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ABOUT OHIO ROCKS AND MINERALS

By

Carolyn Farnsworth

OHIO DIVISION OF GEOLOGICAL SURVEY

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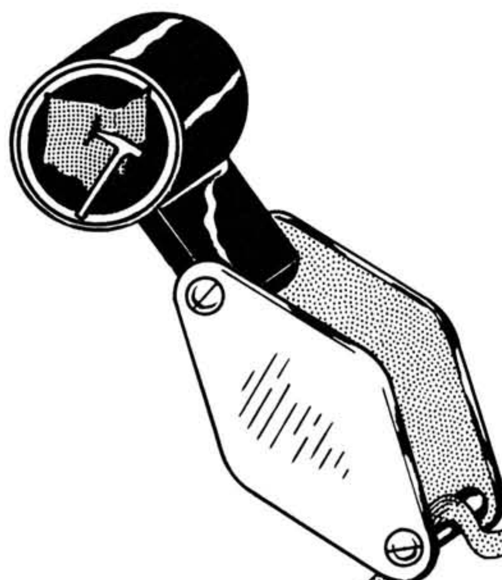
ABOUT OHIO ROCKS AND MINERALS

An Adaptation of Rocks and Minerals of Ohio,
published by the Ohio Division of Geological Survey

By

Carolyn Farnsworth



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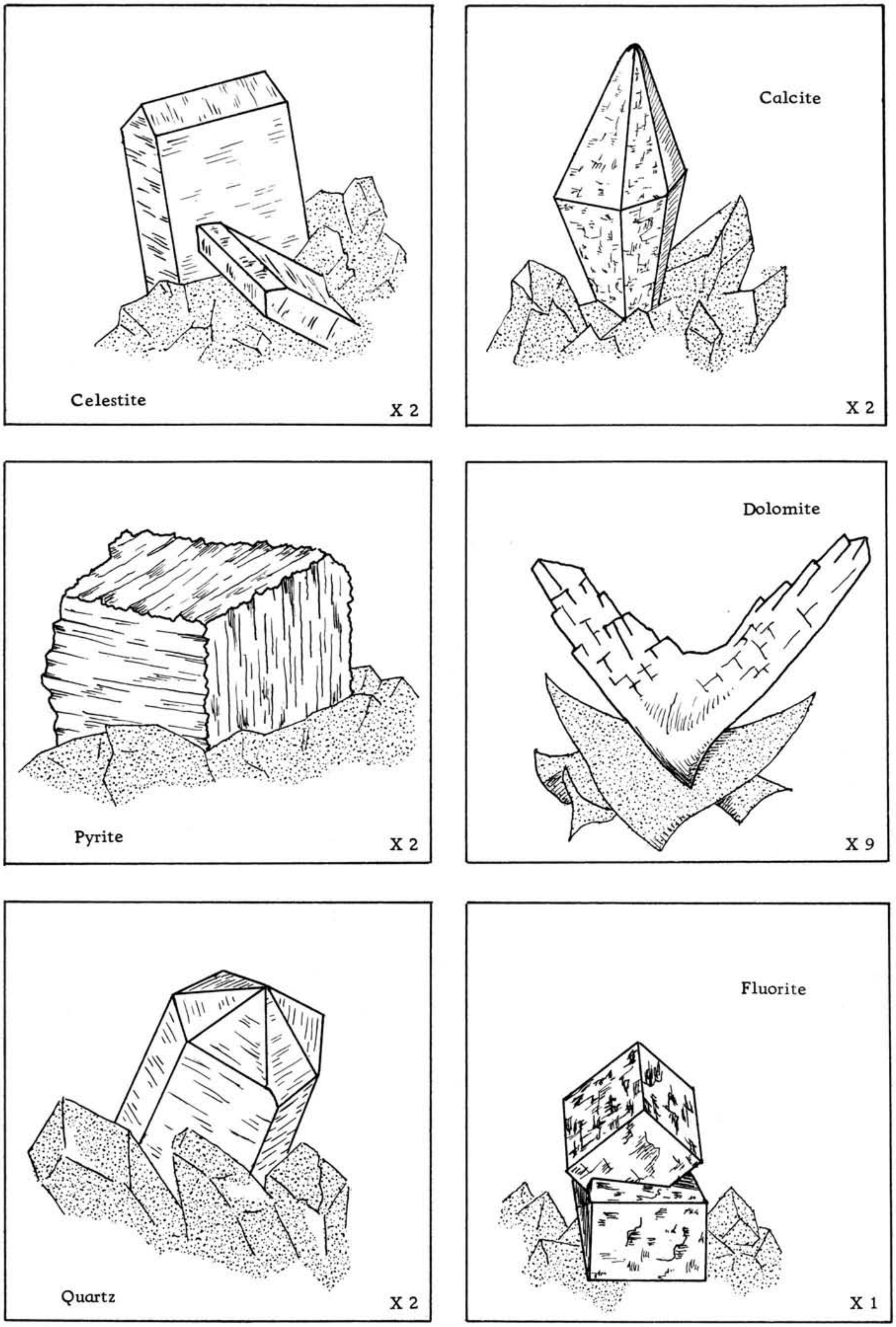

FRONTISPIECE - Some Typical Crystal Forms of Ohio Minerals

(X 1, natural size; X 2, two times larger than natural size; X 9, nine times larger than natural size)

ABOUT OHIO ROCKS AND MINERALS

How to Identify Rocks

Rocks are the materials of which the crust of the earth is made. They are mixtures of one or more minerals. Limestone is made of the mineral calcite; dolomite rock is a mixture of the minerals calcite and dolomite. Rocks have no fixed chemical compositions but minerals always do. Rocks are classified according to their composition and physical properties, properties that you can test by sight, taste, feel,or smell.

Rocks can be divided into three great classes according to their mode of origin.

When molten material (magma) from within the earth cools on the surface as eruptive volcanic matter or quiet lava flows, the rocks formed are called igneous or "fire rocks." Igneous rocks are also formed when the magma cools before reaching the earth's surface. In this case, we can see these "fire rocks" only when they are later exposed by the wearing away of the overlying materials. Lava, granite, and basalt are kinds of igneous rocks.

Wind, ice, and water are continually breaking up rocks at or near the surface of the earth. The pieces or particles of rock are carried away by wind, glaciers, running water, lakes, and even organisms of various kinds, and are dropped somewhere else like the bottom of a lake or the mouth of a river. Rock fragments laid down in this manner are called sediments, for they have settled to the bottom of a body of water. Rocks formed from fragments of other rocks are called sedimentary rocks. For example, a rock made up of sand grains washed together and deposited by a river, is a sedimentary rock called sandstone. The shells of dead animals and fragments of plants also fall to the bottom of the lake with rock sediments. Animals and plants preserved in sedimentary rocks are called fossils.

The loose unconsolidated rocks and organic fragments are gradually changed into solid rock. Sediments deposited under water may be bound together by the action of cementing agents such as silica, calcium carbonate, or iron oxide, which coat the open spaces between the rock grains. Or, the weight of the overlying material may compress the rock grains together. Or, the sediments themselves may undergo changes which solidify the mass into rock. All three methods of consolidation and compaction may act together or separately, depending on the type of sediments and on the conditions under which they were deposited.

It is possible for both igneous and sedimentary rocks to undergo changes (metamorphosis) caused by heat and pressure. The rocks formed from this change are known as metamorphic rocks or "changed rocks." Quartzite is a metamorphic rock. It was originally a sandstone that was changed by heat and pressure.

