VIRGINIA MINERALS

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
Richmond, Virginia

Published quarterly by the DIVISION OF MINERAL RESOURCES
Natural Resources Building, McCormick Road, Charlottesville, VA 22903

VOL. 40 | FEBRUARY/MAY 1994 | NO. 1 & 2

MINERALS OF ROCKBRIDGE COUNTY, VIRGINIA

D. Allen Penick, Jr.

INTRODUCTION

Rockbridge County has a great diversity of rocks and minerals. Rocks within the county range in geologic age from Precambrian through Devonian (oldest to youngest) covering a time span of at least 1000 million years. The county lies mostly within the Valley and Ridge Physiographic Province (Figure 1). This province is underlain by sedimentary rocks composed of dolostone, limestone, sandstone, and shale. The extreme eastern part of Rockbridge County is within the Blue Ridge Physiographic Province. This area is represented by all three major rock types: sedimentary, igneous, and metamorphic. These include dolostone, quartzite, interbedded sandstone and shale, granite, granodiorite, and unakite. In general, the oldest rocks are found in the eastern portion with younger rocks outcropping in the western part of the county (Figure 2).

Mining has played an important part in the history of Rockbridge County. Indians probably were the first collectors of local quartz and quartzite from which they shaped projectile points. Important deposits of iron ore were mined in the 1800s near the towns of Buena Vista, Goshen, Vesuvius, and in Arnold Valley. Other early mines in the county produced manganese, travertine-marl, tin, niter (saltpeter), lithographic limestone, silica sand, and cave onyx.

The county has been prospected for barite, gibbsite (alumina), gold, silver, limonite (ocher), beryl, sphalerite (zinc), and ilmenite and rutile (titanium), but no production has been reported for these minerals. Quarries are still producing dolostone, limestone, and quartzite for construction aggregate and shale for brick manufacture.

This report describes 102 minerals and native elements which have been reported from the county. Rockbridge County is one of the more prolific mineral collecting areas in Virginia. A large percentage of the minerals are concentrated in three areas: in the tin deposits near the headwaters of Irish Creek; the Vesuvius iron-manganese district; and in the Lone Jack quarry near Glasgow. In addition Barger's limestone quarry outside Lexington has produced excellent pyrite crystals and other noteworthy minerals. Unusual quartz crystals have been found near Collierstown, House Mountain, and Hog Back Mountain. A rare mineral, rockbridgeite, was first found in and named for Rockbridge County. It was recognized as a distinct mineral species in samples from the Midvale iron mine south of Vesuvius.

In addition to 102 mineral species, three relatively rare rock types also should be mentioned. These rocks will be discussed frequently in the report as

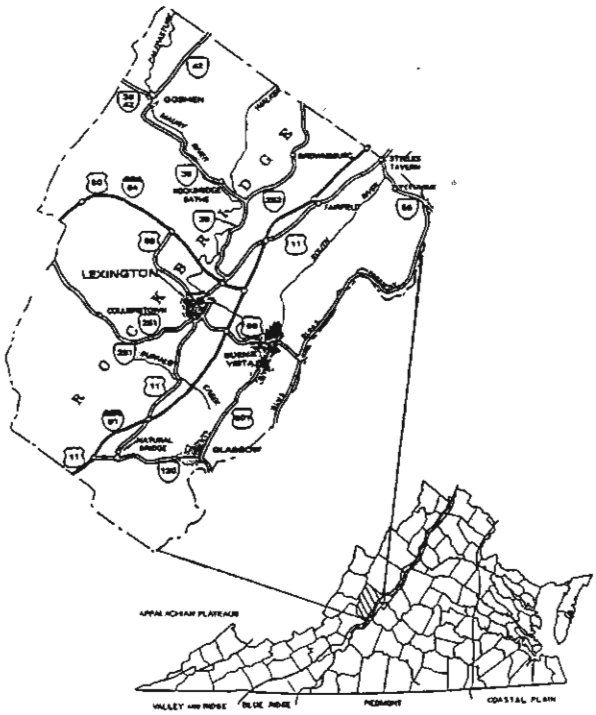
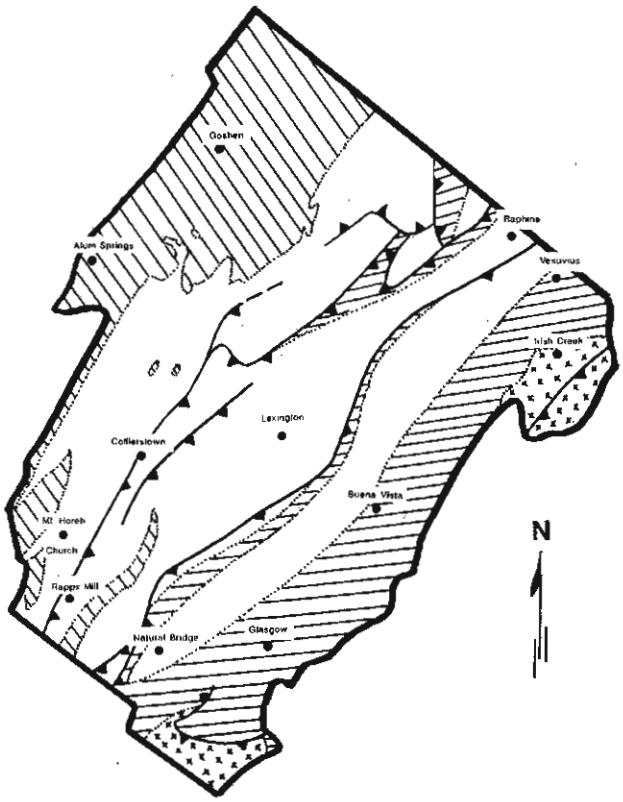


Figure 1. Location map of Rockbridge County, Virginia.

they are associated with many of the minerals found in the county. Unakite is a metamorphic rock found in scattered outcrops along Big Marys Creek, Little Marys Creek, and Irish Creek. It is composed mainly of pink to red feldspar, green epidote, and gray quartz along with other minerals in minor amounts. Unakite is an attractive rock when polished and is used for ornamental-decorative purposes. Kimberlite is a dark igneous intrusive rock found in two separate bodies near Mt. Horeb Church in the southwestern part of the county. Kimberlite is considered the chief source rock for diamonds worldwide. No diamonds have been found to-date, however a large number of other minerals are found in these deposits. These rare rock types were mapped and



EXPLANATION	MILLION-YEARS AGO
DEVONIAN - SILURIAN	425 - 385
ORDOVICIAN	500 - 425
CAMBRIAN	570 - 500
PRE - CAMBRIAN	1000+
THRUST FAULT	

Figure 2. General geologic map of Rockbridge County, Virginia (modified after Butts, 1933).

described by Spencer (1968). Greisen is an altered granitic rock composed mainly of quartz and mica. Topaz, usually found in greisen, is not reported from this locality. Cassiterite, the chief ore of tin, is found along the border between the greisen and the granodiorite country rock at the deposit near Irish Creek. These mines, also known as the Cash mines, consist of the number 1 workings on Panther Run and the number 2 workings located on the ridge about 1200 feet to the southwest (Figure 3).

Most of the localities described in this report have been field checked. Those not checked have been reclaimed or there was not enough information available to locate the site in the field. **It is very important that a collector obtain the permission of the property owner before entering a locality to collect minerals. "Entering private property without permission violates trespass laws and is punishable by law".** For the sake of convenience the minerals in this report are listed alphabetically.

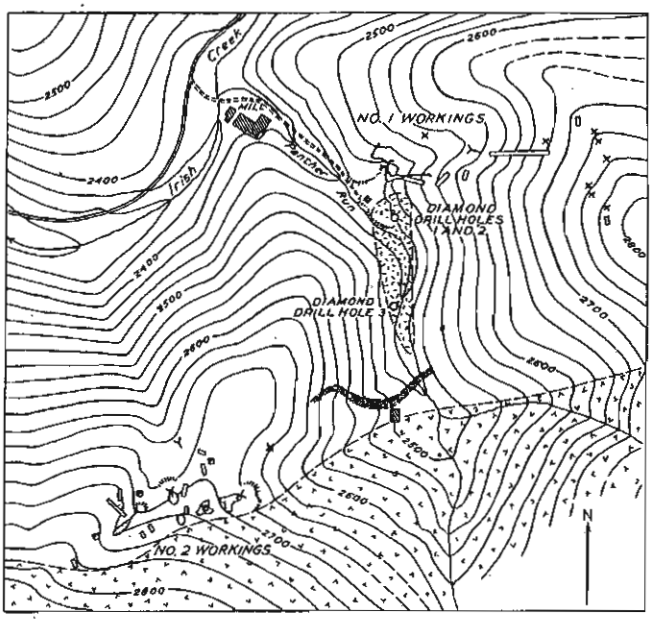
The author would like to express his appreciation to the following persons for their assistance in preparing this report: Richard V. Dietrich, Howard R. Freeland, Thomas M. Gathright, II, William F. Giannini, David A. Hubbard, Jr., Vernon N. Morris, and Roy S. Sites.

MINERAL SPECIES AND ELEMENTS

ACTINOLITE - AMPHIBOLE GROUP (hydrous calcium, magnesium, iron silicate). Actinolite is a common mineral in metamorphic rocks rich in iron and magnesium. It is found as fibrous masses replacing pyroxene group minerals in the metamorposed granodiorite around the Irish Creek tin deposit (Glass and others, 1958).

AIKINITE (lead, copper, bismuth sulfide). This rare bismuth mineral occurs at the Irish Creek tin deposit as blackish gray acicular crystals associated with carbonate minerals (Glass and others, 1958). The crystals have a metallic luster and yellow tarnish.

ANATASE (titanium oxide). Microscopic crystals of anatase have been found in stylolite-like clay seams cutting quartzite in Hellgate Canyon two miles southwest of the James River at Glasgow (Lowry and DeRudder, 1966). The anatase is associated with mica, feldspar, goethite, tourmaline, and zircon. This locality is an abandoned quarry which previously produced sand for glass manufacture.



EXPLANATION

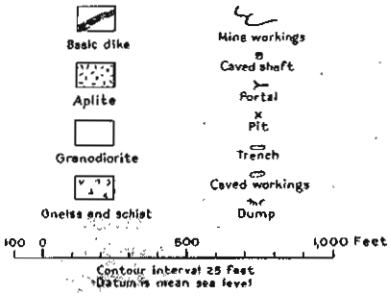


Figure 3. Geologic map of the Irish Creek tin mining area showing location of mine workings, prospect pits, and diamond drill holes (map from Koschmann and others, 1942).

ANKERITE - DOLOMITE GROUP (calcium, iron, magnesium, carbonate). Ankerite occurs in veins as white crystal aggregates with fluorite, siderite, and scheelite at the Irish Creek tin mines (Glass and others, 1958). It is fairly abundant [illegible]

ARAGONITE - ARAGONITE GROUP (calcium carbonate). Aragonite can be found in nearly all caves in Virginia. No specific localities are given. There are approximately 91 caves in Rockbridge County (Douglas, 1964).

ARSENOPYRITE (arsenic sulfide). Arsenopyrite occurs in silvery white to grayish veins two or more inches across in quartz and greisen at the Irish Creek tin deposit. It is often found with cassiterite in the greisen. The mineral has a metallic luster and is the most abundant sulfide in the deposit. Much of the arsenopyrite is gold bearing (see gold).

