4).

Brentwood

Quartz crystals in silicified wood have come from the area behind the Dieners warehouse, one block east of Rhode Island Avenue at Volta Street (J. Griesbach, oral communication, 1975). (Loc. 5).

Fort Foote

Abundant gypsum crystals were found during road construction in the vicinity of River Bend Road, about 4.8 km southwest of Oxon Hill, from 1958 to about 1961 (Swift, 1961; K.A. Funkhouser, oral communication, 1975). Many crystals were euhedral and transparent, with single crystals up to over 15 centimeters long, and rosettes up to 10 centimeters across. The crystals occurred in a narrow zone approximately in the center of a 30 meter section of gray-brown clay of the Patapsco Formation, very similar to the occurrence at Fort Washington, about 8 km to the south. Basaluminite, as earthy white subhedral patches averaging 3 millimeters across (possibly pseudomorphous after hydrobasaluminite) and as yellow, porous zones in the clay was also quite common (Mitchell, 1970). (Loc. 6).

Greenbelt

1. Concretionary limonite nodules containing lipscombite, rockbridgeite, and other rare phosphate minerals were found during excavations for the now abandoned WWV radio transmitter in the 1940's, on NASA property about 350 meters west of the intersection of Greenbelt and Soil Conservation Service Roads. These nodules ranged up to at least 30 centimeters across, and occurred in an orange sandy clay. The phosphate minerals, predominantly green lipscombite and rockbridgeite, generally occur towards the centers of the nodules, and sometimes form boxwork veins in cavities (Fig. 53). Mary E. Mrose, of the U.S. Geological Survey, has found the dark-green material to be lipscombite mixed with, and sometimes apparently altered to, yellow-green rockbridgeite. She also reports light-pink crusts of phosphosiderite, and small amounts of strengite, cacoxenite, strunzite (?), and azovskite (?) (M.E. Mrose, oral communication, 1975). Although careful searching over a number of years has failed to reveal additional localities for similar nodules in this area, more may yet turn up in future excavations as the area is further developed. (Loc. 7).

2. Botryoidal and stalactitic masses of limonite and goethite are found in the large embankments at the Greenbelt Shopping Center on Greenbelt Road near Kenilworth Avenue. (Loc. 8).

Lanham

A specimen of goethite from a construction site in Seabrook Park is in the Smithsonian collection (NMNH-117600). (Loc. 9).

New Carrollton

Colorless to milky quartz crystals up to several centimeters long and sometimes doubly terminated have been found in soil near Fairborn Terrace. (Loc. 10).

Figure 53: Cross section of a phosphate nodule from the former WWV antenna site, Greenbelt, Maryland. Dark gray (dark green) is mostly lipscombite, light gray (light green) is mostly rockbridgeite, and white (light pink) is phosphosiderite. Specimen is about 9 cm long (NMNH 102572).

VIRGINIA

ARLINGTON COUNTY

Arlington

1. Molybdenite and schorl have been found in quartz veins at the junction of Windy Run and the Potomac River, near the end of Filmore Street (S. Silsby, oral communication, 1975). (Loc. 1).
2. Near the intersection of South Walter Reed Drive and Fourmile Run, marcasite crystals in lignitized wood are abundant in a glauconitic sand. (Loc. 2).
3. Agate, jasper, smoky quartz, and amethyst have been found in gravel along Long Branch and in Fourmile Run southeast of Long Branch (S. Silsby, oral communication, 1975). (Loc. 3).
4. Amethyst in loose crystals and in an exposed quartz vein (A. Bonnano, oral communication, 1974) has been found near Pimmit Run at Chain Bridge. Other minerals in schist and quartz veins from near Chain Bridge are kyanite, ilmenite, chlorite, pyrite, limonite replacing pyrite, staurolite (Ulke, 1936), and orthoclase crystals and chalcopyrite (NMNH-DC). A 28-gram gold nugget was reportedly found wedged in a crack in a boulder, in Pimmit Run near Route 123, following a tropical storm in 1971 (Scott Silsby, oral communication, 1975). (Loc. 4).
5. Bladed actinolite crystals are present in massive and foliated steatite on the south bank of Fourmile Run, just upstream from McKinley Road. (Loc. 5).
6. Smoky quartz crystals have been found near the intersection of 24th and North Quincy Streets (Dietrich, 1970). (Loc. 6).
7. Jasper has been found along the banks of Spout Run near Kirkwood Road (Dietrich, 1970). (Loc. 7).
8. Garnet, limonite after pyrite, tourmaline, and smoky quartz crystals are reported to occur on the grounds of Stratford Junior High School, near Old Dominion Drive and Military Road (Dietrich, 1970). (Loc. 8)
9. Galena and garnet are reported from "the Old Dominion Railway cut near North Adam Street" (Dietrich, 1970).
10. Blue quartz, some of which is asteriated, occurs in the gravels of Doctors Run and Fourmile Run south of Columbia Pike (Dietrich, 1970). (Loc. 9).

FAIRFAX COUNTY

(Also see Diabase Quarries of Northern Virginia, p. 121)

Theodora Copper Mine
Herndon (Loc. 1)

Location and History

This mine is reached by taking Copper Mine Road (Route 665) west for 0.8 km from Centreville Road (Route 657) in Herndon. Here a small dirt road leads southwest for about 150 meters through a field to a small patch of trees. The remains of the mine dumps are found adjacent to the dirt road near these trees, and some pits and slag heaps are located in the woods about 50 meters to the west (Fig. 54).

The mine was apparently opened in 1880 (Hotchkiss, 1880) and a smelter was erected on the site. The mine was operated for a very short time, however, and no reference to it can be found after the 1880 article. This article reported a "rich vein of silver"; however, this may have been just specular hematite. Today, the very small dumps are probably the best places in the Washington area to collect chrysocolla and the rare mineral libethenite. This is currently private farmland, and permission must be secured before entering it.

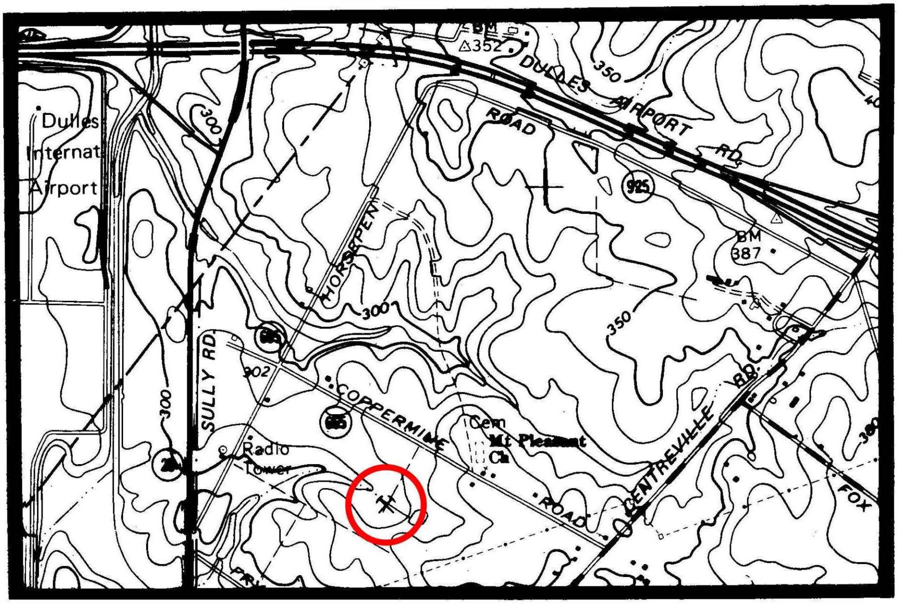

Figure 54: Location of the Theodora copper mine, Herndon, Virginia. (U.S. Geol. Survey Herndon quadrangle, scale 1:24,000).

Description

The Theodora copper mine is situated in a zone of contact metamorphosed, or "baked," shale and sandstone adjacent to a diabase intrusive. Near the contact the country rock is a tan to gray, fine-grained, hard rock known as hornfels. This grades into the reddish shale and sandstone typical of the area. The diabase itself may be seen in the dirt road leading to the mine. In some places disseminated epidote imparts a greenish color to the baked sandstone, while in other places the epidote forms abundant fine-grained lenses and spheroids up to about 2 centimeters across, which give the rock an unusual amygdaloidal-appearing texture. These spheroids are often hollow and are then lined with tiny epidote crystals. Similar spheroids are sometimes found that consist of specular hematite.

The shale and sandstone are commonly impregnated with secondary copper minerals, predominantly malachite and chrysocolla. In places, the copper-bearing solutions preferentially replaced the more feldspathic layers in the sandstone, producing a layered green and tan rock. Fracture surfaces often produce good specimens of chrysocolla and malachite, and sometimes of azurite. The relatively rare copper phosphate libethenite is also found here, as druses of tiny dark-green crystals in cavities in the baked sandstone. Under 10X magnification, the multitude of triangular faces seen on these crystals helps to distinguish them from other similar-appearing copper minerals and epidote. Pseudomalachite, another copper phosphate, is found as dark-green botryoidal crusts.

Specular hematite is quite abundant, ranging from large masses of fine-grained material, to dispersed single crystals. Well-formed crystals are found in vugs and fractures, often associated with copper minerals or epidote. Hematite is also probably the main coloring agent for the red shale and sandstone of the area.

Minerals

Azurite—blue fracture fillings
Chrysocolla—waxy, blue-green to green fracture fillings and impregnations, sometimes botryoidal
Epidote—commonly disseminated; also in lenticular to spheroidal aggregates and as tiny euhedral crystals in cavities
Hematite—specular, often massive, sometimes in platy crystals up to over one centimeter across
Libethenite—druses of tiny dark-green crystals in small cavities
Malachite—green fracture fillings, often fibrous, occasionally botryoidal
Pseudomalachite—green botryoidal crusts with fairly high luster
Quartz—occasional drusy crystals on chrysocolla or malachite

Other Localities
(Also see Plate 3)

Annandale

Amethyst crystals have been found in Holmes Run, near the end of Valleycrest Boulevard (S. Silsby, oral communication, 1975). (Loc. 3).

Bull Run

Several gold flakes were panned from stream gravel in Bull Run, about 2.4 km southeast of U.S. Route 29/211, and about 300 meters south of U.S. Route 66 (NMNH-105364). (Loc. 4).

Centreville

1. Sissler's Quarry—Anthophyllite asbestos with fibers to at least 30 centimeters long (Dietrich, 1970) occurred in this abandoned and much overgrown quarry. The quarry is located about 2.4 km east of Centreville (intersection of Route 620 and U.S. Route 29/211), and about 200 meters south of Route 29/211. (Loc. 5).

2. Amethyst has been reported from the "vicinity of Centreville" (Dietrich, 1970).

Chantilly

1. Malachite, and a smaller amount of azurite, were found in a pipeline excavation in Triassic shale and sandstone just southeast of Tabscott Road, about 1 km south of U.S. Route 50 (D'Agostino and Hanshaw, 1970). Traces of barite, pyrite, and chalcopyrite also were noted. The malachite, azurite, and barite were concentrated with carbonized plant fossils. Spectrographic analysis detected up to 20,000 parts per million (ppm) copper, 1000 ppm manganese, 1000 ppm barium, 500 ppm zirconium, 200 ppm vanadium, 100 ppm strontium, 100 ppm lanthanum, 50 ppm silver, and 30 ppm nickel; fire assay detected up to 0.09 ppm gold (D'Agostino and Hanshaw, 1970). (Loc. 6).

2. Specular hematite with small amounts of malachite in baked and occasionally silicified Triassic shale occurred in excavations about 3.2 km to the southeast of the above-mentioned locality (D'Agostino and Hanshaw, 1970). (Loc. 8).

Several other similar copper and hematite localities are in this vicinity, including the Chantilly copper prospect (Loc. 7). These are indicated on the map of mineral deposits in Triassic rocks (Plate 3).

Dranesville

Chromite in serpentinite has been reported from the vicinity of Dranesville, near the Potomac River (Schlagel, 1957).

Fairfax

Cabochons of jasper (NMNH G-3270), white chalcedony (NMNH G-804), smoky quartz (NMNH G-1341), and colorless quartz with dark inclusions (NMNH G-1449), labelled as coming from "Fairfax Courthouse," are in the gem collection of the Smithsonian.

Falls Church

1. Blue quartz, some asteriated, occurs in the gravels of Tripps Run in Falls Church and Jefferson Village (Dietrich, 1970). (Loc. 9).

2. A specimen of psilomelane from Timber Lane 200 meters north of West Street is in the Smithsonian collections (NMNH-105923). (Loc. 10).

Great Falls

1. Magnetite and large plates of chlorite are found in an abandoned quarry in serpentinite, about 200 meters southeast of the intersection of Leigh Mill Road (Route 683) and Hickory Run Lane, 1 km south of the junction of Routes 683 and 193 (Old Georgetown Pike). (Loc. 11).

