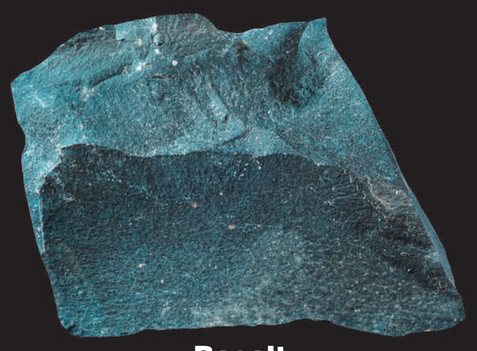
ILLINOIS

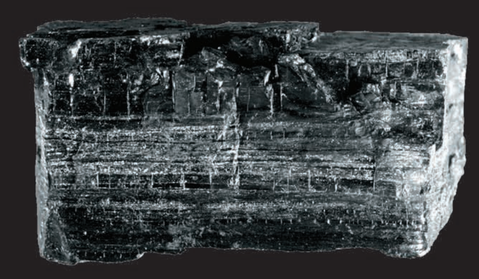
ROCKS AND MINERALS

Agates



Basalt

Calcite

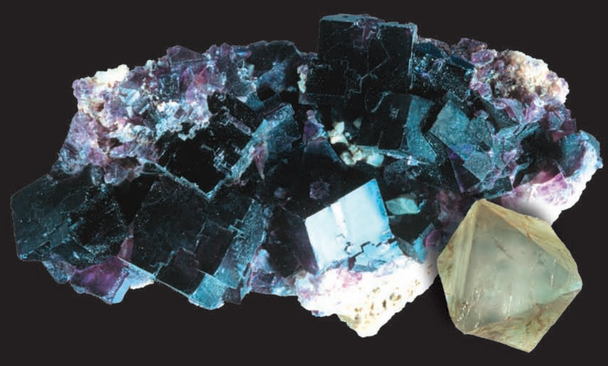


Coal - Bituminous

Conglomerate

Dolomite Crystals

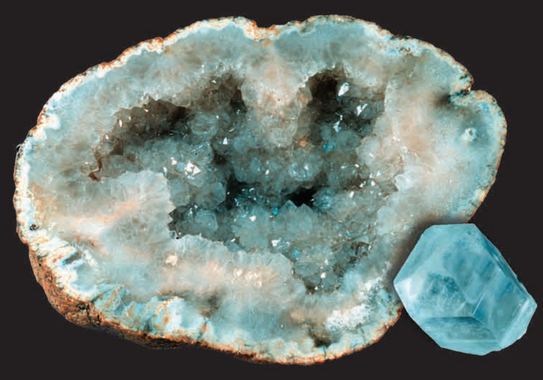
Feldspar



Fluorite / Fluorite Octahedron

Gabbro

Galena



Geode / Quartz Crystal

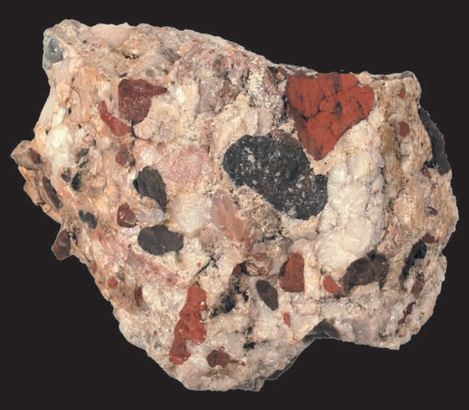
Gneiss

Granites

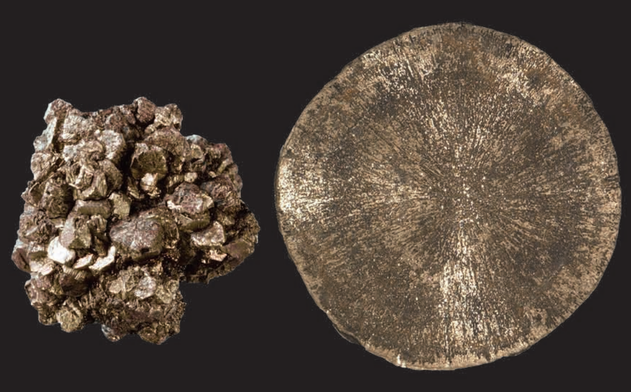
Lamprophyre

Limestone

Porphyry



Puddingstone



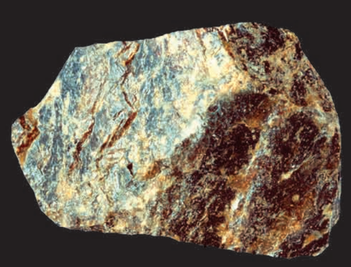
Pyrite / Pyrite Dollar

Quartzite

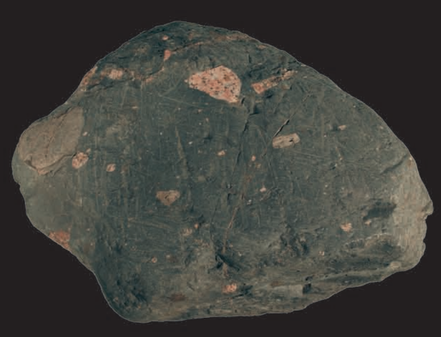
Sandstone

Schist

Selenite Gypsum



Sphalerite



Tillite

Tripoli

Most of us know little about the Earth on which we live. Some of nature's most remarkable wonders, because they are so familiar, go unnoticed. Yet beneath our feet and before our eyes is an intriguing world. At first glance, Illinois may appear to be an unlikely place in which to look for rocks and minerals, but our state is surprisingly rich in these resources. The specimens depicted on this poster were selected by Wayne Frankie of the Prairie Research Institute's Illinois State Geological Survey to represent the variety of rocks and minerals found in our state.

Mineral Groups and Rock Types

Mineral Groups

- Silicates
  - Agates
  - Feldspar
  - Quartz
- Carbonates
  - Calcite
  - Dolomite
- Sulfides
  - Galena
  - Pyrite
  - Sphalerite
- Sulfates
  - Selenite Gypsum
- Halides
  - Fluorite

Rock Types

- Igneous
  - Basalt
  - Gabbro
  - Granites
  - Lamprophyre
  - Porphyry
- Sedimentary
  - Coal
  - Conglomerate
  - Geode
  - Limestone
  - Sandstone
  - Tillite
  - Tripoli
- Metamorphic
  - Gneiss
  - Puddingstone
  - Quartzite
  - Schist

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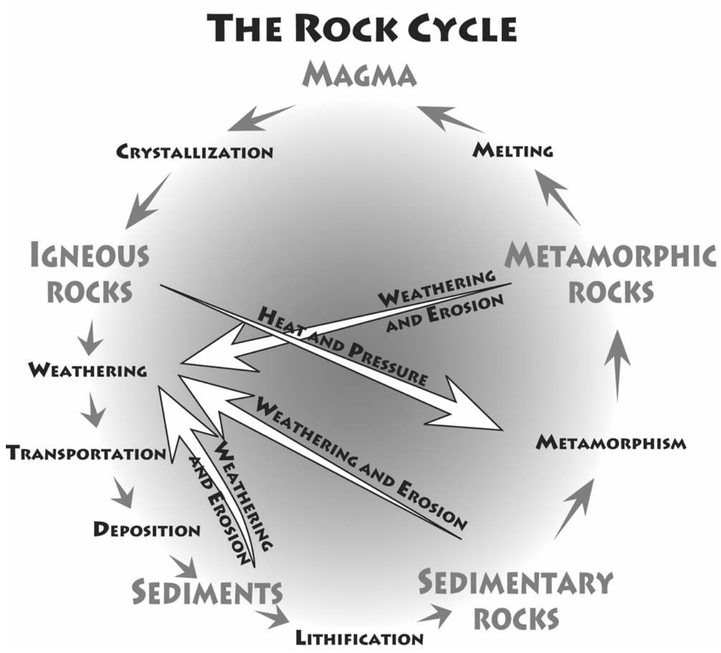
ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Minerals and Rocks

The terms "mineral" and "rock" are often confused. They are frequently used together, and the materials they describe are closely related. A mineral is a naturally occurring, inorganic, chemical element or a group of elements (a compound). A mineral has a crystalline structure and a unique chemical composition. A rock is a mixture of particles or grains of one or more minerals.

Rock Types

Rocks are classified according to how they formed. The broadest grouping of rocks is based on the origin of the rock rather than on the minerals that compose it. In this scheme, all rocks are divided into three general groups: igneous; sedimentary; and metamorphic.



Igneous Rocks

Igneous rocks are categorized based on their texture and composition. They are produced directly from magma, hot molten rock that comes from deep in the Earth. As magma cools, the elements that form individual minerals come together and crystallize, as water crystallizes into ice on a winter day. Different minerals crystallize at different temperatures, which causes differences in grain size, or texture. If magma cools slowly, some individual mineral grains have the opportunity to grow larger than others. These rocks are called intrusive because they form in the Earth's interior. If magma cools quickly, as lava or basalt does, the separate mineral grains are small. These rocks are called extrusive because they extrude onto the exterior of the Earth. Porphyritic rocks are igneous rocks that have large crystals, called phenocrysts, within a small crystal ground mass. The magma that produced these rocks began to form larger crystals within the Earth, followed by rapid cooling as the magma moved upward or extruded onto the surface, forming the fine-grained surrounding rock.

