

STATE OF MICHIGAN  
DEPARTMENT OF NATURAL RESOURCES  
GEOLOGICAL SURVEY DIVISION  
**KEY TO ROCKS & MINERALS COLLECTIONS**

by  
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Reprinted 1968  
Lansing, Michigan

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**INTRODUCTION**

This booklet has been prepared to accompany and explain a set of rocks assembled to acquaint you with a few of the common rocks and minerals of Michigan. The specimens were collected by staff members of the Geological Survey Division from mines, quarries, and outcrops in various counties of the state. They were prepared and labeled with the assistance of the Conservation Work Camp, Parks and Recreation Division, located near Pontiac.

A more comprehensive discussion of the rocks and minerals of Michigan is in Publication 42, *Rocks and Minerals of Michigan*, Geological Survey Division (1951). This booklet can be purchased for 50 cents + sales tax, from the Publication Division, Department of Natural Resources, Lansing, Michigan 48926.

**MINERALS**

A mineral is a rock substance occurring in nature that has a definite chemical composition, crystal form, and other distinct physical properties. A few of the minerals, such as gold and silver, occur as "free" elements, but most minerals are chemical combinations of two or several elements just as plants and animals are chemical combinations. Nearly all of the 90 or more known elements are found in the earth's crust, but only 8 are present in proportions greater than one percent.

In order of abundance the 8 most important elements are:

Element	Symbol	Percent composition of the earth's crust
Oxygen	O	46.46
Silicon	Si	27.61
Aluminum	Al	8.07
Iron	Fe	5.06
Calcium	Ca	3.64
Sodium	Na	2.75
Potassium	K	2.58
Magnesium	Mg	2.07

A few of the more common rockforming minerals are: Feldspar, a combination of one part each of potassium, K, sodium, Na, and aluminum Al, three parts of silicon Si, and eight parts of Oxygen, O. Its symbol is written NaKAlSi<sub>3</sub>O<sub>8</sub> a kind of shorthand devised to show at once the elements and their number composing the mineral, that is the chemistry of and the chemical elements that make the rock. Quartz is a combination of one part of silicon and two parts of oxygen so its symbol is SiO<sub>2</sub>. All limestone deposits are composed chiefly of the mineral calcite (calcium carbonate CaCO<sub>3</sub>). Hematite (iron oxide Fe<sub>2</sub>O<sub>3</sub>) is a combination of iron and oxygen. The union of a metal with oxygen is an oxide. The union of a carbon with oxygen is a carbonate. The union of silicon with oxygen is a silicate. Other important rock-forming minerals are mica, hornblende, augite, olivine, epidote, chloride, serpentine, limonite, apatite, pyrite, garnet, gypsum, halite (rock salt) and anhydrite.

**ROCKS**

A rock is a fragment of the earth's crust made of one or more minerals. Limestone, dolomite, granite, basalt, quartzite are all rocks. They can be distinguished from one another in many ways: by weight, fineness of grain, size or texture, density. One rock may be heavier than another. The minerals of some rocks are so fine that individual grains are invisible. Some rocks have so coarse a texture that the mineral constituents are readily recognized by the unaided eye. Some rocks are porous; others are so dense, the minerals are so fine and tightly inter-locked that the rock has little or no pore space.

Rocks are grouped into three classes: igneous, sedimentary and metamorphic.

## IGNEOUS ROCKS

Igneous rocks were formed by crystallization of the molten magma that solidified to make the earth's crust. The size of the crystals was determined by the rate of cooling. Granite is an igneous rock formed from magma deep within the earth. It is easily recognized by its well developed crystals that were formed through slow cooling. Basalt is fine-grained dark colored igneous rock that formed by rapid cooling of lava on or near the surface of the earth. It is formed of very small crystals and a high powered microscope is needed to see the individual mineral grains. Obsidian is a dark glassy igneous rock made of lava that cooled so quickly no crystals could be formed. Slag from an iron furnace is an artificial obsidian.

