

Rm. 106

OHIO GEOLOGICAL SURVEY

APR 1 1970

GOLD VEINS NEAR GREAT FALLS, MARYLAND

GEOLOGICAL SURVEY BULLETIN 1286



QE 75

B9

no. 1286

C.B.

Gold Veins Near Great Falls, Maryland

By JOHN C. REED, JR., and JOHN C. REED

G E O L O G I C A L S U R V E Y B U L L E T I N 1 2 8 6

*A discussion of the history of
prospecting and mining in the
Great Falls area and a description
of the gold-bearing quartz veins*



UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

Library of Congress catalog-card No. 73-603796

CONTENTS

	Page
Abstract.....	1
Introduction.....	1
Discovery and development.....	4
Geologic setting.....	10
Gold-bearing veins and shear zones.....	15
Age of mineralization.....	21
Outlook for further development.....	21
References cited.....	22

ILLUSTRATIONS

	Page
PLATE 1. Map of underground workings.....	In pocket
2. Map of the vein system near Great Falls showing location of principal mines.....	In pocket
FIGURE 1. Map showing gold mines in Montgomery County, Md., and location of area studied.....	2
2. Aerial photograph showing prospect pits and trenches near the Ford mine.....	3
3. Graph showing production of gold in Maryland from 1868 to 1951.....	5
4. Isometric block diagram of the Maryland mine.....	9
5. Photographs of ruins of assay laboratory and mill.....	11
6. Equal-area projections of structures in wallrocks and in gold-bearing veins and shear zones.....	15
7. Photographs of gold in quartz and in limonite pseudomorphs after pyrite.....	18
8. Photographs of gold associated with galena.....	21

GOLD VEINS NEAR GREAT FALLS, MARYLAND

BY JOHN C. REED, JR., and JOHN C. REED

ABSTRACT

Small deposits of native gold are present along an anastomosing system of quartz veins and shear zones just east of Great Falls, Montgomery County, Md. The deposits were discovered in 1861 and were worked sporadically until 1951, yielding more than 5,000 ounces of gold.

The vein system and the principal veins within it strike a few degrees west of north, at an appreciable angle to foliation and fold axial planes in enclosing rocks of the Wissahickon Formation of late Precambrian (?) age. The veins cut granitic rocks of Devonian or pre-Devonian age and may be as young as Triassic.

Further development of the deposits is unlikely under present economic conditions because of their generally low gold content and because much of the vein system lies on park property, but study of the Great Falls vein system may be useful in the search for similar deposits elsewhere in the Appalachian Piedmont.

INTRODUCTION

During the past 100 years more than 5,000 ounces of gold, valued at more than \$150,000, have been produced in Maryland, almost all from small mines in the southern part of Montgomery County (fig. 1). These mines have been described in a number of popular articles (Ulke, 1939; Shostek, 1953; Ostrander, 1940; Zodac, 1947; Ingalls, 1960) and have attracted considerable attention among mineral collectors and historians. Emmons (1890) and Weed (1905) briefly examined some of the deposits and published short descriptions, but since their work no systematic geologic study of any of the deposits has been made.

Active mining in the area ended before World War II, and many of the workings have long since been obliterated. Near Great Falls, however, an extensive group of workings along one of the most productive vein systems is still well preserved (fig. 2). Several miles of prospect trenches, dozens of shallow pits, and a few accessible underground openings (pl. 1) afford an unusually good opportunity to examine and map the veins (pl. 2), and nearby exposures along the Potomac River allow detailed study of the wallrocks. A preliminary paper summarizing the results of our study of these deposits has already been published (Reed and Reed, 1967); the present paper is a modified and expanded version of our earlier discussion.

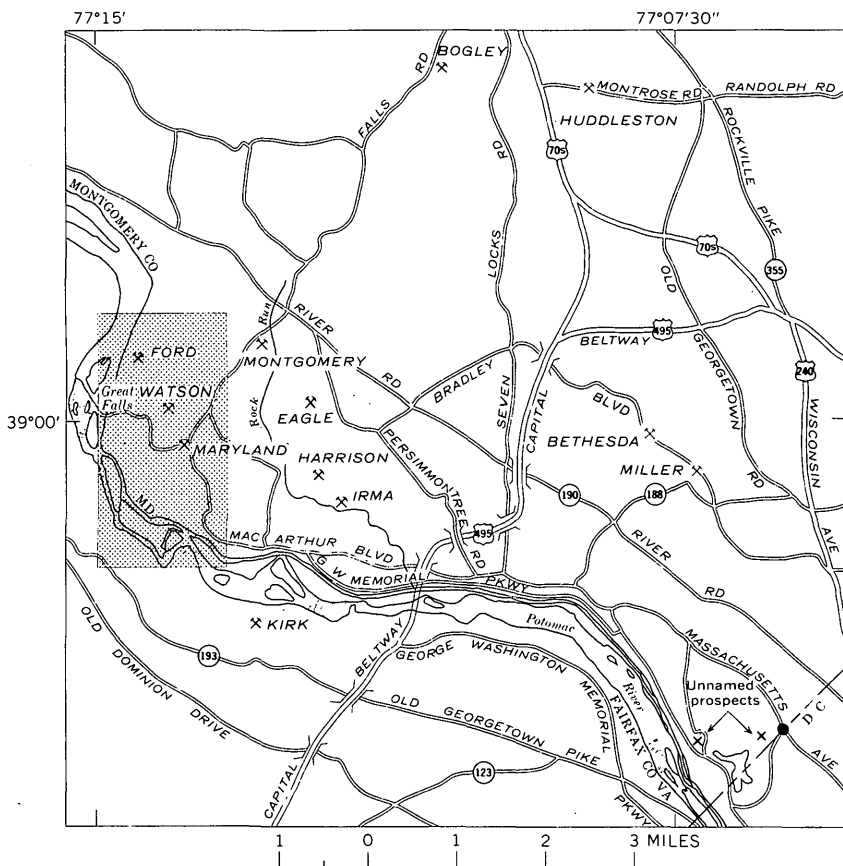


FIGURE 1.—Gold mines in Montgomery County, Md., and location of area studied. Shaded rectangle shows area of plate 2. Modified from Reed and Reed, 1967, fig. 1.