2. A specimen of cubic pyrite crystals in quartz from Great Falls is in the Smithsonian collections (NMNH-DC).

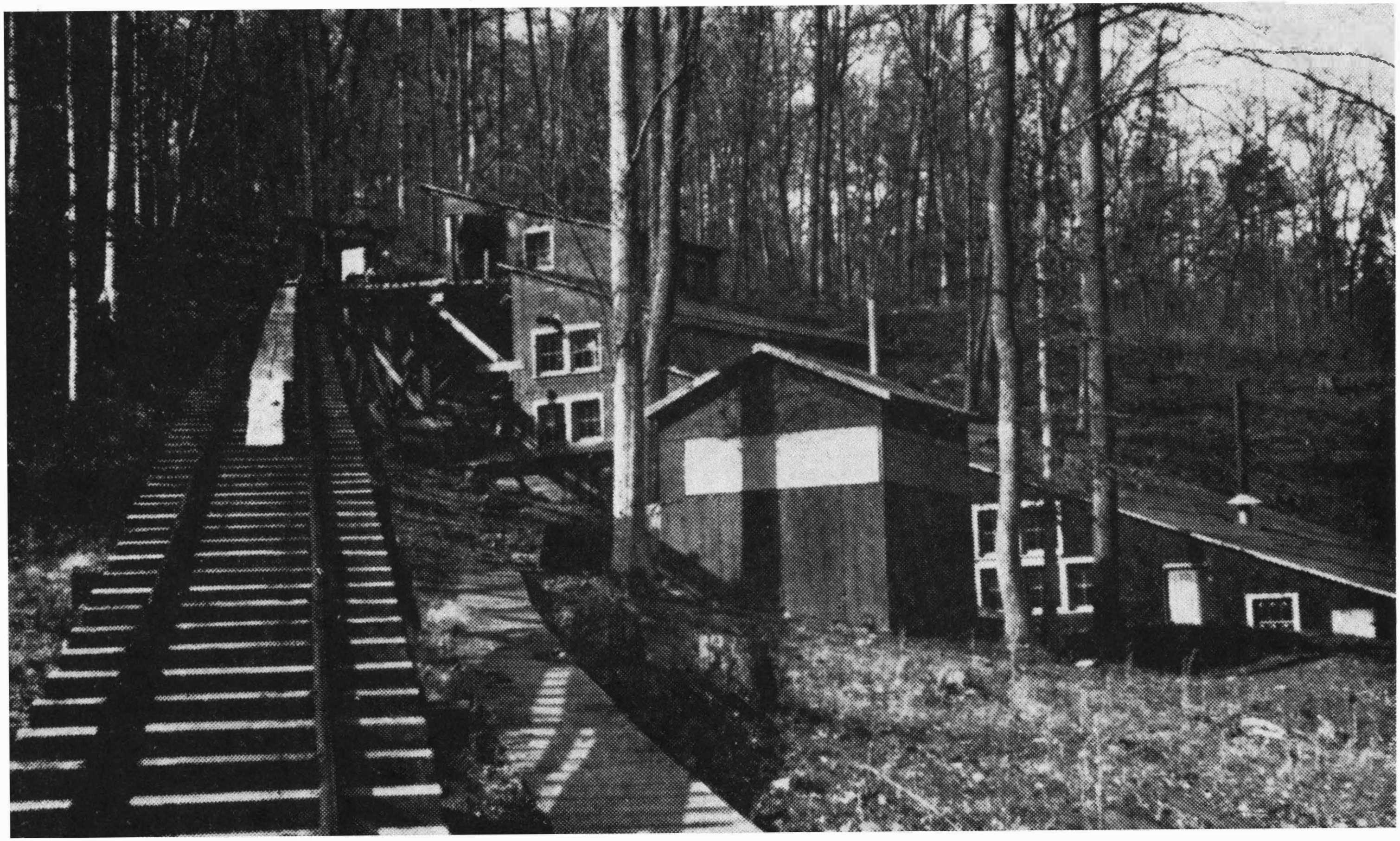

Figure 55: Mill and offices of the Kirk gold mine, McLean, Virginia, in 1939. Photograph courtesy of Bryan Eagle.

Langley

1. Foliated steatite occurs in a ravine in the Turkey Run recreation area, north of the George Washington Parkway and across the Potomac River from Glen Echo, Maryland. Chlorite, limonite after pyrite, and magnetite occur in this rock. A large steatite quarry was operated here at one time (Darton et al., 1900). (Loc. 12).

2. Thin crusts of sulfur crystals, resulting from the decomposition of pyrite, with pyrite cubes to 2.5 centimeters across and limonite replacing pyrite, were found in white quartzite at an unidentified quarry near Langley (Ulke, 1948; NMNH-114213).

Lorton

Pyrite, chlorite, and small quartz crystals are found in foliated Occoquan adamellite, exposed in the large quarries just across the Occoquan River from Occoquan. (Loc. 13).

McLean

1. Kirk Gold Mine (Bullneck Mine)—This abandoned lode mine and placer working are located on both sides of Bullneck Run, 700 meters north of Route 193 (Old Georgetown Pike), about 300 meters south of the Potomac River. The deposit was first worked as a hydraulic placer operation sometime after 1890 by William Kirk, and some large gold nuggets were found (Ulke, 1939). Gold was later mined from pyrite-bearing quartz veins, very similar to those across the Potomac River in Maryland (see p. 81). A 23-meter shaft, with narrow-gauge tracks leading to a crusher and concentration plant, was operated from 1936 to 1937 (Ulke, 1937; Ulke, 1939) (Fig. 55). Galena, chalcopyrite, and bornite were reported from the quartz; and chlorite, sericite, and talc came from the surrounding schist. Foundations of the old buildings and remains of the shafts and dumps can still be seen, and small gold flakes and nuggets can still be panned from Bullneck Run. All this land is property of nearby homeowners, and permission must be obtained before entering it. (Loc. 14).

2. Difficult Run Exposure—Large amounts of Wissahickon schist, gneiss, and amphibolite, containing veins of quartz, pegmatite, and granitic rock, are exposed along Difficult Run, about 0.5 km east of Old Georgetown Pike (Route 193). Small epidote crystals occur in altered fractures in the gneiss and amphibolite; sharp magnetite octahedra up to 4 millimeters across and small quartz crystals occur in cavities in the quartz veins; and masses of dark-green apatite that fluoresce yellow in ultraviolet radiation are found in the pegmatite. (Loc. 15).

Reston

Jenkins Farm Prospects—Several copper and steatite prospects are located on a hill just southwest of Piney Run, 1.1 km west of the junction of Routes 7 and 606, and about 300 meters southwest of Route 7 (Fig. 56). These prospects or small mines, which according to local residents were opened during

Figure 56: The Jenkins Farm prospects, looking southwest from near Virginia Route 7. The depressions to the right of the road are the prospects; the closer pits contain mostly steatite, while the more distant pits contain copper minerals.

the Civil War, contain serpentinite and massive to slightly foliated steatite. Malachite occurs in the serpentinite, sometimes in thick, radially fibrous masses. The serpentinite also contains chlorite, fibrous white to green tremolite-actinolite, and small veins of chrysotile asbestos. The steatite is fine-grained, and consists of talc with subordinate chlorite and magnetite. (Loc. 16).

Nonspecific Localities

1. A deeply weathered, rust-colored carbonaceous schist containing andalusite (variety chiastolite), reportedly occurs in a narrow belt west of Fairfax and Vienna (Johnston, 1962). This belt is said to trend northeastward, varying from about 15 to 100 meters in width, occurring near the western border of a belt of amphibolites and metavolcanics. The andalusite crystals, reportedly 0.3 to 2.5 centimeters wide and 1 to 5 centimeters long, are often altered to sericite (Johnston, 1962). Johnston (1962) also reports that kyanite occasionally occurs in this rock.

2. Black tarlike crusts and botryoidal masses of lithiophorite are found abundantly in fractured quartz veins and in soil in the vicinity of Fairfax and Falls Church, especially around Pender (Milton, 1958; Cosminsky, 1949).

3. Sillimanite needles up to 2.5 centimeters long, often in fan or sheaflike aggregates, constitute up to 20 percent of some of the schists along the Potomac River between Great Falls and Turkey Island (Reed and Jolly, 1963).

4. Talc mines and steatite (soapstone) quarries were located: 2.0 km east of Annandale; 3.4 km east of Tenley; 4.8 km east of Falls Church; and near Wiehle Station on the Bluemont Branch of the Southern Railroad (Morrill, 1972).

5. Specimens of sharp magnetite octahedra to 5 millimeters across in chlorite schist (NMNH-82730) and of gold and pyrite in quartz (NMNH-82728) from Pimmit Run are in the Smithsonian collections.

6. A specimen of gold with galena in quartz, from an unlocated area called "Mineral Ridge" in Fairfax County, is in the Smithsonian collections (NMNH-10832).

FAUQUIER COUNTY

Barite Mines Near Catlett
Introduction

Veins of white, tabular barite such as those found near Catlett, are characteristic of the Triassic deposits throughout the eastern United States. The two barite mines in the Catlett region that were visited by the author display substantially different geological environments, one being in diabase and the other in an apparent fault zone in shale.

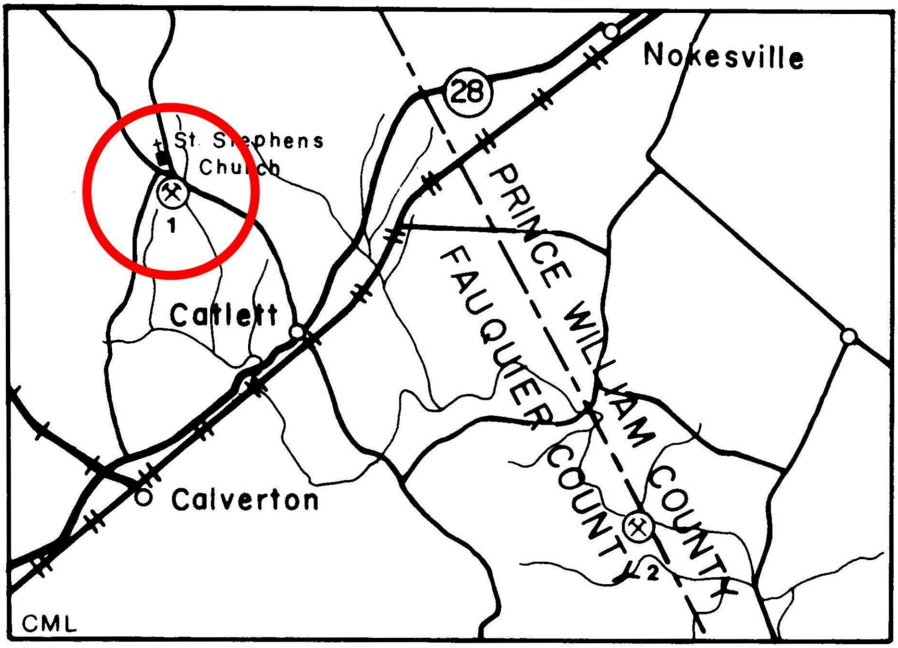

Figure 57: Locations of barite mines near Catlett, Virginia. Scale 1:125,000.

Saint Stephen's Mine
Catlett, (Loc. 1)

Location and History

This mine is located about 3.2 km northwest of Catlett and 300 meters southwest of Saint Stephen's Church (intersection of Routes 667 and 603). It is most easily reached by going to the first farmhouse south of Route 667 on the east side of Route 603, and then taking a path to the northwest for several hundred meters (see Fig. 57). The mine workings are near the end of this path, mostly on the north side of it.

The mine was reportedly operated for a short time just after the Civil War, and produced about 2 x 10^6 kg (2,200 short tons) of barite (Edmondson, 1938).

Description

Abandoned for over a hundred years, this mine is now discernible from the surrounding woods only with considerable difficulty. Numerous pits and trenches trending northwestward can still be observed on the crest of the hill, amid small overgrown dump piles. The series of pits reportedly extended for about 400 meters (Edmondson, 1938).

The barite occurs as fracture fillings in a large diabase dike, in an environment similar to the barite veins of the Connecticut River Valley. It forms subradial to subparallel aggregates of white, opaque, tabular crystals with dimensions in the order of several centimeters. Small cavities are fairly common within the intergrown plates of barite and contain euhedral tabular barite crystals, though rarely of great size. No other minerals were observed with the barite.

Cedar Run Mine
Catlett, (Loc. 2)

Location and History

To reach this mine, take Route 806 for about 4.8 km southeast from Catlett, turn left (east) on Route 640, and follow this for about 3.2 km to the farm at the end. The largest mine pit, roughly circular and about fifty meters in diameter, is now a small swampy pond. It is about 100 meters behind (east of) the barns on the farm. Small trenches are found in the nearby fields and woods, and reportedly extended to the other side of Cedar Run, in Prince William County (Luttrell, 1966). Pieces of ore and country rock can still be found scattered through the fields and in the dirt roads.

The Cedar Run mine operated intermittently from 1845 to 1903. It was the first barite mine in Virginia, and probably in the United States, producing several thousand tons of barite (Edmondson, 1938). Edmondson (1938) indicates that there was originally an 80 meter long inclined tunnel, as well as several trenches and vertical shafts. Roberts (1928) (who, unfortunately, called this mine the Saint Stephen's mine) reported that in 1903 there were three shafts on the property, the deepest being about 30 meters. He also reported that the mine followed fissures containing pure barite that varied irregularly from 0.6 to 2.6 meters in width. Much good ore remained when the mine closed in 1903, but problems with ground water and with occasional flooding from Cedar Run could not be overcome profitably.

Description

This mine was operated along zones of brecciated red shale and gray calcareous shale in the eastern part of the Triassic basin. The barite occurs mostly as coarse tabular white aggregates in fractures in the brecciated shale, along with coarse-grained calcite and lesser amounts of fine-grained quartz. Some of the barite occurs as narrow veins of fine-grained, layered material that crosscut the tabular barite. Euhedral barite crystals are not common, although fine crystals have been reported (Morrill, 1972).