The rocks in Ohio are almost entirely sedimentary in origin. In past geologic times, large shallow bodies of water covered the State. Limestone, sandstone, and shale are examples of sedimentary rocks deposited by or precipitated from these seas. During part of its geologic history Ohio was dry land. Rocks were worn down during this time, and the fragments were not deposited in Ohio, but were carried into lowlands to the southeast. Gypsum and rock salt were left when shallow seas covering eastern Ohio slowly evaporated, just as Great Salt Lake in Utah is evaporating today. Moist, swamp-like conditions with thick plant growths prevailed in eastern Ohio during portions of Ohio's geologic past, and coal was formed. Glacial ice plucked, gouged, and spread a hummocky surface of fine fragments, pebbles, and boulders over western and northeastern Ohio. Wind blew dust-sized particles to form deposits in central-southwestern Ohio.

Igneous and metamorphic rocks have been brought into Ohio by the several great ice sheets that covered more than two-thirds of Ohio's land surface. The lapidarist, the hobbyist who cuts and polishes rocks and changes them into jewelry, uses the igneous and metamorphic rocks.

Thus, all three types of rocks may be collected in Ohio, but the most common are the sedimentary rocks.

All sedimentary rocks in Ohio are similar in that they occur in beds or layers. The grains making up sedimentary rocks tend to be arranged in parallel layers because they were originally deposited that way. However, differences in size of grains, arrangement of grains, color, and composition are varied enough so that sedimentary rocks can be distinguished from each other. One feature may be diagnostic and then identification is easily confirmed by use of other properties of the rock.

Photo by Fletcher Twitty

Figure 1. - Conglomerate. Conglomerate is formed of pebbles of different sizes and it looks like gravel cemented together. This conglomerate is composed of quartz pebbles and sand. Conglomerate provides scenic beauty in northern and southern Ohio, forming the features of Rock Run, Nelson Ledges, Kennedy Ledges, Chaplin State Forest, and many others. Lenses of conglomerate are present in the sandstone which forms the scenic features of Hocking State Parks. X . 33 (One-third natural size.)

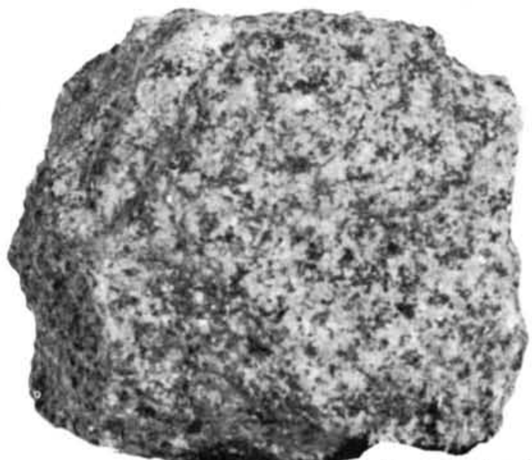

Photo by Art Whittemore

Figure 2. - Granite. This is a piece of granite boulder which was carried into Ohio from Canada by ice during the Ice Age. Granite is probably the most common and easiest recognized igneous rock. It is generally coarse grained with grains one-sixteenth to one-half inch or more across. It is speckled with pink and white, although gold, silver, and black flecks of color are common. The pinkish grains belong to a group of minerals known as feldspar, which is the most abundant mineral in granite. The gray, glassy grains are quartz. The few scattered black to dark green grains or prisms are hornblende. The gold and silver flecks are mica, a thin platy mineral sometimes called isinglass. X . 5 (One-half natural size.)

Every sedimentary rock tends to have at least one characteristic property which distinguishes it from other similar sedimentary materials.

Color. - Color is the first feature that is noticed. Always check the color on a fresh unweathered surface. Color is not always a good test since one type of rock may occur in a wide range of colors. Coal is black, but limestone is white, brown, gray, or any combination of these colors. Also, individual persons differ in their ability to determine color.

Texture. - Texture refers to the size of the grains of rock. Rock material composed mainly of sand-sized grains is called sand, if loose, or sandstone if consolidated. If the particles are smaller than sand but coarser than clay, the sediment is called silt or siltstone. The finest particles make up the rock materials clay and claystone. Conglomerate consists of pebbles cemented together. No sediment is perfectly sorted, that is, no sediment contains only one particle size. The range of grain size may be great but the naming of the rock material is determined by the dominant grain size present.

Hardness. - Hardness is useful in the field in making preliminary tests on rocks. It is really a test of "scratchability," the ability of a mineral of predetermined hardness to scratch or be scratched by another. Each mineral possesses a characteristic hardness; the tests for determining mineral hardness are described in the accompanying section on minerals. Rocks composed of aggregates of minerals do not have a characteristic hardness, rather fragments of each different mineral have their own hardness.

Though hardness is not an important rock identification property, it can help in comparing different types of sedimentary rocks because most sedimentary rocks are made up of only one mineral. Exposure to weathering and erosion agents reduces the original hardness of the rock.

Fracture. - Rocks and minerals break in different ways. This property is called fracture. Most rocks that are firm and solid generally break with a hackly fracture. Those rocks that are fine grained generally have a distinct conchoidal fracture like the rounded surface of a clam shell, or the surface may be splintery, or the surface may be broad and flat.

Composition. - Most rocks are aggregates or mixtures of minerals, therefore they have no fixed chemical composition.

Exceptions are rocks composed of one mineral. Wherever such a mineral occurs over an area large enough to be mapped as a separate unit, it is given the rock name. Limestone, which is composed of the mineral calcite is an example of such a rock in Ohio.

Dilute (10 percent) hydrochloric acid, vinegar (acetic acid), and lemon juice are particularly useful in identifying carbonate rocks such as limestone. If a rock bubbles or effervesces when treated with one of these acids, a carbonate is present. The acid causes a chemical reaction which releases the gas carbon dioxide. Be sure the individual grains or crystals are bubbling and not the material between the grains, because rocks composed of noncarbonate minerals may be cemented by a carbonate. Use your hand lens to watch the bubbling.

Exact chemical composition can be determined only by chemical tests or microscopic analyses. Although such tests may be too advanced for the average collector, it is interesting to know that the exact composition of minerals can be determined if necessary.

Origin. - By carefully studying the texture and other rock properties a geologist can determine a great deal about the rock's origin.

Occurrence. - Because some areas of Ohio are covered by soil or by tens of feet of glacial drift, the best places to observe and collect rocks are road cuts, stream banks, man-made diggings, and the like.

Table for the Identification of Ohio Rocks[1,2]

I. Coarse-grained rocks--rock crystals, grains or particles can be seen with the unaided eye

   A. Individual rock grains, crystals or fragments can be scratched by a knife blade

      1. Does not fizz in dilute hydrochloric acid; does not contain fossils

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1 For a complete description of the rocks named in this table see the books listed on pages 27-29. Starred books are very useful.