AUGITE - PYROXENE GROUP (calcium, sodium, magnesium, iron, aluminum, silicate). Augite is the primary pyroxene mineral in the granodiorite country rock near the Irish Creek tin mines where it occurs as lath-shaped crystals (Glass and others, 1958).

BARITE - BARITE GROUP (barium sulfate). At the Lone Jack quarry near Glasgow, two forms of barite crystals are found: thin tabular colorless to bluish and thick tabular white, cream, or yellowish (Figure 4). Associated minerals are calcite, dolomite, and marcasite (Dietrich, 1985).

Small clear tabular barite crystals occur in cavities in limestone with calcite and quartz crystals at Barger's Quarry near Lexington. A barite crystal from the quarry can be seen in the Washington and Lee University geology collection (Penick, 1987).

The Johnson barite prospect is located 0.75 mile north of the Botetourt-Rockbridge County line, and 0.25 mile west of U.S. Highway 11. Fragments of white and dark gray barite were uncovered while repairing a local farm road (Edmundson, 1938).

The Becktel prospect is reported to be located approximately 4 miles south of Lexington and 0.5 mile west of U.S. Highway 11, (exact location unknown). The prospect consists of small barite fragments associated with chert probably from the Beekmantown Formation (Edmundson, 1938).

The Shorter prospect is located 0.5 mile northwest of Rapps Mill in the southwestern part of the county. The prospect consists of a few shallow test pits and scattered fragments of barite (Edmundson, 1938).

A white barite vein 18 inches wide cutting granite is reported east of the nature campon Big Marys Creek, 3 miles south of Vesuvius. Specific gravity tests run on a sample indicates that the vein is pure barite (Steidtmann, 1940). This occurrence has not been located by the writer.

Figure 4. White, blocky barite crystals with dolomite, calcite, and pyrite, largest barite crystal 0.2 inch. Lone Jack quarry near Glasgow, photograph by T.M. Gathright, II, courtesy of R. V. Dietrich.

BERYL (beryllium silicate). Beryl occurs in the greisen at the Irish Creek tin deposits as slender hexagonal prisms from 1 to 5 mm long and about 2 mm across. Most of the beryl is pale green but some is yellow. Some of the green beryl prisms are bent and many are fractured. The fractures are filled with flourite and quartz. The yellow beryl may be associated with phenakite (Glass and others, 1958). To the writer's knowledge no gem quality beryl has been found from this locality.

During World War II, the Bethlehem Steel Corporation conducted an investigation for beryl and tin in this area.

BIOTITE - MICA GROUP (potassium, magnesium, iron, silicate). Green biotite is fairly abundant in the country rock at the Irish Creek tin mines in the east-west tunnel of the number 1 workings. It is associated with the greisen and may represent alteration of brown biotite which may later alter to chlorite (Glass and others, 1958).

BIRNESSITE (sodium, manganese, oxide). Birnessite occurs with other black manganese oxide minerals collected from the dumps of the Kelly Bank mine near Vesuvius (Mitchell and Freeland, 1978).

BISMUTITE (bismuth carbonate). At the Irish Creek tin mines this rare, white, submetallic carbonate mineral was found in a 6-inch wide quartz vein that cuts the greisen. The location is approximately 15 feet west of the adit at the number 1 workings (sample by W.F. Giannini; X-ray identification by O.M. Fordham).

CACOXENITE (hydrous iron phosphate). Cacoxenite occurs as golden yellow fibers in cavities in rockbridgeite at the Dixie mine near Vesuvius. Associated minerals are strengite and kidwellite. It also forms radiating bursts and resinous globules in iron ore at the Dixie mine (Barwood and Zelazny, 1982).

At the Kelly Bank mine, one mile east of Vesuvius, cacoxenite occurs as golden yellow fibers in manganian oxide ore (Paul Desautels, personal communication, 1962). This mine has been reclaimed. The mineral is also found with rockbridgeite 10 miles east of Lexington near the crest of South Mountain near Midvale (Koening, 1877). This occurrence was probably at the Midvale mine.

CALCITE - CALCITE GROUP (calcium carbonate). Calcite is a widespread mineral in the limestone formations of Rockbridge County. Most calcite occurs as white masses and veins that cut the pre-existing carbonate rocks. Two operating quarries in the county have produced excellent examples of calcite crystals.

At the Lone Jack quarry near Glasgow calcite occurs as (a) colorless, bluish, or yellowish, vitreous, transparent, prismatic crystals to 10 mm long with obtuse rhombohedral terminations; (b) colorless to white to yellowish, translucent and substransparent, scalenohedral crystals (dog-tooth spar) 5-300 mm long (Figure 5); (c) white, pearly, fibrous masses; (d) colorless, vitreous, transparent, prismatic crystals up to 10 mm long; and (e) colorless, vitreous, pearly, and transparent scalenohedral crystals up to 15 mm long (Dietrich, 1985). Calcite at the Lone Jack quarry commonly occurs in veins and cavities in limestone and dolostone with dolomite, pyrite, marcasite, barite, fluorite and palygorskite (Figure 6).

At Barger's quarry east of Lexington calcite occurs both as veins and in well formed crystals in limestone (Figure 7). Clear, lustrous rhombohedral crystals to 0.3 inches across have been found associated with quartz, fluorite, and rarely, barite (Penick, 1987). Some crystals are gray to smoky in appearance.

CASSITERITE - RUTILE GROUP (tin oxide). Cassiterite is the major ore of tin and the most important mineral at the Irish Creek deposit. It occurs as brown lustrous short pyramidal crystals in greisen next to massive quartz veins (Figure 8). White cassiterite has also been reported from these deposits (Ulke, 1894). The mineral is almost always associated with gray quartz and muscovite. It is often found with siderite and may be confused with that mineral. However, distinct cleavage, high specific gravity, and polysynthetic twinning distinguish cassiterite from siderite (Glass and others, 1958). Cassi-

terite also forms veinlets, lenses, and irregular compact masses. A few clear gem quality crystals have been found.

CELADONITE - MICA GROUP (potassium, magnesium, iron, aluminum, silicate). At the Lone Jack quarry near Glasgow celadonite occurs as green coatings on shear zone surfaces and joints in carbonate rocks. The mineral was identified by X-ray analysis (Dietrich, 1985).

Figure 5. Calcite crystal 10 inches long from Lone Jack quarry near Glasgow, photograph by G.K. McCauley, courtesy of R.V. Dietrich.

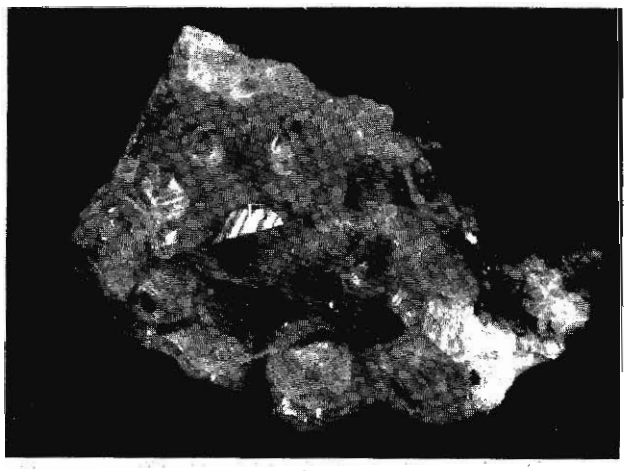


Figure 6. Scalenhedral calcite crystals, some with a coating of small pyrite crystals, Lone Jack quarry, specimen 4 inches across; photograph by T.M. Gathright, II.

CHALCOPYRITE - CHALCOPYRITE GROUP (copper, iron, sulfide). Chalcopyrite is similar to pyrite in appearanc and is found as small yellow crystals and irregular grains with bismuth sulfides adjacent to siderite veins at the Irish Creek tin deposits. It is also found with pyrrhotite in the greisen zone (Glass and others, 1958). Small masses of chalcopyrite associated with malachite, microcline, and magnetite are found in unakite along Irish Creek several miles south of the tin mine area.

Small yellow crystals of calcopyrite are found sporadically in cavities and disseminated in the dolostone throughout the Lone Jack quarry. A few chalcopyrite crystals are altered to limonite pseudomorphs and malachite, the latter coats cleavage surfaces of calcite adjacent to the pseudomorphs (Dietrich, 1985).

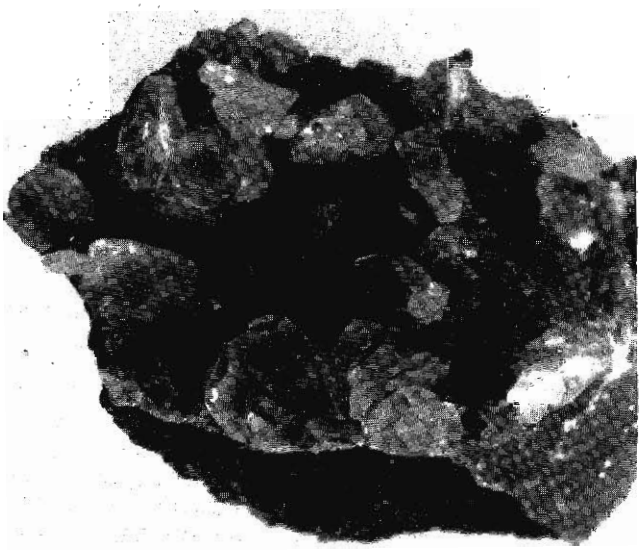


Figure 7. Calcite crystals in limestone, Barger quarry near Lexington, specimen 4 inches across; photograph by T. M. Gathright, II.

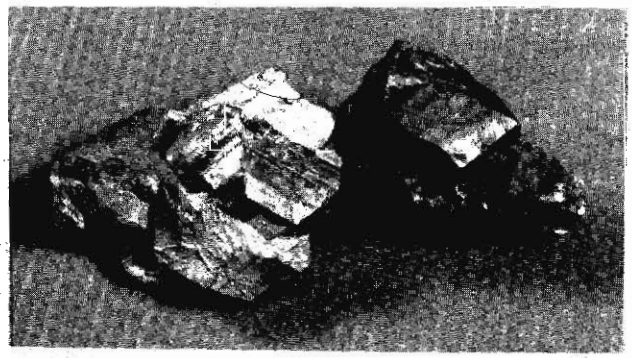


Figure 8. Crystals of brown lustrous cassiterite from the tin mines near Irish Creek; crystals about 1 inch in length; photograph by T. M. Gathright, specimen in collection of D. A. Hubbard.

CHLORITE - CHLORITE GROUP (aluminum, iron, magnesium, silicate). At the Irish Creek tin mines chlorite occurs as pale green veinlets and lenses within the greisen. Most of the chlorite is an alteration product of muscovite and is found on muscovite cleavage and along boundaries of fluorite grains (Glass, 1958).

At the Lone Jack quarry chlorite is found as green coatings on slickensided surfaces on the host dolostone (X-ray identification by R.V. Dietrich).

CHURCHITE (hydrous yittrium phosphate). At the time of its discovery at the Kelly Bank mine in 1944 churchite had only been verified from one other

locality in the world (Milton and others, 1944). At that time churchite was known as weinschenkite. The mineral occurs as snow-white fibrous aggregates coating brown siliceous limonite or black manganian oxide. The white fibers have a silky luster and make attractive specimens against the dark matrix material. These aggregates appear as spherulites up to several millimeters in diameter. An excellent specimen of churchite can be seen in the Washington and Lee University geology collection in Lexington.