Igneous rocks can also be classified by composition into felsic and mafic rocks. Felsic igneous rocks are made up primarily of feldspar and quartz (silica). Mafic igneous rocks are made up primarily of minerals rich in iron and magnesium. Felsic rocks are usually light to intermediate in color, and mafic igneous rocks are usually dark.

Examples of intrusive (formed within the Earth) and extrusive (formed on the Earth's surface) igneous rocks

Color	Intrusive (coarse-grained, large crystals)	Extrusive (fine-grained, small crystals)
Light	Granite, Diorite	Rhyolite, Andesite, Pumice
Dark	Gabbro, Peridotite, Lamprophyre	Basalt, Obsidian

Sedimentary Rocks

Most of the rocks native to Illinois are sedimentary rocks. Some are made of small pieces of shells, plant and animal remains, and weathered fragments of other rocks (sediments) that have been moved by rivers, waves, winds, or ice (glaciers). These sediments have been deposited and compacted or cemented by mineral matter that precipitated out of water moving through the voids between sediment particles. Pores are voids in sedimentary rocks that were not filled with material. Such sedimentary rocks are called clastic (meaning "broken pieces") rocks. Other sedimentary rocks may be formed by chemical precipitation from water (chemical) or consist of fossil remains (organic).

Clastic sedimentary rocks are classified by their grain size or texture (examples include gravel, sand, silt, and clay) and their mineral composition. Rocks, such as gypsum and some limestones, were formed by chemical precipitation from sea water. Organic rocks, such as limestone, come from animal remains and chemical precipitation; coal comes from plant remains.

Some common sedimentary rocks classified by texture and composition

Rock	Texture	Composition
Clastic		
Conglomerate	Round pebbles	Pebbles, cobbles, boulders
Breccia	Angular fragments	Cemented by sand and clay
Sandstone	Sand-sized grains	Mostly quartz, feldspar, some mica
Siltstone	Very fine grains	Mostly quartz, feldspar, some clay
Shale	Microscopic grains	Mostly clay, some mica flakes
Organic		
Limestone	Microscopic to coarse crystals	Calcite from shells or shell fragments (animal remains)
Chalk	Very fine-grained	Calcite from microscopic animal remains
Coal	Microscopic	Carbon from plant remains
Chemical		
Rock salt	Cubic crystals	Halite
Gypsum	Microscopic to coarse crystals	Gypsum
Limestone	Microscopic to coarse crystals	Calcite precipitated from seawater

Metamorphic Rocks

Metamorphic rocks are rocks that have changed form. This change can be caused by heat and pressure that occur below the surface of the Earth or by heat from upward-moving magma or melted rocks. Chemical reactions can also change rock form. Metamorphic rocks are found in Illinois as boulders and pebbles in glacial drift. Foliated metamorphic rocks contain minerals that occur in layers; unfoliated rocks are massive.

Some examples of metamorphic rocks and their texture and origin

Rock	Texture	Original Rock Type	Original Rock Group
Foliated			
Slate	Fine (microscopic)	Shale	Sedimentary
Schist	Medium to coarse	Slate	Metamorphic
		Basalt	Igneous
		Granite	Igneous
Gneiss	Coarse	Granite	Igneous
Unfoliated			
Quartzite	Medium	Sandstone	Sedimentary
Marble	Coarse	Limestone	Sedimentary

Identifying Minerals

Most minerals can be characterized and classified by their unique physical properties: hardness; luster; color; streak; specific gravity; cleavage; fracture; and tenacity.

Hardness

The ability to resist being scratched, or hardness, is a useful property for identifying minerals. Frederick Mohs, a German mineralogist, produced a hardness scale using a set of ten minerals. The scale arranges the minerals in order of increasing hardness. Each higher-numbered (harder) mineral will scratch any mineral with a lower number (softer).

Mohs hardness scale and common field tests for hardness

Hardness	Mineral	Common field test
1	Talc	Easily scratched with a fingernail
2	Gypsum	Scratched by a fingernail (2.5)
3	Calcite	Scratched by a penny (3)
4	Fluorite	Difficult to scratch by a nail (4); scratched easily by a knife (>5)
5	Apatite	Difficult to scratch with a knife (>5); barely scratches glass (5.5)
6	Feldspar	Scratched by a steel file (6.5); easily scratches glass
7	Quartz	Scratches a steel file and glass
8	Topaz	Difficult to test in the field
9	Corundum	Difficult to test in the field
10	Diamond	Difficult to test in the field

Luster

Luster is how a mineral reflects light. The terms "metallic" and "nonmetallic" describe types of luster. Some minerals that don't exhibit luster are referred to as "earthy," "chalky," or "dull."

Types of luster and examples

Luster	Example
Metallic	Galena/Pyrite
Nonmetallic	
Adamantine (brilliant)	Diamond
Vitreous (glassy)	Quartz
Pearly	Talc
Resinous	Sphalerite
Silky	Asbestos/Fibrous Gypsum
Greasy	Graphite
No luster	
Dull or earthy	Limonite
Chalky	Chalk

Color

Color should be considered when identifying a mineral but should not be used as the major identifying characteristic.

