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MINERALS OF WASHINGTON, D.C. AND VICINITY

by

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[Reports - Open File Series]

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INTRODUCTION

"There was no talke, no hope, no worke, but
dig gold, wash gold, refine gold, loade 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), 1608.1/

In 1608 this was the situation that one might have encountered around what is now Washington, D.C. The unexplored Virginia colony held the possibility of yielding vast amounts of gold and precious gems, which England hoped could match Spain's mineral discoveries in South and Central America. In an attempt to discover this anticipated mineral wealth, the early English explorers were accompanied by numerous prospectors and assayers (called "refiners"), whose enthusiasm inspired the harsh words quoted above. Virginia gold, of course, never did stock the English treasury; 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

1/ From Smith, 1819, p. 169

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 true 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 clearly distinguished 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 two barrels of this iron ore to England in 1608. Smith also reported visiting an Indian mine near the Quiyough (probably Occoquan) River, where a silvery metallic 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 Georges County, Maryland, produced iron from local ores until 1916.

In around 1808 high grade chromite deposits were discovered in eastern ~~central~~ Maryland by Isaac Tyson, Jr. These deposits made Maryland the world's leading chromium producer 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.

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The early explorers' dreams of gold were finally realized (to a modest extent) in the Washington area during the mid-1800s, with the discovery of gold in Montgomery County, Maryland. Commercial recovery of gold, although always on a small scale, continued intermittently into the 1950s, 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.

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 recently come from suburban Virginia. All told, more than 250 localities for over 150 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 1975. 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.

Scope of Report

This report covers approximately 14,500 square kilometers centered roughly about Washington, D.C., with the region within a 50 kilometer radius of the city covered in most detail (see fig. 1). The localities

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Fig. 1 near here.

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are divided into two broad categories: major localities and other localities. Major localities are those which 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 which are no longer accessible. These are only given for the region of most detailed coverage. I have selected only those localities which 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

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1:2,500,000

Fig. 1

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 which are now inaccessible.

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Much public property is also 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 Herb 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.

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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 around Washington) and generally have rolling hills with more relief than the Coastal Plain. Rivers are usually faster moving and never show substantial tides. The rocks of the Piedmont are usually hard, crystalline, and quite folded and faulted. They are metamorphic and igneous in origin, ranging in age from about 400 million to 1.2 billion years old. 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 this boundary has been termed the <u>Fall Line</u>. The geology of Washington and vicinity has been compiled from many sources on the geologic map of Plate 2.

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Figure 2 here.

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 this 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 (190-225 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 formed in large basins partially bounded by faults. According to the theories of plate tectonics, these basins opened up from the stretching forces 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.

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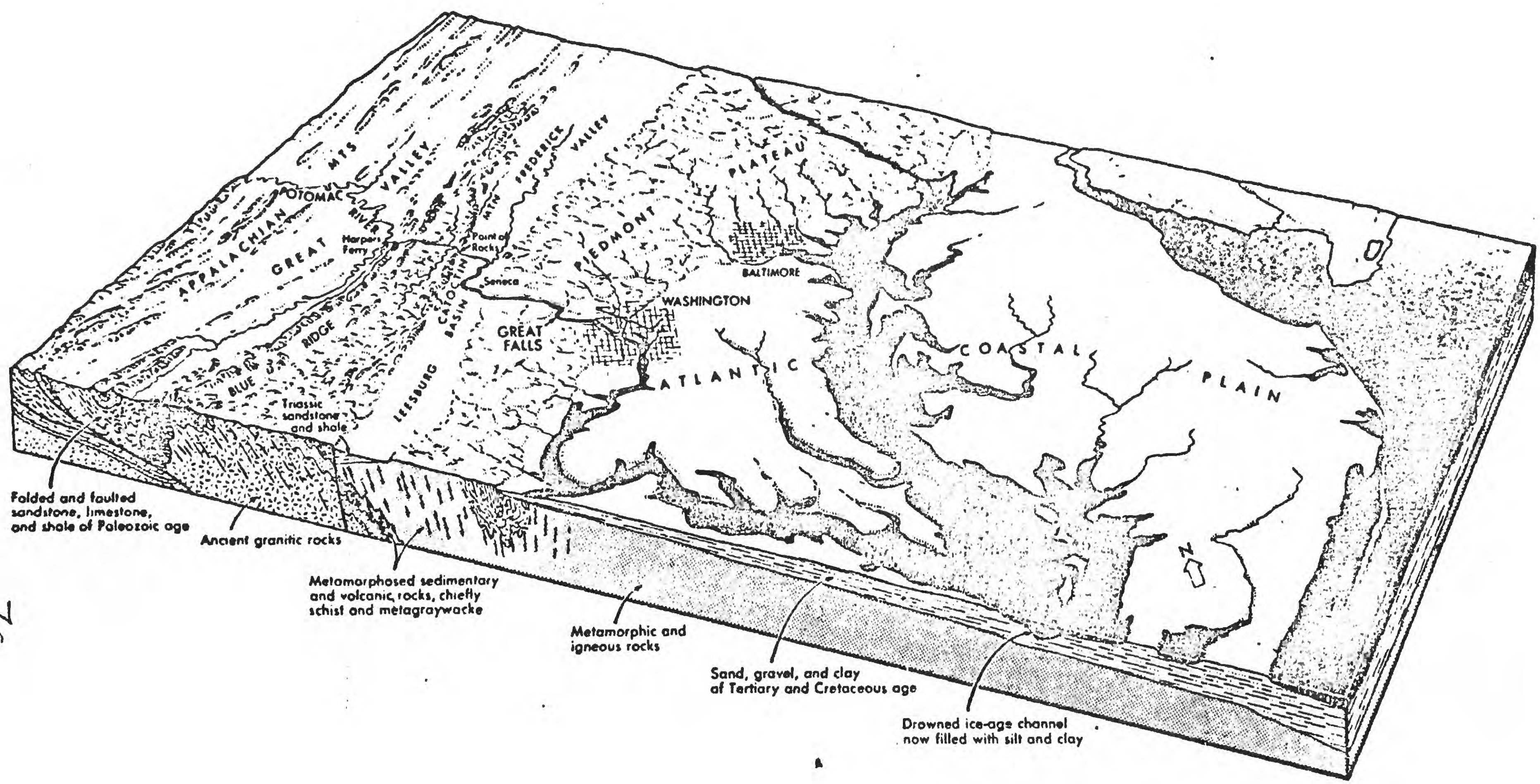

Fig. 2 BLOCK DIAGRAM OF THE D. C. REGION SHOWING PHYSIOGRAPHIC PROVINCES AND MAJOR GEOGRAPHIC AND GEOLOGIC FEATURES

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 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.

Coastal Plain

The clay, sand, and gravel of the Coastal Plain have never been subjected to high pressures or temperatures, and generally remain soft, or 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).

Figure 3 here.

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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
TERTIARY	Pliocene (?)	2-7	Upland Deposits	Gravel and sand, locally limonite cemented; minor silt and red, white, and gray clay	Limonite common
TERTIARY	Miocene	7-26	Chesapeake Group: St. Marys 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[1]
TERTIARY	Eocene	38-53	Pamunkey Group: Nanjemoy Formation	Pink to gray clay, overlain by fine to medium grained gray, argillaceous, micaceous, glauconitic sand	Glauconite
TERTIARY	Paleocene	53-65	Pamunkey Group: 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 (?)[1]
TERTIARY	Paleocene	53-65	Pamunkey Group: Brightseat Formation	Dark-gray to gray-green argillaceous, micacoues silt and sand; local indurated calcareous beds	Mica common; occasional phosphate nodules
CRETACEOUS	Upper Cretaceous	65-90	Monmouth 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
CRETACEOUS	Upper Cretaceous	65-90	Matawan Formation	Dark-gray, micaceous, glauconitic, argillaceous sand and silt	Glauconite, mica
CRETACEOUS	Upper Cretaceous	65-90	Magothy Formation	White lignitic sand and white to orange-brown limonite-stained quartz gravel; dark-gray, laminated silty clay	Limonite, some marcasite
CRETACEOUS	Lower Cretaceous	90-136	Potomac Group (includes Arundel Clay)	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

Fig. 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)

[1]Dryden, 1932

A complete description of all the Coastal Plain formations is beyond the scope of this book, and for futher information the references given at the end of the chapter should be consulted.

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 at 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 which are abundantly distributed through the Cretaceous Arundel Formation (see p. 44). 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 glauconitic clays of the Patapsco and Monmouth formations, although it also occurs in similar Miocene clays 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 associate of the gypsum.

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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. 120), they occurred at the very top of the Monmouth 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. 128).

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Also occurring in the clays and glauconitic sands are masses of carbonized wood called <u>lignite</u>. The lignite often contains and commonly is replaced by marcasite. This marcasite tends to alter and crumble upon exposure to the air, and is very difficult to preserve. Silicified wood is also found, sometimes with 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 Formation, of Paleocene age, directly overlies the Cretaceous deposits. 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 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 occurences 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 Series

The large series of metamorphic rocks that underlie the Washington area Piedmont are predominately in a group of related formations known as the Glenarm Series. The Glenarm Series, named for the type exposure at 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 this series which are present in the Washington area are, from the base upwards: (1) a narrow layer of quartzites and quartz-rich schists called the Setters Formation; (2) the moderately magnesian and aluminous marble of the Cockeysville Formation; and (3) the thickest part of the series, consisting of the schists and gneisses of the Wissahickon Formation. Higgins (1972) also includes the Chopawamsic Formation, the Quantico Slate, and the James Run Formation in the Glenarm Series.

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Interesting features of the Maryland section of the Glenarm Series 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 all 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 often 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 portions 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. The Setters Formation is exposed along the flanks of the gneiss domes, and in this environment excellent kyanite crystals have been collected around 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 geologic map, should aid in uncovering new, and possibly better localities for kyanite and staurolite in the Washington-Baltimore area.

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Cockeysville Formation

The Cockeysville Formation directly overlies the Setters Formation, and like 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 much 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, which 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 more common minerals given above, less abundant minerals such as fluorite, pyrrhotite, and rutile also occur. These minerals are sometimes found in contact zones surrounding pegmatites, as at the Greenspring quarry (p. 58). Calc-silicate zones are also common at the Howard-Montgomery quarry (p. 74). Some of the

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finest mineral specimens to come out of the Cockeysville Formation are the nearly transparent brown dravite crystals, which are especially common at the Texas quarries (p. 53).

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

Wissahickon Formation

The Wissahickon Formation is a thick sequence of a large variety of metamorphic rocks. These include mica shists, chlorite schists, boulder and pebble gneisses, phyllites, and other related rocks. The Wissahickon also contains numerous quartz veins (some metal-bearing) and pegmatites, as well as intrusive granitic rocks, interlayered serpentinites and other ultramafic rocks, and rare 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 rare, with apatite, magnetite, epidote-clinozoisite, allanite, monazite, zircon, and xenotime reported as minor accessories (Hopson, 1964).

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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 meta-sedimentary rocks, about 2000 to 3300 meters thick, located in north-eastern Virginia. It underlies the Ordovician Quantico Slate, and over-lies 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

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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 a 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. 149) 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 contains more metasedimentary and granitic rocks than the Chopawamsic, including some highly metamorphosed gneisses.

Ijamsville and Urbana Formations

These formations occur in northwestern Montgomery and Howard Counties and southern Frederick County, Maryland, and probably overlie the Wissahickon Formation (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.

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Under the microscope these rocks are found to contain paragonite, chloritoid, and stilpomelane, in addition to the predominant chlorite and muscovite (Hopson, 1964). More sandy portions also contain quartz and albite, with epidote, tourmaline, apatite, titantite, 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. 111) apparently was operated in Ijamsville phyllite. Rare 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 <u>quartz float</u>) 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 possibly fine crystals. While the

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quartz in these veins is generally white, gray, or light brown, the crystals in cavities range from water clear (as at Aspen Hill, p. 117) to dark smoky brown (as around Columbia, p. 83) to amethyst (as in Arlington,p. 130). In some veins, as at Aspen Hill, tiny inclusions of chlorite give some crystals a green color.

The quartz frequently 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 the basic lithium-aluminum-cobalt-manganese oxide, lithiophorite. Some of these oxides result from the decomposition of sulfides, but most are merely the result of groundwater deposition.

The quartz veins nearly always have small amounts of fine-grained muscovite (sericite) in thin fractures, and the sericite 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 found 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. 84, 116) are known to produce specimens of fine rutilated quartz.

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In addition, the quartz veins have produced a host of metallic minerals, most notably gold (see p. 104). 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. The gold often contains some silver, and platinum has been reported from these veins as well (F. W. Stevens, verbal commúnication, 1975).

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

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Chalcopyrite (?)*(g)

Chlorite (m)

Feldspars (c)

Galena (r,g)

Goethite (c,s)

Gold (r)

- Electrum (r)

Hematite (m,s)

Ilmenite (m)

Limonite (c,s)

Lithiophorite (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 (?)

Wad (m,s)

*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 mineralo-

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gists, as well as major sources of wealth for miners and lapidarists. 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 nearly any other rock type, 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 it commonly ranges up to a meter or more in some deposits. Giant "logs" of beryl and spodumene several meters long are commonplace at certain pegmatites around the world, and crystals of feldspar and beryl up to nearly a meter across have been found at 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 hot water and other gases, often containing high concentrations of dissolved rare and volatile

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elements and silica, are abundant and play a major role in the formation of the rock.

Pegmatites are divided into the two broad categories of <u>simple</u> and <u>complex</u>, 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, though not always, larger than the average simple pegmatites.

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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 fig. 4. All these zones are not

Fig. 4 here.

necessarily 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. 35).

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

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 meta-

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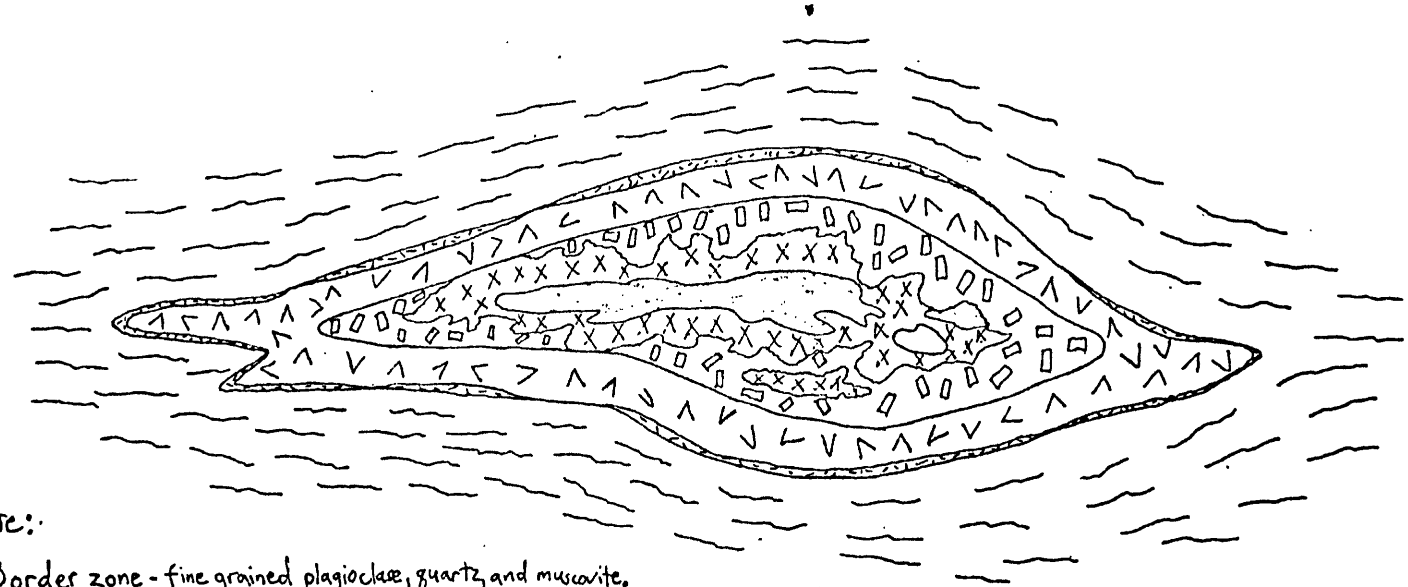

Pegmatite:

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

Schist or gneiss

Fig. 4

morphism, 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 which they contain. To further confuse things, numerous variants of the Wissahickon Formation 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 observe. 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. 136), in a foliated

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adamellite criss-crossed by numerous quartz veins. Few mineral specimens have come from these rocks.

Small dikes of generally unfoliated granitic rocks are quite 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 occasionally 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 very 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 and steatite are produced.

In the Washington area, gabbroic rocks compose the Baltimore Gabbro Complex, which extends in discontinuous belts from around Savage,

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Maryland, northeastward into Pennsylvania. Gabbro is the predominant rock type (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. 86).

Fig. 5 here.

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 which you can expect to see in these rocks are: actinolite, apatite, calcite, chalcopyrite, chlorite, clinozoisite-epidote, garnet, hornblende, ilmenite, magnetite, olivine, plagioclase, pyrite, pyroxenes, quartz, and titanite.

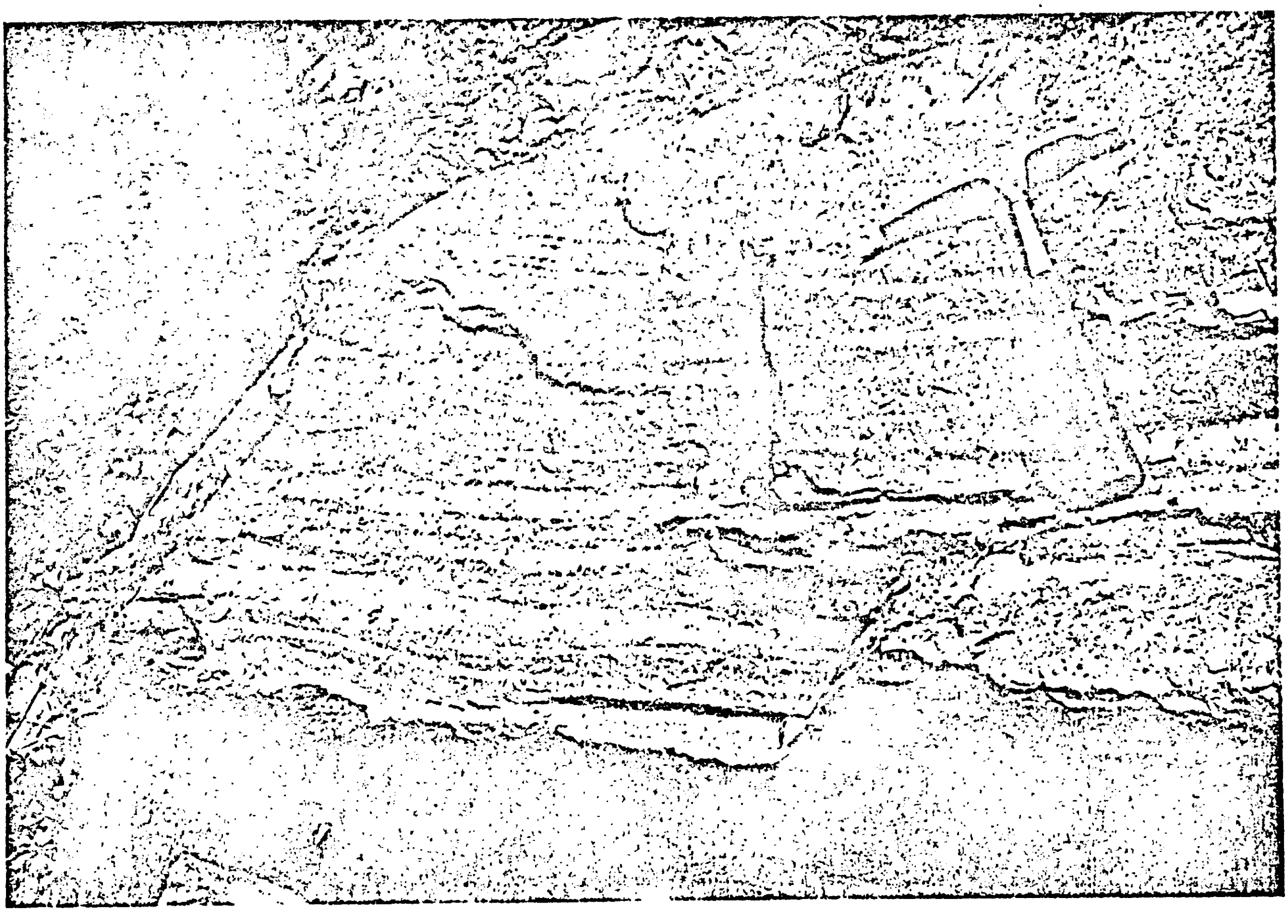

Fig. 5

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 the same chemical compositions, but different crystal structures and physical properties. Chrysotile tends to be fibrous, forming asbestos; but all these minerals are generally intimately intergrown and cannot be distinguished from eachother by any simple tests. Williamsite is a popular name given to translucent green, gem-quality serpentine, which usually has black inclusion 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. 94) and Delight (p. 48) 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 producers of much the same material. Areas underlain by serpentinite are generally quite easy to recognize. The weathering of serpentinite produces a reddish, poor soil, and the vegatation in such areas tends to be quite sparse and stunted (fig. 10). Such "serpentine barrens" are characteristic of areas underlain by serpentinite throughout the world.

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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. 45). The composition of serpentinite, being unusually high in magnesium, iron, chromium, and water, and low in silica and aluminum, has produced an unusual suite of minerals that makes the serpentinites some of the most interesting mineralogical sites around Washington.

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 emerald green from chromium, massive grossular and hydrogrossular, clinozoisite, and zoisite. Cavities in this rock often contain well formed crystals of these minerals, as well as of calcite and aragonite. 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 the serpentinite.

Various other veins and alteration zones in the serpentinite produce a host of other minerals. For more information on the mineralogy of these deposits, see the descriptions of the Hunting Hill (p. 94) and Soldiers Delight (p. 48) localities.

Steatite

Like serpentinite, steatite ("soapstone") is usually the result of the hydration of an ultramafic igneous rock such as periodotite or dunite, but where the alteration has proceeded to an even greater extent. The rims of serpentinite bodies are often composed of steatite themselves. 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. 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 preferred foliation. Steatite tends to weather 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 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. 102), in Washington, D. C. (p. 30), around Arlington, Virginia (p. 130), and at numerous smaller localities. The local steatite was long used by the American Indians for making bowls and other carvings, and most of the steatite bodies show some evidence of prehistoric mining.

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Triassic Deposits

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

The Triassic 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. The geology of the Triassic rocks and the locations of the associated mineral localities are shown on Plate 3.

Diabase

Diabase is a moderately fine-grained (about 1-5 mm), fairly dark igneous rock, that is a compositional equivalent to the extrusive lava-forming 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 or gabbro pegmatite. Volcaniclastic rocks and thin beds of basalt frequently occur near the diabase in the area.

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In the Washington area, Triassic diabase is most abundant in northern Virginia (fig. 6), where numerous quarries have been opened to

Fig. 6 here.

extract this rock for crushed stone. Smaller deposits also occur in neighboring Maryland. Some diabase dikes occur outside the limits of the Triassic 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. 155).

Sedimentary Rocks

The Triassic 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

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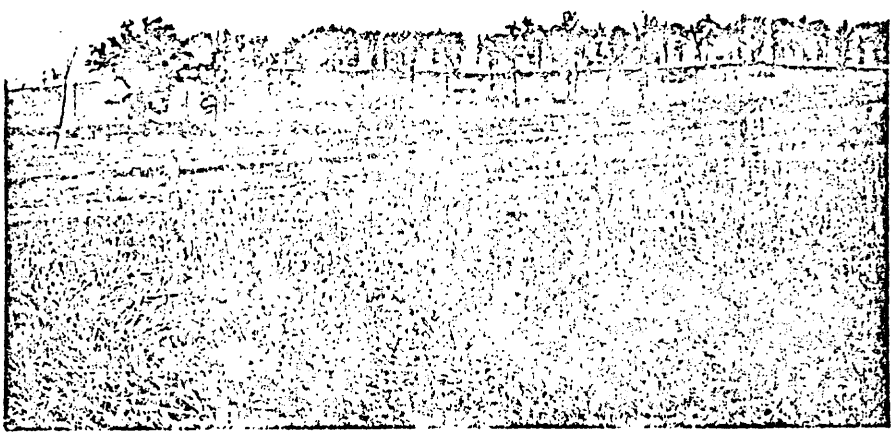

Fig. 6

do occur near contacts with diabase intrusives and occasionally in fault zones, as it discussed in the subsequent section.

Diabase Contact Zones and Related Deposits

When the hot, 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 and never more than a few hundred meters from the contact. In the red shales and sandstones, the most common results 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 <u>hornfels</u>. In some areas of intense contact metamorphism small nodules of fine-grained cordierite were produced in the hornfels.

In a number of 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 cooper minerals are other common associates of the con-

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tact 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 copper greens and blues, concentrated on fracture and bedding surfaces, give a misleading indication of the economic value of the rock, however, as the numerous abandoned, unprofitable copper mines and prospects in the area testify. 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 occasionally found in these zones.

The copper-rich zones also often contain a substantial amount of silver, reportedly up to twenty ounces per ton of ore (625 ppm) (Virginias, 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 also occur in some of these zones (D'Agostino and Hanshaw, 1970), and assays have detected substantial nickel (Virginias, 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

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with a known diabase body. The veins are generally quite 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 quite 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, 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 occasionally 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. 145).

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,,and possibly economic, 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 discussed 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 Maryland 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 Washington, D.C., and Vicinity

General: Johnston, 1964; Lonsdale, 1927; Maryland Dept. of Geology, Mines, and Water Resources, 1952; Maryland Geological Survey, 1964; 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.

Glenarm Series: Choquette, 1960; Higgins, 1972; Reed and Jolly, 1963;

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Southwick and Fisher, 1967.

Triassic Rocks: Roberts, 1928.

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MINERAL LOCALITIES

DISTRICT OF COLUMBIA

Washington

Figure 7 here.

Mineral localities in Washington, as in most big 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 given in the past tense, they still exist as clues to where similar, or even 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, verbal communication, 1975). Some of the goethite stalactites were exceedingly elongated and delicate, and occurred with the other minerals in hollow concretions, reportedly 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).*

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

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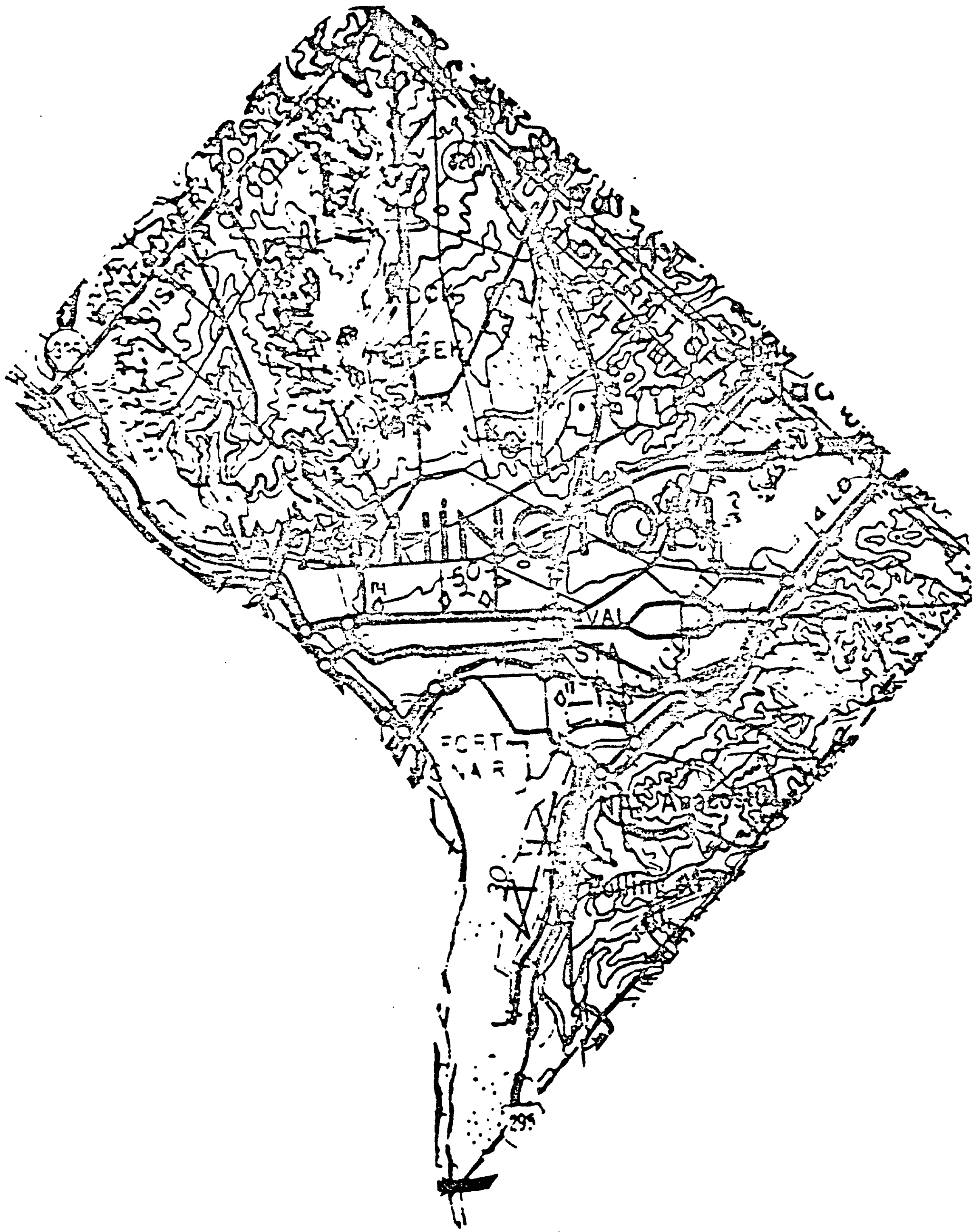

Fig. 7. Locations of mineral deposits in Washington, D. C. Numbers are the same as those used in Plate 1, and refer to the localities described in the text.