## SEDIMENTARY ROCKS

Sedimentary rocks are rocks made by compaction of accumulations of bits of older rocks, broken and worn off by various chemical and physical means. These fragments carried by streams and rivers to bodies of water are dropped as sediments - hence sedimentary rocks. For several reasons the sediments are arranged in distinct layers or beds called strata and the rocks are said to be stratified. Different kinds of material are washed down by the transporting streams: coarse fragments that become cemented into conglomerates; sand that becomes sandstone; silt and clay that become shales; and lime that is dropped out of water by chemical means becomes limestone. Limestone rock is formed also by the accumulation of the shells of many small animals such as corals and snails and mollusks that lived in the sea. Many sandstones, shales and limestones contain petrified shells, or casts of the inside of shells or molds of the shell. In some rocks the shell itself has been preserved. These records of former life are fossils. Rock that contains such records is known as fossiliferous.

## METAMORPHIC ROCKS

When rocks, igneous or sedimentary are subjected to great pressure and heat, their texture and mineral composition is changed or altered and new rock types are produced that are metamorphic or changed rocks. Granite under great pressure is altered to a banded rock called gneiss. Shale under pressure becomes slate; limestone becomes marble; sandstone becomes quartzite. These metamorphic rocks may be changed again and the minerals flattened and be gathered together, such a rock is a schist. This pressure, invariably accompanied by heat, is caused partly by the great weight of overlying sediments and rocks but chiefly by strains, internal movements, and dislocations produced in the earth's crust by its gradual shrinking and contraction in cooling.

## IDENTIFICATION

Minerals differ from one another in many ways; by their color or streak, luster, hardness, cleavage, fracture and specific gravity. Close observation of these ordinary physical properties enable one to identify a score of important natural occurring minerals; some must be studied under the microscope, and others identified by their radio-activity and fluorescence.

## COLOR AND STREAK

Many minerals are white or colorless, but a small amount of strongly colored impurities may be pigments to giving different colorations. Some minerals always have characteristic colors as red, yellow, or green.

The color of the powder and/or streak of some minerals is useful in their identification. The streak of a mineral is the mark it leaves when scratched on a plate of unglazed or rough-finished porcelain. The color of the streak or powder of many minerals is different than the color of the solid mineral. The streak of all light colored minerals is white and, therefore, of little use in identification, but streak color is of great value in identifying strongly colored minerals. Powdered graphite is black - a pencil, therefore, streaks or writes black. Hematite, the common mineral of iron ore may be red, brown or black, but its streak is rust red.

## LUSTER

The reflected light or "shine" of minerals is luster. Copper has a shiny appearance. It is a metal, so we say it has "metallic luster". Quartz has no "metallic luster" but it resembles glass, so it has glassy or vitreous luster which is "nonmetallic luster". One may determine luster, then, by asking what does the mineral look or shine like. Minerals that reflect light like metals have a metallic luster and are opaque since they reflect all light. Minerals that let some of the light pass through are translucent. Minerals that let nearly all light pass through are transparent. Minerals that reflect a little light are dull in appearance. Those that reflect no light are earthy.

## HARDNESS

Some minerals (Gypsum, No. 6 of the collection) are so soft they can be scratched with the fingernail but on others (as specimen No. 3, quartz) not even the hardest knife can make an impression. Each mineral has a characteristic hardness. The hardness of an unknown mineral may be determined by comparison with a mineral of a graded series of known hardness.

A mineral that can scratch calcite, hardness 3, but will not scratch fluorite, hardness 4, is rated a hardness of 3.5. Minerals that can be scratched by the fingernail range from 1 to 2.5 in hardness; by a penny 2.5 to 3.5; by a steel knife 3.5 to 5.5; by glass 5.5 to 6; by a steel file 6 to 7; by a diamond 8 to 9. Diamond is the hardest

of all known minerals and, therefore, can scratch all the others.

The mineral series known as the scale of hardness is in order of hardness:

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

## CLEAVAGE AND FRACTURE (way of breakage)

Certain minerals, because of molecular arrangements, split or separate more easily in one direction than in another. The property of splitting along planes parallel to the face of a crystal is known as cleavage. Minerals may have only one plane of cleavage or they may have two, three or more. If rock salt (specimen No. 7) is given a sharp blow with a hammer, it breaks or cleaves into small fragments all the same shape. If we examine one of these fragments we will find three planes of cleavage at right angle to each other, two horizontal, and one vertical. This is a cube. The fragments of minerals that cleave retain the crystal shape of the mineral.