CLAUDETITE (arsenic oxide). Claudetite is a colorless to white secondary mineral formed by the oxidation of aresenic minerals. It is found in association with arsenopyrite at the Irish Creek tin mines (specimen NMNH#139820 of the Smithsonian Institution collection, Dietrich, 1990).

CLINOZOISITE - EPIDOTE GROUP (hydrous calcium, aluminum, silicate). Clinozoisite is a rare mineral in the Irish Creek district and occurs in pinkish gray clusters of slender flat crystals from 2 to 3 mm long. It is found in a veinlet (0.25 inch wide and 7 feet long) cutting a shear zone in the base of the east-west tunnel (number 1 workings). It is associated with chlorite and calcite in greisen (Glass and others, 1958).

COPIAPITE (hydrous iron sulfate). Copiapite occurs as yellowish powdery masses with paracoquimbite at the Kelly Bank mine near Vesuvius (R.S. Mitchell's notes).

CRYPTOMELANE - CRYPTOMELANE GROUP (manganese oxide). Cryptomelane occurs as black botryoidal to nodular masses at the Kelly Bank mine near Vesuvius (Mitchell and Freeland, 1978).

DIOPSIDE - PYROXENE GROUP (calcium, magnesium, silicate). Diopside is found as small green chromium rich grains in samples taken from a kimberlite occurence near Mt. Horeb Church in the southwestern part of the county. Associated minerals are ilmenite, phlogopite (mica), talc, serpentine, pyrope (garnet), and spinel (X-ray analyses by O. M. Fordham).

DOLOMITE - DOLOMITE GROUP (calcium, magnesium, carbonate). Dolomite is found as colorless to white, pink, and white to buff rhombohedral crystals and saddle shaped groups at the Lone Jack quarry (Figure 9). It is found with calcite, barite, fluorite, pyrite, marcasite, and palygorskite in cavities in the dolostone host rocks (Dietrich, 1985). Dolomite is also a major constituent of dolostone in other areas within the county.

Figure 9. Pink, saddle-shaped dolomite crystals with coating of small pyrite crystals, specimen 4 inches across; photograph by T. M. Gathright, II.

DUFRENITE (iron phosphate). Much of the dufrenite described in early reports is actually rockbridgeite. However, recent studies by Kearns and Penick (1989) show that dufrenite does occur with rockbridgeite at the Dixie iron mine near Vesuvius. It is found as thin, dark bluish-green layers sandwiched between layers of yellowish kidwellite. Other associated minerals are strengite and rockbridgeite. Identification of dufrenite was based on microscropic comparison with known material from Cherokee County, Alabama and X-ray powder diffraction patterns. This is the first verified occurence of dufrenite from Virginia.

EPIDOTE - EPIDOTE GROUP (calcium, aluminum, iron siliciate). Epidote is a fairly widespread mineral in the Blue Ridge Mountain areas of Rockbridge County. It is one of the major constituents of the unakite that is found in outcrops and streams along Irish Creek, Big Marys Creek, and Little Marys Creek. Pistachio-green crystals of epidote up to 0.4 inchs in length have been found in quartz veins cutting unakite in the old quarry on State Highway 56, 1.5 miles east of Vesuvius. At the Irish Creek tin deposit-epidote occurs in the metamorphoric granodiorite county rock and as relicts in greisen (Glass and others, 1958).

EPSOMITE (hydrous magnesium sulfate). Epsomite occurs as white, pearly, transluscent, acicular crystals up to 5 mm long on dolostone at the Lone Jack quarry near Glasgow (Dietrich, 1985).

FELDSPAR GROUP. Feldspar group minerals, (see microcline and orthoclase) are common in igneous and metamorphic rocks of the Blue Ridge area of Rockbridge County.

FERROHORNBLENDE - AMPHIBOLE GROUP (calcium, iron, magnesium, alumimum, silicate). Ferrohornblende is found as black crystals in the granodiorite at the Irish Creek tin deposit, (Glass and others, 1958).

FLUORAPATITE - APATITE GROUP (calcium, fluorine, phosphate). Fluorapatite is common both in granodiorite and in greisen at the Irish Creek tin deposit where it is associated with a variety of accessory minerals (Glass and others, 1958).

FLUORITE (calcium fluoride). Fluorite is found in Barger's quarry near Lexington as purple to pink cubic crystals up to 0.25 inch across associated with calcite, quartz, and rarely, barite. Fluorite also occurs as purple "smears" on slickensided surfaces (Penick, 1987).

Fluorite is one of the principal minerals of the greisen at the Irish Creek tin deposit. Most of the fluorite is fine grained and is white, colorless, or purple. It penetrates fissures and fractures of the quartz veins and in places cuts through beryl and muscovite. It is not found in the country rock (Glass and others, 1958).

At Lone Jack quarry near Glasgow fluorite occurs as colorless, yellowish, or purple, transparent crystals. Some of the crystals are zoned yellewish to purplish to colorless (Dietrich, 1985). Fluorite occurs both with the host dolostone and in cavities in limestone with dolomite, calcite and pyrite.

GALENA (lead sulfide). Galena is found as bright metallic grains in greisen at Irish Creek (Glass and others, 1958). It is also found in limestone 2 miles west of Lexington (Dana, 1892); and as small octahedral and "distorted flat crystals" at the Lone Jack quarry near Glasgow (Dietrich, 1963).

GALENOBISMUTITE (lead, bismuth, sulfide). This rare bismuth mineral occurs in thin, lead-gray to tin-white lath-like crystals with siderite and muscovite at the number 1 workings at the Irish Creek tin mines. It is also associated with aikinite. It has a metallic luster and develops yellow iridescence where exposed to weathering (Koschmann and others, 1942).

GARNET - GARNET GROUP (iron, aluminum, silicate). Unidentified garnet crystals, probably almandine, can be found as dark red, weathered, and

fractured crystal masses in several roadcuts along State Road 603 (X-ray analyses by O. M. Fordham). The crystals, with an average size of 0.2 inch, are found in felsite, a rock composed primarily of quartz and feldspar.

GIBBSITE (hydrous aluminum oxide). Gibbsite is the main constituent of the bauxite deposits found along Chalk Mine Run about 2 miles northeast of Buena Vista (Warren and others, 1965). The mineral is one of the main ores of aluminum.

GOETHITE (iron hydroxide). Goethite is a fairly common mineral which is found in most of the iron and manganese mines scattered throughout the county. The mineral occurs generally as either brown to black rounded masses or in radiating fibrous aggregates. It was the main ore mineral at the Dixie mine, where it was deposited with rockbridgeite in a fault zone.

It could previously be found with manganese minerals at the Kelly Bank mine, which has been reclaimed. Goethite is being found in some of the old iron mines along Brattons Run in the western part of the county; these mines supplied iron ore to the California furnance and later to the Victoria furnace in Goshen. Other goethite localities include the old Locher silica quarry a few miles south of Goshen, Marys Creek mine, Hogpen Hollow mine, Midvale mine, and the Jordan mine near Buena Vista. Blood red to iridescent copper brown adamantine goethite "buttons" occur with calcite crystals at Lone Jack quarry near Glasgow (Figure 10; Dietrich, 1990). Goethite also is a major constituent of the pseudormorphs after pyrite (goethite after pyrite) from Barger's quarry near Lexington (Penick, 1987).

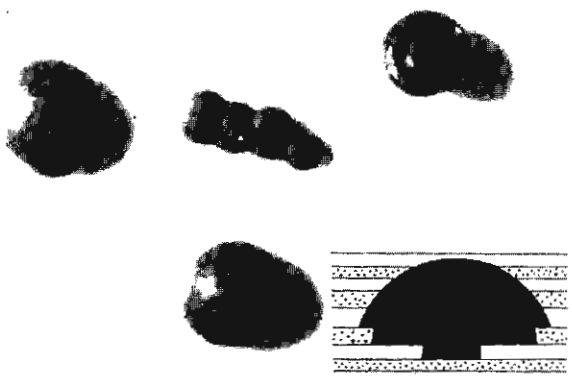


Figure 10. Blood red to copper-brown goethite "buttons" etched from calcite crystals from a vug in the Lone Jack quarry (50X); photograph by G. K. McCauley, courtesy of R. V. Dietrich.

GOLD - NATIVE ELEMENT. Samples of arsenopyrite from the Irish Creek tin deposit have recently been fire assayed and show values of 7.796 troy ounces of gold per ton (Sweet and Lovett, 1985). Old reports of "The Virginias" (1884, p. 38) also describe high assays in both gold and silver in samples of arsenopyrite taken from these mines. Gold is intimately associated with the arsenopyrite and cannot be detected by visual inspection.

Gold has been identified in soil samples by geochemical methods on Yankee Horse Ridge three miles southwest of the tin mines (Good, 1991). The highest concentration in the soil samples ranged from 0.33 to 0.51 parts per million. Samples of the felsic quartz monzonite bedrock assay up to 0.17 troy ounces per ton of gold or 5.8 parts per million.

GRAPHITE - NATIVE ELEMENT. Graphite occurs as black to steel-gray disseminated grains in felsic gneiss on Nettle Mountain (R. S. Good, personal communication).

GYPSUM (hydrous calcium sulfate). Single crystals and radial groups up to 5 mm across occur on joint surfaces in the argillaceous dolostone at Lone Jack quarry near Glasgow (Figure 11; Dietrich, 1960). Gypsum can be found also as a white powdery material that shows strong green fluorescence in long-wave ultra-violet light (Dietrich, 1985). Samples of this material were submitted by H. L. Grow of Rockbridge County.

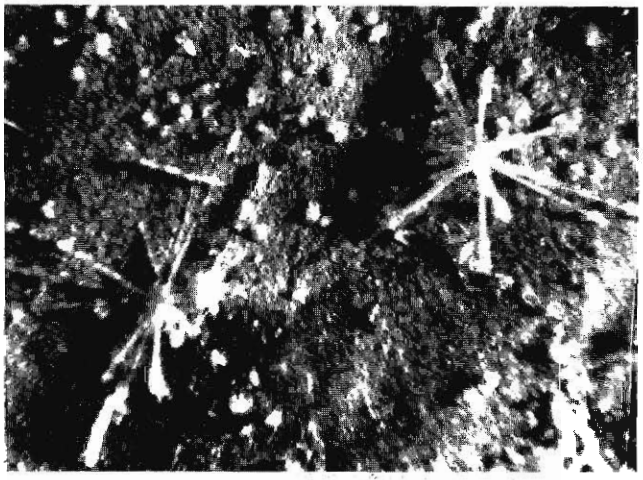


Figure 11. Spider-shaped groups of gypsum crystals on dolostone (~20X), from Lone Jack quarry near Glasgow; courtesy of R. V. Dietrich.

HALLOYSITE - KAOLINITE-SERPENTINE GROUP (hydrous aluminum silicate). Veins of halloysite and kaolinite are found in fractures in the Cambrian-age Antietam (Erwin) quartzite at the W. C. Mathews quarry near Natural Bridge Station (Leonard, 1962).

HEMATITE - HEMATITE GROUP (iron oxide). Hematite is a heavy, reddish-brown to black mineral with a distinctive deep red streak. It is the most important ore of iron. It can be found in many of the iron mines located throughout the county generally associated with goethite-limonite. Hematite is found on Yankee Horse Ridge as hematitic boxworks with pyrite, arsenopyrite, and gold (Sweet and others, 1989).

It is also found in the oxidizied zone of the Irish Creek tin deposit as an alteration product of titanium-rich magnetite (Glass and others, 1958).