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, verbal communication, 1975). (Loc.3).

4. Foliated steatite containing chlorite and limonite pseudomorphs after pyrite occurs in a roadcut along 46th St. between Fessenden and Garrison Sts., 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., near Alice Deal Junior High School, was in the Smithsonian mineral collection (USNM) (Loc. 5).

6. Twinned rutile crystals in quartz were found along Piney Branch near Spring Road, N.W. (A. Bonanno, verbal 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 occurred (A. Bonanno, verbal communication, 1974). (Loc. 7).

8. Specimens of jasper and hornblende from the vicinity of Pierce Mill, near Tilden St. in Rock Creek Park, are in the Smithsonian collections, Numbers 106404 and 103068 respectively. (Loc. 8).

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

10. A piece of massive white opal containing quartz fragments was reportedly found in soil on Blagden Ave., near 16th St., N.W. (Ulke, 1936). (Loc. 10).

11. A marcasite concretion was found at First and M Sts., N.E. (Ulke, 1936). (Loc. 11).

12. Laumontite crystals were found in "stone quarries along Connecticut Ave.," (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 Ave. 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 Univ. shaft of the Waterworks Extension Project, 1883-1885, were found analcite crystals to two cm across, tremolite, hornblende, stilbite, and calcite (Ulke, 1936, and Smithsonian specimens (USNM-DC*)). (Loc. 14).

17. A specimen of gold in quartz from Longbridge, where M St. crosses Rock Creek, is in the Smithsonian collection (USNM 12013). Light

* USNM-DC refers to U.S. National Museum, uncatalogued collection of minerals from Washington, D.C. and vicinity.

yellowish green apatite crystals up to 5 cm 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 seven 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 (USNM 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 analcite, in quartz veins and hornblende diorite. (Loc. 16).

19. A pit in steatite and chlorite schist, called the Rose Hill Quarry, was located just west of the intersection of Albemarle St. and Connecticut Ave., N.W., and was first worked in prehistoric times by American Indians (Holmes, 1890). Actinolite crystals occurred in the steatite (USNM-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 Streeet, N.W. (USNM-DC). (Loc. 18).

21. Dark green hornblende crystals up to three centimeters long occur in Wissahickon schist at the National Zoological Park (USNM-DC).

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

Chrysocolla- crusts on rocks (Ulke, 1936, and USNM-DC).

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867-100

Titanite- light green, transparent crystals in chlorite are in the Smithsonian collection (USNM-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

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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, furnishes [sic] 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

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here (Ostrander and Price, 1940). (Loc. 4).

Miscellaneous localities

Iron Mines in the Coastal Plain of Anne Arundel, Prince Georges, 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 a bed of lignitic gray clay (red-orange when weathered), of Lower Cretaceous age, sometimes known as the Arundel Clay (Fig. 3). When fresh and free of impurities the siderite nodules are gray to light tan, massive, and break with a conchoidal fracture. Small crystals of siderite and sometimes gypsum occur in fractures. Most of the nodules, however, are at least partially oxidized to orange-brown limonite, and contain abundant impurities of quartz sand and other materials. Limonite is used as a generic term to include a mixture of poorly defined 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 <u>ocher</u>, 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, the 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. 124).

Virtually all the mines and furnaces indicated on the map (Fig. 8) are now obliterated, but similar material is easily and abundantly

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available from any roadcut, claypit, or other excavation nearly anywhere within this belt of Arundel Clay.

Figure 8 here.

BALTIMORE COUNTY

Soldiers Delight

Figure 9 here.

Location

Soldiers Delight is a region rather than a particular locality, and its approximate extent is indicated on Fig. 9.

Description

The Soldiers Delight district is underlain by serpentinite, and is characterized by rolling hills with a thin, red-orange soil cover that supports grasses and generally scrubby vegetation (Fig. 10). A number of chromite mines and small stone quarries have been opened in this vicinity, 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.

Figure 10 here.

The serpentinite at Soldiers Delight differs from that at the Hunting Hill quarry (p. 94) 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

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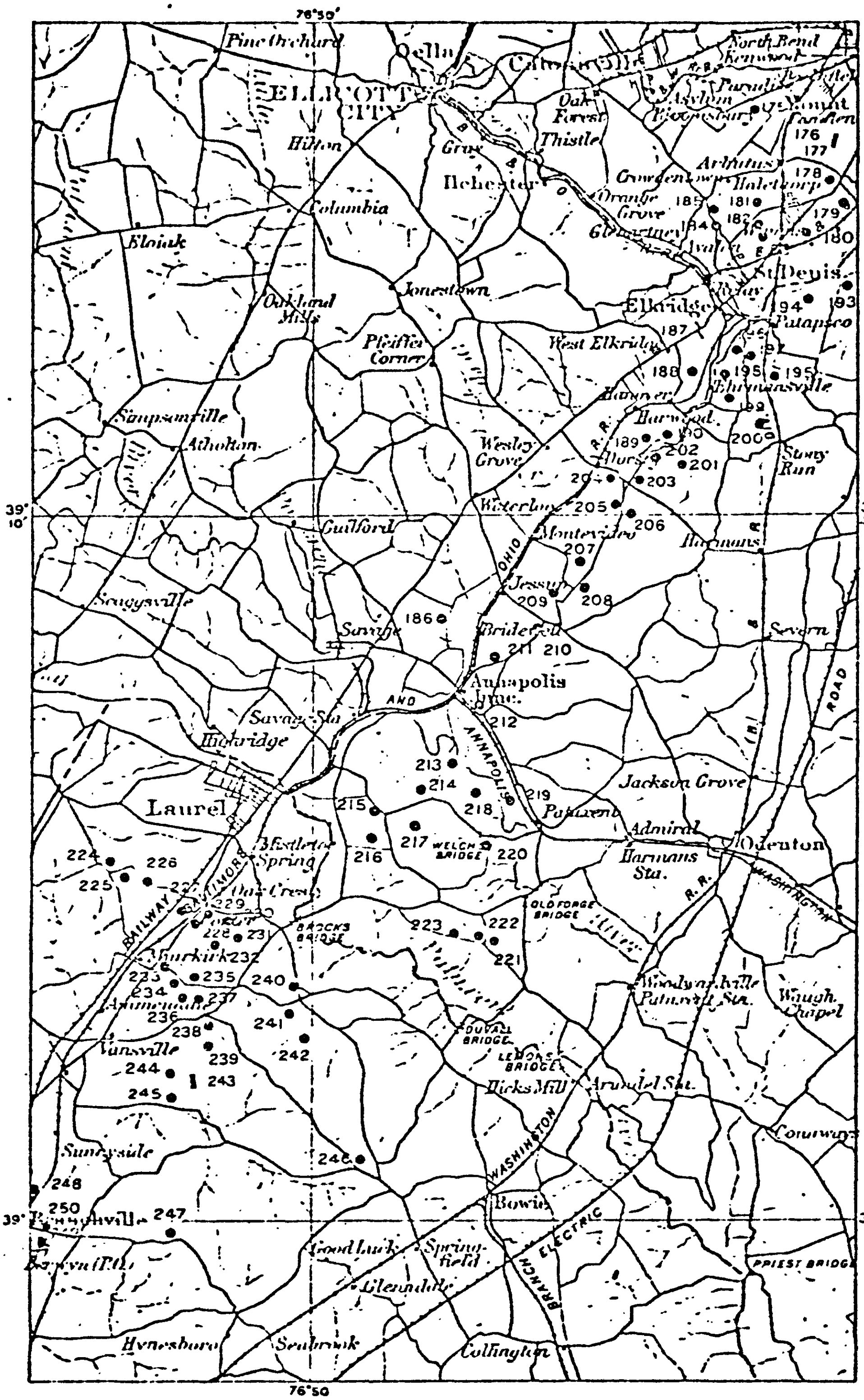

LOCATION OF IRON ORE BANKS IN PARTS OF BALTIMORE, HOWARD, ANNE ARUNDEL AND PRINCE GEORGE'S COUNTIES

Fig. 8·

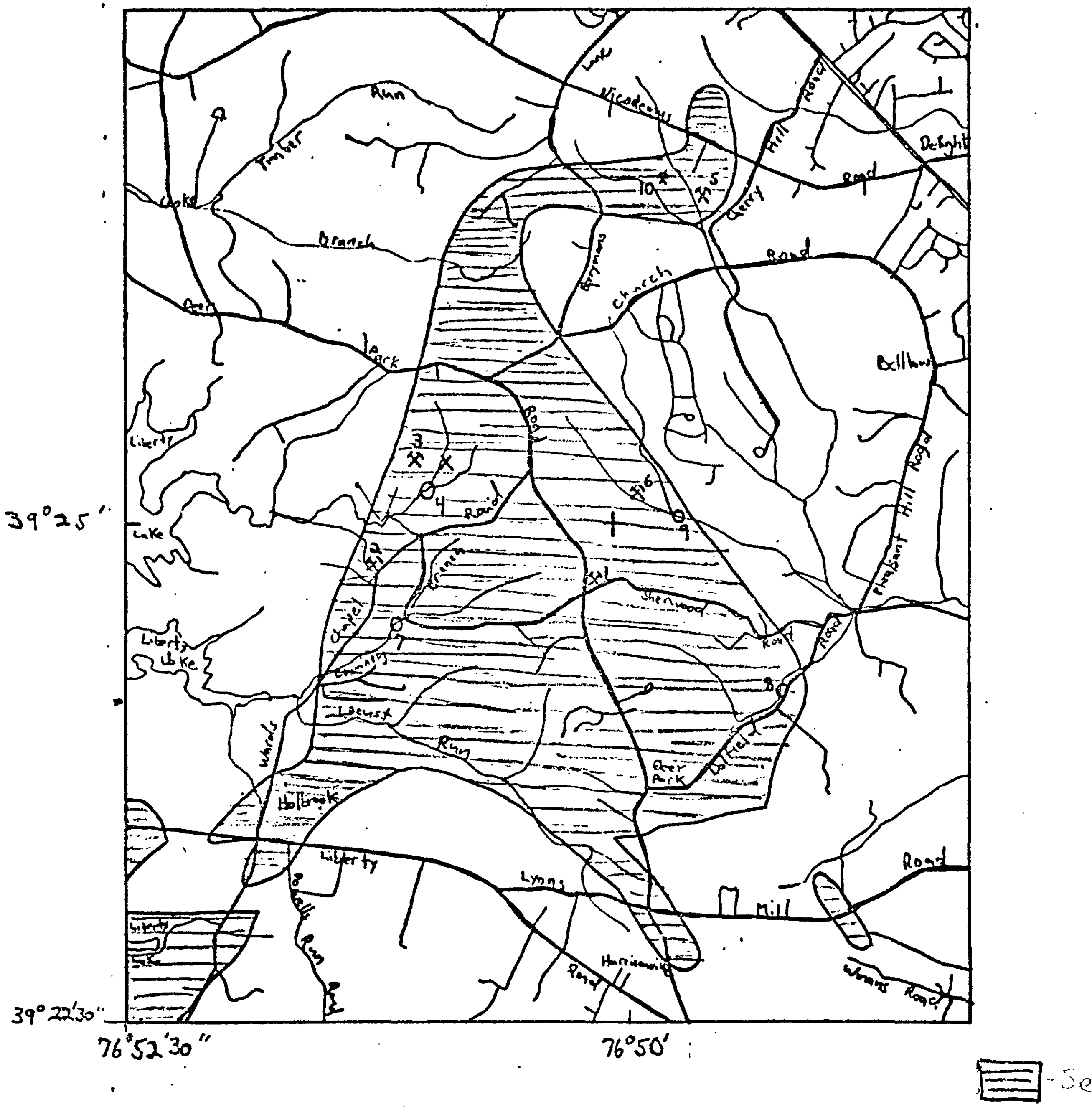

Fig. 9.

Localities

1. Choate mine
2. Weir mine
3. Harris mine
4. Old Triplett placer
5. Calhoun mine
6. Unnamed chromite mine
7. Triplett placer
8. Oolfield (ROSE) placer
9. Gore placer
10. Oelight quarry

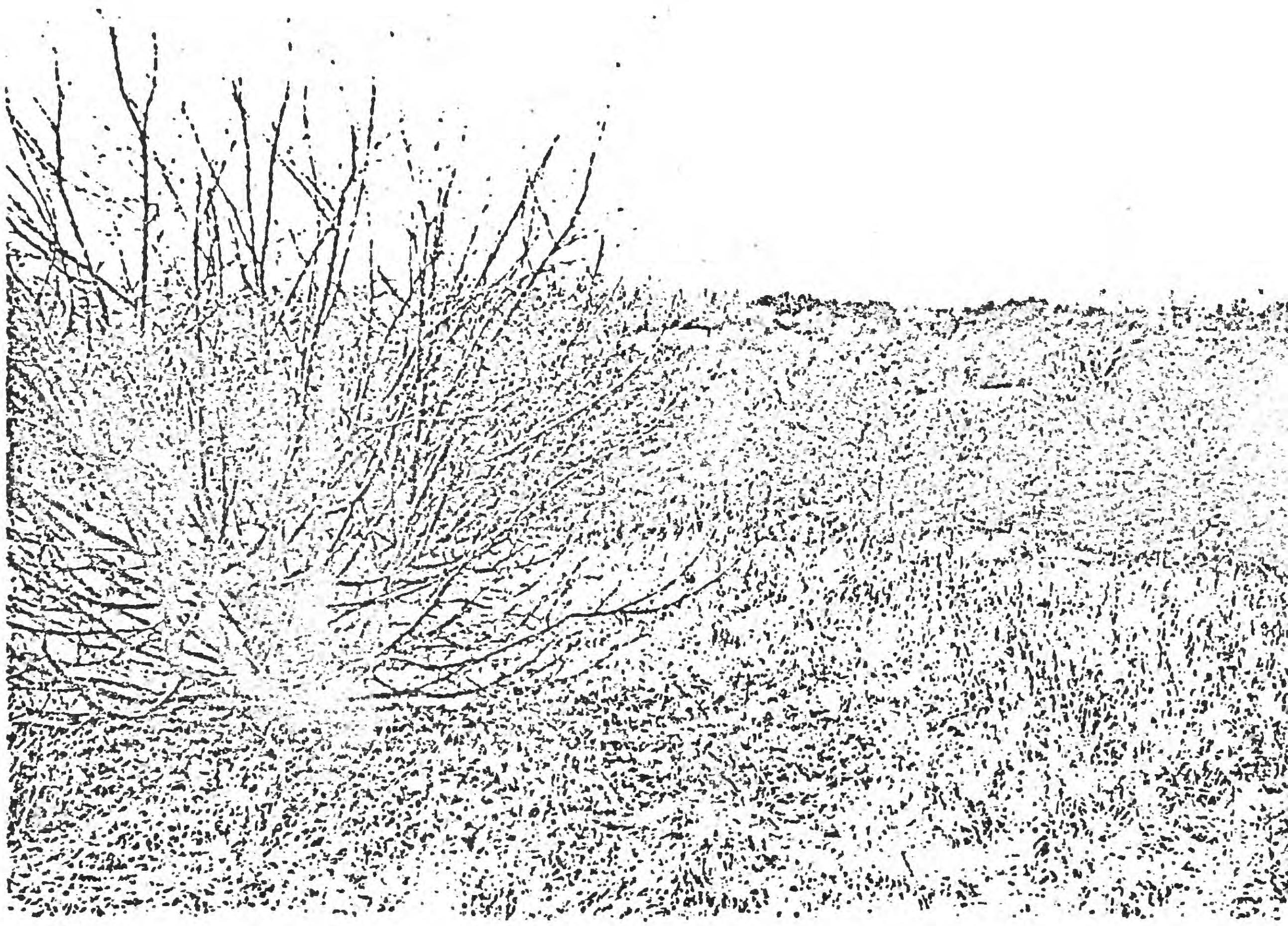

Fig. 10.

(known as "birdseye ore"), but veins and lenses of massive chromite up to more than a meter across are not rare. Williamsite, the translucent green gem variety of serpentine is commonly associated with concentrations of chromite.

Veins of magnesite are also quite common, as are scattered masses of geothite 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. 48)

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

Kammererite - pink to purple chromian chlorite, with chromite

Goethite - black to brown masses in weathered serpentinite

Magnesite - chalky white veins

Quartz - chalcedony and jasper common as float

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Serpentine - williamsite occurs near concentrations of chromite; variety picrolite also present

Stevensite - in waxy brown veins, mixed with serpentine minerals ("deweylite"); fluoresces green in ultraviolet radiation.

Talc - massive, or foliated white to light green crystals, in altered serpentinite

Wad - black masses in weathered 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 waterfilled mine is still visible (fig. 11), 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 disseminated "birdseye ore" is abundant. Specimens of the other minerals listed above can be found, with some digging, in the surrounding small dumps.

Fig. 11 here.

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

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Fig. 11

100 meters west of the road, just north of the lumber yard.

The Weir Mine was the largest chrome working in this district, through 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. 9). 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

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magnesite, white opal, "deweylite" (a yellow to brown, soft, waxy mixture of stevensite and the serpentine minerals clinochrysotile and lizardite), and chalcedony. These altered zones most commonly form curving sheets from a few centimeters to a meter thick, bounded by slickenslides.

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, are also frequently encountered in these zones.

This quarry is known particularly for the large quantities of the serpentine rock picrolite (see p. 28), which occurs in regions 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. 12). Large rhombs of calcite are

Fig. 12 here

sometimes found in this material, as are concentrations of fine chromite grains.

Chromite is quite 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), and garnierite has also been reported from this quarry (Ostrander and Price, 1940). As the rock at the Delight quarry has been extensively

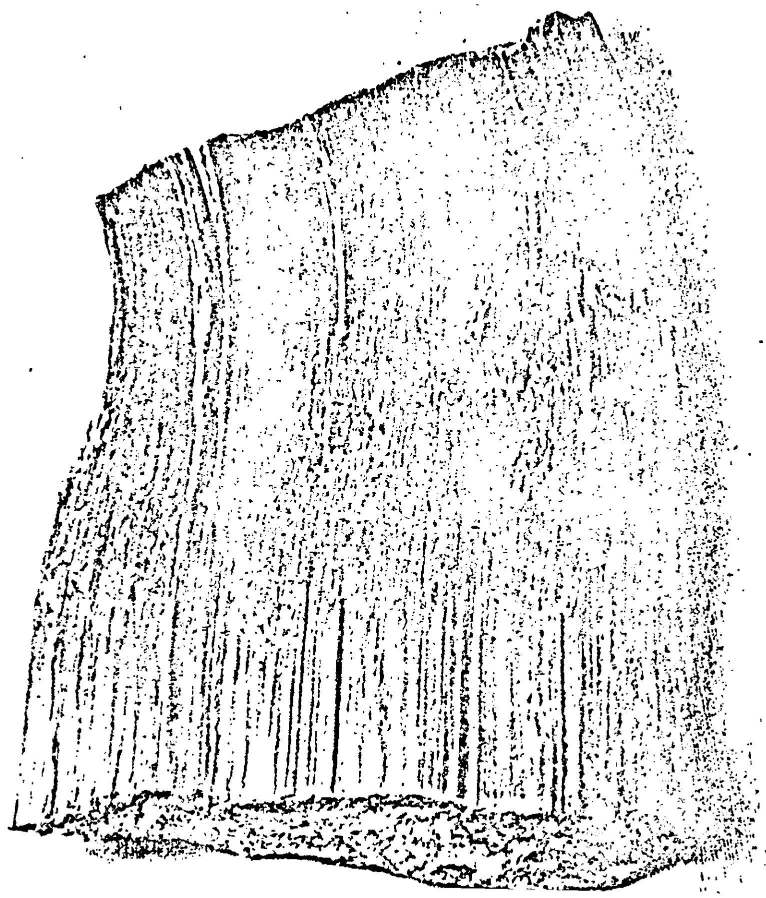

Fig. 12

altered, and contains an abundance of fracture fillings, replacement zones, and small cavities, it can be expected that a number of additional minerals will turn up upon further inspection.

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).

Opal - white; mixed with magnesite and as separate translucent veins, often with dendritic pyrolusite.

Pyrolusite - black dendrites with magnesite and opal.

Quartz - drusy crystals less than three 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).

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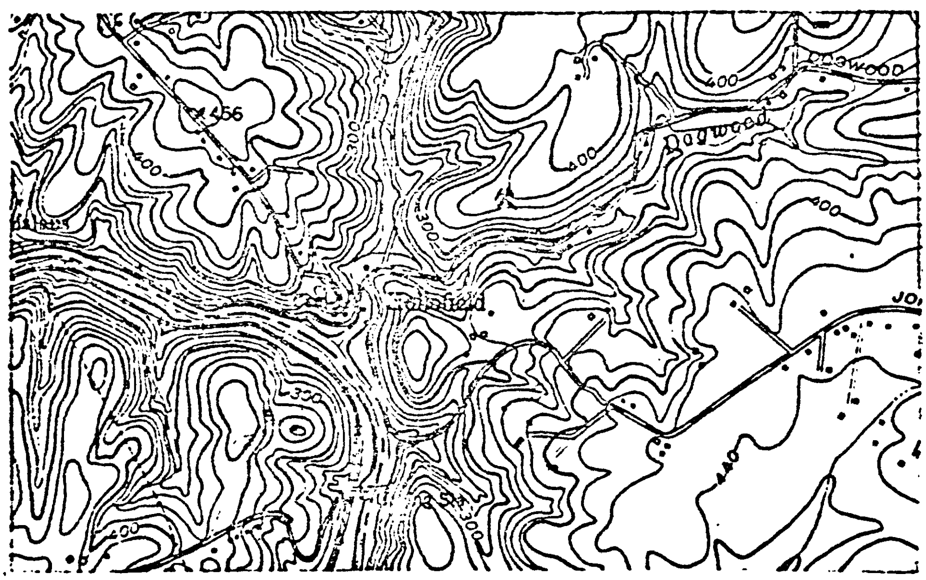
456
400
300
400
DOGWOOD
Dogwood
400
300
400
300
300
300
400
440
JO

Fig. 13.

Fig. 14

Serpentine - constitutes bulk of serpentinite; contains antigorite, lizardite, chrysotile, and clinochrysotile; picrolite is quite common; williamsite is occasionally found

Stevensite - waxy yellow to brown veins mixed with clinochrysotile and lizardite ("deweylite")

Bok Asbestos Mine

Hollofield

Loc. 11

Fig. 13 here

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. 14). 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.

Fig. 14 here

Description

The Bok asbestos mine is situated in a body of partially amphibolized layered gabbro and pyroxenite. This rock is probably a portion of the Baltimore Gabbro Complex (p. 26), as described by Hopson (1964).

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The asbestos mined here was the white, fibrous variety of the amphibole anthophyllite. Anthophyllite fibers 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 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

Fig. 15 here

Quarries in the Cockeysville Formation

The following three quarries, as well as the Howard-Montgomery quarry in Howard County (p. 74), are located in the marble and related rocks of the Cockeysville Formation. 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 Formation see p. 14.

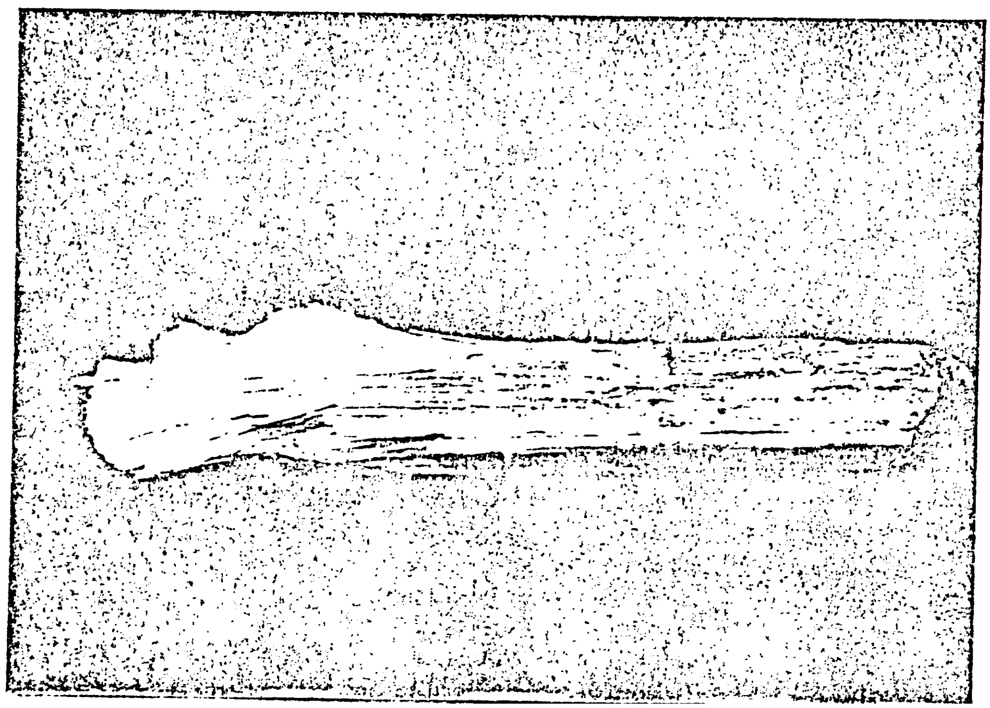

Fig. 15 Anthophyllite asbestos from the Cole Mine. Specimen is 11 cm. long.

