IDENTIFICATION GUIDE

COMMON MINERALS & ROCKS

OF VIRGINIA

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

IDENTIFICATION GUIDE TO COMMON MINERALS AND ROCKS OF VIRGINIA

GUSTAV B. BAETCKE

INFORMATION CIRCULAR 3

VIRGINIA DIVISION OF MINERAL RESOURCES

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IDENTIFICATION GUIDE TO COMMON MINERALS AND ROCKS OF VIRGINIA

By

GUSTAV B. BAETCKE

INTRODUCTION

A great number of different kinds of minerals and rocks are found in Virginia and the State is a rich and generous collecting area for "rockhounds" and mineral collectors. This Identification Guide contains descriptions of minerals and rocks, descriptions of physical tests, and illustrations which may be used to make rock and mineral identifications. General areas are listed from which particular rocks and minerals may be collected. Information about equipment, collecting methods, and specimen preparation is included, and should the collector become interested in obtaining more technical information, a list of selected references appears at the end of the publication.

NOTES ON COLLECTING SPECIMENS

Virginia has an abundance of easily accessible collection localities. Rock exposures situated along streams or road cuts are ideal places to collect samples. Mine dumps and quarries are excellent sources for rock and mineral specimens but should be entered only upon receiving the consent of the owner or manager.

Collecting in State and National Parks is prohibited by law unless the collector has written permission from a park ranger or superintendent.

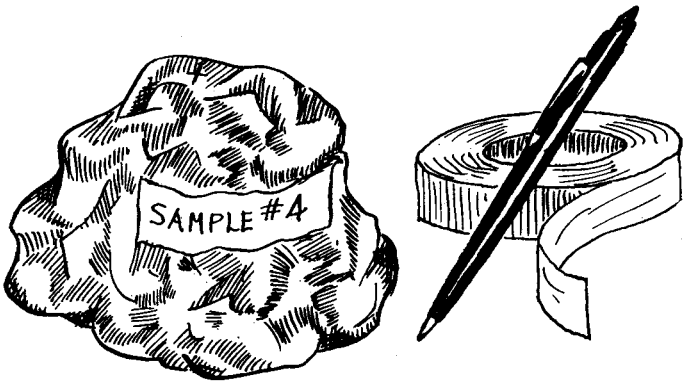
ALWAYS BE SURE TO GET PERMISSION to hunt specimens on private property. Land owners are usually friendly and cooperative when asked for permission to enter and collect.

To be of value as a mineralogical specimen, each sample must be labeled as to the exact locality from which it was collected. The location name and an identifying number should be printed on a piece of adhesive tape and attached to the sample. Each sample should be well wrapped in a piece of paper or cloth to prevent its being scratched or fractured when carried, a practice essential for preserving soft, easily shattered mineral specimens.

A permanent label may be made by adding a small patch of enamel or nail polish to a corner of the specimen and an identifying number

lettered in with india ink. The location and additional information such as the name of the collector, the date, and the rock and mineral name should be witten beside the corresponding number in a notebook for permanent record.

There are many different methods for mounting and displaying rock and mineral specimens and each collector usually designs his own arrangement. Small, representative specimens may be mounted on a piece of plywood or stiff cardboard, with identifying labels printed under each specimen. Arranged in this fashion, the specimens are easily stored and make interesting exhibits. Larger specimens are usually placed in compartmented boxes or trays and kept in a cabinet. Unusual and fragile specimens are often mounted in cotton-filled boxes with glass covers.



FIELD EQUIPMENT

One of the most important tools of the mineral collector is a rock hammer used for chipping rocks to get a fresh surface for examination and for breaking off a suitable piece for collection. Excellent rock hammers, costing about $5.00, are available from scientific supply houses and hardware stores. These hammers are square faced on one end and have either a pick point or a chisel blade on the other end. The picks are useful in digging or prying out minerals or rock fragments, the chisels are used for splitting and trimming rocks. Although the choice is one of personal preference, the chisels are probably more useful for the beginner.

An inexpensive pair of shatterproof sun glasses will protect the eyes from stray rock chips or steel splinters that may break off new

hammers. The glasses are especially useful when the collector is doing close, careful work.

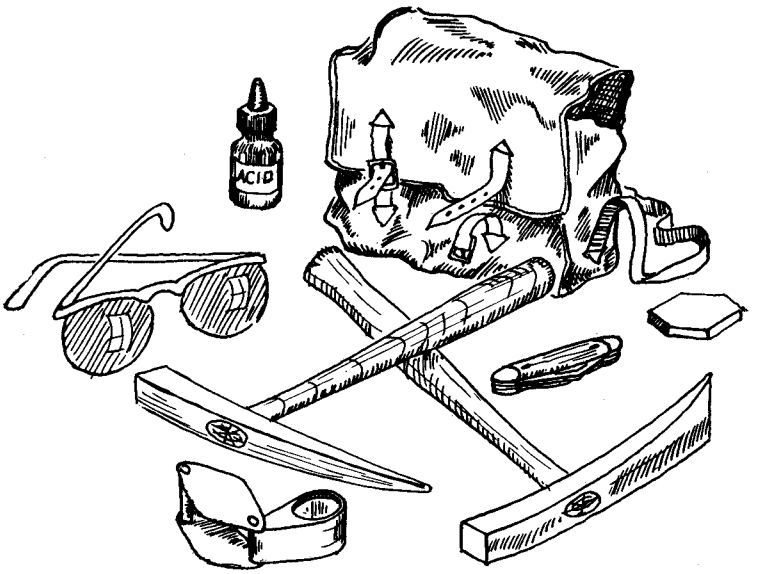
A pocket knife may be used for testing the hardness of rocks and minerals, and for digging minerals out of soft rocks.

A hand lens or small magnifying glass is useful for examining small mineral grains. Inexpensive pocket magnifiers purchased in a dime store are quite adequate.

Any type of durable sack or cloth bag may be used to carry specimens in the field. Army surplus musette bags with a carrying strap are useful.

Dilute hydrochloric acid (10%HCl) is used to test rocks for the presence of certain carbonate minerals. This acid, contained in 1 to 2-ounce dropping bottles, can be purchased from a druggist. Hydrochloric acid is dangerous and all acid bottles should be clearly marked and kept from the reach of children. Any acid that gets on the clothes or skin should be immediately washed off with fresh water.

A streak plate is used to determine the color of the powder of a mineral. Any piece of white, unglazed porcelain, such as a bathroom tile, can be used as a streak plate.



MINERAL PROPERTIES

GENERAL DISCUSSION

A mineral is a naturally occurring inorganic substance which possesses characteristic physical properties, and has a definite chemical composition. Ordinary table salt conforms to this definition and is known as the mineral halite. The garnet that is affixed to "sandpaper" is another example. Ice is a true mineral and often occurs as delicate star-shaped crystals called snow. Coal and petroleum are classified as mineral resources but are of organic origin and are not true minerals.

Most minerals have a characteristic and orderly internal arrangement of atoms. If a mineral is allowed freedom of growth, this internal arrangement is sometimes expressed by the formation of crystals, geometrical forms bounded by smooth surfaces.

Minerals have long been objects of investigation and study, and within the last century there has been established an accurate and useful system for mineral identification and classification.

Early mineralogical knowledge was intermingled with alchemy, astrology, superstition, and various religious beliefs. Some minerals were valued simply as objects of adornment; others, often used as charms or amulets, were believed to possess mystical powers that would protect the wearer from bad luck or illness. Minerals were grouped according to the alphabetical sequence of name, supposed magical or medicinal powers, and color. There was no recognized distinction between rocks, minerals, fossils, or even stone-age implements dug from the earth—all were included in one large category called "fossils."

During the early part of the sixteenth century rich ore deposits were discovered in the middle European countries of Saxony and Bohemia. Intensive study of the minerals mined from these deposits provided the basis for modern mineralogy. More than one thousand distinct mineral species have been recognized and described. Many of these minerals can be identified only by microscopic, chemical, or x-ray examination, but these are relatively uncommon and rarely encountered by the amateur collector. The common rock-forming minerals can be identified by distinctive physical properties that are easily recognized in hand specimens. These properties, listed and defined below, provide a means for rapid and accurate mineral identification.

PHYSICAL PROPERTIES

COLOR

In minerals of a constant chemical composition, color, or the lack of it, may be a characteristic property. Many minerals, however, contain impurities or inclusions or have slight changes in chemical composition and therefore are variable in color. Quartz, for example, is transparent and colorless when pure, but impure varieties may be black, brown, pink, purple, blue, yellow or white.

TRANSPARENCY

The clearness of a mineral or its relative ability to transmit light are degrees of transparency. Minerals through which objects can be distinctly seen are transparent. Those which transmit light but through which objects cannot be distinctly seen are translucent. Minerals which do not transmit light are opaque.

LUSTER

The luster of a mineral is the appearance of its surface in ordinary light. Minerals exhibit two general types of luster, metallic and non-metallic. Metallic lusters are similar to the appearance of metals such as brass, copper, silver, iron, or tin, and are exhibited by minerals that are usually quite heavy and opaque. Non-metallic lusters are briefly described as follows:

Luster	*As exhibited by*
Vitreous (the most common luster)	Broken glass
Dull or Earthy	Chalk, clay, plaster
Greasy	Any oiled surface
Silky	Glass wool
Resinous	Pitch or resin
Pearly	Mother-of-Pearl
Adamantine	A diamond

STREAK

The color of the powder produced by crushing, filing, or scratching a mineral on a piece of white unglazed porcelain is called the streak. Streaks frequently have colors different from that of the minerals and are very useful in mineral identification.

HARDNESS

The hardness of a mineral is the degree of resistance it offers to being scratched or abraded by other materials. Degrees of hardness are

determined by observing the comparative ease or difficulty with which a mineral scratches or is scratched by another mineral, a piece of glass, a fingernail, or knife. A scale of hardness, known as Mohs' scale, is composed of ten common minerals arranged in order of increasing hardness. These minerals are: (1) talc, (2) gypsum, (3) calcite, (4) fluorite, (5) apatite, (6) feldspar, (7) quartz, (8) topaz, (9) corundum, and (10) diamond. A mineral with a relative hardness of 3.5 will scratch calcite and be scratched by fluorite. Fluorite in turn will be scratched by any mineral with a hardness number greater than four. Two minerals of the same hardness may each be scratched by the other or neither will be scratched. Always test the hardness of a mineral on a fresh fracture or cleavage surface. Weathered surfaces usually are coated with alteration products that are much softer than the mineral.

Minerals may be conveniently grouped into three classes of hardness: soft—minerals softer than 2.5—can be scratched by a fingernail; medium—minerals harder than 2.5—will scratch a fingernail, but are softer than 5.5 and are scratched by a steel knife blade or a piece of windowglass; hard—minerals harder than 5.5—will scratch a steel knife blade or windowglass.

Mohs' scale is only an expression of relative hardnesses (H). Corundum, H-9, is at least 1000 times as hard as talc, H-1. Diamond, H-10, is at least 5 times as hard as corundum, H-9.

CRYSTALS AND CRYSTAL FORMS

Minerals developed under favorable conditions often grow into definite and characteristic forms. These forms, known as crystals, are solids bounded by flat surfaces or faces and are used to identify minerals. Crystals are classified on the basis of shape and symmetry into six large groups or crystal systems. Crystal forms within these systems are varied and diverse. Some crystals are long and thin and are described as needle-like or fibrous; some are flat and tabular; others are shaped like cubes or prisms. There are numerous other forms and combinations of forms. Their description and classification is the basis of the interesting field of study known as geometrical crystallography.

Minerals rarely occur as perfect single crystals. Most mineral specimens are masses of irregular grains or particles and are called crystalline aggregates. Crystalline aggregates may be dendritic or fern-like, micaceous or platy, fibrous, earthy, bladed, granular, or columnar. Aggregates may be composed of rounded particles the size of fish eggs called oölites; if the particles are the size of peas, they are called pisolites.

Rounded or nodular masses are concretionary, globular, or, if they resemble closely packed bunches of grapes, botryoidal.

Minerals that have no external crystal form, but posses an internal crystalline structure, are said to be massive. A few minerals have no orderly internal arrangement of their atoms and, therefore, lack crystal structure. They are called non-crystalline or amorphous. Opal and volcanic glass are amorphous.

CLEAVAGE

Many minerals are easily split or broken along certain definite lines or planes. This property is called cleavage. It is restricted to inherent planes of weakness, called cleavage planes, which are always parallel to a potential crystal face of a mineral. There is a distinct difference between a cleavage face and a crystal face. Crystal faces are developed on the surfaces of minerals during crystallization. Cleavage faces are produced by breaking or splitting a mineral along definite planes after the mineral has formed. Cleavage planes pass through the entire mineral and are almost infinite in number. Massive minerals lack crystal faces but may possess an excellent cleavage. The presence of cleavage in a mineral or crystal can often be recognized by studying the surface of a specimen to detect the presence and direction of cleavage cracks. Minerals may have one, two, three, four, or six directions of cleavage. Amorphous minerals have no cleavage.

Cleavages meet at constant angles that are characteristic for individual minerals. Micas, which are among the most common of the rock-forming minerals, possess a perfect cleavage in one direction and are easily split into paper-thin sheets. Common table salt has three directions of cleavage that meet at right angles to form cubes. Cleavage is not restricted to any particle size. If a mineral with good cleavage is crushed or scratched, the powder, observed under a hand lens or microscope, is seen to be composed of cleavage fragments.

FRACTURE

A surface that is produced when a mineral is broken but not cleaved is referred to as a fracture. Minerals that fracture break just as easily in one direction as in another. Fractures are described as: conchoidal or shell-like, such as exhibited by broken glass; splintery, similar to wood; earthy, similar to chalk or plaster; even, nearly flat surfaces; or uneven, irregular surfaces.

SPECIFIC GRAVITY

Specific gravity is one of the most constant physical properties of a mineral. It is the ratio between the weight of a substance and the weight of an equal volume of water. Minerals have an average specific gravity of 2.8 and are, therefore, almost three times as heavy as water.

MINERAL DESCRIPTIONS

MINERALS WITH A METALLIC LUSTER

GALENA

Galena, H-2.5 [lead sulfide, PbS], is a heavy, opaque, dark-gray lead-colored mineral that has a bright metallic luster on fresh surfaces. It is so soft that it will mark paper; its streak is grayish black. Galena is usually massive, and cleaves into perfect cubes. The principal source of lead, galena may also contain small amounts of silver.

