GUIDE TO SOME MINERALS AND ROCKS IN INDIANA

by

Seymour S. Greenberg
Wayne M. Bundy
Duncan J. McGregor

Indiana Department of Conservation

GEOLOGICAL SURVEY

Circular No. 4

1958

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Bloomington

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GUIDE TO SOME MINERALS AND ROCKS IN INDIANA

By Seymour S. Greenberg, Wayne M. Bundy,
and Duncan J. McGregor

INTRODUCTION

The study of minerals and rocks is an important part of the science of geology, which treats of the history of the earth and its life, especially as recorded in the rocks. Surprisingly many of us accept as commonplace many of nature's creations because they are so familiar. Actually, we can find the earth we live on a fascinating world if only we open our eyes to see it.

Geologically, Indiana is an interesting state. It has many fascinating geologic and scenic prospects in its more rugged regions., and even its flat areas possess much interesting geologic phenomenan.

At one time or another everyone probably has been curious about some particular rock or other object originating in the earth. But most of us who have been curious about these rocks or objects could not identify them, and thus our curiosity remained unsatisfied because we could find no explanation for their existence. This circular was prepared with the hope that it may satisfy, at least in part, the curiosity aroused by finding rocks or minerals. It is hoped that those who have discovered rocks and minerals will be encouraged to become further acquainted with their finds by using this guide.

It is impossible to cover fully in this brief report all the characteristics and variations of each kind of rock and mineral found in Indiana. For detailed information regarding Indiana geology, the reader should consult the more detailed reports of the Geological Survey and its predecessors.

MINERALS

DEFINITION

Minerals are natural inorganic substances that have definite chemical compositions and definite physical properties. *Natural* means that man did not make the mineral. *Inorganic* means that neither animal nor plant life formed the mineral. *Definite chemical compositions* mean that no matter where the mineral is found, it will contain the same chemical elements. *Definite physical properties* mean that the same mineral wherever found will have the same color, hardness, weight, luster, cleavage, streak, and crystal form. These physical properties are most useful in identifying minerals.

PHYSICAL AND CHEMICAL PROPERTIES USED FOR IDENTIFYING MINERALS

Elaborate instruments sometimes are used to identify minerals, but a knowledge of external physical properties of minerals is usually sufficient to distinguish them. External physical properties are those features of the mineral which can be seen with the unaided eye and generally are dependent on the internal structure of the mineral. The external physical properties most useful in mineral identification are discussed in the following paragraphs.

HARDNESS

The resistance shown by the surface of a mineral when it is scratched defines its hardness. Moh's hardness scale (given below) is used to indicate the relative hardness of minerals.

Moh's hardness scale

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Ortoclase
7. Quartz
8. Topaz
9. Corundum
10. Diamond

In this scale talc is the softest mineral and diamond is the hardest mineral. If a mineral is scratched by fluorite, but not by calcite, its hardness is between 3 and 4. If some of the above minerals are not available, hardness determinations can be made by using common materials such as a fingernail, which has a hardness value between 2 and 3; a copper penny, between 3 and 4; a knife blade, between 5 and 6; a piece of window glass, between 4 and 6; or a steel file, between 6 and 7.

LUSTER

Luster refers to the general appearance of the surface of a mineral and is described by the following terms:

Metallic: having the appearance of a metal (pyrite and galena)

Glassy: having the appearance of glass (quartz)

Shiny: very shiny or brilliant (diamond)

Silky: having the appearance of silk (fibrous gypsum)

Earthy: having a dull earthlike appearance (clay mineral).

COLOR

Color is an important physical property for recognizing minerals. Some minerals vary widely in color; this variation is caused by impurities or by slight changes in chemical composition or structure. Color is the most useful property for identifying minerals which have a metallic luster because the color is usually constant in these minerals; for example, magnetite is always black. Many of the more common minerals, however, such as quartz and calcite, have a wide variety of colors, and this color cannot be used extensively as a means of identifying these minerals.

A freshly broken surface must be used to determine the color of a mineral because surface changes may produce a tarnish. For example, the green tarnish on copper or the rust on iron is not the true color of the fresh metal.

STREAK

The color of the powder obtained by scratching or rubbing the mineral on a porous porcelain plate is known as its *streak.* The color of a particular mineral may vary greatly, but its streak generally is the same. A streak may be lighter or darker than a mineral, it may be the same color as the mineral, or it may be an entirely different color. Most common minerals, however, have a colorless streak.

CRYSTALS

Atoms and molecules tend to take on a definite pattern or arrangement in the mineral during its formation. Under ideal conditions of mineral growth the orderly internal arrangement of atoms and molecules may be expressed outwardly in a definite geometric pattern. The excellent external forms which result from these geometric patterns are called *crystals* (fig. 1). Well-developed crystals are not common because conditions of growth generally are unfavorable for their formation. The shape of the crystals is described by such names as *cube, pyramid, prism* (elongated form), *octahedron* (8 -sided form), *dodecahedron* (12-sided form), and *rhombohedron* (6-sided

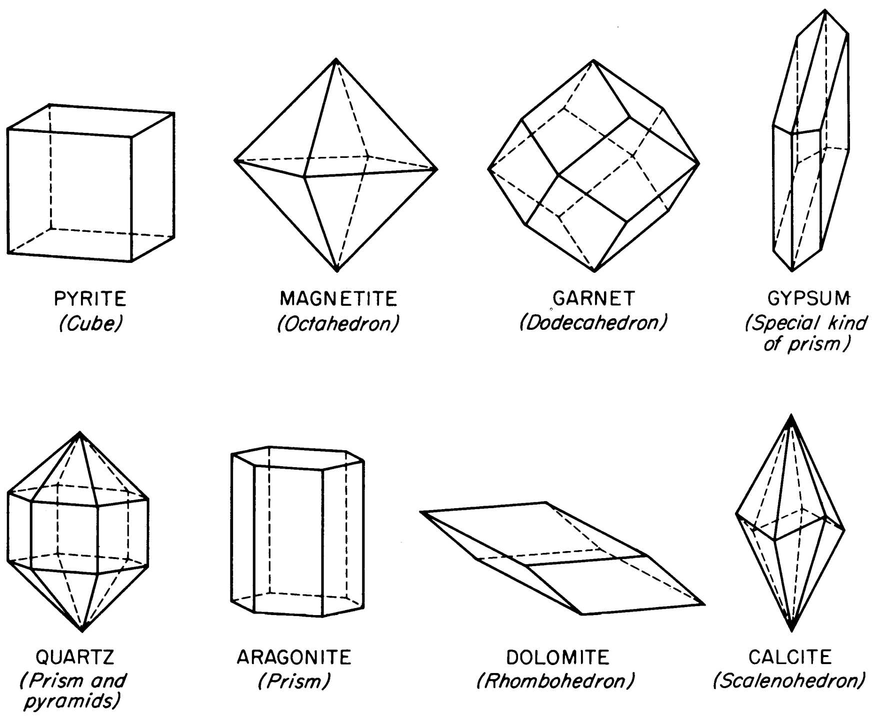

Figure 1. *Crystal shapes of some common minerals. Modified from Hurlbut, 1941*

prism whose faces are parallelograms) (fig. 1). A few minerals can never have crystals because there is no orderly arrangement of their atoms and molecules. Such minerals are called *amorphous*.

CLEAVAGE AND FRACTURE

If a mineral tends to break along planes in at least one definite direction, it is said to exhibit cleavage. If a mineral does not break along a definite plane, it is said to fracture. If a mineral exhibits cleavage, all specimens of that mineral have the same type of cleavage- -that is, they break along the same planes. Cleavage is well illustrated by the mineral calcite (fig. 2). All specimens of calcite break along the same three

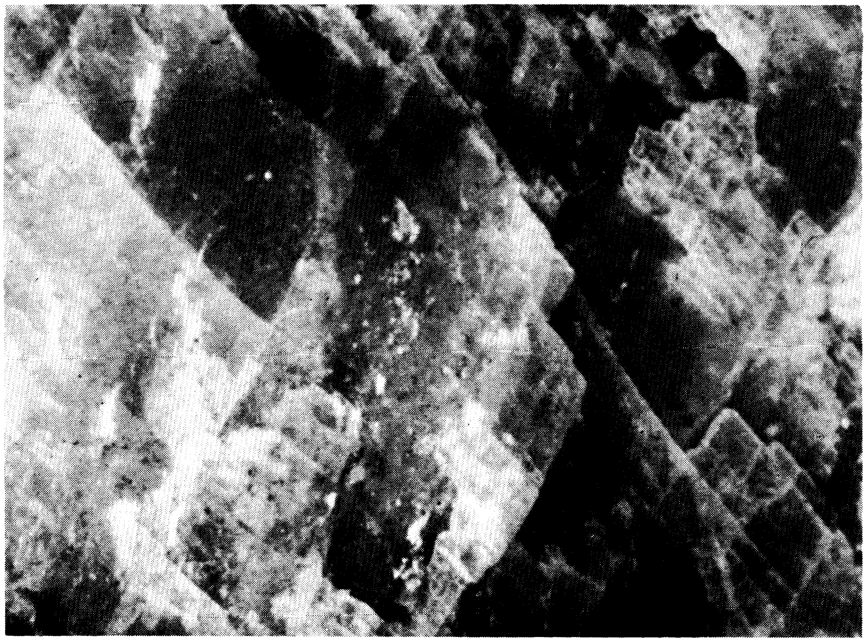

Figure *2.--Cleavage in calcite.*

planes, and the cleavage fragments are more or less smooth-surfaced rhombohedrons (fig. 2). Similarily, if a mineral fractures, all samples of that mineral fracture and the kind of fracture is similar in each. Two kinds of fracture are: *(1) conchoidal:* fractured surface is smooth and curved like a shell (quartz) and (2) *hackly:* fractured surface is irregular and jagged (copper).

MAGNETISM

Minerals which are attracted to a magnet are said to be magnetic. Very few minerals are magnetic, and consequently this property generally makes the identification of this kind of mineral easy.