HEXAHYDRITE (hydrous magnesium sulfate). Hexahydrite is found as colorless, acicular, white, crystalline powder and powdery masses on dolostone at the Lone Jack quarry near Glasgow (Dietrich, 1963).

HYPERSTHENE - PYROXENE GROUP (magnesium, iron, silicate). Hypersthene is the most abundant pyroxene in the granodiorite at the Irish Creek tin deposits (Glass and others, 1958).

ILLITE (hydrous, potassium, aluminum, magnesium, iron, silicate). This brown clay mineral occurs frequently as inclusions in quartz crystals near Collierstown (X-ray analysis by R. S. Mitchell).

ILMENITE - ILMENITE GROUP (iron, titanium, oxide).
Ilmenite along with rutile was discovered in 1939 on the Robinson Gap road about 2 miles southeast of Buena Vista. The ilmenite-rutile deposit occurs as black bands interbedded with reddish-brown quartzite. The mineralized zone is 15 feet thick and can be traced for a distance of 0.25 mile. Other minerals found in the quartzite include quartz, feldspar, apatite, tourmaline, and zircon (Bloomer and DeWitt, 1941). Ilmenite also occurs as grains in greisen and granodiorite at the Irish Creek tin deposit (Koschmann and others, 1942). Magnesium rich ilmenite is reported from the kimberlite near Mt. Horeb Church (Sears and Gilbert, 1973).

JAROSITE (hydrous potassium, iron, sulfate). Jarosite has been reported in brecciated ferruginous quartzite at the Midvale iron mine near Vesuvius. It forms as yellow to dark brown coatings and crusts on the iron ore (Palache and others, 1951).

KAOLINITE - KAOLINITE-SERPENTINE GROUP (hydrous aluminum silicate). Kaolinite is a common alteration product of rocks with a high feldspar content. Several areas within the county have notable occurrences of kaolinite. Veins of kaolinite and halloysite are found in fractures in the Cambrian age Antietam (Erwin) quartzite at the W. C. Mathews quarry near Natural Bridge Station (Leonard, 1962). Kaolinite is the chief clay mineral in the bauxite occurrence at the Chalk Mine Run deposit 2 miles northeast of Buena Vista (Warren, and others, 1965). Stringers of pure kaolinite occur in residual clay in the vicinity of Buena Vista (Leonard, 1962). Kaolinite also occurs as milky white masses, along with microcline, in shear zones cutting green shale at the Lone Jack quarry (Dietrich, 1985).

At the Irish Creek tin deposit kaolinite is found as earthy alteration products replacing feldspar and other silicates (Glass and others, 1958).

KIDWELLITE (hydrous sodium, iron, phosphate). Kidwellite is found as greenish to yellow-brown crusts and coatings with rockbridgeite on the dumps of the Dixie iron mine near Vesuvius (Barwood and Zelazny, 1982). It occurs with strengite, dufrenite, and rarely cacoxenite in cavities with rockbridgeite. It is also present as reddish-brown layers adjacent to fibrous rockbridgeite. Dufrenite is usually found between two layers of kidwellite, producing the sequence rockbridgeite-kidwellite-dufrenite-kidwellite (Kearns, and Penick, 1989).

LEPIDOCROCITE (iron oxide). Lepidocrocite has been tentatively identified as a constituent of the magnetic goethite "buttons" found at the Lone Jack quarry near Glasgow (Dietrich, 1963).

LEUCOXENE (titanium oxide). Leucoxene occurs as an alteration product of ilmenite and is fairly common in the greisen at the Irish Creek tin deposits (Glass and others, 1958).

LIMONITE (iron oxide). Limonite is discredited as a mineral species but may still be used as a convenient field term to be applied to natural dark brown hydrous iron oxides of which exact identities are unknown. Most limonite is actually goethite. Limonite was the basis for the major portion of Virginia's former iron industry and can be found to some extent in all iron mines located in the county. It can also be found as an iron stain on many rocks and minerals.

Pseudomorphs of limonite after pyrite occur east of Lexington near the west end of South Mountain (Campbell, 1881); coatings and replacements consisting chiefly of limonite occur at Lone Jack quarry near Glasgow (Dietrich, 1963).

LITHIOPHORITE (aluminum, lithium, manganese, oxide).
Black lithiophorite constitutes part or all of some of the manganese oxide nodules at the Kelly Bank mine near Vesuvius (Mitchell and Freeland, 1978). Lithiophorite and cryptomelane are the most important manganese bearing minerals at this deposit.

MAGNETITE - SPINEL GROUP (iron oxide). Magnetite is a black, metallic, strongly magnetic mineral which usually forms as sharp octahedral crystals. It is considered to be one of the major ores of iron. The titanian-rich variety of magnetite, formerly called titanomagnetite, has been reported from the Irish Creek tin deposits. It occurs as black grains both in greisen and granodiorite (Glass and others, 1958). Magnetite can also be found along Irish Creek several miles southwest of the tin mines. It is associated with unakite, pyrite, chalcopyrite, malachite, epidote, microcline, quartz, and chlorite (X-ray analysis by R. S. Mitchell).

MALACHITE (copper carbonate). Green malachite coatings occur on calcite cleavage surfaces at the Lone Jack quarry near Glasgow. Other associated minerals include dolomite, fluorite, barite, and quartz (Dietrich, 1985).

Malachite also occurs with unakite along Irish Creek several miles southwest of the tin mines. Associated minerals are pyrite, quartz, chalcopyrite, pink microcline, magnetite, epidote, and chlorite (X-ray analysis by R.S. Mitchell). A sample from this locality was assayed and found to contain a small amount of silver.

MANGANITE (manganese oxide). Well formed metallic crystals of manganite are found at the Midvale iron mine just south of Midvale Station on the Norfolk and Western Railroad (C.E. Sears, personal communication). Manganite can occur in some of the manganese mines in the Vesuvius area.

MARCASITE - MARCASITE GROUP (iron sulfide). Marcasite resembles pyrite somewhat but is generally paler in color and has distinctive cockscomb external features as opposed to the cubic crystal form of pyrite.

Numerous small (3-10 mm lengthwise) bronze-yellow striated marcasite rods with acute diamond-shaped cross-sections occur with barite, fluorite and calcite in cavities within a shaly part of the dolostone at the Lone Jack quarry near Glasgow (Dietrich, 1960). Some rods have modified rectangular marcasite crystals on their ends resembling "hammers" (Figure 12).

Figure 12. Marcasite "hammer" (5 mm long) in calcite-lined cavity from Lone Jack quarry near Glasgow; photograph courtesy of R.V. Dietrich.

MELANTERITE (hydrous iron sulfate). Melanterite occurs sporadically as greenish-white, white, crystalline, dull to pearly coatings on the host dolostone at the Lone Jack quarry near Glasgow (Dietrich, 1985). The mineral is most likely an alteration product of pyrite. It is the common "alum" of Virginia and has a sweet, metallic taste.

MICROCLINE - FELDSPAR GROUP (potassium, aluminum, silicate). Microcline is common in many of the igneous and metamorphic rocks of the Blue Ridge Mountain areas in Rockbridge County. It is a primary constituent of unakite which is found in relative abundance in the Vesuvius, Little Marys Creek, Big Marys Creek, and Irish Creek areas. Microcline is the predominant constituent of some of the salmon-orange, fine granular, vein-like zones in a few of the sheared greenish shale zones within rocks at the Lone Jack quarry (Dietrich, 1985). Good examples can also be found along Irish Creek approximately several miles southwest of the tin deposits where it occurs in unakite as deep pink to orange cleavage masses with pyrite, chalcopyrite, malachite,

quartz, epidote, and magnetite (X-ray analyses by R.S. Mitchell).

MONTMORILLONITE - SMECTITE GROUP (aluminum, magnesium, silicate). Montmorillonite can be found along fault zones as an alteration product of granodiorite at the Irish Creek tin deposits. It occurs as waxlike masses about 5 feet thick near the number 2 workings (Koschmann and others, 1942). It is also found at the Lone Jack quarry in cavities as white to cream colored coatings with calcite, dolomite and chalcopyrite (Dietrich, 1962).

MUSCOVITE - MICA GROUP (hydrous potassium, aluminum, silicate). Muscovite is a common constituent of many igneous and metamorphic rocks of the Blue Ridge Mountains in Rockbridge County.

Damourite is no longer a mineral species but was used to describe "hydromica" muscovite which contains more water than "normal" muscovite, (Dietrich, 1990). This variety of muscovite can be found at the Irish Creek tin mines associated with cassiterite (Anonymous, 1894).

Good examples of fine grained muscovite or sericite can be found in greisen at the Irish Creek tin deposits associated with cassiterite and quartz.

"Green phengitic mica" occurs in the quartzite and as bundles and aggregates in stylolitic seams within the lower Erwin quartzite in Hellgate Canyon about 2 miles southwest of the James River at Glasgow (Lowry and DeRudder, 1966).

NACRITE (hydrous aluminum silicate). Nacrite has been found in cavities as white pearly microcrystalline masses, with barite, calcite, chalcopyrite, dolomite, and marcasite at the Lone Jack quarry near Glasgow (Dietrich, 1985).

NITER - SALTPETER OF SOME MINERALOGISTS (potassium nitrate). Niter is found as delicate crusts and crystalline powder on the walls of many limestone caves. It is also found in loose soils in such caves. The best known deposit in the county is at Natural Bridge where Salpeter Cave is located. During the War of 1812 and the Civil War this cave was mined for nitrates derived from niter and used to make gunpowder.

NONTRONITE (hydrous sodium, iron, aluminum, silicate).
Nontronite is a greenish-yellow earthy to compact material with a soapy feel. It is found associated with cassiterite, quartz, beryl, fluorite, siderite, biotite, and chlorite at the Irish Creek tin deposit (Koschmann and others, 1942).

ORTHOCLASE - FELDSPAR GROUP (potassium, aluminum, silicate). Orthoclase is the primary feldspar mineral in granodiorite country rock at the Irish Creek tin deposit (Glass and others, 1958).

PALYGORSKITE (hydrous magnesium, aluminum, silicate).
This rare mineral occurs as soft, tough, white fibrous masses, up to about 10 inches on cleavage planes and slickensided surfaces in the Cambrian-age Rome Formation in the Lone Jack quarry near Glasgow (Dietrich, 1960). Some of these web-like masses contain small pyrite and calcite crystals (Figures 13 & 14). The mineral is thought to be an alteration product of dolomite.

Palygorskite from this locality was first described by Laswell and Stow (1955). The original sample was submitted by D.E. Brady, Jr. This occurrence of palygorskite is the first recorded in Virginia.

PARACOQUIMBITE (iron sulfate). The mineral is found as white, fine-grained sugary masses associated with copiapite at the Kelly Bank mine near Vesuvius (R.S. Mitchell's notes).

PARISITE (fluorine-carbonate of calcium and cerium group of rare earths). Parisite is an extremely rare mineral which occurs rarely at the Irish Creek tin deposit. This is the only reported occurrence for the mineral in Virginia. It forms as small elongated brownish-amber, transparent crystals with beryl, purple fluorite, quartz, and siderite. It resembles bastnasite, a rare earth mineral, in some of its physical and optical properties (Glass and others, 1958).

PHENAKITE (beryllium silicate). Phenakite is found in greisen at the Irish Creek tin deposit with beryl, cassiterite, and quartz. It can also be found enclosed in and in veins that cut chlorite and fluorite (Koschmann and others, 1942). The mineral occurs as white to brown elongated crystals that show much the same habit as beryl and in some cases they may be pseudomorphs after beryl. Phenakite has a higher beryllium content than beryl. It is harder than quartz which it resembles. Also phenakite commonly shows vertical striations down the C-axis whereas they are horizontal on quartz.