2 Abbreviations: (S) sedimentary rock; (I) igneous rock; (M) metamorphic rock; (U) loose, unconsolidated sediments; (A) associated with sedimentary rocks.

a. Can be scratched with your fingernail; sugary appearance; conchoidal or fibrous fracture -------------------- gypsum (S)

b. Cannot be scratched with your fingernail but can be scratched with a copper coin; dissolves in water; tastes salty------------------------ salt (S)

2. Fizzes in dilute acid; cannot be scratched with your fingernail

a. Fizzes very slowly in dilute acid but a little faster if powdered; may contain fossils------------------ dolomite (S)

b. Fizzes quickly in dilute acid; may contain fossils------------------ limestone (S)

c. Fizzes quickly in dilute acid; does not contain fossils; banded; dark buff, orange and shades of brown----- travertine (A)

B. Individual rock particles too hard to be scratched by a knife blade

1. Rocks composed of particles that interlock (there are no open spaces between the grains or crystals); found as boulders, pebbles, or fragments in glacial drift

a. Minerals in indistinct bands; firm; difficult to break---------------- gneiss (M)

b. Minerals in definite parallel layers; one mineral predominates; splits easily along the parallel banding--------------------------- schist (M)

c. Crystals or grains not oriented in any particular direction

(1). Speckled light gray, white, pink, or tan with only a few dark minerals; gold, silver, and black flecks of color are common--------------------- granite (I)

(2). Color medium gray, darker in color than granite----------- diorite (I)

(3). Color dark gray to black; mineral grains smaller than diorite------------------------ basalt (I)

2. Rock or rock materials composed of particles that do not interlock

   a. Particles not uniform in size; a mixture of pebbles and smaller particles

      (1). Solid rock; pebbles cemented together---------------------- conglomerate (S)

      (2). Rock fragments all sizes from boulders to clay; compact but not cemented------------------ till (U)

      (3). Loose rock material; neither cemented or compacted-------- gravel (U)

   b. Particles fairly uniform in size, about the size of grains of sugar

      (1). Loose rock material; not cemented; feels gritty---------- sand (U)

      (2). Solid rock; cemented

         (a). Rock breaks around grains; feels sandy; can be separated into individual grains------------ sandstone (S)

         (b). Rock breaks across grains; cannot be separated into individual grains; found as boulders, pebbles, and fragments in glacial drift-------------- quartzite (M)

II. Fine-grained rocks--rock crystals, grains, or particles not easily seen with unaided eye or with a magnifying glass

A. Rock cannot be scratched with a knife; may contain a few crystals or particles large enough to see

1. Brittle; splintery or conchoidal fracture; sharp corners and edges left when broken or chipped; white or gray; found as nodules or thin beds in limestone--------- chert (A)

2. Dark gray to black; found as boulders, pebbles, or fragments in glacial drift----- basalt (I)

3. White, gray, pink, brown; rock breaks through the grains; found as boulders, pebbles, or fragments in glacial drift----- quartzite (M)

B. Rock or rock material soft enough to be cut with a knife

1. Smells "earthy" when moistened

a. Rock material not entirely fine grained, but contains scattered pebbles and sand------------------------------- till (U)

b. Rock material fairly uniformly fine grained

(1). Does not feel gritty when rubbed against the edge of your teeth--- clay (S)(U)

(2). Does feel gritty when rubbed against the edge of your teeth

(a). Solid; breaks into thin platy fragments, chips or splinters---------------- shale (S)

(b). Solid; does not break into thin platy fragments or chips; may effervesce slightly----------------- siltstone (S)

2. Does not smell "earthy" when moistened

   a. Dark gray to black; very light in weight when dry; contains plant fragments---- peat (U)

   b. White, gray; soft; not solid; gummy when wet and chalky when dry; almost always contains snail shells; fizzes in dilute hydrochloric acid----------- marl (U)

   c. Black, contains bands of shiny and dull material; may contain plant fossils which can be seen; burns------ coal (S)

   d. Open; porous; yellowish brown; as nodules or sheets one to two feet thick------------------------------- bog ore (U)

   e. Sponge-like texture; gray; fizzes in dilute hydrochloric acid----------- tufa (U)

   f. Solid; makes a ringing sound when hit with a hammer; fizzes in dilute hydrochloric acid; may contain fossils

      (1). Fizzes freely in acid----------- limestone (S)

      (2). Fizzes very slowly in acid, but a little faster if powdered--------------------- dolomite (S)

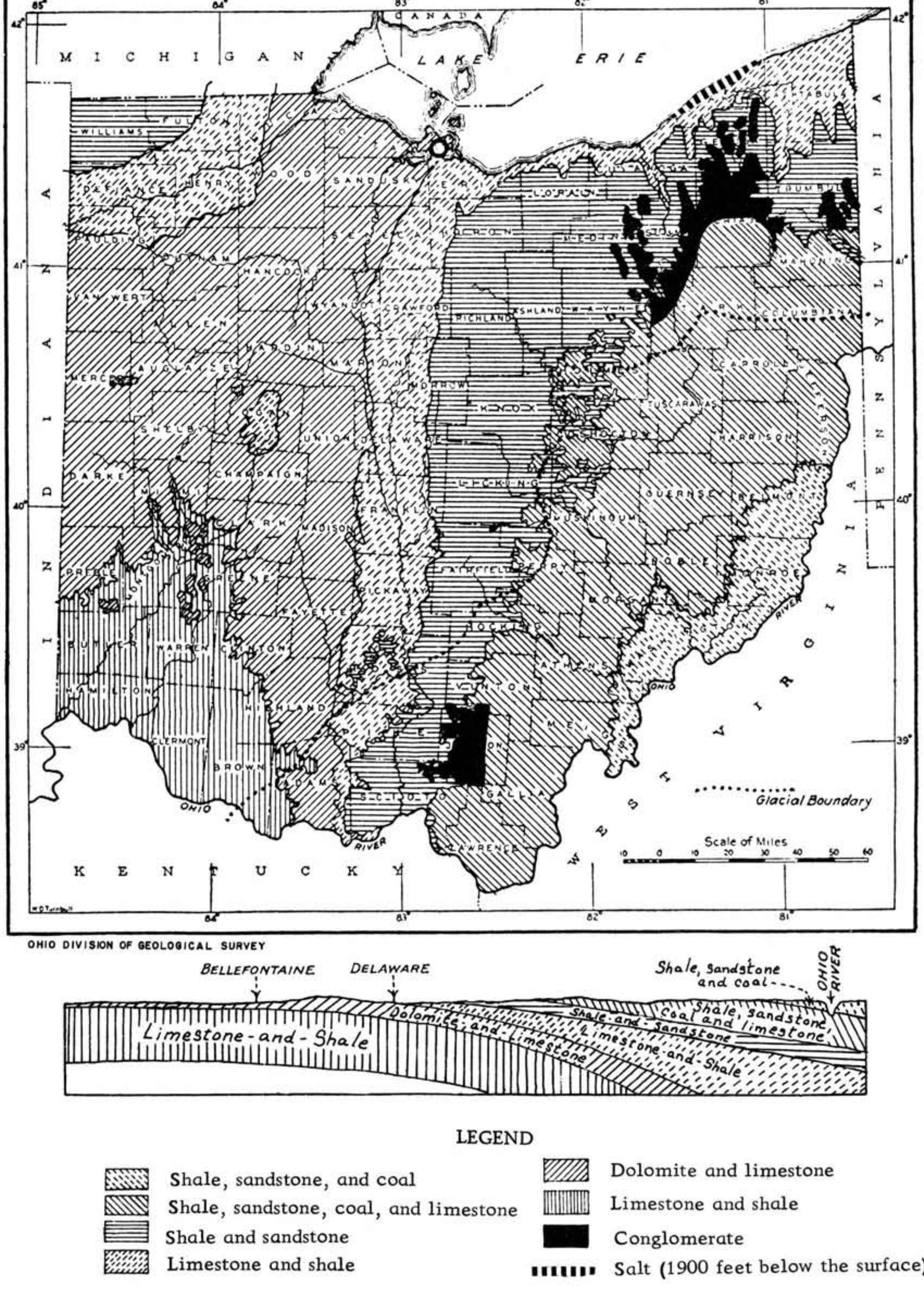

FIGURE 3. - COLLECTING ROCKS IN OHIO

How to Distinguish Minerals

A mineral is matter other than animal or vegetable matter found in nature. It is made up of one or more distinct elements in a definite chemical combination; for example, quartz is a combination of a definite amount of silicon and oxygen. The elements that make up a particular mineral are the same no matter where that mineral is found.