SPECIFIC GRAVITY

If a small piece of mineral feels heavy in the hand, the mineral has a high specific gravity; if the piece feels light, the mineral has a low specific gravity. For example, a golf ball has a high specific gravity and a ping pong ball has a low specific gravity.

EFFERVESCENCE IN DILUTE HYDROCHLORIC ACID

Effervescence in dilute hydrochloric acid is usually considered to be a chemical property rather than a physical property; it is included here because of its usefulness in identifying certain common minerals.

Some minerals, due to certain chemical constituents, bubble, hiss, and foam when a drop of cold dilute hydrochloric acid (1 part acid to 9 parts water) is applied to them. This phenomenon, which is the violent dissolution of the mineral, is called *effervescence.*

EQUIPMENT FOR DETERMINING PHYSICAL AND CHEMICAL PROPERTIES

Some equipment that is helpful in determining the aforementioned properties is:

1. A penknife (for hardness tests).
2. Porous porcelain substance (for streak determinations)
3. A magnet (for determination of magnetism).
4. Dilute hydrochloric acid (muriatic acid) (for effervescence tests). This may be purchased at most drugstores.
5. Magnifying glass.

DESCRIPTIONS OF MINERALS

The minerals calcite, limonite, and quartz occur abundantly throughout Indiana and are the ones most likely to be found by the amateur mineralogist. The rest of the minerals occur less abundantly and only in certain areas of the State. (See the list of selected mineral localities listed by county, p. 26.) All minerals unless stated otherwise stated otherwise are found in sedimentary rocks (p. 47).

In the descriptions that follow the chernical formula opposite the name of the mineral tells what elements are present and in what proportion they exist to one another. Thus CaF^2 after the mineral fluorite means that this mineral contains twice as many Fluorine (F) atons as calcium (Ca) atoms. The elements mentioned in the text and their abbreviations are listed in table 1.

Table 1.—*List of elements mentioned in the text and their abbreviations*

Element	Abbreviation
Aluminum - - - - - - - - - - - - - - - -	Al
Barium - - - - - - - - - - - - - - - - - -	Ba
Calcium - - - - - - - - - - - - - - - - -	Ca
Carbon - - - - - - - - - - - - - - - - - -	C
Copper- - - - - - - - - - - - - - - - - -	Cu
Fluorine- - - - - - - - - - - - - - - - - -	F
Gold -	Au
Hydrogen - - - -- -- - - - - - - - - - - -	H
Iron -	Fe
Magnesium - - - - - - - - - - - - - - -	Mg
Oxygen - - - - - - - - - - - - - - - - - -	O
Phosphorus - - - - - - - - - - - - - - -	P
Potassium - - - - - - - - - - - - - - - -	K
Silicon - - - - - - - - - - - - - - - - - -	Si
Strontium - - - - - - - - - - - - - - - -	Sr
Sulfur - - - - - - - - - - - - - - - - - - -	S
Zinc -	Zn

CALCITE - $CaCO_3$

(Calcium carbonate)

Hardness 3; specific gravity low; commonly white or colorless; streak colorless; luster usually glassy and rarely earthy; effervescence strong; crystals, if present, are generally scalenohedrons (fig. 1); excellent cleavage in form of rhombohedrally shaped fragments (fig. 2), but cleavage not recognizable if crystals are absent.

The distinctive cleavage and the strong effervescence in cold dilute hydrochloric acid identify calcite. It has the same chemical formula as aragonite, but its atoms are arranged in a different geometric pattern; this causes the differences in crystallinity and cleavage. Calcite is the main constituent of limestones and marbles and is a minor constituent of many other types of rock.

LIMONITE - FeO (OH) H_20

(Iron oxide with water)

Hardness ranges from 1 to 5.5; specific gravity high; brown, yellow, or red; streak yellowish brown; luster earthy; crystals absent; cleavage not recognizable.

Limonite is distinguished by its color, streak, and poor crystallinity. It occurs as coatings on all types of sedimentary rocks. Goethite is similar to limonite except that it usually occurs in needlelike crystals.

QUARTZ - SiO_2

(Silicon dioxide)

Hardness 7; specific gravity low; usually colorless or white but may be any color, *streak colorless; luster glassy; crystals, if present, usually contain prisms and pyramids (fig. 1); fracture conchoidal.*

The features that best distinguish quartz are its hardness and conchoidal fracture. Quartz is the main constituent of sandstones and of many igneous and metamorphic rocks, and it is a minor constituent of practically all other types of rock.

ANHYDRITE - $CaSO_4$

(Calcium sulphate)

Hardness 3 to 3.5; specific gravity medium weight; white to bluish white; streak colorless; luster glassy, crystals absent; three directions of good cleavage at right angles to one another.

Anhydrite is distinguished from calcite by its lack of effervescence in hydrochloric acid and from gypsum by its greater hardness. In Indiana it occurs with gypsum.

APATITE - $Ca_5 F(PO_4)_3$

(Calcium fluophosphate)

Hardness 5 (can just be scratched with a knife); specific gravity medium weight; commonly black and rarely brown, green, blue, violet, or colorless; streak colorless; luster glassy; crystals elongated if present; cleavage in one direction and poor.

Apatite is usually recognized by its elongated crystals and by its hardness. However, in Indiana, apatite typically is poorly crystalline and not too abundant. It probably will be difficult to identify in this form. Apatite is a minor constituent of many igneous and metamorphic rocks.

ARAGONITE - $CaCO_3$

(Calcium carbonate)

Hardness 3.5 to 4; specific gravity low to medium weight; white or colorless and rarely pale yellow; streak colorless; luster glassy; effervescence strong; crystals usually present and are thin and needlelike; cleavage very poor in two directions.

Aragonite is distinguished from most minerals by its strong effervescence in cold dilute hydrochloric acid and from calcite by its nonrhombohedral cleavage. (See calcite, p. 16.) Aragonite occurs in caves in Indiana.

BARITE - $BaSO_4$

(Barium sulphate)

Hardness 3 to 3.5; high specific gravity; white of colorless and rarely light shades of blue, yellow, or red; streak colorless; luster glassy; diamond-shaped and flattened crystals present; cleavage good in two directions.

Barite can be recognized by its high specific gravity, by its good cleavage, and by the shape of its crystals.

CELESTITE - $SrSO_4$

(Strontium sulphate)

Hardness 3 to 3.5; specific gravity medium weight; colorless or white and rarely light blue or light red; streak colorless; luster glassy; crystals (usually flattened) present; cleavage perfect in two directions.

Celestite is very similar to barite, but it has a lower specific gravity than barite. In Indiana celestite is rare, but it is found with calcite in quartz geodes. (See p. 56.)

CLAY MINERALS - $Al_2 Si_2 0_5 (OH)_4$

(Aluminium silicates with water)

The clay minerals are a group of minerals which have similar chemical composition, similar atomic structure, and thus similar properties.

Hardness 2 to 2.5; specific gravity low; usually white but may be any color; streak colorless; luster earthy; crystals absent; cleavage not recognizable.

Softness, earthy appearance, and the lack of crystallinity are the best criteria for the recognition of clay minerals. However, the individual clay minerals almost always have to be identified by laboratory methods because of their extremely small size. Clay minerals are economically important in Indiana, as pottery and bricks are made from them.

COPPER - Cu

Hardness 2.5 to 3; specific gravity high; red to dark red on fresh surface, tarnishes black; streak shiny red, luster metallic, earthy when tarnished; crystals absent; commonly in twisted and wirelike masses; fracture hackly.

Copper is recognized by its color, fracture, high specific gravity, and wirelike form. Glaciers have transported a small amount of copper nuggets into Indiana from the Lake Superior copper district .

DIAMOND – C

(Carbon)

Hardness 10 (hardest substance known; specific gravity medium weight; pale yellow or colorless and less commonly light shades of red, green, blue, or brown; streak colorless; luster shiny; crystals (generally eight aided or octahedron) present; cleavage perfect in two directions, yielding octahedrons.

Diamond is distinguished from similar-appearing substances (for example, glass) by its great hardness, shiny luster, and crystal form. About 30 diamond crystals have been found in the glacial drift and stream beds of Indiana in the past 100 years.

DOLOMITE - $CaMg(CO_3)_2$

(Calcium magnesium carbonate)

Hardness 3.5 to 4; specific gravity medium weight; colorless, pink, or white and rarely gray, green, brown, or black; streak colorless; luster glassy; powdered sample effervesces slightly; fragments do not effervesce; cleavage perfect in two directions, yielding rhombohedrons (fig. 1); cleavage recognizable only if crystals are present.

Dolomite is distinguished from most minerals by its cleavage and from calcite by the lack of effervescence on large fragments. Dolomite is the main constituent of the rock named dolomite and is present in most limestones.

FLUORITE - CaF_2

(Calcium fluoride)

Hardness 4; specific gravity medium weight to low; commonly yellow or blue and less commonly colorless, white, green, or brown; streak colorless; luster glassy; crystals present as cubes; cleavage perfect, forming eight-sided figures (octahedrons).

Fluorite is recognized most readily by its color, cubic crystals, and octahedral cleavage. It is rare, but it is found as cavity fillings and as veins in limestones.

GLAUCONITE - $K_2 (MgFe)_2 Al_6 (Si_4 O_{10}) (OH)_{12}$

(Potassium-magnesium-iron-aluminum silicate)

Hardness 1 to 2; specific gravity low; pale green, blue green, or yellow green; streak green gray; luster earthy; crystals absent; cleavage unrecognizable owing to lack of crystals.

The lack of good crystals, the green color, and the softness beat distinguish glauconite. Glauconite is in most shales and limestones of the State as surface coatings and as grains.

GOLD - Au

Hardness 2.5 to 3; specific gravity very high; golden yellow; streak golden yellow; luster metallic; crystals absent; commonly in irregular sheets, scales, and masses; fracture hackly.

Gold can easily be confused with pyrite or biotite. It is distinguished from pyrite by its softness and from biotite by its lack of cleavage, its streak, and its much higher specific gravity. Very small amounts of gold have been found in the glacial drift and stream beds of Indiana.