Many of the workings near Great Falls lie within the George Washington Memorial Parkway, which is administered by the U.S. National Park Service. Prospecting is prohibited in the parkway, and specimens may be collected only with the written approval of the superintendent. Prospecting or collecting on adjacent private lands, of course, requires the consent of the owners. Most of the underground workings are partly caved and some are decidedly unsafe. They should be entered only with great caution!

We would like to express our appreciation to Dr. William L. Hendrickson, chief of interpretation, George Washington Memorial Parkway, for his interest and encouragement of our study; to Mr. Paul H. Keller, seasonal naturalist at Great Falls Park, for his assistance in the field; and especially to Mr. Edgar T. Ingalls of Potomac, Md.,



FIGURE 2.—Aerial photograph showing surface workings along part of Great Falls vein system. For location of area, see plate 2. Note pits and trenches along Ford vein and vein to west. Lines of trees in open field east of Ford vein mark outcrops of other quartz veins. Long east-west prospect trenches (T) date from exploration work during 1915-18.

former underground foreman at the Maryland mine, who provided much firsthand information on the history and development of the Great Falls gold deposits and kindly allowed us to examine and photograph his collection of gold specimens. Our study was greatly facilitated by a comprehensive bibliography and file of newspaper clippings, extracts of published articles, mint returns, and field notes prepared by Nancy C. Pearre, formerly of the U.S. Geological Survey.

DISCOVERY AND DEVELOPMENT

The most authoritative account of the discovery of gold near Great Falls is that by Ingalls (1960). He states that the discovery was made in 1861 near the present site of the Maryland mine (pl. 2) by Private Cleary, a member of a regiment of California volunteers under the command of Col. Edward A. Baker which was camped in the area to guard against a Confederate attack across the Potomac following the first Battle of Bull Run. Shosteck (1953) gives the discoverer's name as John Clear and the date of discovery as 1864.

There is no record of any California units in the Eastern Theater during the Civil War. In the spring of 1861, however, Edward Baker, then Senator from Oregon and a close personal friend of President Lincoln, was commissioned colonel and authorized to recruit three regiments of infantry in Philadelphia. One of these, the 71st Pennsylvania, was placed under his command and was informally referred to as the "1st California," apparently in honor of Baker and several of his officers who had come from the west coast (Banes, 1876). The 71st Pennsylvania camped near Great Falls on the night of September 30, 1861, on a march from Chain Bridge to Rockville, Md. From October 3 to 20 the regiment was camped at Poolesville, about 15 miles to the northwest, and it is possible that small detachments remained in the Great Falls area during part of that time. Colonel Baker was killed in action at the Battle of Balls Bluff on October 21, where the regiment was heavily engaged. Following this action, the regiment was assigned to picket duty along the Potomac, where it remained during most of the winter (Banes, 1876).

No Private Cleary or Clear appears on the roster of the 71st Pennsylvania (Bales, 1869), but the rolls carry the names of Alexander McCleary, private, Company C, and John Carey, private Company K. Private McCleary enlisted at Philadelphia on May 21, 1861, and was discharged on a surgeon's certificate on April 5, 1862; Private Carey enlisted at Philadelphia on June 28, 1861, and was discharged for wounds received at Antietam on September 17, 1862. Both of these men were apparently with the regiment when it was near Great Falls,

and it is reasonable to assume that one or the other of them made the gold discovery.

Following his discharge, Private McCleary (or Carey) organized a group that bought the farm on which the original discovery was made (Ingalls, 1960). Considerable prospecting and developing work were done, and in 1867 a shaft was sunk to a depth of about 100 feet at the future site of the Maryland mine (pl. 2; fig. 4). Mint records (fig. 3) show that at least 7 ounces of gold were produced in 1868 and 4 ounces in 1869, but much of the early production may never have reached the mint. At any rate, the work was soon abandoned.

Sometime in the 1880's, gold was discovered in the vicinity of the Ford mine (pl. 2) by George Kirk, a Georgia prospector. By the time of Emmons' visit in February 1890, the veins were being worked by extensive opencuts on both sides of Cool Spring Branch, and a small mill was in operation near the mouth of the branch. At that time the tract was known as the Allerton-Ream property. There is no record of the production from those workings, but certainly part of the total Maryland production between 1880 and 1891 must have been from that source. Underground development at the Ford mine probably began about 1890, but there is no record of its progress.

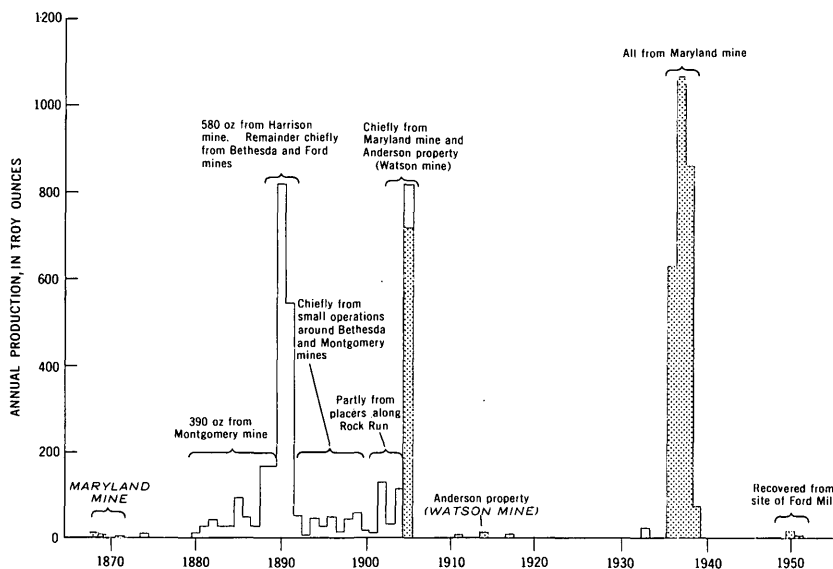


FIGURE 3.—Graph showing production of gold in Maryland from 1868 to 1951. Stipple indicates production from the Great Falls vein system. For locations of mines outside Great Falls area, see figure 1.