The other type of breaking, fracture, is not determined by any arrangement of molecules or crystal form. A mineral which breaks with a semicircular surface like glass, has conchoidal fracture - chert, specimen No. 5 is an example. Other types of fractures have descriptive names - smooth, uneven, hacky or jagged, shell-like, earthy and splintering.

## SPECIFIC GRAVITY

If we compare the weight of a mineral to the weight of an equal volume of water, result is the specific gravity of the mineral. Quartz, for example, has a specific gravity of 2.63, that is it is 2.63 times as heavy as an equal volume of water. Hematite has a specific gravity that ranges from 4.7 to 5.3, or is about two times the weight of an equal volume of quartz.

## FOSSILS

If we go into a stone quarry and examine the many rock fragments, we may find petrified shells or impressions of shells or plants. These are fossils. They are the remains of plants and animals that were buried in sands or soft muds on some ancient sea floor. We seldom find the original limy or nearly shell, since it was dissolved very slowly and replaced bit by bit by some other mineral. This replacement was brought about by slowly circulating groundwater that dissolved the original

material of the buried shell, animal, or plant and deposited some other mineral in its place. Silica, calcite, and pyrite are the most common replacing minerals.

## DESCRIPTIONS OF SPECIMENS

### MINERALS

#### *Specimen No. 1 Jaspilite*

Jaspilite (iron ore and silica,  $\text{Fe}_2\text{O}_3 \text{ SiO}_2$ ). Iron ore mined from open pit at Republic, Marquette County.

Color: steel gray or iron black with bands of bright red jasper. Luster: metallic to submetallic. Streak: reddish brown. Hardness: 5 to 6. Fracture: uneven. Specific gravity: 4.7 to 5.3.

Jaspilite is the most important iron ore mined in the Northern Peninsula of Michigan. Iron ore was discovered in September, 1844, when a party of government engineers and surveyors noticed a marked local disturbance of their compass needle at a point near the present city of Negaunee. As a result of their reports it was not long before many explorers and mining engineers entered the district and began mining ore at several localities. The village of Negaunee and Ishpeming were founded and grew up with the mines. The bulk of the ore now produced in the Northern Peninsula is shipped by boat from the ports of Marquette and Escanaba, Michigan, to mills in Detroit, Indiana, Illinois, Ohio, New York and Pennsylvania.

A number of minerals of minor economic significance associated with the iron ore are pyrite, calcite, barite, grunerite, garnet, masonite, tourmaline and molybdenite.

#### *Specimen No. 2 Copper*

Copper (the element Cu) Copper mine near Houghton, Houghton County.

Color: copper red. Luster: metallic. Streak: metallic, shining. Hardness: 2,5 to 3. Fracture: hacky. Specific gravity: 8.84. Others: highly ductile and malleable. (It can be pulled and twisted and pounded into shape).

Approximately 20 percent of the copper mined in Northern Michigan is native or pure copper in ancient lava flows (basalt) and their interbedded conglomerates. The copper that filled gas bubbles of the old lavas is called amygdaloid. Copper that filled spaces in broken pebbly lavas is called conglomerate.

The copper mined in shafts in Houghton, Keweenaw County, is native copper. The White Pine mine in Ontonagon County mines a copper ore chalcocite. Associated with the copper are minerals which are attractive enough when cut and polished to be classed as gem stones. A few copper minerals easily found in almost any mine rock pile are: thomsonite, agate, chalcocite, bornite, chalcopyrite, prehnite, epidote,

natrolite, and datolite.



up about 60 percent of the igneous rocks. Feldspar is quarried by the Superior Rocks Products Co. from a coarse-grained pegmatite vein. It is used in the manufacture of terrazo and ornamental concrete.