GYPSUM - $CaSO_4 \cdot 2H_2O$

(Calcium sulphate with water)

Hardness 2 (can be scratched with a fingernail); specific gravity low; white or colorless; luster glassy and rarely silky; crystals usually absent; cleavage in three directions and recognizable if crystals are present.

Gypsum is recognized by its softness. In Indiana it occurs in shales and limestones and caves. Gypsum is mined in Indiana and is used to make plaster and plasterboard.

MARCASITE - FeS_2

(iron disulphide)

Hardness 6 to 6.5; specific gravity high; pate bronze yellow, tarnishes yellow to brown; streak grayish black; luster metallic; crystals may or may not be present; spear-shaped aggregates are common; cleavage not recognizable.

The spear-shaped aggregates distinguish marcasite from pyrite; both are composed of the same chemical elements, but the atoms are arranged in different geometric patterns. In Indiana marcasite occurs in close association with pyrite in shales and coals.

PYRITE - FeS_2

(Iron disulphide)

Hardness 6 to 6.5; specific gravity high; pale brass yellow, tarnishes to a darker yellow; streak black; luster metallic; crystals may or may not be present; if present, they are cubes; cleavage in two directions and recognizable only if crystals are present.

Pyrite has been called “fool’s gold” because it has a close resemblance to gold (p. 20). Pyrite, however, is much harder than gold. The cubic crystals, if present, distinguish it from marcasite (p. 21).

SIDERITE - $FeCO_3$

(Iron carbonate)

Hardness 3.5 to 4; specific gravity medium weight; light to dark brown; streak, colorless; luster glassy; crystals may or may not be present; if present, they are rhombohedrons (fig. 1); cleavage excellent in two directions, yielding rhombohedral fragments; cleavage recognizable only if crystals are present.

Siderite is distinguished from most other minerals by its distinctive cleavage, from calcite (p. 16) by its lack of effervescence, and from dolomite (p. 19) by its darker color and higher specific gravity. In Indiana poorly crystalline siderite is found in some shales, and good crystals occur sporadically in geodes.

SPHALERITE – ZnS

(Zinc sulphide)

Hardness 3.5 to 4; specific gravity medium weight to high; commonly brown, black, or yellow and rarely green; streak yellow to brown; luster metallic to shiny, crystals may or may not be present; cleavage perfect, yielding 12-sided fragments (dodecahedrons); cleavage recognizable only if crystals are present.

Sphalerite is best recognized by its color, streak, luster, and cleavage. In Indiana it occurs in limestones, dolomites, shales, and geodes.

STRONTIANITE - $SrCO_3$

(Strontium carbonate)

Hardness 3.5 to 4; specific gravity medium weight; colorless or white and rarely green or yellow; streak colorless; luster glassy; effervescence strong; crystals in many samples thin and needlelike; cleavage good in one direction.

The strong effervescence in cold dilute hydrochloric acid distinguishes strontianite from most other minerals. The lack of rhombic cleavage distinguishes it from calcite (p. 16), and its higher specific gravity separates it from aragonite. Strontianite is very rare in Indiana; it is found mostly in cavities and veins of limestones.

The following minerals occur in igneous and metamorphic rocks and thus are found only in material brought in by the glaciers (p. 45 and 49).

Orthoclase - hardness 6; red, pink, or salmon brown; streak colorless; crystals usually present; cleavage good in two directions.

Plagioclase - hardness 6; white to gray; streak colorless; crystals usually present; cleavage good in two directions. The term *feldspar* maybe used for either orthoclase or plagioclase.

Biotite - hardness 2.5 to 3; brown to black; streak colorless; crystals present; cleavage excellent; splits into very thin, transparent flakes.

Muscovite - hardness 2 to 2. 5; colorless; streak colorless, crystals present cleavage excellent; splits into thin, transparent flakes. The term *mica* may be used for either biotite or muscovite.

Hornblende and *augite* (difficult to tell one from the other) - hardness 5 to 6; dark green to black; streak colorless; crystals present; cleavage good, yielding elongated pieces. The term *iron-magnesian mineral* may be used for either hornblende or augite. *Amphibole* is another term for hornblende and *pyroxene* is another term for augite.

Magnetit - hardness 6; black; streak black; luster metallic; magnetism strong; crystals present and are eight sided (octahedrons) (fig. 1); fracture conchoidal.

Garnet - hardness 6. 5 to 7. 5; reddish brown; streak colorless; most crystals twelve sided (dodecahedrons) (fig. 1); fracture conchoidal.

MINERAL IDENTIFICATION KEY

Using the key (table 2) will enable the reader to identify most minerals found in Indiana. The key is to be used in the following manner: (1) Examine the streak to see whether or not it is colored, and then classify the mineral as belonging to section A or B of the key. (2) Determine the hardness of the mineral, and then classify the mineral according to the three subgroups of A or B. (3) Examine other properties of the mineral to determine which mineral name in the subgroup fits best. (4) Confirm the identification by referring to the page number beside the name of the mineral to obtain a more complete description of the mineral.

Table 2--*Mineral identification key*

A. Streak colored

		Page
1. Hardness less than 3		
Streak green gray; no crystals; color green	*Glauconite*	20
Streak red; color red; twisted and wirelike forms	*Copper*	18
Streak yellow brown; color brown; no crystals	*Limonite*	16
Streak yellow; color golden yellow; Forms as irregular sheets; Hackly fracture	*Gold*	20
2. Hardness form 3 to 6		
Streak yellow to brown Cleavage dodecahedral; hardness 3. 5 to 4	*Sphalerite*	22
Crystals needlelike; hardness 5 to 5.5	*Goethite*	16
Streak black; color black; magnetic; hardness *6*	*Magnetite*	23

B. Streak colorless

1. Hardness less than 3		
Cleavage distinct Splits into thin flakes; brown to black color	*Biotite*	22
Splits into thin flakes; colorless	*Muscovite*	23
Cleavage in three directions; color white or colorless	*Gypsum*	20
No cleavage Color generally white; no Crystals	*Clay minerals*	18

Table 2.--*Mineral identification key--Continued*

		Page
B. Streak colorless—Continued		
2. Hardness between 3 and 6		
Efferverscence		
Rhombic cleavage; hardness 3	*Calcite*	16
Cleavage not rhombic;		
needlelike crystals..........................	*Aragonite* or	17
	Strontianite	22
No efferverscence		
Cleavage rhombic		
Color white or pink	*Dolomite*	19
Color light to dark brown	*Siderite*	21
Cleaveage not rhombic		
No crystals; hardness 5; color usually black...........	*Apatite*	17
No crystals; hardness 3 to 3.5; color white................	*Anhydrite*	17
Cubic crystals; octahedral cleavage; color yellow or blue.................................	*Fluorite*	19
Crystals present; color white; Specific gravity medium weight to high..................	*Barite* or	17
	Celestite	18
3. Hardness greater than 6		
Distinct cleavage		
Crystals present; cleavage octahedral; hardness 10....	*Diamond*	19
Cleavage in two directions; color red; hardness 6.................	*Orthoclase*	22
Cleavage in two directions; color White...............................	P*lagioclase*	22
Cleavage elongated; color black-	*Augite* or	23
	Hornblende	23
No cleavage		
Conchoidal fracture; hardness 7-	*Quartz*	16
Crystals dodecahedral; color reddish brown..................	*Garnet*	23

SELECTED MINERAL LOCALITIES LISTED BY COUNTY [1]

BARTHOLOMEW COUNTY:

1. Meshberger Stone Company quarry, 2 miles northeast of Elizabethtown, NE1/4 sec. 6, T. 8 N., R. 7 E.

   Apatite, calcite, fluorite, glauconite, marcasite, pyrite, quartz, and sphalerite.

BENTON COUNTY:

2. Outcrops along Carpenter Creek 1. 5 miles south of Remington (Jasper County), NE1/ 4 sec. 1, T. 26 N., R. 7 W.

   Barite.

3. Cuts along small tributary to Big Pine Creek 7 miles northeast of Fowler, NW l/ 4NW l/ 4 sec. 34, T. 26 N. , R. 7 W.

   Aragonite.

4. Cuts along Big Pine Creek 7 miles east of Fowler, NW1/ 4SW1/ 4 sec. 34, T. 26 N., R. 7 W.

   Barite.

BROWN COUNTY:

5. Road cut on Indiana 46 100 feet north of entrance to Brown County State Park, 2 miles southwest of Nashville, NE1/ 4NE1/ 4 sec. 35, T. 9 N., R. 2 E.

   Aragonite, goethite, and quartz.

CASS COUNTY:

6. France Stone Company quarry, 2. 5 miles east of Logansport, NE1/4 sec. 27, T. 27 N., R. 2 E.

   Apatite, calcite, glauconite, marcasite, pyrite, and quartz.

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[1] Compiled from Erd, R. C., 1954, The mineralogy of Indiana (unpublished A. M. thesis): 170 p., 4 pls., 1 fig., Ind. Univ. (See figure 3 for the location of counties mentioned in this list.)

CLAY COUNTY:

7. Hydraulic Press Brick Company pit, 1 mile north of Brazil, NE1/ 4NE 1/ 4 sec. 25, T. 13 N. , R. 7 W.

   Sphalerite.

CRAWFORD COUNTY:

8. Marengo Cave, northeast edge of Marengo, center NW1/ 4 sec. 6, T. 2 S., R. 2 E.

   Aragonite and gypsum.

9. Louisvilie Cement Company quarry, northwest edge of Milltown, SW sec. 10, T. 2 S., R. 2 E.

   Dolomite and fluorite.

10. Road cut on Indiana 62 near Wyandotte Cave, 0. 25 mile east of Wyandotte, NW1/ 4 sec. 27, T. 3 S. , R. 2 E.

    Dolomite.

11. Wyandotte Cave, at Wyandotte, NW1/ 4 sec. 28, T. 3 S., R. 2 E.

    Calcite and gypsum.

DECATUR COUNTY:

12. New Point Stone Company quarry, 1 mile north of New Point, S1/ 2SW 1/ 4SW1/ 4 sec. 8, T. 10 N., R. 11 E.

    Barite, calcite, dolomite, glauconite, goethite,. marcasite, and pyrite.