Streak

Streak is the color of the powdered mineral, which is often more useful for identification than the color of the whole mineral. Rubbing the mineral on a streak plate will produce a streak, except from minerals that are harder than the streak plate.

Specific Gravity

Specific gravity is the ratio between the mass (weight) of a mineral and the mass (weight) of an equal volume of water. A mineral's specific gravity (SG) can be determined by dividing its weight in air by the weight of an equal volume of water. For instance, quartz with a density of 2.65 is 2.65 times as heavy as the same volume of water.

SG = mineral mass ÷ water mass

Cleavage

The way in which a mineral breaks along smooth, flat planes is called cleavage. These breaks occur along planes of weakness in the mineral's structure. If a mineral breaks along an irregular surface, it does not have cleavage.

Fracture

When a mineral breaks irregularly, the breaks are called fractures. Breaks can be described as grainy, hackly (jagged), conchoidal (curved), or splintery.

Tenacity

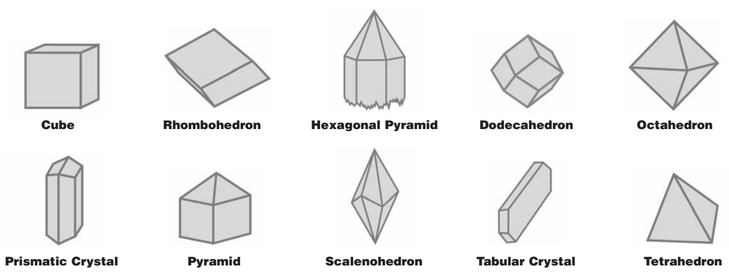
How well a mineral resists breakage is tenacity. Tenacity is described by the following terms.

- **brittle** - crushes to angular fragments (quartz)
- **malleable** - can be modified in shape without breaking and flattened to a thin sheet (copper, gold)
- **sectile** - can be cut with a knife into thin shavings (talc)
- **flexible** - bends but does not regain its shape once released (selenite gypsum)
- **elastic** - bends and regains its original shape when released (muscovite and biotite mica)

Other Diagnostic Traits

These characteristics may also be useful in identifying some minerals.

- **transparency** - objects are visible when viewed through a mineral
- **translucency** - light, but not an image, is transmitted through a mineral
- **opaqueness** - no light is transmitted, even on the thinnest edges
- **taste** - used to help identify some minerals, such as halite (salt)
- **acid reaction** - object reacts to weak hydrochloric acid (calcite, limestone)
- **magnetism** - a distinguishing characteristic of magnetite
- **crystal shape** - cubic, rhombohedral (tilted cube), hexagonal (six-sided), and others (See illustration.)



Mineral and Rock Descriptions

Only a few of the most common rocks and minerals of our state are shown on this poster. Many other types can be collected in the state, too. The *Selected Readings* section of the poster provides a list of resources for you to use when learning about or identifying the remainder of Illinois' rocks and minerals.

Quartz Quartz (SiO_2) is the most common mineral, making up 12 percent of Earth's crust. There are two main types of quartz: (1) crystalline; and (2) dense (microcrystalline to cryptocrystalline). Many dense varieties occur in Illinois. Some varieties of cryptocrystalline quartz are used for semiprecious gems. They include chalcedony, agate, onyx, and jasper.

Quartz crystals are typically six-sided and elongated with sharply pointed pyramidlike ends. They tend to grow in clusters. Good, large crystals are rare in Illinois. However, well-formed crystals occur within some geodes and within certain openings in some limestone and sandstone layers. Quartz occurs as rock crystal (colorless, transparent), milky quartz (white, nearly opaque), and smoky quartz (smoky yellow to gray or brown) in geodes from the Warsaw and Keokuk Limestones of the Nauvoo-Hamilton-Warsaw area. Quartz also occurs as vein and cavity fillings associated with fluorite, sphalerite, and galena in southern Illinois.

Diagnostic Traits: brittle; hardness = 7; colorless or tinted; transparent or translucent; glassy to brilliant luster (transparent quartz); breaks irregularly with a good curved fracture (conchoidal); SG = 2.65

Feldspar The second most common group of minerals is the feldspars. All feldspars are made of aluminum, silicon, and oxygen combined with varying amounts of one or more metals, particularly potassium, sodium, and calcium. Potassium feldspars are usually pink to red, but otherwise white, gray, yellow, or pale green. Plagioclase feldspars contain calcium and/or sodium and are commonly white or gray. Fine lines or striations can be seen with a hand lens on cleavage faces.

Feldspar is used as flux for glass and ceramic manufacture, abrasives, and fillers in paint and plastics. Feldspar decomposition products are clay minerals that are present in most soils. In Illinois, relatively small feldspar crystals can be found associated with quartz and other minerals in granite and gneiss boulders, and larger crystals occur in some pebbles in glacial drift.