### **Specimen No. 5 Chert**

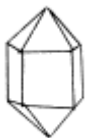
Chert (silicon dioxide  $\text{SiO}_2$ ) road exposure 2 miles east of Manistique on U.S. 2, Schoolcraft County. Shore Lake Michigan 1.5 mile north of Norwood, Charlevoix County.

Color: variable. Luster: vitreous. Hardness: 7. Fracture: conchoidal. Specific gravity: 2.65.

Hard nodular masses, or chert concretions, are in many limestones. They were formed from silica-rich waters that at one time percolated through the limestone to a point favorable for precipitation. Chert is one of several impurities found in our rock formations. Commercially it has no value. Flint is a variety of chert. Compare quartz, Specimen No, 3 and chert - both are silicon dioxide but quartz has a crystalline form whereas the crystals of chert are microscopic.

### **Specimen No. 3 Quartz**

Quartz (silicon dioxide,  $\text{SiO}_2$ ), quarry of the Superior Rock Products Co. located approximately 5 miles northeast of Randville, Dickinson County.



Color: colorless. Luster: vitreous rather greasy. Streak: white. Hardness: 7. Fracture: conchoidal, uneven. Specific gravity: 2.65. Quartz is so hard that it cannot be scratched by a knife blade, but it readily scratches glass.

Quartz is a common rock-forming mineral in granite and other igneous rocks. It is the main constituent of sands, sandstones, and quartzite. Quartz that fills in fissures in rocks is known as vein quartz. A white quartz or silica sandstone is quarried at Rockwood, Wayne County, for the manufacture of glass. Many gem stones are colored quartz; the amethyst is purple, tiger's eye, brown; jasper, red to black; agate and chalcedony many colors. Onyx is banded quartz of many colors.

### **Specimen No. 4 Feldspar**

Feldspar (a sodium aluminum silicate  $\text{NaKAlSi}_3\text{O}_8$ ) quarry of the Superior Rock Products Co. located approximately 5 miles northeast of Randville, Dickinson County.



Color: pink, white. Luster: vitreous Streak: uncolored. Hardness: 6 to 6.5. Fracture: conchoidal to uneven. Specific gravity: 2.5 to 2.62. Cleavage: along one plane surface, along a second somewhat less so. Feldspar can be slightly scratched with a knife blade and is just hard enough to scratch glass.

Feldspar is a very important rock forming mineral making

### **Specimen No. 6 Gypsum**

Gypsum (hydrous (with water) calcium sulphate  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) Quarry of the United States Gypsum Co., Alabaster, Iosco County.



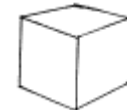
Color: colorless, white, pink, in places black. Luster: vitreous, pearly, silty, dull, depending on variety. Streak: white. Hardness: 1.5 to 2. Fracture: crumbly. Specific gravity: 2.32. Gypsum is so soft that it can easily be scratched by the fingernail.

Of the five varieties of gypsum the most common is the massive fine-grained, white with gray veinlets. Gypsum is mined at Grand Rapids and quarried at Alabaster and National City. Gypsum has many uses but most of the gypsum produced in Michigan is used for manufacture of prefabricated products such as lath, wallboard, and sheeting.

### **Specimen No. 7 Rock Salt**

Rock Salt (sodium chloride,  $\text{NaCl}$ ) Salt mine of the International Salt Co., Detroit, Wayne County.

Color: colorless, white. Luster: vitreous, transparent to translucent to opaque. Cleavage: three good cleavage planes at right angles to each other. Hardness: 2 to 2.5. Specific gravity: 2.1 to 2.3. Rock salt can easily be recognized by taste.



Michigan has ranked as the leading salt producing state for many years. Salt is mined at Detroit by means of a shaft 1,135 feet deep into the salt formation. Plants at St. Clair and Marysville, St. Clair County, and at Manistee, Manistee County, recover salt by wells from artificial brines, formed by dissolving rock salt of the salt

formation.

Although salt is one of the most indispensable of all minerals for food, seasoning and preserving, the bulk of the production is used by the chemical industry where it is employed in the preparation of a long list of chemicals, especially soda ash and caustic soda. Chlorine, made from salt, is widely used in bleaching pulp, paper and textile; as a water sterilizer; for the manufacture of hydrochloric acid; and for many other purposes.