FLOYD COUNTY:

13. Floyd County Stone Company quarry, I mile southwest of Edwardsville, NE1/ 4NE1/ 4 see. 11, T. 3 S. , R. 5 E.

    Gypsum and quartz.

FOUNTAIN COUNTY:

14. Morgan Coal Company pit, 2 miles northeast of Kingman, SW1/ 4SE1/ 4 see. 20, T. 18 N., R. 7 W.

    Gypsum, marcasite, and pyrite.

GREENE COUNTY:

15. Yake Coal Company pit (abandoned), 1 mile southwest of Switz City, SE 1/ 4NW1/ 4 sec. 28, T. 7 N., R. 6 W.

    Goethite and gypsum.

HARRISON COUNTY:

16. Road cut on Indiana 62, 5 miles west of Corydon, SW1/ 4NE1/ 4 sec. 20, T. 3 S. , R. 3 E.

    Calcite, dolomite, and fluorite.

17. Road cut on Indiana 62, 5.1 mile west of Corydon, NE l/ 4SWl/ 4 sec. 20, T. 3 S. , R. 3 E.

    Aragonite, dolomite, and fluorite.

18. Corydon Stone Company quarry (abandoned), 2.5 miles southwest of Lanesville, NE1/ 4SWl/ 4 see. 25, T. 3 S., R. 4 E.

    Calcite and quartz.

19. Corydon Stone Company quarry, northwest edge of Corydon, SE1/ 4SE1/ 4 sec. 25, T. 3 S., R. 3 E.

    Calcite, fluorite, and quartz.

HOWARD COUNTY:

20. Stuntz -Yeoman quarry, 1. 25 miles west of Kokomo, NW1/ 4NE 1/ 4 sec. 3, T. 23 N., R. 3 E.

    Sphalerite.

HUNTINGTON COUNTY:

21. Erie Stone Company quarry, east edge of Huntington, SE1/ 4SW1/ 4 and SW1/ 4SE1/ 4 sec. 12, T. 28 N., R. 9 E.

Calcite, dolomite, marcasite, pyrite, quartz, and sphalerite

JACKSON COUNTY:

22. Seymour Gravel Company quarry (abandoned), 2 miles north west of Medora, SE1/ 4SE1/ 4 sec. 29, T. 5 N. , R. 3 E.

Barite, dolomite, marcasite, pyrite, quartz, siderite, and sphalerite.

23. Old abandoned quarry immediately west of the Seymour Gravel Company quarry (see above), SW1/ 4SE1/ 4 sec. 29, T. 5 N., R. 3 E.

Barite, dolomite, marcasite, quartz, and sphalerite.

JASPER COUNTY:

24. Babcock Construction Company quarry, southeast edge of Rensselaer, SE1/ 4SE1/ 4 sec. 30, T. 29 N., R. 6 W.

Calcite, pyrite, and sphalerite.

JEFFERSON COUNTY:

25. Cut along the Pennsylvania Railroad on the north edge of Madison, NE 1/ 4SW1/ 4 sec. 34, T. 4 N., R. 10 E.

Barite, calcite, dolomite, and pyrite.

JENNINGS COUNTY:

26. Paul Frank quarry, northeast edge of North Vernon, NE1/ 4 sec. 34, T. 7 N., R. 8 E.

Barite, calcite, dolomite, glauconite, pyrite, and sphalerite

KNOX COUNTY:

27. Bicknell Coal Company (Pan Handle mine), 2. 5 miles southwest of Bicknell, SE1/ 2 Donation 142, Washington Township.

    Sphalerite.

LAWRENCE COUNTY:

28. Outcrop in ravine 1.25 miles east of Heltonville, SE1/ 4NE1/ 4 sec. 25, T. 6 N., R. 1 E.

    Sphalerite.

29. Outcrop on the west side of Southerlin Hill on Indiana 54, 2. 5 miles west of Springville, NW1/ 4 sec. 20, T. 6 N., R. 2 W.

    Barite.

30. Ralph Rogers Company quarry, 2 miles southwest of Springville, SE1/ 4SE1/ 4 sec. 2 9, T. 6 N. , R. 2 W.

    Gypsum and sphalerite.

31. Webster quarry (abandoned), 3. 5 miles southwest of Springville, SW 1/ 4NE1/ 4 sec. 31, T. 6 N., R. 2 W.

    Barite.

32. Outcrop along the Leesville Road 0. 5 mile south of U. S. 50 and 2 miles northwest of Leesville, SE1/ 4NE1/ 4 sec. 17, T. 5 N., R. 2 E.

    Barite.

33. Outcrop in drainage ditch along Indiana 58, 3 miles northeast of Bedford, SE1/ 4SE1/ 4 sec. 5, T. 5 N. , R. 1 E.

    Barite.

34. Williams Limestone Company quarry (abandoned), east edge of Bedford, NW1/ 4NE1/ 4 sec. 24, T. 5 N. , R. I W.

    Calcite.

LAWRENCE COUNTY- -Continued:

35. Abandoned quarry and cut along the Baltimore and Ohio Railroad 2 miles southeast of Buddha, NE1/ 4NW1/ 4 sec. 23, T. 4 N. , R. 1 E.

Barite, calcite, celestite, quartz, sphalerite, and strontianite.

Lehigh Portland Cement Company quarry, 2 miles northeast of Mitchell, S 1/ 2 sec. 30, T. 4 N. , R. 1 E.

Anhydrite, calcite, celestite, gypsum, and quartz.

37. Cut at the overhead cross of Indiana 450 over the Chicago, Milwaukee, St. Paul, and Pacific Railroad 1 mile west of Williams, SE1/ 4SW1/ 4 sec. 6, T. 4 N., R. 2 W.

Barite.

38. Cut along the Baltimore and Ohio Railroad 1 mile east of Huron, S1/ 2 sec. 5, T. 3 N., R. 2 W.

Goethite and gypsum.

39. Nally, Ballard, and Cato quarry, 0. 5 mile west of Georgia, SE1/ 4NE1/ 4 and NE1/ 4SE1/ 4 sec. 12, T. 3 N., R. 2 W.

Barite, dolomite, and strontianite.

MADISON COUNTY:

40. Standard Materials Corporation quarry, northwest corner of Lapel, E1/ 2NW1/ 4 and W1/2NE1/4 sec. 28, T. 19 N. , R. 6 E.

Calcite and sphalerite.

MIAMI COUNTY:

41. Outcrop along Big Pipe Creek 1 mile northeast of Bunker Hill, SW1/ 4 NE1/ 4SW1/ 4 sec. 29, T. 26 N., R. 4 E.

Pyrite.

MONROE COUNTY:

42. Road cut on new Indiana 37, 7. 5 miles north of Bloomington, NE1/ 4 SE1/ 4 sec. 21, T. 10 N., R. 1 W.

    Barite and siderite.

43. Abandoned quarry 0.5 mile east of Unionville on Indiana 45, NW1/ 4SW1/ 4 sec. 10, T. 9 N. , R. 1 E.

    Barite, calcite, dolomite, glauconite, goethite, pyrite, quartz, and sphalerite.

44. Road cut on new Indiana 37, 5 miles north of Bloomington, NE1/ 4NW 1/ 4 sec. 4, T. 9 N., R. 1 W.

    Aragonite, barite, calcite, dolomite, goethite, quartz, siderite, and sphalerite.

45. Road cut on new Indiana 37, 2 miles north of Bloomington, NW1/ 4SW1/ 4 and SW1/ 4NW1/ 4 sec. 21, T. 9 N., R. 1 W.

    Apatite, barite, dolomite, glauconite, goethite, quartz, siderite and sphalerite.

46. Small abandoned quarry 1.8 miles east of Bloomington on Indiana 45, SW1/ 4 sec. 25, T. 9N., R. 1 W.

    Barite, sphalerite, and strontianite.

47. Outcrop in small tributary to Griffys Creek 1 mile north ofBloomington, SW1/ 4NW1/ 4 sec. 27, T. 9 N., R. 1 W.

    Sphalerite.

48. Outcrop and wash in small stream near the University Reservoir, northeast edge of Bloomington, SE1/ 4NW1/4 sec. 34, T. 9 N. , R. 1 W.

    Fluorite and sphalerite.

49. Bloomington Crushed Stone Company quarry, 0. 5 mile north of Bloomington, SW1/ 4NW1/ 4 sec. 28, T. 9 N., R. 1 W.

    Barite, calcite, celestite, dolomite, glauconite, goethite, gypsum, marcasite, pyrite, quartz, sphalerite, and strontianite.

MONROE COUNTY- -Continued:

50. Road cut on Indiana 46, 5 miles east of Bloomington, SW1/ 4NE1/ 4 sec. 4, T. 8 N. , R. 1 E.

    Barite and calcite.

51. Road cut on Indiana 37 south of Monon Railroad overhead bridge 0. 5 mile southeast of Clear Creek, SW1/ 4NW1/ 4 sec. 28, T. 8 N., R. 1 W.

    Barite.

52. Abandoned quarry on Ketchem Road 2.75 miles west of Smithville, SW1/ 4NE1/ 4 sec. 6, T. 7 N. , R. 1 W.

    Dolomite and sphalerite.

53. Smithville quarry (abandoned), 1 mile southeast of Smithville, SW1/ 4 NW1/ 4 sec. 11, T. 7 N., R. 1 W.

    Barite, calcite, dolomite, and quartz.

54. Road cut on Indiana 3 7 0.75 mile north of Harrodsburg, NW1/ 4 SE1/ 4 sec. 20, T. 7 N. , R. 1 W.

    Aragonite, barite, calcite, dolomite, and quartz.

55. Road cut on Indiana 37 at the south edge of Harrodsburg, W1/ 2SE1/ 4 NE1/ 4 sec. 29, T. 7 N., R. 1 W.

    Barite, goethite, quartz, and siderite.

56. Road cut on Indiana 37 south of the bridge over Clear Creek 1.25 miles south of Harrodsburg, NE1/ 4SW1/ 4 sec. 32, T. 7 N. , R. 1 W.