Diagnostic Traits: hardness = 6; smooth, glassy or pearly luster; good cleavages along two planes and at nearly right angles to each other; SG = about 2.6; white streak; mineral color varies

Calcite Calcite ($CaCO_3$) consists of calcium carbonate. Calcite is the principal mineral in limestones, and crystals occur in many concretions. Calcite is white or colorless, but impurities may tint it shades of yellow or gray. Transparent calcite is rarer than the tinted varieties. Transparent calcite (known as "Iceland Spar") has the property of double refraction: an image appears double when viewed through it.

Calcite has a variety of crystal forms but, in Illinois, most commonly contains flattened, block-shaped (rhombohedron) crystals and elongate crystals with tapering points (scalenohedron) known as "dogtooth spar."

Calcite crystals are found in Illinois as linings in geodes, especially in the Nauvoo-Hamilton-Warsaw area. Thin calcite veins occur along joints in coal beds and vugs within limestone and dolomite. Small amounts of clear crystalline calcite are associated with various ores in northwestern and southern Illinois.

Diagnostic Traits: glassy luster; white or colorless streak; hardness = 3; SG = 2.71; effervesces with dilute hydrochloric acid or full-strength vinegar; when broken along three cleavage planes forms six-sided blocks (rhombs)

Fluorite Fluorite (CaF_2), or fluorspar, is made up of calcium and fluorine. The mineral is easily identified by its perfect cleavage, color, and hardness. Extensive deposits of fluorite, once one of Illinois' important commercial minerals, occur in Hardin and Pope counties in southern Illinois.

Fluorite occurs in cubic crystals that may be twinned. Most often, fluorite occurs as irregular masses in which individual crystals cannot be distinguished. Fluorite can be split along its four cleavage planes into diamond-shaped, eight-sided forms (octahedrons).

Fluorite is used to make hydrofluoric acid and to form a slag in the production of iron and steel. It is also used in toothpaste, in many chemical products, and to make colored glass, enamels, and glazes in the ceramics industry. Our state mineral is no longer mined in Illinois, the last mine closing in 1997.

Diagnostic Traits: commonly gray, white, or colorless but may be green, blue, purple, pink, or yellow; colorless streak; glassy luster; hardness = about 4; SG = 3 - 3.3; transparent to translucent

Gypsum Gypsum ($CaSO_4 \cdot 2H_20$), hydrous calcium sulfate, occurs in several forms. Selenite is a coarsely crystalline, transparent to translucent variety, composed of flat, nearly diamond-shaped crystals that can be split easily into thin sheets, have a glassy luster, and often grow together. Selenite crystals occur in shales of southern, north-central, and western Illinois and can be picked up at the surface. Satin spar gypsum has crystals resembling silky threads closely packed together, splits parallel to the fibers, and is found as fillings in cracks within rocks and as thin layers in shales. Massive microcrystalline gypsum is granular. Gypsum deposits occur deep underground in Illinois but have not been mined.

Diagnostic Traits: colorless; transparent to translucent but may be stained yellow by impurities; white streak; hardness = 2; SG = 2.3

Pyrite and Marcasite Pyrite and marcasite (FeS_2) are iron disulfide compounds. They look similar but have different crystal forms. Pyrite crystals are cubes, while marcasite crystals are blade- or needle-shaped. The "pyrite dollars" found in Illinois are marcasite.

Pyrite and marcasite, often called "fool's gold," have been mistaken for gold because they are yellow and metallic. However, they are much harder than gold, tarnish, and leave a dark streak, while gold is soft, heavy, does not tarnish, and leaves a yellow streak. Gold is malleable, but pyrite or marcasite is reduced to powder if pounded and gives off an odor of sulfur if heated. Both pyrite and marcasite are common as surface coatings, veins, and concretions in coal and in dark shales associated with coal. They are referred to as "coal brasses" or "sulfur" when found as impurities in coal. Coal brasses recovered from Illinois coal have been used in the manufacture of sulfuric acid for industrial use.

Diagnostic Traits: dark green-black streak; brittle; hardness 6.0 - 6.5; brassy yellow color; metallic luster; opaque; SG = 5.0

Sphalerite Sphalerite (ZnS), zinc sulfide, is a zinc ore. Sphalerite was mined with galena in northwestern Illinois and in southern Illinois with galena and fluorite. Small crystals occasionally are found in limestones, within geodes, and as crystalline masses in clay-ironstone concretions.

Diagnostic Traits: resinous luster; white to yellow and brown streak; yellow, yellow-brown, red-brown or brown-black color; hardness = 3.5 - 4.0; SG = 3.9 - 4.1; brittle (scratches penny but not glass); opaque but thin edges may be translucent

Galena Galena (PbS), lead sulfide, is the principal ore of lead. Galena was an important mineral resource in Illinois during the nineteenth century and the first half of the twentieth century. It was mined in northwestern and southern Illinois. Galena is found in small voids within limestones and dolomites and as crystals in geodes. It is often associated with fluorite and sphalerite deposits.