Figure 13. Web-like palygorskite surrounding small pyrite crystals (~600X) from the Lone Jack quarry; photograph courtesy of R. V. Dietrich.

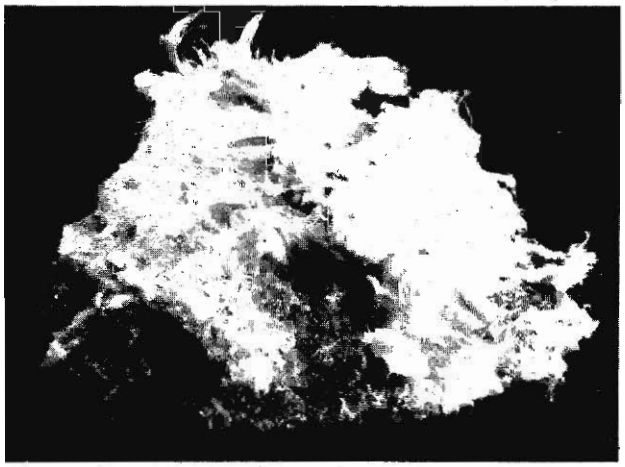


Figure 14. White, fluffly mass of palygorskite with small calcite crystals from Lone Jack quarry, specimen 4 inches across; photograph by T. M. Gathright, II.

PHLOGOPITE - MICA GROUP (hydrous potassium, magnesium, aluminum, silicate). Phlogopite mica is generally light brown to yellowish in color and is found in magnesium rich metamorphic rocks and kimberlites. It occurs in the Mt. Horeb kimberlite deposits (Sears and Gilert, 1973).

PIGEONITE - PYROXENE GROUP (magnesium, iron, calcium, silicate). Pigeonite has been found in granodiorite at Irish Creek (Koschmann and others, 1942). The mineral occurs as dark colored lath-shaped crystals which are almost identical to augite in appearance.

PSILOMELANE. A general field term for massive, hard, not specifically identified manganese oxides found in most of the mines worked for manganese

in the county (see Wad).

PUMPELLYITE - PUMPELLYITE GROUP (hydrous calcium, magnesium, maganese, aluminum, iron, silicate). Pumpellyite occurs as dark green masses in unakite with epidote, feldspar, and quartz. It is usually darker green than epidote. It is found in an abandoned quarry on State Highway 56, 1.5 miles east of Vesuvius (X-ray analysis by R.S. Mitchell).

PYRITE - PYRITE GROUP (iron sulfide known as "fools gold"). Small pyritohedrons are found in black chert nodules in the lower part of the Cambrian-age Rome Formation near the southwestern end of Sallings Mountain near Natural Bridge Station (Leonard, 1962). The mineral is also found at the Lone Jack quarry near Glasgow where the relationship of two kinds of pyrite exists: as tarnished relatively complex crystals some of which are twinned; and brassy yellow untarnished simple cubes which occur in weblike masses of palygorskite within calcite-lined vugs in dolostone (Dietrich, 1963a).

Excellent octahedral pyrite crystals up to 2 inches in length can be found in Ordovician limestone in Barger's quarry near Lexington (Figure 15). These specimens represent some of the finest examples of pyrite octahedrons in the United States (Figure 16; Penick, 1987). The octahedral crystals are almost always in combination with other forms such as the cube and pyritohedron. Single cubes are extremely rare in this quarry; only one has been observed by the writer (Figure 17). Some specimens are aggregates of crystals dominated by cube faces. The aggregates range in size from 1 to 4 inches in diameter. Also some specimens display intergrowths of two crystals that resemble twinning. Most of the pyrite has crystallized in dense limestone matrix. Rare and complex forms of pyrite were recognized in the Lexington area as early as 1886. Limonite pseudomorphs after pyrite were described by Meem (1886).

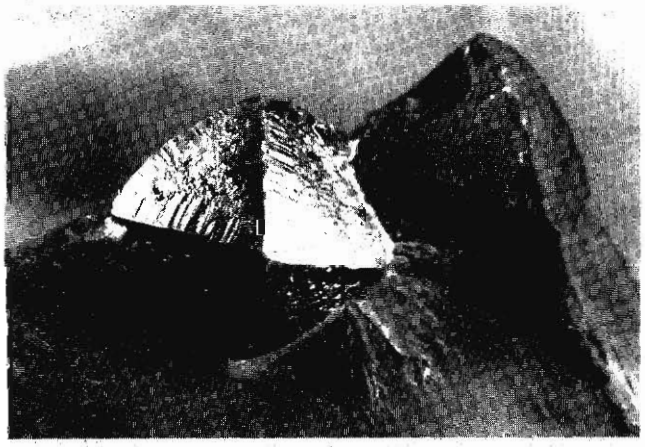


Figure 15. Octahedral pyrite crystal in limestone from Barger's quarry near Lexington. Field of view is 3 inches; crystal is 1.6 inches. Photograph by T.M. Gathright, II.

PYROPE - GARNET GROUP (magnesium, aluminum, silicate). Pyrope garnet occurs as brilliant rose-red grains in kimberlite at the Mt. Horeb Church area in the southwestern part of the county. Pyrope was found with zircon, ilmenite, chromium rich spinel, rutile, and a green amphibole mineral (Sears and Gilbert, 1973).

PYROLUSITE - RUTILE GROUP (manganese oxide). Pyrolusite is the mineral that is commonly called "crystallized ore" by miners. It occurs at most of the manganese deposits in Virginia as both steel gray crystals and as black sooty reniform masses. Pyrolusite is also found as dark bluish gray dendrites on quartzite at the Lone Jack quarry near Glasgow (Dietrich, 1963a).

PYRRHOTITE (iron sulfide). Pyrrhotite is reported from the Irish Creek tin deposit (M.H. Stow, personal communication to R. V. Dietrich). The mineral has a brownish-bronze color and is weakly to strongly magnetic. Pyrrhotite is often associated with nickel and platinum deposits.

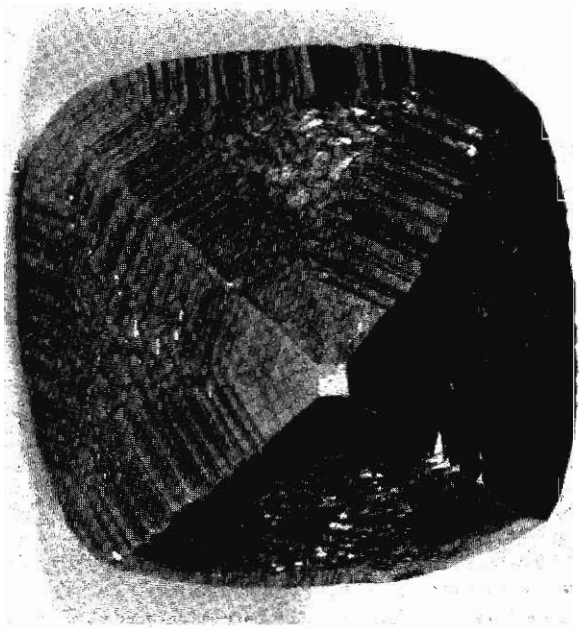


Figure 16. Pyrite crystal with cube and striated octahedral faces, crystal 1.3 inches across, Barger quarry near Lexington; photograph by T. M. Gathright, II.

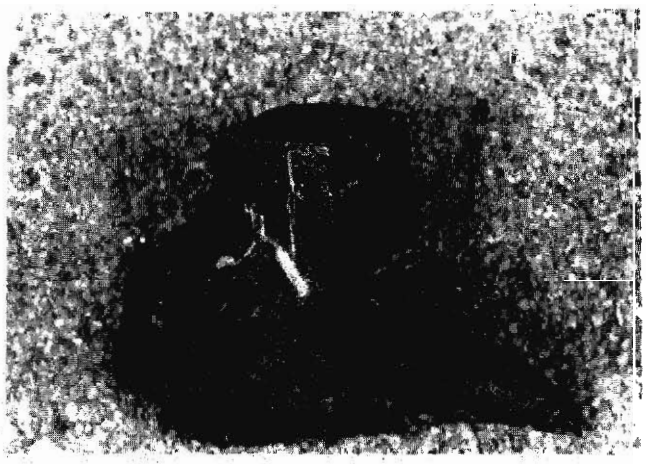


Figure 17. Pyrite crystal (0.8 inch) in limestone from Barger quarry near Lexington; photograph by D. A. Hubbard.

QUARTZ (silica oxide). Quartz is a common mineral occurring in many rocks within Rockbridge County. It is found in veins and cavities in limestone, as chert masses in dolostone, as a major constituent in sandstone, quartzite, and in some of the igneous rocks in the Blue Ridge Mountain portion of the county. Quartz veins to 5 feet wide are found with greisen at the Irish Creek tin deposits.

The best quartz crystals have been discovered in soils overlying Upper Ordovician limestone. These crystals can be found in many places in the county where this limestone occurs. The crystals weather from cavities in the limestone. Erosion scars between limestone outcrops are the best places to look for crystals. Crystals up to 4 inches in length have been found by the writer near Collierstown. Several farms in the area have produced excellent crystals. These crystals range from clear to smoky. Some have illite (clay) inclusions which can produce spectacular specimens (Figure 18). Both scepter and reverse scepter crystals to 3 inches can be found, some are doubly terminated, and most have extremely smooth and lustrous crystal faces. Crystals may also

be complex and show a "stacked" arrangement. Some of these crystals have been used in jewelry particularly the clear ones which resemble the famous "herkimer diamonds" of New York State. Good crystals can also be found in the Kerrs Creek and House Mountain areas. Interesting single crystals and crystal clusters have also been found in Barger's quarry.

Amethyst, the purple variety of quartz, has been found at the Irish Creek tin deposits, although not of gem quality (Zeitner, 1968). Gem quality jasper (quartz colored red by iron oxide) has been found in the Arnold Valley area (Herbert Grow, personal communication).

Figure 18. Two 3 inch long quartz crystals from near Collierstown, crystal on left is doubly terminated and has clay inclusions; photograph by T. M. Gathright, II.

RHOMBOCLASE (hydrogen, iron sulfate). Rhomboclase is found as white subtranslucent sugary masses atop copiapite at the Kelly Bank mine near Vesuvius (R.S. Mitchell's notes).

ROCKBRIDGEITE (hydrous iron, manganese, phosphate). Rockbridgeite is a relatively rare mineral named for Rockbridge County, Virginia because it was first recognized in this county as a distinct mineral species in samples from the Midvale iron mine south of Vesuvius. The mineral was found in some abundance on the dumps of the mine. The name rockbridgeite was proposed by Professor Clifford Frondell of Harvard University for material previously identified as dufrenite (Frondell, 1949). The Midvale mine has been reclaimed and no evidence of mining remains.

More recently rockbridgeite can be found on the dumps of the Dixie mine east of Vesuvius (Barwood and Zelazany, 1982). The mineral occurs as dark green, fine-grained masses and as dark green fibrous concentric bands with reddish brown to black goethite. Well formed crystals of rockbridgeite have not been reported. Other associated minerals are cacoxenite, dufrenite, kidwellite, and strengite (Kearns and Penick, 1989). It has been discovered recently that rockbridgeite from the Dixie mine takes an excellent polish which resembles black jade. Polished cabochons can be used with sterling silver to make attractive jewelry (Figure 19).