Where cross sections of veins could be seen, in large rock fragments in the soil, it could be observed that the barite apparently crystallized earlier than some calcite; and much of the barite is brecciated and recemented by the calcite. In such breccia, fragments of barite have corroded edges and are surrounded by selvages of fine-grained calcite. Due to the lack of exposures and the paucity of samples, a complete paragenetic sequence could not be constructed, but the following major stages in the formation of the ore can be tentatively assigned:

1. Brecciation of shale, cementation by very fine-grained calcite
2. Crystallization of coarse, tabular barite in fissures
3. Crystallization of fine-grained, layered barite
4. Further brecciation of shale and of barite veins
5. Crystallization of calcite and small amounts of fine-grained quartz, and replacement of some barite

The evidence tends to indicate crystallization within a fault zone. Although the fragmental and chaotic nature of the shale could be ascribed to original conditions of deposition, the clearly brecciated condition of the barite almost certainly indicates some shearing movement. The origin of the barium-bearing solutions is unclear; they may have been derived from percolating ground water, from water heated by nearby diabase intrusions, from the diabase intrusions themselves, or from any combination of these sources. Although no diabase was observed around the mine, a very large dike is exposed about 2 kilometers to the west, and more may occur at depth.

Minerals

Barite—coarse, tabular, white intergrown crystals; lesser fine-grained, layered material; euhedral tabular crystals in vugs

Calcite—very fine grained as cementing material in brecciated shale; colorless, finely to coarsely crystalline in barite veins; scalenohedral crystals up to 1 cm common in cavities

Chalcopyrite—rare grains in barite

Galena—rare grains in barite

Malachite—uncommon green stains on barite

Pyrite—cubic crystals reported from shale (Roberts, 1928)

Quartz—colorless seams less than 3 mm wide in tabular barite; occasional drusy crystals in cavities with etched calcite and barite

LOUDOUN COUNTY

(Also see: Diabase quarries of northern Virginia, p. 121, and Plate 3)

Aldie

Allanite is a possible constituent of an epidotized granite located 4.8 km west of Aldie; the granite contains quartz, plagioclase, orthoclase, biotite, chlorite, and magnetite (Mitchell, 1966).

Belmont

1. State Roads quarry (pyroclastics quarry)—A small quarry, now filled in, was located 5.6 km southeast of Leesburg, just west of Goose Creek, and about 200 meters north of Route 7. It was located in a sequence of pyroclastic rocks and thin basalt flows that contained plagioclase, pyroxene, epidote, calcite, quartz, biotite, zircon, rutile, chlorite, amphibole, prehnite, chalcopyrite, hematite, pyrolusite, malachite, chabazite, heulandite, and stilbite (Toewe, 1966; Bruce Maier, oral communication, 1975). Small crystals of most of these minerals were found in amygdules. A stratigraphic section of this quarry is given by Toewe (1966). (Loc. 7).
2. Goose Creek copper mines (including Eagle mine, Alice ledge, Peacock ledge, and S.W. ridge)—In 1883, the Eagle Mining Company sank a number of shafts and tunnels just west of Goose Creek, about 2.4 km south of the Potomac River, in what they called "the richest carbonate ore in this or any other country, showing by actual and reliable tests from 20 to 80 per cent in copper and 20 ounces of silver to the ton" (Hotchkiss, 1884). Although this report is undoubtedly exaggerated, copper minerals do in fact occur in the baked shale and sandstone here. In the 1960s, some exploratory work for copper, silver and nickel was done at this location (J.F. Windolph, Jr., oral communication, 1975). The author came across a group of small barite pits in this immediate vicinity (see Plate 3.) (Loc. 8).

Conklin

Jasper and moss agate were found at the "Bull Run talc quarry," reportedly 5.6 km from Centreville on Route 659 (Morrill, 1972).

Evergreen Mills

1. The roadcuts at the intersection of Routes 621 and 625, just south of Goose Creek, provide an excellent exposure of contact metamorphosed Triassic shale, sandstone, calcareous conglomerate, and pyroclastics. In narrow zones within the conglomerate are found amethystine quartz, small green garnet crystals, specular hematite, chalcopyrite, bornite, malachite, calcite crystals, and epidote. Fire assay and quantitative spectrographic analysis detected up to 0.01 ppm platinum and 0.011 ppm palladium from coarse-grained diabase near this locality (James P. Minard, oral communication, 1976). (Loc. 9)
2. Datolite and prehnite were found in a drill core 0.8 km east of Evergreen Mills (Dietrich, 1970).

Furnace Mountain
Iron mines (Loc. 10)—see p. 49

Figure 58: Water-filled Leesburg Lime Co., Inc. quarry, Leesburg, Virginia.

Leesburg

Leesburg Lime Company, Inc. quarry (Loc. 11) and White quarry (Loc. 12)—These quarries were opened in contact metamorphosed and partially silicified limestone conglomerate in the southern part of Leesburg, north of the railroad tracks near the end of Harrison Street. The White quarry was opened in 1884, but was apparently abandoned shortly thereafter; while the larger Leesburg Lime Company, Inc. quarry (Fig. 58), just to the northwest of the White quarry, was opened in 1888 and operated until 1945 (Toewe, 1966). The White quarry has been covered over and the Leesburg Lime Company, Inc. quarry is water filled, but some of the tailings remain around their perimeters. Diabase was reported at the bottom of both workings (Shannon, 1926b). The paper by Shannon (1926b) gives a very complete descrioption of the Leesburg Lime Company quarry, and the following description is based mostly on this article.

Large amounts of a fine-grained, greenish-gray rock are present, consisting mostly of diopside and massive garnet (dominantly andradite), with tiny grains of magnetite, idocrase, serpentine, and possibly colerainite. Xonotlite occurs as round, densely fibrous patches up to 6 centimeters in diameter, and as veins of radiating acicular crystals up to about 5 millimeters wide with wollastonite and possibly thaumasite. The xonotlite is light pink and translucent when fresh, but becomes opaque, white, and almost chalky upon exposure to air.

Hydrothermally derived veins, averaging 2 centimeters wide but occasionally broadening to 8 centimeters, cut this rock. These consist predominantly of datolite and/or calcite, with occasional barite and minute bladed white crystals of a mineral thought to be diopside. Cavities, which occur in the wider portions of these veins, contain well formed datolite and calcite crystals, tabular white barite crystals up to 3 centimeters across, and rare bipyramidal crystals of apophyllite. Tabular empty cavities, probably derived from the dissolution of preexisting anhydrite, are rather common in the datolite.

Mountville

1. Loudoun Marble Company quarry—This quarry, now water-filled, is located 2.6 km east of the junction of Routes 733 and 734, just south of Goose Creek and Route 733. It was opened in a small lens of marble containing zones of serpentinite, possibly near a contact with basalt (Parker, 1968). Minerals reported are: magnetite in veins and in crystals up to 5 centimeters across, radiating greenish tremolite-actinolite, serpentine, clinochlore crystals, epidote, fluorite, diopside, talc, titanite, andradite, and grossular (Dietrich, 1970; Smithsonian specimens). Limonite pseudomorphs after pyrite have been found in the surrounding soil (Dietrich, 1970). (Loc. 13).

2. Goose Creek Lime Company quarries—These water-filled quarries are about 1 km north-northeast of the Loudoun Marble Company quarry, about 200 meters north of Route 733. They were opened in a similar marble lens, and apparently contained a similar suite of minerals (Parker, 1968). Large quartz crystals have been found in the soil just north of the pits (Silsby, oral communication, 1975). (Loc. 14).

Oatlands

1. Veasco Quarry (Vesco Stone Corporation Quarry)—This quarry is located about 1.6 km west of the junction of Routes 15 and 733 (Parrott, 1949). It was operated in green metavolcanic schist. Minerals reported are: pyrite crystals to 3.2 centimeters, magnetite octahedra, tremolite-actinolite, hematite, azurite stains on quartz, epidote, and chlorite (Dietrich, 1970; Morrill, 1972; Parrott, 1949). (Loc. 15).

2. Ocher was prospected 1.1 km north-northeast of Oatlands (Toewe, 1966). (Loc. 16).

Sterling

1. Specular hematite in epidote was found during road construction on Route 7 at Broad Run, near Route 28. (Loc. 17).

2. Secondary copper minerals are found in a roadcut on the east side of Route 28, 4 km south of Route 7 and 160 meters north of Route 625 (see Fig. 59). They occur in red to gray Triassic siltstone, shale, and arkose, associated with and often replacing plant fossils. Malachite, sometimes in fibrous aggregates, is common, with smaller amounts of lustrous, botryoidal blue-green pseudomalachite, and waxy green veinlets of chrysocolla. Dendritic manganese oxides are also abundant. This locality is used as a field trip stop by some

schools, so collecting here should be kept to an absolute minimum. (Loc. 18).

Figure 59: Roadcut along Virginia Route 28 in Sterling, Virginia, where copper minerals associated with Triassic plant fossils are found, looking northwest.

PRINCE WILLIAM COUNTY
(Also see: Diabase quarries of northern Virginia, p. 121; and Plate 3)

Cabin Branch Mine
Dumfries, (Loc. 1)

Location and History

To reach this mine, take Mine Road (Route 629) southwest from Route 1 in the northern part of Dumfries. This road winds around for about 2.4 km following Quantico Creek, and then makes a very sharp right turn. Do not take this turn, but continue straight on a dirt road for about 150 meters until a gate is reached, and park here with permission of the local homeowners. The mine is about 600 meters further down the road, in Prince William Forest Park, and consists of several acres of bulldozed dumps on both sides of Quantico Creek (Fig. 61). Several old foundations, and old shafts now covered by cement slabs, are also present. The mine is on federal park property, and mineral collecting is prohibited without special permission.

The Cabin Branch mine was opened in 1889, and operated intermittently as a producer of pyrite until 1920. It was a fairly large operation, and steady production was apparently maintained from 1908 to 1919. A narrow-gauge railroad carried the ore to the main rail line, and also to the Potomac River where it was loaded onto ships. The pyrite was used to make sulfuric acid, while the small amounts of silver and gold reported in the ore were apparently never utilized (Lonsdale, 1927; Watson, 1907).

Description

The Cabin Branch mine is situated in the northern part of the "gold-pyrite belt" of northeastern Virginia. Within this belt, numerous sulfide and quartz lenses were mined for gold and pyrite in the metasedimentary and metavolcanic schists and amphibolites. Further information on the "gold-pyrite belt" is given by Lonsdale (1927).

This mine was opened in the Chopowamsic Formation (see p. 11), which here consists of mica and hornblende schists that locally grade into amphibolite. The schists commonly contain biotite, epidote, chlorite, and garnet. Small quartz and quartz-calcite veins and lenses, often containing some pyrite, are common throughout these rocks, and grade into the large pyrite-rich ore lenses.

The ore at the Cabin Branch mine consists predominantly of large lenses of massive pyrite, commonly in association with quartz and calcite. Blocks of

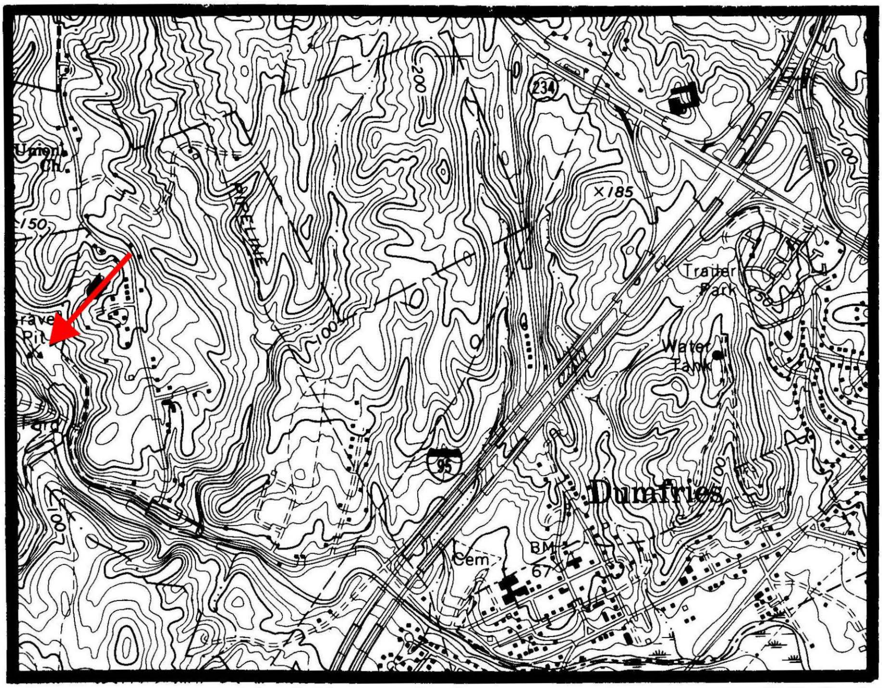

Figure 60: Location of the Cabin Branch mine, near Dumfries, Virginia. (U.S. Geol. Survey Quantico quadrangle, scale 1:24,000).

massive pyrite up to a meter across can still be seen on the dumps. Small amounts of pyrrhotite, chalcopyrite, galena, and sphalerite are found as disseminated grains in the pyrite. Coatings of malachite are common, especially on calcite.

Figure 61: Bulldozed dumps of the Cabin Branch mine along Quantico Creek, near Dumfries, Virginia.