Diagnostic Traits: steel gray; hardness = 2.5; SG = 7.4 - 7.6; opaque; metallic silver-colored luster (may be dulled by coating of lead carbonate); gray or black streak; cube-shaped crystals break into cubic, right-angled cleavage fragments; will mark paper and can be scratched by a penny

Granite Granite is an intrusive igneous rock. It consists chiefly of feldspar and quartz with small amounts of biotite, muscovite, or hornblende. Most granite is light-colored, but it can be white, gray, yellow, pink, or deep red. Texture ranges from medium- to coarse-grained.

Granite pebbles or boulders are the most common igneous rocks found in glacial deposits in Illinois. These rocks are not native to the state but were brought here by the glacial ice sheets that advanced southward across Canada to cover much of the northern United States during Pleistocene time.

Granite is used extensively as building stone. Native Precambrian granitic rock lies at great depths beneath the state and has been recovered from oil test drillings along the western, northern, and southern margins of Illinois.

Gabbro Gabbro is an intrusive igneous rock that is heavier and darker than granite. Gabbro is composed mainly of feldspar and dark, iron-bearing minerals. It is coarse-grained and contains very little or no quartz. Mineral crystals in gabbro are tightly interlocked, making the rock difficult to break. Weathered gabbro is a rust color on the surface because the iron minerals in gabbro weather in the same way that a piece of metallic iron becomes coated with rust when left outdoors. Like other igneous rocks found near the surface in Illinois, gabbro was carried into Illinois by glaciers and deposited as glacial debris.

Porphyry Porphyry is an igneous rock identified by its texture rather than its variable mineral content. Large, distinct crystals, phenocrysts, of minerals are embedded in a matrix of fine-grained rock. The phenocrysts, commonly feldspar, formed before the main molten mass of the rock crystallized. Any igneous rock may have a porphyritic variety, such as granite porphyry or basalt porphyry, although porphyries are most likely to form in association with fine-grained igneous rocks. Porphyry is found in Illinois only in glacial drift.

Basalt Basalt is a widely distributed extrusive volcanic rock. It is composed of pyroxene, feldspar, magnetite, and sometimes olivine, biotite, and hornblende. The dark green, gray, or black color is due to the dark minerals that make up much of the rock. The minerals in basalt are fine-grained and closely packed together. Phenocrysts of olivine, pyroxene, and hornblende may be present. Basalt is identified by its dark color and fine-grained texture. The glaciers brought basalt into Illinois along with other igneous rocks.

Lamprophyre Lamprophyre is the only igneous rock native to Illinois that crops out at the surface. It is found as dikes (irregular veins) or sills (thin roughly horizontal sheets) that were formed when molten rock from deeper in the Earth intruded into cracks and fissures in the bedrock of southeastern Illinois in Hardin, Pope, Gallatin, and Saline counties. Lamprophyre ranges from very fine- to medium-grained rock and has an even texture. It is dark gray to green-gray, depending on the minerals present, and weathers to a distinctive brown or tan color. In general, lamprophyre is composed of biotite, hornblende, and pyroxene.

Gneiss and Schist Gneiss is a metamorphic rock composed of roughly parallel bands of different minerals. It is medium- to coarse-grained and light in color. The names given to gneiss emphasize a distinctive texture or indicate a dominant mineral composition. For example, biotite gneiss emphasizes a mineral, and granite gneiss indicates the rock's composition.

Schist is much like gneiss but is fine-grained and has a thinly layered, micaceous structure that often makes the rock break with a wavy, shiny surface. Some common types of schistose rocks are talc schist, chlorite schist, and hornblende schist. As the names indicate, they are characterized by their dominant mineral. Gneiss and schist are not native to Illinois but are found in the glacial drift.

Quartzite Quartzite is a metamorphic rock that originally was quartz sandstone. Quartzites are produced by intense heat and/or pressure, probably aided by hot silica-bearing solutions. The quartz grains may be so closely interlocked that individual grains are no longer recognizable. The rock fractures conchoidally (with a curved surface) through both the grains and cement, so the broken surface, unlike that of sandstone, is smooth and may exhibit a glassy luster.

Color depends upon the amount and kind of impurities that are present. An all-quartz quartzite is white or gray, but iron or other elements may change the quartzite's color to shades of purple, yellow, brown, or red. Quartzite is a very resistant, hard rock and cannot be scratched by a knife. Quartzite is abundant as boulders and pebbles in the glacial drift of Illinois, having been brought into the state during the Ice Age.