In 1903 or 1904, considerable prospecting and development work were done on the veins along Carroll Branch, between the Maryland mine and the Allerton-Ream property. That area, which includes the site of the Watson mine (pl. 2), was known as the Anderson property and was operated by the Great Falls Gold Mining Co. The veins and workings were described by Weed (1905); he discussed seven named veins, but the only one that can be specifically identified from his descriptions is the Potomac vein (pl. 2). According to Weed, this vein was explored by a 135-foot adit north of MacArthur Boulevard. The dump and caved portal of this tunnel are still visible from the road, about 100 yards east of the entrance to the parking lot at Great Falls Park. The other six veins Weed described are probably those that cross Carroll Branch north and northwest of the site of the Watson mine (pl. 2). The workings in that area consisted of many pits and trenches and a few shallow shafts with short drifts and crosscuts. The operations continued until at least 1909.

About 1900 the property subsequently known as the Maryland mine was taken over by the Maryland Gold Mining Co. A 135-foot shaft (fig. 4, No. 1 shaft) was sunk, and the vein was explored by drifts on the 50- and 100-foot levels (Ingalls, 1960). On the 100-foot level the vein was followed for about 100 feet in each direction from the shaft (Weed, 1905). In 1903 a new shaft (fig. 4, No. 2 shaft) was started west of the vein and 60 feet south of the old shaft. It was intended to cut the vein at a depth of 500 feet, but, instead, intersected it at 200 feet and was bottomed at 210 feet in 1906. The mine was shut down in 1908. In 1912 the mine was reopened briefly by the Empress Gold Mining Co. of Philadelphia and some development work was done on the 135-foot level, but the company's option was not renewed.

The most systematic exploration of the Great Falls veins began in 1915 when the Atlantic Development Co. acquired the Ford mine. By 1918 the company had acquired tracts totaling 2,100 acres that included nearly all the known vein system. A. A. Hassan, a mining geologist and consulting engineer, directed an exploration program that included extensive trenching, vein stripping, and diamond drilling. The long east-west cross trenches (fig. 2; pl. 2) and most trenches and pits along the veins date from that period. No complete record of the results of the diamond drilling remains, but Ingalls (1960) reports that a drill hole 1,000 feet north of the Maryland mine proved

the vein to a depth of 456 feet, and that holes near the Ford mine showed that the veins extend to a depth of at least 500 feet. Some underground development work was done in the Ford and Maryland mines, but no production was recorded. The assay laboratory at the Ford mine (fig. 5A) was probably built during that period.

An interesting sidelight on the operations is related by E. T. Ingalls and T. B. Nolan (oral commun., 1966). They report that the extensive trenching under Hassan's direction aroused considerable suspicion and gave rise to newspaper reports that entrenchments were being prepared for a German attack on Washington! As a result of the allegations, H. G. Ferguson, of the U.S. Geological Survey, was dispatched to examine the operations. Unfortunately, no copy of his confidential report can be located, but apparently he was able to certify that Mr. Hassan was indeed searching for gold and had no ulterior motive.

In the fall of 1917 the surface exploration program was abandoned and the mines were closed down, but the Maryland mine was reopened in the spring of 1918. Development work was done on the 135- and 200-foot levels between 1918 and 1921 and some ore was mined; but as no mill was in operation, the ore was stockpiled and no production was recorded. The mine was closed, and the entire property was sold in 1922.

No further exploration or mining was done on the Great Falls vein system until after the price of gold was increased to \$35 an ounce in 1934. Stimulated by the higher price of gold, the Maryland Mining Co. was organized in October 1935; the Maryland mine was opened again, and a new mill was installed (fig. 5B). Between 1936 and 1940 about 6,000 tons of ore were produced, principally from stopes on the 135- and 200-foot levels, and more than 2,500 ounces of gold, valued at \$90,000, were recovered (fig. 3). The mine was closed in 1940.

The Ford mine is reported to have been worked briefly as late as 1940, but no production was reported and there is no record of the developments.

Since 1940 the mines have remained closed. Spare-time prospecting by E. T. Ingalls and his son Huntley yielded 20 ounces of gold in 1950 and 1 ounce in 1951. Since 1951 there has been no recorded production.