The first lead mine in Virginia was owned and operated by Colonel Chiswell, a British army officer, who has been credited with the discovery of galena and sphalerite disseminated in dolomites near Austinville, Wythe County. Colonel Chiswell began mining about 1750 and continued to mine lead ore until the beginning of the Revolutionary War when his property reverted to the Commonwealth of Virginia. During the American Revolution, General Washington detailed men to work the mines to provide lead for ammunition used by the Continental army. During the Civil War the Austinville mines furnished most of the lead used by the Confederate forces east of the Mississippi River. Lead ore is mined and concentrated by the New Jersey Zinc Company at Austinville. The ore concentrates are shipped to smelters in Pennsylvania and Illinois, where the lead is recovered and refined.

PYRITE

Pyrite, H-6 to 6.5 [iron sulfide, FeS_2], also known as fool's gold or iron pyrites, is a pale brass-yellow to golden-yellow mineral that is opaque and has a greenish to brownish-black streak. It oxidizes easily and often exhibits brown or multi-colored tarnish colors. Although brittle, it is hard enough to scratch glass. Pyrite may occur as cube-shaped crystals with faces marked by parallel lines, or furrows, called striations. Pyrite is found in many types of rock as granular masses or as scattered grains, collectively called disseminations.

Pyrite was one of the first minerals to be mined in Virginia. Several enterprising members of the original Jamestown Settlement spent a considerable part of one winter secretly hand picking yellow colored metallic fragments from the sands of the James River. A barrel of the fragments, together with optimistic accounts of further gold reserves to be found in the sands of the river, was sent back to England the following spring. Further examination revealed that the material was "fool's gold" or pyrite. Extensive deposits of pyrite were later discovered in the crystalline schists of the northern Piedmont of Virginia. These deposits, mined from about 1882 to 1905, were formerly the largest producers of pyrite in the United States. No pyrite is presently being mined in Virginia. (Plate 1-A, p. 22).

MARCASITE

Marcasite, H-6 to 6.5 [iron sulfide, FeS_2], also called white iron pyrites or spear pyrites, closely resembles pyrite but is less abundant. It may be distinguished from pyrite by its lighter pale yellow or steel gray color, its unpleasant brassy taste, and its flat tabular crystals that resemble cockscombs or spear heads. Marcasite tarnishes and decomposes to a white powder. Crystals of marcasite are often joined into balls or nodules that have a definite radial structure. Marcasite may also be massive or granular. (Plate 1-B, p. 22).

Marcasite is commonly found in the black shales and coals of the Ridge and Valley and Cumberland Plateau provinces. Marcasite has no industrial use.

PYROLUSITE

Pyrolusite, H-1 to 2.5 [manganese oxide, MnO_2], a black to dark steel-gray mineral so soft that it soils the fingers, is opaque and has a black to bluish-black streak. It may occur as radially fibrous or granular to powdery masses.

In Virginia the important deposits of manganese ore are found in the Ridge and Valley, Blue Ridge, and Piedmont provinces. Small deposits have been found in the sediments of the Coastal Plain province. The manganese ores usually contain mixtures of pyrolusite, psilomelane, manganite, and wad which occur as nodules, lenticular masses, stringers, and disseminations in residual clays. The pyrolusite is called "crystallized ore."

Most of the manganese ore produced has been from mines in Augusta, Smyth, Bland, Wythe, and Frederick counties. Manganese ore was mined as early as 1834 and until 1916 the Virginia deposits were the source of more than half of the manganese ore mined in the

United States. During the period from 1953 to 1959, 100,000 long tons of ore were mined and sold to the domestic ore purchase program of the Federal government. The manganese ore is used principally in the manufacture of steel and its alloys.

MANGANITE

Manganite, H-4 [hydrated manganese oxide, MnO (OH)], is opaque, steel-gray to iron-black in color, and has a reddish-brown to black streak. It frequently occurs as deeply grooved or striated prismatic crystals arranged in groups or bundles, or as fibrous and columnar masses. Manganite alters easily to pyrolusite and is usually intermixed with that mineral. Manganite is used with pyrolusite in the preparation of oxygen and chlorine.

ILMENITE

Ilmenite, H-5 to 6 [iron-titanium oxide, $FeTiO_3$], is a brownish-black to iron-black opaque mineral with a black to brownish-red streak. It has a conchoidal to uneven fracture. Ilmenite possesses a slight magnetism which can be increased by heating the mineral.

Ilmenite is obtained from nelsonite, a rock composed principally of ilmenite and apatite. Tabular bodies of this rock are found in Nelson, Amherst and Roanoke counties near the contact between the rocks of the Blue Ridge province and the rocks of the Ridge and Valley province. These deposits are mined in the Piney River district of Amherst County by the American Cyanamid Company. The titanium dioxide that is recovered from the ilmenite is utilized in paint pigments.

SPECULAR HEMATITE

Specular Hematite, H-5.5 to 6.5 [iron oxide, Fe_2O_3], also called specularite, is a hard, distinctly scaley, steel-gray or black type of hematite with a metallic luster. It is opaque except in very thin scales and has a cherry-red to reddish-brown streak. It may be slightly magnetic due to the presence of small amounts of magnetite.

Specular hematite occurs in several areas of the central-western portion of the Piedmont province. In the period between 1880 and 1882 the iron business in the State increased sharply and several specularite mines were opened in Nelson, Campbell, and Amherst counties. The ore from these mines was sent to furnaces in Lynchburg. The mines closed about 1893 and, the specularite deposits were never again considered to have industrial importance.

MAGNETITE

Magnetite, H-5.5 to 6.5 [iron oxide, $FeFe_2O_4$], is a strongly magnetic opaque mineral that has an iron-black color and a black streak. It has a conchoidal to uneven fracture. Magnetite usually occurs as coarse to fine-grained masses or as scattered grains in other minerals or rocks.

Major deposits of magnetite are located in Pittsylvania, Franklin, Patrick, Carroll, and Grayson counties and northeast of Lynchburg in Amherst, Nelson, and Buckingham counties. The deposits occur as lenses up to 12 feet thick, either in schists or along the contacts between schists and limestones. These magnetite deposits were mined during the "iron boom" in the 1880's and then sporadically until about 1906. This ore is not found in sufficient amounts in the State to be competitive with the hematite ores from the Alabama and Lake Superior districts.

RUTILE

Rutile, H-6 to 6.5 [titanium dioxide TiO_2], is an opaque to transparent mineral with an adamantine luster. It frequently occurs as well developed crystals that are striated and possess distinct prismatic and pyramidal cleavages. In color rutile may be red, reddish brown, or black; the streak is yellow or pale brown. (Plate 2-A, p. 23).

The Roseland district of Amherst and Nelson counties for many years supplied a large percentage of the rutile that was consumed in the United States. The rutile occurs as grains disseminated in igneous rocks composed mainly of plagioclase feldspar. Rutile has also been produced from deposits located in Hanover County.

MINERALS WITH A NON-METALLIC LUSTER

GYPSUM

Gypsum, H-1.5 to 2 [calcium sulfate with water, $CaSO_4.2H_2O$], may be colorless, white, light gray, yellow, red, brown, or black; has a white streak; and has a vitreous to pearly or silky luster. It is transparent to opaque and is soft enough to be scratched by the fingernail. Gypsum may occur as clear crystals and cleavable masses called selenite, as fibrous masses with a silky luster called satin spar, or as massive fine-grained rock gypsum. (Plate 2-B, p. 23).

The major gypsum deposits are located in the valley of the North Fork of the Holston River in Washington and Smyth counties. The gypsum is found as beds interstratified with dolomites, limestones, and shales and is frequently associated with anhydrite and rock salt. As early as 1835 gypsum from this area was utilized as fertilizer (land

plaster), and by 1907 several mines were operating to produce gypsum for the manufacture of Plaster of Paris. The United States Gypsum Company mines and mills gypsum at Plasterco, Washington County. The gypsum is utilized to make Plaster of Paris, plaster board, and other building products.

ANHYDRITE

Anhydrite, H-3 to 3.5 [calcium sulfate without water, $CaSO_4$], commonly occurs with gypsum. It is harder than gypsum and cannot be scratched by the fingernail. It has a vitreous to pearly luster, is transparent to translucent, and generally occurs as granular or fibrous masses. It may be colorless, white, gray, blue, red or black; its streak is white.

Anhydrite occurs in the gypsum deposits of Washington and Smyth counties. The gypsum and anhydrite merge into each other and miners often refer to gypsum as "soft" plaster and to anhydrite as "hard" plaster. At Plasterco the United States Gypsum Company separates the anhydrite from the gypsum and stockpiles the anhydrite for possible future use.

BARITE

Barite, H-3 to 3.5 [barium sulfate, $BaSO_4$], is a transparent to opaque mineral with a vitreous to pearly luster, and an uneven fracture. It may be colorless, white, blue, yellow, red, or brown; its streak is white. Barite can be easily identified by its high specific gravity (4.3 to 4.7); it is one of the heavier non-metallic minerals.

Barite was mined as early as 1845 from a deposit along the Prince William-Fauquier county line. Since that time, small amounts of barite have been found in nearly every county in the State. The principal barite prospects and mines are located in Bedford, Botetourt, Campbell, Fauquier, Grayson, Pittsylvania, Russell, Smyth, and Tazewell counties. Barite occurs as veins and fissure fillings, as residual deposits in clay, and as replacement deposits in fractured limestones and dolomites. Virginia was a major barite-producing area for 48 years and in 1914 furnished 65 per cent of the barite mined in the United States. Barite is the source of the element barium which is used in the manufacture of paint, glass, and insecticides; it is the principal constituent of heavy muds used in oil well drilling.

SPHALERITE

Sphalerite, H-3.5 to 4 [zinc sulfide, ZnS], also called zinc blende or blackjack, has a resinous to adamantine luster and is transparent

to translucent. In color it may be white, yellow, brown, or black. The streak may be white, pale yellow, or brown, but it is always lighter than the color of the mineral specimen. Sphalerite has good cleavage in six directions and breaks into twelve-sided pieces.

Sphalerite ore was first discovered in Virginia in 1886 at Bertha, near Austinville, Wythe County, and subsequently has been reported from nearly every county west of the Blue Ridge province and from several counties in the Piedmont province. The present commercial deposits are near Austinville in Wythe County and Timberville in Rockingham County. The mineral occurs as disseminated grains and veinlets in coarse-grained dolomite. At Austinville sphalerite, together with an associated mineral, galena, is mined and concentrated by the New Jersey Zinc Company. The sphalerite at Timberville is mined and concentrated by the Tri-State Zinc Company. The concentrates are shipped to Pennsylvania and Illinois for smelting and recovery of zinc metal. The dolomite removed with the metallic ores is crushed and sold as agricultural lime.

CALCITE

Calcite, H-3 [calcium carbonate, $CaCO_3$], is one of the most abundant non-metallic minerals. It occurs in more than 300 different crystal forms and more than 1,000 combinations of forms. Calcite possesses three perfect cleavage directions and specimens are cleaved easily into six-sided pieces, called rhombohedrons, that have diamond-shaped sides. When treated with cold dilute hydrochloric acid calcite fizzes, or effervesces freely. Calcite may be any color; its streak is white or grayish. It has a vitreous to earthy luster and may be transparent to opaque. Calcite is the chief constituent of the limestones of the Ridge and Valley province and forms many of the stalactites and stalagmites of the caverns found in that region. Calcite is also the principal constituent of the marbles of the Piedmont province and serves as the cementing agent in many sandstones and shales. Large pockets of calcite crystals are found in many of the limestone formations, and calcite veinlets are common in almost every igneous, sedimentary, and metamorphic rock type. (Plate 3-A, p. 24).

DOLOMITE

Dolomite, H-3.5 to 4, [calcium magnesium carbonate, $CaMg(CO_3)_2$], is closely related to calcite. It is easily distinguished from calcite by its greater hardness and by testing it with cold dilute hydrochloric acid. Calcite fizzes freely when treated with acid; dolomite effervesces only when it is scratched or powdered. Dolomite may be

white, pink, brown, yellow, or black; it is rarely colorless. It has a vitreous to pearly luster, a white streak, and is transparent to translucent. Dolomite, like calcite, possesses a perfect rhombohedral cleavage and is easily broken into six-sided fragments with diamond-shaped faces. Crystals of dolomite have curved faces and are saddle-shaped.

Dolomite is the chief constituent of sedimentary rocks called dolomites. These rocks are found in many places in the Ridge and Valley province and are usually interstratified with limestones. The mineral, associated with calcite, is also found as a constituent of some of the marbles of the Piedmont province. Vein dolomite occurs less commonly than vein calcite. Individual specimens of the mineral dolomite have little value except to the mineral collector.

ARAGONITE

Aragonite, H-3.5 to 4, [calcium carbonate, $CaCO_3$], has the same chemical composition as calcite but is harder and has an imperfect cleavage. It fizzes readily when treated with cold dilute hydrochloric acid and is thereby distinguished from dolomite. The mineral may be colorless, white, yellow, red, blue, or black; its streak is white or gray. It is transparent to translucent and has a greasy luster on fresh fracture surfaces, a vitreous luster on all other surfaces.

Aragonite occurs as stalagmites and stalactites in many of the caverns of the Ridge and Valley province and as iridescent layers on seashells found along the coast. Aragonite, incidentally associated with calcite in oyster shells, is utilized in the manufacture of lime.

APATITE

Apatite, H-5, [calcium fluro-phosphate, $Ca_5F(PO_4)_3$], frequently occurs as well-developed prismatic crystals, six-sided, or hexagonal in cross-section. The edges of the crystal may be slightly rounded and have a fused appearance. In color it may be brown, gray, yellow, green, blue, red, purple, white or colorless but its streak is white. The mineral is usually opaque but may be translucent or transparent. It has a conchoidal fracture and a vitreous to greasy luster. Apatite is a widely distributed mineral which may occur as microscopic crystals in nearly all types of rocks. It also occurs as fibrous, nodular, oölitic, and earthy masses.

Apatite is a constituent of nelsonite, an ilmenite-bearing rock found in Amherst, Nelson, and Roanoke counties. Apatite crystals are found in the mica pegmatites in Amelia County. Well developed transparent apatite crystals are sometimes used as gem stones, but the mineral is too soft to be durable.

FLUORITE

Fluorite, H-4, [calcium fluoride, CaF_2], also called fluorspar, is colorless, white, yellow, green, red, blue, purple, or brown and has a white streak. Fluorite crystals are usually cube-shaped; the mineral has excellent octahedral cleavage and may be easily broken into fragments with triangular faces. Fluorite has a vitreous luster and is transparent to opaque. Massive fluorite may resemble calcite, but is harder, has a different cleavage, and does not react when treated with cold dilute hydrochloric acid. Chlorophane is a variety of fluorite which gives off a green phosphorescent light when heated.

The largest known deposit of fluorite in Virginia is located near Faber, Albemarle County. The fluorite lenses occur in schists and contain sphalerite and galena. At the time that the deposit was mined for galena and sphalerite, the fluorite was considered gangue or waste material. Fluorite occurs in the majority of the barite deposits and in the pegmatites of Amelia County.