Minerals

Actinolite—(Morrill, 1972).
Biotite—in schist.
Calcite—white, commonly with quartz; highly modified nearly equant crystals in cavities.
Chalcopyrite—grains in pyrite and quartz.
Chlorite—in schist.
Epidote—small light-green grains in schist.
Galena—disseminated grains in massive pyrite.
Garnet—in mica schist.
Gold—trace reported in analyses (Lonsdale, 1927; Watson, 1907).
Gypsum—white to yellow efflorescences on pyrite and limonite (X-rayed, Mary E. Mrose, 1975).
Hornblende—acicular dark-green crystals in schist and amphibolite.
Limonite—abundant masses, often with efflorescences of gypsum.
Malachite—green stains, with calcite and chalcopyrite.
Melanterite—(Morrill, 1972)
Pyrite—abundant, as massive lenses up to at least a meter across.
Pyrrhotite—(Morrill, 1972).

Quartz—common in veins and lenses with calcite and pyrite.
Schorl—(Lonsdale, 1927).
Silver—trace reported in analyses (Lonsdale, 1927).
Sphalerite—disseminated brown grains in massive pyrite.

Other Localities

Aden

A barite mine was located about two miles southwest of Aden; see Fauquier County, Barite mines near Catlett, p. 110.

Agnewville

Agnewville prospect—This is a small pyrite prospect in black slate of the Quantico Formation, consisting of two shafts originally about 13 meters deep (now overgrown and mostly filled) on either side of a small creek. The shafts are located about 3.2 km southwest of Woodbridge and 1.4 km south of the junction of Routes 639 and 784. Cubic pyrite crystals are found scattered through the slate, and Luttrell (1966) reported "disseminated coarse arsenopyrite, and limonite after pyrite (?) in a light-gray rock that might be a felsic dike." Gold has also been reported from this prospect. Small quartz veins transect the slate. (Loc. 2)

Brentsville

Brentsville copper prospect—Two small prospect pits were opened approximately 200 meters southeast of the old courthouse at Brentsville. They are located in Triassic red shale, though the pits are now so overgrown that few rocks can be seen. Roberts (1928) reported large amounts of malachite and azurite in the rock and stated that similar material could be found in a nearby sandstone quarry. He also mentioned that no diabase dikes are evident in the vicinity, in contrast to the association seen at most of the Triassic copper deposits. (Loc. 3).

Dale City

Crawford gold placers—Gold was discovered shortly before 1935 by William P. Crawford along a section of Neabsco Creek (about 0.8 km north of Neabsco Church on Route 610, and 1.8 km west of Route 95), and on a small tributary called Jack Patterson's Run. The gravel here, part of which reportedly contained 0.76 grams of gold per cubic meter, was worked for several years using an amalgam plate, mechanical gold pans, and sluice boxes (Pardee and Park, 1948). Very tiny flakes of gold could still be recovered by panning when the creek was examined in 1975, and pebbles of chatoyant blue quartz are abundant. (Loc. 4)

Dumfries

Pyrite deposit in Prince William Forest—If the paved road which leads to the Cabin Branch mine (p. 116) is followed (by making a sharp right turn instead of continuing straight on the dirt road to the Cabin Branch mine), an area of abundant sulfides is reached. The paved portion of the road ends at a gate, and an unpaved road continues north for about 1.6 km. Within the roadbed are found blocks of massive pyrite up to nearly a meter across. These contain some arsenopyrite and small amounts of sphalerite, galena, and crusts of copiapite (?). The mineralogy is very similar to that observed at the Cabin Branch mine, and the country rock is again mica schist and hornblende schist crossed by numerous quartz veins. Attractive specimens of elongated dark-green to black hornblende crystals in schist can also be found in the roadbed. (Loc. 5).

Independent Hill

Greenwood gold prospect—The old mine road leading to this prospect originates from the southeast corner of the intersection of Routes 646 and 619, at an abandoned wooden church, about 0.8 km southeast of Independent Hill. This road, which is nearly impassable even on foot, leads for about 0.8 km to the completely overgrown prospect. The prospect originally consisted of two vertical shafts and some trenches, and has been abandoned since the early 1900's (Luttrell, 1966). Pyrite was reported by Morrill (1972), but little if any gold was ever actually found. (Loc. 6).

Joplin

Joplin prospect—This small pyrite prospect in schist was reported to be 1.6 km north of Joplin (Luttrell, 1966) and 3.2 km west of the Cabin Branch mine, on a small branch of Quantico Run (Morrill, 1972), in Prince William Forest Park. (Loc. 7).

Manassas

Barite in Triassic shale was reported from 3.2 km south of Manassas (Lutrell, 1966).

Minnieville

Amethyst is reported from an unspecified location in Minnieville (Schlegel, 1957). (Loc. 8).

Occoquan

Large masses of pyrite containing gold and bladed crystals, possibly of stibnite, are reported from Occoquan Creek at Occoquan (Morrill, 1972). (Loc. 9).

DIABASE QUARRIES OF NORTHERN VIRGINIA

Introduction

The active diabase quarries of northern Virginia are probably the best current producers of fine mineral specimens in the Washington area. Cabinet-quality examples of translucent apple-green prehnite, often spangled with colorless crystals of apophyllite that occasionally reach record dimensions, are well known. Lesser known is the wide variety of zeolites, pyroxenes, amphiboles, sulfides, and other more unusual minerals that commonly occur as exceptionally well formed or large crystals. The quarries are operated on a large scale for crushed stone (used primarily in road building and concrete manufacture), and they can be expected to produce excellent mineral specimens for many years to come.

All the quarries are located in large dikes and sills of Triassic diabase, and due to the similarity of their mineralogy they are here treated together. Several different geologic environments are associated with the diabase, and the presence or absence of these environments primarily determines which minerals are found at a given quarry.

Geology

The geologic environments found in the diabase quarries can be broadly categorized as: (1) unaltered diabase and diabase pegmatite; (2) late, albitic differentiates of the diabase; and (3) hydrothermally altered zones in the other rocks. A fourth category, of contact metamorphosed rocks surrounding the diabase, is present in a few of the quarries, and is discussed in more detail on p. 20.

Late differentiates of the diabase are those rocks that crystallized from the final fluids remaining after the bulk of the diabase had solidified. These final fluids were enriched in water, sodium, and silica relative to the diabase, while being relatively depleted in magnesium, iron, and calcium, and tended to produce lighter colored and often coarser-grained rocks. These include veins and small dikes of aplite and albitic pegmatite. Hydrothermally altered zones are places where moderately heated water flowed through joints and other fractures, partially dissolving the rock, and then depositing new minerals.

Mineralogy

Diabase: The unaltered diabase is a gray rock consisting predominantly of intergrown plagioclase and pyroxene, with a grain size around 1 to 3 mm. Most of the pyroxene from this rock is augite or, less commonly, pigeonite. Shannon (1926a) found the plagioclase from the Old Goose Creek quarry to be labradorite. Magnetite, ilmenite, biotite, chalcopyrite, and apatite are frequent accessories, and granophyric intergrowths of quartz and feldspar (similar in appearance to very fine-grained graphic granite) are occasionally encountered.

The diabase pegmatite has virtually the same mineralogy as the ordinary diabase, but differs in having a much coarser grain size and somewhat higher proportion of feldspar. Diabase pegmatite is especially prominent at the Old and New Goose Creek quarries, where bladed crystals of pigeonite and augite (or intergrowths of the two) up to at least 25 cm long are common.

Aplite and Albitic Pegmatite: Veins and small dikes of these light-colored, albite-rich rocks are found in several of the quarries.

Aplite occurs only in narrow veins that are a few centimeters across, and consists of fine-grained albite and quartz, often as granophyric intergrowths. Small grains of diopside, titanite, epidote, and apatite are common accessories. A central zone of diopside is sometimes present in these veins.

The albitic pegmatites form coarse-grained veins and dikes consisting of albite and quartz, commonly as granophyre, with a variable amount of bladed augite that is usually replaced by diopside. Miarolitic cavities (cavities formed during crystallization of the rock, often lined with euhedral crystals) are not uncommon in this rock, and have produced a host of unusual and very well crystallized minerals (mostly micro-size), especially at the Manassas quarry. Shannon (1926a) noted that at the Old Goose Creek quarry these cavities were most abundant in the pyroxene-poor albitic pegmatites that contain a large amount of granophyre. The miarolitic cavities contain well formed, though small, crystals of quartz, albite, epidote, titanite, chlorite, apatite, chalcopyrite, fibrous green amphibole (byssolite), and diopside.

Hydrothermally Altered Zones: These zones include various altered seams and fractures, as well as large, open cavities. The simplest and most commonly observed alteration effect is the presence of green chlorite, diopside, and hornblende in narrow joints and shear zones. Calcite, biotite, titanite, specular hematite, ilmenite, apatite, chalcopyrite, and byssolite are also found in these seams, though cavities and well formed crystals are rare. Shannon (1926a) described seams of hydrothermally derived diopside at the Old Goose Creek quarry that contained titanite crystals and a narrow central zone of purple axinite. These seams sometimes had tiny cavities that contained axinite and epidote crystals, with byssolite and possibly apophyllite.

Somewhat larger shear zones, generally several centimeters wide and often containing fragments of crushed rock, are characterized by larger cavities that contain the prehnite, apophyllite, and zeolites for which these quarries are best known. Pale to dark-green prehnite is the most common constituent of these zones, and it often entirely fills the seams. In open cavities the prehnite forms botryoidal masses of fine to coarse (to about 6 mm) crystals. These are often covered by crystals of other minerals, most notably colorless to light tan or pink apophyllite. The largest euhedral crystals known in the world (up to about 20 centimeters) came from the Centreville quarry (Fig. 63), where they were associated with large amounts of thaumasite and byssolite.

Zeolites, particularly laumontite, stilbite, and chabazite, are frequently found on prehnite, and also occur as separate veins. Stilbite and chabazite commonly occur together, the best specimens being found at the Manassas and Chantilly quarries. Thaumasite and tiny white balls and tufts of okenite are fairly common at the Centreville quarry. Thomsonite, natrolite, scolecite, gyrolite, and heulandite have also come from the diabase quarries.

Pale-green datolite is found in hydrothermally derived cavities; it is most common at the Old and New Goose Creek quarries.

Water-clear quartz crystals, often highly modified, are fairly common on prehnite. Calcite crystals are commonly found, and seams of calcite occasionally contain native silver (Herbert Corbett, oral communication, 1975).

Sulfides and sulfosalts also occur in these cavities, most commonly chalcopyrite, pyrite, bornite, and galena. Yellow sphalerite crystals are rare but are sometimes exceptionally transparent and well formed. Greenockite crystals have also been found in some of the quarries, and small crystals of the rare sulfosalts wittichenite and cuprobismutite have been found at the Centreville quarry (Medici, 1972).

Hornfels and Other Contact Metamorphosed Sedimentary Rocks and Pyroclastics: These rocks are discussed in the section on Triassic deposits (p. 20), and are described only briefly here. They are best exposed at the Chantilly and Manassas quarries, where they have produced a number of unusual minerals. At the Chantilly quarry, large specimens of stilbite and chabazite have come from numerous cavities in the hornfels which overlies the diabase. Small nodules of fine-grained cordierite also come from this rock. At the Manassas quarry, a large number of minerals occur as microcrystals in small cavities in a similar hornfels (see Fig. 62).

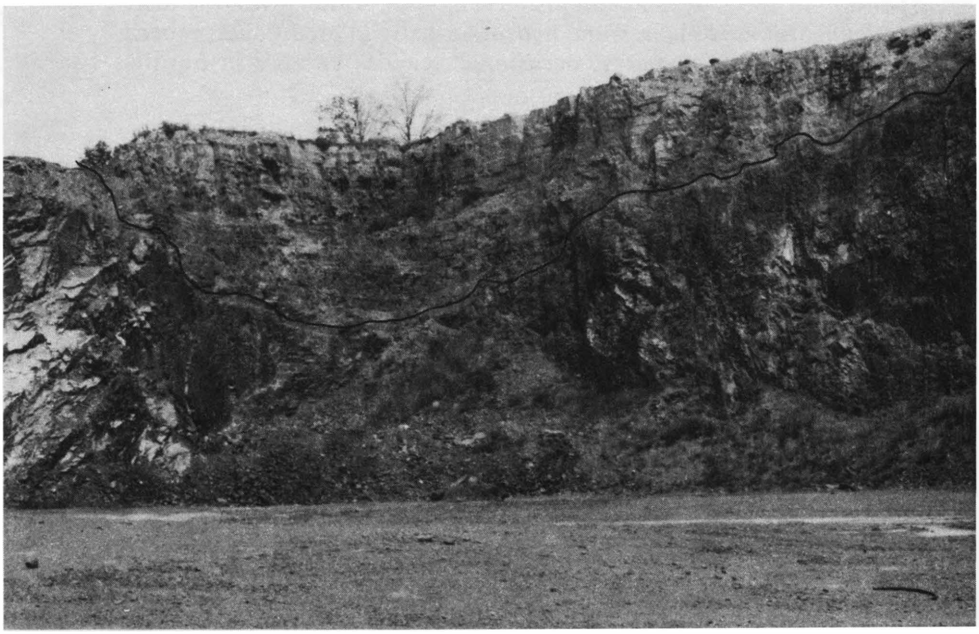

Figure 62: Hornfels (layered) underlain by diabase (massive) at the Manassas quarry, near Manassas, Virginia. Note the very irregular contact.

Acmite—reported constituent of diabase at the Manassas quarry (1)*

Actinolite-tremolite—pale to dark-green, fibrous masses in hydrothermally derived cavities (byssolite)

Aikinite—silvery, very sharp prismatic crystals to about 3 mm long, on prehnite from the Chantilly quarry. Collected by Norman Martin, 1976.