There are many kinds of minerals because there are so many possible combinations of elements. One mineral differs from another in its chemical composition, and each mineral has its own properties of hardness, color, streak, luster, cleavage, form, and association. By studying these properties and characteristics, minerals can be identified.

Hardness. - This property is really a measure of the "scratchability" of a mineral; a harder mineral will scratch a softer mineral. A mineral's grade of hardness is measured by scratching the mineral with an object of known hardness. There are 10 grades of hardness according to Mohs scale, which is used by mineralogists to classify hardness; each grade is assigned a number.

Mohs Scale of Hardness

No.	Mineral	No.	Mineral
1	Talc	6	Orthoclase
2	Gypsum	7	Quartz
3	Calcite	8	Topaz or beryl
4	Fluorite	9	Corundum
5	Apatite	10	Diamond

Figure 3. - Collecting rocks in Ohio. To the west and north of the glacial boundary, solid rock is covered in many places by tens of feet of glacial drift (till, clay, and sand), and rock can be seen only in quarries and along streams and road cuts. Look for igneous pebbles of granite, diorite, and basalt, and metamorphic pebbles of quartzite, schist, and gneiss along streams in the area to the west of the glacial boundary. Bog ore, marl, and peat deposits are located to the west and north of the glacial boundary. Chert is found as nodules and lenses in limestone and dolomite. Travertine deposits are found in caves in limestone and dolomite. Tufa is associated with the marl deposits near Castalia in Erie County.

Mohs scale of hardness is arranged so that a mineral can scratch all minerals assigned a lower number on the scale, and each mineral can be scratched by all minerals that have a higher number. For example: fluorite can scratch talc, gypsum, and calcite. It in turn can be scratched by apatite, orthoclase, quartz, topaz or beryl, corundum, and diamond.

A small set of the minerals in the Mohs scale of hardness can be purchased from many mineral dealers. If you already have a mineral collection, you can make your own hardness scale by selecting the minerals listed in this scale.

Sometimes you will not have these minerals with you; then it is convenient to know the hardness of some common things which are usually available to you: your fingernail, a copper penny, a piece of window glass, and a knife blade or piece of steel. Your fingernail has a hardness slightly over 2. All minerals that can be scratched by your fingernail have a hardness of less than 2. 5. A copper penny has a hardness of about 3. 5. All minerals that can be scratched by a copper penny have a hardness of less than 3. 5. Window glass and a steel knife blade have hardnesses of about 5. 5. A steel knife blade will scratch all minerals that are less than 5. 5. In turn, a mineral that scratches window glass or a piece of steel has a hardness of more than 5. 5. With practice you will be able to distinguish minerals with a hardness under 5 by the ease which they can be scratched by your knife blade. By combining these tests, you can tell within two or three grades the hardness of a mineral.

Make the test for hardness on a mineral where scratches won't show. Do not test crystal faces. Good crystals are difficult to find and you don't want to ruin one by scratching it.

Test a fresh surface of the mineral for its hardness. Many minerals become soft and powdery when they are exposed to the weather, and their true hardness is difficult to find then.

A mineral that is porous or granular will appear to be softer than it actually is, because the granules will break off. Use the mineral to scratch a copper coin, window glass, etc., for a truer test of hardness of the granular mineral.

After you have scratched a mineral, rub over the scratch with your finger. The scratch may be only the powder of the softer testing material, which would therefore rub off and indicate that the testing material was softer than the mineral.

Photo courtesy Ward's Natural Science Establishment

Figure 4. - The hardness test. This set of hardness points consists of minerals of known hardness mounted on brass rods. Test for hardness by drawing a point across the mineral. If the point leaves a scratch, the mineral is softer than the point, but if it doesn't leave a scratch the mineral is harder. Repeat the test with the next higher point in the hardness scale.

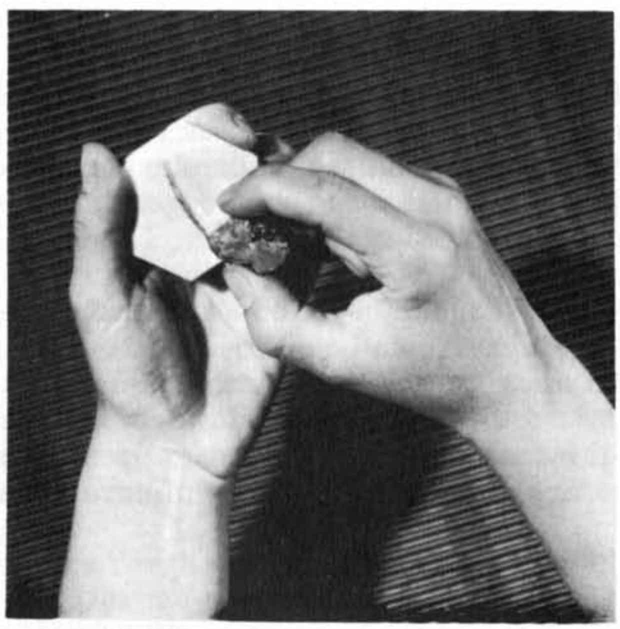

Photo courtesy Ward's Natural Science Establishment

Figure 5. - The streak test. Test the powder streak color of a mineral by rubbing the mineral across a streak plate or a piece of chert. The streak colors can be removed from the streak plate by washing it with kitchen cleanser.

Color. - Color is an important property, for it is easy to identify some minerals by their color. Pyrite, for example, is always yellow. But this property may be misleading because different pieces of some minerals have different colors. Calcite may be colorless, white, yellow, orange, black, blue, and many other colors. In this case, the color will not help very much in identifying the mineral, but the other properties of calcite, such as hardness, cleavage, and shape will help you recognize it.

The color of a mineral is caused by the elements that make up the mineral, by impurities, or by optical properties of the mineral. For example, minerals containing oxidized iron are commonly red or red brown.

Always look for the color of a mineral on a fresh surface. Many minerals tend to change color when they have been exposed to the weather.

Streak. - The streak or color of the powdered mineral is a more reliable characteristic than the actual color of the mineral. The streak color may sometimes be used to distinguish between two or more minerals that have the same color.

The streak may be observed from the color of the powdered mineral made when you are testing for hardness. Or you can crush a small piece with a hammer. The streak color can also be tested by rubbing the mineral on a streak plate or a piece of chert. A streak plate is any white unglazed tile, which can be purchased from a tile contractor. Or, you can use the broken edge of a plate or the unglazed back of a glazed tile.

Luster. - The manner in which a mineral reflects light is known as luster. Minerals can be divided into two classes by the luster, those with metallic and those with nonmetallic lusters.