ROZENITE - ROZENITE GROUP (hydrous iron sulfate). Rozenite can be found with melanterite as dull white encrustations on dolostone at the Lone Jack quarry near Glasgow (Dietrich, 1963).

RUTILE - RUTILE GROUP (titanium oxide). Red grains of rutile are found with black ilmenite creating a banded appearance in quartzite at the base of the Precambrian Unicoi Formation on the Robinson Gap road, 2 miles east of Buena Visita (Bloomer and DeWitt, 1941). Rutile is also found in the country rock and the greisen at the Irish Creek tin deposit (Glass and others, 1958). Rutile grains have been reported from the kimberlite deposits near Mt. Horeb Church (Sears and Gilbert, 1973).

SCHEELITE (calcium tungstate). Scheelite is an important ore of tungsten and occurs both in greisen and in carbonate veins with wolframite and cassiterite at the Irish Creek tin deposits. It mainly appears as brown cleavage masses but crystals as much as 6 mm across occur with cassiterite crystals (Glass and others, 1958). The mineral shows bright blue fluorescence under ultraviolet light.

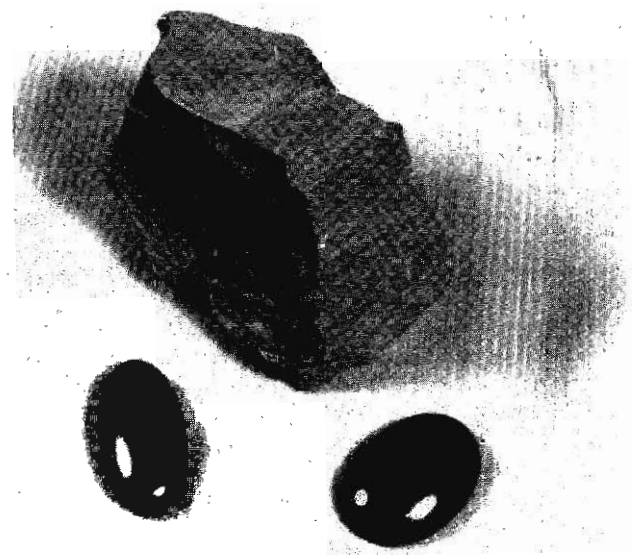


Figure 19. Specimens of rockbridgeite from the Dixie mine with two polished cabochons cut from the same material, cabochons are 1 inch long; photograph by T. M. Gathright, II.

SCORODITE (hydrous iron arsenate). Scorodite is an alteration product of arsenopyrite in greisen and in quartz veins at the Irish Creek tin deposit (Morgan, 1938). It occurs as leek green encrustations on arsenopyrite.

SERPENTINE - KAOLINITE-SERPENTINE GROUP (hydrous magnesium, iron, silicate). Serpentine has been identified in samples from the Mt. Horeb kimberlite deposits (X-ray analyses by Ollie Fordham).

SIDERITE - CALCITE GROUP (iron carbonate). Siderite is the most abundant carbonate at the Irish Creek tin deposit. It occurs in veins and in brown rhombohedral masses both in the greisen and vein quartz. In hand specimen siderite superficially resembles cassiterite however siderite has pronounced rhombohedral cleavage while cassiterite does not. The mineral is associated with ankerite, fluorite, and cassiterite (Glass and others, 1958).

SILVER - NATIVE ELEMENT. Silver is associated with gold in arsenopyrite veins at the Irish Creek tin deposit. Recent assays indicate 11.16 troy ounces of silver per ton from a sample of arsenopyrite (Sweet and Lovett, 1985).

SPHALERITE - SPHALERITE GROUP (zinc sulfide). Sphalerite is the most important ore of zinc and occurs as orange to brown waxy masses with calcite and dolomite at the Lone Jack quarry near Glasgow (Dietrich, 1985). It also occurs as dark brown, resinous, crystalline masses in greisen and quartz veins at the Irish Creek tin deposit (Glass and others, 1958). The sphalerite at this locality resembles cassiterite.

SPINEL - SPINEL GROUP (magnesium, aluminum, oxide). Chromium-rich spinel has been found in a [illegible] sample from the Mt. Horeb Church deposit in the southwestern [illegible] County. It occurs as small bright-green grains (X-ray analyses by Oliver [illegible]).

STARKEYITE - ROZENITE GROUP (hydrous magnesium sulfate). Starkeyite occurs admixed [illegible] powdery encrustations on some surfaces of the [illegible] the Lone Jack quarry near

Glasgow (Dietrich, 1985).

STRENGITE (hydrous iron phosphate). Strengite occurs as minute reddish brown crystals in fractures, 1 mile southeast of Midvale (Koening, 1877). Also bright purple crystals of strengite on both rockbridgeite and kidwellite were reported from the Midvale mine (Barwood and Zelazny, 1982). Strengite is relatively common at the Dixie mine and occurs as divergent sprays and spherical aggregates of brilliant lilac-pink prisms. The crystals are generally less than 3 mm in size and usually form in cavities with kidwellite. Small flattened crystals of strengite have also been observed as radiating aggregates on goethite or rockbridgeite (Kearns and Penick, 1989).

TAAFFEITE (magnesium, alumimum, beryllium, oxide). The rare mineral taaffeite can be found as bright green coatings on cassiterite at the Irish Creek tin mines (R.S. Mitchell's notes). This is the only reported occurrence of taaffeite in Virginia.

THENARDITE (sodium sulfate). Thenardite, that fluoresces bright light blue in long-wave ultra-violet radiation, was found as white powdery spherules in dolostone in the Lone Jack quarry near Glasgow (Dietrich, 1985).

TALC (hydrous magnesium silicate). Talc, an alteration product of serpentine, was identified at the Mt. Horeb Church kimberlite deposit (X-ray analyses by O.M. Fordham).

TOURMALINE - TOURMALINE GROUP (complex hydrous silicate of sodium, magnesium, aluminum, and boron).
Black tourmaline crystals, probably schorl, have been found in a quartz vein intruding quartzite in the Erwin Formation at the Lone Jack quarry near Glasgow (Figure 20; J.L. Dickinson, Jr., personal communication, 1980). Small black tourmaline crystals have also been reported from the tin deposits near Irish Creek, where they generally occur in fractures in cassiterite (Glass and others, 1958).

TURQUOISE - TURQUOISE GROUP (hydrous copper, aluminum, phosphate)

Turquoise has been identified from the dumps of Kelly Bank iron-manganese mine near Vesuvius. It ranges from green to blue-green to white and occurs as earthy porous masses 2 to 3 mm across. The mineral also occurs as thin botryoidal crusts which exhibit color banding (Mitchell and Freeland, 1978). Turquoise is also found in nodules with wavellite. When broken open these nodules often reveal water-clear prisms of wavellite on massive turquoise. They make excellent specimens (Barwood and Zelazny, 1982). No gem quality turquoise has been found at this locality.

VARISCITE (hydrous aluminum phosphate). Variscite is found at the Kelly Bank mine near Vesuvius with wavellite and turquoise. It occurs as thin white to gray vitreous crystalline crusts with botryoidal and globular structures. These crusts are fibrous to granular and have surfaces which sparkle due to small crystal faces (Mitchell and Freeland, 1978). Variscite also occurs as green veins and masses in porous nodules of wavellite (Barwood and Zelazny, 1982).

VERMICULITE (hydrous magnesium, iron, silicate). Vermiculite is a yellowish-brown micaceous mineral found as a network of veinlets and local aggregates in greisen at the Irish Creek tin mines. It resembles biotite and nontronite and is associated with them (Koschmann and others, 1942).

WAD (soft manganese oxide). Wad is no longer a credited mineral species but usage is still applied to dark brown earthy manganium oxides such as psilomelane and lampadite whose exact identities are unknown. The following descriptions of wad are as they were originally reported.

Wad was reported from Hogpen Hollow and the Midvale mines near Vesuvius (Hewett and Fleischer, 1960). Psilomelane pseudomorphs after clay from the Kelly Bank mine near Vesuvius are included on the list of "Pseudomorphs in the National Study Collection of Minerals" in the Smithsonian Institution (Dietrich, 1990).

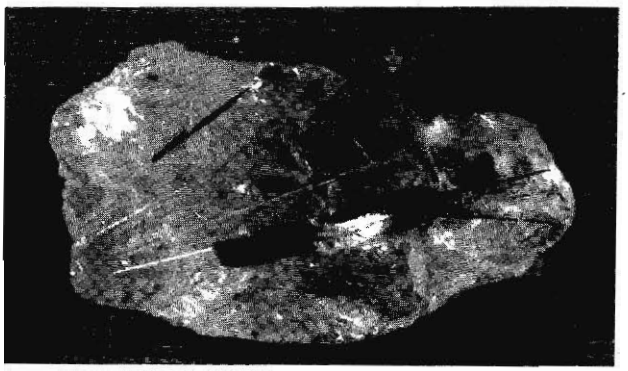


Figure 20. Black tourmaline crystals in clear quartz from the Erwin quartzite from the Lone Jack quarry, specimen 3 inches long; photograph by T.M. Gathright, II.

WAVELLITE (hydrous aluminum phosphate). Wavellite is the most abundant phosphate found at the Kelly Bank mine near Vesuvius. It occurs as gray to white vitreous radiating fibers and needles in botryoidal or globular groups to 7 mm in diameter (Mitchell and Freeland, 1978). Wavellite occurs as nodules associated with turquoise and other phosphate minerals (Figure 21).

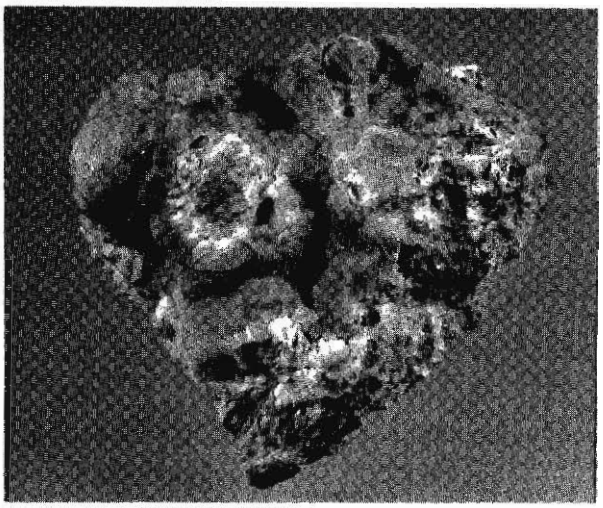


Figure 21. Three-inch nodule of wavellite and turquoise from the Kelly Bank mine; photograph by Howard Freeland.

WOLFRAMITE (iron, manganese, tungstate). Wolframite is intermediate in composition between ferric iron-rich ferberite and manganian-rich hubnerite. It occurs as black veinlets in greisen with cassiterite and muscovite. It also forms laminae along mica cleavage planes producing an intricate meshwork, which towards the center of the meshwork, may form an almost solid mass (Glass and others, 1958). Wolframite is also closely associated with scheelite.

ZIRCON (zirconium silicate). Zircon has been reported from Petetes Gap (Dana, 1892). It is also found at the Irish Creek tin deposits as small elongated tetragonal crystals in granodiorite and as a relict mineral in the greisen. It may also occur in clusters (Glass and others, 1958). At least four morphologically distinct populations of zircons have been reported from the Mt. Horeb Church kimberlite deposits (Sears and Gilbert, 1973).

ZOISITE - EPIDOTE GROUP (hydrous calcium, aluminum, silicate). Zoisite can be found at the Irish Creek tin deposits where it occurs as prismatic crystals in calcite veins with clinozoisite (Glass and others, 1958).