Albite—white crystals in albitic rocks, euhedral in cavities; occasional colorless, transparent crystals in hydrothermally altered zones. Crystals from miarolitic cavities at the Old Goose Creek quarry have a mean refractive index of 1.530 to 1.531 (2).

Analcime—possibly occurs at the Gainesville quarry (7)

Anhydrite—rare, pale-pink to lavender grains in cavities, with chalcopyrite, at the Centreville quarry.

Apatite—an accessory mineral in all rock types; white, prismatic to acicular euhedral crystals in some hydrothermally altered zones, especially at the Centreville quarry; occasional acicular crystals in hornfels and miarolitic cavities (1)

Figure 63: Large apophyllite crystal on prehnite from the Centreville quarry, Centreville, Virginia. Crystal is about 13.5 x 13.5 x 10.1 cm. (NMNH C-6649).

*Numbers in parentheses refer to the references listed in Table 1.

Apophyllite—common in many hydrothermally altered cavities; colorless to light pink or tan; pseudocubic to square tabular or, more rarely bipyramidal crystals; often with prehnite; large crystals and groups of crystals at the Centreville quarry reached nearly 20 centimeters across (Fig. 63). Analysis of apophyllite from the Old Goose Creek quarry gave (2):

Oxides	Weight Percent
SiO_2	51.80
Al_2O_3	0.70
CaO	25.54
MgO	0.56
K_2O	5.52
Na_2O	0.58
H_2O	15.31
F	1.75
	101.76
O=F	0.74
Total	101.02

Aragonite—small acicular crystals reported from hydrothermally altered cavities in diabase at the Manassas quarry (1)

Augite—dark-green to black crystals as constituent of diabase; up to several centimeters long in diabase pegmatite; sometimes intergrown with pigeonite, often altered to diopside or hornblende; commony titaniferous. An analysis of augite from the Old Goose Creek quarry gave (2):

Oxides	Weight Percent
SiO_2	50.26
TiO_2	0.80
Al_2O_3	2.10
Fe_2O_3	none
FeO	18.20
MnO	0.35
CaO	15.56
MgO	13.30
Total	100.57

Axinite—purple, granular material in centers of some diopside-filled seams at the Old Goose Creek quarry, with euhedral wedge-shaped crystals in small cavities (2)

Babingtonite—tiny, black, wedge-shaped crystals in hydrothermally altered cavities.

Biotite—an accessory mineral in diabase and diabase pegmatite (2)

*Numbers in parentheses refer to the references listed in Table 1.

Bornite—masses up to at least 7.5 centimeters in hydrothermally altered zones; usually associated with chalcopyrite or pseudomorphous after it; pseudomorphs after crude tetrahedra of chalcopyrite were found at the Centreville quarry (5); occasionally occurs in hornfels (1)
Byssolite—see: actinolite-tremolite
Calcite—colorless to yellow veins and crystals; crystals usually scalenohedral or rhombohedral, sometimes nearly equant and highly modified; crystals especially common with stilbite at the Manassas quarry, in at least two generations: rhombohedral, formed before the stilbite, and scalenohedral, formed after the stilbite.
Chabazite—colorless to yellow rhombohedral crystals in relatively unaltered cavities in diabase; also in hornfels; often with stilbite; the best crystals generally from Manassas and Chantilly quarries.
Chalcocite—gray, sooty material occasionally found with bornite (5)
Chalcopyrite—accessory in diabase; in masses to several centimeters across in hydrothermally altered zones, sometimes in tetrahedral crystals, and sometimes altered to bornite; as small crystals in miarolitic cavities; also in hornfels.
Chlorite—green masses in hydrothermally altered zones; as lustrous dark-green coatings on many slickensides
Clinozoisite-epidote—yellow to green drusy crystals in cavities of hydrothermally altered rocks and in hornfels
Cordierite—gray to dark blue-gray nodules to about 1 centimeter in diameter in hornfels
Cristobalite—from cavities in an albitic vein at the Manassas quarry (1)
Cuprobismutite—rare, tiny hairlike crystals protruding from wittichenite crystals on prehnite from the Centreville quarry (5)
Datolite—colorless to pale-green, well formed, usually transparent crystals in cavities in relatively unaltered diabase; best crystals generally from Old and New Goose Creek and Manassas quarries; Shannon (1926a) found the datolite from the Old Goose Creek quarry to be of at least two generations, from before and after the crystallization of prehnite.
Diopside—gray-green, in albitic and hydrothermally altered rocks, commonly as alterations of augite or pigeonite; tiny euhedral crystals in miarolitic cavities; in narrow seams at the Old Goose Creek quarry (2)
Dolomite—reported from hornfels at the Manassas quarry (1)
Galena—rare; cubic crystals with octahedral modifications up to about one centimeter on edge, on prehnite.
Goethite—small, fanlike sprays in hornfels and in hydrothermally altered rocks (1)
Greenockite—rare, small, yellow-green crystals, commonly in boxwork aggregates, from hydrothermally derived cavities (1, 3)
Grossular—light-pink grains in albitic rocks; reddish-brown crystals reported from hornfels at the Manassas quarry (1).
Gyrolite—white balls up to 14 mm across on prehnite and chlorite from Chantilly quarry
Hematite—specular in chlorite seams, and as small rounded aggregates in diabase and hornfels.
Heulandite—small crystals, usually associated with stilbite, in hydrothermally altered cavities.

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*Numbers in parentheses refer to the references listed in Table 1.

Hornblende—fine-grained, as replacement of pyroxene.
Ilmenite—an accessory mineral in the diabase (2); occasionally in seams of chlorite.
Jamesonite—possibly occurs at the Centreville quarry (5).
Labradorite—the plagioclase from the Old Goose Creek quarry was found to be labradorite, about An_{55} (2).
Laumontite—common, as crusts of small, prismatic, colorless crystals, occasionally radiating, in seams within diabase; often not associated with other hydrothermally derived minerals; alters on exposure to leonhardite. Laumontite from the Old Goose Creek quarry gave the following analysis (2):

Oxides	Weight Percent
SiO_2	52.00
Al_2O_3	22.90
Fe_2O_3	Trace
CaO	11.90
MgO	0.26
BaO	Trace
H_2O + 110° C	12.00
H_2O - 110° C	1.44
Total	100.50

Leonhardite—white, crumbly, dehydration product of laumontite.
Limonite—brown stains common in many fractures and cavities.
Magnetite—common accessory in diabase; skeletal crystals in diabase and diabase pegmatite at the Old Goose Creek quarry (2); occasionally in albitic rocks, euhedral crystals in miarolitic cavities.
Malachite—green stains and small acicular crystals with chalcopyrite; also as small "buttons" in hornfels (1)
Mordenite (ptilolite)—reported from the Centreville quarry (8)
Muscovite—small crystals in albitic rocks; crystals up to 3 cm across at diabase-hornfels contact; smaller, etched crystals in hornfels at the Manassas quarry (1)
Natrolite—scarce; acicular colorless crystals from hydrothermally altered cavities
Okenite—tiny white balls on prehnite and apophyllite from the Centreville quarry
Opal—uncommon, white to yellow, botryoidal coatings in fractures; a piece with blue opalescence reported from the Manassas quarry (3)
Orthoclase—reported from hornfels at the Manassas quarry (1)
Pectolite—uncommon, white to tan acicular-radiating crystals in hydrothermally altered zones; verified by powder X-ray diffraction from the Manassas quarry (1)
Pigeonite—constituent of diabase and diabase pegmatite; at the Old and New Goose Creek quarries many of the large, bladed, pleochroic dark-green to purple pyroxene crystals from diabase pegmatite are primarily pigeonite

*Numbers in parentheses refer to the references listed in Table 1.

Plagioclase—calcic, as constituent of diabase; sodic in albitic rocks (also see albite and labradorite)

Prehnite—translucent to transparent; pale to bright-green or yellow-green, sometimes dark-green from inclusions of chlorite and actinolite; in veins and encrustations in hydrothermally altered zones, where cavities contain botryoidal, globular, and stalactitic aggregates of crystals with numerous habits; single crystals scarce; occasionally found in hornfels. Prehnite from the Old Goose Creek quarry had the following composition (2):

Oxides	Weight Percent
SiO_2	41.90
Al_2O_3	19.38
Fe_2O_3	6.93
FeO	0.48
CaO	26.70
MgO	0.41
BaO	Trace
H_2O + 110° C	4.84
H_2O - 110° C	0.06
Total	100.70

Psilomelane—possibly occurs at the Bull Run quarry (3).

Pumpellyite—fine-grained, black, micaceous material in hornfels at the Manassas quarry (1)

Pyrite—as small masses and crystals with prehnite in hydrothermally altered zones.

Pyrrhotite—small crystals reported from hornfels, with hematite (1).

Quartz—constituent of aplite and albitic pegmatite; as granophyric intergrowths in diabase and albitic rocks; euhedral, transparent, colorless crystals are common in cavities of hydrothermally altered zones, often with prehnite and apophyllite; as drusy crystals in hornfels.

Riebeckite—reported from hydrothermally altered zones at the Bull Run quarry (3)

Rutile—small crystals reported from hornfels at the Manassas quarry (1)

Scapolite—white, radiating, bladed crystals up to 4 centimeters long and 5 millimeters wide in fractures in diabase; possibly mizzonite (X-rayed by M.E. Mrose, 1975)

Scheelite—small masses; fluoresces blue in shortwave ultraviolet radiation; reported from hornfels at the Manassas quarry (1)

Schorl—small crystals reported from hornfels at the Manassas quarry (1)

Scolecite—white, radiating crystals identified from the Manassas quarry (3) (Pete Dunn, oral communication, 1975)

Silver—scarce, as small wires in calcite veins or on prehnite.

Sphalerite—scarce; light-green to brownish-yellow crystals in hydrothermally altered zones, sometimes as superb crystals up to 2 centimeters across on prehnite; best crystals have come from the Bull Run quarry (flat, triangular plates) and the Virginia Trap Rock quarry.

*Numbers in parentheses refer to the references listed in Table 1.

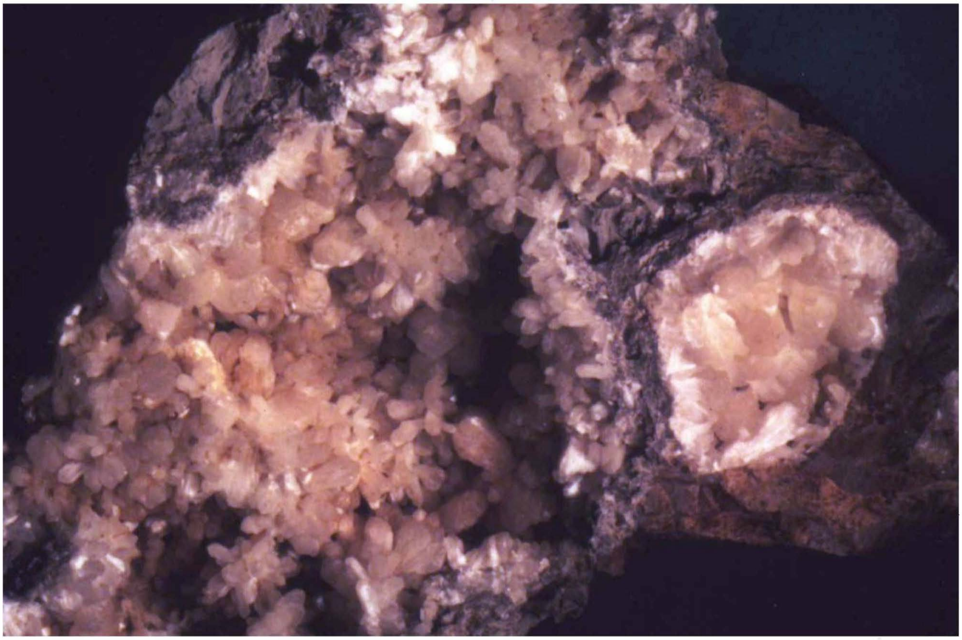

Figure 64: Stilbite crystals in hornfels from the Chantilly quarry, Chantilly, Virginia. Crystals are up to 1 cm. long.

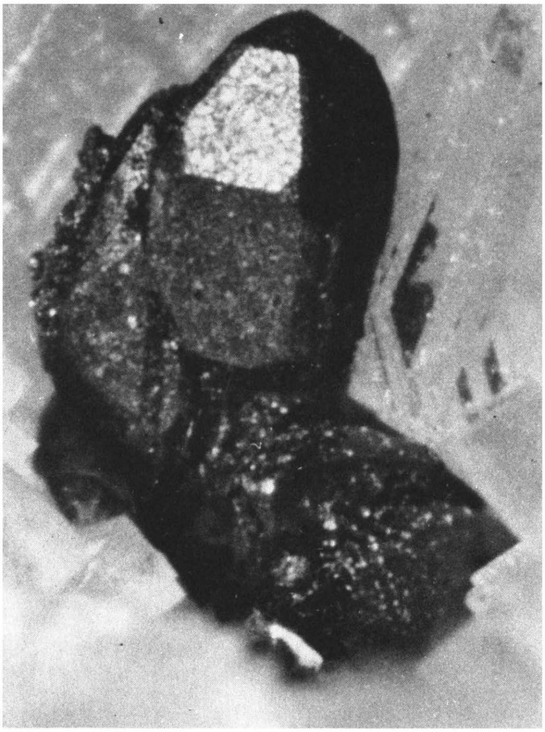

Figure 65: Wittichenite crystals on prehnite from the Centreville quarry, Centreville, Virginia. Largest crystal is 1 mm long. Photograph by Ben Kinkead.