## IGNEOUS ROCKS

### ***Specimen No. 8 Granite***

Granite is an igneous rock. Road cut exposure along County Road 581, south of Marquette, Marquette County.

Granite is a coarse-grained igneous rock consisting mainly of feldspar, quartz, and mica. Most granite is light in color due to its quartz minerals, but color shades may differ according to the proportion of dark and light minerals it contains. Granite occurs in masses of all shapes and sizes in several of the counties of the western Northern Peninsula, and in glacial gravel pits everywhere in the state. Michigan has no production of granite, but in some states it is quarried for building purposes and for memorial stones.

### ***Specimen No. 9 Diorite***

Diorite, an igneous rock. Abandoned stone quarry 1.5 miles southwest of Negaunee, Marquette County.

Diorite is a dark greenish granular rock consisting principally of feldspar and hornblende. Notice the absence of quartz and the dark color of the rock. Scattered throughout the district of Ishpeming and Negaunee are steep hills and bluffs of diorite. The rock has withstood weathering and erosion better than the original enclosing rock and hence stands out at present as "diorite knobs". The rock has been quarried at Negaunee for road stone.

## SEDIMENTARY ROCKS

### ***Specimen No. 10 Sandstone***

Sandstone, a sedimentary rock. Abandoned sandstone quarry about 4 miles east of Ionia, Ionia County. Abandoned sandstone quarry at Grind Stone City, Huron County.

Sandstone is composed mainly of cemented and/or interlocked quartz grains. Sandstones are very fine to very coarse grained. They may be red, gray, white, or yellow in color.

In the middle 1930's an old sandstone quarry near Ionia was reopened and sandstone quarried for building stone for the present Ionia Methodist Church after the older

church had been destroyed by fire. Today the only sandstone operations in the state are at Napoleon, Jackson County and Rockwood, Wayne County. The stone produced at Napoleon is sold for flagstone, stepping stone, veneer stone, wall stone, and rock gardens. The sandstone quarried at Rockwood is very pure silica and is used for the manufacture of glass. Sandstone at Grind Stone City was formerly quarried for the manufacture of grindstones.

### ***Specimen No. 11 Shale***

Shale, a fine-grained sedimentary rock. Shale pit of the Penn-Dixie Cement Corp. one mile south of Ellsworth, Antrim County.

Shale ranges in color from gray to black, but may be red or green, brown or blue. When breathed upon it has an argillaceous or clayey smell.

Shales are solidified beds of silty mud and clay which settled on ancient lake or sea bottoms. If ground to powder, shales make good material for brick and tile manufacture and if mixed with limestone and gypsum in certain proportions, make excellent Portland cement. Quantities of shale are produced in Michigan for these purposes.

### ***Specimen No. 12 Limestone***

Limestone (a sedimentary rock mainly calcium carbonate  $\text{CaCO}_3$ ). Quarry of the Presque Isle Corp., approximately 2 miles north of Presque Isle, Presque Isle Co.

Color: gray to blue gray. Hardness: 3. Specific gravity: 2.75. Limestone may be fine or coarse-grained, compact or composed of fragmental material made by chemical precipitate and/or accumulations of lime shells and coral reefs. Effervesces (dissolves with bubbling) freely with weak acid.

Pure limestone is in great demand in many branches of industry. It is used for flux in the manufacture of steel. It is the chief raw material used in making of Portland cement. It is an important raw material used in metallurgy and in many chemical industries; such as alkali, calcium carbide, sugar, paper, glass, butter and plastics manufacture. Michigan has more than a dozen limestone operations located in the Northern and Southern Peninsulas.

### ***Specimen No. 13 Dolomite***

Dolomite (a sedimentary rock, calcium magnesium carbonate  $\text{CaMgCO}_3$ ). Quarry of the Drummond Dolomite Co., Inc. located on Drummond Island, Chippewa Co.