    Siderite and sphalerite.

57. Quimby and Stephen quarry, 2. 8 miles south of Stanford, SW1/ 4SE1/ 4 sec. 6, T. 7 N. , R. 2 W.

    Marcasite and pyrite.

MONTGOMERY COUNTY:

58. Above the iron bridge over Sugar Creek 1 mile west of Crawfordsville, center sec. 21, T. 19 N. , R. 4 W.

Calcite and quartz.

59. New Ross Limestone Company quarry, 1. 5 miles south of New Ross, NE1/ 4NE1/ 4 sec. 3, T. 17 N. , R. 3 W.

Barite and strontianite.

60. Parkersburg quarry (abandoned), 1. 25 miles north of Parkersburg, S1/ 2 NW1/ 4NW1/ 4 sec. 32, T. 17N., R. 4W.

Sphalerite.

61. Waveland Stone Company quarry, 2 miles southwest of Waveland, SE1/ 4SW1/ 4 sec. 34, T. 17 N., R. 6 W.

Aragonite, barite, goethite, siderite, and sphalerite.

MORGAN COUNTY:

62. Brooklyn Shale Company pit, 0.5 mile southwest of Brooklyn, NE1/ 4NE1/ 4 sec. 3 5, T. 13 N. , R. 1 E.

Barite and gypsum.

63. Road cut on Indiana 67 near junction with Indiana 39, 1 mile west of Martinsville, NE1/ 4 SW1/ 4 sec. 32, T. 12 N., R. 1 E.

Marcasite.

ORANGE COUNTY:

64. Radcliff and Berry, Inc. quarry, 1 mile northwest of Orleans, SW1/ 4 SE1/ 4 sec. 24, T. 3 N., R. 1 W.

Barite.

OWEN COUNTY:

65. Cut on secondary road 2 miles north of Gossett, NE1/ 4NE1/ 4 sec. 29, T. 11 N., R. 2 W.

    Sphalerite.

66. Cut near railroad station in the southeast corner of Gosport, NE1/ 4SW1/ 4 sec. 32, T. 11 N., R. 2 W.

    Quartz, siderite, and sphalerite.

67. Dunn Limestone Company quarry, 3. 5 miles northeast of Spencer, NE1/ 4NW1/ 4 sec. 10, T. 10 N., R. 3 W.

    Celestite.

68. Abandoned quarry at the junction of Indiana 46 and secondary road to Gosport 4 miles east of Spencer, SE1/ 4SE1/ 4 sec. 24, T. 10 N. , R. 3 W.

    Barite, marcasite, pyrite, and siderite.

69. Outcrop along McCormick's Creek, McCormick's Creek State Park, NE1/ 4 sec. 22, T. ION., R. 3W.

    Sphalerite.

70. France Stone Company quarry, 1 mile southwest of Spencer. NE1/ 4 sec. 30, T. 10 N. , R. 3 W.

    Gypsum.

PARKE COUNTY:

71. Wallace quarry (abandoned), 3 miles east of Grange Corner, NE1/ 4 sec. 7, T. 17 N. , R. 6 W.

    Barite, dolomite, and sphalerite.

72. William Dee clay pit, 2.5 miles northwest of Bloomingdale, SE1/ 4 NW1/ 4 sec. 9, T. 16 N., R. 8 W.

    Sphalerite.

PERRY COUNTY:

73. Lutring and Sons quarry, 0.6 mile east of Branchville, SE1/ 4 sec. 18, T. 4S., R. 1W.

    Aragonite, calcite, gypsum, and marcasite.

74. Scheeler quarry, 1 mile northeast of Derby, NW1/ 4SE1/ 4 sec. 32, T. 5 S., R. 1 W.

    Barite.

PIKE COUNTY:

75. Enos Coal Mining Company pit, 2 miles northwest of Spurgeon, SW1/ 4 NW1/ 4 sec. 2, T. 3 S., R. 8 W.

    Marcasite and pyrite.

PULASKI COUNTY:

76. Francesville Stone Company quarry, 2 miles south of Francesville, NE1/ 4SW1/ 4 sec. 16, T. 29 N., R. 4 W.

    Pyrite.

PUTNAM COUNTY:

77. Russellville Stone Company quarry, 0. 5 mile south of Russellville, NW1/ 4SE1/ 4 sec. 8, T. 16 N., R. 5 W.

    Barite, quartz, and sphalerite.

78. Abandoned quarry 4 miles south of Russellville, center SE1/ 4 sec. 28, T. 16 N., R. 5 W.

    Quartz and sphalerite.

79. Big Walnut Creek 5 miles northeast of Greencastle, T. 14 N. , R. 4 W.

    Dolomite, goethite, pyrite, quartz, and sphalerite.

PUTNAM COUNTY- -Continued:

80. Ohio and Indiana Stone Company quarry, 1 mile southwest of Greencastle, junction secs. 10, 20, 29, and 30, T. 14 N. , R. 4 W.

Dolomite and sphalerite.

81. Lone Star Cement Company quarry, 0.25 mile southeast of Limedale, junction secs. 28, 29, 32, and 33, T. 14 N. , R. 4 W.

Siderite and sphalerite.

82. Indiana State Farm quarry, 1 mile southwest of Putnamville, NW1/ 4SW1/ 4 sec. 17, T. 13 N., R. 4 W.

Siderite.

RIPLEY COUNTY:

83. Road cut on Indiana 129, 6 miles southeast of Versailles, NE1/ 4SW1/ 4 sec. 8, T. 6 N. , R. 12 E.

Barite and calcite.

RUSH COUNTY:

84. Rush County Stone Company quarry, west edge of Moscow, W1/ 2SE1/ 4 sec. 18, T. 12 N. , R. 9 E.

Calcite and pyrite.

SCOTT COUNTY:

85. Scott County Stone Company quarry, 2 miles south of Blocher, NE1/ 4NW1/ 4 sec. 20, T. 3 N., R. 8 E.

Dolomite and sphalerite.

SHELBY COUNTY:

86. Cave Stone Company quarry, 0. 5 mile west of Norristown, NE1/4NW1/4 sec. 32, T. 11 N., R. 7 E.

Calcite and fluorite.

SWITZERLAND COUNTY:

87. Tri-County Stone Company quarry, 3 miles northwest of Bennington, NE1/ 4NW l/ 4 sec. 9, T. 5 N. , R. 12 E.

    Barite.

VERMILLION COUNTY:

88. Outcrops along the Little Vermillion River, sec. 32, T. 17 N. , R. 10 W.

    Sphalerite.

89. Ayrshire Collieries pit, 3.5 miles west of Clinton, NW1/ 4 sec. 24, T. 14 N., R. 10 W.

    Pyrite.

WABASH COUNTY:

90. American Rack Wool quarry (abandoned), west edge of Wabash, SE1/ 4SWl/ 4SEl/ 4 sec. 9, T. 27 N., R. 6 E.

    Glauconite.

91. Abandoned quarry 3 miles west of Wabash, SE1/ 4NW1/ 4 sec. 13, T. 27 N., R. 5 E.

    Calcite and marcasite.

WARREN COUNTY:

92. Bluff along Mud Pine Creek 1. 5 miles west of Rainsville, SWl/ 4NE l/ 4 sec. 29, T. 23 N., R. 8 W.

    Barite and sphalerite.

93. Small coal mine on the north side of Indiana 63 4. 5 miles south of West Lebanon, SWl/ 4SW1/ 4 sec. 2, T. 20 N. , R. 9 W.

    Sphalerite.

WASHINGTON COUNTY:

94. Abandoned quarry on the west side of Indiana 13 5 on the north edge of Plattsburg, SW l/ 4SW1/ 4 sec. 4, T. 3 N. , R. 4 E.

Barite.

95. Cut along the Monon Railroad on the south edge of Harristown, west line SEl/ 4 sec. 24, T. 2 N. , R. 4 E.

Sphalerite.

96. Ralph Rogers Company quarry (abandoned), 1 mile south of Salem, NW1/4SE1/4 sec. 20, T. 2 N. , R. 4 E.

Celestite, gypsum, and quartz.

97. Cut for dam spillway 2 miles south of Salem, on the east side of Indiana 135, NW l/ 4NE l/ 4 sec. 32, T. 2 N. , R. 4 E.

Barite, quartz, and sphalerite.

98. Outcrop in small stream 1. 75 miles northwest of Salem, SW1/ 4SW1/ 4 sec. 12, T. 2 N., R. 3 E.

Pyrite.

99. Salem Lime and Stone Company quarry (abandoned), 1 mile west of Salem, SW1/ 4SEl/ 4 sec. 13, T. 2 N., R. 3 E.

Sphalerite.

100. Hoosier Lime and Stone Company quarry, 0. 7 mile west of Salem, NE1/ 4 sec. 24, T. 2 N., R. 3 E.

Gypsum and sphalerite.

101. Road cut on Indiana 60 3 miles northwest of Pekin, SW1/ 4NEl/ 4 sec. 2, T. 1 N., R. 4 E.

Quartz.

WASHINGTON COUNTY- -Continued:

102. Road cut on Indiana 60 immediately south of locality 101 (above), 3 miles northwest of Pekin, SW1/ 4SE1/ 4 sec. 2, T. 1 N. , R. 4 E.

Aragonite, quartz, siderite, and sphalerite.

103. Small abandoned quarry 1. 2 5 miles west of Pekin, SWl/ 4SEl/ 4 sec. 22, T. IN., R. 4 E.

Barite, fluorite, gypsum, and sphalerite.

104. Abandoned quarry 2.25 miles west of Pekin, SW1/ 4SEl/ 4 sec. 2 1, T. 1 N. , R. 4 E.

Sphalerite.

105. Abandoned quarry on the west side of Indiana 135 5 miles southwest of Pekin, SE1/ 4SE1/ 4 see. 5, T. 1 S., R. 4 E.

Gypsum.

WAYNE COUNTY:

106. DeBolt quarry, 3 miles southeast of Richmond, NE1/ 4SW1/ 4 sec. 11, T. 13N., R. 1 W.

Apatite, barite, calcite, glauconite, goethite, and sphalerite.