Stilbite—colorless to yellow, stellate to "bow tie" aggregates in hydrothermally altered diabase and hornfels, often with chabazite; best crystals have come from Chantilly and Manassas quarries (Fig. 64)
Thaumasite—chalky-white encrusting masses, and acicular to silky tufts of crystals in hydrothermally altered zones, usually with apophyllite; sometimes as white to pale-blue films on prehnite.
Thomsonite—yellow botryoidal masses on prehnite with laumontite from the Old Goose Creek quarry (NMNH 115257)
Titanite—resinous brown crystals, common as accessory mineral in diabase and albitic rocks (though most easily visible in light-colored rocks); euhedral crystals occur in miarolitic and hydrothermally altered cavities
Topaz—small crystals from miarolitic cavities at the Manassas quarry (1)
Vermiculite—brown micaceous masses locally common at contact of diabase and hornfels at the Manassas quarry (1)
Wittichenite—anhedral "rope-like" dull gray masses, and lustrous, stubby, modified prismatic crystals, with prehnite and cuprobismutite, from the Centreville quarry (5). (Fig. 65).
Wurtzite—possibly occurs at the Centreville quarry (5)
Xenotime—reported from an aplite dike at the Virginia Trap Rock quarry (6)
Zircon—small brown crystals in miarolitic cavities at the Manassas quarry and possibly at the New Goose Creek quarry; also as colorless transparent crystals in hornfels at the Manassas quarry (1)

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*Numbers in parentheses refer to the references listed in Table 1.

Figure 66: Hornfels containing cordierite and abundant stilbite at the western end of the Chantilly quarry, Chantilly, Virginia. Surface in foreground marks the top of the diabase.

Localities

The following quarries are currently operating or have operated recently. Many of the active quarries allow mineral collecting on Saturdays.

Bull Run Quarry—Loudoun County (Loc. 1), 4.8 km south-southwest of Conklin, just east of Route 659. Currently operated by the Bull Run Stone Company of Manassas, Virginia. Hydrothermally altered zones and cavities are rather scarce, but large apophyllite crystals and superb platy yellow crystals of sphalerite have been found here.

Centreville Quarry (Fairfax Quarry, Sissler's Quarry)—Fairfax County (Loc. 2), about 5 km west of Centreville. Owned and operated by Luck Quarries, Inc. of Richmond, Virginia. In 1953 and again in 1967, large tubelike cavities were uncovered, containing abundant prehnite, apophyllite, byssolite, and thaumasite; and some rarer minerals, including okenite, wittichenite, and cuprobismutite. A somewhat smaller tube was exposed in 1975. Some of the largest and finest known apophyllite crystals came from these cavities (Fig. 63). For more information, see Trapp (1968) and Medici (1972).

Chantilly Quarry—Loudoun County (Loc. 2), just north of Route 50, about 6.4 km northwest of Chantilly (Route 657). Currently operated by Chantilly Crushed Stone, Inc. of Chantilly, Virginia. Much of the prehnite from this quarry has an exceptionally bright green color. Excellent stilbite crystals with chabazite are abundant in the gray hornfels which overlies the diabase, exposed at the west end of the quarry (Fig. 66).

Gainesville Quarry—Prince William County (Loc. 10), just south of Route 29/211, about 1.6 km west-southwest of Gainesville (Route 55). Presently owned and intermittently operated by Sam Jones of Gainesville, Virginia.

Loudoun Quarry (Loudoun Stone Company Quarry)—Loudoun County (Loc. 3), just south of Route 606, 3.2 km west of Herndon (junction Routes 606 and 228). Currently operated by Chantilly Crushed Stone, Inc. of Chantilly, Virginia. Calcite veins in this quarry sometimes contain native silver.

Manassas Quarry—Prince William County (Loc. 11), just north of Route 674, 4 km northwest of Manassas (junction Routes 234 and 28). Presently operated by Vulcan Materials Company, which has a regional office in Springfield, Virginia. This quarry is known for containing a large number of unusual minerals as microcrystals in miarolitic cavities, hydrothermally altered cavities, and vugs in the overlying hornfels. Large well-formed stilbite and chabazite crystals also occur here.

New Goose Creek Quarry (Luck's Goose Creek Quarry)—Loudoun County (Loc. 4), just west of Route 659 in Belmont, about 2.4 km south of Route 7. Owned and intermittently operated by Luck Quarries, Inc. of Richmond, Virginia. Diabase pegmatite containing long blades of pigeonite is abundant, and cavities with datolite crystals to 2.5 centimeters across are fairly abundant.

Old Goose Creek Quarry (Goose Creek Quarry, Arlington Quarry, Belmont Quarry)—Loudoun County (Loc. 5), about 200 meters northeast of the New Goose Creek quarry, owned by Luck Quarries, Inc. of Richmond, Virginia. Currently abandoned and partially water filled. The mineralogy is very similar to that at the New Goose Creek quarry, and the geology was described in great detail by Shannon (1926a).

Virginia Trap Rock Quarry (Goose Creek quarry)—Loudoun County (Loc. 6), just west of Route 653, 0.8 km south of Route 7 and 0.6 km west of

Goose Creek. Currently operated by Virginia Trap Rock, Inc. of Leesburg, Virginia. Much of the prehnite here is in unusually coarse and well-formed crystals. Handsome cubic galena crystals with octahedral modifications, and superb yellow sphalerite crystals up to 2 centimeters across, are occasionally found on prehnite. Yellow titanite crystals up to at least five millimeters long are rather common in aplite.

MINERALS	Hornfels	Hydrothermally altered zones	Aplite and albitic pegmatite	Diabase and diabase pegmatite	Bull Run Quarry	Centreville Quarry	Chantilly Quarry	Gainesville Quarry	Loudoun Quarry	Manassas Quarry	New Goose Creek Quarry	Old Goose Creek Quarry	Virginia Trap Rock Quarry
ROCK TYPES: Diabase and diabase pegmatite					X	X	X	X	X	X	X	X	X
ROCK TYPES: Aplite and albitic pegmatite						X			X	X	X	X	X
ROCK TYPES: Hydrothermally altered zones					X	X	X	X	X	X	X	X	X
ROCK TYPES: Hornfels					X		X			X			
Acmite				X						(1)			
Actinolite		X			X	X		X		X		(2)	
Aikinite		X					X						
Albite	X	X	X			X			X	X	X	X	X
Analcime		X						(7)					
Anhydrite		X				X							
Apatite	X	X	X	X	X	X	X	X	X	X	X	X	X
Apophyllite		X			X	X	X	X		X	X	X	X
Aragonite		X								(1)			
Augite				X	X	X	X	X	X	X	X	X	X
Axinite			X									(2)	
Babingtonite		X				(5)	(3)			(1)	(3)	(4)	
Biotite	X									(3)			
Bornite	X	X			X	X		X	(3)	X		X	
Calcite	X	X			X	X	X	X	X	X	X	X	X
Chabazite	X	X			(3)	X	X			X		X	X

Table 1. Minerals of the Northern Virginia Diabase Quarries

The rock types present at each quarry, and the rock type(s) that each mineral occurs in, are indicated where known. Abbreviations: X—known occurrence; (?)—unverified or questionable occurrence. Numbers in parentheses indicate references for reported occurrences: (1) Herbert Corbett, oral communication, 1975; (2) Shannon, 1926a; (3) Bruce Maier, oral and written commuication, 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1966; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

MINERALS	HORNFELS	HYDROTHERMALLY ALTERED ZONES	APLITE AND ALBITIC PEGMATITE	DIABASE AND DIABASE PEGMATITE	BULL RUN QUARRY	CENTREVILLE QUARRY	CHANTILLY QUARRY	GAINESVILLE QUARRY	LOUDOUN QUARRY	MANASSAS QUARRY	NEW GOOSE CREEK QUARRY	OLD GOOSE CREEK QUARRY	VIRGINIA TRAP ROCK QUARRY
ROCK TYPES: Diabase and diabase pegmatite					X	X	X	X	X	X	X	X	X
ROCK TYPES: Aplite and albitic pegmatite						X			X	X	X	X	X
ROCK TYPES: Hydrothermally altered zones					X	X	X	X	X	X	X	X	X
ROCK TYPES: Hornfels					X		X			X			
Chalcocite		X				(5)							
Chalcopyrite	X	X	X	X	X	X	X	X	X	X	X	X	X
Chlorite		X			X	X	X	X	X	X	X	X	X
Clinozoisite-epidote	X	X				X	X			X		X	X
Cordierite	X						X						
Cristobalite			X							(1)			
Cuprobismutite		X				(5)							
Datolite		X			(3)	X				X	X	X	X
Diopside		X	X			X			X	X	X	X	X
Dolomite	X									(1)			
Galena		X			(3)	X				X		(2)	X
Goethite	X	X								(1)			
Greenockite		X			(3)	(5)			(1)	(1)			
Grossular	X		X						X	(1)			
Gyrolite		X					X						
Hematite	X	X		X		X	X			X			

Table 1. Minerals of the Northern Virginia Diabase Quarries (Continued)

The rock types present at each quarry, and the rock type(s) that each mineral occurs in, are indicated where known. Abbreviations: X—known occurrence; (?)—unverified or questionable occurrence. Numbers in parentheses indicate references for reported occurrences: (1) Herbert Corbett, oral communication, 1975; (2) Shannon, 1926a; (3) Bruce Maier, oral and written commuication, 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1966; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

MINERALS	DIABASE AND DIABASE PEGMATITE	APLITE AND ALBITIC PEGMATITE	HYDROTHERMALLY ALTERED ZONES	HORNFELS	BULL RUN QUARRY	CENTREVILLE QUARRY	CHANTILLY QUARRY	GAINESVILLE QUARRY	LOUDOUN QUARRY	MANASSAS QUARRY	NEW GOOSE CREEK QUARRY	OLD GOOSE CREEK QUARRY	VIRGINIA TRAP ROCK QUARRY
ROCK TYPES: DIABASE AND DIABASE PEGMATITE					X	X	X	X	X	X	X	X	X
ROCK TYPES: APLITE AND ALBITIC PEGMATITE						X			X	X	X	X	X
ROCK TYPES: HYDROTHERMALLY ALTERED ZONES					X	X	X	X	X	X	X	X	X
ROCK TYPES: HORNFELS					X		X			X			
Heulandite	X	X			(3)		X			X			
Hornblende		X			X		X			X	X	X	X
Ilmenite		X		X		(5)						(2)	
Jamesonite		(?)				(5)							
Labradorite				X								(2)	
Laumonite		X			X	X	X	X	X	X	X	X	
Leonhardite		X			X	X	X	X	X	X	X	X	
Limonite	X	X			X	X	X	X	X	X	X	X	
Magnetite			X	X	X	X	X	X	X	X	X	X	X
Malachite	X	X				X				X			
Mordenite		X				(8)							
Muscovite	X		X							X			
Natrolite		X			(3)					(1)	(3)	(8)	
Okenite		X				(5)							

Table 1. Minerals of the Northern Virginia Diabase Quarries (Continued)

The rock types present at each quarry, and the rock type(s) that each mineral occurs in, are indicated where known. Abbreviations: X—known occurrence; (?)—unverified or questionable occurrence. Numbers in parentheses indicate references for reported occurrences: (1) Herbert Corbett, oral communication, 1975; (2) Shannon, 1926a; (3) Bruce Maier, oral and written commuication, 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1966; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

	Diabase and Diabase Pegmatite	Aplite and Albitic Pegmatite	Hydrothermally Altered Zones	Hornfels	Bull Run Quarry	Centreville Quarry	Chantilly Quarry	Gainesville Quarry	Loudoun Quarry	Manassas Quarry	New Goose Creek Quarry	Old Goose Creek Quarry	Virginia Trap Rock Quarry
ROCK TYPES: Diabase and Diabase Pegmatite					X	X	X	X	X	X	X	X	X
Aplite and Albitic Pegmatite						X			X	X	X	X	X
Hydrothermally Altered Zones					X	X	X	X	X	X	X	X	X
Hornfels					X		X			X			
MINERALS													
Opal		X			(3)					X		(3)	(3)
Orthoclase	X									(1)			
Pectolite		X			(3)	X				(1)			
Pigeonite				X							X	X	
Plagioclase	X	X	X	X	X	X	X	X	X	X	X	X	X
Prehnite	X	X			X	X	X	X	X	X	X	X	X
Psilomelane		(?)			(3)								
Pumpellyite	X						(9)			(1)			
Pyrite	X	X		X	(3)					X	X		
Pyrrhotite	X									(1)			
Quartz	X	X	X	X	X	X	X	X	X	X	X	X	X
Riebeckite		X			(3)								
Rutile	X									(1)			
Scapolite		X							X				
Scheelite	X									(1)			

Table 1. Minerals of the Northern Virginia Diabase Quarries (Continued)

The rock types present at each quarry, and the rock type(s) that each mineral occurs in, are indicated where known. Abbreviations: X—known occurrence; (?)—unverified or questionable occurrence. Numbers in parentheses indicate references for reported occurrences: (1) Herbert Corbett, oral communication, 1975; (2) Shannon, 1926a; (3) Bruce Maier, oral and written commuication, 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1966; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