Texas Quarries

(H. T. Campbell Limestone Quarry)

Texas

Loc. 12

Fig. 16 here

Location

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

Description

The Texas quarries are a group of very large openings in the Cockeysville Formation, the largest of which is currently operating. The rock here is broadly divided 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 does white, bladed tremolite, often in radiating aggregates, and gray-green diopside. Purple fluorite was common at one time in the marble, and will probably be uncovered again. Pyrite crystals, both

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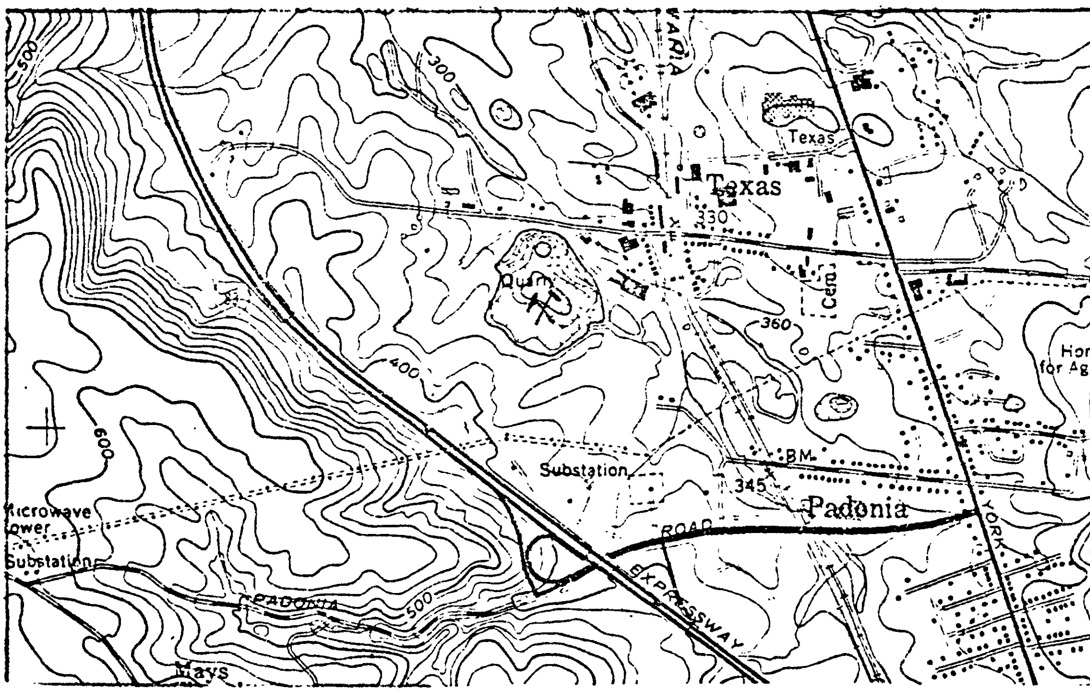

500
300
Texas
Texas
330
Quarry
Cem
360
400
600
Home
for Age
BM
Substation
345
Padonia
Microwave
tower
Substation
ROAD
EXPRESSWAY
YORK
PADONIA
500
Mays

Fig. 16.

pyritohedra and octahedra, are quite easily found, as is massive pyrrhotite.

Minerals

Amphibole - fibrous variety known as "mountain leather" (Ostrander and Price, 1940)

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

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Margarite (Ostrander and Price, 1940)

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

Plagioclase - gray to light green masses with quartz in pegmatitic pods

Pyrite - common as irregular masses, occasionally as small octahedra or pyritohedra

Pyrolusite - occasional dendrites on marble

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 (Ostrander and Price, 1940)

Tremolite - white, bladed crystals, often in radiating aggregates, in calc-silicate zones with quartz and talc

Wollastonite (Ostrander and Price, 1940)

Marriottsville Quarry

Hernwood

Loc. 13

Fig. 17 here

Location

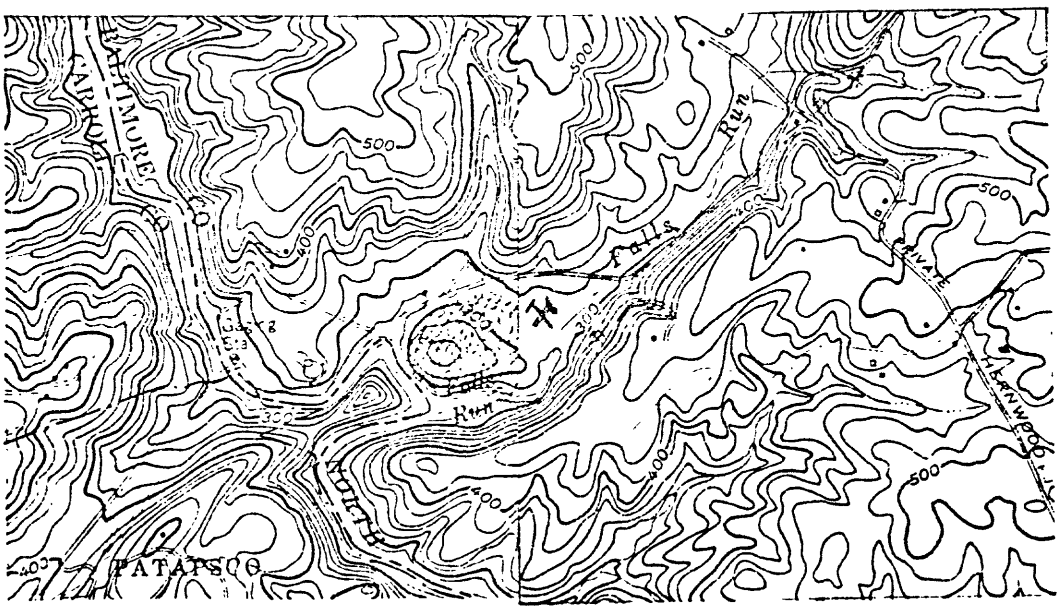
The Marriottsville quarry is about 4.8 km northeast of Marriottsville, and is reached by taking Marriottsville Road for about 0.3 km northeast from its juncture with Wards Chapel Road. The quarry is currently operated for crushed stone by the Harry T. Campbell Sons' Company, and permission to enter it must be obtained at the quarry office.

Description

This is another large opening in the Cockeysville Formation, 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 or biotite and quartz, is commonly interlayered with the marble (fig. 18).

Fig. 18 here

At some places in the quarry, layers of calcite marble and of phlogopite-biotite-, quartz-, titanite-, and pyrite-rich rock, each a few centimeters



BALTIMORE
CARROLL
500
400
300
Falls
Run
Cooks
Run
NORTH
PATAPSCO
PRIVATE
HARNWOOD

Fig. 17.

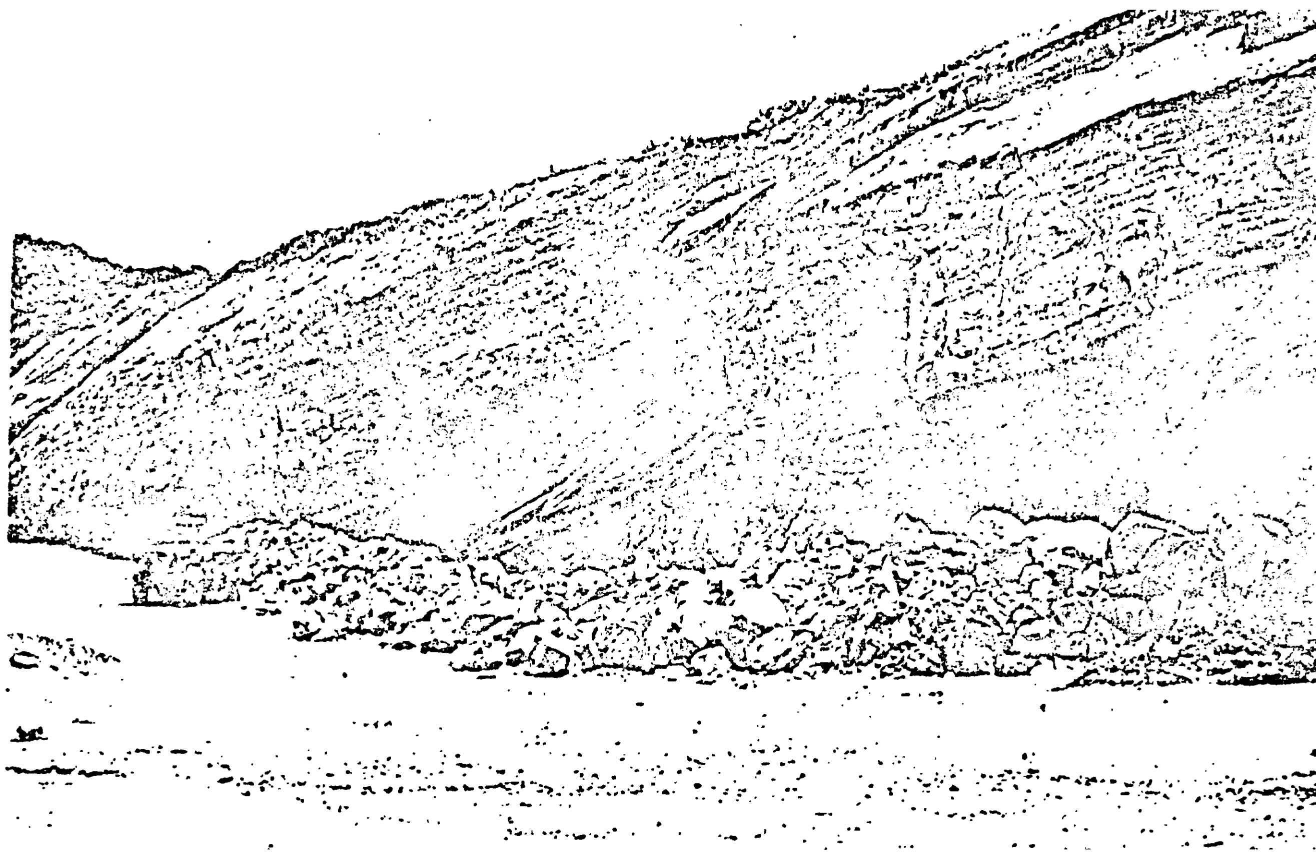


Fig. 18

thick, alternate regularly with eachother 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. 18).

This quarry is near the contact with the overlying Wissahickon Formation (see p. 15), and some of the schists of this formation 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 kyanite blades, as well as garnet and staurolite crystals.

Minerals

Apatite - occasional 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 - occasional 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 - occasional 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

Muscovite - occasional plates with quartz, euhedral crystals in cavities

Phlogopite - abundant throughout marble, often segregated in layers with quartz

Plagioclase - occasional gray to light-green crystals with quartz

Pyrite - common as irregular masses; concentrated in calcite marble immediately overlying large gneissic layers

Pyrrhotite - occasional 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

Talc - occasional foliated masses with tremolite

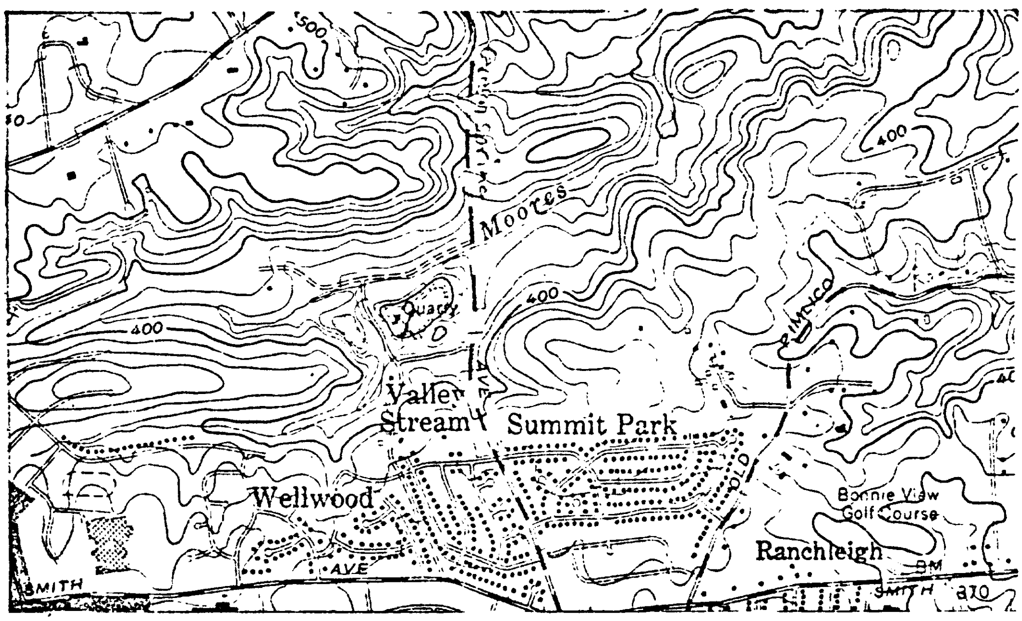
Tremolite - white, bladed, often radiating crystals, in calc-silicate zones with quartz

Greenspring Quarry
(McMahon Quarry)
Towson
Loc. 14

Fig. 19 here

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.



Moores
Quarry
400
400
400
Valley
Stream
Summit Park
Wellwood
Bonnie View
Golf Course
Ranchleigh
BM
SMITH
AVE
OLD
PIMLICO

Fig. 19.

Description

The Greenspring quarry is a large opening in a predominantly gneissic facies of the Cockeysville Formation. 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 the pegmatites. 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, dray 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 bulk of marble; also in calc-gneiss

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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 pegmatites

Garnet - small crystals in pegmatite

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 pegmatite and calc-gneiss

Muscovite - coarse crystals in pegmatite

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 pegmatites; also as fine-grained, sometimes irridescent coatings on fracture surfaces

Pyrrhotite - massive, in marble, with coarse white calcite

Quartz - in veins, pegmatites, and calc-gneiss; occasional crystals in cavities

Rutile - elongated prismatic, striated, silver-colored crystals, at

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contacts between pegmatites and marble, with dravite and muscovite

Scapolite - occasional small gray crystals, fluoresces yellow in long-wave 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

Fig. 20 here

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

Fig. 20.

from Route 32 (fig. 21).

Fig. 21 here

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

The underground workings are flooded and generally inaccessible, and collecting can be done on the dumps. This is mostly reservoir property, and permission from the County 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

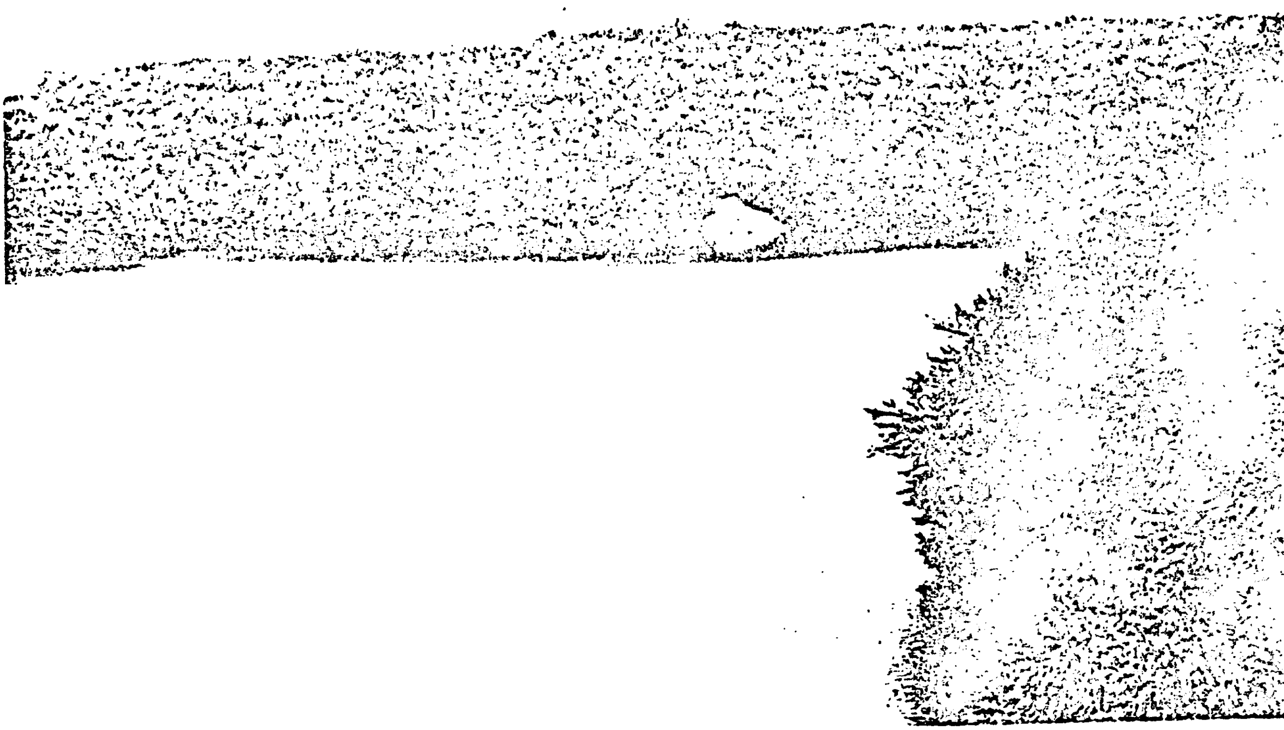

Fig. 21

grains. In places, magnetite and chalcopyrite are mixed in almost equal proportions, producing a salt-and-pepper effect.

The cobalt minerals of these veins are in the linnaeite group, (Co, Ni, Cu)$_3$S$_4$, and one of the members of this group, carrollite, Co$_2$CuS$_4$, was named after its occurrence here in Carroll County. At Mineral Hill, the composition apparently ranges between carrollite and siegenite, (NiCo)$_3$S$_4$ (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 which 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 the primary minerals 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. 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

Fig. 22 here

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

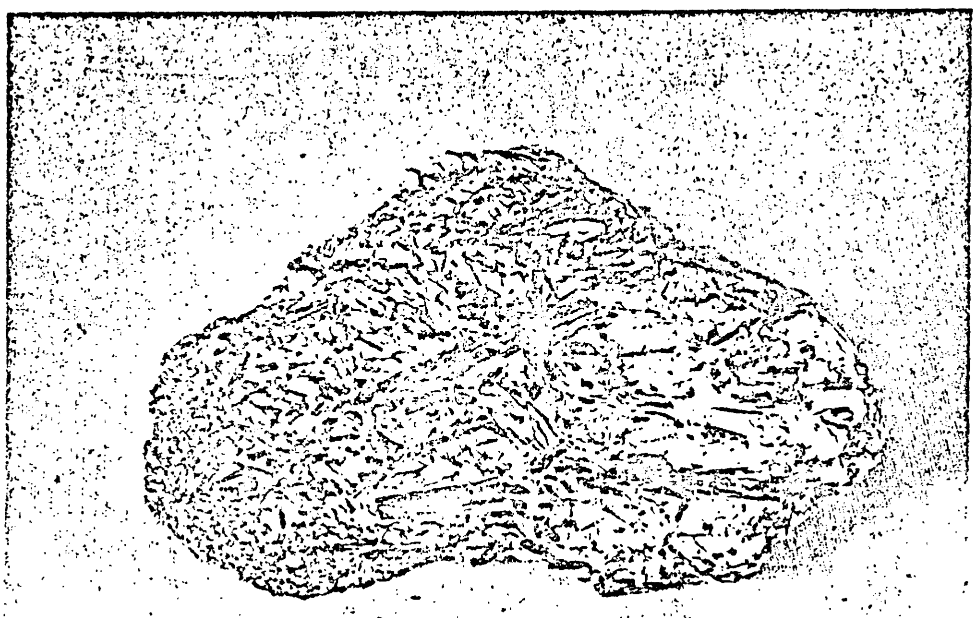

Fig. 22

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
AnO	34.48
CoO	1.48
CuO	0.14
MnO	0.26
Insol.	1.50
Total	99.14

Gold - small flakes in magnetite (USNM 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.

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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

Fig. 23 here

Location and History

The Springfield 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. 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

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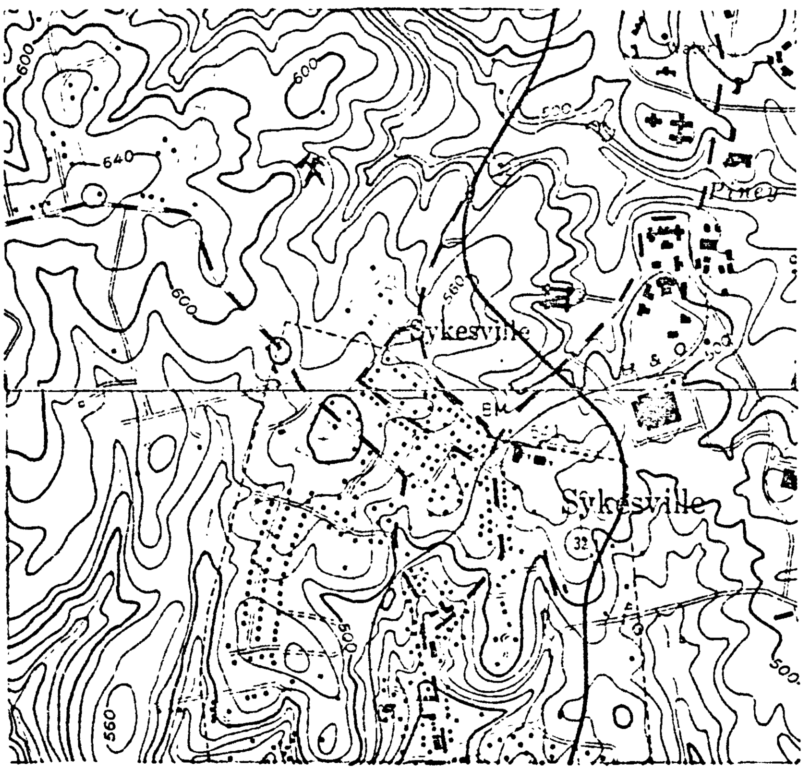

600
600
640
500
Piney
560
600
Sykesville
Sykesville
32
500
560
500

Fig. 23.

ferrosilicon (Heyl and Pearre, 1965).

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 calcopyrite 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

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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 - occasional lustrous, black, botryoidal masses

Idaite - USNM 103479

Limonite - red to brown masses and stains

Linnaeite - cuprian; silvery to pinkish-gray metallic masses, and rare octahedral crystals, in magnetite. Shannon (1926) gave the following analyses 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

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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) - in 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

Fig. 24 here

Location

This quarry can be reached by taking Lime Plant Road for about 1.6 km east from Route 75 in New London. 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

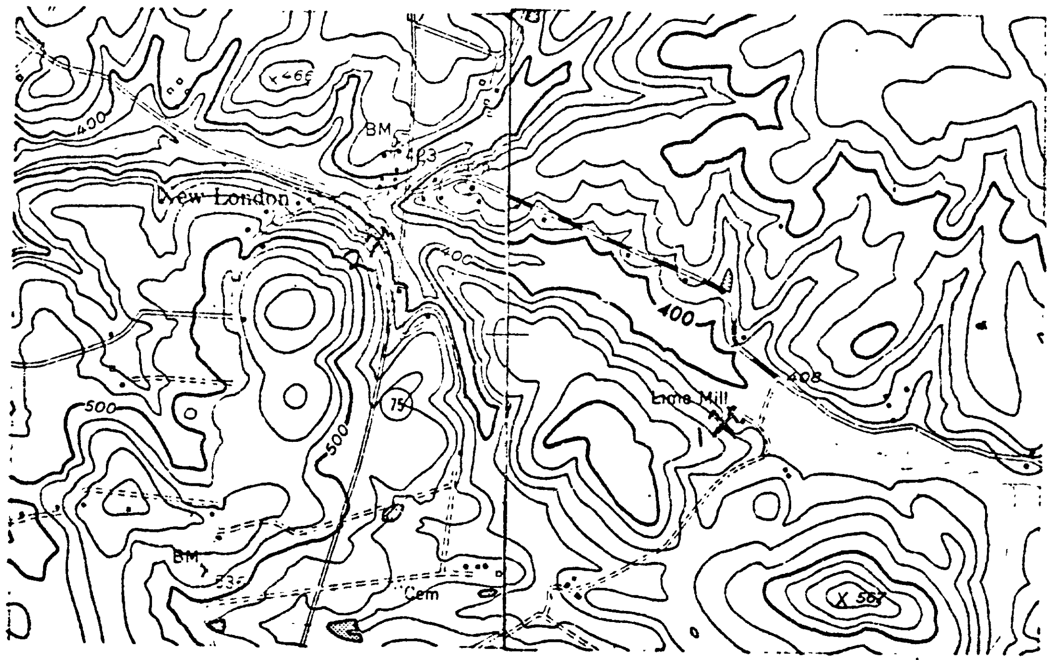

Fig. 24.

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. 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 often seen as a secondary coating on the other minerals, as is pyrolusite, which often occurs in delicate dendrites (see fig. 25). Hemimorphite and smithsonite have been found here

Fig. 25 here

recently (G. Brewer, personal communication, 1975), as have rosasite, cuprite, and linarite (H. Corbett, verbal communication, 1975).

Metallic minerals have been found in similar environments throughout this part of Frederick County, and the bulletin by Pearre and Heyl (1965) describes these deposits in detail. At the nearby New London Copper Mine (see above map), 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,

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Fig. 25

silver, and gold, in a fissure vein (probably a fault) striking N. 69° W. and dipping southward at 70° in black phyllite and a thin lens of marble.

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, verbal 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, verbal communication, 1975)

Limonite - orange stains common

Linarite - small, elongated blue crystals (H. Corbett, verbal communication, 1975)

Malachite - green stains on marble, often associated with pyrolusite

Pyrolusite - 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, verbal communication, 1975)

Smithsonite - reported as white crusts (G. Brewer, verbal communication, 1975)

Sphalerite - light to usually 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

Fig. 26 here

Location

This locality 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 often cause mineral collectors to put it in the ranks of the world's more desirable mineral species. The goethite from Point of Rocks, however, is exceptional for its occurrence in highly lustrous, black, botryoidal and stalactitic masses (see fig. 27).

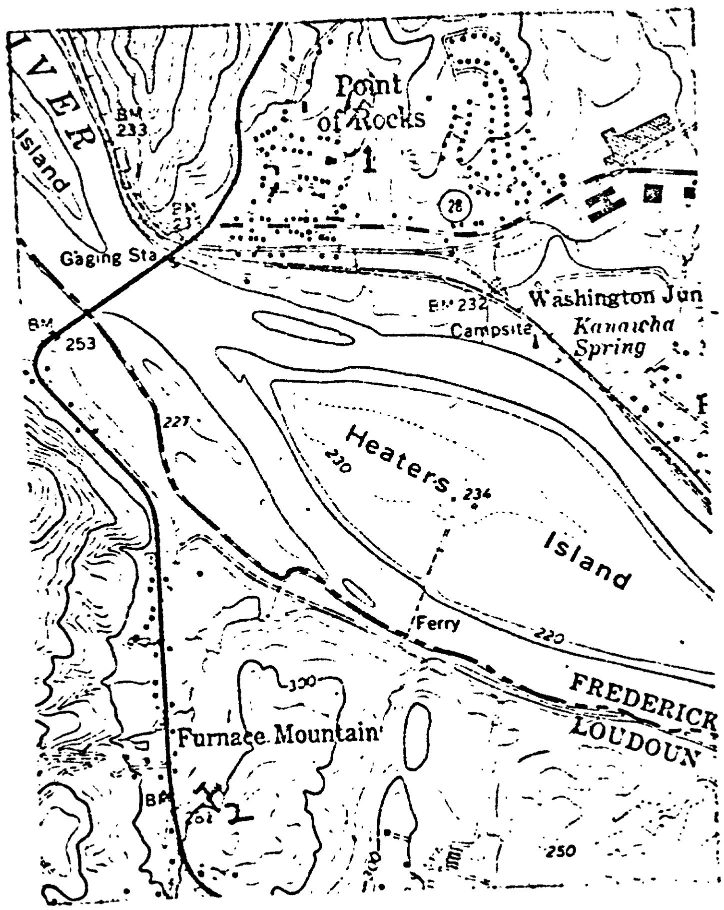
Point of Rocks
BM 233
Island
Gaging Sta
BM 232
Washington Jun
Kanawha Spring
Campsite
BM 253
227
Heaters Island
230
234
Ferry
220
FREDERICK
LOUDOUN
Furnace Mountain
300
250
28

Fig. 26.

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.