LIMONITE

Limonite, H-1 to 5.5, [iron oxide with water], is a yellowish-brown or black, opaque, non-crystalline material with a characteristic yellow-brown streak. It occurs as compact earthy masses soft enough to mark paper and as stalactitic or botryoidal masses with varnish-like surfaces which cannot be scratched by a knife. Limonite is the common decomposition product of iron minerals and has wide-spread distribution.

Iron ore was first mined in 1609 by the Jamestown colonists and the first American iron works were erected between 1619 and 1622 near Falling Creek, south of Richmond. These works were destroyed during the Indian massacre of 1622 and iron mining was not resumed until a century later.

The major production of iron ore in Virginia has been from deposits of limonite in Alleghany, Bath, Shenandoah, Pulaski, Smyth, Louisa, Spotsylvania, Carroll, and Grayson counties. From 1890 to 1901 Virginia led all states in the production of limonitic iron ore. The production of iron ore in the State ceased about 1930. The iron ore reserves of Virginia are not exhausted and may be of future industrial value.

HEMATITE

Hematite, H-1 to 6, [iron oxide, Fe_2O_3], is scarlet, red, or brown, has a cherry-red to reddish-brown streak, has a dull earthy luster, and is opaque. The fracture is uneven or earthy. Hematite usually occurs in soft granular, oölitic, or earthy masses, some of which contain fossil

shell fragments. Harder, compact varieties have a submetallic, varnish-like luster, a fibrous or botryoidal structure, and an uneven or splintery fracture. Hematite is the cementing material in some types of rocks and is found in red clays and shales.

Hematite has been produced from four major districts in Virginia: near Roanoke, Roanoke County, near Iron Gate and Low Moor in Alleghany County, in Lee and Wise counties, and northeast of Lynchburg in Amherst, Nelson, and Buckingham counties. The hematite deposits of Lee, Wise, and Alleghany counties contain oölitic and fossiliferous hematite ores commonly known as Clinton ores. Clinton ore has been mined in all the Appalachian states from New York to Alabama and is the raw material for the iron industry at Birmingham, Alabama. Clinton ore was mined at Iron Gate about 1880 and near Low Moor in 1905 and 1906. In Lee and Wise counties, the Clinton ores were mined from 1825 to about 1900. Hematite ore in Roanoke County was mined from 1880 to about 1930. Large quantities of hematite ore were produced from the Lynchburg district during the "iron boom" of the 1880's. At the present time there is no production of iron ore in Virginia. The iron ore deposits are not exhausted and may prove to be of future economic value.

WAD

Wad, H-1 to 6.5, an earthy mixture of manganese minerals, is usually soft enough to soil the fingers. Its specific gravity may be low enough to make the substance feel light to the hand. Wad has a dull, earthy luster, is black, bluish-black, or brownish-black, and has a liver-brown to black streak. It is often found as earthy, poorly consolidated masses; porous masses; and as crusts or stains on other minerals or rocks.

PSILOMELANE

Psilomelane, H-6 to 6.5, [manganese oxide with water, $MnO_2.H_2O$], also known as black hematite, is steel gray to black in color and has a black to brownish-black streak. It is opaque, has a dull to submetallic luster, and has a conchoidal fracture. Psilomelane is found as botryoidal and stalactitic masses that have fairly smooth surfaces. (Plate 3-B, p. 24).

QUARTZ

Quartz, H-7, [silicon dioxide, SiO_2], is, next to water, the most common of all oxides. It is one of the hardest of the common minerals and will easily scratch steel or glass. Quartz has a vitreous luster, is transparent to opaque, and may be colorless, white, red, pink, blue, yellow, purple, green, brown, or black. It has a distinct conchoidal fracture,

but is without cleavage. Quartz is often found as well-developed crystals consisting of six-sided prisms, generally with striated faces, capped by pyramids on one or both ends. (Plate 4, p. 25).

Quartz crystals and coarsely crystalline masses are named according to color. Varieties include pink rose quartz, dark grayish-brown smoky quartz, milk-white milky quartz, yellow citrine, purple amethyst and colorless rock crystal. Other varieties of quartz, compact and exceedingly fine grained (cryptocrystalline), are chert, flint, agate, onyx, jasper, and chalcedony. Chert is opaque and is white, dull gray, blue, brown, or black. Chalcedony has a waxy luster and if formed of banded layers that are irregular it is called agate, or if regular and parallel, onyx. Jasper is an opaque red-colored variety of quartz.

Quartz is found in almost all rocks and is the predominant mineral in sandstone, conglomerate, and quartzite. The principal commercial deposits of quartz in the State are sandstones and quartzites mined to produce glass sand and building material. Individual, doubly terminated colorless quartz crystals of interest to the mineral collector occur in the dolomitic rock near Lusters Gate, Montgomery County, and in bauxite near Spottswood, Augusta County.

TALC

Talc, H-1 to 2.5, [hydrous magnesium silicate, $Mg(OH)_2Si_4O_{10}$], is a soft, dark-green to silvery-white mineral with a characteristic greasy or soapy feel. It is opaque to transparent and has a pearly to greasy luster. The streak is usually white but in some dark varieties may have a greenish tint. Talc has a perfect cleavage in one direction and is easily split into thin scales or plates that are flexible but not elastic. Talc is an alteration product of magnesium silicate minerals.

Talc is found in many of the counties of the Piedmont province. The major deposits of the impure massive variety of talc known as soapstone occur in a narrow belt extending from Alberene, Albermarle County, southwestward through Lynchburg, Amherst County, and into Campbell County.

CHLORITE

Chlorite, H-1 to 2.5, [hydrous iron magnesium aluminum silicates], is a general term applied to a group of minerals closely related to the micas. Chlorite is translucent to opaque, has a characteristic grass-green to blackish-green color, a greenish streak, and a faint pearly luster. The mineral may have a slightly soapy feel but not as pronounced as that of talc. Chlorite has a perfect cleavage in one direction and is easily

split into thin plates. It is commonly found as thin-layered (foliated) masses and as scaly coatings on other minerals. Chlorite occurs in many rocks of the Piedmont province and is the principal constituent of many of the schists of the region.

MUSCOVITE

Muscovite, H-2 to 3, [hydrous potassium aluminum silicate], also known as white mica, potash mica, and isinglass, is the most common of the micas. It is transparent to translucent, has a pearly to vitreous luster, and is usually colorless, less often yellowish, brownish, or reddish. Its streak is white. Muscovite possesses a perfect cleavage in one direction which permits it to be split into thin, flat, flexible and elastic sheets.

Muscovite is a common mineral in many rocks of the Piedmont province. Commercial deposits of sheet mica are found in the pegmatites in Amelia, Goochland, Henry, Franklin, and Pittsylvania counties. The earliest recorded muscovite production in Virginia was in 1867 in Hanover County. Early settlers in Amelia County claimed mica was mined by the Indians in that region prior to the time the colonists arrived. Mica mining in Virginia has been sporadic. The major periods of production were in the 1880's, 1900 to 1902, and 1913 to 1923. The largest volume of mica produced in Virginia is reported in 1918. Since that time production has been small and most of the mica mines have been abandoned. (Plate 5-A, p. 26).

Sheet muscovite is used principally as an insulating material in electrical apparatus. Ground muscovite is used as fire-proofing material and in the manufacture of wallpaper, paints, rubber, and lubricants.

BIOTITE

Biotite, H-2.5 to 3 [hydrous potassium magnesium iron aluminum silicate], also known as black mica, is a transparent to opaque, dark green to black mica with a white to greenish streak and a pearly to submetallic luster. Biotite has excellent cleavage in one direction and is easily split into flat, thin, flexible and elastic sheets.

Biotite is frequently associated with muscovite, and, like muscovite, occurs in many of the rocks of the Piedmont province. Large books and sheets of biotite have been reported from the pegmatites of Amelia, Bedford, and Hanover counties. The mineral is of interest to collectors, but has no present commercial use.

KYANITE

Kyanite, H-4 to 7, [aluminum silicate, Al_2SiO_5], also known as disthene, is a transparent to translucent blue, reddish brown, or green

mineral with a white streak and a vitreous to pearly luster. It occurs as long-bladed crystals that have a pronounced directional variation in hardness. Hardness measured parallel to the long direction of the blades is 4 to 5; hardness measured across the blades is 6 to 7. Kyanite is often found as coarse-bladed, columnar, or fibrous masses.

The major deposits of kyanite in Virginia are located in Buckingham, Charlotte, and Prince Edward counties. Kyanite is mined at Willis Mountain near Sprouses Corner in Buckingham County and at Baker Mountain near Darlington Heights in Prince Edward County. Both deposits are owned and operated by the Kyanite Mining Corporation. The kyanite is marketed for use in the ceramic and refractory industries.

AUGITE

Augite, H-5 to 6, [calcium magnesium iron aluminum silicate], is a member of the important group of rock-forming minerals called pyroxenes. It is usually opaque, has a black to greenish-black color, a white to greenish-gray streak, and a vitreous to dull luster. Augite occurs as short, four- or eight-sided prismatic crystals that have two directions of cleavage that meet at right angles.

Augite is a major constituent in many of the dark-colored igneous rocks of the Blue Ridge and Piedmont provinces.

HORNBLENDE

Hornblende, H-5 to 6, [hydrous calcium magnesium iron aluminum silicate], belongs to a group of rock-forming minerals called amphiboles. It is a dark green to black mineral with a white to greenish-gray streak and a vitreous to silky luster. It is commonly translucent to opaque but may be transparent. Hornblende usually occurs as long, six-sided prismatic crystals with two directions of cleavage that meet at angles of 56 and 124 degrees. The cleavage of hornblende is better developed than that of augite.

Hornblende commonly occurs in many of the igneous and metamorphic rocks of the Blue Ridge and Piedmont provinces.

FELDSPAR

Feldspar, H-6, [potassium, sodium, and calcium aluminum silicates], is the name of a large group of rock-forming minerals that have similar chemical compositions and similar physical properties. The feldspars are classed into the orthoclase feldspars (including microcline) that contain potassium, and the plagioclase feldspars that contain sodium and calcium. (Plate 5-B, p. 26).

The orthoclase feldspars are usually flesh-pink or red, yellowish, or grayish-white and have a white streak. They are transparent to opaque and have a vitreous to pearly luster. They often occur as well-developed, stubby, prismatic crystals that have two good cleavages that meet at right angles. Amazon stone, or amazonite, is a bright green variety of microcline which is often cut and polished for gem purposes.

The plagioclase feldspars are usually colorless, white, or gray, are transparent to translucent, have a vitreous to pearly luster, and have a white streak. They may occur as small prismatic crystals, but are often found as cleavable or granular masses. Cleavelandite is the white platy variety of the soda-rich plagioclase, albite. (Plate 6-A, p. 27).

Feldspar is a major constituent in the crystalline rocks of the Blue Ridge and Piedmont provinces. The commercial deposits of this mineral are, however, generally restricted to pegmatite dikes that penetrate the older crystalline rocks. The most important feldspar mined from these deposits is microcline. Prior to 1907 feldspar was produced largely from the mica-bearing pegmatites of Amelia County. Since that time deposits of feldspar have been discovered in Amherst, Bedford, Franklin, Hanover, Henry, Nelson, and Pittsylvania counties. Feldspar is produced in Bedford County by the Clinchfield Sand and Feldspar Corporation, in Hanover County by Metal and Thermit Corporation, and in the Nelson-Amherst district by the Riverton Lime and Stone Company, the International Minerals and Chemical Corporation, and Buffalo Mines Incorporated. Feldspar is utilized by glass and ceramic industries.

EPIDOTE

Epidote, H-6 to 7, [hydrous calcium aluminum iron silicate], is characterized by its yellowish-green (pistachio) color and white streak. The mineral is transparent to opaque and has a vitreous to resinous luster; when weathered it may have a dull luster. Epidote occurs as course-to fine-grained rock-masses or, less commonly, as deeply striated prismatic crystals that have an uneven fracture. It is a major constituent in unakite, a unique variety of granite-like rock found in the Blue Ridge and is a replacement mineral in many of the dark-colored rocks of the Piedmont province. Well-developed crystals of epidote have been reported from the pegmatites of Amelia County. Clear and transparent crystals of dark-green epidote are sometimes used for gem purposes.

GARNET

Garnet, H-6.5 to 7.5, [silicates of calcium, magnesium, manganese, iron, aluminum, and chromium], is the general name applied to a group

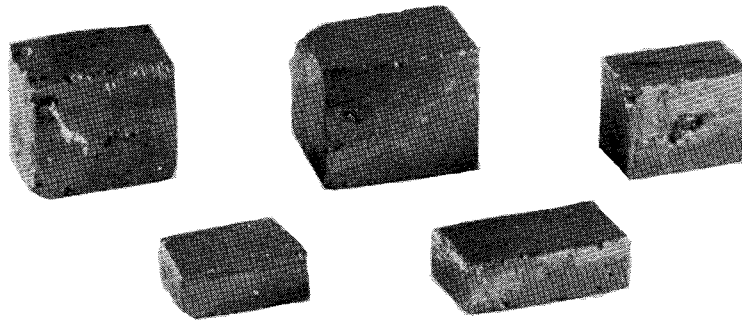
of six minerals that have similar physical properties but differ in chemical composition. Garnets are red, green, yellow, brown, or black, less frequently white or colorless and are transparent to opaque. The streak is white (weathered surfaces may yield a reddish-brown streak); the luster vitreous to resinous. Garnets are often found as twelve- or twenty-four-sided crystals which have a conchoidal to uneven fracture. Garnets are sometimes partially or completely replaced by the mineral chlorite.

Garnet is a common mineral in the crystalline schists and gneisses of the Blue Ridge and Piedmont provinces. Ordinarily garnets are small and fractured and a minor constituent of the rocks in which they are found. However, large unfractured specimens of gem-quality garnet have been collected from the pegmatites of Amelia County and are the only garnets of commercial value found in Virginia.

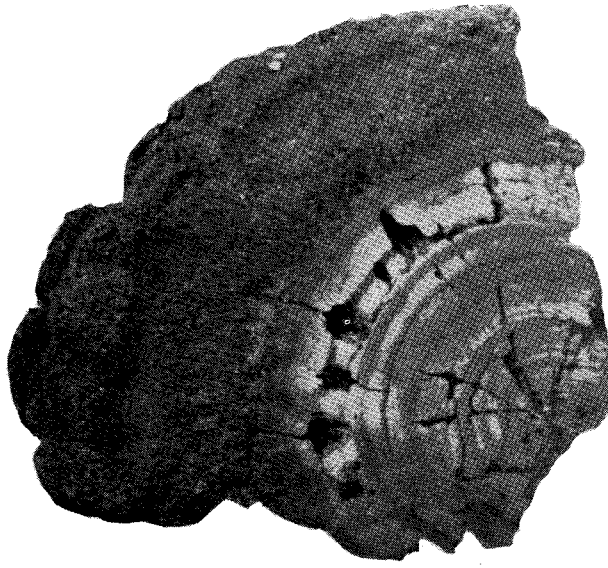
STAUROLITE

Staurolite, H-7 to 7.5, [hydrous iron aluminum silicate], usually occurs as well-developed six-sided prismatic crystals that may be twinned so as to form natural crosses known as "Fairy Stone Crosses." The mineral is reddish-brown, has a white streak (weathered surfaces may yield a reddish-brown streak), a vitreous to dull luster, and is transparent to opaque. Fresh staurolite easily scratches steel or glass. Weathered specimens may be quite soft. (Plate 6-B, p. 27).