Puddingstone An unusual glacial erratic in Illinois is the jasper conglomerate or puddingstone. These conglomerates were transported from Canadian rocks along the far northwestern shore of Lake Huron in Ontario. In the early 1800s, English settlers there gave the stone its "puddingstone" name because it looked like boiled suet pudding with currants and red cherries. Jasper is a fine-grained, red to brown, iron-bearing chert, and the jasper conglomerate is considered to be a transitional rock—from sedimentary to metamorphic. Jasper conglomerates were originally sandstone conglomerates containing white quartz sand and clasts of red jasper. Heat and pressure transformed them into low-grade metamorphic rocks. The light, fine-grained matrix that surrounds the pebbles and stones is primarily a white quartzite. Some jasper conglomerates contain minerals, such as chromite, corundum, platinum, diamonds, gold, sapphire, and zircon. Although somewhat rare in Illinois, jasper conglomerates are found in northeastern-source glacial deposits.

Tillites Tillite is made up of sediment that was carried or deposited by glaciers and later cemented to form rock. Fairly common in the glacial deposits of Illinois, tillites were transported by glaciers from rocks near Ontario, Canada. Tillites have a fine-grained structure that contains pebbles and larger-sized pieces of distinctive rock types. Most tillites have a dark green, gray, or gray-brown matrix that contains lighter-colored, fairly angular igneous or metamorphic pebbles.

Conglomerate This sedimentary rock is made up of pebbles or other rock fragments (sand and gravel) cemented together by a matrix of finer material, generally silica, calcium carbonate, clay, iron oxide, or a mixture of these substances. The rounded rock fragments were worn by being rolled in streams or by waves along beaches. Conglomerate may be made up of any type of rock or mineral but is most commonly chert, quartz, quartzite, granite, and gneiss. In Illinois, conglomerates commonly are found at the base of sandstone formations and as beds in the lower Pennsylvanian-aged rocks. They are also found in some gravel deposits.

Sandstone Sandstone is a clastic sedimentary rock consisting of sand-sized grains held together by a cementing material. In general, the individual grains in sandstone are visible to the unaided eye. As sandstones become more finely grained, they grade into siltstones; as they become more coarsely grained, they grade into conglomerates. Quartz is the dominant mineral in sandstone, but other rock and mineral grains (especially feldspar, muscovite, hornblende, magnetite, or garnet) generally are present. Sandstones are commonly cemented by carbonates, silica, iron oxides, or clays. Most sandstones are a shade of gray or brown, but the color may vary from gray or white to yellow, brown, or red. The color largely depends on the type of cement, the amount of organic material present, and the amount and degree of oxidation of iron in the rock.

Sandstone crops out in many places throughout the state. In Ogle and La Salle counties many tons of almost pure quartz sand are mined from the St. Peter Sandstone and sold for a variety of uses, including abrasive sand, molding sand, and sand for making glass. In southern Illinois, colored sandstones have been quarried for building stone.

Limestone and Dolomite Limestone is a sedimentary rock formed in various ways. Some are deposited when calcium carbonate precipitates from solution; others are formed when the shells or skeletons of organisms such as brachiopods, clams, and corals accumulate on a sea floor. Crystals range from fine to coarse. Many limestones contain other minerals, such as chert, clay, or sand, and, in some places, limestones grade into dolomite (calcium-magnesium carbonate). Many limestones are very light gray or gray. Yellow or brown shades are caused by iron oxide impurities, and dark gray to black colors are from organic matter.

Limestone effervesces in dilute hydrochloric acid or full-strength vinegar, but dolomite must be powdered before it effervesces. In nature, limestones may be dissolved by percolating groundwater containing weak acid. In many places, such solution of limestones has produced sinkholes, caves, and caverns, especially in the Illinois karst terrain of St. Clair, Monroe, and Randolph counties.

Limestone has many uses: building stone; road surfacing; railroad ballast; portland cement manufacture; and, if of high purity, for making lime and chemicals and as a flux in smelting metals. Limestone is added at coal-burning plants to curtail acid emissions, an important consideration when using Illinois coal. Agricultural limestone is used to add calcium to the soil, reducing soil acidity.

Limestone outcrops are abundant in Illinois, especially along the bluffs of the Mississippi, Ohio, and Illinois rivers. Quarries that mine limestone or dolomite are scattered throughout Illinois.

Tripoli Tripoli is a white or light brown powdery substance that rubs off on the hands like chalk. It consists mostly of very small quartz particles that result from the weathering of calcareous chert or highly siliceous limestone. Tripoli is finely ground and used as "white rouge" for polishing optical lenses, as a filler in paints, in making ceramic products, as a component of buffing compounds, and as a fine abrasive. Tripoli occurs in Alexander and Union counties.