Fig. 27 here

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. 26). 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

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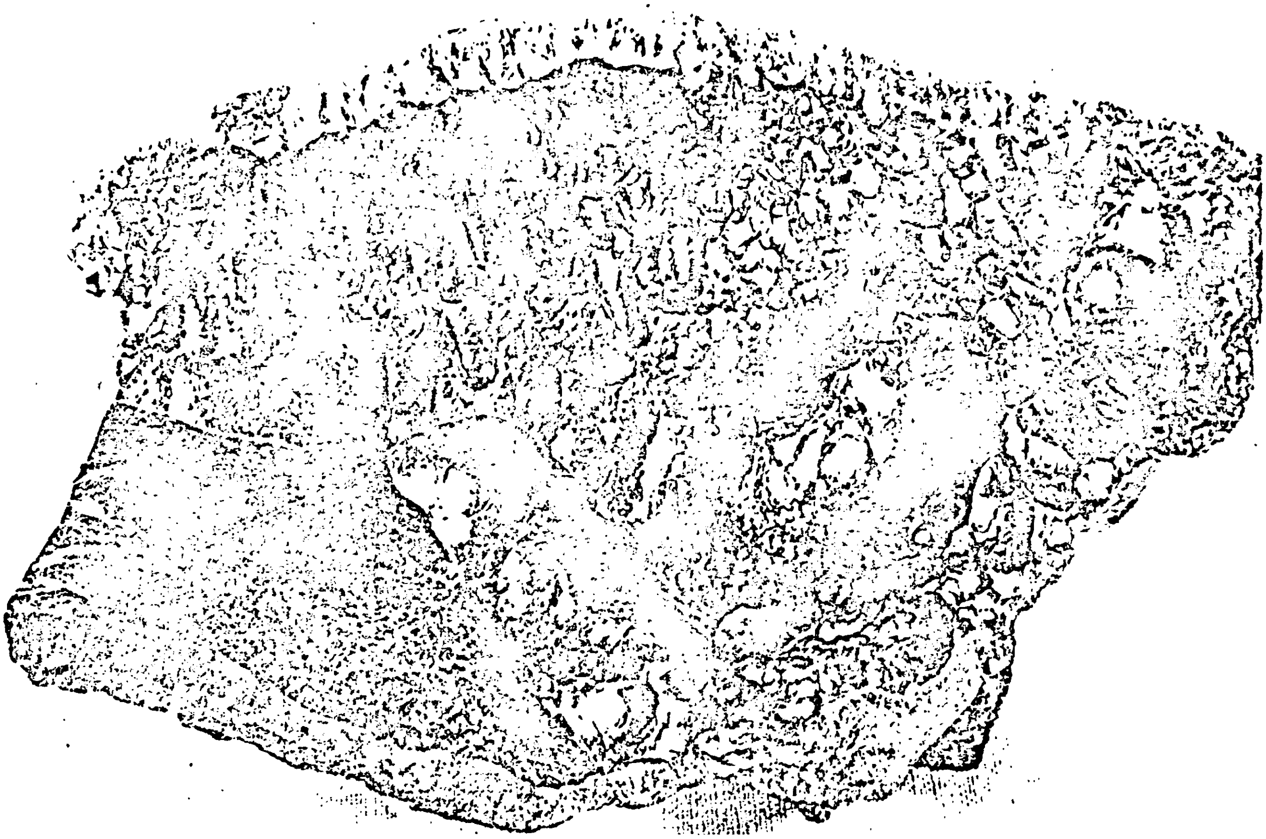

Fig. 27

HOWARD COUNTY

Howard-Montgomery Quarry

(Brighton Quarry)

Clarksville

Loc. 1

Fig. 28 here

Location

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

Description

The Howard-Montgomery quarry is situated in a rather thin portion of the Cockeysville formation along the southern flank of the Clarksville gneiss dome. The mineralogy and geology is characteristic of the Cockeysville formation (see p. 14), 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. 29), which sometimes grade into a calcite-bearing biotite-quartz gneiss, especially towards the upper parts of the quarry. Metadolomite is

Fig. 29 here

somewhat less abundant than calcite marble, and usually occurs as fine-grained gray layers.

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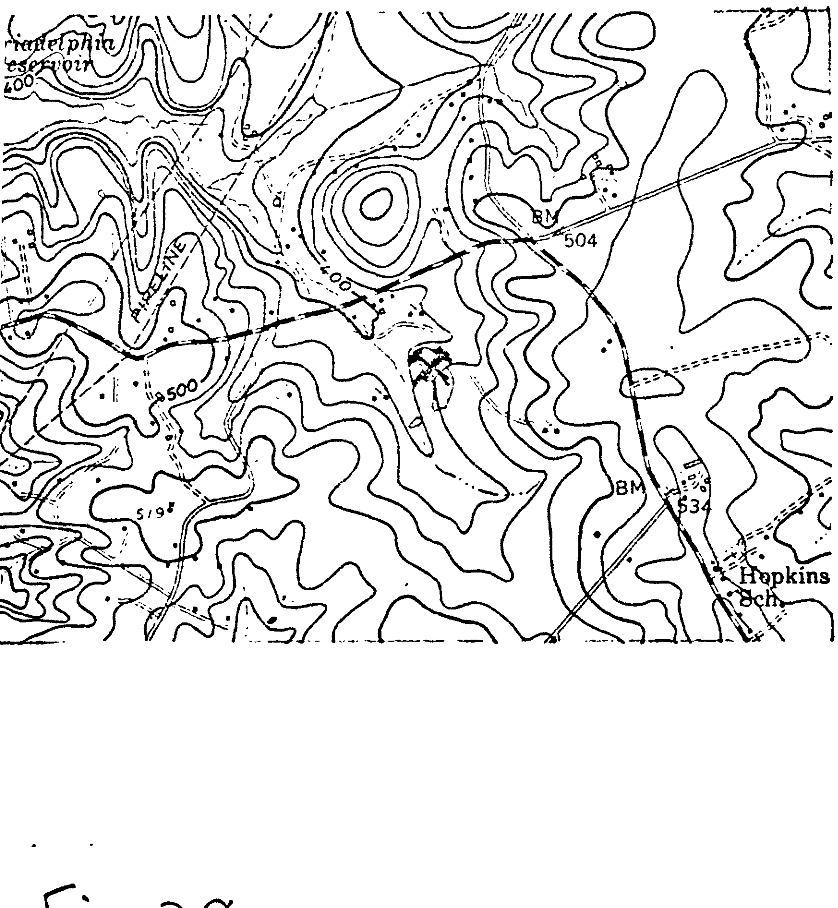

iadelphia
eservoir
400
PIPELINE
400
BM
504
500
519
BM
534
Hopkins
Sch.

Fig. 28.

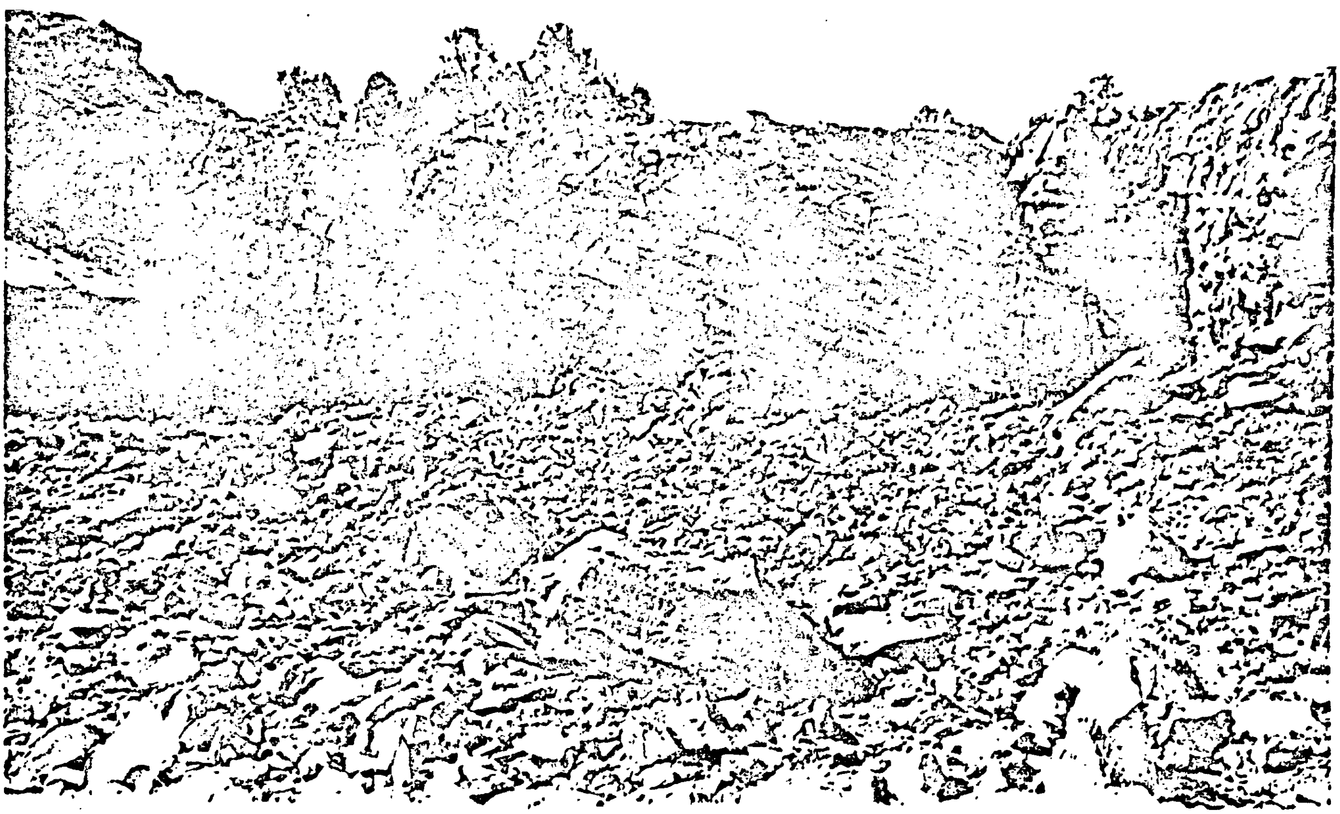

Fig. 29

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 plagioclase crystals, as well as some chalcopyrite, pyrite, muscovite, and phlogopite. A number of other minerals are found at 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 which 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. 30). 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, verbal 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 expect, see the section on the Cockeysville Formation (p. 14), and also descriptions of the other quarries in this formation.

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Fig. 30 here

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

Limonite - brown to orange stains common, especially near pyrite

Malachite - occasional coatings, mostly with chalcopyrite

Mackinawite - black, tetragonal flattened bipyramial 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

Plagioclase - occasional gray crystals, with quartz

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, often twinned silvery crystals up to 2 cm long with quartz; sometimes in cavities

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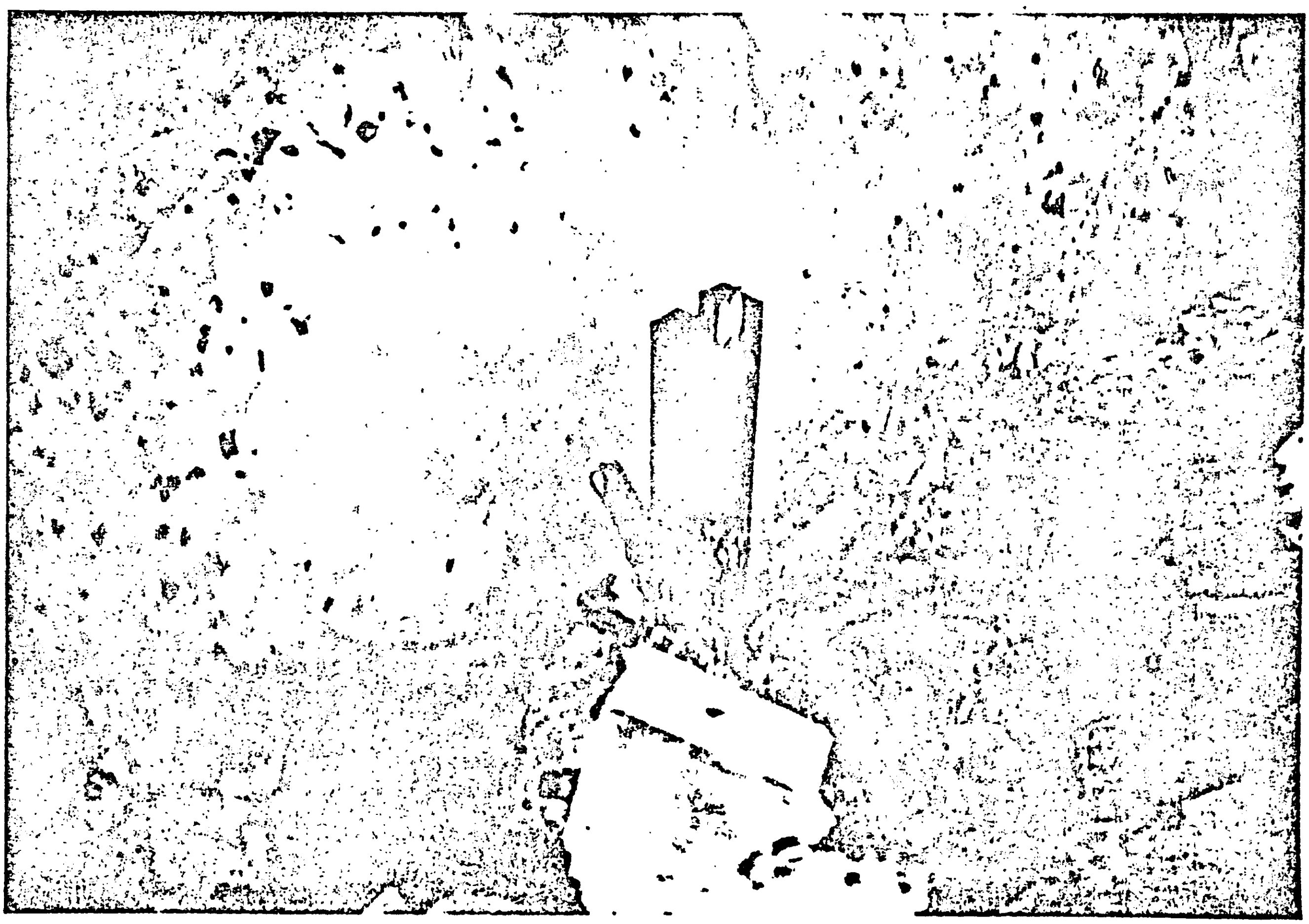

Fig. 30.

Scapolite - (Karl Funkhouser, verbal 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

Fig. 31 here

Location and History

The Ben Murphy mine is located immediately to the west of US Route 29, 1.8 km north of the Patuxent River. Some of the dumps are visible from the road (see fig. 32). The old pits were in the small ravine which goes under the road and are now nearly undiscernible. Collecting is restricted to the dumps near the road.

Fig. 32 here

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 property of the Washington Suburban Sanitary Commission and permission from them must be secured before entering the property.

Description

This mine was opened in a pegmatite dike very typical of the complex pegmatites in the Wissahickon Formation of Howard and Montgomery Counties. As the pegmatite is no longer exposed, the exact

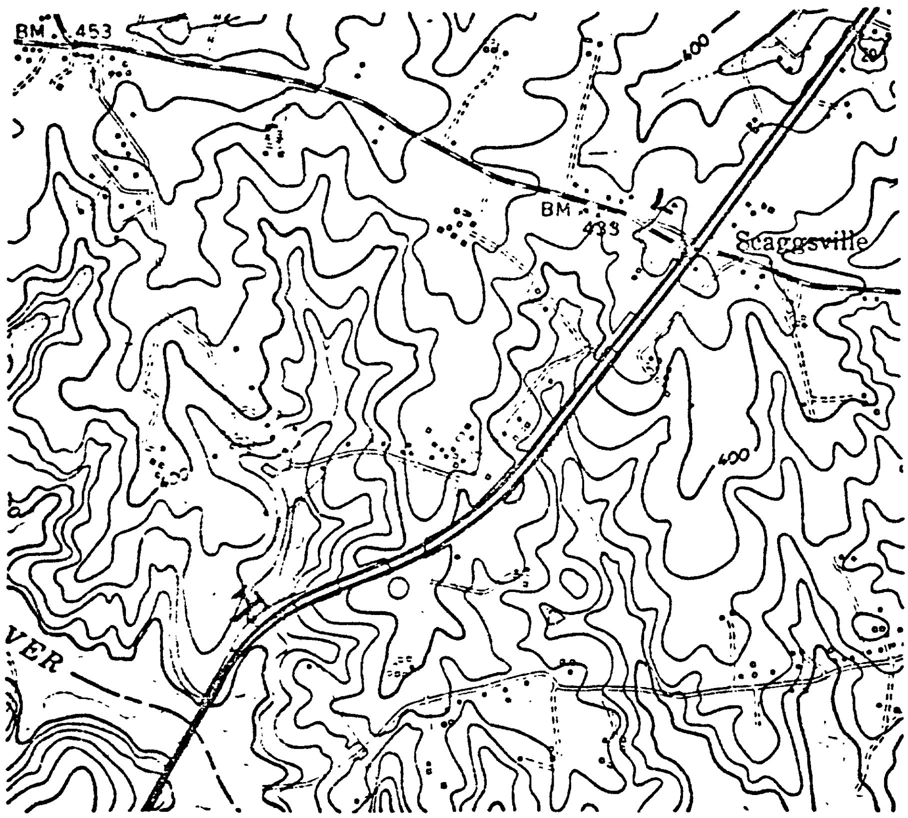

Fig. 31.

Fig. 32

zonal arrangement 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 microcline; 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 greenish 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. 88), but instead as fine-grained, sugary aggregates, apparently as replacements of microcline.

Gahnite is quite abundant as anhedral masses, often

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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 yellowish-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 whole 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, often with beryl and spessartine

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 quite common in inter-

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mediate 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

Microcline - reddish anhedral crystals in intermediate zone, sometimes replaced by sugary albite

Muscovite - coarse greenish books to at least 20 cm across; sericite common on fracture surfaces and in contacts between minerals

Pyrolusite - black, often dendritic; commonly associated with spessartine

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, often with gahnite

Frost Quarry

(Fannie Frost Feldspar Quarry)

Woodstock

Loc. 3

Fig. 33 here

Location

The Frost quarry is reached by taking Route 99 for 2.1 km southeast from Woodstock (Route 125) to Green Clover Road, and following this north for 1.2 km. Turn left and go for about sixty 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

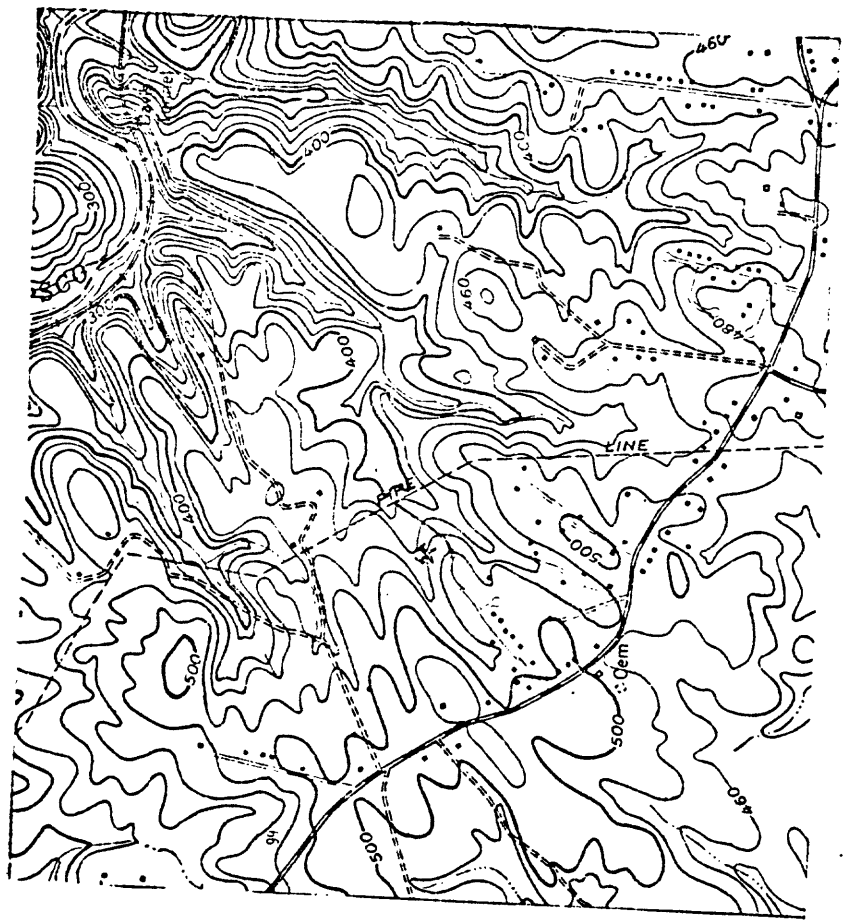

Fig. 33.

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 Formation 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 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 (see fig. 34).

Fig. 34 here

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Fig. 34

Small masses of pyrrhotite also are fairly common.

Often associated with titanite are elongated aquamarine beryl crystals, up to several centimeters long, light blue, and quite 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 thirty centimeters across

*Allanite

Beryl - elongated, light blue, transparent crystals in pegmatite

Biotite - occasional black plates in pegmatite

*Clinozoisite-epidote

Diopside - dark green, splintery, prismatic crystals to 30 cm long and 10 cm wide

*Dolomite (probably from marble)

*Hornblende

*Idocrase (from marble)

Limonite - abundant brown stains

Microcline - gray to tan crystals in pegmatite to over a meter across

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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). (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

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in recent years. George Brewer (personal communication, 1974) specifically 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 amethyst 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. Rice Mine - 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. 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,

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quartz, calcite, stilbite, and olivine (Ostrander and Price, 1940). (Loc. 11).

2. Nontronite, a clay mineral in the montmorillonite group, constitutes about 18.9 percent 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

Limonite after pyrite cubes are abundant in the soil around Glenelg. (Loc. 13).

Ilchester

Good specimens of graphically intergrown microcline and quartz occurred at the Mount Saint Clement College quarry, on the property of Saint Mary's College, about 0.8 km west of the main building on a dirt road. The small quarry has been filled in but graphic granite can still be found as float in the vicinity (see fig. 35). (Loc. 14).

Fig. 35 here

Marriottsville

1. Abundant scattered schorl crystals in Setters Formation quartzite (see fig. 36) occur in the several flagstone quarries on Marriottsville Road within 2 km south of Marriottsville (Loc. 15).

Fig. 36 here

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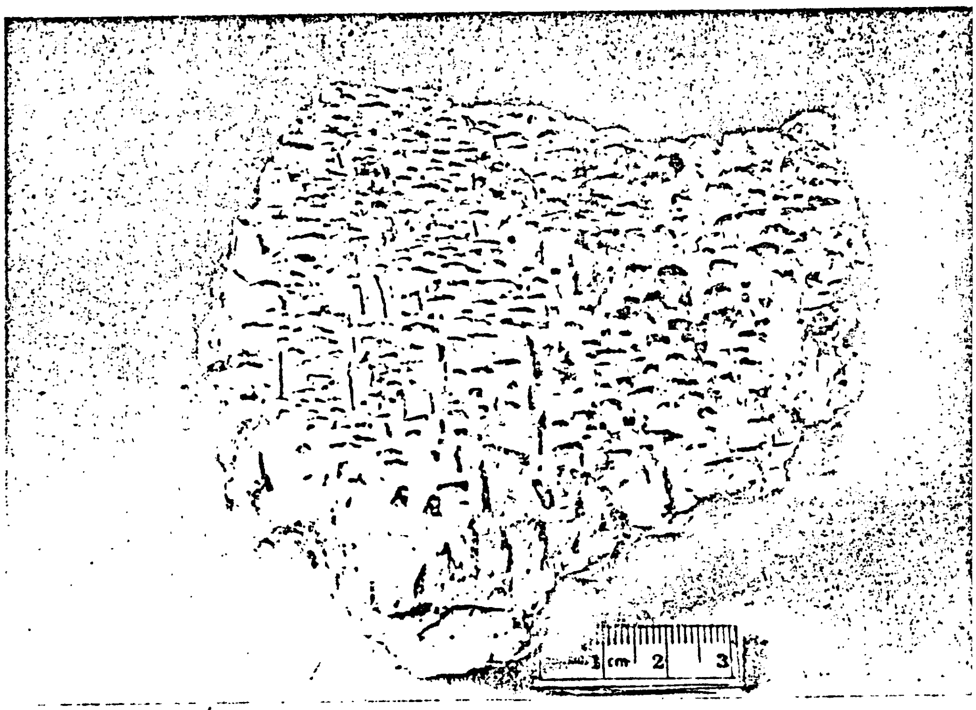

Fig. 35

Fig. 36

2. A small opening in Cockeysville Formation 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. 39), kyanite, staurolite, garnet, limonite after pyrite, and quartz crystals were found (Ostrander and Price, 1940). (Loc. 18).

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., verbal communication, 1973). (Loc. 19).

Savage

Savage Gabbro Quarry - This large, currently abandoned quarry is located on property of the Arundel Corporation of Baltimore, 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).

Fig. 37 here

Scaggsville

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

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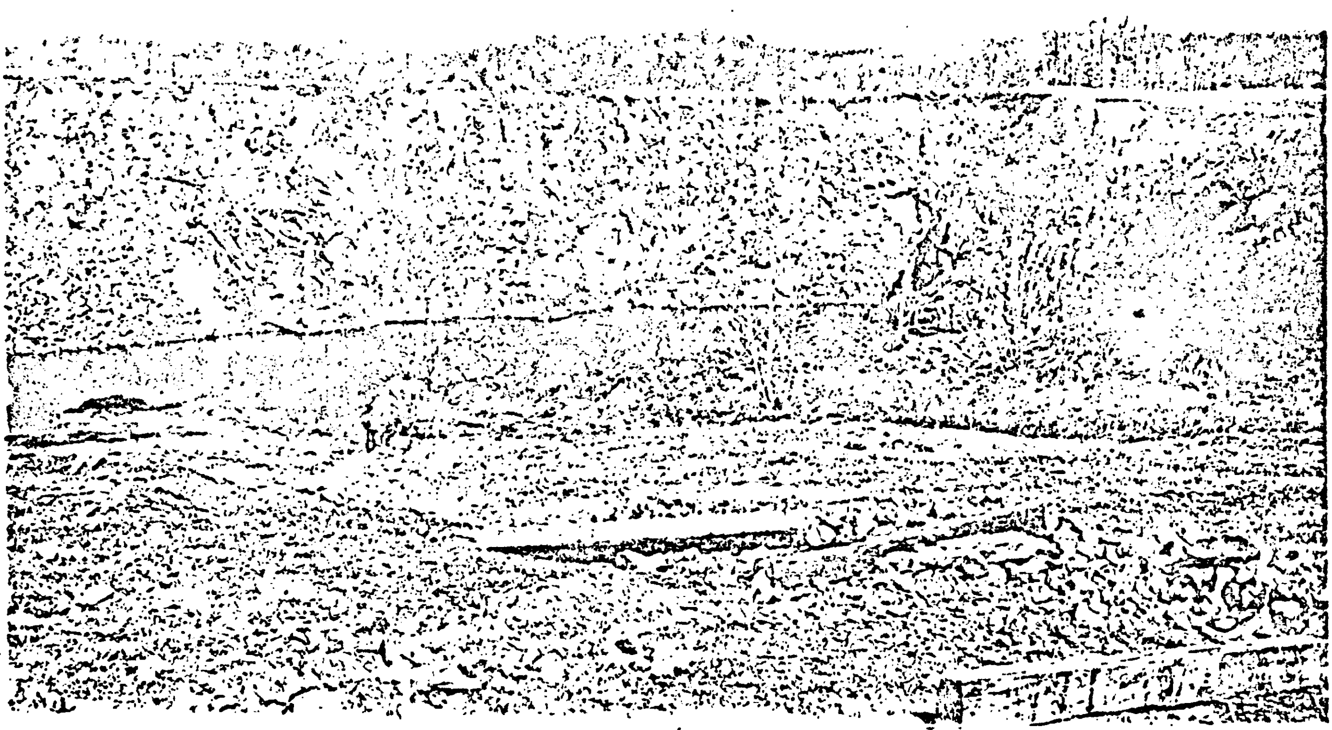

Fig. 37

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, pyrolusite, 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 (Fig. 38). Plates of muscovite with quartz, microcline, and albite occur in pegmatite (Loc. 23).

Fig. 38 here

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.80), were of

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Fig. 38

simple mineralogy, containing microcline, sodic plagioclase, quartz, muscovite, and biotite, sometimes with garnet, magnetite, and apatite as accessories. Good specimens of graphic granite (see fig. 35) have come from a few of the mines/ 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 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. Most of this information is taken from a report by Singewald (1928), which 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.