107. Abandoned quarry immediately west of bridge of Indiana 227 over Elkhorn Creek 2. 25 miles northwest of Boston, NE1/ 4 SW l/4 sec. 22, T. 13 N. , R. 1 W.

Barite.

WELLS COUNTY:

108. Erie Stone Company quarry, 1. 5 miles north of Bluffton, SWl/ 4NW1/ 4 sec. 28, T. 27 N., R. 12 E.

Dolomite, marcasite, and pyrite.

WELLS COUNTY- -Continued:

109. Heller Stone Company quarry, 7 miles west and 1 mile north of Bluffton, NW1/ 4SE1/ 4 sec. 29, T. 27 N., R. 11 E.

Calcite, goethite, gypsum, marcasite, pyrite, and sphalerite.

WHITE COUNTY:

110. Monon Crushed Stone Company quarry, 1 mile south of Monon, SEl/ 4NE l/ 4 sec. 28, T. 28 N. , R. 4 W.

Pyrite and quartz.

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[2]Numbers refer to localities shown in county list (p. 26-41).

Sphalerite	1, 7, 20, 21, 22, 23, 24, 26, 27, 28, 30, 35, 40, 43, 44, 45, 46, 47, 48, 49, 52, 56, 60, 61, 65, 66, 69, 71, 72, 77, 78, 79, 80, 81, 85, 88, 92, 93, 95, 97, 99, 100, 102, 103, 104, 106, 109.
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ROCKS

DEFINITION

Rocks are aggregates of minerals which form the solid crust of the earth. The kinds of rocks are many, and the way they look depends upon the minerals present, the size of individual mineral grains, and the manner in which the minerals are associated. Rock materials that make up the earth may be divided into two categories: (1) surficial material (loose and unconsolidated fragments) and (2) bedrock (consolidated material).

SURFICIAL MATERIALS

Surficial materials include (1) glacial deposits, (2) lake deposits, (3) wind deposits, (4) stream deposits, and (5) soils. All these surficial deposits consist of materials derived from bedrock and thus may contain many kinds of rocks and minerals.

BEDROCK

Geologists divide rocks into three classes according to origin. *Igneous rocks* have been formed from melted material (magma) that has solidified upon cooling. *Sedimentary rocks* have been formed at the surface of the earth either from accumulation and cementation of rock fragments, minerals, and fossils or by precipitation of solid particles from sea water and other surface solutions. *Metamorphic rocks* have been formed by the transformation or alteration--while in the solid state--of pre-existing rocks by means of pressure, heat, and chemically active fluids.

Rocks are difficult to classify because one rock type may grade into another. However, rocks can be assigned to one of the three classes mentioned above, and subdivisions of these classes can be made. This is like classifying people into tall, medium, and short, even though we know there are many gradations in size.

IGNEOUS ROCKS

CLASSIFICATION

Igneous rocks are formed by solidification of melted material that originated within the earth. These rocks occur as intrusive and extrusive masses. Intrusive rocks are formed when melted material rises within the earth but does not reach the surface. The melted material cools and solidifies under a cover of rock and becomes accessible to view only when uncovered by erosion. Extrusive rocks are formed when melted material reaches the earth's surface and is discharged through an opening or vent. The melted rock flows out over the surface and solidifies. Igneous rocks do not crop out at the surface in Indiana. They are found only in the glacial drift and in streams that flow through or from the regions of glacial drift.

Igneous rocks are classified according to (1) texture (the size of the crystals or grains) and (2) mineralogic composition (the minerals present and their relative abundance. (See table 3.) A rock of coarse-grained texture is one whose mineral grains are large enough to be seen and identified with the unaided eye. A rock of fine-grained texture is one whose mineral grains are small and represent, at best, mere specks. One cannot identify the minerals of fine-grained rocks unless he uses a microscope. Some igneous rocks have large mineral crystals or phenocrysts embedded in a dense or granular groundmass of much smaller crystals. These rocks are said to have a *porphyritic texture*. The name given to a particular igneous rock because of its mineralogic composition is commonly prefixed to the word porphyry if that igneous rock has a porphyritic texture. Thus an igneous rock may be called a granite porphyry or a diorite porphyry.

DESCRIPTIONS OF COMMON IGNEOUS ROCKS

Granite is probably the most common igneous rock found in the glacial drift of Indiana. This rock is characterized by a coarse-grained texture and is composed mostly of quartz and feldspar. These two minerals make most granites appear light colored, generally pink or gray. Biotite and hornblende are commonly present in most granites, and they give the rock a mottled appearance. *Granodiorite* is like granite except that the feldspar is plagioclase instead of orthoclase.

Diorite and *gabbro* are composed of iron-magnesian minerals and plagioclase feldspar. These rocks generally are dark gray or black. The iron-magnesian minerals in diorite are mostly hornblende, and in gabbro they are mostly augite. *Diabase* is similar to gabbro, but is slightly finer grained.

Rhyolite has a fine-grained groundmass commonly speckled with large crystals of quartz and orthoclase. Rhyolites are found generally in flowing lava. *Andesite* has a fine-grained groundmass and large crystals of plagioclase and ranges widely in color.

Table 3.--Classification of igneous rocks

Mineral composition	Texture	
	Coarse-grained	Fine-grained
Excess of light-colored minerals: Feldspars and quartz abundant; some biotite.	Granite[1] Granodiorite[2]	Rhyolite[1] Dacite[2]
Excess of light-colored minerals: Plagioclase feldspars predominant; no quartz; some biotite; some iron-magnesian minerals.	Diorite	Andesite
Excess of dark-colored minerals: Iron-magnesian minerals abundant; no quartz; feldspars predominant.	Diabase Gabbro	Basalt

[1]Feldspar predominantly orthoclase.

[2]Feldspar predominantly plagioclase.

Andesite occurs abundantly in flowing lava. *Dacite* is similar to andesite but it contains some large quartz crystals. *Basalt* is composed of iron-magnesian minerals and some feldspar. Mineral grains are small and cannot be distinguished without the aid of a microscope. The rock is generally black, gray, green, or blue and is uniformly dull in appearance.

SEDIMENTARY ROCKS

CLASSIFICATION

Sedimentary rocks are formed from accumulations of rock fragments, minerals, and fossils which have been transported to their present locations by streams, currents, or winds or by precipitation of solid particles from sea water or river water. Because it is difficult to determine the origin of a particular sedimentary rock, a classification based on grain size and chief mineral content is used (table 4).

DESCRIPTIONS OF COMMON SEDIMENTARY ROCKS

Limestone is composed almost entirely of the mineral calcite. Limestones differ in appearance and color according to their grain size and amount of impurities. Some black limestones contain organic matter and give off a fetid odor when they are freshly broken. Most limestones are light colored, and many contain numerous fossils.

Dolomite resembles limestone. It is composed chiefly of the mineral dolomite for which it was named. The rock dolomite commonly grades into limestones, and thus it is difficult to determine the amounts of the minerals calcite and dolomite in the rock.

Sandstone is composed of cemented grains of sand size (1/ 16 inch to l/ 64 inch in diameter - - 1 inch equals 25 millimeters). Most sand grains are quartz, but many other minerals and other rock fragments of sand size may be found in sandstone.

Conglomerate is composed chiefly of cemented gravel (rounded pebbles more than l/ 16 inch in diameter). Most conglomerates have sand-size particles filling the spaces between the pebbles. *Breccia* resembles conglomerate, but the individual pebbles are angular instead of round.

Shale is composed mainly of clay minerals which are less than l/ 64 inch in diameter. Other minerals in shale are mica and quartz. Some shales break along

Table 4.--Classification of sedimentary rocks[1]

Mineral grain size	Mineralogic composition				
	Calcite	Dolomite	Quartz	Gypsum-anhydrite	Clay minerals
1/16 inch (1.4 mm) or greater	Limestone	Dolomite	Quartz conglomerate or breccia		
1/64 inch to 1/16 inch (o.4 mm to 1.4 mm)			Sandstone		
Cannot be seen with unaided eye			Chert or flint	Evaporites	Clay or shale

[1]Sedimentary rocks also include the following mineral fuels:
peat (decomposed plant remains with some stems, leaves, and roots visisble).
coal (decomposed plant remains with stems, leaves, and roots not visible).

Closely spaced planes, but others break into small angular blocks. The term *mudstone* commonly is applied to the latter.

Chert consists of quartz grains which are less than 1/64 inch in diameter. This rock occurs rarely in large masses, but rather it is found in limestone and dolomite as nodules that resemble a knobby potato, as distinct layers, or as thin discontinuous layers. Dark-colored chert is called *flint.*

Peat and coal consist of the altered remains of land-dwelling plants. Peat consists of partially decomposed plant remains whose leaves, stems, and roots can be distinguished. In places where peat has been covered by large amounts of sediments, it has become compacted and has been transformed into coal. The extent of the transformation determines the rank of coal. The lowest ranked coal is known as lignite, and successively higher ranks are known as bituminous and anthracite.

Evaporites, represented by such minerals as halite, gypsum, and anhydrite, are deposits commonly formed from the evaporation of sea water. Whenever sea water is evaporated to dryness in the laboratory, many minerals are formed, but rock salt (halite) is the most abundant. Minerals are precipitated from sea water in order of their solubility. Thus rock gypsum (less soluble) is precipitated from sea water before halite (more soluble).

METAMORPHIC ROCKS

CLASSIFICATION

Metamorphic rocks are formed as igneous and sedimentary rocks are changed in either their mineral content or their grain size, or both. These changes are largely the result of pressure created at depths within the earth or of heat derived from nearby melted rock. These changes are not uniform; the metamorphic rock may grade into the rock from which it was formed without sharp distinctions, or the metamorphic process may have been so intense as to alter thoroughly the character of the rock and thus to form what appears to be a new rock. Metamorphic rocks do not crop out at the surface in Indiana. They are found only in the glacial drift and in streams that flow through or from the regions of glacial drift.