Coal Coal, an organic stratified rock, is formed from accumulated plant material and partially decayed plants (peat) that were buried in Illinois more than 290 million years ago. Sediments deposited over the peat buried and compacted it. Chemical changes gradually took place and resulted in the loss of water and gases, leaving a higher percentage of carbon than the original material contained. This process is called coalification. The amount of such change that has taken place determines the rank of the coal. The lowest rank is called lignite, the intermediate is called bituminous (soft) coal, and coals of the highest rank and the highest carbon content are called anthracite (hard) coal. Mineral matter, such as shale, clay, or pyrite, generally is present in the coal and becomes ash when the coal is burned. All of the coal mined in Illinois is bituminous coal. It is black, brittle, and breaks into angular blocks; has a shiny luster; and generally shows a banded structure.

Coal mining is an important Illinois industry, and the state contains the largest known reserves of bituminous coal in the United States, under about two-thirds of the state. The coal in most mining areas averages 5 to 7 feet thick and may attain a thickness of 15 feet. Illinois coal is used mainly for generating electric power, for industrial purposes, and for heating. In industry, coal is used extensively for power and heating; for firing clay products, such as brick, tile, pottery, porcelain, and china; and for making coke. When mixed with coal from the eastern United States, certain Illinois coals produce metallurgical coke for making steel. Gases, oils, and tars derived in processing coal for coke have been used for making many chemical products, including dyes, perfumes, explosives, medicines, insecticides, plastics, and road tar.

Geodes Geodes are roughly spherical, hollow bodies that may be filled with layers of minerals, lined with crystals, or both. As a rule, the outer layer of geodes found in Illinois is composed of chalcedony, a form of fine microcrystalline silica. Geodes are commonly associated with limestone and dolomite or, at some places, with shale. Quartz is the most common mineral deposited in geodes, but other minerals also are found.

Geodes grow inward from the outer shell. Some of the best mineral specimens known in Illinois are found as crystal linings in geodes. Hollow geodes are the most desirable because they have better crystals. In Illinois, geodes can be found in the Warsaw Formation in the area of Nauvoo, Hamilton, and Warsaw, but they also occur in other areas and in other formations.

Selected Readings

Bradbury, J. C., G. C. Finger, and R. L. Major. 1968. *Fluorspar in Illinois.* Illinois State Geological Survey, Urbana, Illinois. Circular 420. 64 pp.
Learn more about the official state mineral—its geology, mining history, and uses.

Collinson, C. 2002. *Guide for beginning fossil hunters.* Illinois State Geological Survey, Urbana, Illinois. Geoscience Education Series 15. 48 pp.
An update of an Illinois State Geological Survey classic, this booklet features 22 full-page plates of fossil drawings and eight color plates of fossil photographs. Tips on collecting fossils and descriptions of basic fossil types make this publication an excellent source of information for beginning collectors.

Frankie, W. T. 2004. *Guide to rocks and minerals of Illinois.* Illinois State Geological Survey, Urbana, Illinois. Geoscience Education Series 16. 69 pp.
This publication features more than 40 color photographs of Illinois' common rocks and minerals. Sections on how to identify minerals and rocks along with identification keys and flow charts make it an excellent source of information for beginning collectors.

Johnsen, O. 2002. *Minerals of the world: Princeton field guides.* Princeton University Press, Princeton, New Jersey. 440 pp.
A well-illustrated and informative book covering more than 500 minerals. Over 600 color photographs and crystallographic diagrams located next to the text descriptions help with identification.

Killey, M. M. 1998. *Illinois' ice age legacy.* Illinois State Geological Survey, Urbana, Illinois. Educational Series 14. 66 pp.
This book describes the glaciers that moved across Illinois including their history, the deposits they left behind, and how geologists learn about them.

Klein, C. 2001. *Manual of mineralogy* (after James D. Dana). John Wiley and Sons, New York. 656 pp.
This standard college text for mineralogy is a great reference for the advanced collector.

Pough, F. H. and R. T. Peterson. 1998. *Field guide to rocks and minerals.* Houghton Mifflin Company, Boston. 542 pp.
A standard reference for many years, this book is still a great field guide.

Symes, R. F. 2000. *Rocks and minerals: eyewitness books.* DK Publishing, Inc., New York. 64 pp.
A beautifully illustrated book, it is a great resource for generating interest in early collectors.

Symes, R. F. and R. R. Harding. 2000. *Crystal and gem: eyewitness books.* DK Publishing, Inc., New York. 64 pp.
This volume is a well-illustrated resource for beginning collectors.

Zim, H. S. and P. R. Shaffer. 1970. *Rocks and minerals: golden nature guide.* Golden Press, New York. 160 pp.
One of the most popular books for beginners, it is well illustrated with drawings.

Agency Resources

More information about rocks and minerals is available. The Prairie Research Institute's Illinois State Geological Survey researchers study rocks and minerals, maintain research collections, educate the public about these natural resources and offer educator resources. The Illinois Department of Natural Resources' Division of Education, Office of Mines and Minerals and Illinois State Museum also offer educational materials and programs about geological resources.

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