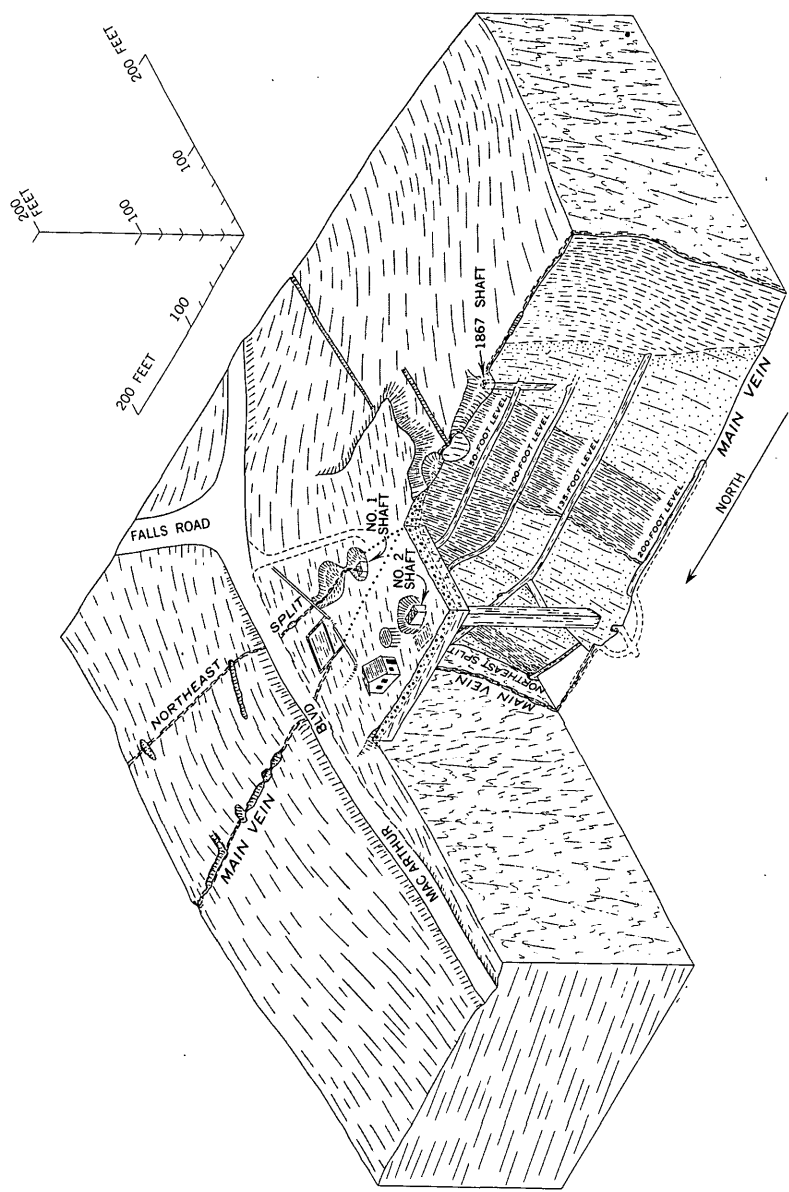


FIGURE 4.—Isometric block diagram of the Maryland mine. Surface details shown as they appeared in 1967. Underground workings as they appeared in 1940, at the time the mine was closed; sketched from recollections by E. T. Ingalls, underground foreman from 1936 to 1940. The block has been cut away to expose the surface of the main (Maryland) vein south of the No. 2 shaft and the surface of the northeast split north of the shaft. Vein stippled where predominantly quartz and coarsely lined where quartz is absent. Finely lined areas are stopes from which ore has been removed. Lines in country rock on vertical faces of block are diagrammatic traces of foliation and bedding in schist and graywacke. Pattern of coarse angular dots on block faces near No. 2 shaft indicates dump material. Circular structure north of No. 2 shaft is the foundation of a 25,000-gallon water tank. The building to the north was the blacksmith shop. The rectangle west of No. 2 shaft is the foundation of the hoist house; the rectangle north of No. 1 shaft is the foundation of the mine office and assay laboratory. The ruin of the mill (fig. 5) lies about 200 feet southwest of No. 2 shaft on the part of the block that has been removed. From Reed and Reed, 1967, figure 3.



GEOLOGIC SETTING

The principal country rocks in the Great Falls area are interlayered mica schist and metamorphosed graywacke cut by dikes, sills, and small irregular plugs of light-colored granite and, locally, by dikes of lamprophyre. The schist and graywacke are part of the Wissahickon Formation, a thick sequence of metamorphosed sedimentary rocks that crops out over wide areas in the Piedmont plateau in Virginia, Maryland, and Pennsylvania, including much of western Montgomery County, Md. (Cloos and Cooke, 1953). Recent studies indicate that the Wissahickon probably is of late Precambrian age and that it was metamorphosed and invaded by granitic rocks during the early Paleozoic (Hopson, 1964).

Outcrops of the country rocks are generally sparse in the immediate vicinity of the gold deposits, but enough exposures are present to show that the rocks are identical with those spectacularly exposed a few thousand feet to the south along the Potomac River gorge and described in detail by Cloos and Anderson (1950), Fisher (1963), Reed and Jolly (1963), and Hopson (1964).

The schist and graywacke are intimately interlayered in all proportions, but schist is the predominant rock type in most of the area. Where fresh, it is a lustrous medium- to fine-grained bluish- or greenish-gray rock composed predominantly of quartz, plagioclase, muscovite, biotite, and chlorite. Locally, it contains relict grains of



B

FIGURE 5.—Ruins of assay laboratory and mill. *A*, Ruins of assay laboratory at the Ford mine, about 100 feet east of No. 2 shaft. Brick structure in foreground was the furnace; cement tables in the background held analytical balances used for precise weighing. *B*, Ruins of mill at the Maryland mine. Ore cars entered on trestle at *a*, and dumped into ore bin (*b*). Ore was fed into primary jaw crusher located on concrete foundation at *c*, where the ore was crushed to fragments about 3 inches in diameter. It was then hoisted by bucket elevator to a second jaw crusher (*d*). From there, the ore passed through a 10-stamp mill (*e*) and ball mill (*f*). Finely crushed ore then passed through an impact amalgamator where free gold combined with mercury; it then passed over concentrating tables where gold-bearing sulfide minerals were recovered.

sillimanite, kyanite, garnet, and potassic feldspar that crystallized during the climax of early Paleozoic metamorphism; in many places, however, these minerals have been largely converted to chlorite and fine-grained white mica that formed during later shearing and lower temperature metamorphism. Much of the schist is crisscrossed by light-colored seams and veinlets of quartz and feldspar (albite) that locally form as much as 50 percent of the rock and give it a "shredded" appearance. Similar veined schist along the Potomac River gorge was interpreted by Reed and Jolly (1963) to be the result of partial melting of the schist, but Hopson (1964) has shown that the veinlets were more likely formed by segregation of the quartz and feldspar during metamorphism, without fusion.