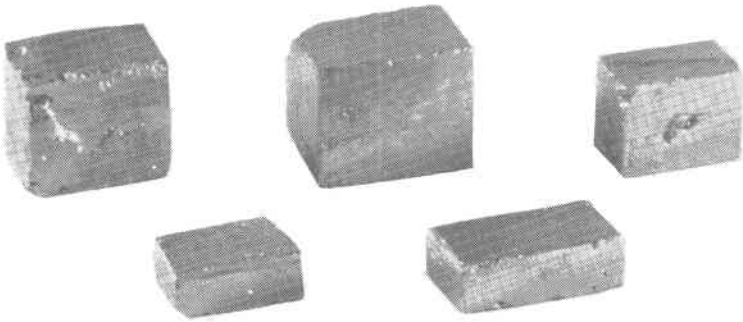
Staurolite commonly occurs as disseminations in schists that extend from Patrick County through Campbell, Franklin, Henry, and Pittsylvania counties into Appomattox County. Staurolite crystals mined from the schists are sold as "Fairy Stone Crosses."



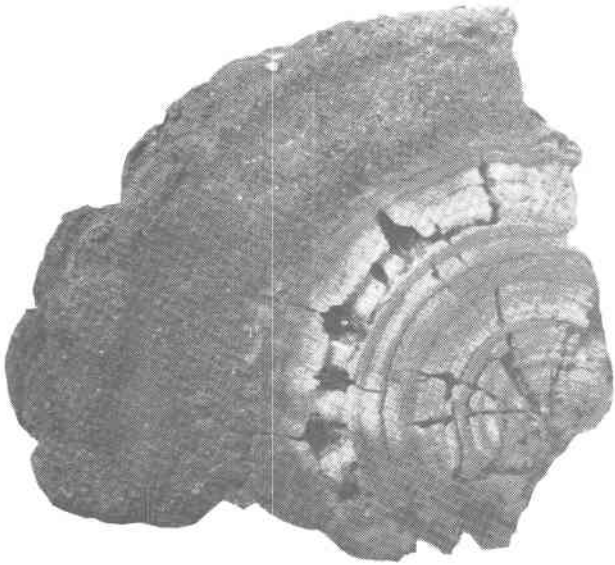
A. Pyrite crystals with conchoidal fractures along the crystal edges (x 2).



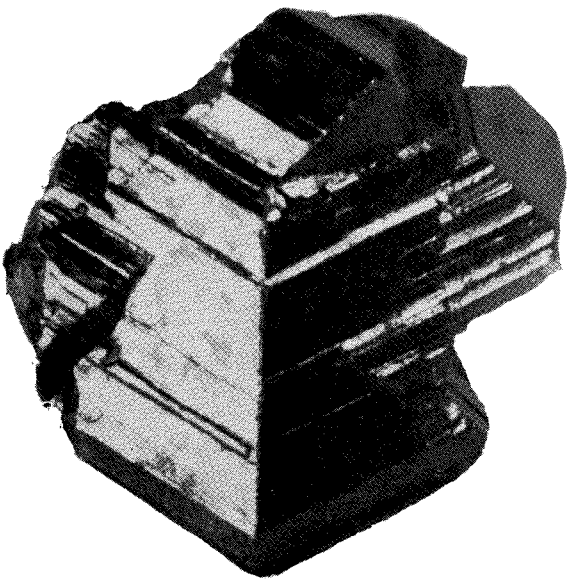
B. Marcasite nodule with a radial structure, light colored bands contain native sulfur (x 3).



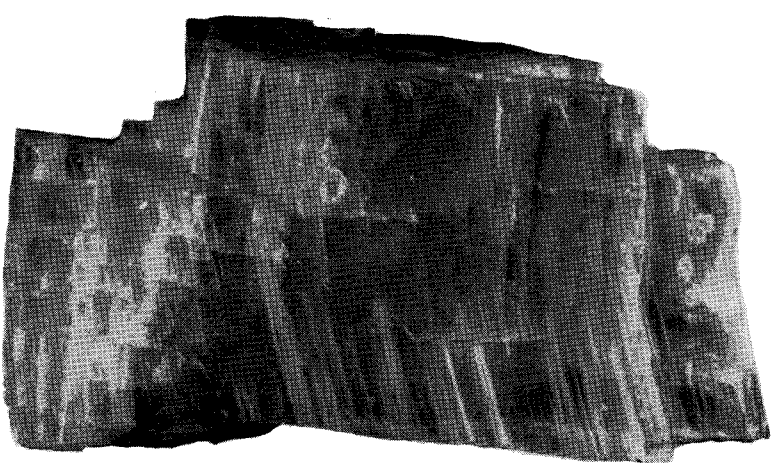
A. Pyrite crystals with conchoidal fractures along the crystal edges (x 2).



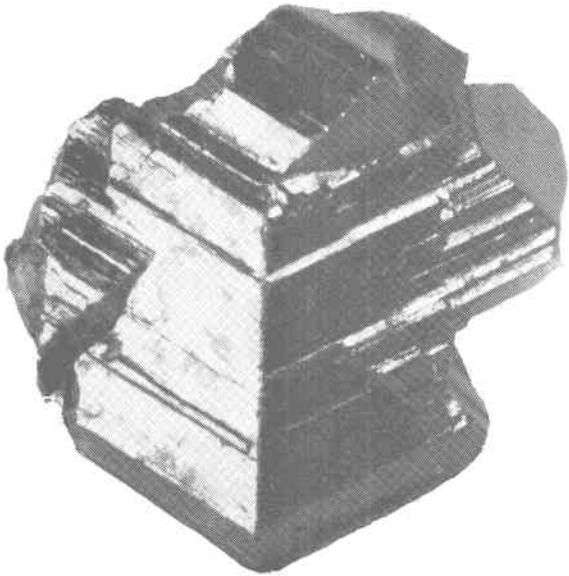
B. Marcasite nodule with a radial structure, light colored bands contain native sulfur (x 3).



A. Rutile crystal with deeply striated crystal faces (x 2).



B. Massive selenite gypsum with well developed lines of cleavage (x 1).



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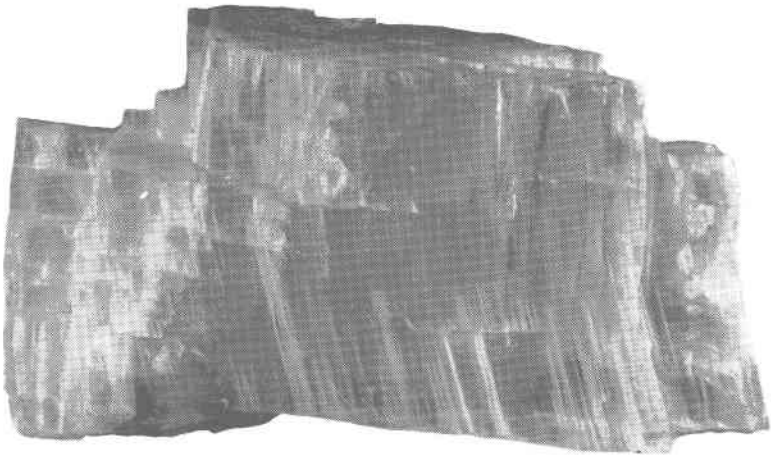
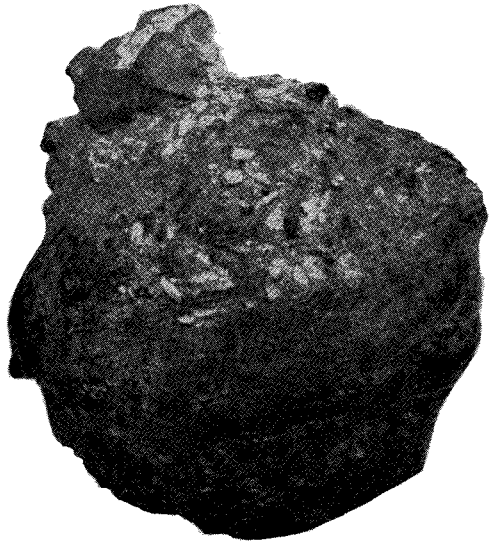
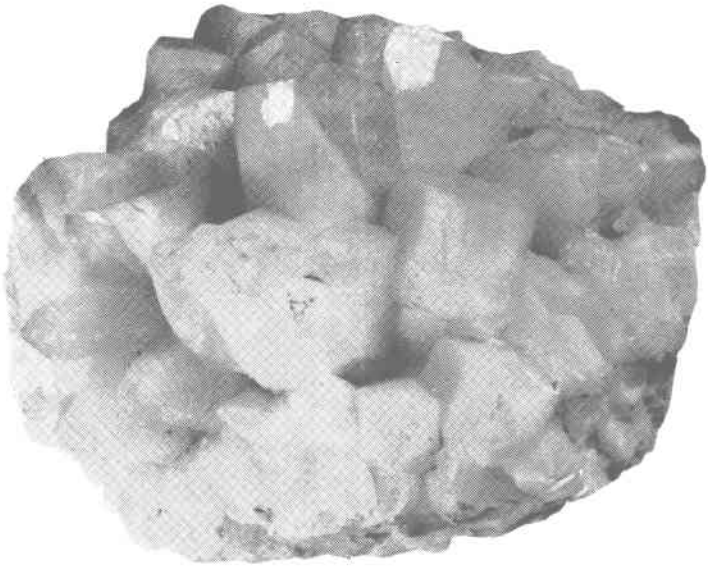


B. Massive selenite gypsum with well developed lines of cleavage (x 1).

A. Aggregate of calcite crystals (x 3/4).

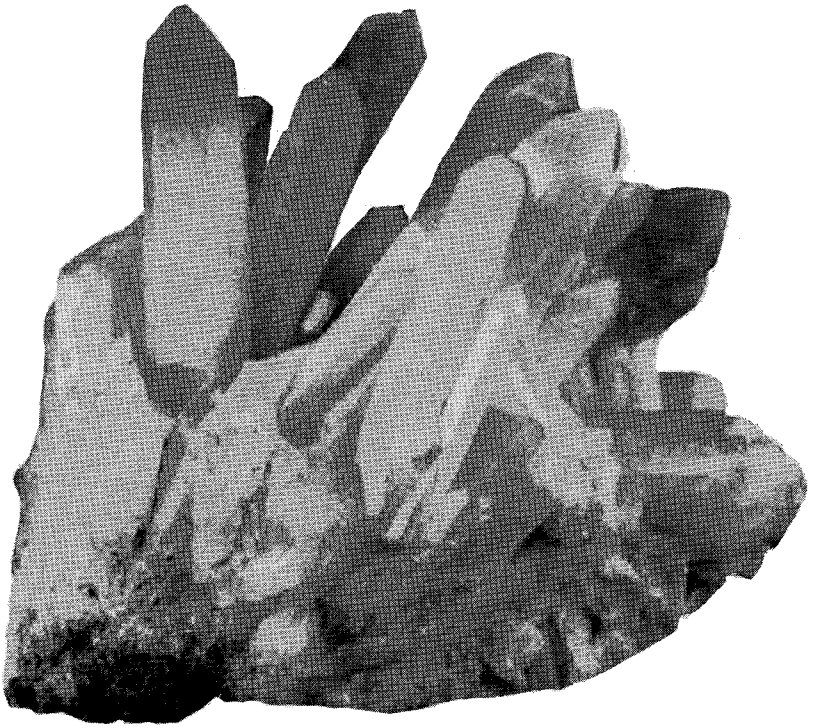


B. Nodule composed of manganese oxides (x 1).

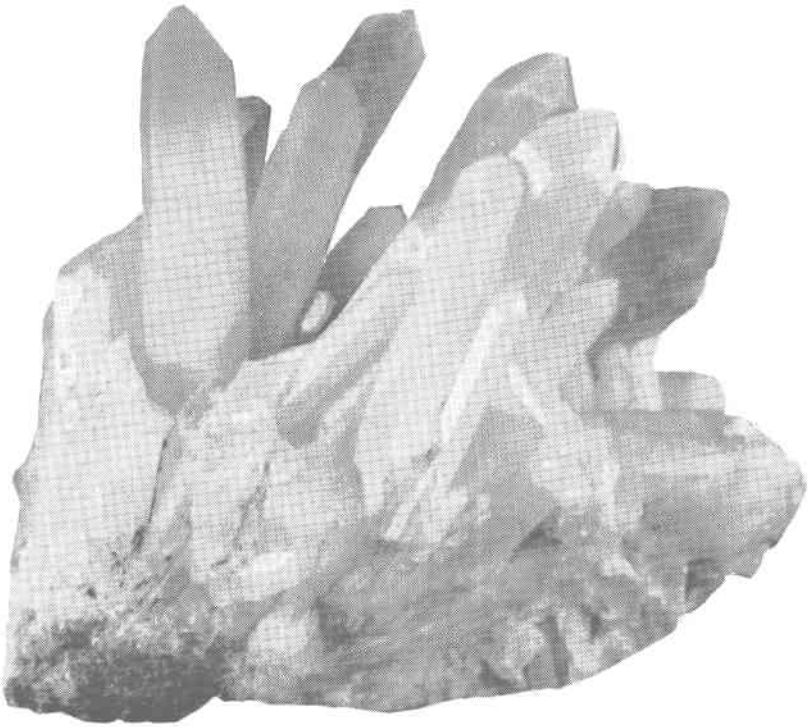


A. Aggregate of calcite crystals (x 3/4).

B. Nodule composed of manganese oxides (x 1).



Aggregate of quartz prisms (x3).