Metallic minerals have the brilliant appearance of a metal. Pyrite and galena are typical examples of minerals that have a metallic luster.

Minerals with a nonmetallic luster do not resemble metals. For example, quartz has a glassy look or a glassy luster. The most common kinds of nonmetallic lusters are listed below:

Glassy--like broken glass; vitreous
Resinous--having the appearance of resin
Pearly--resembles the reflections from the inside of a sea shell
Greasy--appears to be thinly covered with oil
Silky--like silk
Dull--earthy

Cleavage. - The ways in which minerals break help one to separate them into different groups. Some minerals break or part along smooth flat surfaces called cleavage surfaces. Cleavage, or the tendency to break along these smooth surfaces, may be present in one, two, or all three dimensions of a mineral. Consequently, some minerals have one or two smooth surfaces and an irregular break in the other dimension. A few minerals have three directions of cleavage; these tend to break into small box-shaped fragments. Galena has three directions of cleavage at right angles to each other; this means that each cleavage surface is at right angles to the adjacent surfaces and the broken fragments have all six sides shaped like squares or rectangles.

Another common mineral that has three directions of cleavage and therefore breaks easily into flat-sided fragments is calcite. Like galena, the broken fragments of calcite have six flat surfaces, but these cleavage faces do not form squares or rectangles. Instead, each surface has a diamond or rhomboidal shape, developed because the three directions of cleavage in calcite are not at right angles to each other.

Cleavage is related to crystal symmetry and to the arrangement of the mineral's atoms. A mineral having a certain type of cleavage will show that same cleavage no matter what its color or where that mineral is found.

Fracture. - The rough, irregular surfaces developed in the directions lacking in cleavage are called fracture surfaces. Quartz has no cleavage; it breaks like a piece of glass, each fracture surface appearing curved like the inside of a sea shell. The following terms are used to describe the different kinds of fracture surfaces:

> Conchoidal--smooth, curved, circle-like surfaces looking like broken glass; shell-like
> Fibrous or splintery--broken surfaces showing a fibrous or splintery appearance like wood
> Uneven or irregular--rough surfaces
> Even--smooth surfaces that are not as flat as cleavage surfaces

Form. - Different minerals tend to occur in different forms or shapes, which are characteristic of the mineral. Some minerals tend to occur as crystals, which are geometric forms with smooth plane surfaces. These geometric forms include such shapes as cubes, rhombohedrons, and octahedrons. Calcite crystals are characteristically composed of six sides, each of which is a perfect rhomb, so the crystals are called rhombohedral. Crystals of galena take the form of cubes. Fluorite crystals are octahedral, cubic or hexoctahedral.

Most minerals occur as crystals only rarely. There are other forms that minerals may take. A mineral made up of an accumulation of large or small grains is called granular. A mineral of compact material without any apparent structure is termed massive.

Some minerals may occur in several forms. For example, calcite may be found as crystals or in massive form. When it is massive, it has commonly been broken and then it shows the characteristic rhomboidal form, as a result of its cleavage.

Composition. - The exact chemical composition of a mineral cannot be determined without expensive equipment. There are, however, several easy tests that you will find useful in distinguishing minerals. Some minerals (the carbonates) bubble or effervesce when a drop of hydrochloric acid is put on them. Calcite bubbles very rapidly, and dolomite effervesces slowly, but other minerals such as pyrite will not react at all to hydrochloric acid.

When a small piece of a mineral is heated in a flame, it always imparts a characteristic color to the flame. Celestite gives a brilliant crimson color to the flame. Barite gives a yellowish-green flame. Additional chemical tests may be found in a chemistry or determinative mineralogy textbook.

Photo by Art Whittemore

Figure 6. - Calcite and dolomite. Crystals of calcite and dolomite in a cavity in limestone. The long pointed calcite crystals are known as dogtooth spar crystals. The small curved dolomite crystals are known as saddle-back crystals. X . 5 (One-half natural size.)

Photo by Art Whittemore

Figure 7. - Pyrite and dolomite. Crystals of pyrite and dolomite in a cavity in dolomite rock. This crystal form of pyrite is known as pyritohedron. Each face of this crystal has five sides and each crystal has 12 faces. Because of its brass color, pyrite is called fool's gold. X . 5 (One-half natural size.)

Hydrochloric acid, even when dilute, is dangerous and must be handled with care. Your druggist can prepare a 10 percent solution of hydrochloric (muriatic) acid, preferably in an "eye dropper" bottle. Keep the acid out of reach of children. Use it cautiously, and if any is accidently spilled on hands or clothes, wash immediately with soap and water. When you use the acid, put one or two drops onto the mineral, taking care not to contaminate the dropper by touching it to the specimen. Put the acid on an inconspicuous spot on the mineral. After the test, wash the acid off the mineral with water so that someone handling it later will not receive acid burns. Remember that, as the water in dilute hydrochloric acid evaporates, the strength of the acid increases, increasing its potency.

Origin. - Minerals are formed under three principal conditions: (1) the cooling of melted earth materials, (2) deposition from solutions, and (3) deposition from vapors. The minerals that are found in Ohio's rocks were not formed by the cooling of melted earth materials or by deposition from vapors. Minerals formed in these ways are found in areas of past or present volcanic activity and in areas where heat is generated by intense folding or faulting of rocks. These situations do not apply to rocks in Ohio.

The minerals found in the sedimentary rocks of Ohio are formed from solutions. Thousands of years are necessary for this process. As surface water percolates downward through the very small spaces between rock grains it dissolves soluble parts of the rock. The minerals taken into solution from this dissolving action are laid down in rock cavities and fissures. Calcite, celestite, and fluorite crystals are formed in this way. At the same time water is dissolving a part of the rock the water can redeposit the minerals it already has in solution. If the solution containing dissolved minerals comes to the surface, the water evaporates and leaves a surface deposit. Travertine deposits around springs are formed in this way.

Association. - Most minerals are found in association with certain other minerals. The minerals commonly found with a given mineral are characteristic of that mineral, because of similar composition or common origin. Given minerals are also generally related to specific types of rocks. Not only is this mineral or rock association an aid to identification, but it gives a clue as to what other minerals might be found in the same area.

Other properties. - There are other significant properties of minerals which do not fall into the above categories, such as odor, fluorescence, and ability to transmit light. These properties are only occasionally important in distinguishing minerals.

Table for the Identification of Ohio Minerals[1]

The following table will be useful in identifying Ohio's native minerals. Because this table was prepared especially for Ohio minerals it may be misleading and somewhat confusing in the identification of many out-of-State specimens.

Ohio's minerals are divided into two groups, minerals with a metallic or submetallic luster, and those with a nonmetallic luster. Minerals with a metallic or submetallic luster are divided according to degree of hardness. The minerals in this group can be distinguished on the basis of the properties of streak, color, hardness, and other characteristics which are listed in the remarks column of the table.

Minerals which have a nonmetallic luster are separated into two groups on the basis of streak. Those possessing a colored streak can be distinguished by streak, color, hardness, and other properties as given in the remarks column. Minerals with a white or colorless streak are subdivided according to hardness. Characteristics of cleavage and fracture, color, hardness, and other properties also aid in separating the individual minerals.