ROCK TYPES / MINERALS	HORNFELS	HYDROTHERMALLY ALTERED ZONES	APLITE AND ALBITIC PEGMATITE	DIABASE AND DIABASE PEGMATITE	BULL RUN QUARRY	CENTREVILLE QUARRY	CHANTILLY QUARRY	GAINESVILLE QUARRY	LOUDOUN QUARRY	MANASSAS QUARRY	NEW GOOSE CREEK QUARRY	OLD GOOSE CREEK QUARRY	VIRGINIA TRAP ROCK QUARRY
DIABASE AND DIABASE PEGMATITE					X	X	X	X	X	X	X	X	X
APLITE AND ALBITIC PEGMATITE						X			X	X	X	X	X
HYDROTHERMALLY ALTERED ZONES					X	X	X	X	X	X	X	X	X
HORNFELS					X		X			X			
MINERALS													
Schorl	X									(1)			
Scolecite		X								(3)			
Silver		X				(5)			(3)	(1)		(3)	
Sphalerite		X			(3)	(5)	X		X	(1)	(3)	(2)	X
Stilbite	X	X			(3)	X	X		(3)	X	(3)	X	X
Thaumasite		X			X	X		X				X	
Thomsonite		X			(3)							X	
Titanite		X	X	X	X	X	X		X	X	X	X	X
Topaz			X							(1)			
Vermiculite	X									(1)			
Wittichenite		X				(5)							
Wurtzite		(?)				(5)							
Xenotime			X										(6)
Zircon	X		X							(1)			

Table 1. Minerals of the Northern Virginia Diabase Quarries (Continued)

The rock types present at each quarry, and the rock type(s) that each mineral occurs in, are indicated where known. Abbreviations: X—known occurrence; (?)—unverified or questionable occurrence. Numbers in parentheses indicate references for reported occurrences: (1) Herbert Corbett, oral communication, 1975; (2) Shannon, 1926a; (3) Bruce Maier, oral and written commuication, 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1966; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

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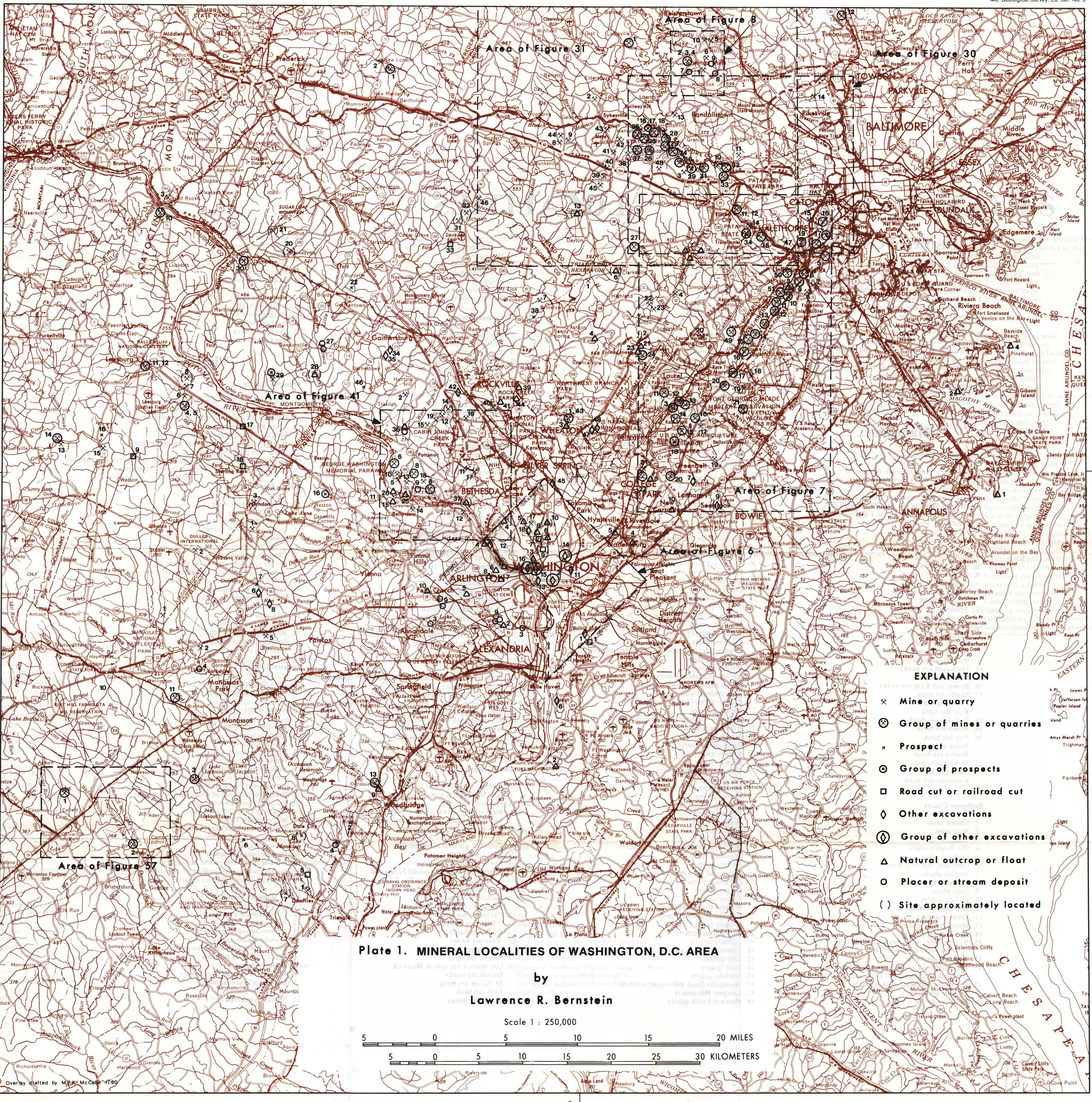
Plate 1
Minerals of the Washington, D.C. area
L.R. Bernstein
Md. Geological Survey, Ed. Ser. No. 5

PLATE 1



Base map from U.S. Geological Survey, 1957 (revised 1969)
Baltimore and Washington two-degree sheets

77°

Locality key on back

LOCALITIES

District of Columbia

1. Oxon Run goethite occurrence
2. Constitution Avenue vivianite occurrences
3. Massachusetts Avenue marcasite occurrence
4. Fort Baylor Park steatite occurrence
5. Connecticut Avenue psilomelane occurrence
6. Piney Branch rutile and titanite occurrence
7. Rock Creek staurolite occurrence
8. Pierce Mill jasper occurrence
9. Harvard Street piemontite occurrence
10. Blagden Avenue opal occurrence
11. Marcasite occurrence at First and M Streets, N.E.
12. Chain Bridge exposures
13. Constitution Avenue galena and cerussite occurrence
14. Howard University occurrences
15. Longbridge gold occurrence
16. Foundry Branch rutile occurrences
17. Rose Hill quarry
18. Van Ness Street quartz crystal occurrence

Maryland

Anne Arundel County

1. Greenbury Point vivianite occurrence
2. North Ferry Point pyrite deposit
3. Hanover marcasite occurrence
4. Pinehurst marcasite occurrence

5- 21. Iron Mines in the Arundel Formation.
More detail is shown on Fig. 7.

5. Benson ore banks
Soper Hall ore banks
6. Randel ore banks
Crook ore bank
7. Hollins ore bank
8. Smith ore bank
9. German ore bank
Plumbmer ore banks
10. Timber Neck ore banks
Lafey ore bank
11. Anderson ore bank
Dorsey ore banks
12. Disney ore bank
Harmon ore bank
13. Ellicott ore bank
Goldwine ore bank
Bennett ore bank
14. Linthicum ore banks
15. Hobbs ore banks
16. Brown and King ore banks
17. Skully ore bank
Priest deposit
Rose ore bank
18. Sydicum ore bank
19. Welch ore bank
20. Ties ore bank
Tyson ore banks
Waters ore bank
21. Berkley ore bank
Rieve ore bank
Gosweiler ore bank

Baltimore County

1. Choate mine
2. Weir mine
3. Harris mine
4. Old Triplett placer
5. Calhoun mine
6. Unnamed chromite mine
7. Triplett placer
8. Dolfield (Rose) placer
9. Gore placer
10. Delight quarry
11. Bok asbestos mine
12. Texas quarries
13. Marriottsville quarry
14. Greenspring quarry

15-19. Iron mines in the Arundel Formation.
More detail is shown on Fig. 7.

15. Kennedy ore bank
16. Excelsior Brick and Pottery Company banks
Ore banks northwest of Lansdowne
17. Ore banks northeast of Halethorpe
Virginia ore banks
18. Kraft ore banks
19. Miller ore banks
Ring ore banks
Coursey ore bank
Randle ore bank
Stapleton ore bank

Carroll County

1. Mineral Hill Mine
2. Springfield mine

Frederick County

1. Farmers Cooperative limestone quarry
2. New London copper mine
3. Point of Rocks goethite locality

Howard County

1. Howard-Montgomery quarry
2. Ben Murphy mica mine
3. Frost quarry
4. Atholton quarry
5. Carrolls Mill sillimanite, kyanite, and garnet occurrence
6. Clarksville smoky quartz occurrence
7. Columbia quartz crystal occurrences
8. Rice mine
9. Forsythe mine
10. Alberton quarry
11. Ellicott City granite quarries
12. Ellicott City nontronite occurrence
13. Glenelg limonite after pyrite occurrences
14. Mount Saint Clement College quarry
15. Marriottsville flagstone quarries
16. Marriottsville marble prospect
17. Marriottsville talc prospect
18. Marriottsville kyanite occurrence
19. Pine Orchard autunite occurrence
20. Savage gabbro quarry
21. Patuxent River schorl occurrence
22. Maryland mica mine
23. Parlet prospect
24. Woodstock granite quarries

25-48. Feldspar and quartz mines.
More detail is shown on Figs. 30 and 31.

25. Warfield quarry
Albert Sandusky quarry
Lee Rendu quarry
Unnamed feldspar quarries near Marriottsville
26. Mathews quarry
Wright quarry
Harold Stromberg quarry
Baugh and Sons Company quarry
Zepp feldspar quarry
Product Sales Company quarry
27. Melvin quarries
28. Baltimore Feldspar Company quarries
29. Arrington quarries
Moody quarry
Zepp quartz quarries
30. Shipley quarry
Brown quarry
Unnamed feldspar quarry
31. Gary quarry
Dorseys Run quarry
32. Theis quarries
Perry quarries
33. Streker quarries
Highe quarries
Fagan quarries
34. Thomas quarry
Baltimore Feldspar Company quarry
Wharton quarry
Weber quarry
Fisher and Carozza quarries
35. O'Connor Farm quarries
36. Hanna quarry
Feazer quarry
37. Herbert Crooks quarry
38. Richard Williams quarry
39. Ridgely quarry
40. Harry Akers quarry
41. Iglehart quarry
42. Unnamed quartz quarry
43. Day quarry
44. Beck quarry
45. Hudson quarry
46. Annapolis Rock white quartz quarry
47. Lawyers Hill quarry
48. Howard Smith quarry

49-51. Iron mines in the Arundel Formation.
More detail is shown on Fig. 7.

49. Halsup ore bank
Scaggs ore bank
50. Talbott ore bank
Brooks ore bank
51. Hobbs ore banks
Brown ore banks

Montgomery County

1. Kensington mica mine
2. Hunting Hill quarry
3. Northwest Branch locality
4. Ednor steatite locality
5. Maryland gold mine
6. Ford gold mine
7. Ellicott gold mine
8. Mines along Rock Run (more detail shown on Fig. 41)
9. Rock Run gold placers
10. Anderson gold mine
11. Bethesda gold mine
12. Bogley gold mine
13. Fawsett gold mine
14. Gillotts gold mine
15. Grady gold mine
16. Huddleston gold mine
17. Miller gold mine
18. Sawyer gold mine
19. Stevens-Roudebush gold mine
20. Barnesville "copper mine"
21. Barnesville "gold mine"
22. Black Hills "gold mine"
23. Burtonsville gahnite occurrence
24. Earth Products Company feldspar mine
25. Cropley magnetite occurrence
26. Widewater copper occurrence
27. Dawsonville gold occurrences
28. Dawsonville cinnabar occurrence
29. Sugarland copper mine
30. Dickerson quarries
31. Etchison chrome mine
32. Lyde Griffith property
33. Etchison magnetite occurrence
34. Gaithersburg copper occurrence
35. Gaithersburg magnetite occurrence
36. Glen rutilated and blue quartz occurrences
37. Glen Echo gold occurrence
38. Olney gold (?) prospect
39. Aspen Hill quartz crystal occurrence
40. Halpine quarry
41. Peary High School limonite replacing pyrite occurrence
42. Rockville gold occurrence
43. Hermleigh Road locality
44. Harmony Hills rutile, pyrite, and quartz occurrence
45. Blair Apartments pyrite occurrence
46. Muddy Branch steatite prospect
47. Whiteoak pegmatite occurrence
48. Paint Branch garnet locality

Prince George's County

1. Wheeler Road vivianite locality
2. Fort Washington gypsum locality
3. Muirkirk clay pits
4. Bladensburg siderite and marcasite occurrence
5. Brentwood quartz crystal occurrence
6. Fort Foote gypsum occurrence
7. Greenbelt phosphate occurrence
8. Greenbelt goethite occurrence
9. Lanham goethite occurrence
10. New Carrollton quartz crystal occurrence

11-22. Iron mines in the Arundel Formation.
More detail is shown on Fig. 7.