Figs. 39 and 40 here

MONTGOMERY COUNTY

Kensington Mica Mine

(Gilmore, Gilbert, B. H. Warner, or Gremoses Mica Mine)

Silver Spring

Loc. 1

Fig. 41 here

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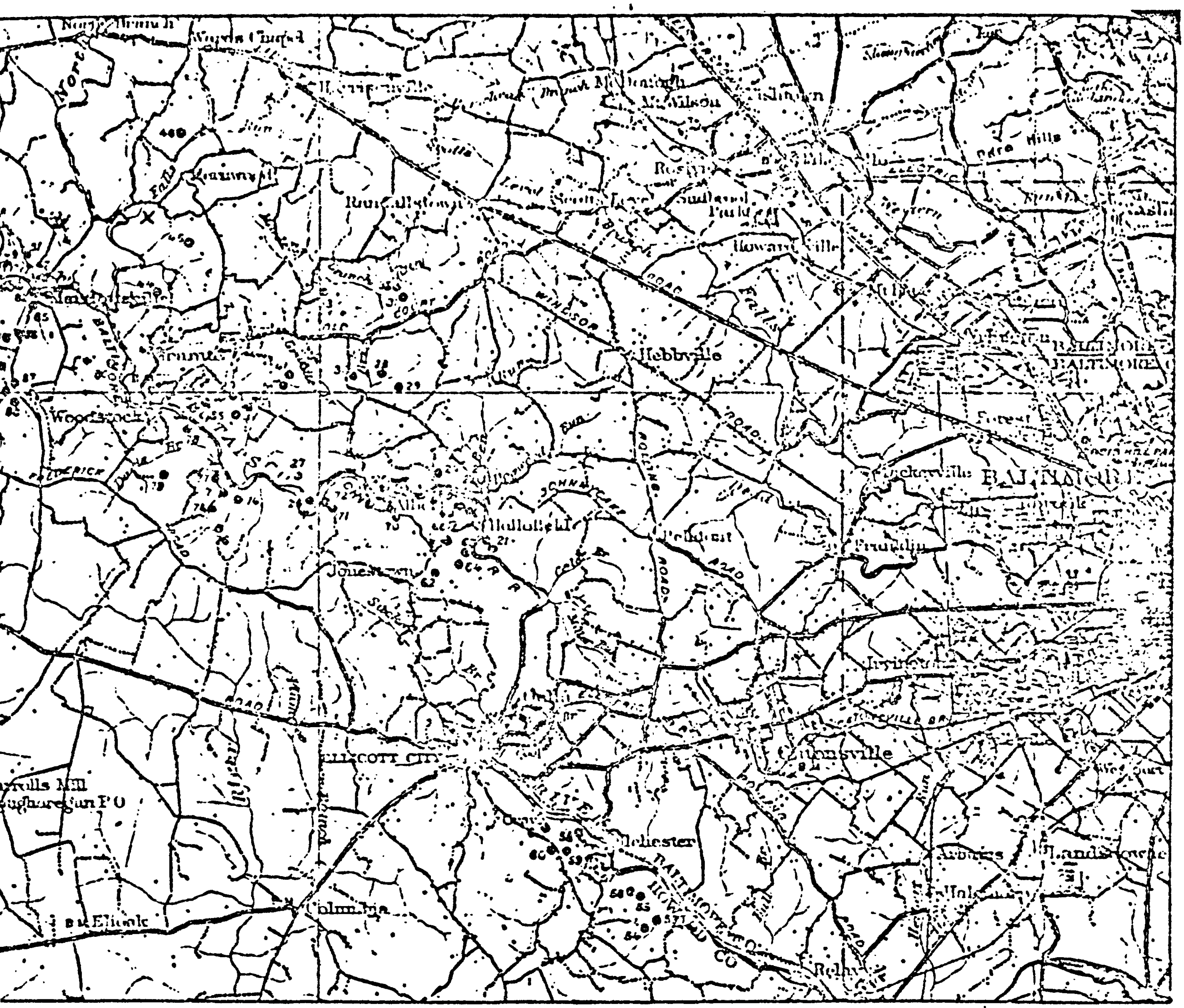
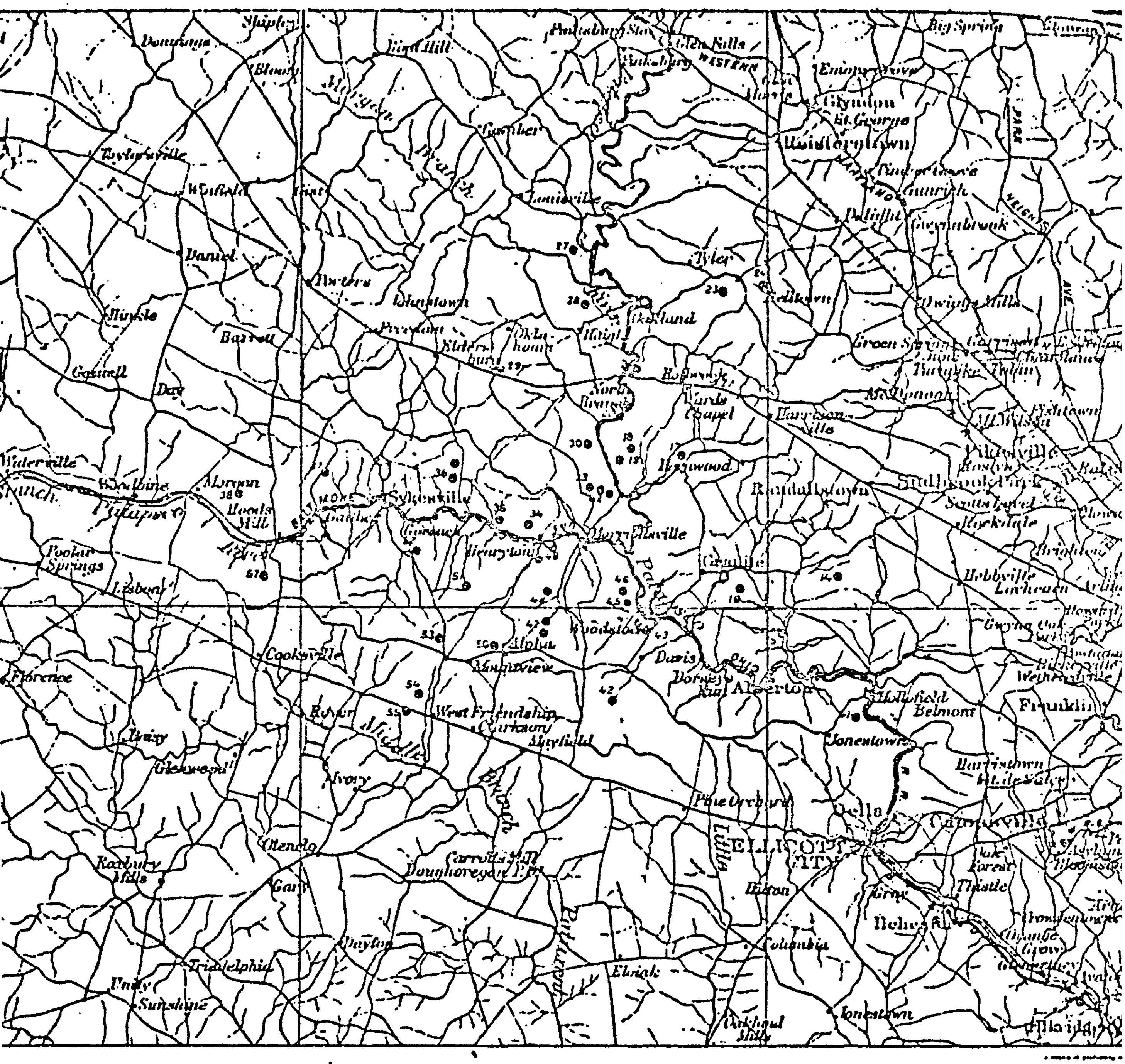


Location of Feldspar Quarries in part of Baltimore County and in Carroll and Howard Counties.
Scale, one inch equals two miles

Fig. 39.



Location of Flint Quarries in part of Baltimore, Carroll and Howard Counties.

Scale, one inch equals three miles

Fig. 40.

55 [?]

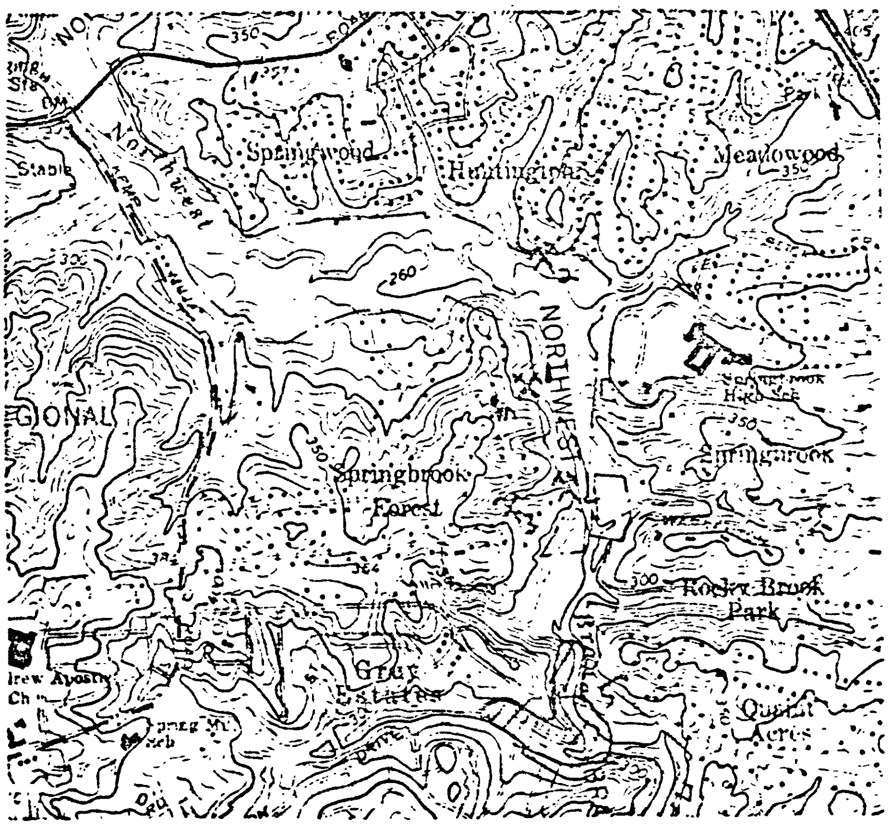

Springwood
Meadowood
350
260
NORTHWEST
Stable
Springbrook Forest
Rocky Brook Park
Gray Estates
Quaint Acres
300

Fig. 41.

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. 41), 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 are 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.

Mica mining began here around 1882, and 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 were 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 for 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 three to

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five meters wide with a strike of N 30° E (Sterrett, 1923), conformable with the surrounding Wissahickon gneiss. From observations of dump specimens, five 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, 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 eighteen kg in weight are found in this region, although the crystals are rarely well formed. Masses of gray to gray-green manganoan apatite up to fifteen cm across are also found in this area, often within beryl crystals. These

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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.

Fig. 42 here

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 and the radioactive mineral.

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-green "books" from a few millimeters to at least twenty-five centimeters across. Occasional 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

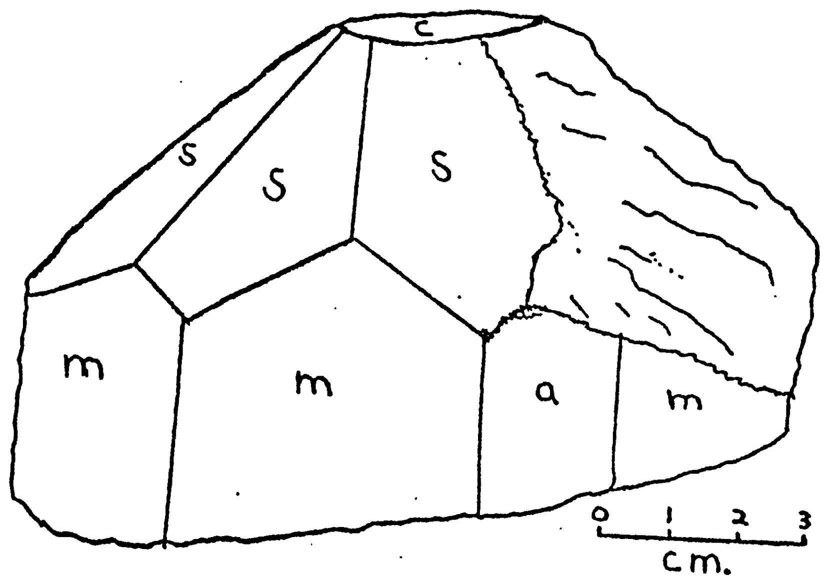

Fig. 42

the area so that more complete investigations can be made.

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 index of refraction, 1.530 (Shannon, 1926), 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; often associated with spessartine and pyrolusite

Autunite - small yellow flakes, fluoresces green. Optical data (Shannon, 1926): biaxial (-), 2V small, $\alpha \approx 1.555$, $\beta = 1.575$, $\gamma = 1.578$; X = colorless, Y and Z = pale yellow.

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. 42) 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.

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 occasionally 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).

Pyrolusite - black, dendritic on fracture surfaces; often associated with spessartine.

Quartz - gray to brown; intergrown in border and wall zones, interstitial in microcline and albite zones; predominate in core as

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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 pyrolusite. It is close to endmember spessartine, as revealed in the analysis given by Shannon (1926):

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

Fig. 43 here

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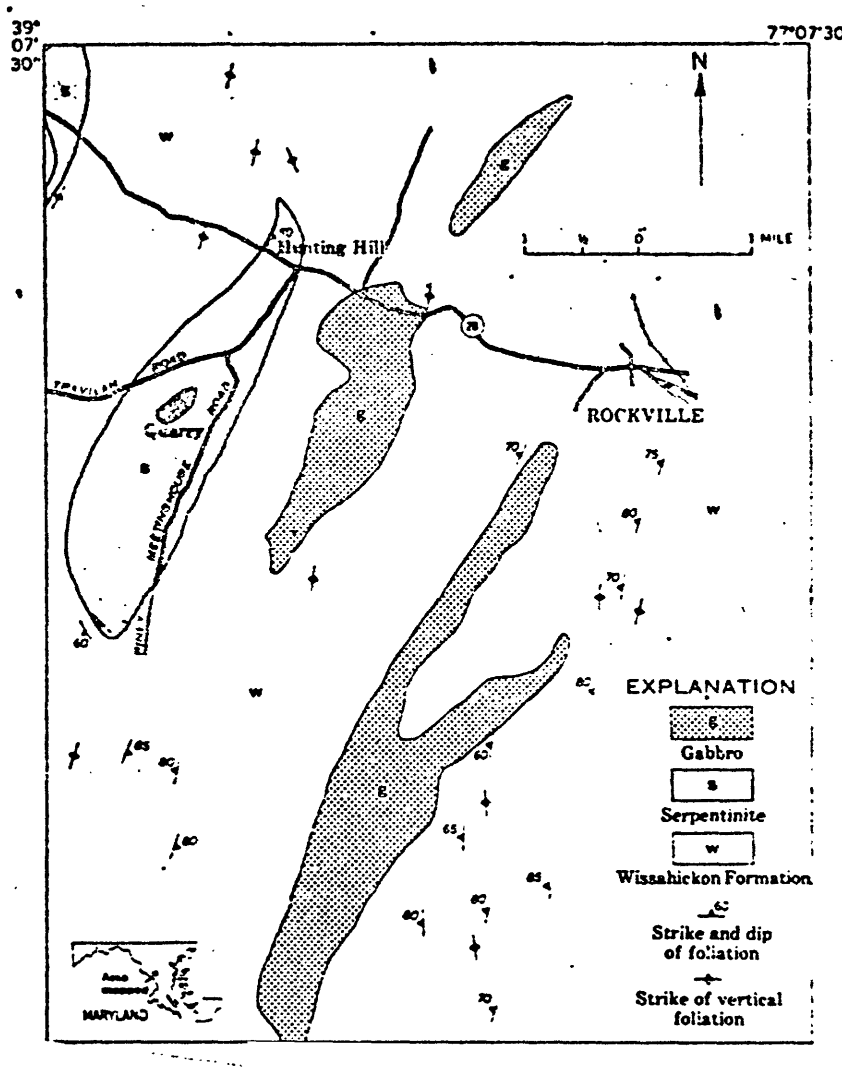
39°
07'
30"
77°07'30"
N
1 MILE
Hunting Hill
Quarry
ROCKVILLE
EXPLANATION
Gabbro
Serpentinite
Wissahickon Formation
Strike and dip
of foliation
Strike of vertical
foliation
MARYLAND

Fig. 43

Location

This quarry is located four miles west of Rockville, and is reached by taking Travilah Road south from Route 28 for about a mile, to Piney Mettinghouse Road and the quarry entrance. This has 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.

Fig. 44 here

Description

The Hunting Hill quarry is situated near the center of a roughly lenticular serpentinite body, about four miles long and one mile wide (see map). 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 which cut through it.

The most abundant rock type after serpentinite is rodingite (see p. 29), which occurs as large, light colored, generally vertical dikes, or in irregular masses. This rodingite is composed of gray to emerald-green diopside crystals up to twenty centimeters across, occurring in a fine-grained groundmass consisting of tan to cinnamon or pink massive grossular and hydrogrossular, yellow clinozoisite, and gray to pink

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Fig. 44

zoisite. Tremolite crystals, commonly in radiating aggregates, are often encountered in the serpentinite adjacent to these rodingite bodies, and are occasionally found within the rodingite.

Narrow vugs in the rodingite have produced the superb transparent grossular crystals, cinnamon colored and up to several centimeters across, that have made this one of the favorite collecting spots in the Washington area (see fig. 45). In these same vugs are also found yellow clinozoisite crystals and occasionally light green diopside crystals.

Fig. 45 here

Larger cavities in the rodingite have produced large rhombohedral calcite crystals, radiating aragonite sprays, and coatings of micro-crystalline 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 veins rarely more than three 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 five centimeters wide in shear zones that nearly always display slickenslides.

Veins of chalky white magnesite mixed with hyalite and residual fragments of serpentine, up to several centimeters thick, are rather common. A vein of hydromagnesite five millimeters thick, containing

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Fig. 45

rosettes of tiny white acicular hydromagnesite crystals, was reported by Larrab (1969). Veins of white to gray hyalite, often with mosslike pyrolusite inclusions, have occasionally been found. Brown to green chalcedony veins up to fifteen 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 sixty centimeters wide; and thinner veins of talc, penninite chlorite, anthophyllite, and "deweylite" (a yellow-brown, waxy mixture of stevensite and chrysotile). A single six 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 quite likely that some entirely new minerals will be discovered here.

Minerals

Actinolite (Larrabee, 1969)

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Diopside - white, gray, to green (chromian) in rodingite; crystals up to twenty centimeters across

Dolomite - white minute crystals, often 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)

Hyalite - mixed with magnesite; also as gray to white veins, often with pyrolusite dendrites

Hydrogrossular - massive and as crystals in rodingite; 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 hyalite, in serpentinite

Magnetite - black dust, grains, and small octahedral crystals throughout serpentinite; octahedra up to 5 mm reported by Larrabee (1969)

Olivine - tiny residual grains in serpentinite

Penninite - a chlorite mineral; in small veins and elsewhere in serpentinite

Platinum and Palladium - traces reported by Larrabee (1969)

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Prehnite - white to pale green botryoidal aggregates and coarse crystals in vugs in rodingite

Pyrolusite - dendrites with hyalite and magnesite

Pyrite (Larrabee, 1969)

Pyrrhotite (Larrabee, 1969)

Quartz - brown to green chalcedony, and minute 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 radiating, 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. 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.

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Description

While this locality in all likelyhood 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 in si from pinheads up to about three centimeters. These nearly always occur as euhedral dodecahedral crystals, and are generally dark red, though often partially weathered to brownish limonite. Cleaving the schist will often liberate 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 quite common.

Schorl is also abundant in the schist, sometimes forming radiating aggregates in the plane of schistosity. Staurolite is unusually abundant here for the Wissahickon Formation, occurring as stubby, almost brick-shaped, dark red-brown to black, brittle crystals, often characteristically twinned into crosses or "X's" (see fig. 46). It is almost always

Fig. 46 here

associated with the garnet crystals. Some thin quartzite layers in the schist contain abundant epidote-clinozoisite, though rarely in good crystals.

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Fig. 46

In addition to the schist, numerous fragments of quartz veins are present as float. Many of these contain fine schorl crystals; transparent quartz crystals are often 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	Quartz-crystals	Beryl
Epidote-Clinozoisite	Schorl	Spessartine
Schorl	Pyrite	
Staurolite		

Ednor Steatite Locality

Ednor

Loc. 4

Fig. 47 here

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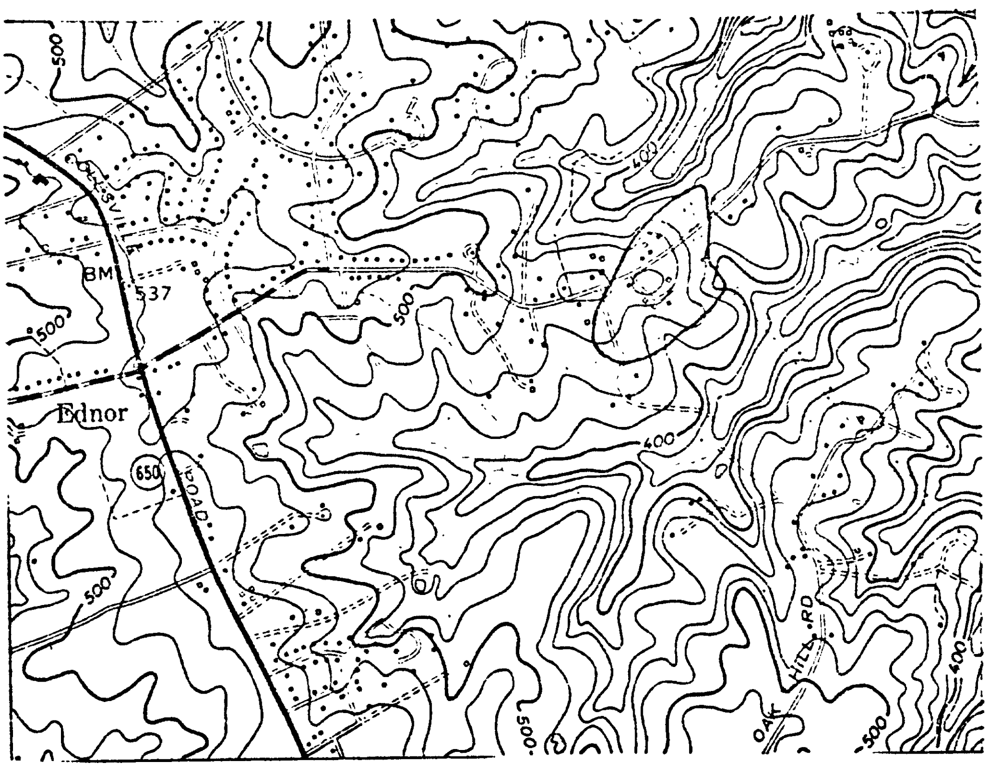

Fig. 47

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. 48) are possible sources of specimens (obtain permission before collecting).

Fig. 48 here

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. 49). Much of the talc occurs as radiating fibrous aggregates, and is probably pseudomorphous after actinolite or some other mineral.

Fig. 49 here

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 five millimeters across, and limonite pseudomorphs after pyrite cubes up to one centimeter across,

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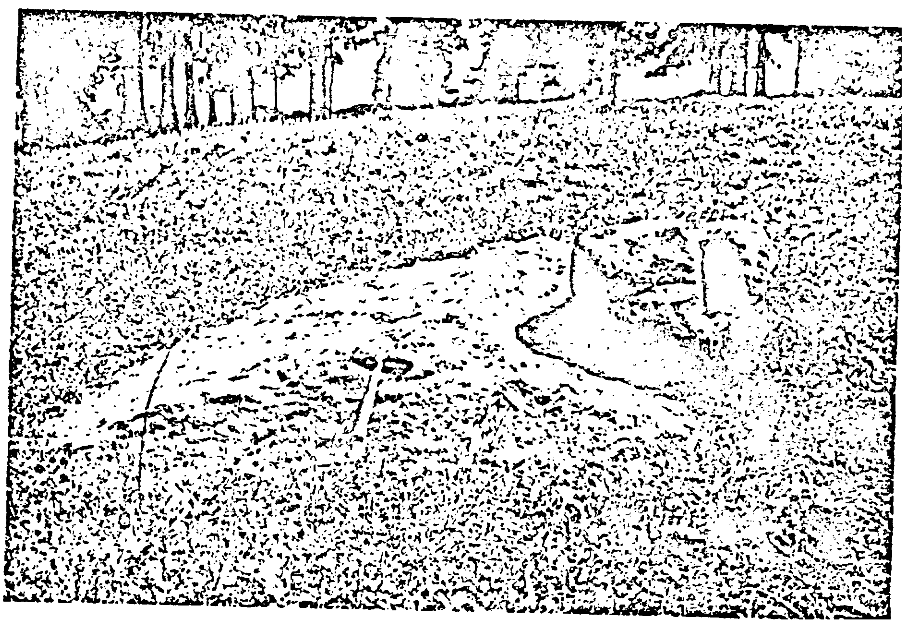

Fig. 48

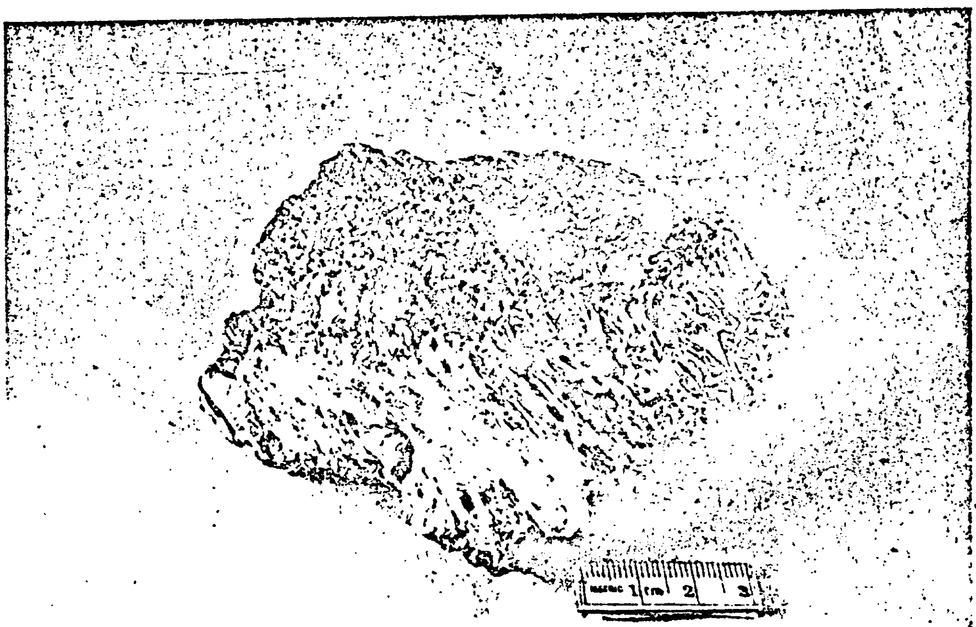

Fig. 49

are fairly abundant throughout the rock.

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; occasionally coarsely foliated (Fig. 49).

Gold Mines of Montgomery County

Introduction

In the mid-1800s 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 this time, operating sporadically, with a brief rekindling of mining activity in the 1930's. Most of the operations centered about Great Falls, Maryland, but scattered veins were worked in Sandy Spring, Rockville, Bethesda, and across the Potomac in McLean, Virginia (see Kirk Mine, p.136). None of the mines remain in operation today, and the last producing mine, the Maryland Mine, operated intermittently into the early 1950s. 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.