Many metamorphic rocks exhibit a parallel arrangement of their mineral components; this layered or banded structure is known as *foliation.* The layers may be broad bands, as in gneiss, or they may be thin layers, as in slate. Such rocks may be split easily along these bands or layers.

Metamorphic rocks are classified according to texture (grain size and arrangement) and mineralogic composition (table 5). The principal textures are:

(1) Granoblastic--unfoliated; mineral grains are visible.

(2) Slaty--very thinly foliated; parallel planes of splitting caused by layered minerals such as the micas. The individual minerals may or may not be visible.

(3) Schistose--thinly foliated; thin parallel bands or lenses. Mineral grains are visible and are of the platy or rodlike type such as are found in the micas and amphiboles.

(4) Gneissose--broadly foliated; layers are wavy; minerals are coarse and easy to recognize; generally alternation of light and dark minerals.

DESCRIPTIONS OF COMMON METAMORPIHC ROCKS

Quartzite a hard sugary-looking granoblastic rock composed almost entirely of interlocking quartz grains. The rock breaks across the grains rather than around the grains., as in a sandstone. Quartzites are formed from sandstones and are the most abundant metamorphic rock type found in the glacial drift in Indiana.

Marble is a granoblastic rock composed mostly of calcite or dolornite. It is formed by the metamorphism of limestone and dolomite.

Slate and *phyllite* have slaty textures, and their mineral grains are too small to be identified by the unaided eye. Slate is dull gray and phyllite is shiny on a cleavage surface. Most slates are formed by the metamorphism of shale.

Schists, as expected, have schistose texture. Schists commonly are called by the mineral that causes the foliation--for example, mica schist and amphibole schist. Schists are formed by the metamorphism of many different types of igneous and sedimentary rocks.

Gneiss is an example of a rock with gneissose texture. Gneisses are among the most abundant metamorphic rocks, and most of them are derived from the

Table 5.--Classification of *metamorphic rocks*

Rock	Texture	Rock commonly derived from	Chief mineral
Quartzite	Granoblastic (unfoliated)	Sandstone	Quartz
Marble	Granoblastic (unfoliated)	Limestone	Calcite
Slate	Slaty (very thinly foliated)	Shale	Mica, quartz
Schist	Schistose (thinly foliated)	Basalt, andesite, shale, rhyolite, gabbro	Plagioclase, muscovite, biotite, quartz, amphibole
Gneiss	Gneissose (broadly foliated)	Granite, shale, diorite, rhyolite, etc.	Feldspars, quartz, mica, amphibole, garnet

IDENTIFICATION OF ROCKS

To classify an Indiana rock as sedimentary, igneous, or metamorphic, one should determine if most of the minerals in the rock are the same (sedimentary rock) or if the rock has many different minerals (igneous or metamorphic rock). If the rock has many different minerals, one should determine if the rock is foliated (metamorphic rock) or if the rock is unfoliated (igneous rock). After the rock has been classified, one should consult the appropriate classification table (tables 3, 4, and 5) to determine the name of the rock.

GENERAL LOCALITIES FOR ROCK COLLECTING

Igneous and metamorphic rocks are not native to Indiana--that is, they are not found in the bedrock. Many thousands of years ago glacial ice first piled up in central Canada and subsequently spread out in all directions. As the ice moved across southern Canada, it picked up vast amounts of igneous and metamorphic rocks. Farther southward in parts of Ohio, Michigan, Wisconsin, and Indiana, the ice picked up sedimentary rocks. All these rocks were transported southward and finally were dropped when the ice melted.

The three glaciers that crossed Indiana are known as the Kansan, Illionian, and Wisconsin. The southernmost extensions of these glaciers in Indiana are shown by heavy broken lines in figure 3.

Igneous, metamorphic, and sedimentary rocks can be found in the debris left by the melting ice (within the glacial boundaries), and these rocks can be found in some places beyond the glacial boundaries in the valleys of streams which carried this debris beyond the limits of the ice. Probably the best collecting places for igneous and metamorphic rocks are those areas within the glacial boundary in which gravel pits have been opened.

Sedimentary rocks constitute the bedrock throughout Indiana. In the driftless area, that part of the State not covered by ice (fig. 3), sedimentary rocks are found at or near the surface. Here limestones, sandstones, and shales are abundant in natural outcrop or in quarries. In some places in the glaciated areas stripping and quarrying have removed the glacial material, and thus bedrock can be seen. As the Illinoian glacial material is very thin in many places, more quarrying and stripping have been done in the area of Illinoian glaciation than in the area of Wisconsin glaciation (fig. 3). These strip pits and quarries are excellent sites for collecting sedimentary rocks in the areas north of the glacial boundaries. The mineral collecting localities (p. 26) also are excellent places to collect rocks.

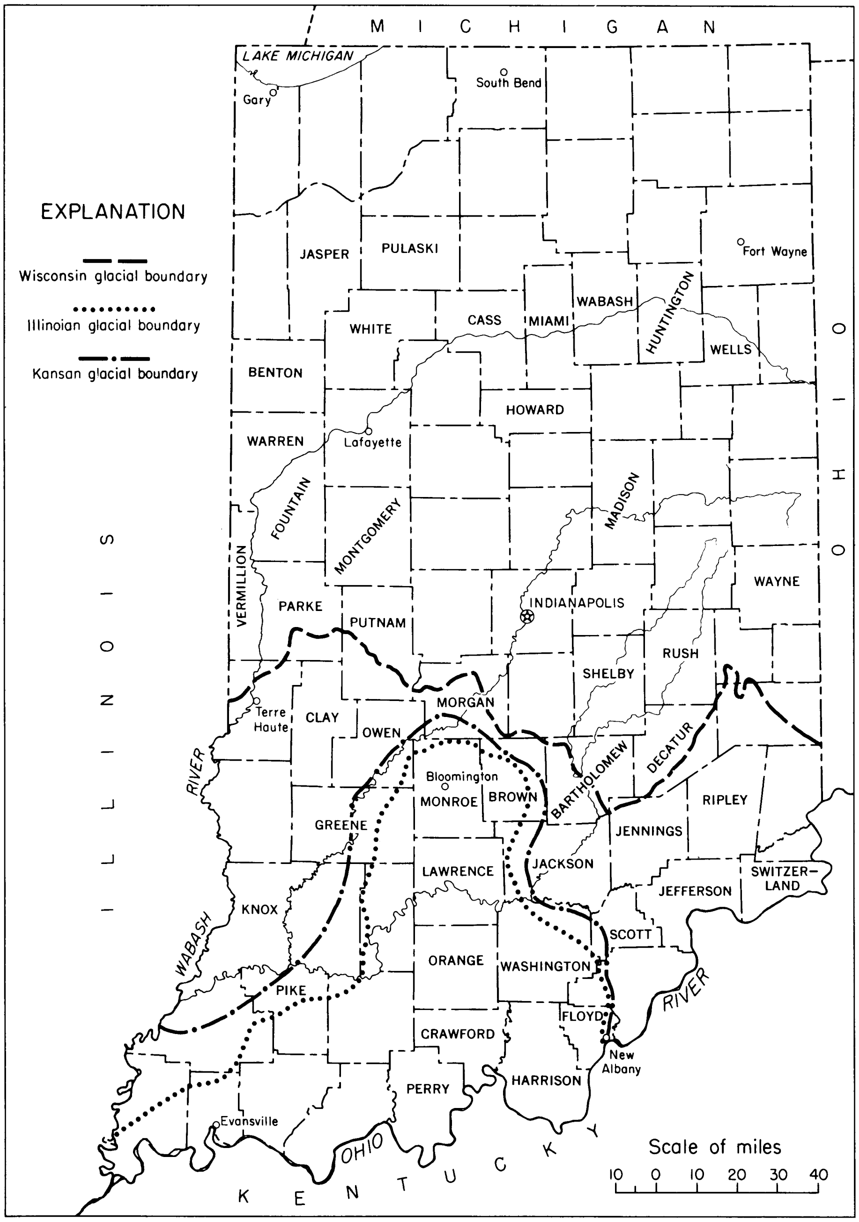

Figure 3. *Map of Indiana showing glacial boundaries and counties mentioned in the list of selected mineral localities. Glacial boundaries after Wayne, 1956, fig. 2.*

SECONDARY ROCK STRUCTURES

GENERAL STATEMENT

Secondary rock structures are formed after the rock has been formed. These structures are the result of the deposition of minerals by ground water. Even today rocks in the earth's crust are undergoing changes caused by ground-water solutions. An excellent example of the effect of ground water is the formation of caves in southern Indiana. Subsurface water, containing carbon dioxide, acts as a weak acid and dissolves the limestone to form the caves. The dissolved limestone then is deposited to form secondary rock structures.

DESCRIPTIONS OF SOME SECONDARY ROCK STRUCTURES

Travertine is a type of limestone formed by the evaporation of natural waters containing calcium carbonate. It is a dense, banded deposit and commonly is found in caverns as stalactites and stalagmites.

Stalactites are formed only in caverns which are above the water table. Ground water seeps downward through the limestone and becomes filled with calcium carbonate. This ground water collects as droplets on the cavern roof. Evaporation of the droplets and loss of carbon dioxide result in the precipitation of calcium carbonate, which has been obtained from the limestone above. As this process continues, "iciclelike" masses of calcium carbonate are formed; these are called stalactities.

Some droplets of water fall from the cavern roof to the floor, and thus deposits of calcium carbonate also grow upward; these are called *stalagmites.* Eventually a stalactite and stalagmite may grow together to form a column.

Many other forms of travertine occur in caves, and some of them assume fantastic shapes. All these forms of travertine, however, grow in the same way as stalactites and stalagmites.