The graywacke, a medium- to fine-grained light-bluish-gray massive rock, is composed principally of quartz and plagioclase feldspar and

contains lesser amounts of muscovite and biotite. Beds range in thickness from a few inches to as much as 3 feet; many are finely laminated, and a few have graded bedding.

The schist and graywacke have been complexly folded, but because of the scarcity of outcrops, the pattern of the folds cannot be worked out in detail in the area of the gold-bearing veins. Mapping along the Potomac River gorge indicates that the folds of the principal set are nearly isoclinal and have axial planes that strike N. 10°–20° E. and are vertical or dip steeply east (pl. 2). The fold axes plunge gently to moderately northeast or southwest. Axes of the major folds are spaced 2,000–4,000 feet apart, and the amplitude of the folds probably is about 3,000 feet. Attitudes of structures in the scattered outcrops of country rocks near the gold veins (pl. 2; fig. 6A) are consistent with that fold pattern. Bedding in graywacke and foliation in schist generally strike a few degrees east of north and are vertical or dip steeply east or west. Commonly, the schist has two subparallel foliations. The older, which probably is parallel to bedding, is folded into minute isoclines, many of which have sheared apart and remain only as rootless fold hinges. The later foliation parallels the limbs of these microfolds but transects their noses; it probably is parallel to the axial planes of the major isoclinal folds. Axes of the microfolds and intersection of the two foliations in the schist produce a lineation in the schist which plunges gently to moderately south and probably is parallel to the axes of the major folds. Small crenulations in micaceous partings in the graywacke have a similar orientation. A second lineation (fig. 6A) in the schist is marked by steeply plunging mineral streaks, grooves, and crenulations on the foliation planes. This lineation is apparently younger than that parallel to fold axes and was probably produced during late shearing and retrogressive metamorphism (Reed and Jolly, 1963).

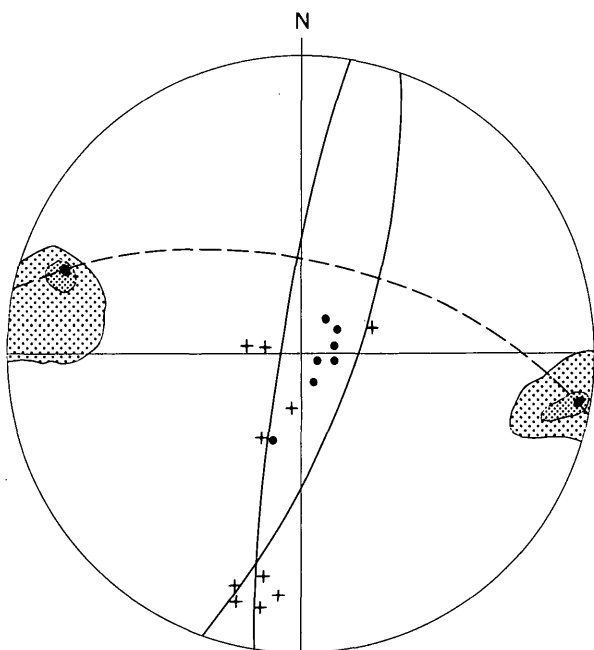
The granitic rock that cuts the schist and graywacke is identical with the Bear Island Granite of Hopson (1964). It is a fine-grained white rock that ranges in composition from quartz monzonite to quartz diorite and contains small amounts of muscovite and, locally, of biotite. The granite is particularly susceptible to weathering and is generally

exposed only in the underground workings. Granite dikes and sills are widespread throughout the area, and some large bodies are several hundred feet in diameter, but lack of exposures makes it virtually impossible to map the distribution of the granite in detail.

The granite was emplaced after the enclosing schist and graywacke were folded and metamorphosed, but before the latest episode of shearing and low-temperature metamorphism. Radiometric age determinations summarized by Hopson (1964) suggest that regional metamorphism in that part of the Piedmont reached a climax in Ordovician time (about 440 million years ago) and that the youngest granites, including the granite in the Great Falls area, were emplaced no later than 370 million years ago (Devonian). No firm date can be placed on the late shearing and low-temperature alteration, but a few scattered age determinations suggest that they must have occurred before 300 million years ago (Pennsylvanian). This shearing and alteration predated emplacement of the gold-bearing veins.

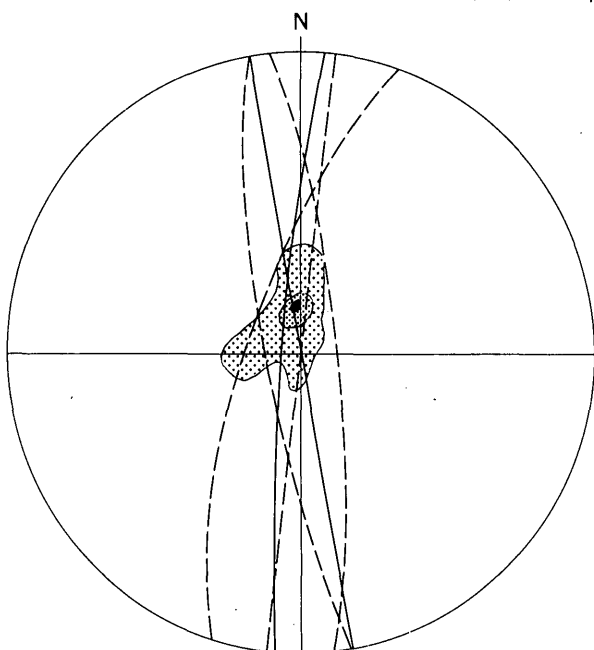
A group of narrow, closely spaced lamprophyre dikes is exposed along the Potomac River near the northern end of Bear Island (pl. 2). The dikes range in thickness from a few inches to 2 feet, and two to five dikes occur in a zone about 25 feet wide. The dikes are composed of a fine-grained dark-green nonfoliated rock that contains phenocrysts of fresh biotite as much as .5 mm in diameter. The matrix consists principally of biotite, actinolite, albite, epidote, and calcite. These dikes follow cross joints normal to axes of the major folds. They are completely undeformed, but are offset by a fault which is parallel with, and probably related to, the gold-bearing veins and shear zones. The lamprophyre dikes are exposed only in the cliffs at the edge of the river and for a short distance on the western shore, but a distinct magnetic low associated with them has been traced for several hundred feet to the east (pl. 2). The age of the dikes is uncertain. They are clearly post-tectonic and may be as old as Ordovician or as young as Triassic.¹

¹ Potassium-argon ages on biotite phenocrysts recently determined by R. F. Marvin, of the U.S. Geological Survey, are about 360 m.y., suggesting that the dikes are of Middle Devonian age.