Fig. 50 here

The gold occurs in native form in quartz veins, along with pyrite, galena, sphalerite, and ilmenite. These veins are often vuggy and

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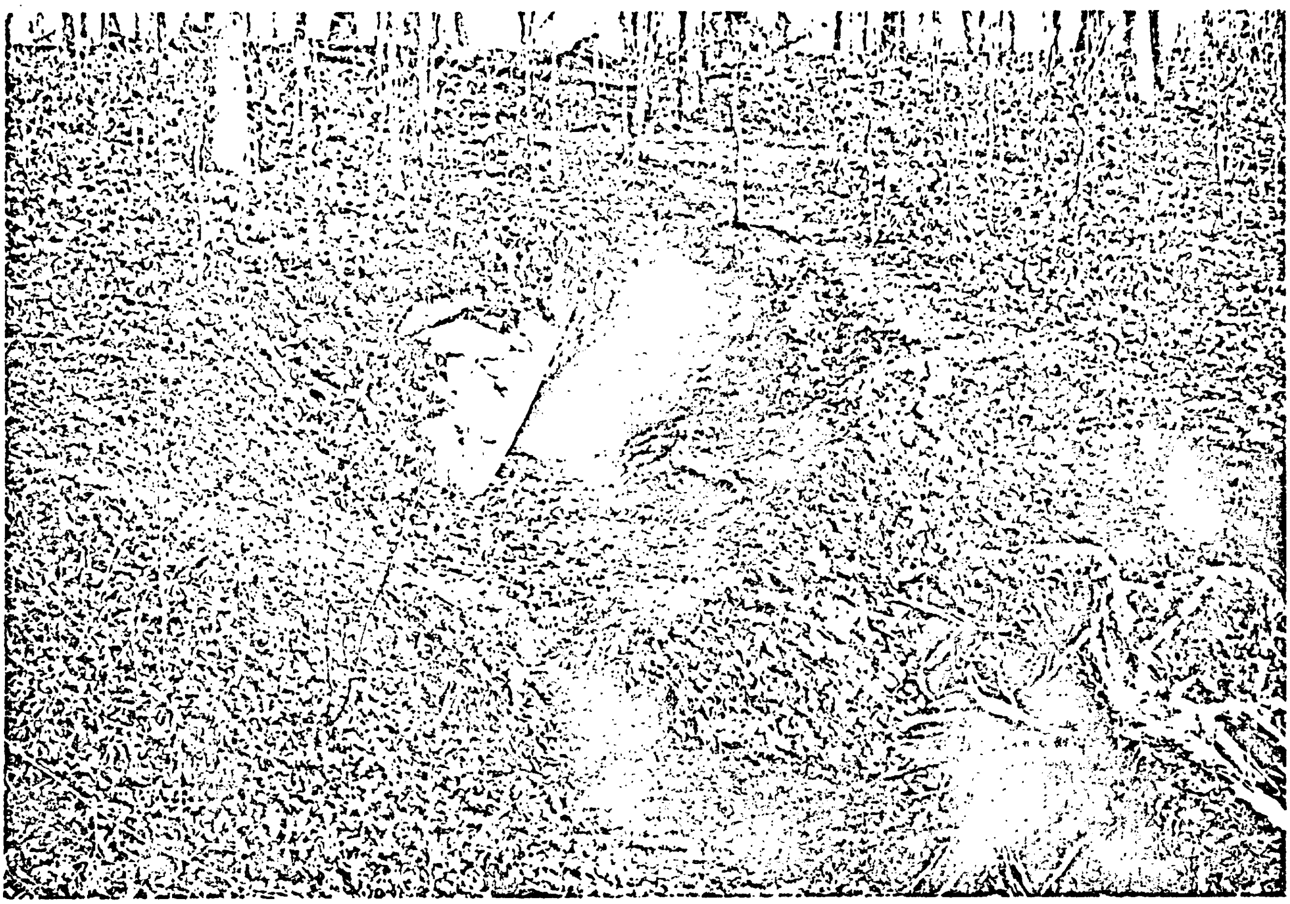

Fig. 50

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 occasionally 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, verbal communication, 1975). Specimens of the gold and associated minerals can be viewed at the Great Falls Museum in Great Falls.

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 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 technic 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 Cropely. 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

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

(1) Ulke, 1933

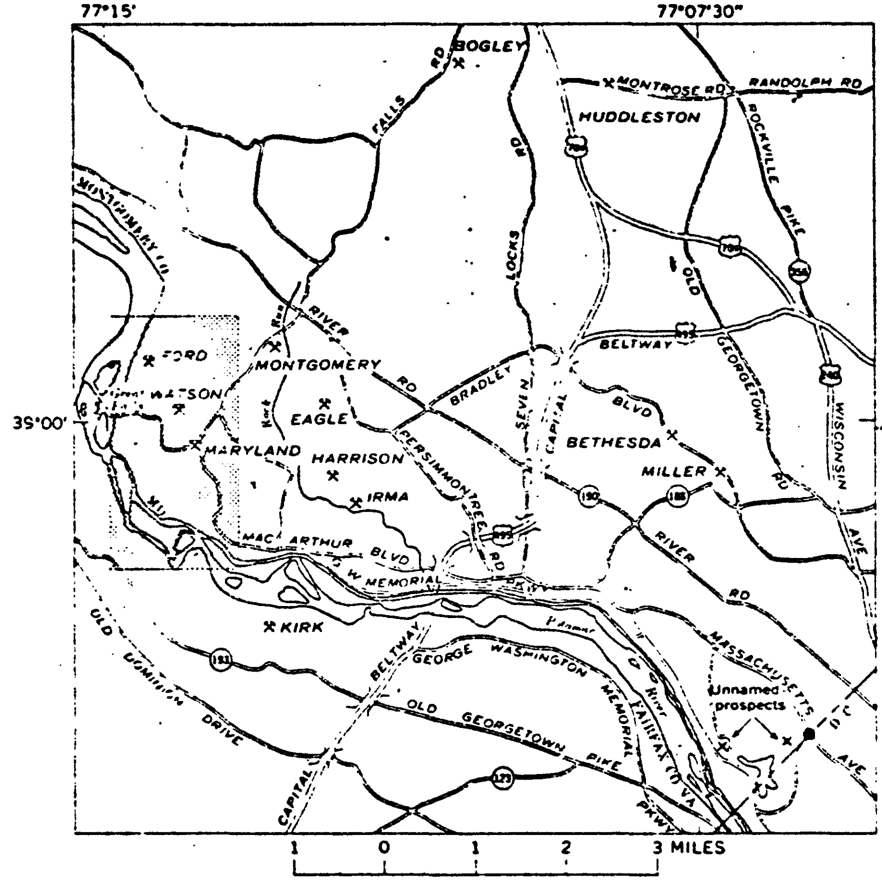
(2) Zodac, 1947

(3) Frank W. Stevens, personal communication, 1975

(4) Ulke, 1939

Mines

Fig. 51 here



77°15'
77°07'30"
39°00'
BOGLEY
FALLS RD
MONTROSE RD
RANDOLPH RD
HUDDLESTON
ROCKVILLE PIKE
LOCKS RD
OLD GEORGETOWN RD
BELTWAY
WISCONSIN AVE
MONTGOMERY CO
RIVER RD
FORD
WATSON
MONTGOMERY
EAGLE
MARYLAND
HARRISON
IRMA
BRADLEY
PERSIMMON TREE RD
SEVEN LOCKS
CAPITAL
BLVD
BETHESDA
MILLER
MAC ARTHUR BLVD
G W MEMORIAL PKWY
KIRK
OLD DOMINION DRIVE
BELTWAY
GEORGE WASHINGTON MEMORIAL PKWY
MASSACHUSETTS AVE
D C
Unnamed prospects
OLD GEORGETOWN PIKE
FAIRFAX CO VA
CAPITAL
1 0 1 2 3 MILES

Fig. 51.

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 McArthur 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, often in cubic crystals up to two centimeters across, is 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, 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, verbal communication, 1975).

Fig. 52 here

Ford Mine

(Allerton-Ream Property)

Loc. 6

This mine is reached either from the Chesapeake and Ohio Canal

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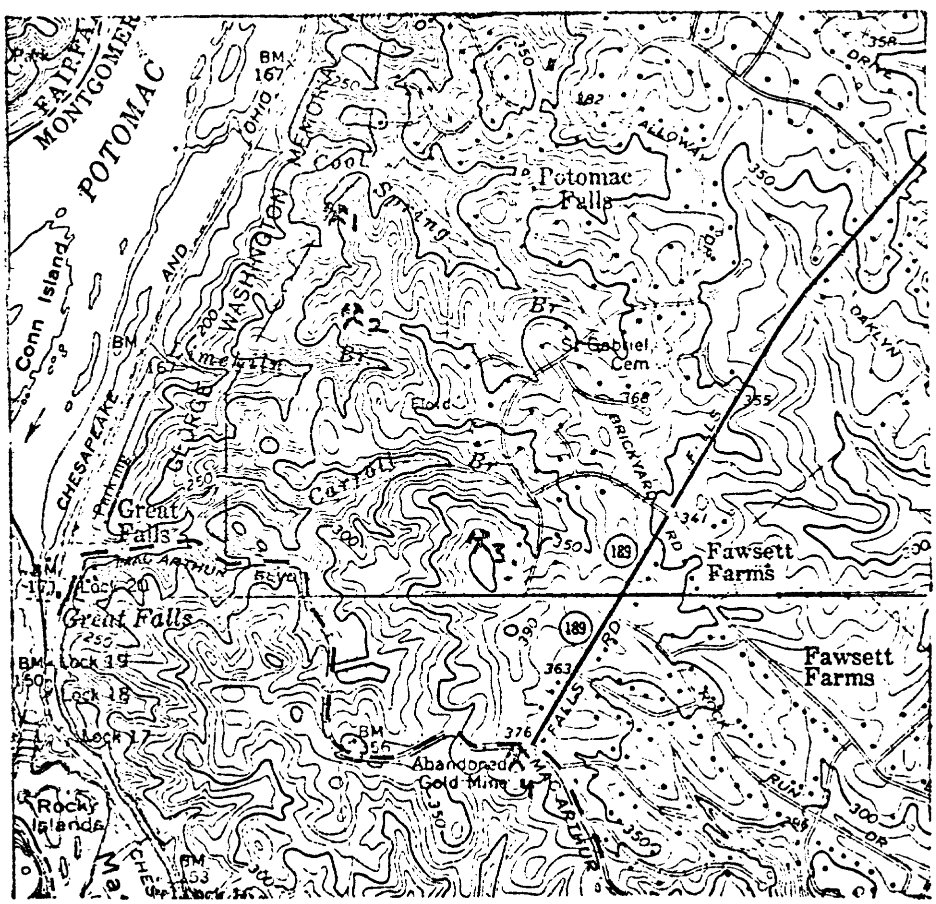
POTOMAC
MONTGOMERY
Conn Island
BM 167
Potomac Falls
St Gabriel Cem
Great Falls
Lock 20
Lock 19
Lock 18
Lock 17
Rocky Islands
Fawsett Farms
Fawsett Farms
Abandoned Gold Mine
FALLS RD
BRICKYARD RD
189

Fig. 52.

towpath, or from Stanmore Court, by going around the lake (refer to map). 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 remaining pyrite also occurs, and limonite after pyrite cubes are quite 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

Fig. 53 here

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 a hundred 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 about $20 an ounce) of very finely divided gold, occurring in quartz veins "amidst a decomposed talcose slate [schist]" (Emmons, 1854).

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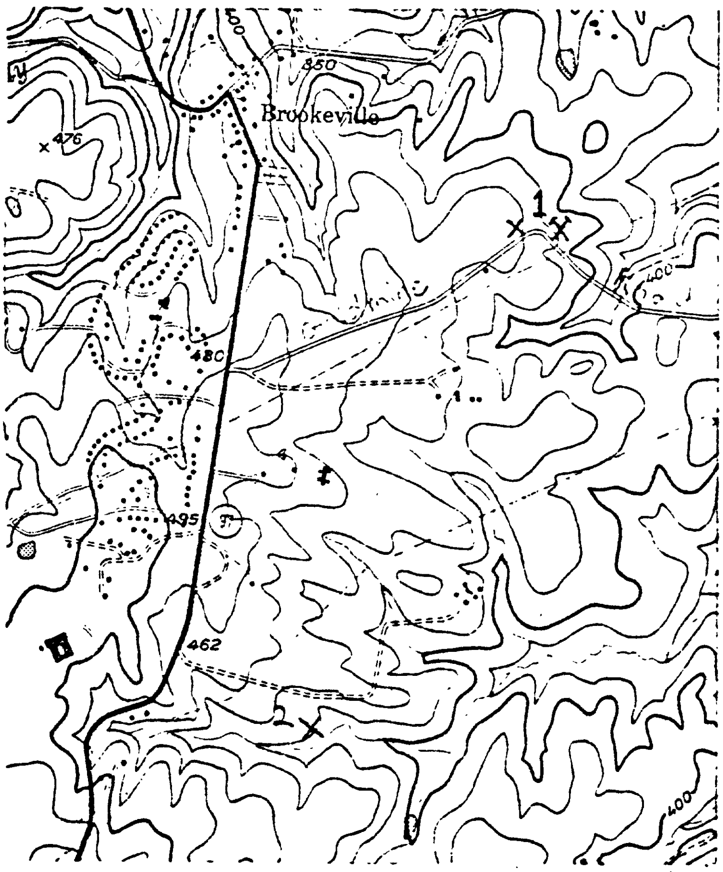

Fig. 53.

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. 50). 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 in Potomac (Frank W. Stevens, verbal 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, personal communication, 1975). (Loc. 14).

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Grady Mine - Near the intersection of Chesley and Canfield Roads in Rockville (Frank W. Stevens, personal 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 seven cm across), partially altered to limonite, were uncovered, but no gold was observed. The gold apparently occurred in quartz veins in gabbro, which here reportedly contained pyrite, schorl, chlorite, and white, gray, or pink ankerite (Ulke, 1933). Ulke (1933) reported the refractive indices of the ankerite to be $\omega = 1.694$, $\varepsilon = 1.510$, 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).

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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, verbal 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, verbal 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, verbal communication, 1975). The rock here is chlorite-rich phyllite of the Ijamsville Formation transected 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, two miles northwest of Barnesville, possibly in Frederick County (J. F. Windolph, Jr., verbal communication, 1975). (Loc. 21).

Boyds

<u>Black Hills Gold Mine</u> - 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., verbal communication, 1975). When visited by the author in 1975, the mine consisted of a roughly cubic pit about three meters on a side which has been converted into a storage cellar (see fig. 54). The pit is in schist crossed by small quartz veins. Pyrite in quartz is quite common in the immediate vicinity. (Loc. 22).

Fig. 54 here

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 quite dubious.

Burtonsville

1. Small (less than five 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

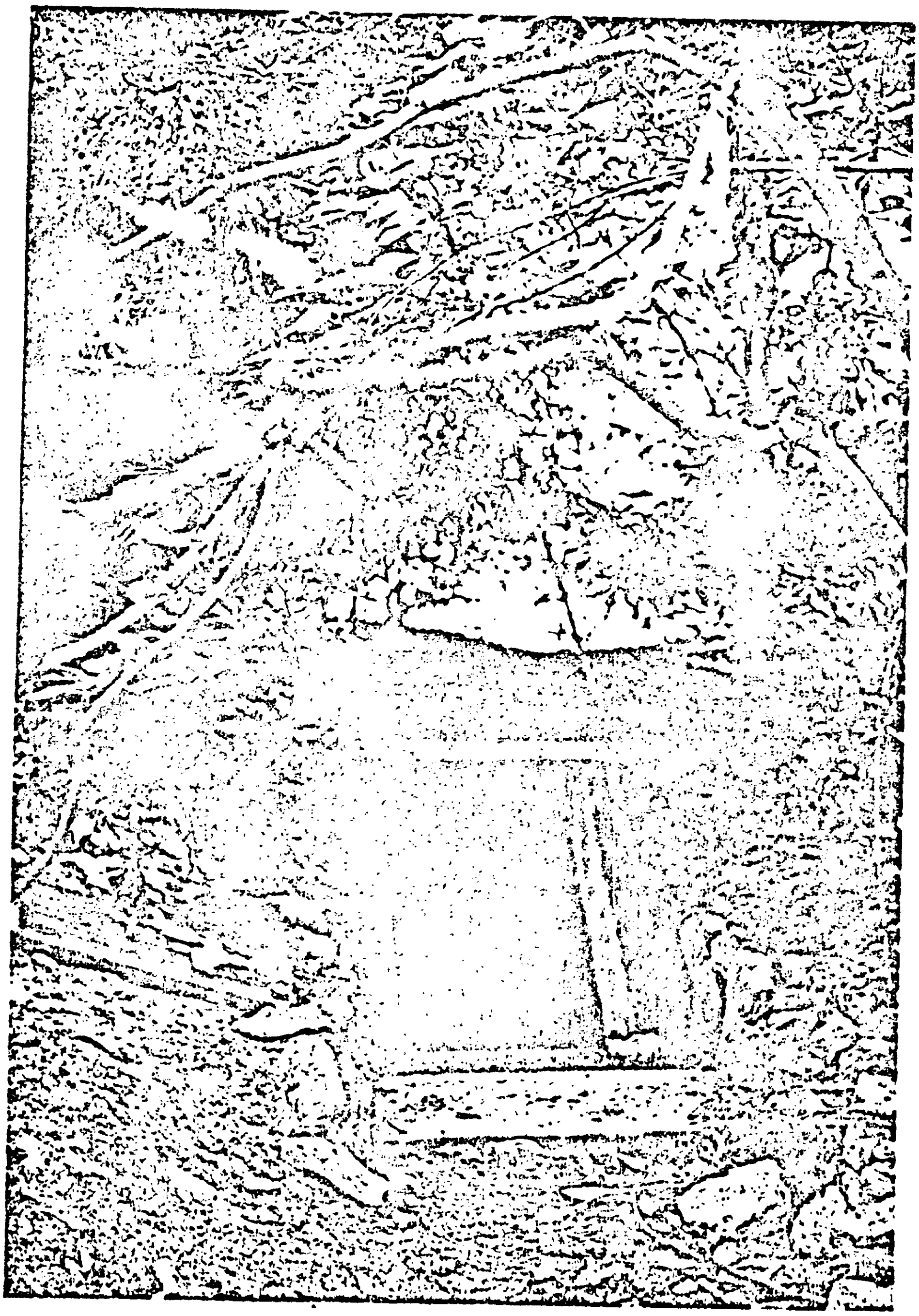

Fig. 54

operated for a short time (Singewald, 1928). (Loc. 24).

Cropley

1. Magnetite octahedra to over two centimeters across in chlorite schist were recently collected at an undisclosed location in Cropley, near the Potomac River (Scott Silsby, verbal 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, verbal 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., verbal communication, 1975). Magnetite octahedra up to one 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., verbal communication, 1975). (Loc. 28).

3. <u>Sugarland Copper Mine</u> - 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 twenty meters, and it then turned north

for about sixty-five meters (John F. Windolph, Jr., verbal communication, 1975). The mine is now mostly caved in and grown over, in the midst 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., verbal communication, 1975) (see map of Triassic mineral deposits in pocket). (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, 1926; 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 (1926) 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, verbal 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 which is converted to talc-bearing schist along shear zones (J. F. Windolph, Jr., verbal 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, verbal 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

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located 1.4 km northeast of Olney (see fig. 53). 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 the cemetery, in Aspen Hill. The quartz crystals were common as float, but could be easily traced to small quartz veins which outcropped 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 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, verbal 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, verbal commun., 1975). (Loc. 41).

4. Eighty-seven grams of gold was recovered from quartz veins during excavation for the house at 228 Falls Road (Route 189), 200 meters southwest of Route 28 (Frank W. Stevens, personal 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 (USNM 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, verbal 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, verbal communication, 1975). (Loc. 44).

4. During excavations for the Blair Apartments, on East-West Highway in downtown Silver Spring, cubic pyrite cyrstals to fifteen centimeters across were found (J. Griesbach, verbal communication, 1975). (Loc. 45).

Travilah

A small steatite prospect, containing talc, chlorite, magnetite

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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): torbernite, uraninite (?), calcopyrite, 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 two 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).

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PRINCE GEORGE'S COUNTY

Wheeler Road Vivianite Locality

Oxon Hill

Loc. 1

Fig. 55 here

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. 55).

Fig. 56 here

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 Monmouth Formation, a glauconitic gray-green clay, and the overlying Miocene Calvert Formation, here represented by limonite-rich argillaceous sand and gravel (see fig. 57). 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,

Fig. 57 here

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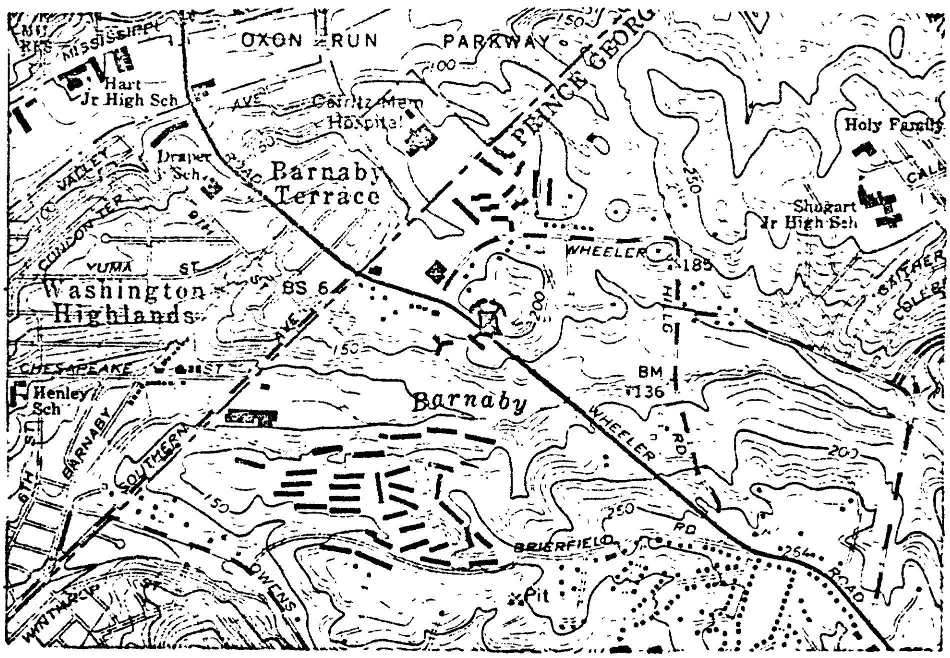
OXON RUN PARKWAY
PRINCE GEORG
Hart
Jr High Sch
Draper
Sch
Barnaby
Terrace
Washington
Highlands
BS 6
Holy Family
Shugart
Jr High Sch
WHEELER
185
BM
136
Barnaby
CHESAPEAKE
ST
Henley
Sch
SOUTHERN
BARNABY
WHEELER
RD
BRIERFIELD
RD
ROAD
Pit
OWENS
YUMA
ST
VALLEY

Fig. 55.

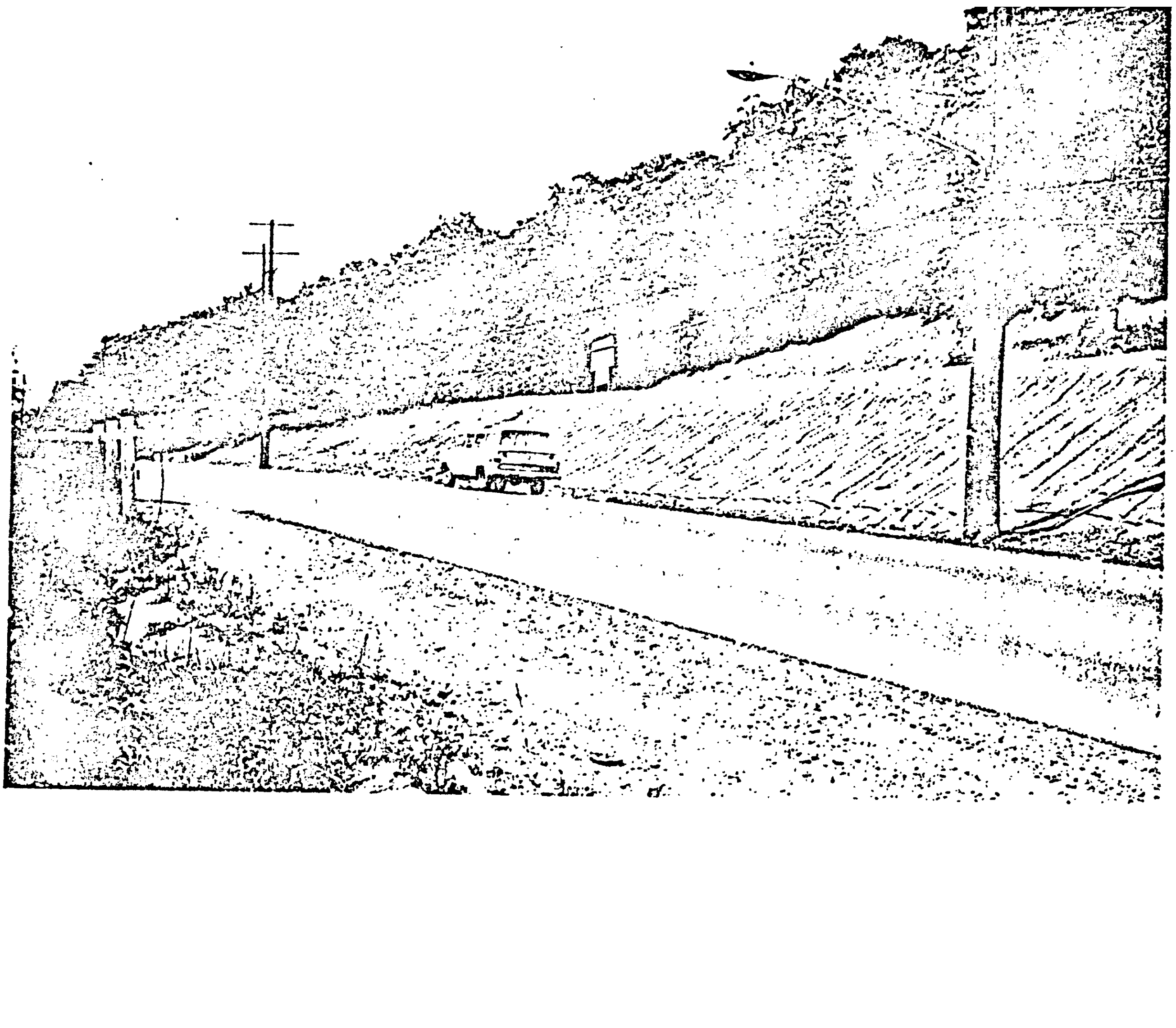

Fig. 56

Fig. 57

which probably represent filled depressions in a Miocene beach (Earl Kauffman, verbal communication, 1975). The bones themselves were almost certainly the primary source of the phosphate contained in the vivianite.

The vivianite nodules range from under one centimeter to over thirty centimeters across, the larger nodules generally consisting of a coalescence of smaller ones. 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 the ferrous iron. Much of the vivianite at this deposit has been further oxidized to brownish hydrous iron oxides.

Fig. 58 here

Tiny gypsum crystals, usually less than one 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

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Fig. 58

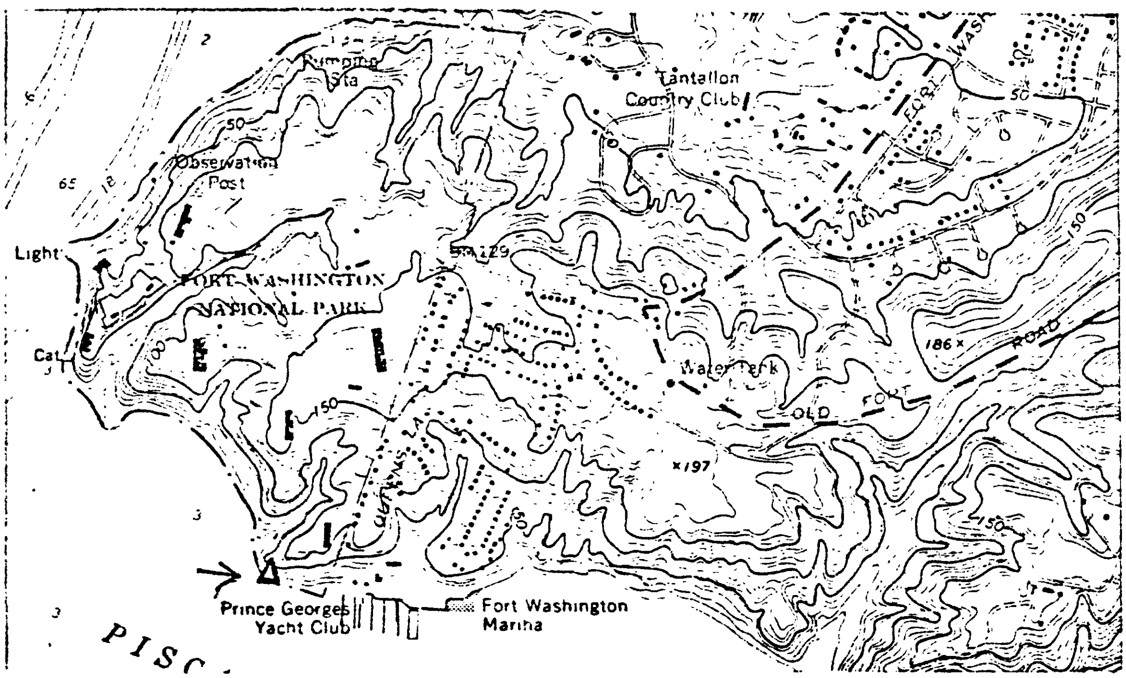
Pumping Sta
Tantallon Country Club
Observation Post
Light
FORT WASHINGTON NATIONAL PARK
Cat
Water Tank
OLD FORT ROAD
Prince Georges Yacht Club
Fort Washington Marina
PISC

Fig. 59.