Stylolite seams, sometimes called "crowsfeet," are abundant in Indiana limestones and dolomites (fig. 4). Like caverns they are the result of solution of limestones and dolomites. In contrast to caverns, however, the formation of stylolites does not result in the formation of open spaces. Solution occurs along planes which separate layers of a relatively soluble rock such as limestone. The most soluble part of the rock dissolves first, and the less soluble part is forced against the adjacent bed. This force is brought about by pressure arising from

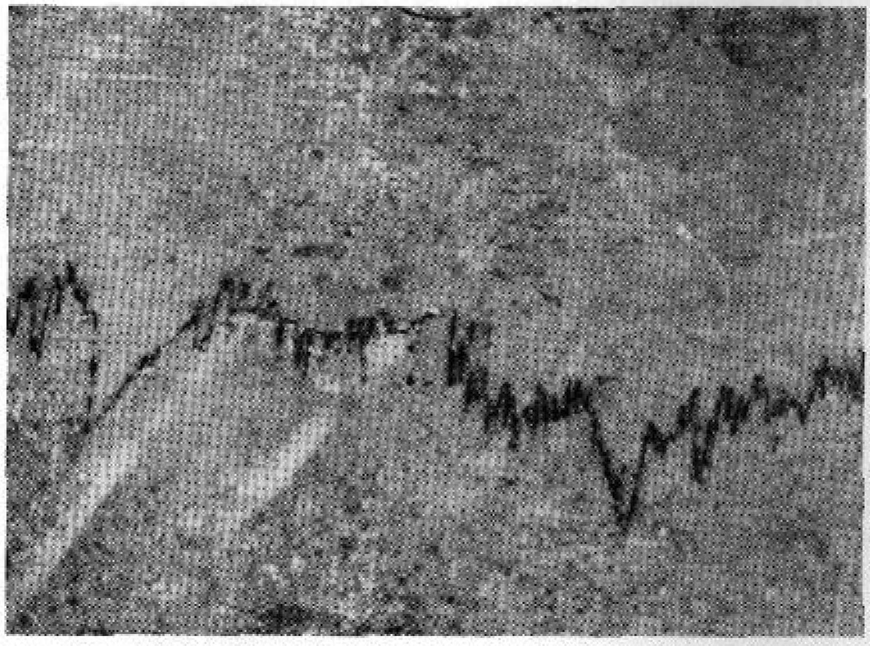

Figure 4--*Stylolite in limestone.*

the weight of the overlying bedrock. The process results in the formation of an irregular toothed line between the adjacent rock beds. This line is called a stylolite.

Concretions are solid masses of mineral matter that differ from the enclosing rock. Most of them are spherical, but some may be nodular or disc shaped. A few concretions display grotesque shapes.

Concretions vary in size from microscopic pellets to huge spheriodal objects as much as 10 feet in diameter. Their structure is generally concentric around some nucleus, as a fossil shell, leaf, or other object, and may resemble the interior of an onion. Minerals which form concretions are calcite, pyrite, marcasite, and siderite. Concretions are abundant in many shales and also may be found in limestone and sandstone. Most of them are smooth and compact, but a few contain radiating cracks, which may be filled with other mineral matter.

Some minerals contained in concretions have economic value. Large concretions of pyrite or marcasite are abundant in some coals and associated in southwestern Indiana, and in the past these concretions have been mined for use in making sulfuric acid. Iron deposits, formerly mined in southwestern Indiana, are partly composed of concretions.

Geodes are hollow spherical bodies of rock (fig. 5). They range from less than 1 inch to 2 feet or more in diameter. The outer irregular and knobby shell of most geodes is composed of chalcedony, a mineral whose composition and appearance are similar to chert. Rhythmic banding, with individual bands showing different colors, is common within this outer zone. The outer shell is most commonly lined with well-developed, inward-projecting quartz crystals. Although some geodes are almost completely filled with mineral matter, the rhythmic banding and inward-projecting crystals indicate mineral precipitation within open spaces. Additional minerals which may be found as lining material are calcite, aragonite, pyrite, and sphalerite. Geodes are found in limestone and dolomite beds and less commonly in sandstones and shales.

Geodes do not have economic value because their content of potentially valuable minerals is negligible; they are, however, a source of minerals, and some of the best mineral specimens in Indiana have been found in geodes.

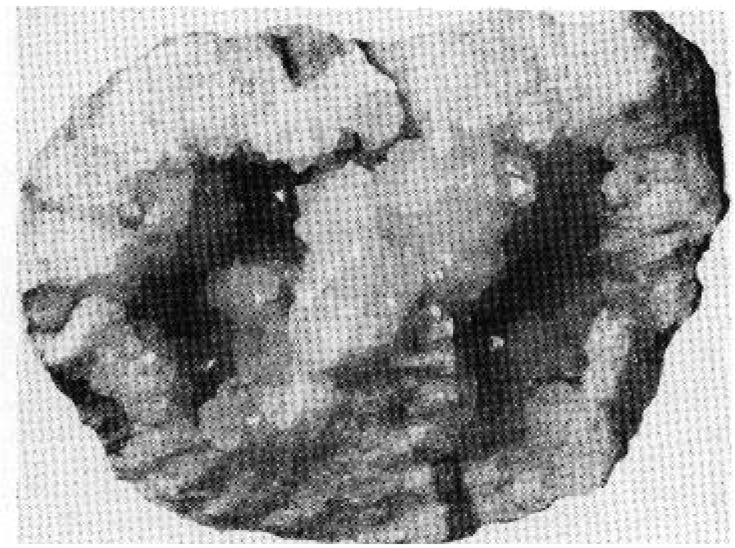

Figure *5.--Geode composed of the mineral quartz.*

Geodes have been used as borders in flower gardens and even as structural framework for many homes in southern Indiana.

Veins are tabular or sheetlike masses of minerals which follow fractures or bedding planes in the enclosing rock. They are formed by the filling of open spaces or by the replacement of the enclosing rock. The length of veins is variable and maybe as little as a fraction of an inch or as much as several miles. The mineral composition of veins also is variable but commonly is quartz, calcite, gypsum, limonite, or pyrite, or a combination of these minerals. Small veins containing these minerals are common in Indiana rocks.

Although many metals, such as gold, silver, copper, zinc, and lead, are derived from vein deposits in other states, vein minerals have never been economically important in Indiana.

Dendrites are delicate mineral growths resembling moss or branches in outline (fig. 6) and are found in most rock types. They generally appear as coating on the faces of minor fractures in minerals and rocks. Most dendrites are composed of limonite.

SOME ECONOMIC USES OF INDIANA'S MINERALS AND ROCKS

This guide to the common minerals and rocks of Indiana can appropriately close with a brief explanation of the industrial uses of these minerals and rocks. Glacial drift is the source of gravel for surfacing roads and of sand and gravel used as aggregate in concrete and "blacktop" paving materials. Some glacial

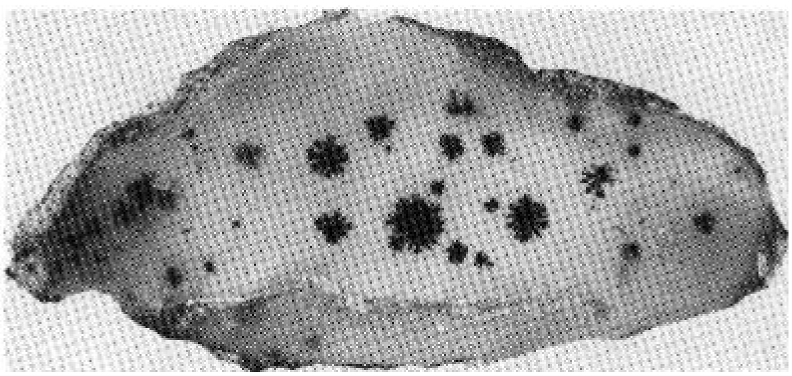

Figure 6.--*Dendrites in quartz.*

clays are used in manufacturing bricks, drain tile, and other ceramic products. As glacial drift consists of fragments of many rock types, the mineral composition varies greatly.

Sandstone is quarried for building stone and whetstones in Indiana and is used locally for flagstones. Sandstone that contains less than 1 or 2 percent of impurities (components other than silica) is classed as high-silica sandstone and may be used in manufacturing glass. Indiana sandstones were formerly used for glass manufacturing, and the State contains large reserves of sandstone that can be processed to meet the exacting specifications of the glass industry; at present, however, all glass sand used in Indiana is imported.

Clay and shale are used for making brick, tile, and other ceramic products. Special kinds of shale are used for making rock wool and lightweight aggregate and serve as a source of silica and alumina in manufacturing cement.

Limestone is quarried extensively for building stone. Crushed limestone and dolomite are used for surfacing roads and as construction aggregate, fluxstone, and agricultural limestone. The cement industry uses ground limestone as raw material, and the chemical industries use it as a source of calcium, calcium oxide, and calcium carbonate. Indiana has much limestone suitable for all these uses.

Calcareous marl, a fresh-water deposit consisting of calcite and aragonite and some organic material, is used for soil treatment in the northern part of the State where limestone is not available locally.

Gypsum, calcium sulphate with chemically combined water, is found in surface rocks in Indiana largely in the form of nodules or ball-like masses. Gypsum and anhydrite (calcium sulphate without chemically combined water) occur in beds beneath the surface in southwestern Indiana. Gypsum is mined at depths of 300 to 600 feet in Martin County by two companies. It is used in the raw (uncalcined) state as a retarder in cement and for agricultural purposes. When gypsum is heated, most of its chemically combined water is driven off. This heating process to remove the water is called calcination, and the product is called calcined gypsum or plaster of paris. Calcined gypsum is used in plasters, wallboard, tooth paste, and numerous other manufactured products.

Rock salt is not known to exist either at the surface or in subsurface rocks in Indiana, but brines have been found in wells drilled in many parts of the State. Early settlers in Indiana evaporated brines to obtain salt.

Coal is an organic rock composed mostly of consolidated carbonized plant matter. When coal is burned, gases and heat are given off and the impurities are left as ash. The quality of coal is determined by the amount of ash and by the amount of heat produced in burning. Many grades of bituminous coal (soft coal) are mined in Indiana for use as fuel by railroads, generating plants, factories, and homes. Peat, found only in the glaciated area of Indiana, is used as a soil conditioner.

Petroleum and natural gas are not minerals or rocks, but they accumulate in the pore spaces and fractures of sedimentary rocks. Indiana's oil and gas are obtained from such permeable reservoirs in sandstone, limestone, dolomite, and shale.

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