The general outline for the identification table is as follows:

I. Minerals with metallic or submetallic luster
   A. Will leave a mark on paper, can be scratched by fingernail (hardness less than $2\frac{1}{2}$)
   B. Can be scratched by a knife; will not readily leave a colored mark on paper (hardness greater than $2\frac{1}{2}$, but less than $5\frac{1}{2}$)
   C. Cannot be scratched by a knife, but can be scratched by quartz (hardness greater than $5\frac{1}{2}$ but less than 7)

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1 For a complete description of the minerals named in this table consult the books which are listed in Selected Books on Rocks and Minerals. The books that are starred will be especially useful.

II. Minerals with nonmetallic luster
   A. Streak definitely colored
   B. Streak white or colorless
      1. Can be scratched by fingernail (hardness less than $2\frac{1}{2}$)
      2. Cannot be scratched by fingernail, but can be scratched by a copper coin (hardness greater than $2\frac{1}{2}$ but less than 3)
      3. Cannot be scratched by copper coin, but can be scratched by knife (hardness greater than 3 but less than $5\frac{1}{2}$)
         a. Cleavage conspicuous
         b. Cleavage not conspicuous
      4. Cannot be scratched by knife, but can be scratched by quartz (hardness greater than $5\frac{1}{2}$ but less than 7)

Figure 8. - Collecting minerals in Ohio.

The following minerals are found in varying quantity and quality in cavities and cracks of dolomite and limestone deposits in this area: aragonite, barite, calcite, celestite, dolomite, galena, gypsum, marcasite, pyrite, quartz, sphalerite, and strontianite.

Marcasite and pyrite crystals and nodules are found in the shale of this area.

Marcasite, pyrite, and sulfur are associated with clay and coal beds. Siderite, hematite, and limonite occur as nodules or beds. Flint layers are also found in this region. Quartz crystals commonly line cavities in the flint. Selenite crystals are found in some of the clay deposits of this area and in the area to the west and north of the glacial boundary.

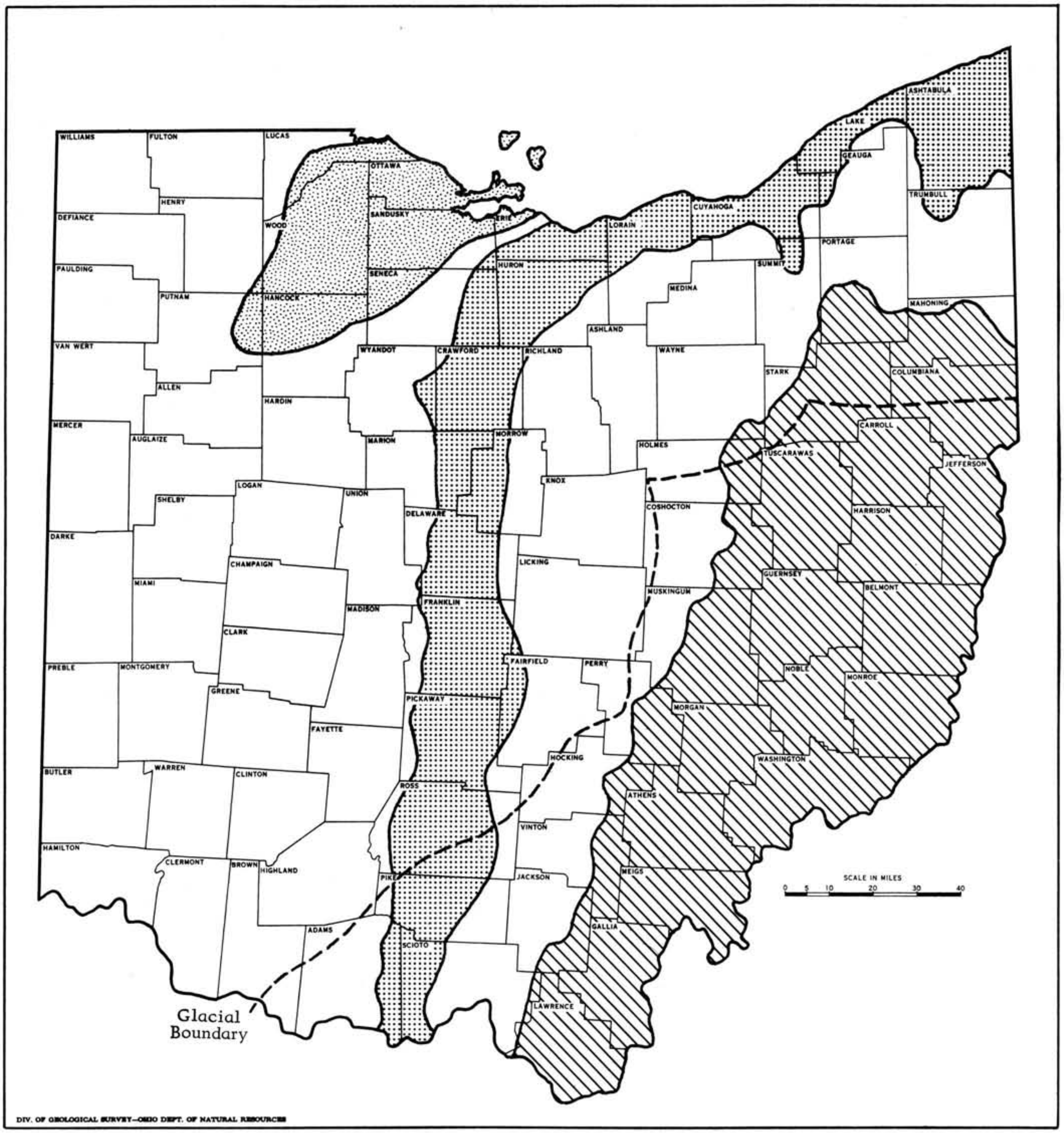

FIGURE 8. - COLLECTING MINERALS IN OHIO

I. Minerals with metallic or submetallic luster

A. Will leave a mark on paper, can be scratched by fingernail (hardness less than $2\frac{1}{2}$)

Streak	Color	Hardness	Remarks	Name
Lead gray	Lead gray, tarnishes to black	$2\frac{1}{2}$	In cubic crystals; massive granular	Galena
Indian red or brown	Red to black	$5\frac{1}{2}$-$6\frac{1}{2}$ Apparent hardness less on weathered surfaces	Massive granular; kidney-shaped masses; dull luster	Hematite
Yellowish brown to brown	Various shades of brown	5-$5\frac{1}{2}$ Apparent hardness as low as 1	Glassy to dull luster; as crusts or nodules	Limonite

B. Can be scratched by a knife; will not readily leave a mark on paper (hardness greater than $2\frac{1}{2}$, but less than $5\frac{1}{2}$)

Streak	Color	Hardness	Remarks	Name
Lead gray	Lead gray, tarnishes to black	$2\frac{1}{2}$	In cubic crystals and granular masses; perfect cubic cleavage	Galena
White to brown and yellow	Brownish yellow, reddish brown, or brown to black	$3\frac{1}{2}$-4	Resinous luster; perfect cleavage in 6 directions	Sphalerite
Indian red or brown	Red to black	$5\frac{1}{2}$-$6\frac{1}{2}$ Almost always harder than knife	Massive granular; kidney-shaped masses; dull luster	Hematite
Yellowish brown to brown	Various shades of brown	5-$5\frac{1}{2}$	Glassy to dull luster; as crusts or nodules	Limonite