A

Contours 10, 20, and 25 percent



B

Contours 10, 20, and 30 percent

GOLD-BEARING VEINS AND SHEAR ZONES

The gold deposits occur along an anastomosing system of veins and shear zones that extends from the Chesapeake and Ohio Canal near the east end of Widewater northward to the mouth of Cool Spring Branch, a distance of about 2.5 miles (pl. 2). Most of the veins are confined to a belt about 0.25 mile wide that trends approximately N. 10° W., but some prospecting and perhaps a little mining have been done on the Potomac vein and scattered smaller veins west of the main zone.

The quartz veins range in width from a few inches to as much as 20 feet. They are composed of sugary to vitreous quartz and commonly contain thin septa and irregular blocks of the wallrocks. In many places distinct sheeting in the quartz is defined by close-spaced sericite-coated shear planes parallel to the vein walls. The walls and shear planes generally display a strong, steeply plunging lineation defined by grooves and striae in the quartz and by streaks of fine mica on foliation planes in the wallrocks.

The quartz veins pinch and swell abruptly and commonly pass along strike into zones that consist of clayey fault gouge and altered and silicified schist which contains discontinuous pods and lenses of quartz and abundant disseminated sulfides. Lineation in the shear zones is similar to, and parallel with, lineation on the walls of the quartz veins. Because the shear zones are generally unrecognizable in float and are never exposed in natural outcrops, they can be mapped only where they have been prospected. They probably are much more extensive and continuous than indicated on plate 2.

The gold-bearing veins and shear zones have three principal orientations: (1) N. 5°–15° W., with dips ranging between 80° W. and 80° E.; N. 0°–15° E., generally with dips ranging from vertical to 70° W.; (3) N. 20° W., with dips ranging from 60° W. to 85° W.

FIGURE 6.—Equal-area projections of structures in wallrocks and in gold-bearing veins and shear zones. Lower hemisphere plot with planes of projection horizontal and north at the top. Contours show percentage of measurements that fall within 1 percent of the area of the projection. *A*, Thirty poles to bedding in wallrocks. Solid great circles are traces of planes normal to 25 percent maxima. Dashed great circle is inferred trace of A–C plane. Crosses are projections of axes of minor folds or crenulations; dots are projections of striae or elongate mineral grains and aggregates. *B*, Projections of 26 measurements of grooving, striations, or mineral streaking in gold-bearing veins and shear zones. Solid great circles show average attitudes of northeast- and northwest-trending veins and shear zones. Dashed great circles indicate approximate range in attitudes of the two sets of veins and shear zones. Note that the lineation maximum lies near the intersection of the two solid great circles and that most of the lineations plot within the area bounded by the four dashed great circles.

There are no obvious differences in mineralogy or internal structure between veins of these three sets. The first two sets form the mineralized zone that has been most intensively prospected and includes the sites of the only productive mines. The third set includes the Potomac vein and other veins west of the main zone; these veins have been explored in only a few places.

The two sets of northwest-trending veins clearly transect structures in the country rocks (fig. 6A). The north- or northeast-trending set is parallel or subparallel to foliation in the enclosing rocks of the Wissahickon Formation. Striae and grooves on the vein walls have diverse orientations, but most are transverse to regional lineation trends in the country rocks (Cloos and Cooke, 1953; Reed and Jolly, 1963). A statistical diagram (fig. 6B) indicates that lineations in and on the walls of the veins are generally parallel to intersections between the veins, but nowhere can this relation be demonstrated directly.

The amount of movement along the shear zones in the main area of mineralization cannot be readily determined because of lack of markers in the wallrocks. However, the apparent horizontal offset of the lamprophyre dikes along the fault that controls the alinement of the Potomac River southeast of Rocky Islands, and which is probably related to the vein system, is about 80 feet in a right-lateral sense.

Unfortunately, the intersection of the lamprophyre dikes with the fault surface is almost exactly parallel to the grooves and striae which presumably mark the movement direction in the veins and shear zones (fig. 6B). It is therefore impossible to make a reliable determination of the total movement along the fault. On the basis of offset in fold axes, Fisher (1963) estimated that the movement has been about 1,000 feet down on the southwest side of the fault. This estimate is compatible with the dike offset and with the movement direction inferred from grooves and slickensides. These relations suggest that the shear zones mark normal faults with displacements of a few hundred or a few thousand feet.

The principal sulfide in the veins and shear zones is pyrite; it occurs in cubes as much as 1 inch in diameter and as smaller disseminated grains and irregular masses, both in the quartz veins and in the altered rocks in the shear zones. Pyrite is also common in the immediately adjacent wallrocks. Chalcopyrite is locally associated with pyrite in the quartz veins. Galena is common in the richest parts of the vein in the Maryland mine, and some sphalerite and pyrrhotite have been reported (Zodac, 1947; Ingalls, 1960). In many places the veins and shear zones are devoid of sulfides. In float and in most surface exposures the sulfides have been largely removed by weathering, leaving only limonite-stained vugs or limonite pseudomorphs. Many of the

vugs are lined with small crystals of secondary quartz. Various types of vuggy vein quartz and silicified schist were referred to by the miners as "honey comb," "gingerbread," and "hickory bark" ore.