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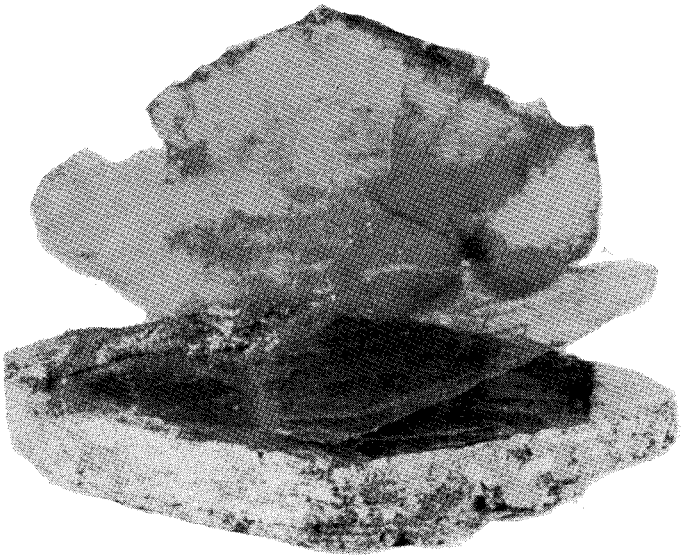
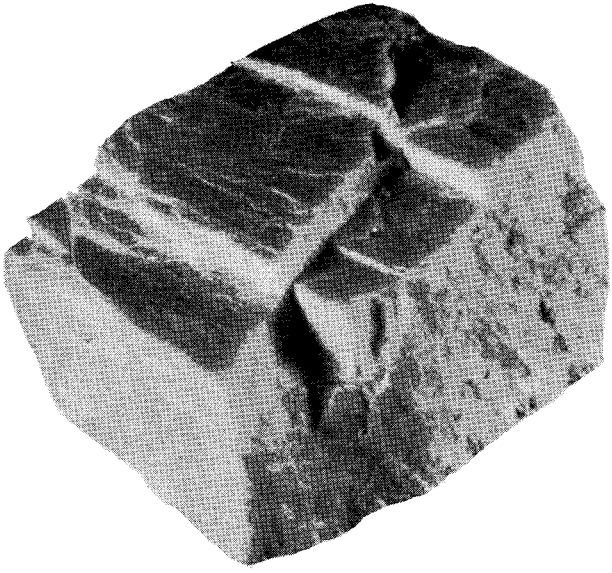
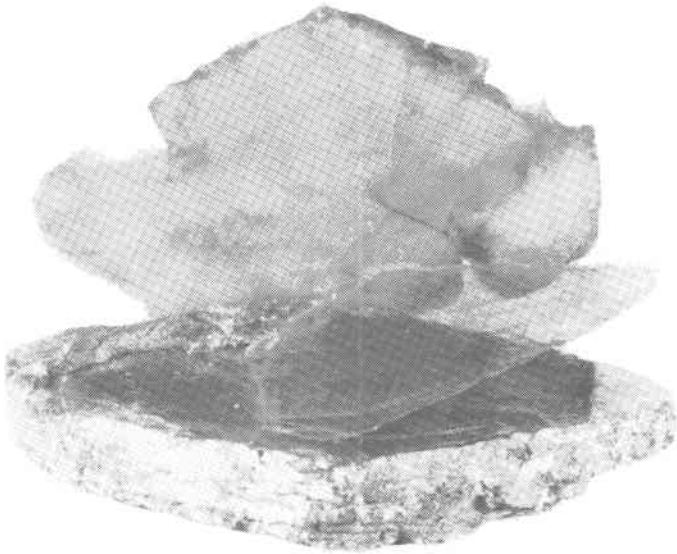


A. Muscovite with a highly perfect basal cleavage that permits thin, transparent sheets to be split from the specimen (x ½).



B. Microcline with rectangular cleavage and typical blocky outline (x½).



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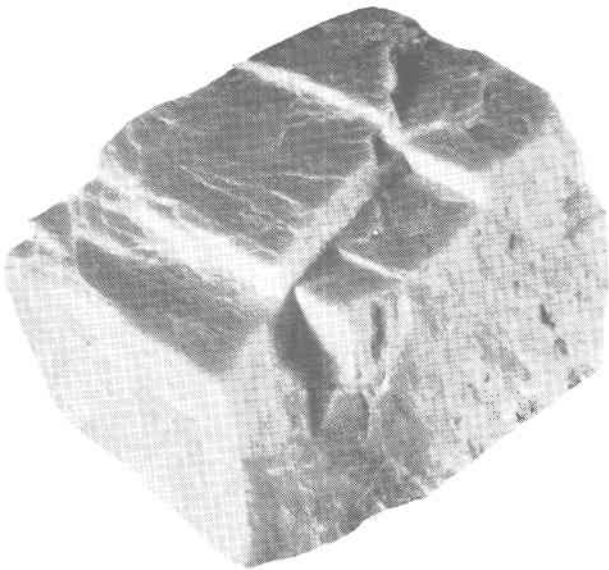
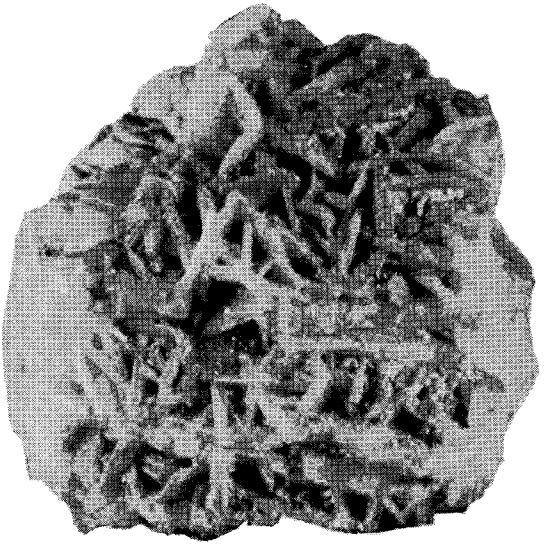
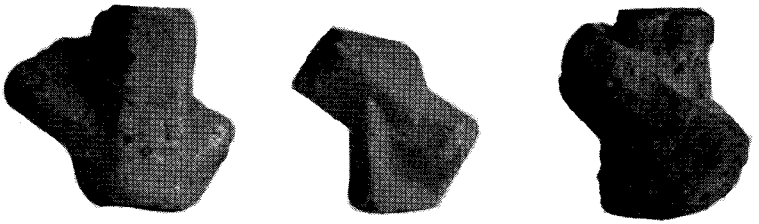


B. Microcline with rectangular cleavage and typical blocky outline (x½).



A. Cleavelandite, a platy variety of the plagioclase, albite, plates are encrusted with minute flakes of muscovite (x ½).



B. Staurolite crystals twinned to form "Fairy Stone Crosses" (x 2).

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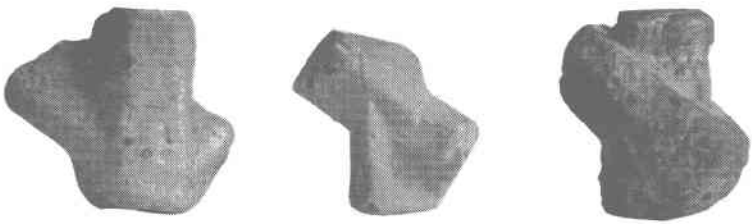


B. Staurolite crystals twinned to form "Fairy Stone Crosses" (x 2).

ROCK DESCRIPTIONS

GENERAL DISCUSSION

Rocks are natural solids that make up the crust of the earth. They are usually composed of aggregates of mineral crystals, grains, or fragments. A rock may be composed of a single mineral, but with the exception of a few rock types this is unusual. Rocks are classed into three major groups, igneous, sedimentary, and metamorphic, which are subdivided on the basis of texture and mineral composition.

Igneous rocks are formed by the cooling and solidification of molten rock material, called magma. Magma may cool and crystallize beneath the surface of the earth to form intrusive igneous rocks such as granite or may flow out on the surface as lava to solidify into extrusive igneous rocks such as basalt.

Sedimentary rocks, such as sandstone and limestone, are formed by consolidation of sediments deposited by water, wind or ice. These sediments consist of (1) rock and mineral fragments derived from pre-existing rocks and (2) chemical and biochemical precipitates from oceans, seas, and lakes.

Metamorphic rocks, such as slate, are the most varied and complex of the three major groups. They are formed from pre-existing rocks that are altered by the interaction of heat, pressure, and fluids.

Some igneous, sedimentary, and metamorphic rocks may have identical mineral compositions. For this reason the characteristics used to identify rocks are a combination of their distinctive physical and structural properties, textures, and mineral compositions.

IGNEOUS ROCKS

Igneous rocks are believed to be the original rock type from which all other rock types were derived. Although they make up about 90% of the total volume of the earth's crust, they are usually concealed by a cover of sedimentary and metamorphic rocks. Igneous rocks are formed by the cooling and solidification (usually by crystallization) of a molten mixture of silicate material called magma. They generally possess a distinctive crystalline texture that is produced by the growing together and interlocking of the individual mineral crystals that compose the rock. Igneous rocks are generally harder and tougher than sedimentary rocks. There are two major groups of igneous rocks: (1) intrusive igneous rocks that are formed by the crystallization of magma that has cooled within the earth's crust, and (2) extrusive igneous rocks

that are formed by the solidification of magma after it reaches the surface and flows out as lava or is blown into the air as volcanic ash and fragments. The naming and classification of the rocks in these two groups is based upon a combination of grain size and mineral composition. Although these combinations are numerous, igneous rocks may be grouped into a small number of general types.

The mineral composition of igneous rocks may be related entirely or in part to the composition of the particular magma from which they originated. The grain size of these rocks often reflects the rate of cooling of the magma. When the rate of cooling is slow, such as in magmas that are insulated by the surrounding rocks, the individual crystals form and grow to become relatively large. Rocks formed by this process are composed of crystals that are visible to the naked eye. When the cooling is rapid, such as in lavas that are not insulated, the individual crystals are small and not easily distinguished by the naked eye. In some cases the cooling and solidification may be so rapid that there is no crystallization and a natural glass, such as rhyolitic glass (obsidian) is formed. Frequently a magma undergoes two different rates of cooling. The magma may start to cool under conditions that are favorable for the growth of large crystals (a slow rate of cooling) and then flow nearer to the surface where, during a rapid cooling process, the large crystals are entrapped in a fine-grained groundmass. These large crystals are called phenocrysts, the fine-grained groundmass is the rock matrix. If the phenocrysts make up more than 50% of the rock it is called a porphyry, such as a granite porphyry. If the matrix material makes up more than 50% of the rock it is called porphyritic, such as a porphyritic granite.

Table 1 contains a general classification of igneous rocks based upon grain size and mineral composition. The rocks listed in each horizontal column have the same mineral composition and differ only in grain size. They are divided into three large families, the granite-rhyolite family, the diorite-andesite family, and the gabbro-basalt family, plus their glassy non-crystalline equivalents. The rocks within each family may be produced by the same type of magma. Thus from a particular magma of granitic composition rhyolite, or rhyolitic glass may be produced. The majority of intrusive igneous rocks contain predominately light-colored minerals and are closely related to granite in mineral composition. The majority of extrusive igneous rocks contain predominately dark-colored minerals and are closely related to basalt in mineral composition.

TABLE 1. *General Classification of Igneous Rocks*

	Intrusive Rocks	Extrusive Rocks		Mineral	
	Crystals larger than 1 mm	Crystals smaller than 1 mm	Crystals not visible	Composition	
Rocks are Light Colored	Granite	Rhyolite	Rhyolitic Glass	Quartz Orthoclase Biotite Plagioclase *muscovite *hornblende *augite	Light Colored Minerals
	—Grades into—	—Grades into—	—Grades into—		
Intermediate	Diorite	Andesite	Andesitic Glass	Plagioclase Hornblende Biotite *quartz *augite	Intermediate
	—Grades into—	—Grades into—	—Grades into—		
Rocks are Dark Colored	Gabbro	Basalt	Basaltic Glass	Plagioclase Augite *biotite *hornblende	Dark Colored Minerals

*These minerals may or may not be present.

Some igneous rocks that have distinctive textures are given special names. Rhyolite, andesite, and basalt often contain gas cavities called vesicules and are called vesicular, such as vesicular basalt. If the vesicules are filled with another mineral the rock is called amygdaloidal, such as an amygdaloidal basalt. Extremely vesicular, light, frothy obsidian is called pumice; extremely vesicular basalt is called scoria. Some intrusive igneous rocks are exceedingly coarse-grained and are called pegmatites, such as granite pegmatite. Diabase is a named used loosely to describe a gabbro or basalt that containes predominant lath-like or rod-like crystals (phenocrysts) of feldspar arranged haphazardly in a fine grained matrix. Rocks that have distinctive mineral compositions are often given special names. Unakite is the name given to a type of granite that contains large amounts of yellowish-green epidote and pink feldspar. Nelsonite is a rock composed chiefly of ilmenite and apatite.

The following general descriptions may be useful for hand specimen identification of the igneous rocks listed in this section:

GRANITE

Granite is a granular, even-grained rock composed chiefly of quartz, pink and white feldspar, minor amounts of mica (usually biotite), hornblende, and augite. It is usually pink or gray, but may also be red or mottled (Plate 7-A, p. 39).

DIORITE

Diorite is a granular rock composed chiefly of white plagioclase and black hornblende and biotite. It is generally grayish and has a distinctive salt-and-pepper appearance. Diorites contain almost no quartz.

GABBRO

Gabbro is a granular dark gray or black rock composed chiefly of black augite, hornblende, biotite, and dark-colored plagioclase. It contains no visible quartz.

RHYOLITE, ANDESITE, AND BASALT

Rhyolite, andesite, and basalt are fine-grained and their individual mineral components cannot be distinguished by the unaided eye. As a general rule, however, rhyolite is white or reddish, andesite is gray, and basalt is dark gray or black. Rhyolite is relatively rare, basalt is common. Because of the difficulty of hand specimen identification of extrusive igneous rock, the general term felsite is often used to name any light-colored fine-grained igneous rock and the dark-colored rocks are called basalts.

UNAKITE

Unakite is a coarse-grained variety of granite-like rock composed of pink feldspar, yellowish-green epidote, and gray quartz.

NELSONITE

Nelsonite is a fine-grained rock composed of steel-gray ilmenite and cream-colored apatite. It has a distinctive speckled appearance.

SEDIMENTARY ROCKS

Sedimentary rocks are the most abundant rock type exposed at the surface of the earth. They are laid down as a series of individual beds, one on top of another, and are therefore known as stratified or layered rocks. Sedimentary rocks may contain the petrified remains of animals and plants that existed at the time that the sediments were deposited. These remains, together with other evidences of past life such as tracks, imprints, casts, and molds, are called fossils, and they are characteristic

of these rocks. Sedimentary rocks may be divided into (1) clastic or fragmental sedimentary rocks, such as siltstone or sandstone, that are composed of rock and mineral grains or fragments produced by the disintegration of older rocks, (2) non-clastic or non-fragmental sedimentary rocks such as chert and some limestones that are composed of minerals that were precipitated from the waters of oceans, seas, and lakes, and (3) organic sedimentary rocks such as coal. The sedimentary rocks of the first group are named according to the size, shape, and composition of the fragments that compose them. Those of the second group are named according to their mineral composition.