REFERENCES CITED

Anonymous, 1894, Cash mine near Vesuvius, Virginia: U.S. Geological Survey, Mineral Resources, p. 180-189.

Barwood, H. L., and Zelazny, L. W., 1982, Phosphate Minerals in the Vesuvius, Virginia, area and notes on type locality for rockbridgeite: Rocks and Minerals, v. 57, n. 1, p. 20-22.

Bloomer, R. O., and DeWitt, Wallace, 1941, Titaniferous sandstone near Buena Vista, Virginia: Economic Geology, v. 36, p. 747-749.

Butts, Charles, 1933, Geologic map of the Appalachian Valley in Virginia: Virginia Division of Mineral Resources Bulletin 42 (map reprinted in 1992).

Campbell, J. L., 1881, On dufrenite from Rockbridge County, Virginia, The American Journal of Science, v. XXI, no's. 121-126, p. 65-67.

Dana, E. S., 1892, The System of Mineralogy of James Dwight Dana, descriptive mineralogy entirely rewritten and much enlarged, 6th edition: New York, John Wiley, 1134 p.

Dietrich, R. V., 1960, Virginia mineral localities, 1960 edition: Virginia Polytechnic Institute, Engineering Experiment Station Series, Bulletin 138, 84 p.

Dietrich, R. V., 1962, Southern Field Excursion Guidebook: International Mineralogical Association, 3rd General Congress, Washington, D.C., 59 p.

Dietrich, R. V., 1963, Minerals from Lone Jack quarry, Rockbridge, County, Virginia: Virginia Polytechnic Institute, Mineral Industry Journal, v. X, n. 1, p. 1-6.

Dietrich, R. V., 1985, Lone Jack quarry, Rockbridge County, Virginia: Rocks and Minerals, v. 60, n. 4, p. 157-163.

Dietrich, R. V., 1990, Minerals of Virginia, 1990: Department of Mines, Minerals, and Energy, Division of Mineral Resources, 474 p.

Douglas, H. H., 1964, Caves of Virginia: Virginia Cave Survey, Falls Church, Virginia, 761 p.

Edmundson, R. S., 1938, Barite deposits of Virginia: Virginia Geological Survey Bulletin 53, 85 p.

Frondel, Clifford, 1949, The dufrenite problem: American Mineralogist, v. 34, p. 513-540.

Glass, J. J., Koschmann, A. H., and Vhay, J. S., 1958, Minerals of the cassiterite-bearing veins at Irish Creek, Virginia, and their paragenetic relations: Economic Geology, v. 53, n. 1, p. 65-84.

Good, R. S., 1991, Gold mineralization, and tin, base metals, and thorium anomalies at Yankee Horse Ridge, Irish Creek tin area, Rockbridge County, Virginia: Virginia Division of Mineral Resources Publication 112, 41 p.

Hewett, D. F., and Fleischer, M., 1960, Deposits of the manganese oxides: Economic Geology, v. 55, p. 1-55.

Kearns, L. E., and Penick, D. A., 1989, The Dixie mine, Rockbridge County, Virginia: Rocks and Minerals, v. 64, n. 1, p. 42-45.

Koenig, G. A., 1877, On strengite from Rockbridge County, Virginia: Academy of National Science, Philadelphia Proceedings, p. 227-278.

Koschmann, A. H., Glass, J. J., and Vhay, J. S., 1942, The deposits of Irish Creek, Virginia: U.S. Geological Survey Bulletin 936K, p. 271-296.

Laswell, T. J., and Stow, M. H., 1955, A Virginia occurrence of palygorskite: Virginia Journal of Science Proceedings, p. 283-284.

Leonard, R. B., 1962, Groundwater Geology along northwest foot of Blue Ridge between Arnold Valley and Elkton, Virginia: Blacksburg, Virginia, Virginia Polytechnic Institute, 211 p.

Lowry, W. D., and DeRudder, R. D., 1966, Stylolites in Antietam sandstone, Hellgate Canyon, Rockbridge County, Virginia (abstract): Geological Society of America Special Paper 101, p. 367.

Meem, J. G., 1886, Limonite pseudormorphs after pyrite: American Journal of Science, vol. 32 (3rd series) p. 187-192, 274-276.

Milton, C. K., Murata, K. J., and Knechtel, M. M., 1944, Weinschenkite, yittrium phosphate dihydrate from Virginia: American Mineralogist v. 29, p. 92-107.

Mitchell, R. S., and Freeland, H. R., 1978, Turquoise from Virginia's Kelly Bank mine: Rocks and Minerals, v. 53, n. 5, p. 214-218.

Morgan, A. L., 1938, Scorodite in Virginia (abstract): Virginia Academy of Science Proceedings for 1938, p. 71-72.

Palache, Charles, Berman, Harry and Frondel, Clifford, 1961, The system of mineralogy of James Dwight Dana and Edward Salisbury Dana, Yale University, 1837-1892; seventh edition, v. 2, 1124 p., John Wiley, New York.

Penick, D. A., 1987, Pyrite and other minerals from Barger's quarry near Lexington, Virginia: Virginia Minerals, v. 33, n. 2, p. 13-17

Sears, C. E., and Gilbert, M. C., 1973, Petrography of the Mt. Horeb Virginia kimberlite (abstract): Geological Society of America abstract with programs, v. 5, n. 5, p. 434.

Spencer, E. W., 1968, Geology of the Natural Bridge, Sugarloaf Mountain, Buchanan, and Arnold Valley quadrangles, Virginia: Virginia Division of Mineral Resources Report of Investigation 13, 55 p.

Steidtmann, Edward, 1940, Barite vein near Lexington Virginia (abstract): Virginia Academy of Science Proceedings, p. 245.

Sweet, P. C., and Lovett, J. A., 1985, Additional gold mines, prospects and occurrences in Virginia: Virginia Minerals, v. 31, n. 4, p. 5.

Sweet, P. C., Good, R. S., Lovett, J. A., Campbell, E. V. M., Wilkes, G. P., and Meyers, L. L., 1989, Copper, lead, and zinc resources of Virginia: Virginia Division of Mineral Resources Publication 93, 185 p.

Ulke, Titus, 1841, The occurence of tin ore at Kings Mountain, North Carolina, and the Cash mine in Vesuvius, Virginia: Mineral Resources in the United States, 1893, p. 178-183.

Warren, W. C., Bridge, Josiah, and Overstreet, E. F., 1965, Bauxite deposits of Virginia: U.S. Geological Survey Bulletin 119, 17 p.

Zeitner, J. C., 1968, Appalachian Mineral and Gem Trails: Lapidary Journal Inc., Devan, Pennsylvania, 134 p.

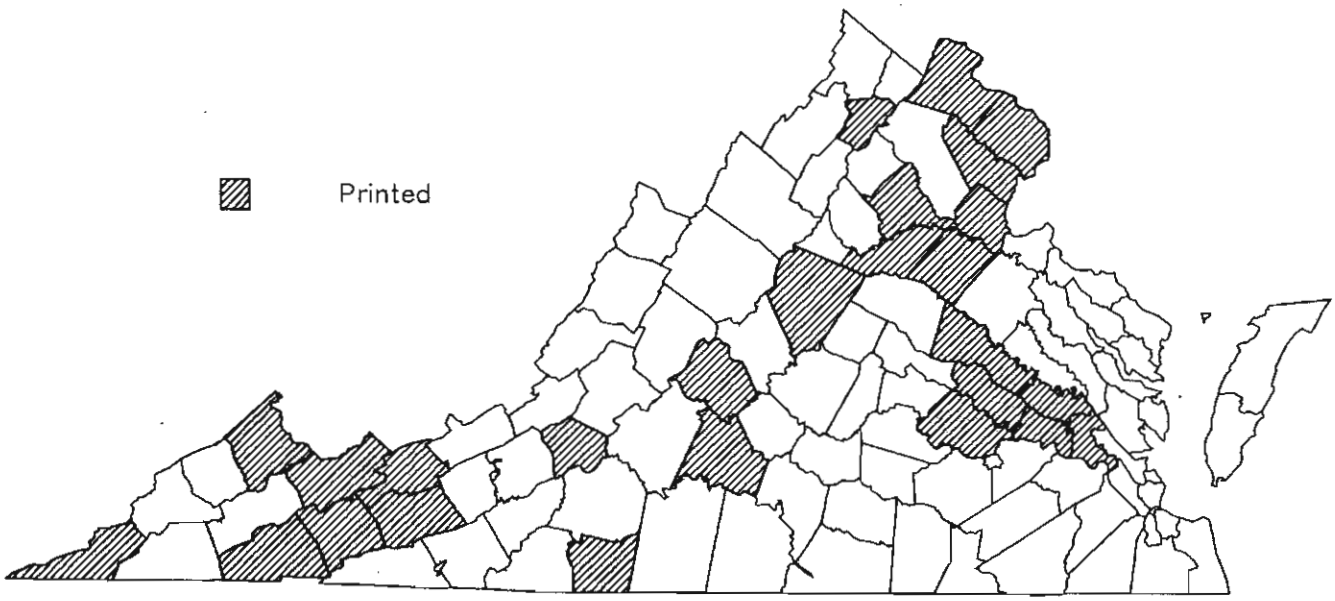
List of Minerals from Rockbridge County, Virginia

1. Actinolite (amphibole group)
2. Aikinite
3. Anatase
4. Ankerite (dolomite group)
5. Aragonite (aragonite group)
6. Arsenopyrite
7. Augite (pyroxene group)
8. Barite (barite group)
9. Beryl
10. Biotite (mica group)
11. Birnessite
12. Bismutite
13. Cacoxenite
14. Calcite (calcite group)
15. Cassiterite (rutile group)
16. Celadonite (mica group)
17. Chalcopyrite (chalcopyrite group)
18. Chlorite (chlorite group)
19. Churchite
20. Claudetite
21. Clinozoisite (epidote group)
22. Copiapite
23. Cryptomelane (cryptomelane group)
24. Diopside (pyroxene group)
25. Dolomite (dolomite group)
26. Dufrenite
27. Epidote (epidote group)
28. Epsomite
29. Feldspar group (see microcline and orthoclase)
30. Ferrohornblende (amphibole group)
31. Fluorite
32. Fluorapatite (apatite group)
33. Galena
34. Galenobismutite
35. Garnet (garnet group)
36. Gibbsite
37. Goethite
38. Gold (element)
39. Graphite (element)
40. Gypsum
41. Halloysite (kaolinite-serpentine group)
42. Hematite (hematite group)
43. Hexahydrite
44. Hypersthene (pyroxene group)
45. Illite
46. Ilmenite (ilmenite group)
47. Jarosite (alunite group)
48. Kaolinite (koalinite-serpentine group)
49. Kidwellite
50. Lepidocrocite
51. Leucoxene
52. Limonite
53. Lithiophorite
54. Magnetite (spinel group)
55. Malachite
56. Manganite
57. Marcasite (marcasite group)
58. Melanterite
59. Microcline (feldspar group)
60. Montmorillonite (smectite group)
61. Muscovite (mica group)
62. Nacrite
63. Niter
64. Nontronite
65. Orthoclase (feldspar group)
66. Palygorskite
67. Parisite
68. Phenakite
69. Phlogopite (mica group)
70. Pigeonite (pyroxene group)
71. Psilomelane
72. Pumpellyite (pumpellyite group)
73. Pyrite (pyrite group)
74. Pyrope (garnet group)
75. Pyrolusite (rutile group)
76. Pyrrhotite
77. Quartz
78. Rhomboclase
79. Rockbridgeite
80. Rozenite (rozenite group)
81. Rutile (rutile group)
82. Scheelite
83. Scorodite
84. Serpentine (kaolinite-serpentine group)
85. Siderite (calcite group)
86. Silver (element)
87. Sphalerite (sphalerite group)
88. Spinel (spinel group)
89. Starkeyite (rozenite group)
90. Strengite
91. Taaffeite
92. Talc
93. Thenardite
94. Tourmaline (tourmaline group)
95. Turquoise (turquoise group)
96. Variscite (variscite group)
97. Vermiculite
98. Wad
99. Wavellite
100. Wolframite
101. Zircon
102. Zoisite (epidote group)

COUNTY TOPOGRAPHIC MAPS

Since the early 1970s the Division of Mineral Resources, in cooperation with the U.S. Geological Survey Topographic Branch, has been producing 1:50,000 scale county topographic maps. Cities are incorporated with their adjacent county, for example the City of Fredericksburg is included with Spotsylvania County. The following counties and cities, shown on the map below have been completed. Currently Bedford and Rockbridge Counties are in preparation and should be available before the end of 1994. Additional counties are planned as funding allows.