Visible gold occurs in small irregular grains and wires in quartz without associated sulfides (fig. 7A) and in pyrite, both in the veins and in the altered schist in shear zones, even where quartz is absent (fig. 7B). Scattered grains are also found in the sulfide-bearing schist adjacent to the quartz veins. Large masses of coarse sheet and wire gold are commonly associated with galena in the Maryland mine (fig. 8). Ingalls (1960) reported that one 40-pound piece of ore from the Maryland mine yielded 125 ounces of gold, and another 30-pound piece yielded 87 ounces. Galena was reported also to have been associated with gold at the Watson mine, but it has not been found elsewhere in the vein system. An unknown, but probably appreciable, proportion of the gold apparently occurs in microscopic or submicroscopic grains, for spectrophotchemical analyses show that vein quartz and altered schist in which no gold is visible contain as much as 5 parts-per-million gold. Weed (1905) reported that a sample of solid pyrite from the 100-foot level of the Maryland mine, which contained no visible gold, assayed 4.25 ounces of gold per ton (149 ppm), and pyrite mill concentrates ran 0.74 ounce of gold per ton (26 ppm).

The distribution of gold in the veins is erratic, making it difficult to estimate the average gold content. Difficulty in blocking out ore shoots was one of the major obstacles to large-scale development of the deposits. Geochemical sampling of surface exposures indicates that in most places the veins and shear zones contain 0.1 to 5 parts-per-million gold; the highest value obtained was 18 parts per million. A. A. Hassan (unpub. report, 1915, kindly made available by E. T. Ingalls) estimated that the average tenor of the Ford vein was about 9.7 parts per million, but he quotes assays which indicate that ore shipped from the Ford mine in 1914 and 1915 had an average gold tenor of about 33 parts per million. An average of about 0.43 ounce of gold per ton (equivalent to 15 ppm) was recovered from ore from the Maryland mine milled between 1936 and 1940, but considerable flour gold and gold locked in sulfides probably was lost. The total production of the mine during those 5 years was 2,570 ounces; of that amount, 212 ounces (or more than 8 percent) came from only 70 pounds of ore (Ingalls, 1960, p. 13).

Very few details of the distribution of the ore shoots can be reconstructed from the presently available information. The only mines from which production has been recorded (the Maryland, Ford, and Watson mines) lie near the intersections of northwest- and (or) northeast-trending veins (pl. 2). Apparently, the richest ore shoots in the Maryland mine plunge steeply northwest (fig. 4) in about the

FIGURE 7.—GOLD IN QUARTZ AND IN LIMONITE

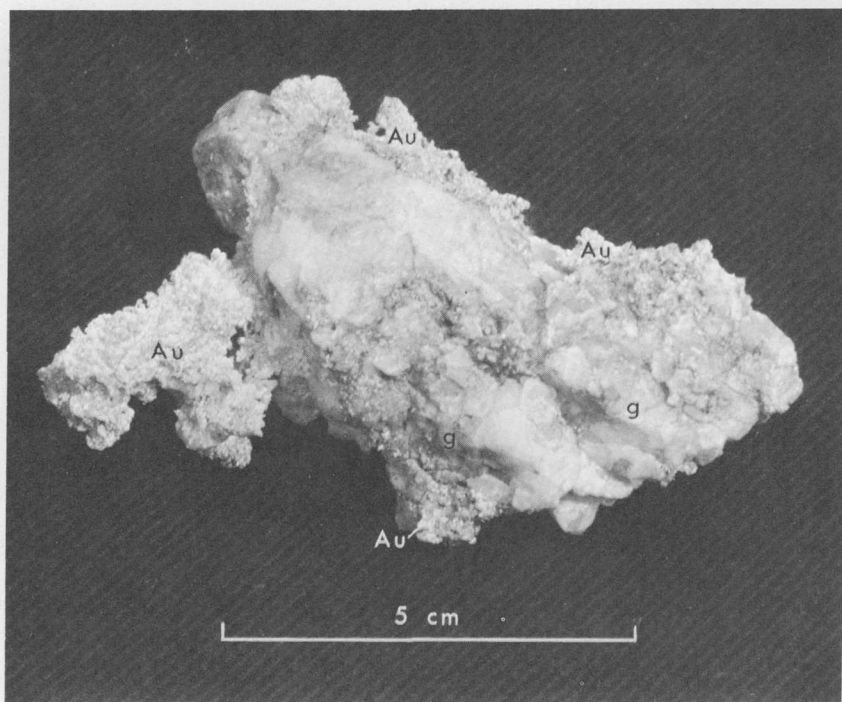


A. Gold (Au) in sheeted vein quartz with schist partings (S). Gold grains are apparently elongated parallel to strong lineation in schist. U.S. National Museum specimen (USNM) 66014 labeled "Montgomery Co., Maryland, gift of George Huddleston, 1880." Possibly from Huddleston mine (fig. 1).