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.

Fort Washington Gypsum Locality

Fort Washington

Loc. 2

Figure. 59 here

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. 60). The gypsum crystals are found in the clays of this cliff, but as this is federal park property, collecting is generally not permitted.

Fig. 60 here

Description

Gypsum crystals, displaying several different habits, occur

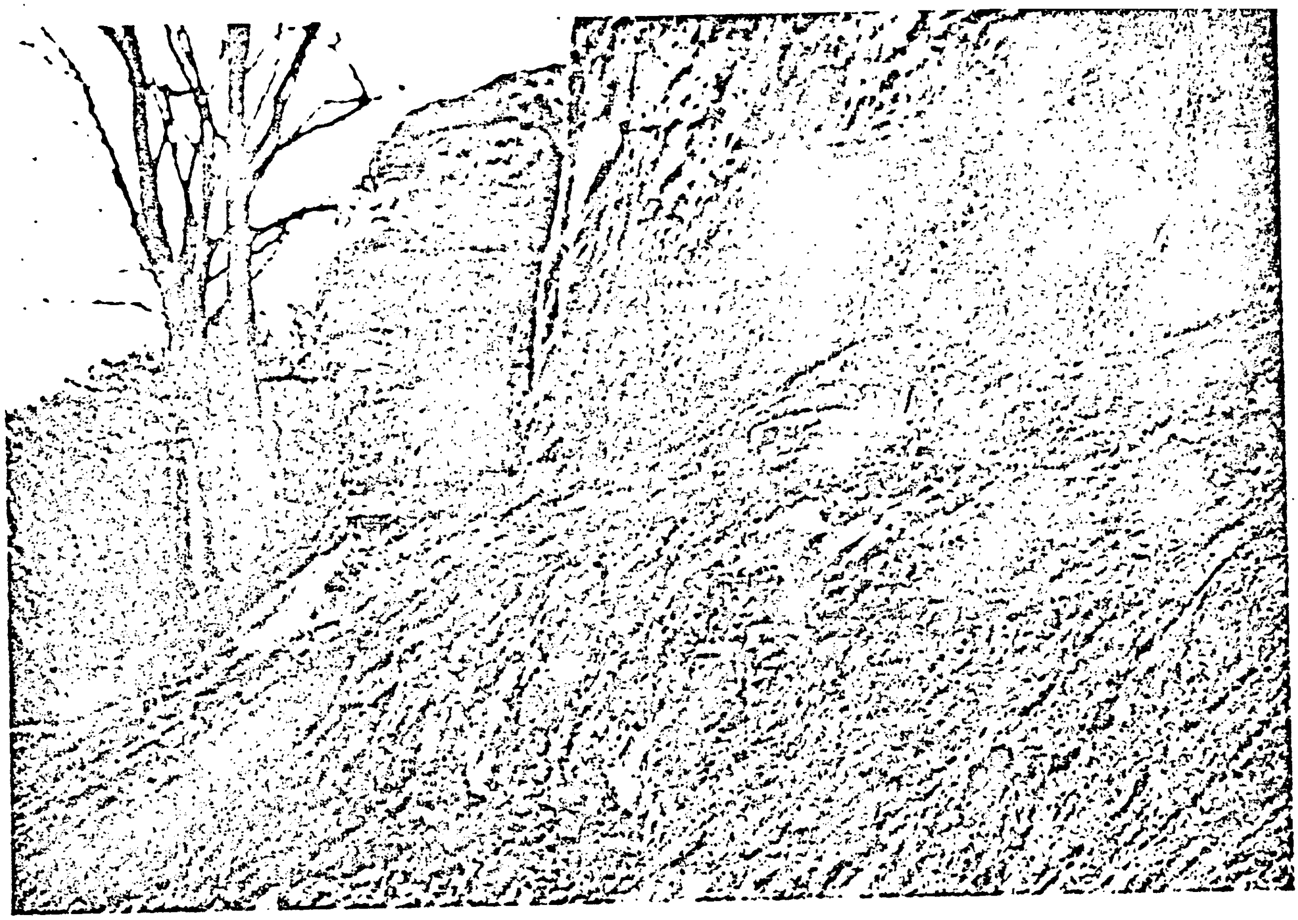

Fig. 50

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. 63).

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. 61).

Fig. 61 here

---

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. 62). 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

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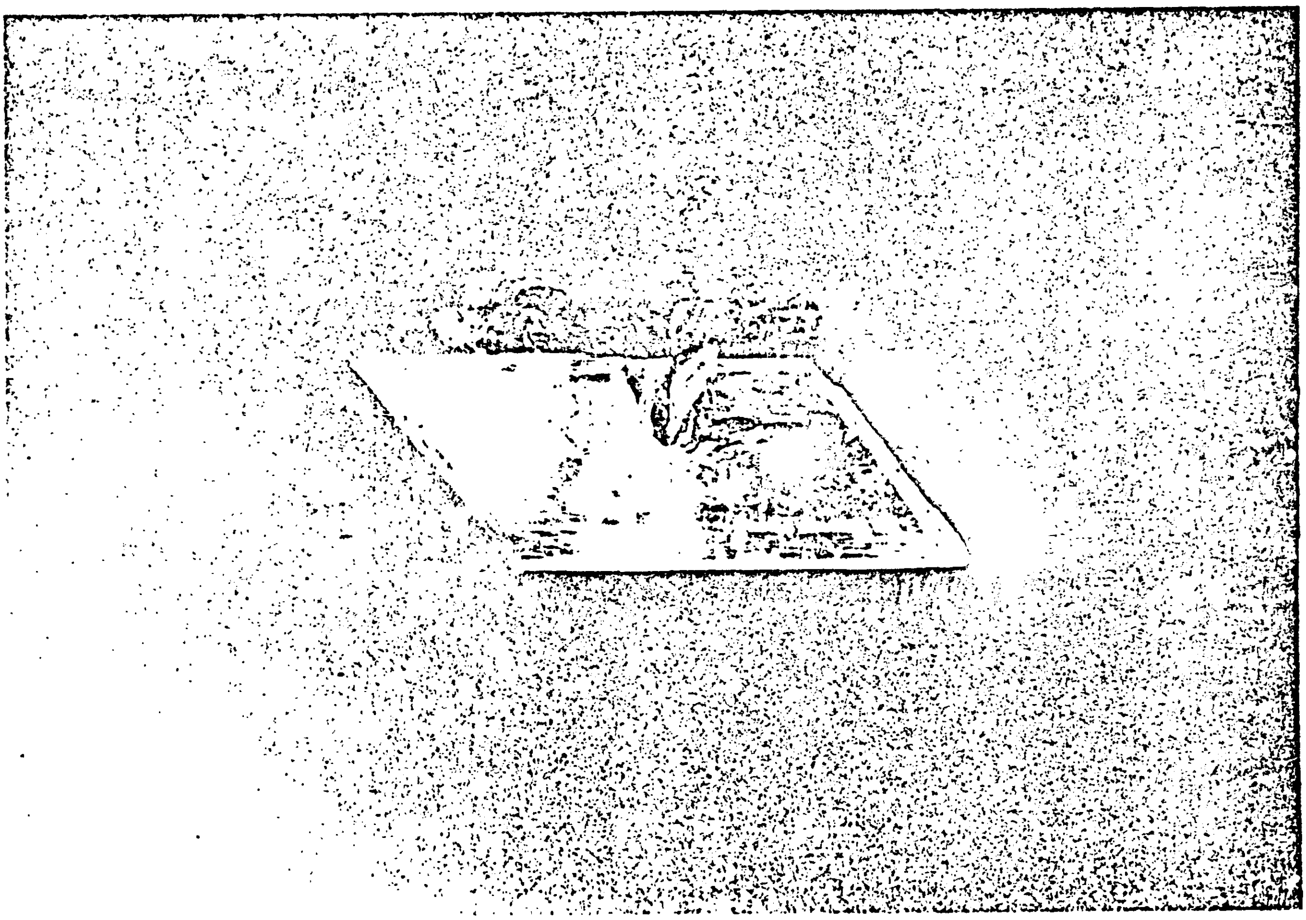

Fig. 61

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.

Fig. 62 here

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

Fig. 63 here

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, often in small concretionary nodules.

Muirkirk Clay Pits

Muirkirk

Loc. 3

Fig. 64 here

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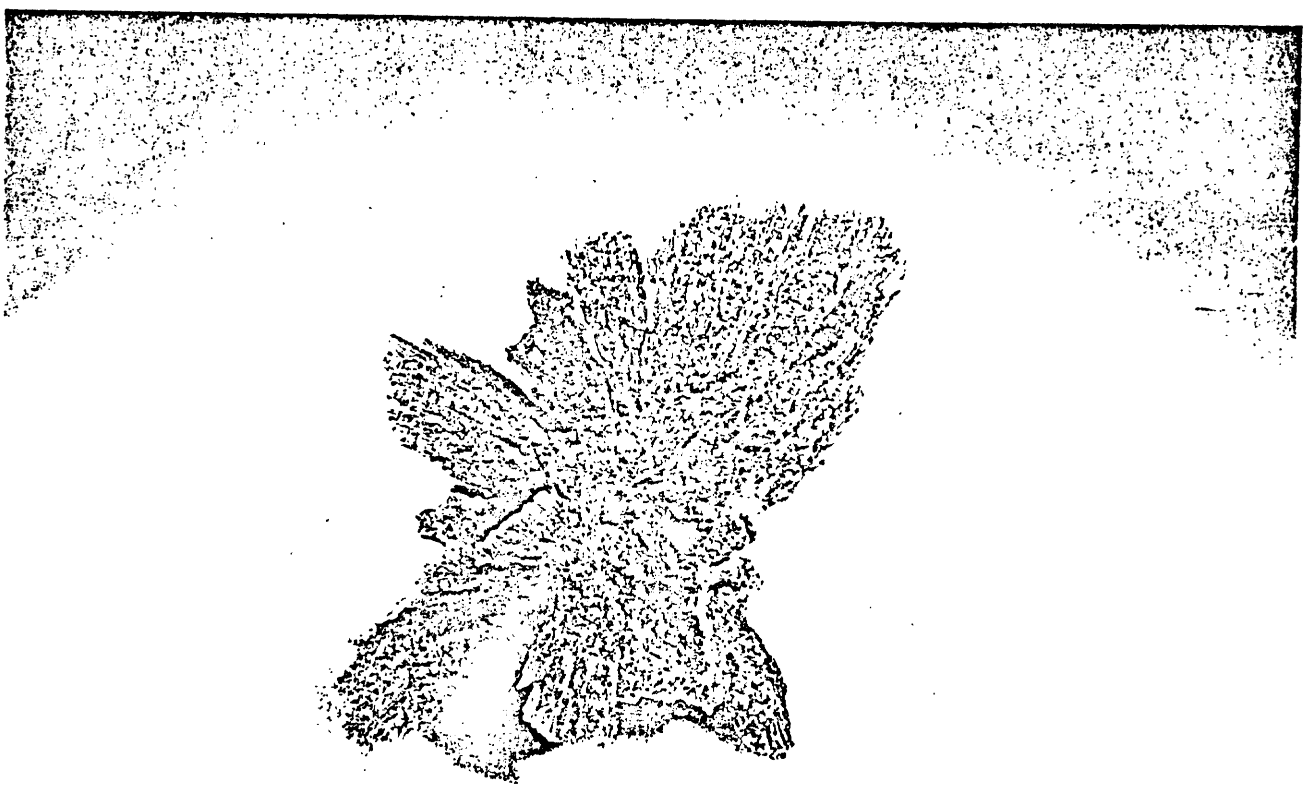
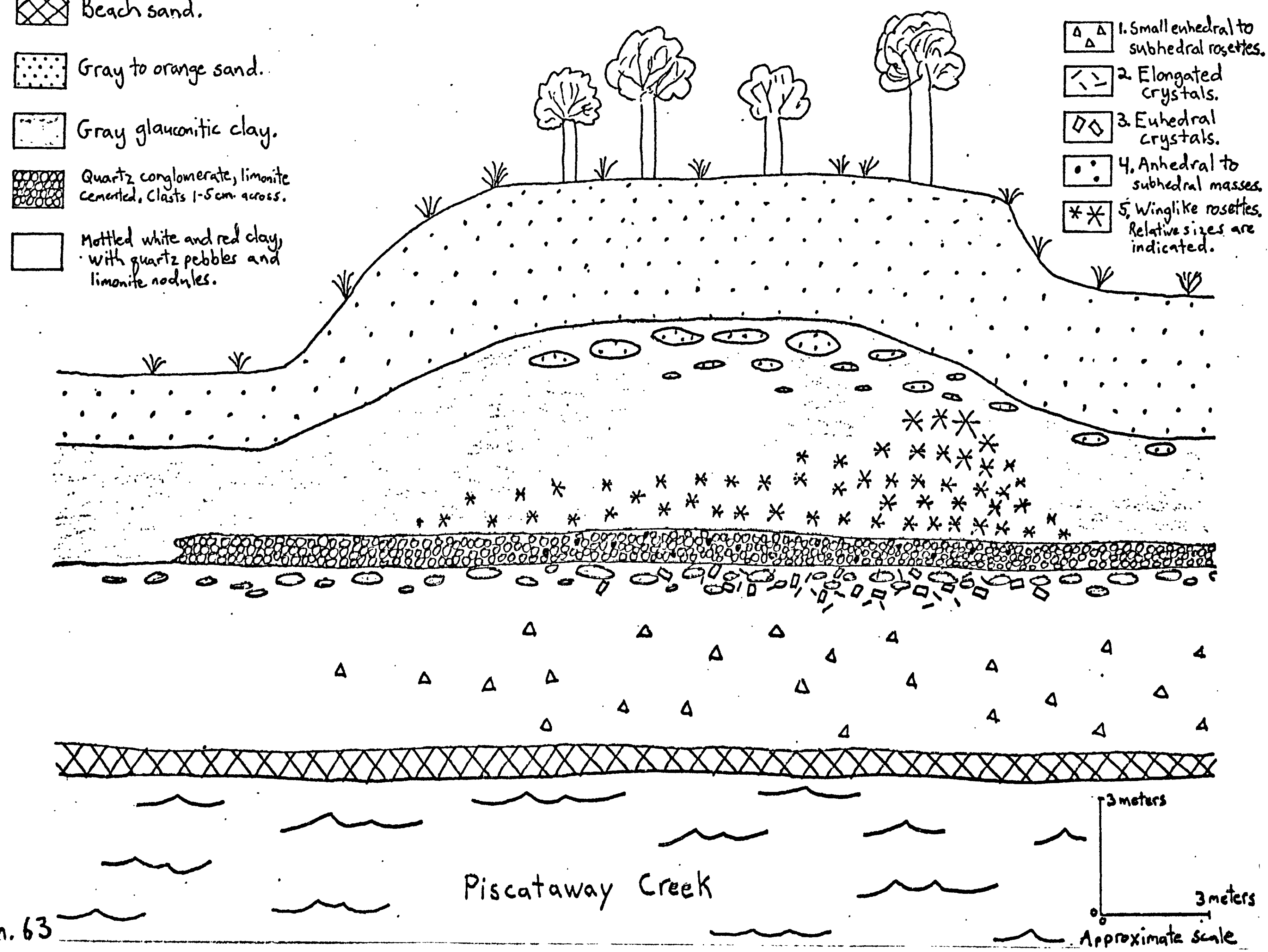


Fig. 62



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

Fig. 63

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 64. The Muirkirk Furnace operated until about 1916, and was the last furnace to process Maryland iron ores. The iron it produced was exceptionally high grade, [illegible] 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 1880s.

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.

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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 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 thirty 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 (wood converted to a black or dark brown carbonaceous material; lignite is a low-grade soft variety of coal). 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,

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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 (fig. 65), and silicified wood and marcasite in lignitized wood also occur here (Loc. 4).

Fig. 65 here

Brentwood

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

Fig. 65

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, verbal communication, 1975). Many crystals were euhedral and transparent, with single crystals up to over fifteen centimeters long, and rosettes up to ten centimeters across. The crystals occurred in a narrow zone approximately in the center of a thirty meter section of gray-brown Patapsco Formation clay, very similar to the occurrence at Fort Washington, about eight km to the south. Basaluminite, as earthy white subhedral patches averaging three 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 1940s, on NASA property about 350 meters west of the intersection of Greenbelt and Soil Conservation Service Roads. These nodules ranged up to at least thirty 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. 66). Mary E. Mrose of

Fig. 66 here

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Fig. 66

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 metastrengite, and small amounts of strengite, cacoxenite, strunzite (?), and azovskite (?) (M. E. Mrose, verbal 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 stalctitic 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 construction work at Bonnie Mae Estates in Seabrook Park is in the Smithsonian collection (USNM 117600).(Loc. 9).

New Carrollton

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

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, verbal 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, verbal communication, 1975). (Loc. 3).

4. Amethyst in loose crystals and in an exposed quartz vein (A. Bonanno, verbal 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 (USNM-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, verbal 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).

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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

Theodora Copper Mine

Herndon

Loc. 1

Fig. 67 here

Location and History

This mine is reached by taking Copper Mine Road (Route 665) west for a half mile from Centreville Road (Route 657) in Herndon. Here a small dirt road leads south 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. 68).

Fig. 68 here

The mine was apparently opened in 1880 (The Virginias, 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 farm-

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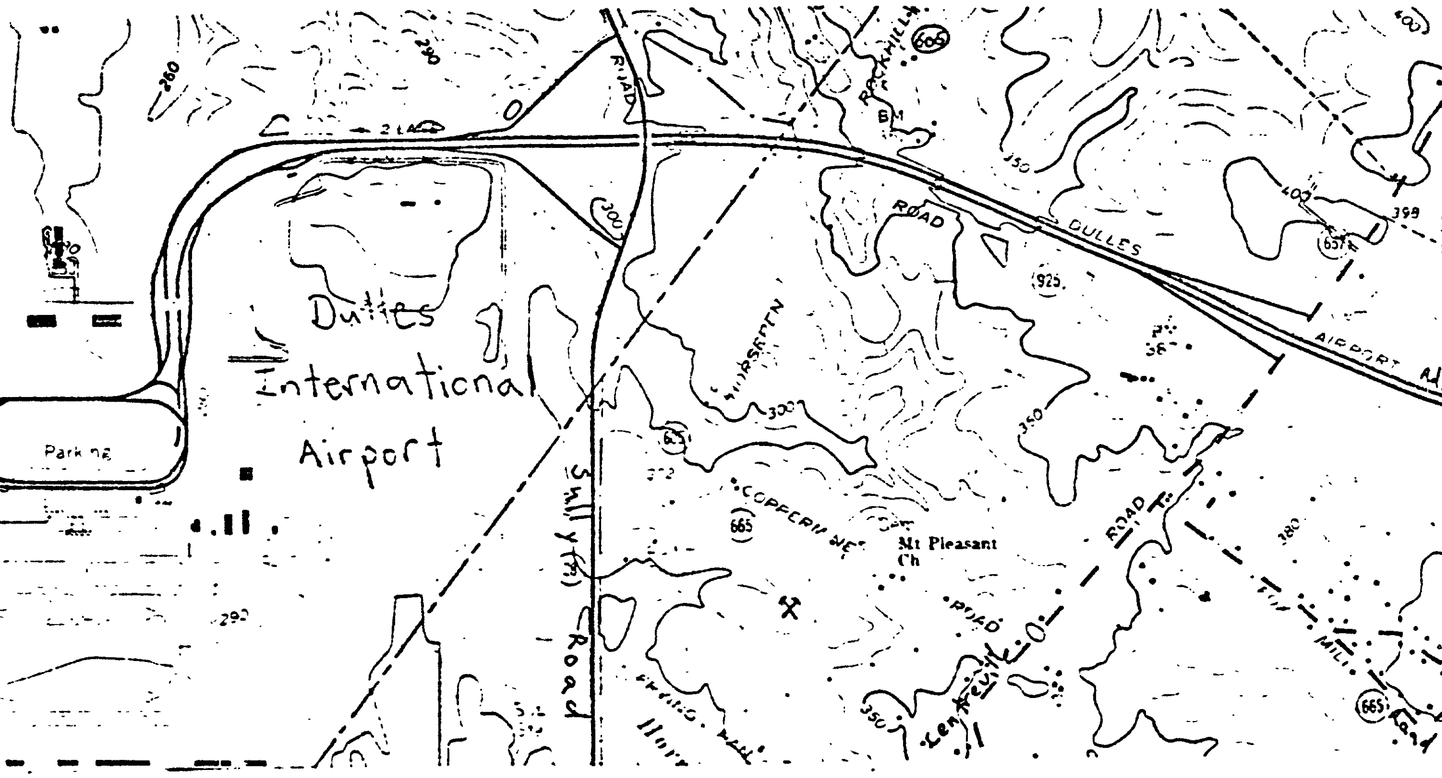

Dulles
International
Airport
Parking
ROAD
DULLES
AIRPORT
Mt Pleasant
Ch
Road
Centreville

Fig. 67.

Fig. 66

land, and permission must be secured before entering it.

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 two 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 also 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 the 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

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phosphate, is found as dark-green botryoidal crusts.

Specular hematite is quite abundant, ranging from large masses of

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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: Diabase Quarries of Northern Virginia, p. 155; and map of mineral deposits in Triassic rocks, in pocket)

Annandale

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

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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 (UNSM 105364). (Loc. 4).

Centreville

1. Sissler's Quarry - Anthophyllite asbestos with fibers to at least thirty 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

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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 2).

Dranesville

Chromite in serpentinite has been reported from the vicinity of Dranesville, near the Potomac River (Schlagel, 1917).

Fairfax

Cabochons of jasper (USNM G-3270) and white chalcedony (USNM G-804), smoky quartz (USNM G-1341) and colorless quartz with dark inclusions (USNM 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 (USNM 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 (USNM-DC).

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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 operated here at one time (U.S. Geological Survey, 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; USNM 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. 104). 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. 69). Galena, chalcopyrite, and

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Fig. 69 here

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 houses, 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 four 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. 70). These prospects or small mines, which according to local

Fig. 70 here

residents were opened during the Civil War, contain serpentinite and massive to slightly foliated steatite. Malachite occurs in the ser-

Fig. 69

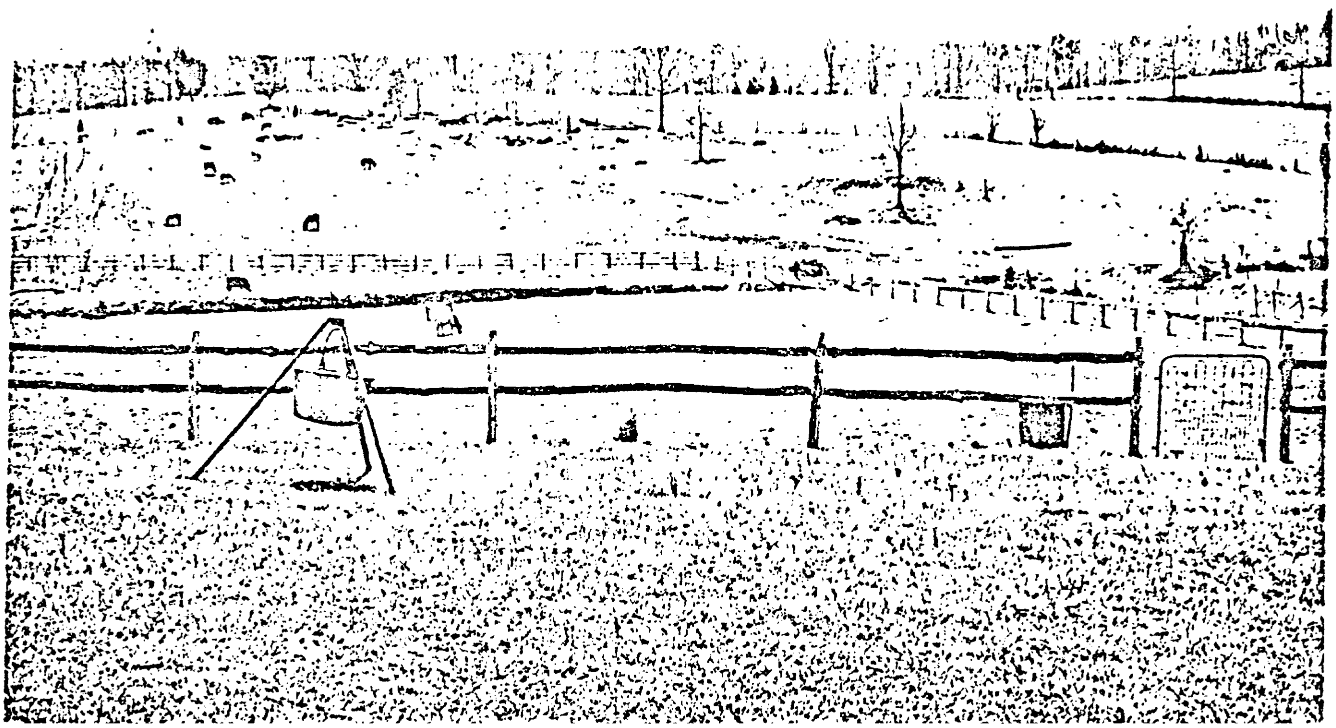

Fig. 70

pentinite, 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, rusty-colored carbonaceous schist, containing andalusite variety (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. Specimens of sharp magnetite octahedra to five millimeters across

No

Figure

No. 71

2

in chlorite schist (USNM 82730) and of gold and pyrite in quartz (USNM 82728) from Pimmit Run are in the Smithsonian collections.

5. A specimen of gold with galena in quartz, from an unlocated area called "Mineral Ridge" in Fairfax County, is in the Smithsonian collections (USNM 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.

Fig. 72 here

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 taking a path for several hundred meters northwest from the first farmhouse south of Route 667 on the east side of Route 603. The mine workings are near the end of this

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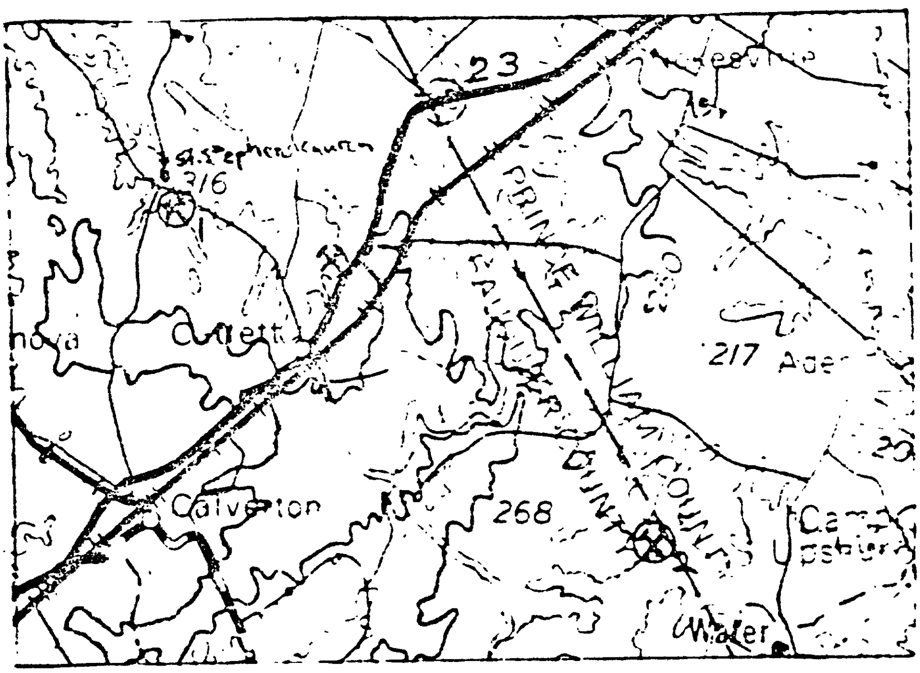

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Fig. 72.

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 2×10^6 kg (2200 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 swamp and

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is about a hundred 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 and 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 thirty 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 which crosscut the tabular barite. Euhedral barite crystals are not common, although fine

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crystals have been reported (Morrill, 1972).