An index to the topographic maps in Virginia is available free from the Division of Mineral Resources (DMR). County topographic maps cost $4.00 plus 4.5% sales tax (Virginia addresses only) plus shipping. Contact DMR at P.O. Box 3667, Charlottesville, VA 22903 or by telephone - 804/293-5121 for postage charges. Prepayment is required.



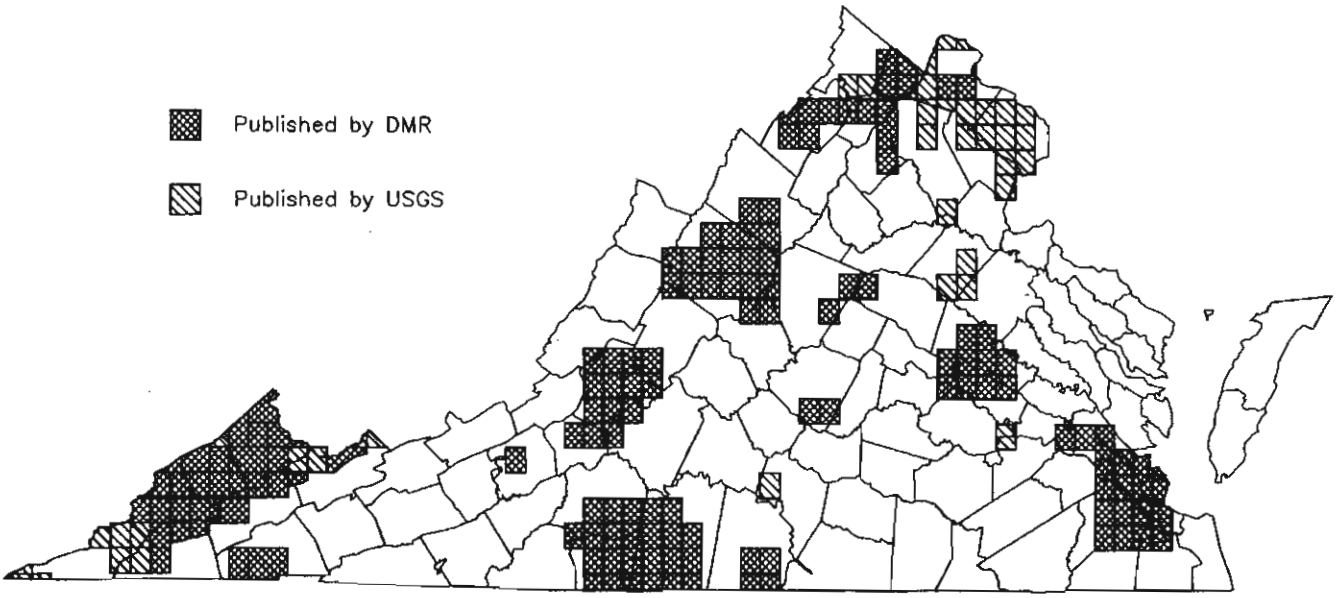
County Topographic Maps

GEOLOGIC MAPS

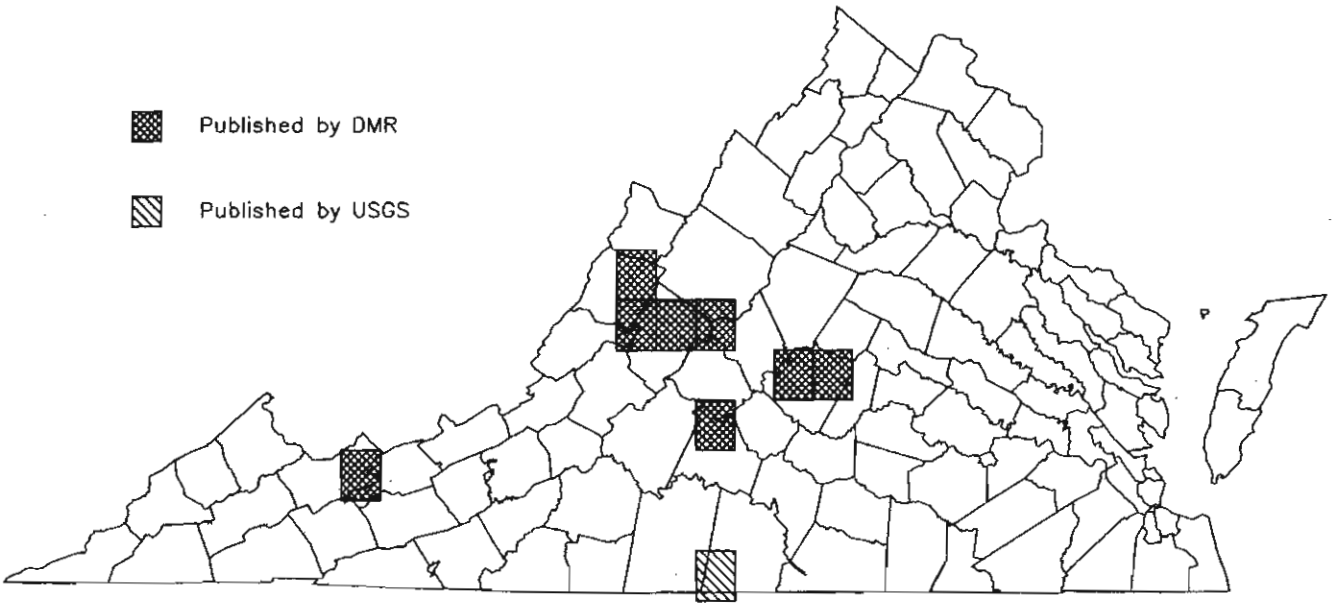
Geologic mapping has been an ongoing activity by the Division of Mineral Resources and its predecessors since 1835. The modern era of geologic mapping began in the late 1930s when the topographic base maps were prepared using aerial photographs.

A geologic map is a graphic representation of the distribution and geometry of earth materials at and near the surface of the earth. They provide information about the age, composition, occurrence of folds and faults, mineral deposits and geologic factors that impact man's activities. Geologic maps are prepared from field surveys and remote sensed data, such as geophysical surveys. The geologic map is the principal source of geological information needed for the resolution of nearly all basic and applied earth-science research and decision-making concerns, and is a guide to most human interactions with the earth. Examples are: distribution and availability of energy and mineral resources; location and nature of natural hazards; distribution of water resources; basic data for planning construction projects, such as dams, highways, and pipelines and industrial plants. Benefits of using geologic data derived from geologic maps include: mitigation of natural hazards; location of karst areas and mines and quarries; groundwater protection; planning for urban growth, mineral extraction, and sequential land use.

Fourteen counties (scale - 1:50,000, 1:62,550, or 1:100,000) have geological maps. Nine 15-minute (scale - 1:62,500) quadrangles and one hundred and ninety-four 7.5-minute (scale - 1:24,000) quadrangles have been published. The following three index maps show the location of geologic maps at a scale of 1:62,500 and larger. Additional regional maps are available but are not shown on the maps. A free "List of Publications and Maps" is available from the Division of Mineral Resources.



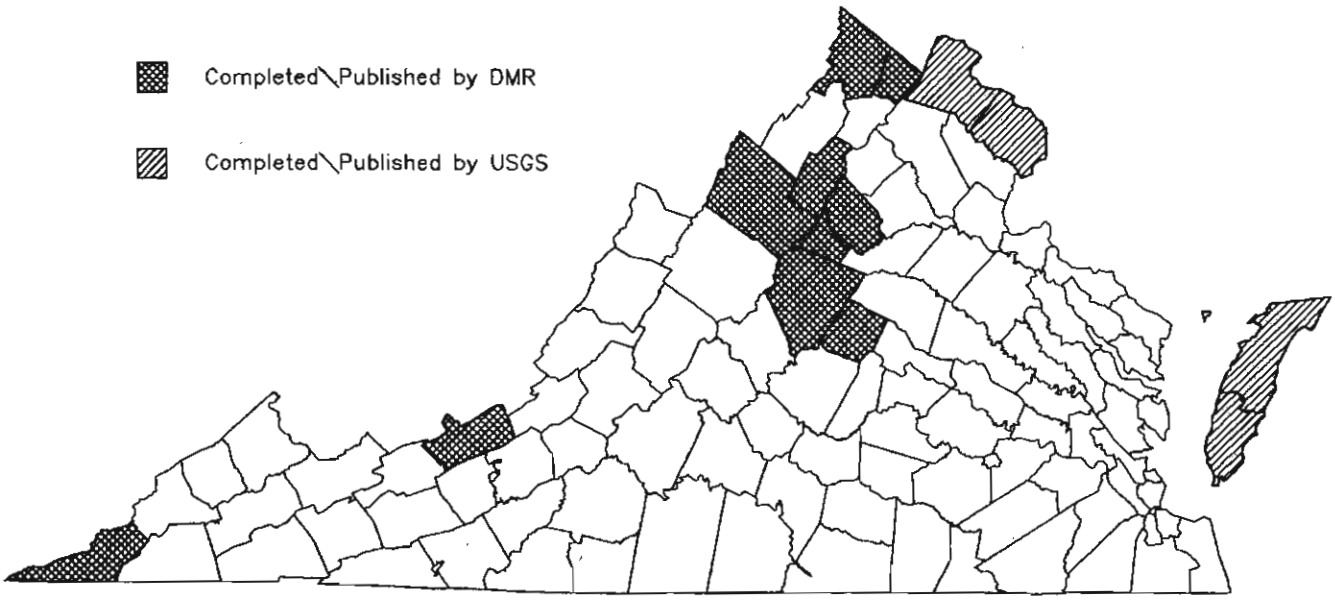
7.5-MINUTE QUADRANGLE GEOLOGIC MAPS (1:24,000)



15-MINUTE QUADRANGLE GEOLOGIC MAPS (1:62,500 SCALE)

Postmaster:
Send address corrections to:
Virginia Division of Mineral Resources
P. O. Box 3667
Charlottesville, VA 22903

Virginia Minerals
Second-Class postage paid at
Charlottesville, Virginia
ISSN 0042-6652



COUNTY GEOLOGIC MAPS

Copyright 1994, Commonwealth of Virginia
Virginia Minerals, Vol. 40, No. 1 & 2, February 1994