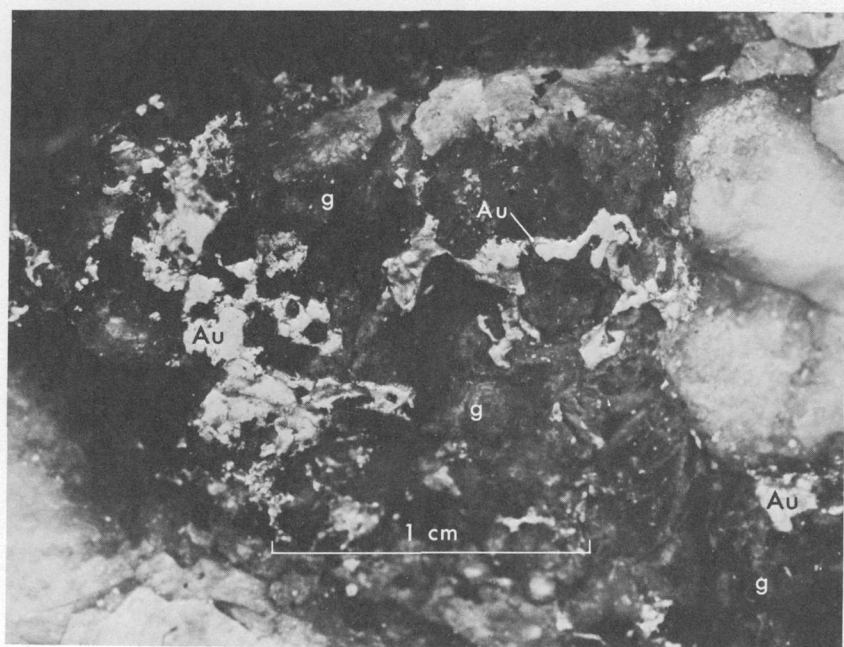
PSEUDOMORPHS AFTER PYRITE



B. Wire gold (Au) in limonite (lim) pseudomorphs after disseminated pyrite, in altered sericite schist (S). USNM 80171, labeled "Potomac Mine." Possibly from workings along the Potomac vein (pl. 2) or from the Montgomery mine (fig. 1), which was once known as the Potomac mine. Photographs by David Massey, U.S. Geological Survey.



A



B

same direction as the grooving and slickensiding in the veins and as the vein intersections. Ingalls (1960, p. 11) reported that most of the gold occurs along the hanging wall, in both the quartz and adjacent country rocks. No information is available on the orientation of the ore shoots in the Ford and Watson mines.

AGE OF MINERALIZATION

The gold-bearing veins and shear zones transect wallrock structures formed during early Paleozoic regional metamorphism and cut granitic rocks emplaced at least 370 million years ago. The mineralization must, therefore, be of post-Devonian age. The only other structures in that part of the Appalachian Piedmont with similar trends are postmetamorphic dikes and faults that cut Triassic rocks in the nearby Leesburg Basin (Toewe, 1966). Thus, the gold deposits near Great Falls may be of Triassic or post-Triassic age.

OUTLOOK FOR FURTHER DEVELOPMENT

Although some spectacularly rich pockets of ore have been found in the Maryland mine, the average gold content of the veins is marginal under present economic conditions. The generally low gold content of the veins, the erratic distribution of gold within the veins, the fact that some of the richest parts of the vein system lie on Federal land, and the high value of the remaining lands for commercial development will probably preclude further development of the gold deposits near Great Falls. Nevertheless, examination of the Great Falls vein system has yielded some clues to the age and origin of the deposits, which may be useful in locating and interpreting similar deposits in other parts of the Appalachian Piedmont.

FIGURE 8.—Gold associated with galena. A, Sheet and wire gold (Au) in quartz associated with galena (g). From 135-foot level, Maryland mine. Specimen from the collection of E. T. Ingalls displayed at the Gold Mine Museum, Potosi, Md. B, Gold (Au) disseminated in galena (g) and quartz. USNM 104638, labeled "Montgomery Co., Md., donor John W. Langdale, Georgetown University." Probably from Maryland mine. Photograph by David Massey, U.S. Geological Survey.

REFERENCES CITED

- Bales, S. P., 1869, *History of Pennsylvania Volunteers, 1861-1865*; v. 2: Harrisburg, 1359 p.
- Banes, C. H., 1876, *History of the Philadelphia Brigade*: Philadelphia, J. P. Lippincott & Co., 315 p.
- Cloos, Ernst, and Anderson, J. L., 1950, The geology of Bear Island, Potomac River, Maryland, *Guidebook 2*: Johns Hopkins Univ. Studies Geology, no. 16, pt. 2, p. II-1—II-13.
- Cloos, Ernst, and Cooke, C. W., 1953, *Geologic map of Montgomery County and the District of Columbia*: Maryland Dept. Geology, Mines, and Water Resources, scale 1:62,500.
- Emmons, S. F., 1890, Notes on the gold deposits of Montgomery County, Maryland: *Am. Inst. Mining Engineers Trans.* 18, p. 391-411.
- Fisher, G. W., 1963, The petrology and structure of the crystalline rocks along the Potomac River near Washington, D.C.: Johns Hopkins Univ. Ph. D. dissert.
- Hopson, C. A., 1964, The crystalline rocks of Howard and Montgomery Counties, in *The geology of Howard and Montgomery Counties*: Baltimore, Maryland Geol. Survey, p. 27-215.
- Ingalls, E. T., 1960, *The discovery of gold at Great Falls, Maryland*: Privately printed, 17 p.
- Ostrander, C. W., 1940, Gold in Montgomery County, Maryland: *Maryland Nat. History Soc. Bull.*, v. 9, no. 4, p. 32-34.
- Reed, J. C., Jr., and Jolly, Janice, 1963, Crystalline rocks of the Potomac River gorge near Washington, D.C.: *U.S. Geol. Survey Prof. Paper* 414-H, 16 p.
- Reed, J. C., Jr., and Reed, J. C., 1967, Gold deposits near Great Falls, Maryland: *Washington Acad. Sci. Jour.*, v. 57, p. 213-224.
- Shosteck, R., 1953, *There's gold in them hills near Great Falls, Maryland*: Silver Spring, Md., privately printed, 7 p.
- Toewe, E. C., 1966, *Geology of the Leesburg quadrangle, Virginia*: Virginia Div. Mineral Resources Rept. Inv. 11, 52 p.
- Ulke, Titus, 1939, Gold mining past and present near Washington, D.C.: *Rocks and Minerals*, v. 14, no. 10, p. 299-305.
- Weed, W. H., 1905, Notes on the gold veins near Great Falls, Maryland: *U.S. Geol. Survey Bull.* 260, p. 128-131.
- Zodac, Peter, 1947, *Trip to a Maryland gold mine*: *Rocks and Minerals*, v. 22, no. 9, p. 834-835.