C. Cannot be scratched by a knife, but can be scratched by quartz (hardness greater than $5\frac{1}{2}$)

Streak	Color	Hardness	Remarks	Name
Greenish or brownish black	Pale brass yellow, tarnishes to darker color	$6-6\frac{1}{2}$	In cubic crystals, pyritohedrons; massive granular; nodular	Pyrite
Grayish black or brownish black	Pale bronze yellow to almost white on fracture surface	$6-6\frac{1}{2}$	Tabular crystals or fibrous masses; commonly in radiating forms	Marcasite
Indian red or brown	Red to black	$5\frac{1}{2}-6\frac{1}{2}$	Massive granular; kidney-shaped masses; dull luster	Hematite
Yellowish brown to brown	Various shades of brown	$5-5\frac{1}{2}$	Glassy to dull luster; as crusts or nodules	Limonite

II. Minerals with nonmetallic luster

A. Streak definitely colored

Streak	Color	Hardness	Remarks	Name
Indian red or brown	Red to black	$5\frac{1}{2}-6\frac{1}{2}$ Apparent hardness less on weathered surfaces	Massive granular; kidney-shaped masses; dull luster	Hematite
Yellowish brown to brown	Various shades of brown	$5-5\frac{1}{2}$ Apparent hardness as low as 1	Glassy to dull luster; as crusts or nodules	Limonite
White to brown and yellow	Brownish yellow, reddish brown, or brown to black	$3\frac{1}{2}-4$	Resinous luster; perfect cleavage in 6 directions	Sphalerite
White or yellowish	Various shades of yellow	$1\frac{1}{2}-2\frac{1}{2}$	Resinous to greasy luster; crystals are pyramids; as crusts or nodules; very fragile	Sulfur

B. Streak white or colorless

1. Can be scratched by fingernail (hardness less than $2\frac{1}{2}$)

Color	Hardness	Remarks	Name
Colorless, white	$1\frac{1}{2}$-2	Prismatic crystals; cleaves into broad folia or sheets; compact massive; sugary texture	Selenite Gypsum
Various shades of yellow	$1\frac{1}{2}$-$2\frac{1}{2}$	Resinous to greasy luster; crystals are pyramids; as crusts or nodules; very fragile	Sulfur

2. Cannot be scratched by fingernail, but can be scratched by copper coin (hardness greater than $2\frac{1}{2}$, but less than 3)

Cleavage, Fracture	Color	Hardness	Remarks	Name
Cleavage in 3 directions at right angles; no cleavage if massive; fracture uneven to splintery	White, but may be tinted (bluish)	3-$3\frac{1}{2}$	Granular; rarely as crystals (thick tabular); pearly to glassy luster	Anhydrite
Cleavage in 3 directions not at right angles, yielding rhombohedral fragments; no cleavage if massive	White or colorless; may be tinted yellow from traces of iron	3	Many forms; glassy to dull luster; effervesces freely in cold acid	Calcite
	Commonly some shade of pink; also white	$3\frac{1}{2}$-4	Curved rhombohedral crystals; massive; effervesces slowly in cold acid only if powdered	Dolomite
Cleavage in 2 directions at right angles, imperfect in third direction; uneven fracture if massive; brittle	Colorless, white, blue, yellow, red	3-$3\frac{1}{2}$	Groups of flat crystals, commonly diamond shaped; granular; heavy for nonmetallic mineral; heavier than celestite; gives blue-green flame	Barite
	Bluish white	3-$3\frac{1}{2}$	Crystals generally long; gives crimson flame; heavy for nonmetallic mineral, but not as heavy as barite	Celestite

3. Cannot be scratched by copper coin, but can be scratched by knife (hardness greater than 3, but less than $5\frac{1}{2}$)

a. Cleavage conspicuous

Cleavage, Fracture	Color	Hardness	Remarks	Name
One cleavage direction (poor)	Commonly colorless, variously tinted	$3\frac{1}{2}$-4	Effervesces in cold acid; crystals long tapering pyramids	Aragonite
Two cleavage directions (imperfect)	Colorless, white	$3\frac{1}{2}$-4	Crystals spear shaped and arranged in radiating groups; columnar, fibrous, and granular; effervesces in cold acid	Strontianite
Three cleavage directions not at right angles (rhombohedral)	White or colorless; may be tinted yellow from trace of iron	3	Many forms; glassy to dull luster; effervesces freely in cold acid	Calcite
	Some shade of pink; also white	$3\frac{1}{2}$-4	Curved rhombohedral crystals; massive; effervesces slowly in cold acid if powdered	Dolomite
	Dark brown or brownish black	$3\frac{3}{4}$-$4\frac{1}{4}$	Rhombohedral crystals which may have curved faces; pearly luster; becomes magnetic after heating	Siderite
Three cleavage directions at right angles	White, but may be tinted (bluish)	3-$3\frac{1}{2}$	Granular, rarely as crystals (thick tabular); pearly to glassy luster	Anhydrite
Cleavage in 2 directions at right angles, imperfect in third direction	Colorless, white, blue, yellow, red	3-$3\frac{1}{2}$	Groups of flat crystals, commonly diamond shaped; granular; heavy for nonmetallic mineral; gives blue-green flame	Barite
	Bluish white	3-$3\frac{1}{2}$	Crystals generally long; gives crimson flame; lighter in weight than barite	Celestite
Four cleavage directions (octahedral)	Colorless, brownish, purple and bluish tints	4	Cubic crystals	Fluorite
Six cleavage directions	Brownish yellow, reddish brown or brown to black	$3\frac{1}{2}$-4	Resinous luster	Sphalerite

b. Cleavage not conspicuous

Color	Hardness	Remarks	Name
Commonly colorless, variously tinted	$3\frac{1}{2}$-4	Effervesces in cold acid; crystals long tapering pyramids in radiating groups	Aragonite
Colorless, white	$3\frac{1}{2}$-4	Crystals spear shaped and arranged in radiating groups; commonly found as crusts; also columnar, fibrous, and granular; effervesces in cold acid; gives crimson flame	Strontianite
White or colorless; may be tinted yellow from trace of iron	3	Fibrous, fine granular, or banded; glassy to dull luster; effervesces freely in cold acid	Calcite
Dark brown or brownish black	$3\frac{3}{4}$-$4\frac{1}{4}$	In cleavable masses but may occur as ironstone concretions in clay; becomes magnetic on heating	Siderite

4. Cannot be scratched by knife, can be scratched by quartz (hardness greater than $5\frac{1}{2}$)

Color	Hardness	Remarks	Name
Colorless or white; may be variously colored due to impurities	7	Crystals are long pointed prisms and pyramids; massive, granular, and fibrous; conchoidal fracture	Quartz

Selected Books on Rocks and Minerals

Although all of the following books will be of interest to collectors of all ages and collecting levels, an attempt was made to select references of special value and interest to the beginning collector. These books can be consulted at your public library or they can be purchased at your local book store. The prices given are subject to change.

* An Illustrated Guide to Common Rocks and Rock Forming Minerals, by David Allan and Vinson Brown. Naturegraph Co., 1956. 32 p. $0.50. "How to identify common rocks."

The First Book of Stones, by Maribell Cormack. Watts, 1950. 93 p. $1.95. Ages 8-11. "A good book to start children on the hobby of rock and mineral collecting. Gives a step-by-step treatment of the rock and mineral hobby."

Popular Prospecting; A Field Guide for the Part-time Prospector, by H. C. Dake. Simpson, 1955. 80 p. $2.00. "Gives details for prospecting for all the important commercial minerals, both metallic and nonmetallic."