The process by which the rock-forming materials that compose sedimentary rocks are accumulated and laid down is known as sedimentation. Clastic and non-clastic sedimentary rocks are formed by two different processes of sedimentation. The rock and mineral fragments that form clastic sedimentary rocks are transported by water, wind, or ice and then are laid down on the surface of the land, in stream and river valleys, on the bottoms of ponds and lakes and on the floor of the sea. These fragments, such as silt and sand, form layers of loose and unconsolidated sediments. As the deposits grow thicker by the addition of more layers, or strata, of sedimentary material, the loose grains are packed together by the weight of the materials above them. Water circulating through the open pore spaces of the sediments may deposit minerals such as calcite or hematite which cement the individual grains and fragments. By these two processes, compaction and cementation, loose unconsolidated sediments may become hard consolidated sedimentary rocks.

Non-clastic or non-fragmental sedimentary rocks are usually formed by chemical processes. Minerals which are dissolved in the waters of oceans, seas, and lakes are precipitated to form distinct sedimentary rocks. For example, calcium carbonate contained in the waters of a sea or lake may be precipitated out to form lime mud that accumulates on the bottom and eventually hardens to form a limestone.

Clastic and non-clastic sedimentary rocks have characteristic features that may often be seen in hand specimens. Depending upon the degree of compaction and cementation, clastic rocks may be described as friable (will crumble easily), coherent, or well-cemented. The non-clastic sedimentary rocks are generally compact, tough and hard to break, and appear to be solid rock masses without individual grains or fragments.

There is a third group of sedimentary rocks that are of organic origin. Coal is an example of this type of rock. It is composed of hydro-

carbons rather than minerals, but is called a mineral fuel. Coal is always found interbedded with sedimentary rocks and is therefore considered to be an organic sedimentary rock.

A classification of sedimentary rocks based upon origin and particle size or composition is given in Table 2. Three rock types referred to in the table—sandstone, shale, and limestone—make up about 99% of all sedimentary rocks. Of these three rock types, shale is the most abundant and limestone is the least abundant. The clastic sedimentary rocks listed in the table are classified according to the size and angularity of the particles that compose them. Sandstones, for example, may be composed of any mineral or any group of minerals of sand size, such as gypsum sand or calcite sand. Most sandstones are, however, composed chiefly of quartz grains of sand size.

TABLE 2: *Classification of Sedimentary Rocks*

ORIGIN	PARTICLE SIZE (DIAMETER)	COMPOSED OF	ROCK NAME
Clastic or Fragmental	Over 2 mm	Rounded Boulders Rounded Cobbles Rounded Pebbles	Conglomerate
		Angular Blocks Angular Fragments	Breccia
	1/16 to 2 mm	Sand Grains	Sandstone
	1/256 to 1/16 mm	Silt Grains	Siltstone
	Less than 1/256 mm	Clay ("mud")	Shale
	No Size Limit	Shell Fragments	Limestone Coquina
Non-Clastic or Chemical Precipitates	Generally not Visible in Hand Specimens	Calcite Dolomite Silica	Limestone Dolomite Chert
Organic	No Size Limit	Plant Remains	Coal

The sedimentary rocks listed in Table 2 are further classified by using terms that describe identifying features of individual specimens. Such descriptive terms are as follows:

argillaceous.....clayey
arenaceous.....sandy (usually quartz grains)
calcareous.....contains calcite
carbonaceous.....contains carbon (coal)
dolomitic.....contains dolomite
ferruginous.....contains hematite or limonite

For example, a sandstone cemented by calcite is a calcareous sandstone. An impure limestone that contains sand grains is an arenaceous limestone; if it contains clay it is an argillaceous limestone. A shale may contain coal or plant remains and be called a carbonaceous shale. More than one descriptive term may be used for a given rock specimen. An impure siltstone that contains calcite and hematite may be described as a ferruginous-calcareous siltstone. These descriptive terms are never used to describe a rock that is composed of the same mineral as the one defined by the term. To call a rock a calcareous limestone or a dolomitic dolomite is incorrect. Some rocks, such as conglomerates and breccias, are described according to the rock name of the fragments that compose them. A conglomerate composed mainly of quartz pebbles may be called a quartz pebble conglomerate. A breccia composed of limestone fragments is a limestone breccia. Some other rocks that have distinctive compositions are given special names. A sandstone that contains large amounts of feldspar fragments is called an arkose. Dark colored sandstone containing angular fragments of quartz, feldspar, and pieces of older rock set in a matrix of clay-sized particles is known as a graywacke. Sedimentary rocks that are nearly pure hematite or limonite may be called sedimentary iron ores (Plates 7-B, 8-A: p. 39, 40).

Most sedimentary rocks can easily be identified and classified on the basis of certain characteristic features that may be seen in hand specimens.

LIMESTONE AND DOLOMITE

Limestone and dolomite are easily scratched by a knife blade, are dense and usually are colored some shade of gray or tan. Limestone effervesces readily when treated with cold dilute hydrochloric acid; dolomite reacts with acid only when scratched or powdered. Some limestones that effervesce very slowly are called dolomitic limestones.

CHERT

Chert often occurs as layers or as nodules in limestone and dolomite. It is usually white, gray, or black in color, has a distinct conchoidal fracture, and easily scratches a knife blade.

SHALE

Shale is a fine-grained rock composed of clay minerals and finely divided rock particles. It is often quite soft when freshly exposed, but becomes hard and brittle when dry. Shales have a thin, paper-like bedding and often split into thin layers or flakes. This property, known as fissilty, is one of their most characteristic features. Shales usually con-

tain enough clay to have a typical earthy smell when they are moistened or breathed upon. Shales may be any color but are usually some shade of gray.

SILTSTONE AND SANDSTONE

Siltstone and sandstone are composed of visible quartz grains that have been cemented together by silica, hematite or limonite, calcite, or some other mineral or material. Calcareous and dolomitic varieties may be identified by testing them with dilute hydrochloric acid. Sandstone and siltstone containing hematite are usually red; those containing limonite are brown. Silica cemented sandstone and siltstone are tough and hard to break. Some siltstone may be confused with shale. Siltstone, however, is very gritty when touched to the teeth; shale is not. As mentioned before, shale also has a characteristic earthy odor.

SEDIMENTARY IRON ORE

Sedimentary iron ore usually occurs as porous masses of yellow-brown limonite, as fossiliferous masses composed of fossil shell fragments that have been replaced and cemented by hematite, and as oölitic masses composed of rounded and flattened grains of hematite that average about 2 mm in diameter.

METAMORPHIC ROCKS

Metamorphic rocks are distinct rock types formed by the alteration of pre-existing igneous or sedimentary rocks. Metamorphic rocks are formed by two general processes. Igneous or sedimentary rocks that are buried within the earth may be altered, chiefly by heat and pressure, to form metamorphic rocks; these same rocks may be intruded by magma and be altered by the heat and chemical activity of liquids and gases produced from the magma. These metamorphic processes may produce textural, mineralogical, or chemical changes in the original rocks, either singly or in combination. Because these processes are usually complex, metamorphic rocks are found in innumerable types and varieties.

Most standard classifications of metamorphic rocks are based upon characteristic textures that can be observed in hand specimens. In general, metamorphic rocks are divided into two distinctive types: foliated and non-foliated. Foliated metamorphic rocks are characterized by layering, banding and parallel alignment of the mineral grains which compose the rock. Foliated metamorphic rocks may be split along roughly parallel surfaces, a property known as rock cleavage. The non-foliated or massive metamorphic rocks are composed of interlocking grains of individual minerals and have textures that greatly resemble

those of igneous rocks. Massive metamorphic rocks are coarse- to fine-grained and do not have the characteristic of foliation.

There are four main types of foliated metamorphic rocks—slate, phyllite, schist, and gneiss. Slate is so fine-grained that many of its component minerals cannot be distinguished even under a hand lens. Slaty cleavage is closely spaced and the cleavage surfaces tend to be smooth and even. Phyllite is somewhat coarser-grained than slate; its component mineral grains are barely visible to the naked eye. Phyllitic cleavage is more widely spaced than slaty cleavage and produces corrugated cleavage surfaces with a glossy luster. Schist is composed of clearly visible mineral flakes and grains. Schistose cleavage is well developed; somewhat wide-spaced, and produces rough cleavage surfaces that have a scaly appearance. Gneiss is usually coarse-grained, granular, and banded. Gneissic textures resemble those of intrusive igneous rocks, such as granite. Gneissic cleavage is rough and indistinct and is usually restricted to the boundary between light- and dark-colored bands that may be an inch or more apart.

These four types of foliated metamorphic rocks are further named and described by adding mineral or rock names before the metamorphic rock name. For example, a schist composed predominantly of muscovite and garnet is called a muscovite-garnet schist. A gneiss with approximately the composition of a granite (quartz, feldspar, muscovite, biotite) is called a granite gneiss. A slate containing scattered grains of pyrite is a pyritic slate.

The non-foliated or massive metamorphic rocks are not layered or banded, and they generally appear to be homogeneous in grain size and composition. They are named according to characteristic mineral assemblages. For example, a massive metamorphic rock that contains some talc is called soapstone. Marble is a massive, granular metamorphic rock composed of calcite or dolomite.

Table 3 contains a generalized classification of metamorphic rocks based upon texture (foliated or non-foliated) and characteristic minerals.

TABLE 3: *Classification of Metamorphic Rocks*

	NAME	CHARACTERISTIC MINERALS	PRE-EXISTING ROCK
Foliated	Slate	Clay	Shale
	Phyllite	Mica	Shale
	Schist	Quartz, Talc Mica, Chlorite Amphibole	Shale, Andesite, Basalt
	Gneiss	Mica Quartz, Feldspar	Granite
Non-Foliated	Marble	Calcite Dolomite	Limestone, Dolomite
	Quartzite	Quartz	Sandstone
	Greenstone	Epidote Chlorite Amphibole	Andesite, Basalt
	Soapstone	Talc	Dark-colored Igneous Rocks such as Basalt

SLATE

Slate is a dense, tough rock that cleaves easily into broad plates or sheets. It may contain preserved or relict bedding that was present in the shale from which it was formed. The cleavage, in most cases, does not follow the relict bedding planes, but cuts across them at various angles (Plate 8-B, p. 40).

PHYLLITE

Phyllite is composed mainly of mica. The mica occurs as thin films rather than definite flakes or scales and has characteristically a wavy appearance and a silky sheen. Phyllite may be regarded as a gradational rock, intermediate between slate and schist.

SCHIST

Schist is composed of platy minerals that are arranged roughly parallel to each other. Schist is readily broken into smaller flakes and fragments because the platy minerals part easily. The most common types are talc schist, chlorite schist, mica schist, and hornblende schist. (Plate 9-A, p. 41).

GNEISS

Gneiss generally contains intermingled grains of feldspar and quartz which are separated by layers of dark minerals, such as hornblende or biotite. Gneissic banding may be either straight and parallel or curved and distorted (Plate 9-B, p. 41).

MARBLE

Marble is composed of calcite and dolomite that has been recrystallized during metamorphism to produce a massive, coarsely crystalline rock. Marble may contain mica, chlorite, and other minerals that often effect a streaked appearance. Marble reacts when treated with cold dilute hydrochloric acid as does limestone and dolomite.

QUARTZITE

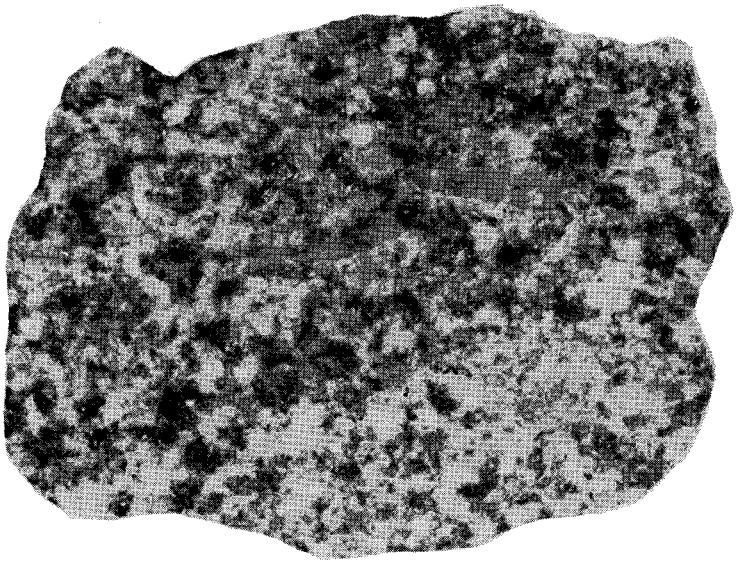
Quartzite is a hard, tough rock composed of interlocking quartz grains which may be distinguished from well-cemented sandstone by the manner in which it fractures. The fractures in sandstone pass around the individual grains that compose the rock. In quartzite the fractures pass through the grains rather than between them.

GREENSTONE

Greenstone is a compact fine-grained rock with a characteristic grayish-green to green color. Greenstone is composed mainly of epidote, chlorite, or a green amphibole.

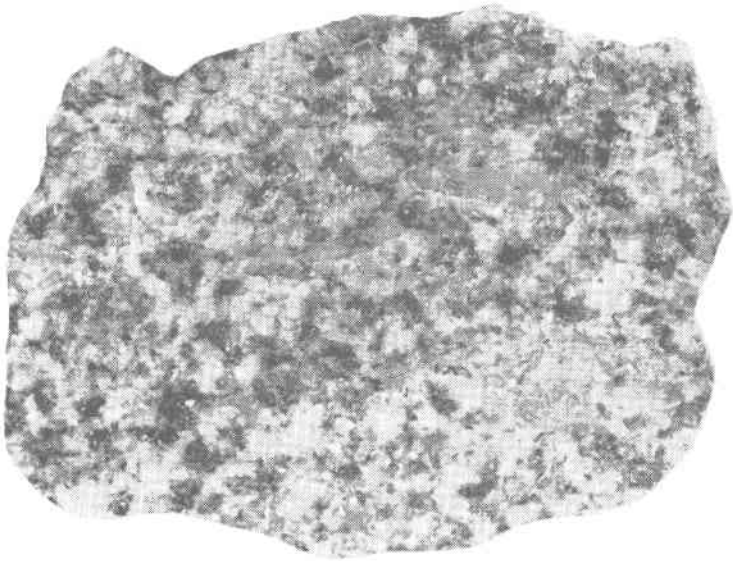
SOAPSTONE

Soapstone is a soft grayish-green to black rock composed mainly of the mineral talc.



A. Granite with a typical granular texture, black mineral is biotite, gray is quartz, and white is feldspar (x 1).

B. Limestone breccia composed of angular fragments of dark-gray limestone cemented by coarsely crystalline white calcite (x ½).