11. Kirwan ore bank
Nicholson ore bank
Ore banks northwest of Contee
12. California ore banks
O'Brien ore banks
Hooff ore banks
13. Allan ore banks
Roberts ore bank
Shriver ore bank
14. Ore banks 1 km east of Muirkirk
Duvall ore banks
Milbrook ore bank
Friel ore bank
Tyson ore banks
15. Green ore banks
Ashland ore bank
16. John Sadilek ore banks
Joseph Sadilek ore bank
17. Haker ore bank
18. Swampoodle ore banks
Donaldson ore banks
Mason ore banks
19. Jones ore bank
20. Hedgman ore banks
21. Buck ore bank
22. Skaggs ore bank
Reed ore bank

Virginia

Arlington County

1. Windy Run molybdenite occurrence
2. Fourmile Run marcasite occurrence
3. Longbranch agate and amethyst occurrence
4. Chain Bridge exposures
5. McKinley Road steatite occurrence
6. North Quincy Street quartz crystal occurrence
7. Spout Run jasper occurrence
8. Stratford Junior High School garnet and quartz crystal occurrence
9. Doctors Run blue and asteriated quartz occurrences

Fairfax County

1. Theodora copper mine
2. Centreville quarry
3. Holmes Run amethyst occurrence
4. Bull Run gold occurrence
5. Sissler's quarry
6. Chantilly copper occurrence
7. Chantilly copper prospect
8. Pender specular hematite occurrence
9. Falls Church blue and asteriated quartz occurrences
10. Falls Church psilomelane occurrence
11. Leigh Mill Road quarry
12. Turkey Run steatite quarry
13. Lorton quarries
14. Kirk gold mine
15. Difficult Run exposure
16. Jenkins Farm prospects
17. Spencer Farm copper prospect

Fauquier County

1. Saint Stephens barite mine
2. Cedar Run barite mine

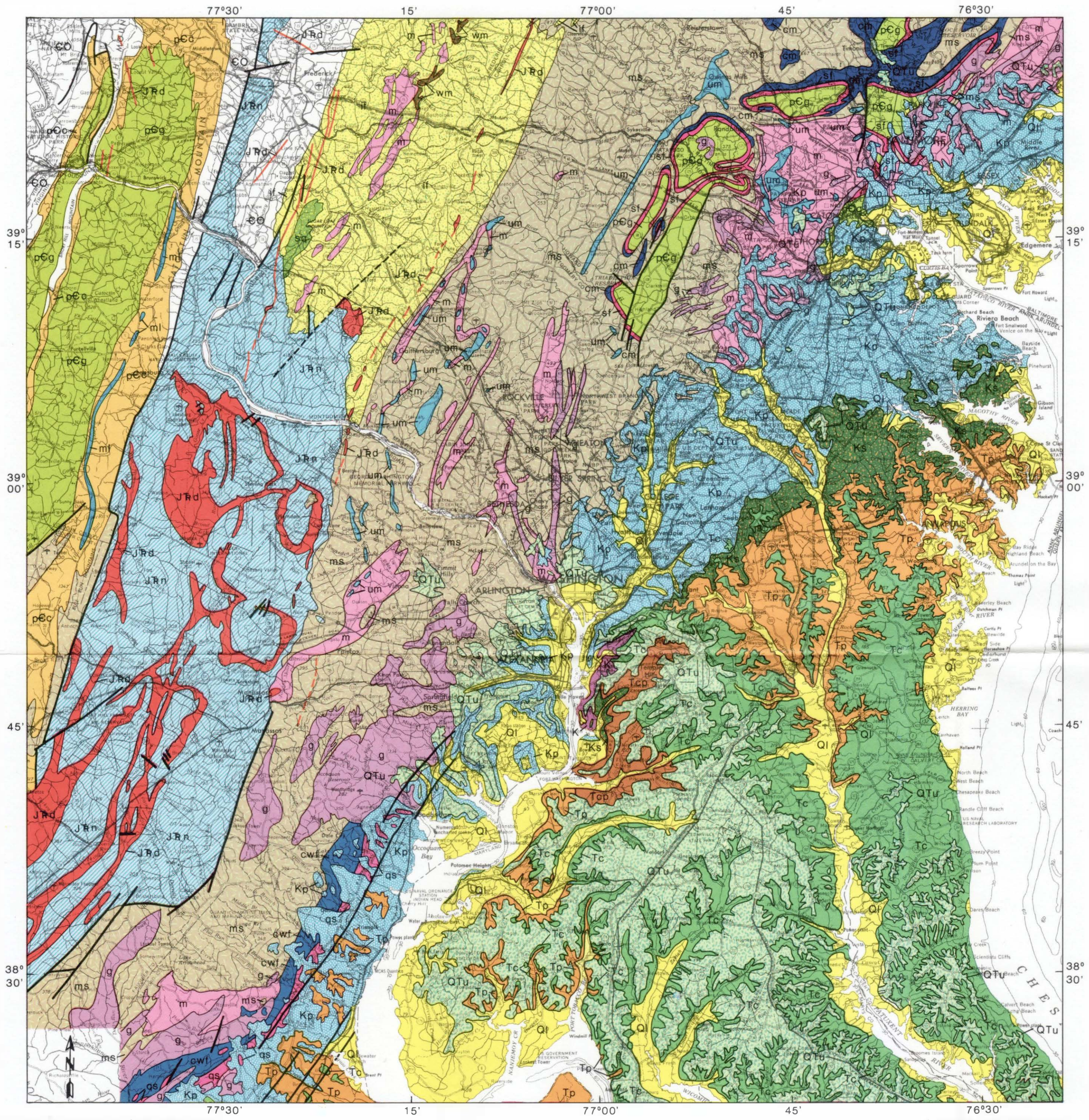
Loudoun County

1. Bull Run quarry
2. Chantilly quarry
3. Loudoun quarry
4. New Goose Creek quarry
5. Old Goose Creek quarry
6. Virginia trap rock quarry
7. State Roads quarry
8. Goose Creek copper mines
9. Evergreen Mills baked conglomerate exposure
10. Furnace Mountain iron mines
11. Leesburg Lime Co., Inc. quarry
12. White quarry
13. Loudoun Marble Company quarry
14. Goose Creek Lime Company quarries
15. Veasco quarry
16. Oatlands ocher prospect
17. Sterling specular hematite occurrence
18. Sterling copper and plant fossil occurrence
19. Sterling copper and silver occurrence

Prince William County

1. Cabin Branch mine
2. Agnewville prospect
3. Brentsville copper prospects
4. Crawford gold placers
5. Prince William Forest pyrite deposit
6. Greenwood gold prospect
7. Joplin prospect
8. Minnieville amethyst occurrence
9. Occoquan River exposure
10. Gainesville quarry
11. Manassas quarry

PLATE 2
MINERALS OF THE WASHINGTON, D.C. AREA
L.R. BERNSTEIN
MD. GEOLOGICAL SURVEY, ED. SER. NO. 5



Base from U. S. Geological Survey Washington, 1:250,000, 1953; Baltimore, 1:250,000, 1957

Compiled from references cited and field work by L. R. Bernstein, 1975-76

SCALE 1:500,000

10 0 10 20 MILES

10 0 10 20 KILOMETERS

GEOLOGIC MAP OF THE WASHINGTON, D. C. AREA

By

Lawrence R. Bernstein

EXPLANATION

COASTAL PLAIN AND PIEDMONT

- Ql — LOWLAND DEPOSITS-Gravel, sand, silt, and clay — QUATERNARY
- QTu — UPLAND DEPOSITS-Gravel and sand — Pleistocene(?) or Pliocene(?) — QUATERNARY(?) OR TERTIARY(?)
- MAJOR UNCONFORMITY
- Tc — CHESAPEAKE GROUP-Clay, sandy clay, and diatomite — Miocene — TERTIARY
- Tp — PAMUNKEY GROUP-Glauconitic sand, silt, and clay — Paleocene to Eocene — TERTIARY
- Tcp — CHESAPEAKE AND PAMUNKEY GROUPS, undivided
- Ks — SEVERN (FORMERLY MONMOUTH), MATAWAN, AND MAGOTHY FORMATIONS-Glauconitic sand, clay, and gravel — Upper Cretaceous — CRETACEOUS
- Kp — POTOMAC GROUP-Clay, quartz, sand, and gravel — Lower Cretaceous — CRETACEOUS
- K — CRETACEOUS DEPOSITS, undivided
- MAJOR UNCONFORMITY
- J₹d — DIABASE — JURASSIC AND TRIASSIC
- J₹n — NEWARK GROUP-Shale, siltstone, sandstone, and conglomerate — JURASSIC AND TRIASSIC
- MAJOR UNCONFORMITY
- qs — QUANTICO SLATE-Carbonaceous slate — LOWER PALEOZOIC
- cwf — CHOPAWAMSIC FORMATION-Gneiss, schist, and amphibolite — LOWER PALEOZOIC
- sq, if, wm — IJAMSVILLE AND URBANA PHYLLITES (INCLUDING FORMER MARBURG SCHIST) (if)-Phyllite and schist; SUGARLOAF MOUNTAIN QUARTZITE (sq); WAKEFIELD MARBLE (wm) — LOWER PALEOZOIC OR PRECAMBRIAN
- ms — METASEDIMENTARY ROCKS (INCLUDING WISSAHICKON FORMATION)-Schist and gneiss — LOWER PALEOZOIC OR PRECAMBRIAN
- COCKEYSVILLE MARBLE — LOWER PALEOZOIC OR PRECAMBRIAN
- sf — SETTERS FORMATION-Quartzite — LOWER PALEOZOIC OR PRECAMBRIAN
- MAJOR UNCONFORMITY
- p€g — GNEISS AND GRANITIC ROCKS — PRECAMBRIAN

IGNEOUS AND METAMORPHIC ROCKS OF UNCERTAIN AGE

- g — GRANITIC ROCKS — PALEOZOIC
- m — MAFIC ROCKS-Gabbro and diorite — PALEOZOIC
- um — ULTRAMAFIC ROCKS-Serpentinite and steatite — PALEOZOIC

FREDERICK VALLEY AND BLUE RIDGE

- €O — CAMBRIAN AND ORDOVICIAN ROCKS (including Chilhowee Group)-Limestone, shale and quartzite — ORDOVICIAN AND CAMBRIAN
- p€c, ml — CATOCTIN AND SWIFT RUN FORMATIONS (p€c)-Metabasalt and phyllite; MARBLE (ml) — PRECAMBRIAN
- MAJOR UNCONFORMITY
- p€g — GNEISS AND GRANITIC ROCKS — PRECAMBRIAN

CONTACT--Approximately located

FAULT--Approximately located; dashed where inferred

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PLATE 3

EXPLANATION

- ⚒ Mine or quarry
- Group of mines or quarries
- × Prospect
- ⊗ Group of prospects
- □ Roadcut or railroad cut
- ◊ Other excavations
- △ Natural outcrop or float
- ○ Placer or stream deposit
- ( ) Site approximately located

Ag	Silver
Au	Gold
Ba	Barite
Bzl	Baked zone: limestone conglomerate
Bzs	Baked zone: shale, siltstone, and sandstone
Bzsl	Baked zone: shale, siltstone, and limestone conglomerate
Cu	Copper minerals, mainly malachite, chrysocolla, and azurite
Db	Diabase
Hg	Cinnabar
Hm	Specular hematite
Lim	Limonite (ocher)
Pyr	Pyroclastics and basalt

Jurassic or Triassic — TRJd — Diabase

Triassic — TRn — Newark Series—Shale, siltstone, sandstone, and conglomerate. Locally includes basalt.

- Contact, approximately located
- Fault, approximately located
- Fault, inferred

LOCALITIES

Maryland

Montgomery County

1. Dickerson quarries (loc. 30)*
2. Sugarland copper mine (loc. 29)
3. Dawsonville gold occurrence (loc. 27)
4. Seneca Creek cinnabar occurrences (loc. 28)

Virginia

Fairfax County

5. Theodora copper mine (loc. 1)
6. Chantilly copper prospect (loc. 7)
7. Chantilly copper occurrence (loc. 6)
8. Pender specular hematite occurrence (loc. 8)
9. Spencer Farm copper prospect
10. Centreville quarry (loc. 2)
11. Bull Run gold occurrence (loc. 4)

Fauquier County

12. Saint Stephens barite mine (loc. 1)
13. Cedar Run barite mine (loc. 2)
14. Botts barite prospect

Loudoun County

15. Leesburg Lime Company, Inc. quarry (loc. 11)
16. White quarry (loc. 12)
17. Goose Creek copper mines (loc. 8)
18. State roads quarry (loc. 7)
19. Virginia trap rock quarry (loc. 6)
20. Old Goose Creek quarry (loc. 5)
21. New Goose Creek quarry (loc. 4)
22. Ocher prospect (loc. 16)
23. Veasco quarry (loc. 15)
24. Evergreen Mills exposure (loc. 9)
25. Sterling specular hematite occurrence (loc. 17)
26. Sterling copper and silver occurrence (loc. 19)
27. Sterling copper and fossil occurrence (loc. 18)
28. Loudoun quarry (loc. 3)
29. Chantilly quarry (loc. 2)
30. Bull Run quarry (loc. 1)

Prince William County

31. Gainesville quarry (loc. 10)
32. Manassas quarry (loc. 11)
33. Brentsville copper prospects (loc. 3)

*Locality number used in Plate 1 and in the text.

Compiled from the following sources: Eggleton, 1975; Froelich, 1975a, 1975b, 1976; Lindskold, 1956; Maryland Geological Survey, 1968; Nelson and Force, 1976; Toewe, 1966, plate 1; Virginia Division of Mineral Resources, 1963; and field work by L.R. Bernstein, 1975-1976.

PLATE 3 MAP SHOWING MINERAL DEPOSITS AND GENERALIZED GEOLOGY OF THE TRIASSIC ROCKS NEAR WASHINGTON, D.C.

by

Lawrence R. Bernstein

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 15 Nautical Miles