Where cross-sections of veins could be seen, in large rock fragments from the soil, it could be observed that the barite apparently crystallized earlier than the calcite ; and much of the barite is itself brecciated and recemented by the calcite. In such breccia, fragments of barite are surrounded by selvages of fine-grained calcite, and have corroded edges. Due to the lack of exposures and the paucity of samples, a complete genetic and 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 two kilometers to the west, and more may occur at depth.

Minerals

Barite - coarse, tabular, white intergrown crystals; and 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. 155; and map of mineral deposits in Triassic rocks, in pocket)

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

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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, verbal 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" (Virginias, 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., verbal commun., 1975). The author encountered 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

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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, verbal commun., 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 - see p. 72. (Loc. 10).

Leesburg

Fig. 73 here

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. 73), 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, 1926). The paper by Shannon (1926) gives a very complete description of the Leesburg Lime Company quarry,

Fig. 73

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 six centimeters in diameter, and as veins of radiating acicular crystals up to about five 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 two centimeters wide but occasionally broadening to eight centimeters, cut this rock. These consist predominantly of datolite and/or calcite, with occasional

Fig. 74 here

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 (fig. 74) and calcite (fig. 75) crystals, tabular white barite crystals up to three 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.

Fig. 75 here

Mountville

1. Loudoun Marble Company Quarry - This quarry, now water filled, is

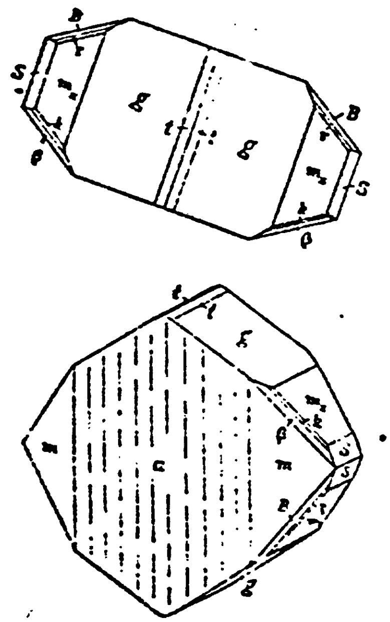

FIG. 2.—DATOLITE. SMALL CRYSTAL SHOWING COMMON HABIT WITH APPARENTLY ORTHORHOMBIC SYMMETRY

Fig. 74. Common habit of datolite from the Leesburg Lime Co. quarry (from Shannon, 1926b, p. 21).

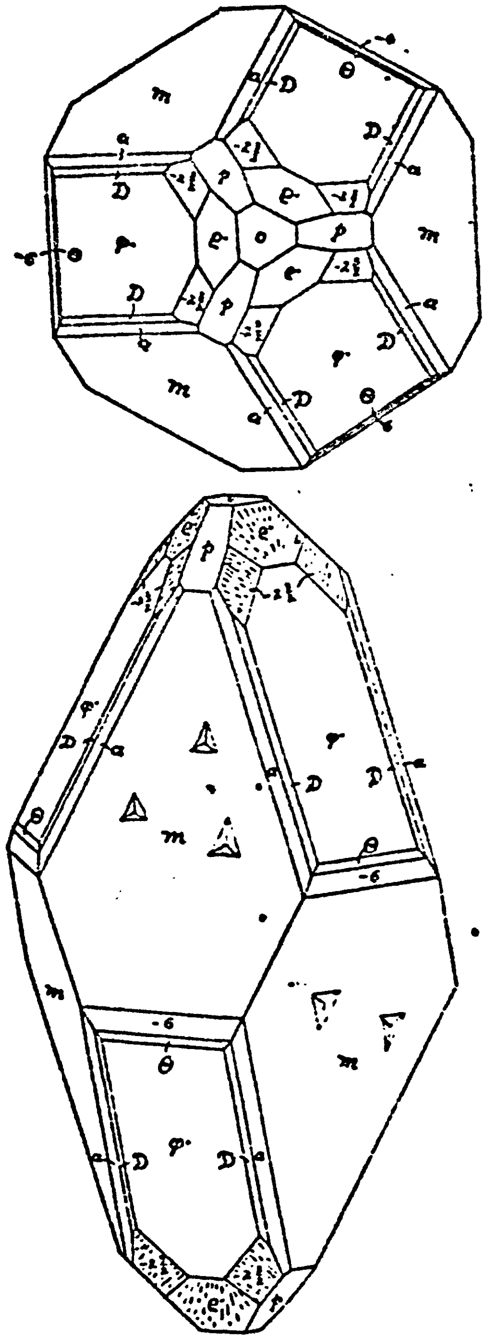

Fig. 75. Habit of colorless calcite crystals from the Leesburg Lime Co. quarry. From Shannon (1926b), p. 30.

or

146 b

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 five 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 (Scott Silsby, verbal 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).

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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 in Triassic red to gray sandstone, siltstone, shale, and arkose, associated with and often replacing plant fossils, 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. 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).

Fig. 76 here

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Fig. 76

14.5u

PRINCE WILLIAM COUNTY

(also see: Diabase Quarries of Northern Virginia, p. 155; and map of mineral deposits in Triassic rocks, in pocket)

Cabin Branch Mine

Dumfries

Loc. 1

Fig. 77 here

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. 78). 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.

Fig. 78 here

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

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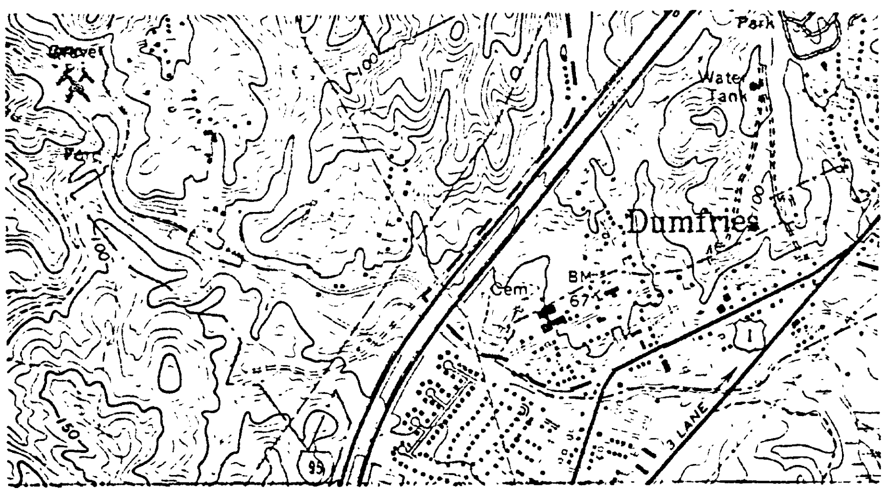

Fig. 77.

Fig. 78

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. 16), 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 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.

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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.

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.

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Other Localities

Aden

A barite mine was located about two miles southwest of Aden; see Fauquier County, Barite Mines Near Catlett, p. 139.

Agnewville

Agnewville prospect - This is a small pyrite prospect in black Quantico Slate, 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 Lüttrell (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. 149) 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).

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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 by 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 one mile north of Joplin (Luttrell, 1966) and two miles 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 two miles south of Manassas (Luttrell, 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).

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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 known the world over. Lesser known are the wide variety of zeolites, pyroxenes, amphiboles, sulfides, and other more unusual minerals which commonly occur as exceptionally well formed or large crystals. The quarries themselves 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. 33 .

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Late differentiates of the diabase are those rocks which 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 one to three millimeters. Most of the pyroxene from this rock is augite or, less commonly, pigeonite. Shannon (1926) 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 or augite (or intergrowths of the two) up to at least

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25 centimeters 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 occasionally 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 (1926) 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,

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chalcopyrite, and byssolite are also found in these seams, though cavities and well formed crystals are rare. Shannon (1926) 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 six millimeters) crystals. These are often covered by crystals of other minerals, most notably colorless to light tan or pink apophyllite. The largest apophyllite crystals known in the world (up to about 20 centimeters) came from the Centreville quarry (fig. 80), 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.

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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 (Herb Carbett, verbal 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 well formed and transparent. 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. 33), 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 (fig. 82) 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.

Fig. 79 here

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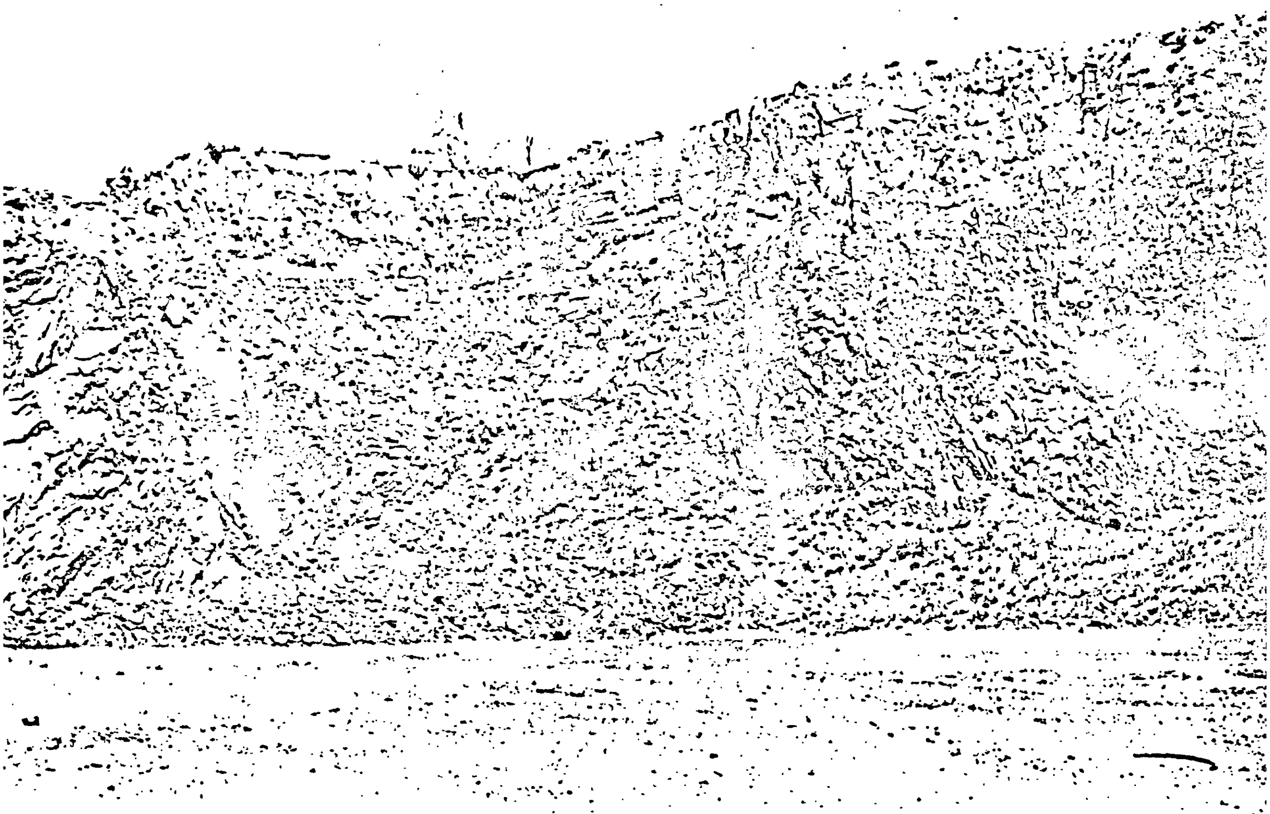

Fig. 79

Minerals

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).

Analcite - possibly occurs at the Gainesville quarry (7)

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

Fig. 80 here

20 centimeters across (fig. 80). Analysis of apophyllite from the Old Goose Creek quarry gave (2):

* Numbers refer to the references listed in Table 1.

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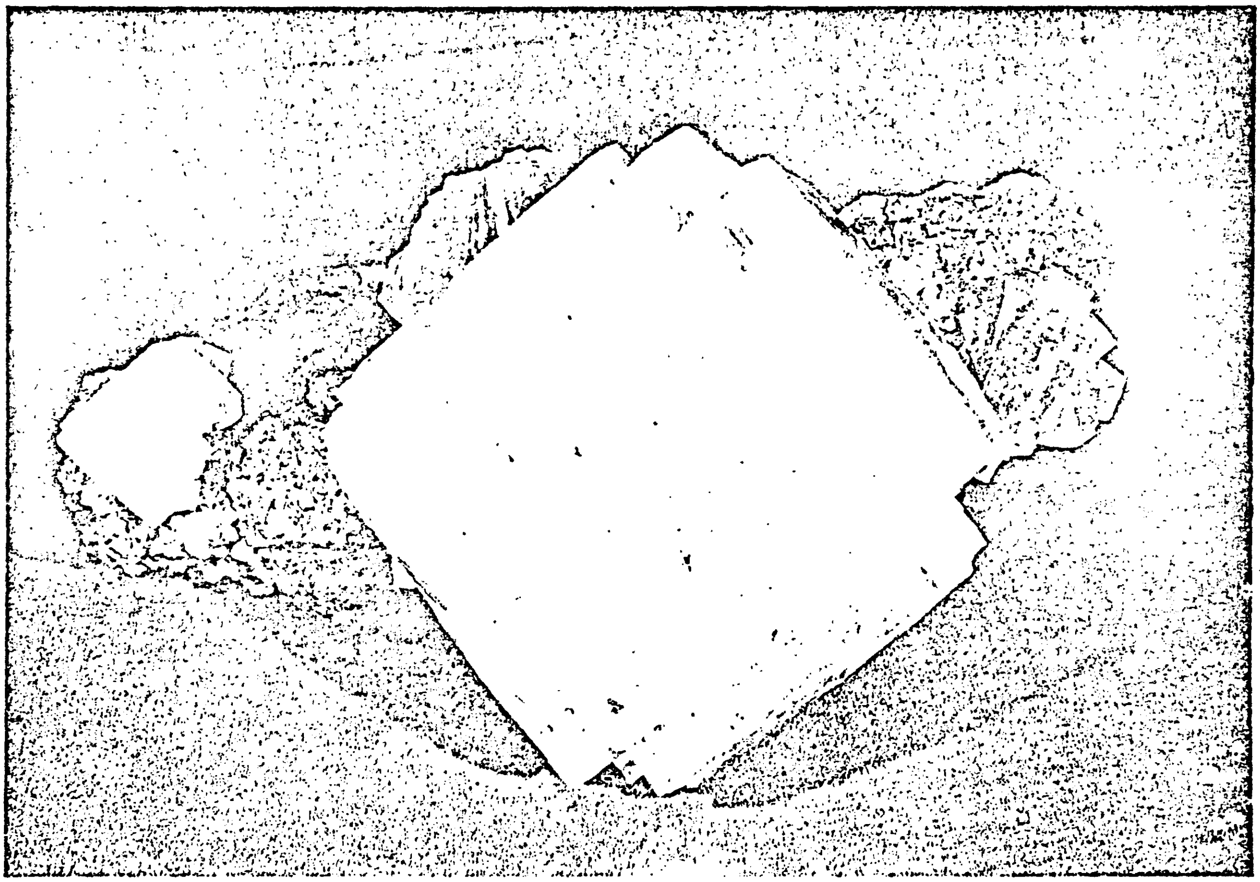

Fig. 80

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; commonly titaniferous. An analysis of augite from the Old Goose Creek quarry gave (2):

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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)

Bornite - masses up to at least 7.5 centimeters in hydrothermally altered zones; usually with and/or pseudomorphous after chalcopyrite; 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

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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 stil- [illegible]. 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 occasionally in hornfels

Chlorite - green masses in hydrothermally altered zones; as lustrous dark-green coatings on many slickenslides

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 one 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

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generally from Old and New Goose Creek and Manassas quarries; Shannon (1926) 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).

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.

Hornblende - fine grained, as replacement of pyroxene.

Ilmenite - an accessory mineral in the diabase (2); occasionally in seams of chlorite.

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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 in diabase; often not associated with other hydrothermally derived minerals; alters on exposure to air 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.

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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 three centimeters across at diabase-hornfels contact; smaller, etched crystals in hornfels at the Manassas quarry (1)

Natrolite - rare; 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

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

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zones, where cavities contain botryoidal, globular, and stalactitic aggregates of crystals with numerous habits; single crystals rare; occasionally found in hornfels. Prehnite from the Old Goose

Fig. 81 here

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,

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Fig. 81

colorless crystals are common in cavities of hydrothermally altered zones, often with prehnite and apophyllite; occasionally 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 four centimeters long and five 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, verbal communication, 1975)

Silver - rare, as small wires in calcite veins or on prehnite

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

Fig. 82 here

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. 82)

Fig. 82

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 (USNM 115257)

Titanite - resinous brown crystals, common as accessory mineral in diabase and albitic rocks (though most 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 occasionally cuprobismutite, from the Centreville quarry (5)

Fig. 83 here

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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TOP

Fig. 83.

Rock types / Localities	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	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
Acmite				X						(1)			
Actinolite		X			X	X		X		X		(2)	
Aikinite		X					X						
Albite	X	X	X			X			X	X	X	X	X
Analcite		X						(7) (?)					
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) Herb Corbett, verbal communication 1975; (2) Shannon, 1926a; (3) Bruce Maier, verbal and written communication 1975; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1964; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

Minerals \ ROCK TYPES	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			
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)			
Hematite	X	X		X		X	X			X			

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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			
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	X
Leonhardite		X			X	X	X	X	X	X	X	X	X
Limonite	X	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)							
Opal		X			(3)					X		(3)	(3)

Table 1. Minerals of the Northern Virginia Diabase Quarries

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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			
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)			
Schorl	X									(1)			

Table 1. Minerals of the Northern Virginia Diabase Quarries

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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			
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

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) Herb Corbett, verbal communication 1975; (2) Shannon, 1926a; (3) Bruce Maier, verbal and written communication 1925; (4) Cosminsky, 1950; (5) Medici, 1972; (6) Toewe, 1964; (7) Cordua, 1968; (8) Ulke, 1936; (9) Trapp, 1964.

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 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. 80). 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. 84).

Fig. 84 here

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 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 - (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 - Loundoun County (Loc. 4), just west of Route 659 in Belmont, about 2.4 km south

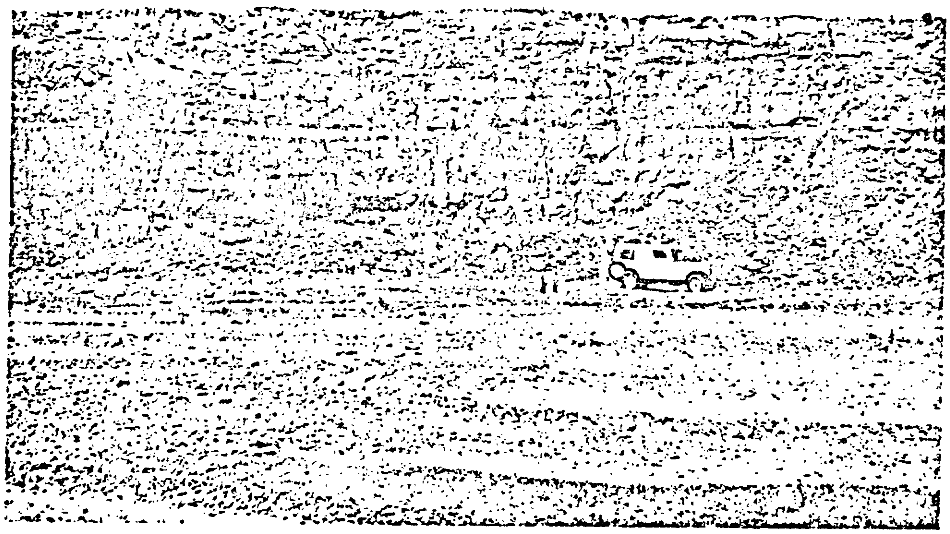

Fig. 84. Hornfels containing abundant stilbite at the western end of the Chantilly Quarry.

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 common.

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 Ouarries, 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 Ouarry (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 (fig. 81). Handsome cubic galena crystals with octahedral modifications, and superb yellow sphalerite crystals to two centimeters across, are occasionally found on prehnite. Yellow titanite crystals up to at least five millimeters long are rather common in aplite.

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Plate 1

Explanation

⚒	Mine or quarry
(⚒)	Group of mines or quarries
X	Prospect
(X)	Group of prospects
Δ	Natural exposure (outcrop or float)
O	Stream or placer deposit
□	Roadcut
◊	Other excavations (e.g. tunnels, foundations)
(◊)	Group of other excavations
( )	Site approximately located

Plate 1

Localities

District of Columbia

1. Oxon Run goethite occurrence (John Greisbach, verbal commun., 1925
2. Constitution Avenue vivianite occurrences (Benn, 1935)
3. Massachusetts Avenue marcasite occurrence (Scott Sibby; verbal comm
4. Fort Baylor Park steatite occurrence
5. Connecticut Avenue psilomelane occurrence
6. Piney Branch rutile and titanite occurrence (A.C. Bonanno, verbal co 19 Ulke,
7. Rock Creek staurolite occurrence (A. C. Bonanno, verbal commun., 1925
8. Pierce Mill jasper occurrence
9. Harvard Street piemontite occurrence. (Ulke, 1936)
10. Blagden Avenue opal occurrence (Ulke, 1936)
11. Marcasite occurrence at First and M streets, N.E. (Ulke, 193
12. Chain Bridge exposures. (Ulke, 1936).
13. Constitution Avenue galena and cerussite occurence (Ulke, 19
14. Howard University occurrences (Ulke, 1936).
15. Longbridge gold occurrence (USNM 12013)
16. Foundry Branch rutile occurrences (USNM 104561, 85429)
17. Rose Hill quarry (Holmes, 1890).
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 (Ostrander and Price, 1940)
4. Pinehurst marcasite occurrence (")

5-21. Iron Mines in the Arundel Formation (Singewald, 1928, p. 278-283
More detail is shown on fig. 8, p.

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
   Plummer ore banks
10. Timber Neck ore banks
    Lafey ore bank
11. Anderson ore bank
    Dorsey ore banks
12. Disney ore bank
    Harmon ore bank

Anne Arundel Co., cont.

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 (Singewald, 1911, p.2
More detail is shown on Fig. 8, p.

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

(over)

19. Miller ore banks
Ring ore banks
Coursey ore bank
Randle ore bank
Stapleton ore bank
~~20. Benson ore banks~~
~~[illegible] ore banks~~
~~Randel ore bank~~
~~[illegible] ore bank~~
~~[illegible] ore bank~~ ~~Pl[illegible]~~
~~21. [illegible] ore bank~~
~~22. [illegible] ol~~

Carroll County

1. Mineral Hill mine
2. Springfield mine

7

Frederick County

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

8

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 (Hopson, 196
6. Clarksville smoky quartz occurrence (Ostrander and Price, 1940)
7. Columbia quartz crystal occurrences.
8. Rice Mine (Singewald, 1911).
9. Forsythe Mine (Singewald, 1911).
10. Alberton quarry (Ostrander and Price, 1940).
11. Ellicott City granite quarries.
12. Ellicott City nontronite occurrence (Hopson, 1964).
13. Glenelg limonite after pyrite occurrences.
14. Mount Saint Clement College quarry.
15. Marriottsville flagstone quarries.
16. Marriottsville marble prospect (Ostrander and Price, 1940).
17. Marriottsville talc prospect (Ostrander and Price, 1940).
18. Marriottsville kyanite occurrence (Ostrander and Price, 1940).
19. Pine Orchard autunite occurrence (J.S. White, Jr., verbal commun., 1973).
20. Savage gabbro quarry
21. Patuxent River schorl occurrence
22. Maryland Mica mine.
23. Parker prospect

Howard Co., cont.

24. Woodstock granite quarries (Ostrander and Price, 1940)
25.-48. Feldspar and quartz mines (Singewald, 1928, pl. 4).
More detail is shown on figs. 39 and 40, p.
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
31. Gary quarry
Dorsey's Run quarry
32. Theis quarries
Perry quarries

(Howard Co., cont.)

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

11

Howard Co, cont

49–51. Iron mines in the Arundel Formation
(Singewald, 1928, p. 275-278). More detail is shown on Fig. 8, p

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. 51)
9. Rock Run gold placers (Pearre, 1981)

( ) 10. Anderson gold Mine (Weed, 1905)

11. Bethesda gold mine (Reed and Reed, 1969)
12. Bogley gold mine

( ) 13. Fawsett gold mine (F.W. Stevens, verbal commun., 1975)

( ) 14. Gillotts gold mine "

15. Grady gold mine "
16. Huddleston gold mine
17. Miller gold mine (Reed and Reed, 1969)

( ) 18. Sawyer gold mine (F.W. Stevens, verbal commun., 1975)

19. Stevens - Rowdebush gold mine "
20. Barnesville "copper mine" (J.F. Windolph, Jr., verbal commun., 19
21. Barnesville "gold mine" (")
22. Black hills "gold mine" (")
23. Buttonsville gahnite occurrence

(over)

24. Earth Products Company feldspar mine (Singewald, 1928).
25. Gropley magnetite occurrence (Scott Silsby, written commun.,
26. Widewater copper occurrence
27. Dawsonville gold occurrences (J.F. Windolph, Jr., Verbal commun., 19
28. Dawsonville cinnabar occurrence (")
29 Sugarland copper mine.
30. Dickerson quarries
31 Etchison chrome mine (Singewald, 1928)
32 Lyde Griffith property (Singewald, 1928)
33. Etchison magnetite occurrence (A.J. Froelich, verbal commun., 1976
34 Gaithersburg copper occurrence (J.F. Windolph, Jr., verbal commun., 1975)
35 Gaithersburg magnetite occurrence (A.J. Froelich, verbal commun., 1976
36. Glen rutilated and blue quartz occurrences
37. Glen Echo gold occurrence (Ostrander and Price, 1940)
38. Olney ~~quartz~~ gold(?) prospect
39. Aspen Hill quartz crystal occurrence
40. Halpine quarry (John Greisbach, verbal commun., 1975)
41. Peary High School limonite replacing pyrite occurrence
42. Rockville gold occurrence (F.W. Stevens, verbal commun., 1975)
43. Hermleigh Road quarry (J. Greisbach, verbal commun., 1975)
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 Georges County

1. Wheeler Road vivianite locality
2. Fort Washington gypsum locality
3. Muirkirk Claypits
4. Bladensburg siderite and marcasite occurrence
5. Brentwood quartz crystal occurrence
6. Fort Foote gypsum occurrence (Mitchell, 1970)
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 (Singewald, 1911, p.20
More detail is shown on fig. 8, p.

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
Anvall 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 (Scot Silsby, verbal comm
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 (Dietrich, 19
7. Spout Run jasper occurrence (Dietrich, 1970)
8. Stratford Junior High school garnet and quartz crystal occurrence
9. Doctors Run blue and asteriated quartz occurrences (Dietrich,

Fairfax County

1. Theodora copper mine
2. Centreville quarry
3. Holmes Run amethyst occurrence (Scott Sibley, verbal commun.,
4. Bull Run gold occurrence (USNM 105364)
5. Sisler's Quarry
6. Chantilly copper occurrence (O'Agostino and Hanshaw, 1970).
7. Chantilly copper prospect
8. Pender specular hematite occurrence (O'Agostino and Hanshaw, 197
9. Falls Church blue and asteriated quartz occurrences (Dietrich, 19
10. Falls Church psilomelane occurrence (USNM 105923)
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

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
9. Evergreen Hills baked conglomerate exposure
10. Furnace Mountain iron mines
11. Leesburg Lime Co., Inc. quarry
12. White quarry
7. State Roads quarry (Toewe, 1966)
6. Virginia Trap Rock quarry
8. Goose Creek copper mines (Toewe, 1966)
13. Loudoun Marble Company quarry
14. Goose Creek Lime Co. quarries
15. Vensco quarry
16. Catlett's ocher prospect (Toewe, 1966).
17. Sterling specular hematite occurrence
18. Sterling copper and plant fossil occurrence

Prince William County

1. Cabin Branch mine
2. Agnewville prospect
3. Brenstville copper prospects
4. Crawford gold placers
5. Prince William Forest pyrite deposit
6. Greenwood gold prospect.
7. Joplin prospect (Luttrell, 1966)
8. Minnieville amethyst occurrence (Schlegel, 1957)
9. Occoquan River exposure (Morrill, 1972)
10. Gainesville quarry
11. Manassas quarry

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