The Pebbles on the Beach, by Clarence Ellis. Faber, Dufour, 1953. 163 p. "Discusses the birth, life, and death of a pebble, kinds of pebbles, and polishing pebbles."

* Getting Acquainted with Minerals, by George L. English and David E. Jensen. McGraw-Hill, 1958. 362 p. 355 illus. $6.95. Ages 15 up. "Discusses mineral collecting as a hobby; describes over 200 minerals; explains how minerals occur in rocks; and provides recognition tables."

Adventure Book of Rocks, by Eva K. Evans. Golden Press, 1955. 93 p. $3.95. Kit to accompany text, $2.95. Ages 8-13.

Along the Hill, by Carroll L. Fenton. Day, 1935. 96 p. $2.25. "About common rocks, minerals, fossils, etc."

Rocks and Their Stories, by Carroll L. and Mildred A. Fenton. Doubleday, 1951. 112 p. $2.75. Ages 10-14. "Very readable."

The Rock Book, by Carroll L. and Mildred A. Fenton. Doubleday, 1940. 357 p. $7.50. Ages 13 up. "Very readable. Covers the subject of rocks completely."

The Rock Hunter's Field Manual, by D. K. Fritzen. Harper, 1959. 207 p. $3.50. "A guide to identification of rocks and minerals by color."

A Popular Guide to Minerals, by L. P. Gratacap. Van Nostrand, 1912. 330 p. Ages 16 up.

* The Book of Minerals, by Alfred C. Hawkins. Wiley, 1935. 161 p. $4.00. Ages 15 up. "Discusses the minerals with which we commonly come in contact."

Rocks and Minerals and the Stories They Tell, by Robert Irving. Knopf, 1956. 175 p. $2.95. Ages 8-13. "An appreciation book."

* My Hobby is Collecting Rocks and Minerals, by David E. Jensen. Children's Press, 1959. 122 p. $3.95. Ages 10-15. "For young rock hobbyists. Easy to read with many illustrations. Covers every phase of the hobby."

* Field Book of Common Rocks and Minerals, by Frederic B. Loomis. Putnam, 1956. 352 p. $4.50. "For identifying rocks and minerals without elaborate equipment."

Rocks and Minerals, by Daniel T. O'Connell. Boy Scouts of America Merit Badge Series, 1937. 59 p. $0.25. Ages 11-14.

Mineral Collectors Handbook, by Richard M. Pearl. Mineral Book Co., 1947. 297 p. Ages 13 up. "An excellent all-round book for the mineral collector."

* How to Know the Minerals and Rocks, by Richard M. Pearl McGraw-Hill, 1955. 188 p. $3.75. As a Signet Key book, $0.50. "A guide to more than 125 important minerals and rocks."

* Rocks and Minerals, by Richard M. Pearl. Barnes & Noble, 1956. 275 p. $1.95. One of the Everday Handbook Series.

1001 Questions Answered About the Mineral Kingdom, by Richard M. Pearl. Dodd, 1959. 326 p. $6.00. Ages 13 up. "Provides many useful facts concerning minerals and gems for the layman."

The True Book of Rocks and Minerals, by Illa Podendorf. Children's Press, 1958. 48 p. $2.00.

* A Field Guide to Rocks and Minerals, by Frederick H. Pough. Houghton Mifflin Co., 1953. $4.50. "One of the best field guides without identification tables."

The Story of Earth Science, by Horace G. Richards. Lippincott, 1959. $3.75. Ages 14 up. "Introduction to rock, mineral, and fossil collecting."

The Story of Rocks and Minerals--A Guidebook for Young Collectors, by David M. Seaman. Harvey, 1956. 100 p. Accompanying kit has 25 specimens of rocks and minerals. $2.95. Separate cloth bound book, $2.50. Ages 8-13.

The Golden Play Book of Rocks and Minerals Stamps, by Paul R. Shaffer. Golden Press, 1958. $0.50.

The Story of Rocks, by Dorothy E. Shuttlesworth. Doubleday, 1957. 56 p. $2.95. Ages 8-13. "Stresses collecting activities."

A Child's Book of Stones and Minerals, by Valerie Swenson. Maxton, 1955. $0.69. Ages 7-10. "For the very young collector."

Maxton Book About Stones and Minerals, by Valerie Swenson. (Children's) Grosset. $2.00.

What is a Rock, by B. J. Syrocki. Beckley-Cardy, 1959. $1.60.

* Let's Look at Some Rocks, by W. J. Wayne. Indiana Geological Survey Inf. Circ. #4, 1958. 36 p. $0.35. "A guide to identifying some of the common rocks of Indiana, but very useful to the beginning collector anywhere."

* For Pebble Pups, A Collecting Guide for Junior Geologists, by Dolla C. Weaver. Chicago Natural History Museum. 95 p. Accompanied by 18 specimens of rocks and minerals $1.25. Ages 9-12. "Written for the beginner in an interesting easy-to-read style."

Rocks all Around Us, by Anne T. White. Random, 1959. $1.95. Ages 8-11.

Minerals, Their Identification, Uses, and How to Collect Them, by Herbert S. Zim and Elizabeth K. Cooper. Harcourt, 1943. 368 p. $4.00. Ages 8-15. "Good book for the young collector."

* Rocks and Minerals, by Herbert S. Zim and Paul Shaffer. Golden Press, 1957. 160 p. $2.50. Paper cover $1.00. Ages 8 up. A Golden Nature Guide. "A well illustrated guide to minerals, gems, and rocks."

How to Collect Minerals, by Peter Zodac. Rocks & Minerals, 1934. 80 p. $1.00. "The beginner's answer for the questions "how?" and "what?"

The following books, published by the Ohio Division of Geological Survey, are of interest to rock and mineral hobbyists.

The Occurrence of Flint in Ohio, by Wilber Stout and R. A. Schoenlaub. 1945. 110 p. $0.50. "Describes flint-bearing rocks. Gives locality by township and section number."

Marl, Tufa Rock, Travertine, and Bog Ore in Ohio, by Wilber Stout. 1940. 56 p. $0.25. Discusses these minerals by county. Gives compositions for some localities."

The Iron Ore Bearing Formations of Ohio, by Wilber Stout. 1944. 230 p. $1.20. "Each iron ore-bearing formation is discussed by county. Localities mentioned by township and section number. Analyses given for some localities."

Ohio Fossils, by Aurele La Rocque and Mildred F. Marple. 1955. 152 p., 413 line drawings. $0.97. "An introduction to the paleontology of Ohio. Fossils described by geologic period. Identification keys provided and collecting localities given."

Handbook for Teachers of Earth Science, by Mildred F. Marple and W. C. Brown. 1955. 61 p. $0.48. "For the student and citizen as well as the teacher. Information about minerals, rocks, fossils. Lists projects to do and how to do them."

Detailed geologic reports are published by the Survey. A list of these reports is available free on request.

Educational Leaflet Series

This is the fifth in a series of leaflets designed to furnish teachers and students with background material on geology. Comments and suggested topics for future leaflets will be greatly appreciated.

Leaflets already available are:

No. 1. THE SEARCH FOR URANIUM
No. 2. WHO WAS WHO IN THE ICE AGE
No. 3. WHAT THE GLACIERS DID TO OHIO
No. 4. FOCUS ON OIL

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