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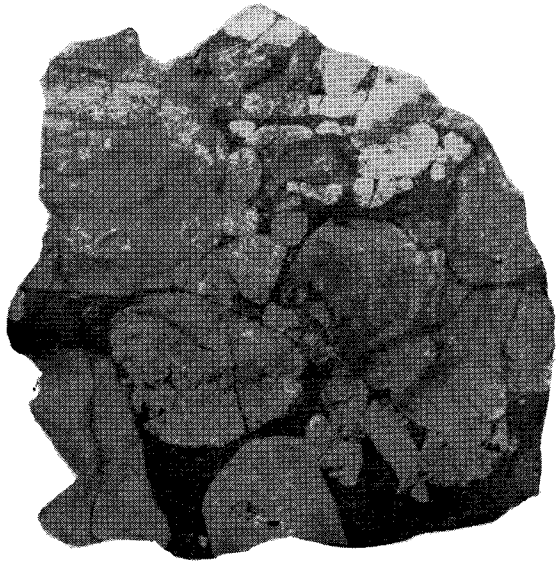
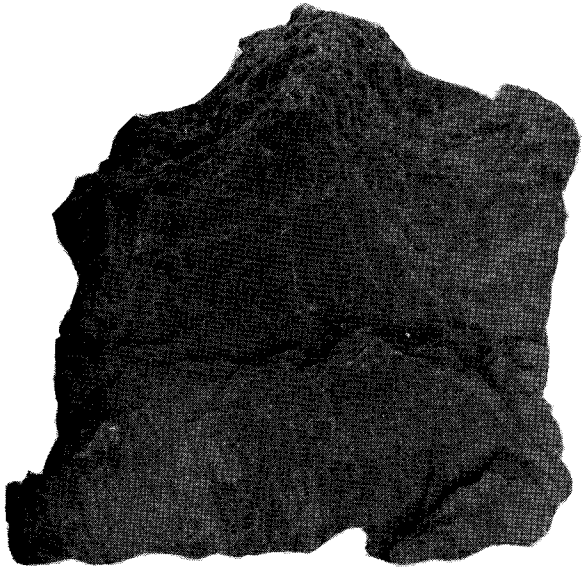
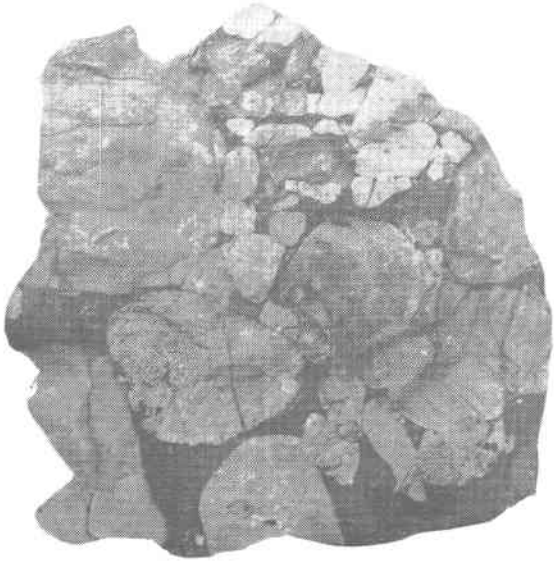


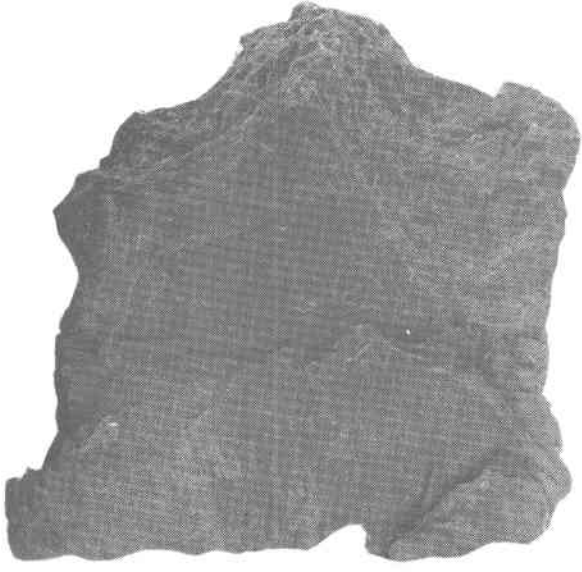
A. Quartz-pebble conglomerate with rounded quartz pebbles in sandstone matrix (x 1).



B. Slate with well developed slaty cleavage (x 1).



A. Quartz-pebble conglomerate with rounded quartz pebbles in sandstone matrix (x 1).



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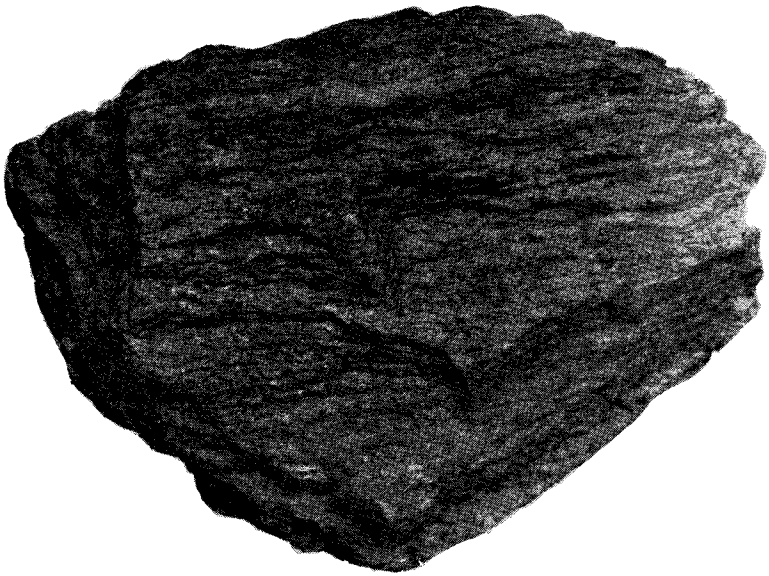
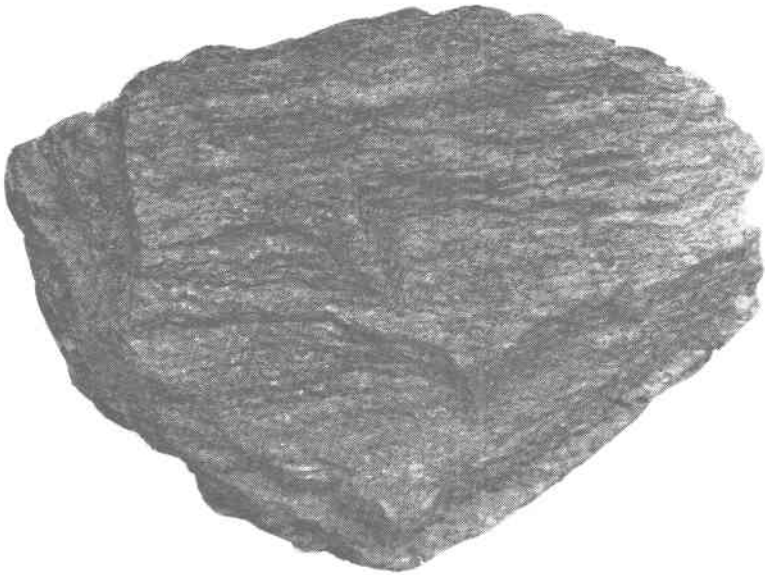


A. Muscovite schist with disseminated grains of pyrite (x 3/4).

B. Quartz-biotite gneiss with typical gneissic banding (x 3/4).



A. Muscovite schist with disseminated grains of pyrite (x 3/4).

B. Quartz-biotite gneiss with typical gneissic banding (x 3/4).

GENERAL DISTRIBUTION OF ROCK TYPES IN VIRGINIA

The five physiographic divisions of Virginia: the Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and Cumberland Plateau provinces are well defined topographically and are markedly different with respect to the underlying rock types.

COASTAL PLAIN PROVINCE

The sedimentary rocks of the Coastal Plain province have been covered with a thin veneer of unconsolidated sediments such as sand, gravel, clay, and marl which locally may be cemented by limonite or calcite. Sand and gravel produced from the Coastal Plain are used in highway construction and in domestic and commercial building. Marl from the Coastal Plain is utilized in the manufacture of agricultural lime and Portland cement.

PIEDMONT PROVINCE

The Piedmont province is predominantly an area of folded and sheared metamorphic rocks such as gneisses, schists, quartzites, marbles, slates, and phyllites which have been intruded by diorites, diabases, and gabbros. In the central and southern portion of the Piedmont province these rocks may be covered by andesitic and rhyolitic volcanic flows that have been, for the greater part, altered to greenstone. Scattered throughout the Piedmont province are the Triassic basins that contain shales, impure limestones, sandstones, and conglomerates. The Piedmont province contains the greatest variety of mineral resources. Slate is quarried in the Arvonia area of Buckingham and Fluvanna counties and used as roofing slate, dimension stone, and roofing granules. Soapstone is quarried at Alberene, Albemarle County and near Schuyler, Nelson County. The soapstone is cut into dimension stone that is utilized in the manufacture of acid-resistant laboratory sink and table tops, and is ground for use in the preparation of insecticides, foundry facings, and rubber and roofing products. "Virginia Greenstone" is quarried south of Lynchburg in Campbell County for use as ornamental and dimension stone. In Culpeper, Fauquier, Prince William, Loudoun, and Fairfax counties diabase is quarried, crushed, and sold for use as road metal. Impure limestones found in Culpeper, Orange, Albemarle, Nelson, Amherst, and Campbell counties are also quarried for use as road metal. Clays and shales are mined extensively in the Piedmont province and are used in the manufacture of brick, tile, and lightweight aggregate.

BLUE RIDGE PROVINCE

The Blue Ridge province is mainly an area of granites, gneisses, and greenstones. Quartzites, sandstones, and shales are exposed along its western boundary. Metallurgical quartzite has been produced from Augusta and Rockbridge counties in the Blue Ridge province and utilized in the manufacture of ferrosilicon alloys. The unakite deposits of the Blue Ridge have been of considerable interest to collectors. Unakite is exposed in an abandoned quarry near Vesuvius, Rockbridge County, and in a roadcut immediately west of Airpoint, Roanoke County.

RIDGE AND VALLEY PROVINCE

The Ridge and Valley province contains all of the sedimentary rock types described in this publication. The principal rock types exposed in the region are limestones and dolomites, sandstones, and shales. The limestones and dolomites are quarried extensively for use as crushed stone, chemical lime, and cement. Coal is mined in the southwestern portion of the province. Clays and shales of the Ridge and Valley province are used in the manufacture of brick and lightweight aggregate.

CUMBERLAND PLATEAU PROVINCE

The Cumberland Plateau province is underlain by shales and sandstones interstratified with many coal beds. Coal produced from this region accounts for approximately two-thirds of the annual value of the mineral production of Virginia.

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MINERAL IDENTIFICATION KEY

NON-METALLIC LUSTER

Hard * (over 5.5)

Black or Gray

Staurolite (*H-7 to 7.5*)—Four or six-sided prismatic crystals; often as crossed twins; white streak.

Quartz (*H-7*)—Vitreous luster; conchoidal fracture; often as six-sided prismatic crystals that are horizontally striated; frequently clear and transparent; white streak.

Garnet (*H-6.5 to 7.5*)—As crystals with 12 or, less commonly, 24 faces; vitreous to resinous luster; brittle; conchoidal fracture; white streak.

Psilomelane (*H-6 to 6.5*)—As botryoidal and stalactitic masses that have fairly smooth surfaces; black to brownish-black streak.

Hornblende (*H-5 to 6*)—Long six-sided prismatic crystals; cleavages meet at angles of about 60 and 125 degrees; more common than augite; grayish-green to grayish-brown streak.

Augite (*H-5 to 6*)—Short stubby four or eight-sided prismatic crystals with two directions of cleavage that meet at right angles; usually has a greenish cast; grayish-green streak.

Yellow or Brown

Staurolite (*H-7 to 7.5*)—Four or six-sided prismatic crystals; often as crossed twins; white streak.

Quartz (*H-7*)—Vitreous luster; conchoidal fracture; often as six-sided prismatic crystals that are horizontally striated; frequently clear and transparent; white streak.

Green or Blue

Epidote (*H-6 to 7*)—Pistachio green or yellowish green; often as granular rock masses; white streak.

Amazonstone (*microcline*) (*H-6*)—Bright green or bluish-green; shows rectangular cleavage; white streak.

Hornblende (*H-5 to 6*)—Dark green; long six-sided prismatic crystals; cleavages meet at angles of about 60 and 125 degrees; more common than augite; grayish-green to grayish-brown streak.

Augite (*H-5 to 6*)—Short stubby four or eight-sided prismatic crystals with two directions of cleavage that meet at right angles; grayish-green streak.

Kyanite (*H-4 to 7*)—Bladed crystals that have a hardness of 4 to 5 measured along their length and a hardness of 6 or 7 measured across their length; white streak.

Red or Pink

Garnet (*H-6.5 to 7.5*)—As crystals with 12 or, less commonly, 24 faces; vitreous to resinous luster; brittle; conchoidal fracture; white streak.

Quartz (*H-7*)—Vitreous luster; conchoidal fracture; often as six-sided prismatic crystals that are horizontally striated; frequently clear and transparent; white streak.

Orthoclase (*H-6*)—Flesh or salmon colored; rectangular cleavage; vitreous; white streak.

Colorless or White

Quartz (*H-7*)—Vitreous luster; conchoidal fracture; often as six-sided prismatic crystals that are horizontally striated; frequently clear and transparent; white streak.

Plagioclase (*H-6*)—As cleavable masses with striated cleavage faces; albite is sometimes found as the white platy variety called cleavelandite; vitreous; white streak.

Orthoclase (*H-6*)—Often as well-developed stubby prismatic crystals; rectangular cleavage; vitreous; white streak.

Medium †(2.5 to 5.5)

Black or Grey

Hornblende (*H-5 to 6*)—Long six-sided prismatic crystals; cleavages meet at angles of about 60 and 125 degrees; more common than augite; grayish-green to grayish-brown streak.

Augite (*H-5 to 6*)—Short stubby four or eight-sided prismatic crystals with two directions of cleavage that meet at right angles; usually has a greenish cast; grayish-green streak.

Dolomite (*H-3.5 to 4*)—Fizzes when treated with cold dilute hydrochloric acid only if scratched or powdered; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Anhydrite (*H-3 to 3.5*)—Vitreous to pearly luster; massive; found with gypsum but is much rarer; white streak.