Dolomite differs from limestone in specific gravity (2.86) and its action toward acid - effervescing only slightly, if at all. Chemically it is a double carbonate of calcium and magnesium ( $\text{Ca-CO}_3\text{MgCO}_3$ ). Dolomite is quarried near Cedarville, Mackinac County, on Drummond Island,

Chippewa County, and at Monroe and Ottawa Lake, Monroe County. It is used largely for flux in the manufacture of steel and for aggregate in the construction of bridges and roads. It is an ore of the metal magnesium.

## METAMORPHIC ROCKS

### **Specimen No. 14 Quartzite**

Quartzite (a metamorphic rock, silicon dioxide  $\text{SiO}_2$ ). Abandoned quarry 2.5 miles southeast of Marquette on the Branch Prison Property, Marquette County.

Color: may be white, brown, purplish or any combination. Hardness: about 7. Specific gravity: about 2.6.

Quartzite is a very hard metamorphic rock. It consists of interlocking quartz grains that are generally not easily recognized by the unaided eye. It is an alteration product of sandstone. The alteration may have been caused by pressure with or without heat and/or by long induration or compaction or interlocking of crystals through millions of years. Quartzite deposits are relatively numerous in the western part of the Northern Peninsula.

### **Specimen No. 15 Slate**

Slate (metamorphosed shale or mud rock). Abandoned slate quarry approximately 6 miles south of Kenton, Iron Co.

Slate splits readily into broad, thin sheets. It is a fine-grain textured rock, and the colors, red, yellow, green, blue, black, or in any combination, may differ from one deposit to another.

Slate deposits are wide-spread in the Northern Peninsula. Formerly slate was quarried in Iron and Baraga Counties for roofing shingles. Though formerly quarried in Iron and Baraga Counties, slate has limited current use.

### **Specimen No. 16 Marble**

Marble (a metamorphic limestone, calcium carbonate or dolomite, calcium magnesium carbonate,  $\text{CaMgCO}_3$ ). Quarry of the Metro-Nite Co., 2.5 miles east of Felch, Dickinson County.

Marble was formed by heat and pressure change or metamorphosis of limestone or dolomite. Marble is relatively soft, has a sugary appearance, sparkles by light reflecting from grains of its mineral calcite. It can be scratched with a knife. The color is normally white but impurities may give colors of red, yellow, green, black or any of these colors in combinations.

At Randville and Felch, Dickinson County, a white crystalline marble is quarried for use as granules in stucco and for artstone and ornamental concrete. A

complex rock known commercially as "verde antique" but often called marble is found in the hills just northeast of Ishpeming. When polished the rock becomes a beautiful green with streaks, veins and mottling of white. Polished verde antique is used for decorative purposes such as stone fronts, counter tops, baseboards and other interior trim. Some pieces are polished for gift material such as pen stands and paper weights.

### **Specimen No. 17 Schist**

Schist. A metamorphic rock. Quarry of the Superior Rock Products Co., approximately 5 miles northeast of Randville, Dickinson County.

Schists may be derived from the metamorphoses of igneous or sedimentary rocks. The minerals have been rearranged in very fine layers, or sheets called laminae. The color of schist is determined by its mineral. Specimen 17 is a hornblende schist, a variety that consists largely of black slender prisms of the mineral hornblende. Crystals of gem stones, as garnet, are developed in some schists. The common talcum powder is a ground schist mineral, talc. This rock is quarried by the Superior Rock Products Co., for roofing granules and for use in ornamental concrete.

## FOSSILS

### **Specimen No. 18 Fossils**

Fossils. A record of former life. Abandoned Rockport Quarry 10 miles northeast of Alpena, Alpena County or Quarry of Penn-Dixie Cement Corp., 2 miles west of Petoskey, Emmet County.

Michigan has many stone quarries where fossils of many kinds are easily found. Good hunting grounds for corals, brachiopods, fossils and a rare trilobite are in the old quarries near Alpena, Bellevue, Marshall, on Drummond Island, in Monroe County and Petoskey. Fossil plants are found in the waste piles of Michigan's former coal mine operations and in the shale quarries at Grand Ledge and Corunna. Many gravel pits yield numerous fossils.



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