Calcite (*H-3*)—Fizzes when treated with cold dilute hydrochloric acid; three perfect cleavages; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Biotite (*H-2.5 to 3*)—Cleaves into thin flexible elastic sheets that are transparent; white to greenish streak.

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*Hard minerals will scratch a knife blade.

†Minerals of medium hardness will not scratch a knifeblade, but will scratch the fingernail.

MINERAL IDENTIFICATION KEY

NON-METALLIC LUSTER

Medium † (2.5 to 5.5—Cont'd)

Black or Gray (Continued)

Limonite (H-1 to 5.5)—Varnish-like surfaces; botryoidal; yellow-brown streak.

Wad (H-1 to 6.5)—Feels light to the hand; usually soft; as porous and earthy masses; liver-brown to black streak.

Yellow or Brown

Apatite (H-5)—Well developed six-sided prismatic crystals; greasy luster; white streak.

Fluorite (H-4)—Cube-shaped crystals that cleave into eight-sided fragments with triangular faces; white streak.

Sphalerite (H-3.5 to 4)—Resinous to adamantine luster; has six directions of cleavage; brittle; gives off a rotten egg odor when treated with cold dilute hydrochloric acid; streak lighter than the color of the mineral.

Calcite (H-3)—Fizzes when treated with cold dilute hydrochloric acid; three perfect cleavages; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Hematite (H-1 to 6)—Earthy, granular, or oölitic masses; may contain fossils; red-brown streak.

Limonite (H-1 to 5.5)—Yellow or brown earthy masses; yellow-brown streak.

Green or Blue

Hornblende (H-5 to 6)—Long six-sided prismatic crystals; cleavages meet at angles of about 60 and 125 degrees; more common than augite; grayish-green to grayish-brown streak.

Augite (H-5 to 6)—Short stubby four or eight-sided prismatic crystals with two directions of cleavage that meet at right angles; grayish-green streak.

Apatite (H-5)—Well-developed six-sided prismatic crystals; greasy luster; white streak.

Kyanite (H-4 to 7)—Bladed crystals that have a hardness of 4 to 5 measured along their length and a hardness of 6 or 7 measured across their length; white streak.

Aragonite (H-3.5 to 4)—Fizzes when treated with cold dilute hydrochloric acid; imperfect cleavage; much rarer than calcite or dolomite; white streak.

Calcite (*H-3*)—Fizzes when treated with cold dilute hydrolchloric acid; three perfect cleavages; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Red or Purple

Fluorite (*H-4*)—Cube shaped crystals that cleave into eight-sided fragments with triangular faces; white streak.

Calcite (*H-3*)—Fizzes when treated with cold dilute hydrochloric acid; three perfect cleavages; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Hematite (*H-1 to 6*)—Earthy granular, or oölitic masses; may contain fossils; red-brown streak.

Colorless or White

Apatite (*H-5*)—Well-developed six-sided prismatic crystals; greasy luster; white streak.

Fluorite (*H-4*)—Cube-shaped crystals that cleave into eight-sided fragments with triangular faces; white streak.

Aragonite (*H-3.5 to 4*)—Fizzes when treated with cold dilute hydrochloric acid; imperfect cleavage; much rarer than calcite or dolomite; white streak.

Dolomite (*H-3.5 to 4*)—Fizzes when treated with cold dilute hydrochloric acid only if scratched or powdered; cleaves into six-sided fragments with diamond-shaped faces; white streak.

Barite (*H-3 to 3.5*)—Feels heavy for a mineral without a metallic luster; uneven fracture; white streak.

Anhydrite (*H-3 to 3.5*)—Vitreous to pearly luster; massive; found with gypsum but is much rarer; white streak.

Calcite (*H-3*)—Fizzes when treated with cold dilute hydrochloric acid; three perfect cleavages; cleaves into six-sided fragments with diamond-shaped faces; white; streak.

Muscovite (*H-2 to 3*)—Silvery; cleaves into thin flexible elastic sheets that are transparent; white streak.

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†Minerals of medium hardness will not scratch a knife blade, but will scratch the fingernail.

MINERAL IDENTIFICATION KEY

NON-METALLIC LUSTER

Soft †† (1 to 2.5)

Black or Gray

Biotite (*H-2.5 to 3*)—Cleaves into thin flexible elastic sheets that are transparent; white to greenish streak.

Wad (*H-1 to 6.5*)—Feels light to the hand; soils the fingers; occurs as porous and earthy masses; liver-brown to black streak.

Yellow or Red

Hematite (*H-1 to 6*)—Earthy; soils the fingers; cherry-red to reddish-brown streak.

Limonite (*H-1 to 5.5*)—Earthy; soils the fingers; yellow-brown streak.

Green

Chlorite (*H-1 to 2.5*)—Dark-green color; splits into thin, flexible, inelastic scales or plates; greenish streak.

Talc (*H-1*)—Characteristic soapy feel; pearly to greasy luster; cleaves into thin flexible scales; greenish-white streak.

Colorless or White

Muscovite (*H-2 to 3*)—Silvery, cleaves into thin flexible elastic sheets that are transparent; white streak.

Gypsum (*H-2*)—Pearly or silky luster, white streak.

Talc (*H-1*)—Characteristic soapy feel; pearly to greasy luster; cleaves into thin flexible scales; greenish-white streak.

METALLIC LUSTER

Hard * (over 5.5)

Red or Reddish-Brown

Rutile (*H-6 to 6.5*)—Well-developed, striated, prismatic crystals; prismatic and pyramidal cleavage, adamantine luster; yellow or pale brown streak.

Yellow or Brassy	*Pyrite* (*H-6 to 6.5*)—Cube-shaped crystals; brittle; conchoidal fracture; greenish to brownish-black streak.
	Marcasite (*H-6 to 6.5*)—Decomposes to a white powder; has an unpleasant brassy taste; much rarer than pyrite; greenish-black streak.
Light Gray or Steel Gray	*Marcasite* (*H-6 to 6.5*)—Decomposes to a white powder; has an unpleasant brassy taste; greenish-black streak.
	Specular Hematite (*H-5.5 to 6.5*)—Micaceous; as bright shiny scales; cherry-red to reddish-brown streak.
Black or Dark Gray	*Magnetite* (*H-5.5 to 6.5*)—Strongly attracted by a magnet; commonly massive or granular or as crystals with eight triangular faces; black streak.
	Ilmenite (*H-5 to 6*)—Slightly attracted by a magnet; black to brownish-red streak
Medium † (2.5 to 5.5)	
Steel Gray to Iron Black	*Manganite* (*H-4*)—Deeply striated prismatic crystals or fibrous masses; rare; found with pyrolusite and psilomelane, reddish-brown or black streak.
Dark Gray	*Galena* (*H-2.5*)—Good cubic cleavage; gives off a rotten egg odor when treated with cold dilute hydrochloric acid; feels heavy; grayish-black streak.
Soft †† (1 to 2.5)	
Dark Steel Gray or Black	*Pyrolusite* (*H-1 to 2.5*)—Soils the fingers; fibrous or powdery masses; black to bluish-black steak.

*Hard minerals will scratch a knife blade.
†Mineral of medium hardness will not scratch a knife blade, but will scratch the fingernail.
††Soft minerals can be scratched by the fingernail.

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver, Commissioner
Charlottesville, Va.

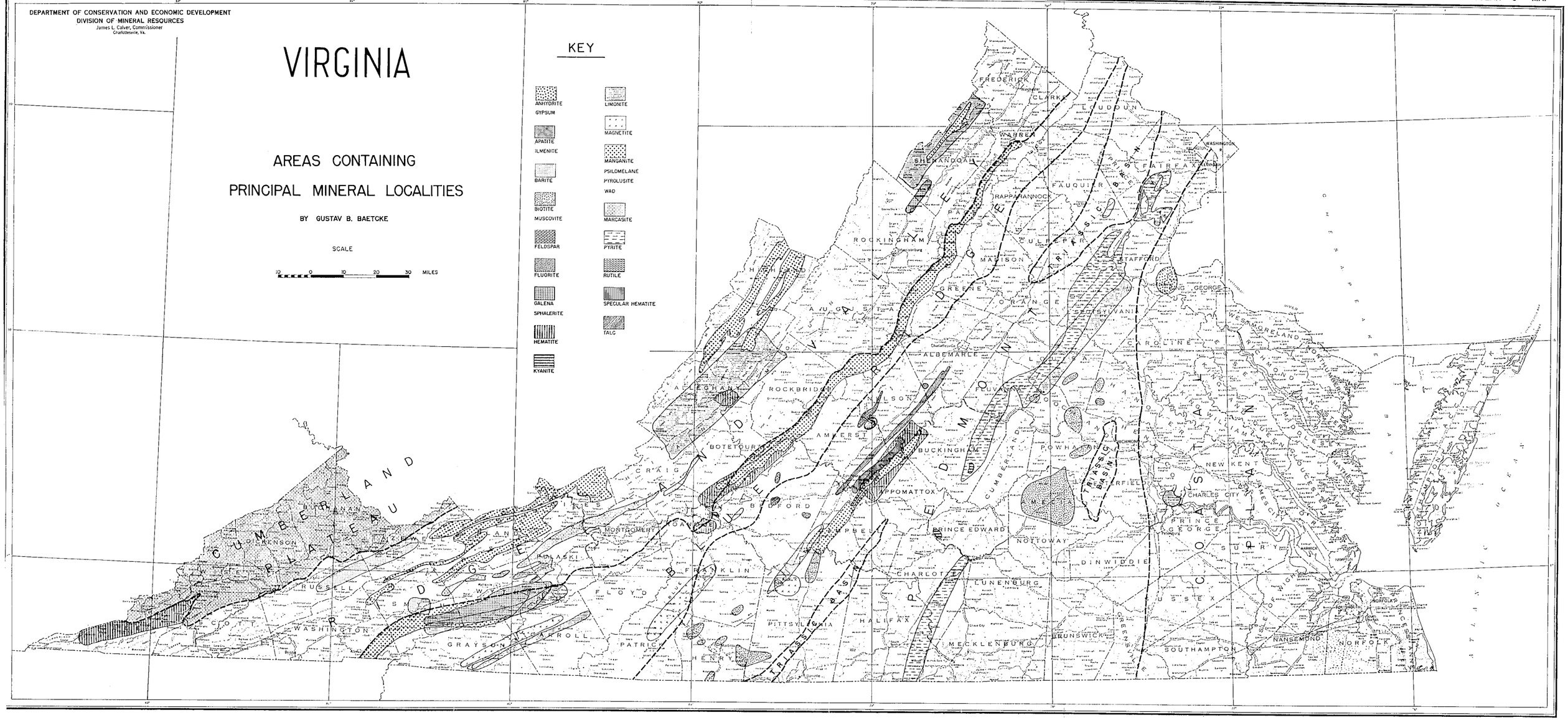
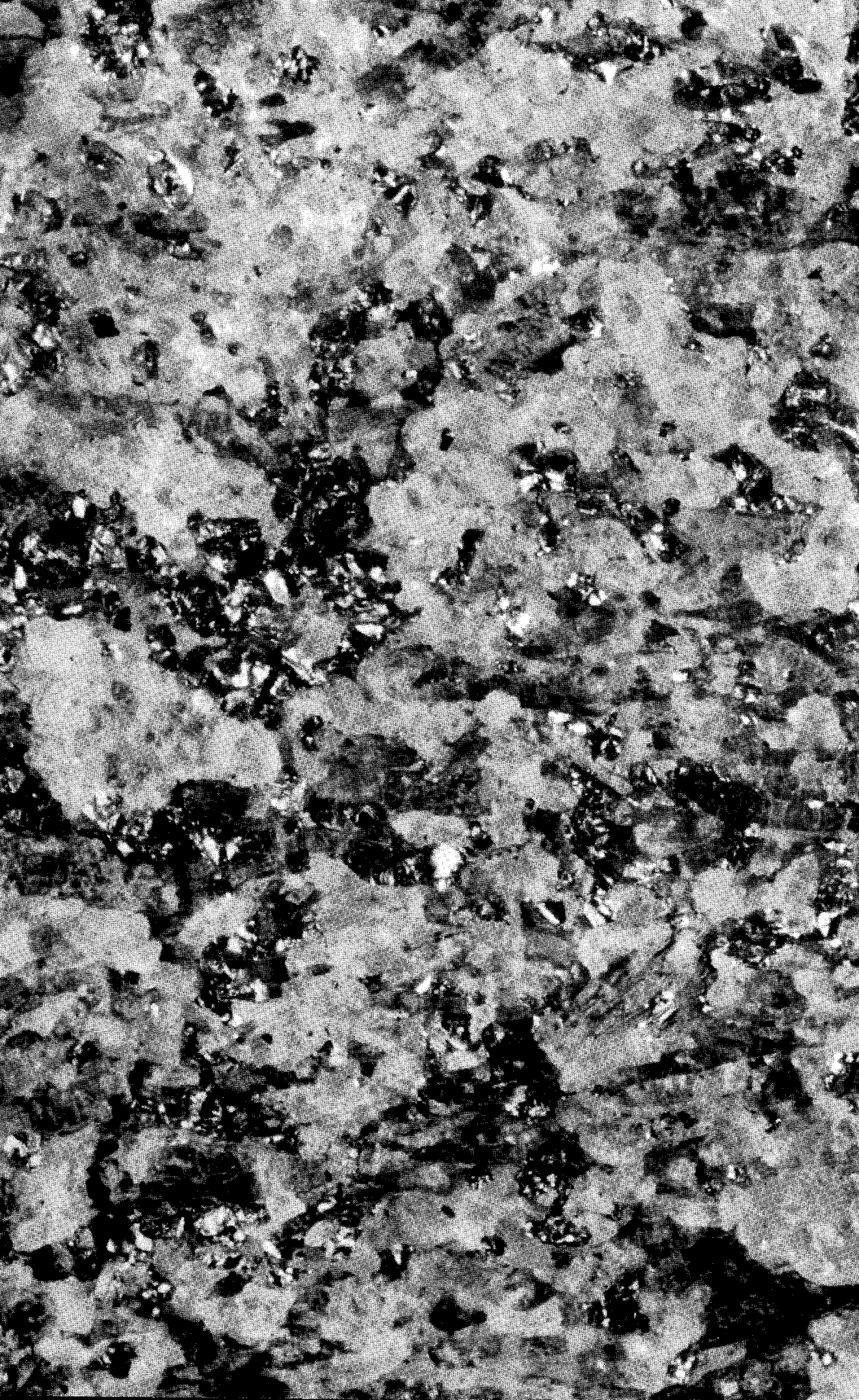
VIRGINIA

AREAS CONTAINING PRINCIPAL MINERAL LOCALITIES

BY GUSTAV B. BAETCKE

SCALE

10 0 10 20 30 MILES



BASE FROM U.S. GEOLOGICAL SURVEY